Salinas River
Long-Term Management Plan

February 2019

Monterey County Water Resources Agency
1441 Schilling Place North Building
Salinas, California

State Coastal Conservancy
1515 Clay Street, 10th Floor
Oakland, California

SALINAS RIVER
LONG-TERM MANAGEMENT PLAN

PREPARED FOR:

Monterey County Water Resources Agency
1441 Schilling Place North Building
Salinas, California 93901
(831) 755-4860

State Coastal Conservancy
1515 Clay Street, 10th Floor
Oakland, California 94612
(510) 286-1015

PREPARED BY:

ICF
201 Mission Street, Suite 1500
San Francisco, California 94105
(415) 677-7100

WITH SUPPORT FROM:

Consensus Building Institute
FISHBIO
FlowWest
Geosyntec
Wood Environment &
Infrastructure Solutions, Inc.
Central Coast Wetlands Group
M.Cubed

February 2019

Monterey County Water Resources Agency and California State Coastal Conservancy. 2019. *Salinas River Long-Term Management Plan*. February. Salinas, CA and Oakland, CA. Prepared by ICF, Consensus Building Institute, FISHBIO, FlowWest, Geosyntec, Wood Environment & Infrastructure Solutions, Inc., Central Coast Wetland Group, and M.Cubed.

Acknowledgements

Development of this long-term management plan was made possible with funding provided by the State of California and administered by the State Coastal Conservancy. In-kind contributions were provided by the Monterey County Water Resources Agency and by stakeholders, primarily through participation in the planning group and associated working group meetings.

We would like to extend our thanks and gratitude to the members of the planning group including representatives from the following entities. Note that the listing of these names here does not imply that these entities agree with or support in full the content of the Salinas River Long-Term Management Plan.

- Braga Farms
- California Coastal Commission
- California Department of Fish and Wildlife
- California State University, Monterey Bay
- Central Coast Wetlands Group
- Costa Farms
- County of San Luis Obispo
- Farm Bureau of Monterey County
- Greenfield/Arroyo Seco Groundwater Sustainability Agency
- Grower-Shipper Association of Central California
- Marina Coast Water District Groundwater Sustainability Agency
- Merrill Farms
- Monterey Bay National Marine Sanctuary
- Monterey County Resource Management Agency
- National Marine Fisheries Service
- Ocean Mist Farms
- Rava Ranches
- Regional Water Quality Control Board, Central Coast
- Resource Conservation District of Monterey County
- Salinas River Stream Maintenance Program River Management Unit Association
- Salinas Valley Basin Groundwater Sustainability Agency
- San Bernardo Rancho
- State Coastal Conservancy
- The Nature Conservancy

- The Otter Project
- Trout Unlimited
- U.S. Fish and Wildlife Service
- Upper Salinas-Las Tablas Resource Conservation District

Contents

Tables

Figures

Acronyms and Abbreviations

AF	acre-feet
Agency Act	Monterey County Water Resources Agency Act
Basin Study	WaterSMART Basin Study for the Salinas River Basin
CalFire	California Department of Forestry and Fire Protection
California SWAP	California State Wildlife Action Plan
CASGEM	California Statewide Groundwater Elevation Monitoring Program
CCSE	Central Coast Salmon Enhancement
CCWG	Central Coast Wetlands Group
CDFW	California Department of Fish and Wildlife
cfs	cubic feet per second
CRAM	California Rapid Assessment Method for Wetlands
CSIP	Castroville Seawater Intrusion Project
CSUMB	California State University, Monterey Bay
DWR	California Department of Water Resources
EIR	environmental impact report
EIS	environmental impact statement
ESA	Endangered Species Act
ESNERR	Elkhorn Slough National Estuarine Research Reserve
FEMA	Federal Emergency Management Agency
FMMP	Farmland Mapping and Monitoring Program
FRAP	Fire Resource and Assessment Program
FY	fiscal year
GSAs	Groundwater Sustainability Agencies
GSP	groundwater sustainability plan
HCP	habitat conservation plan
HUC	Hydrologic Unit Code
IPaC	Information, Planning, and Conservation
IRWM	Integrated regional water management
Lagoon	Salinas River Lagoon
LGMA	California Leafy Green Products Handler Marketing Agreement
LOCA	Localized Constructed Analogs
LTMP	Salinas River Long-Term Management Plan
Ma	million years ago
MCWD	Marina Coast Water District
MCWRA	Monterey County Water Resources Agency
MEP	Management and Enhancement Plan
mg/L	milligrams per liter
MRSWMP	Monterey Regional Storm Water Management Program
msl	mean sea level
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council's
NRCS	Natural Resources Conservation Service

NVCS	National Vegetation Classification System
NWS	National Weather Service
OSR	Old Salinas River
RCDMC	Resource Conservation District of Monterey County
RCIS	regional conservation investment strategy
RCP	Representative Concentration Pathway
Rec Ditch	Reclamation Ditch
Regional Water Board	Central Coast Regional Water Quality Control Board
RM	River Mile
RMU	River Management Unit
RMU Association	Salinas River Stream Maintenance Program River Management Unit Association
RMUs	river management units
RWMG	Regional Water Management Group
Sanctuary	Monterey Bay National Marine Sanctuary
SFEI	San Francisco Estuary Institute
SGMA	Sustainable Groundwater Management Act
SMP	Stream Maintenance Program
SRDF	Salinas River Diversion Facility
State Parks	California Department of State Parks
SVA	Salinas Valley Aquitard
SVWP	Salinas Valley Water Project
SWRP	Storm Water Resources Plan
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
USFWS	U.S. Fish and Wildlife Service
WaterSMART	Reclamation's Sustain and Manage America's Resources for Tomorrow

ES.1 Introduction

Chapter 1, *Introduction*, of the *Salinas River Long-Term Management Plan* (LTMP) provides an overview of the need to develop the LTMP, purpose and goals, and the stakeholder engagement process.

The Salinas River—the longest river system on the central coast of California—provides critical ecosystem benefits and supports a multi-billion-dollar regional economy. Fertile soils in its floodplain, a highly favorable climate, and the use of river flows for aquifer recharge and irrigation make this valley one of the most productive agricultural regions in California. However, the successes of the region have also contributed to management challenges. Among these are maintaining stream flows for agriculture and species habitat; controlling periodic flooding and high levels of invasive plants; and dealing with poor water quality, loss of riparian vegetation, encroachment on the stream channel, and ad-hoc bank stabilization.

To help address the complex management challenges on the Salinas River, the Monterey County Water Resources Agency (MCWRA)—a local flood control and water agency with facilities along the river and jurisdiction over water resource management within Monterey County—has developed the LTMP. This multi-benefit management program is intended to serve the needs of MCWRA's facilities and operations; address river management challenges such as flood control, water supply, and water quality; and outline strategies for conserving and managing natural resources, including threatened and endangered species.

ES.1.1 Purpose and Goals

The purpose of the LTMP is to describe a multi-benefit management program that addresses needs related to MCWRA facilities and operations, as well as related issues such as flood risk reduction, water supply, water quality, natural resource conservation, threatened and endangered species management, and federal and state Endangered Species Acts compliance. The LTMP's primary goals are as follows.

- Identify long-term solutions for management of the Salinas River that include flood reduction, water resource management, stream maintenance, and habitat management for threatened and endangered species.
- Investigate the Salinas River Lagoon for the potential of reducing flooding and improving habitat conditions.
- Identify potential improvements to steelhead migration in the Salinas River utilizing management efforts and anticipated future projects.
- Develop the framework for implementing the LTMP that meets a variety of multi-benefit management goals, including implementation of the forthcoming groundwater sustainability plans for the Salinas Valley.
- Build upon and incorporate public/private partnerships, compatible with existing land uses and water rights.

- Document the historical conditions in the Salinas River watershed in Monterey County.
- Describe the existing conditions in the Salinas River watershed in Monterey County—including the physical, biological, and chemical changes in the system over time—and, to the extent possible, the sources driving those changes.

Because operating MCWRA facilities and managing the Salinas River Lagoon may result in incidental "take"[1] of threatened and endangered species, the LTMP will also support the future development of a habitat conservation plan (HCP), a long-term plan that will address affected federally listed species, establish measures for the conservation of species habitat, and serve as part of MCWRA's application for take authorization from authorities. For the HCP to be approved and take authorization granted, MCWRA must prepare an environmental impact report (EIR) that complies with the California Environmental Quality Act (CEQA) and an environmental impact statement (EIS) that complies with the National Environmental Policy Act (NEPA). Accordingly, the LTMP is an important foundational step in the future development of the HCP, EIS, and EIR, as reflected in the LTMP's final goal below.

- Inform development of a future MCWRA HCP and other planning documents.

ES.1.2 Planning Horizon

The LTMP is not subject to a specific (e.g., 20- or 30-year) planning horizon—instead, it is intended to remain flexible to guide both short- and long-term management needs.

ES.1.3 Stakeholder Engagement

Establishing a stakeholder engagement process to inform LTMP development was a critical first step. The stakeholder process was coordinated by MCWRA and its consultants. Engaging technical experts, regulatory agencies, and landowners was essential for developing a successful LTMP; these and other stakeholders, including members of the public, were involved throughout, providing input and influencing its development.

A planning group and topic-specific working groups were formed by MCWRA to organize and focus stakeholder input. The planning group consisted of approximately 30 members representing a wide variety of interests, including conservation organizations, business and development interests, landowners, agricultural interests, open space land-management organizations, and the general public. Among this group's tasks were reviewing technical and policy issues and making recommendations for plan content.

Working groups delved into specific issues to provide insights and guidance to MCWRA, consultants, and the planning group. Groups were formed around four topic areas: the Salinas River Lagoon, stream maintenance, groundwater, and implementation.

MCWRA kept the public informed throughout the planning process by email, establishing and updating the LTMP website, and hosting a public meeting where members of the public could provide input and influence the development of the LTMP. All planning group meetings were open to the public.

[1] *Take*, as defined by the federal Endangered Species Act, means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect any threatened or endangered species.

ES.2 Planning Efforts in the Salinas River Watershed

Chapter 2, *Background*, describes MCWRA's jurisdiction and authorities, water management responsibilities, projects and programs, and related planning activities to provide context for the LTMP.

ES.2.1 Monterey County Water Resources Agency

MCWRA is a flood control and water agency whose mission and approach to water management balances water supply, flood protection, and environmental sensitivity. MCWRA owns and operates a range of flood control, water supply, groundwater augmentation, and hydroelectric facilities. The agency manages flood and stormwater through its operations at the Nacimiento and San Antonio Dams, conserves such waters through percolation and storage, monitors groundwater extraction, and supports groundwater recharge of the Salinas Valley. Under the Monterey County Water Resources Agency Act (Agency Act), MCWRA has jurisdiction over matters pertaining to water and water supply within the Salinas Valley and is authorized to work as a conjunctive-use agency, utilizing both aboveground and belowground storage facilities to ensure water supply reliability.

One of MCWRA's highest priorities is water conservation operations, primarily by maximizing the amount of groundwater recharge into the Salinas Valley aquifers, largely achieved through timely reservoir releases and a reduction in groundwater pumping through the operation of the Salinas River Diversion Facility (SRDF). Management of Nacimiento and San Antonio Dams is focused primarily on the regulated release of water from those reservoirs to maintain Salinas River streamflow to maximize groundwater recharge from the streambed, operate the SRDF, and provide flows for South-Central California Coast steelhead (steelhead). MCWRA also operates both Nacimiento and San Antonio Dams to enhance the recreation benefits of the reservoirs to the extent compatible with release requirements and constraints. When making reservoir releases, however, MCWRA must consider established agreements and permits with other agencies, while still meeting the primary goals of groundwater recharge, SRDF operation, and flows for steelhead.

In addition to water supply operations, MCWRA also operates its two dams to provide for safe conditions for downstream communities. This involves managing reservoir storage to ensure that there is adequate capacity to contain high levels of projected inflow during storm events. MCWRA coordinates maintenance activities along the Salinas River and its tributaries in partnership with and on behalf of landowners through a program known as the Salinas River Stream Maintenance Program (SMP).

ES.2.2 Current Planning Efforts

The following planning efforts—relevant to Salinas River management—are described in Chapter 2.

- Castroville Seawater Intrusion Project
- Central Coast Wetlands Group projects:
    - Moss Landing and Lower Salinas Valley Sea Level Rise Vulnerability Analysis
    - Water Balance and Flood Modeling for the Greater Monterey County Storm Water Resources Plan
    - Old Salinas River Enhancement Project

    - California Rapid Assessment Method for Wetlands of the Salinas River Lagoon
- Greater Monterey County Integrated Regional Water Management Plan
- Greater Monterey County Storm Water Resources Plan
- Groundwater Sustainability Plans:
    - Salinas Valley Basin Groundwater Sustainability Plan
    - Marina Coast Water District Groundwater Sustainability Plan
    - City of Marina Groundwater Sustainability Plan
    - Arroyo Seco Groundwater Sustainability Plan
- Interlake Tunnel and Spillway Modification Project
- Pure Water Monterey
- Resource Conservation District of Monterey County's Salinas Watershed Invasive Nonnative Plant Control and Restoration Program
- Salinas River Lagoon Management and Enhancement Plan
- Salinas River Stream Maintenance Program
- Salinas Valley Water Project
- Transportation Agency of Monterey County's Regional Conservation Investment Strategy
- Upper Salinas–Las Tablas Resource Conservation District's Watershed Resources Inventory
- WaterSMART Basin Study

ES.3 Study Area

Chapter 3, *Historical and Existing Conditions,* describes the historical and existing abiotic and biotic conditions of the LTMP study area, including the physical characteristics, land uses, water uses, and biological resources. Additionally, the chapter summarizes the environmental pressures and stresses on the river hydrology and natural communities within the study area. The geographic scope of this LTMP is limited to the portion of the Salinas River watershed in which MCWRA conducts management activities. This is defined by the outermost boundary of MCWRA's primary zones of benefit (zones of benefit 9, 2B, and 2C), and by all subwatersheds in the Salinas River watershed that have a confluence with the Salinas River at or downstream of the confluence of the Nacimiento River. The study area includes 118 river miles of the Salinas River (69% of the total length of the Salinas River) and many of its primary tributaries: Arroyo Seco, Nacimiento River, San Antonio River, and San Lorenzo Creek.

ES.3.1 Physical Characteristics

ES.3.1.1 Topography, Geology, Soils, and Climate

The topography of the study area is characterized by the high elevations of the Coast Ranges to the west and the Gabilan and Diablo Ranges to the east of the Salinas River, respectively. This central

portion of the Coast Ranges is defined by the Sierra de Salinas and Santa Lucia Mountains. The Gabilan Range and Diablo Range characterize the eastern portion of the study area with elevations over 5,000 feet. The Salinas Valley comprises the lower elevations of the study area. The lowest points include the city of Salinas, portions of the Salinas River such as the SRDF and the Salinas River Lagoon, and the coastal dunes.

The Salinas Valley is underlain by the Salinian tectonic block, a geologic basement terrane consisting of metamorphic and granitic rock of Paleozoic to Mesozoic age. The Salinian Block is bordered on both east and west by tectonic blocks of the Franciscan Complex. The boundaries between these tectonic blocks are large-scale strike-slip faults: the San Andreas Fault Zone on the east, and the Sur-Nacimiento Fault Zone on the west. Millions of years of tectonic activity on these bounding fault systems transported the Salinan block hundreds of miles northward and inserted it between blocks of the Franciscan Complex.

The soils of the study area are derived from the underlying geologic formations, influenced by the historical and current patterns of climate and hydrology. Productive agriculture of the Salinas Valley is supported by deep, dark, fertile soils, such as the Salinas clay loams. The management area is dominated by the following four soil orders: mollisols, entisols, vertisols, and alfisols.

The study area is characterized by a Mediterranean climate with cool wet winters, and warm dry summers. The Pacific Ocean influences the climate close to the coast, where the weather is often overcast or has coastal fog and cool temperatures. The maritime climatic influence dissipates with increasing distance from the ocean. As such, the inland areas are warmer in the summer and colder in winter.

ES.3.1.2 Hydrology and Water Quality

The Salinas River watershed is the largest in the central coast of California draining approximately 4,240 square miles of land in Monterey and San Luis Obispo Counties. In the study area, the Salinas River is approximately 118 miles long and can be roughly divided into three major reaches based on the dominant channel morphology: upper watershed, Salinas River Valley, and the Salinas River Lagoon.

The Salinas River and its valley have a long history of flooding because of the broad valley topography and the flashy hydrology characteristic of the area. As agricultural and urban development in the floodplain has increased over time, the adverse effects of flooding have grown. Flooding along the Salinas River has caused significant damage and economic impacts to the region.

The Salinas Valley Basin is the largest coastal groundwater basin in Central California, and groundwater is a valuable resource for the valley's agriculture-based economy. Although the Salinas River is ultimately the primary water supply for the valley, most of the water used first infiltrates from the Salinas River into the underlying sediments before being extracted for use through groundwater pumping. Therefore, the Salinas Valley Basin serves as a critical reservoir for seasonal water storage, filled by wet season flows and depleted during the dry season when the agricultural water supply demand is greatest. The groundwater reservoir also provides critical storage during multi-year droughts, providing water supply when surface water resources are depleted. Nevertheless, conveyance of groundwater is a slow process. Typical time for groundwater to flow a mile down the valley within the alluvial aquifers is in the range of 10 to 20 years. The local rate of groundwater recharge and the aquifer thickness influence the quantity of available groundwater locally.

Water quality is a measure of the physical, chemical, and biological characteristics of water. The water quality of a stream is controlled by multiple factors, including the chemical and physical nature of streambed material (e.g., erodibility, grain size, rock type) and influences from outside the stream corridor, such as quality of groundwater and upstream runoff that may be recharging the stream system (Monterey County Water Resources Agency 2014).

The U.S. Environmental Protection Agency 303(d) listings that are impairing the beneficial uses for various segments of the Salinas River include: boron, copper, fecal indicator bacteria, mercury, nutrients, other organics, PCBs, pesticides, pH, salinity, temperature, toxicity, turbidity, water benthic community effects, and water temperature (U.S. Environmental Protection Agency 2018).

ES.3.2 Land Use

Agricultural and open space are the primary land use designations in the study area, as shown in Table ES-1, below. When the Salinas River approaches cities and unincorporated communities, the land use changes from agricultural to urban uses more typical of cities and communities, including residential, industrial, resource conservation, and public/quasi-public land uses.

Table ES-1. Area of Land Use Designations in the Study Area

Land Use Designation	Area (acres)	Percent Land Cover
Agricultural	1,046,954	60.6%
Open Space	590,476	34.3%
Urban	77,925	4.5%
Industrial	7,743	0.5%
Commercial	657	0.1%
Total	**1,720,755**	**100%**

Sources: County of Monterey 2018, County of San Luis Obispo 2018, County of San Benito 2015, GreenInfo Network 2016.
Note: The area does not sum to the total study area due to overlaps and gaps in the available source data.

ES.3.3 Biological Resources

ES.3.3.1 Communities and Land Cover Types

The LTMP uses the terms community and land cover type to classify and describe the biological setting of the study area. The term community means land cover types that are grouped together because of similarity in vegetation type, vegetation structure, ecological function, and current land use. The LTMP recognizes three types of communities: natural communities, semi-natural communities, and non-natural communities. Communities are composed of land cover types. Natural communities are an assemblage of species (plant and animal) that co-occur in the same habitat or area and interact through trophic and spatial relationships. Communities are typically characterized by reference to one or more dominant species (Lincoln et al. 1998). The wide range of climatic, topographic, and soil conditions in the study area contribute to the variety and uniqueness of the natural communities present. Ten broad categories of natural communities in the study area are coastal strand and dune, grasslands, shrublands, forests and woodlands, riparian, wetlands,

riverine, marine, estuarine, and aquatic (ponds, lakes). Three other semi-natural or human-made habitats described herein are agriculture, barren, and developed.

ES.3.3.2 Target Species

A total of 17 target species are identified in the LTMP (Table ES-2) and were selected because they met the following criteria.

- Known to occur in the proposed management area.
- Federally or state-listed or have potential to become listed in the foreseeable future.
- Potential to be impacted by MCWRA's proposed project activities.
- Sufficient data exist to adequately evaluate potential species impacts in the study area.
- Potential for beneficial effects to be realized through improved management.

These species are also those most likely to be considered for or included in the future HCP.

Table ES-2. Target Species

Common Name	Scientific Name	Status Federal/ State/Other[a]
South-Central California Coast steelhead	*Oncorhynchus mykiss*	FT/–/–
Tidewater goby	*Eucyclogobius newberryi*	FE/SSC/–
Vernal pool fairy shrimp	*Branchinecta lynchi*	FT/–/–
Arroyo toad	*Anaxyrus californicus*	FE/–/SSC
California red-legged frog	*Rana draytonii*	FT/–/SSC
California tiger salamander	*Ambystoma californiense*	FT/ST/–
Bank swallow	*Riparia ripiaria*	–/ST/–
California least tern	*Sterna antillarum browni*	FE/SE/FP
Least Bell's vireo	*Vireo bellii pusillus*	FE/SE/–
Western snowy plover	*Charadrius alexandrinus nivosus*	FT/–/SSC
Southern sea otter	*Enhydra lutris nereis*	FT/FP/–
San Joaquin kit fox	*Vulpies macrotis mutica*	FE/ST/–
Monterey spineflower	*Chorizanthe pungens* var. *pungens*	FT/–/1B.2
Sand gilia	*Gilia tenuiflora* ssp. *arenaria*	FE/ST/1B.2
Abbott's bush-mallow	*Malacothamnus abbottii*	–/–/1B.1
Davidson's bush-mallow	*Malacothamnus davidsonii*	–/–/1B.2
Santa Lucia purple amole	*Chlorogalum purpureum var. purpureum*	FT/–/1B.1

[a] FE = Federally Endangered; FT = Federally Threatened; SE = State Endangered; ST = State Threatened; FP = State Fully Protected; SSC = State Species of Special Concern; 1B = California Native Plant Society Ranked rare or endangered in California and elsewhere; .1 = seriously endangered in California; .2 = fairly endangered in California.

ES.3.4 Environmental Pressures and Stresses

Changes in natural communities, altered river hydrology, and changes in climate are considered the primary pressures in the study area. Changes in natural communities include habitat loss, fragmentation and degradation, shifting distribution of natural communities, invasive species, and changes to the natural fire regime. Altered river hydrology includes altered flow from diversions and dams, which could degrade water quality in both the Salinas River and the Salinas River Lagoon. Changes in climate include sea level rise, prolonged drought, changes in average rainfall, changes in storm intensity and frequency, and change in summer fog.

ES.4 Management Overview

Chapter 4, *Management Plan*, describes the foundational assumptions, or drivers, that underpin the LTMP and which were developed though significant discussion and collaboration with stakeholders and the public. These drivers helped guide the direction, scope, and development of the LTMP and created the basis for its management objectives and associated actions.

Developing these objectives and actions required considering the important constraints, limitations, key issues, and needs that determine what can and should be achieved—these planning considerations are described in detail and help illustrate the unique environmental, engineering, and economic circumstances of the Salinas River system.

ES.4.1 Management Objectives and Actions

Comprising the management strategy, the LTMP's management objectives and actions—contained in LTMP Table 4-1, *Salinas River LTMP Management Objectives and Actions* and Table 4-2, *Salinas River LTMP Listed Species Objectives and Actions*—outline a comprehensive solution to the complex water resource management challenges along the Salinas River. Management objectives and actions are identified for six categories: general (applying to all of the Salinas River), the Salinas River Lagoon, stream maintenance, water resource management (surface and ground water), habitat and connectivity, and steelhead.

The LTMP's recommended management actions are designed to form a collective approach to river management. It is a goal of the LTMP to, "[d]evelop the framework for implementing the LTMP that meets a variety of multi-benefit management goals…." As such, while a single objective or action may have a relatively limited scope, the intent for LTMP implementation is that suites of management actions be considered and implemented together to meet "a variety of multi-benefit management goals." For example, Lagoon management action A-LAG-3 calls for an evaluation of new engineered solutions for flood management, while A-LAG-11 calls for development of a sandbar management approach that is considerate of listed species habitat. Neither of these actions is proposed to take priority over the other, but rather be implemented in concert to consider multiple approaches to addressing multiple needs. Additionally, the management actions may be adapted over time.

It is important to acknowledge that most management actions will have implications for other actions or future management needs. For example, changes to the flow prescription in support of steelhead connectivity will affect, and have been affecting, management of riparian vegetation and sediment. Construction of new facilities to support flood management are likely to affect listed species and native vegetation communities. Management projects and activities that touch land or

water will have potential effects requiring environmental review (CEQA or NEPA) and regulatory permits.

ES.4.2 Planning Considerations

Development of the management objectives and actions was driven by a variety of important constraints, limitations, key issues, and needs regarding what should be achieved and what is feasible. Planning considerations are not management objectives or actions in and of themselves, but they do greatly inform the management objectives and actions, as well as other aspects of the LTMP, including the implementation framework. In some cases, the recommended management objectives and actions seek to help solve the problems stated in the planning considerations. In other cases, the planning considerations articulate constraints beyond the scope of the LTMP.

The planning considerations listed below were identified by MCWRA, stakeholders, and/or consultants throughout the LTMP development process, and draw from discussions held at four planning group meetings, five working group meetings, one public meeting, various written comments on meeting materials provided by stakeholders following the meetings, and by the LTMP consulting team.

- Opportunities exist for LTMP development.
- Regulations may drive management actions.
- The time is ripe for collaborative implementation.
- Management funding sources are needed.
- Re-think water management facility needs.
- Share the costs and benefits of river management.
- Flooding affects the community.
- Wildlife needs well-connected habitat in good condition.
- Ensure Lagoon sandbar management is multi-benefit.
- What happens to flood flows and reservoir releases?
- The river changes over time.
- There is support for recreation.

ES.5 Implementation

Chapter 5, *Implementation*, provides a discussion of how the LTMP could be implemented. The chapter discusses possible approaches to LTMP implementation administration, funding opportunities, and relationship to other planning efforts in the region, and summarizes regulations that may apply to LTMP management action implementation.

ES.5.1 Implementation Administration

Throughout development of the LTMP, stakeholders emphasized that successful implementation of the LTMP would depend on multiple agencies, organizations, and other stakeholders coming

together to manage the resources of the Salinas River. Because no entity has been identified to coordinate such collaboration, many stakeholders advocate the formation of a regional entity—possibly a special district, joint powers authority, state conservancy, nonprofit organization, or a coalition—that could not only manage the LTMP, but also support other planning efforts in the region. This entity would also serve as a conduit for funding and hold responsibilities for coordinating and/or executing LTMP actions, tracking progress of LTMP implementation, reviewing and revising the LTMP through adaptive management, and retaining and managing all data associated with implementation.

ES.5.2 Funding

Various funding opportunities were suggested by stakeholders, including the following.

- Adopted resolution or annual budgetary funding by the MCWRA Board of Directors and/or County Board of Supervisors.
- Voter-approved (Proposition 218) assessments, taxes, and/or fees.
- Federal, state, and local partnerships.
- Grants.
- Private and nonprofit sources (e.g., foundations, land trusts, The Nature Conservancy, partnering with landowners and growers).
- MCWRA land or other assets to sell or use as collateral to secure a loan.
- Engaging the County of San Luis Obispo for possible contributions.

ES.5.3 Coordination with Other Planning Efforts

Several existing planning efforts are expected to implement many of the management actions identified in the LTMP. Because these other planning efforts have different goals and are being led by different agencies and stakeholders, there is a risk that they may implement management actions inconsistent from this LMTP. Ensuring consistency and coordination with MCWRA's anticipated HCP and regional groundwater sustainability plans, several of which are under development, are primary concerns.

LTMP stakeholders expressed support for embracing partnerships between MCWRA, landowners, growers, and all other parties working toward better management of the Salinas River. Several existing or soon-to-be-adopted programs provide excellent partnership opportunities in implementation of management actions. In addition to groundwater sustainability plan development as noted above, some programs that are likely to present such opportunities include the following.

- Salinas River Stream Maintenance Program.
- Salinas Watershed Invasive Nonnative Plant Control and Restoration Program.
- Greater Monterey County IRWM Plan.
- Greater Monterey County SWRP.

For management actions that achieve similar goals and objectives across multiple plans, partnerships to acquire funding are expected to be particularly compelling and competitive, and are encouraged.

ES.5.4 Regulatory Compliance

Long-term management solutions for the Salinas River, including flood, water resource, and threatened and endangered species management will require compliance with various environmental regulations. These regulations provide for the protection of streams, floodplains, wetland and riparian vegetation, special-status species, and water quality. Laws and regulations commonly associated with ground-disturbing activities and which may apply to LTMP management actions are described.

ES.6 References

County of Monterey. 2018. County of Monterey Open Data. Available at: https://montereycountyopendata-12017-01-13t232948815z-montereyco.opendata.arcgis.com. Accessed: August 2018.

County of San Benito. 2015. San Benito County 2035 General Plan. Available at: http://cosb.us/wp-content/uploads/Adopted-2035-GPU.pdf. Accessed: August 2018.

County of San Luis Obispo. 2018. County of San Luis Obispo Open Data. Available at: http://opendata.slocounty.ca.gov/datasets/general-plan-land-use-designations. Accessed: August 2018.

GreenInfo Network. 2016. California Conservation Easement Database 2016. Available at: http://www.calands.org/uploads/docs/CCED2016.zip. Accessed: August 2018.

Lincoln, R., G. Boxshall, and P. Clark. 1998. A Dictionary of Ecology, Evolution and Systematics. Second Edition. Cambridge University Press, Cambridge, UK.

Monterey County Water Resources Agency. 2014. Salinas River Stream Maintenance Program Revised Final Environmental Impact Report. State Clearing House #2011041066. June. 332 pp. Available at: http://www.co.monterey.ca.us/home/showdocument?id=19196. Accessed April 2018.

U.S. Environmental Protection Agency. 2018. 2014 and 2016 California Integrated Report (Clean Water Act Section 303(d) List and 305(b) Report). Last updated: April 2018. Available at: https://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2014_2016.shtml.

Chapter 1
Introduction

This chapter introduces the Salinas River system and the *Salinas River Long-Term Management Plan* (LTMP) and identifies its purpose, goals, scope, development process, and organization.

The Salinas River provides critical ecosystem benefits and supports a multi-billion dollar regional economy. Key challenges in managing the river and surrounding lands are periodic flooding, streamflow maintenance for agriculture and species habitat, invasive species, poor water quality, loss of riparian vegetation, encroachment on the stream channel, and ad hoc bank stabilization.

Various water management facilities along and near the Salinas River, including the largest dams in Monterey and San Luis Obispo Counties, are operated by the Monterey County Water Resources Agency (MCWRA). MCWRA also serves as the flood control agency for most of Monterey County. In developing the Salinas River LTMP, MCWRA aims to establish comprehensive solutions to the complex water resource management challenges along the Salinas River. Specifically, the purpose of the LTMP is to provide a multi-benefit management program that addresses the needs of MCWRA facilities and operations, while addressing related issues such as flood risk reduction, water supply, water quality, natural resource conservation, threatened and endangered species management, and compliance with the federal and state environmental laws, including Endangered Species Acts.

The geographic scope of this LTMP is limited to the portion of the Salinas River watershed in which MCWRA conducts management activities. Management actions under the LTMP broadly include water supply management, groundwater recharge, flood management, and riverine habitat enhancement and restoration. The LTMP is not subject to a specific (e.g., 20- or 30-year) planning horizon—instead, it is intended to remain flexible to guide both short- and long-term management needs.

Developing the LTMP and establishing a stakeholder engagement process were coordinated efforts by MCWRA and its consultants. Engaging technical experts, regulatory agencies, and landowners was essential for developing a successful LTMP; these and other stakeholders, including members of the public, were involved throughout, providing input and influencing its development.

1.1 Overview

The Salinas River is the longest river system in the central coast of California. Fertile soils in the floodplain, a highly favorable climate, and the use of river flows for aquifer recharge and irrigation make the Salinas Valley one of the most productive agricultural regions in California. Agriculture in the Salinas Valley generates billions of dollars for the regional economy. However, the successes of the region have also led to management challenges. Among these are maintaining stream flows for agriculture and species habitat; controlling periodic flooding; managing invasive species; and addressing impaired water quality, loss of riparian vegetation, encroachment on the stream channel, and ad hoc bank stabilization. All these factors affect the river and its estuary lagoon.

MCWRA is the primary local agency managing water and minimizing flood risk along the Salinas River. MCWRA operates the largest dam in Monterey County (San Antonio Dam) and in San Luis Obispo County (Nacimiento Dam). MCWRA also operates a variety of water management facilities

along and near the Salinas River, and it is the flood control agency for most of Monterey County. Due to the many and growing challenges facing the Salinas River, it is critical that MCWRA successfully manages the water resources along the Salinas River while minimizing flood risk and addressing the needs of threatened and endangered species. Recognizing these challenges, MCWRA conducted several public meetings in 2013 to begin collecting input on how best to manage the river while addressing multi-benefit needs. Key take-aways from these public meetings included strong desires for local control, for a comprehensive approach, and for oversight to be undertaken by an existing agency (Monterey County Water Resources Agency 2013).

The strategy that evolved consisted of developing and implementing a comprehensive, phased approach that encompasses a range of options. An early step in this phased approach was implementing the Salinas River Stream Maintenance Program (SMP) to provide flood reduction benefits and habitat restoration and enhancement to 90 miles of the Salinas River upstream of the Salinas River Lagoon. Partnering with landowners, the Salinas River Channel Coalition, The Nature Conservancy, the Resource Conservation District of Monterey County, and the Grower-Shipper Association of the Central California, the Salinas River SMP was permitted and began implementation in 2014.

MCWRA intends for this LTMP to be the next step in the process of establishing comprehensive solutions to the complex water resource management challenges along the Salinas River. MCWRA has developed this management strategy in collaboration with all interested parties to meet the goals and objectives for the entire system, while maintaining necessary flexibility.

MCWRA prepared the LTMP with funding provided by the State Coastal Conservancy. During LTMP development, MCWRA actively sought input and feedback from a wide range of local stakeholders (Section 1.4, *Preparation Process*) to identify issues and management recommendations that balance protecting the natural resources in the Salinas River watershed for future generations while meeting the water needs of today's communities.

1.2 Purpose and Goals

The purpose of the Salinas River LTMP is to describe a multi-benefit management program that addresses needs related to MCWRA facilities and operations, as well as related issues such as flood risk reduction, water supply, water quality, natural resource conservation, threatened and endangered species management, and federal and state Endangered Species Acts compliance. The LTMP's primary goals are as follows.

- Identify long-term solutions for management of the Salinas River that include flood reduction, water resource management, stream maintenance, and habitat management for threatened and endangered species.
- Investigate the Salinas River Lagoon for the potential of reducing flooding and improving habitat conditions.
- Identify potential improvements to steelhead migration issues in the Salinas River utilizing management efforts and anticipated future projects.
- Develop the framework for implementing the LTMP that meets a variety of multi-benefit management goals, including implementation of the forthcoming groundwater sustainability plans for the Salinas Valley.

- Build upon and incorporate public/private partnerships, compatible with existing land uses and water rights.
- Document the historical conditions in the Salinas River watershed in Monterey County.
- Describe the existing conditions in the Salinas River watershed in Monterey County—including the physical, biological, and chemical changes in the system over time, and, to the extent possible, the sources driving those changes.
- Inform development of a future MCWRA habitat conservation plan (HCP) and other planning documents.

MCWRA has several facilities in or near the Salinas River in areas where threatened or endangered species listed under the federal Endangered Species Act of 1973 (ESA) may be present. The operations and maintenance of those facilities may affect species listed under ESA and, therefore, necessitate the need for *take* coverage (see Appendix A, *Glossary*). Authorization for take can be accomplished in two different ways under ESA; through a federal nexus under Section 7 or by a nonfederal entity under Section 10. MCWRA currently has Section 7 biological opinions and associated incidental take statements but is anticipating preparing an HCP to provide broader, longer-range coverage under Section 10. The historical and existing conditions of the Salinas River, together with identified management and implementation opportunities (see Chapter 4, *Management Plan*, and Chapter 5, *Implementation*), are intended to substantially inform development of the HCP.

This LTMP supports the future development of an HCP and accompanying California Environmental Quality Act and National Environmental Policy Act documentation (environmental impact report and environmental impact statement, respectively). However, this LTMP is not a regulatory document and will not result in regulatory permits. Similarly, the LTMP does not authorize any projects undertaken by MCWRA, partner agencies, or stakeholders. The LTMP is intended to inform how future projects are designed or implemented.

1.3 Scope

The following sections describe the framework of the LTMP: geographic scope, water resource management activities considered, and planning horizon.

1.3.1 Geographic Scope

The Salinas River originates in the center of San Luis Obispo County and flows 184 miles north and northwest to Monterey Bay, about 80 miles south of San Francisco. The Salinas River watershed[1] is one of the largest in California (Figure 1-1). The mainstem Salinas River originates in San Luis Obispo County in the La Panza Range in the Los Padres National Forest and drains 4,240 square miles, from Santa Margarita Lake at an elevation of 2,400 feet, to Monterey Bay and the Pacific Ocean. The Salinas River watershed is more than twice the size of any other central California coastal river system from San Mateo to Santa Barbara (Monterey County Water Resources Agency 2014). Major tributaries to the Salinas River are the Nacimiento, San Antonio and Arroyo Seco Rivers, and San Lorenzo Creek.

[1] As defined by the U.S. Geologic Survey hydrologic unit code (HUC)-8 boundary (cataloging unit 18060005).

Figure 1-1. Regional Location

The geographic scope of this LTMP is limited to the portion of the Salinas River watershed in which MCWRA conducts management activities. The LTMP defines a *management area* and a *study area*. To define the *management area*, MCWRA first mapped the combined outermost boundary of MCWRA's primary zones of benefit (zones of benefit 9, 2B, and 2C) within the Salinas Valley, together with the seven River Management Units defined by MCWRA's Salinas River SMP (Figure 1-2). Collectively, these boundaries encompass the location of MCWRA's current operational activities in the Salinas River watershed. Next, the management area was extended into San Luis Obispo County to include the channel of the Nacimiento River (where MCWRA manages flows from the Nacimiento Dam), the surface of Nacimiento Reservoir, and lands owned by MCWRA in San Luis Obispo County. Finally, the edges of the management area were refined to exclude small noncontiguous areas within MCWRA's zones of benefit where MCWRA does not conduct management activities (e.g., the portion of zone of benefit 2C just north of Stonewall Creek). The LTMP management area is shown in Figure 1-3.

The northwestern edge of the management area is defined primarily by zone of benefit 2B and includes Salinas River State Beach, Salinas River Lagoon, the Old Salinas River, and a portion of Moro Cojo Slough State Marine Reserve. The central portion of the management area includes zone of benefit 2C and encompasses the cities and surrounding agricultural lands of Salinas, Spreckels, Chualar, Gonzales, Soledad, Greenfield, King City, San Lucas, and San Ardo. The southern section of the management area is defined by zone of benefit 2C, extending south to the county line, and includes Bradley and San Miguel, as well as San Antonio Reservoir.

Because this LTMP also addresses natural resources associated with the Salinas River, it was important to consider other areas within the Salinas River watershed in Monterey County that may affect, or be affected by, the management actions proposed in this LTMP. Using a watershed approach, MCWRA defined a larger LTMP study area including all U.S. Geological Survey Hydrologic Unit Code (HUC)-10 watersheds where the HUC-10 watersheds have a confluence with the Salinas River at or downstream of the confluence of the Nacimiento River. The LTMP study area is defined as the management area, plus all associated watersheds. The study area defines the geographic extent of resource planning described in this LTMP.

The study area lies primarily within Monterey County, with some portions in north San Luis Obispo County and western San Benito County (Figure 1-3). Table 1-1 shows the proportion of the study area located within each county. The study area includes approximately 118 river miles of the Salinas River (67% of the total length of the Salinas River) as well as all of the Nacimiento, San Antonio, and Arroyo Seco watersheds.

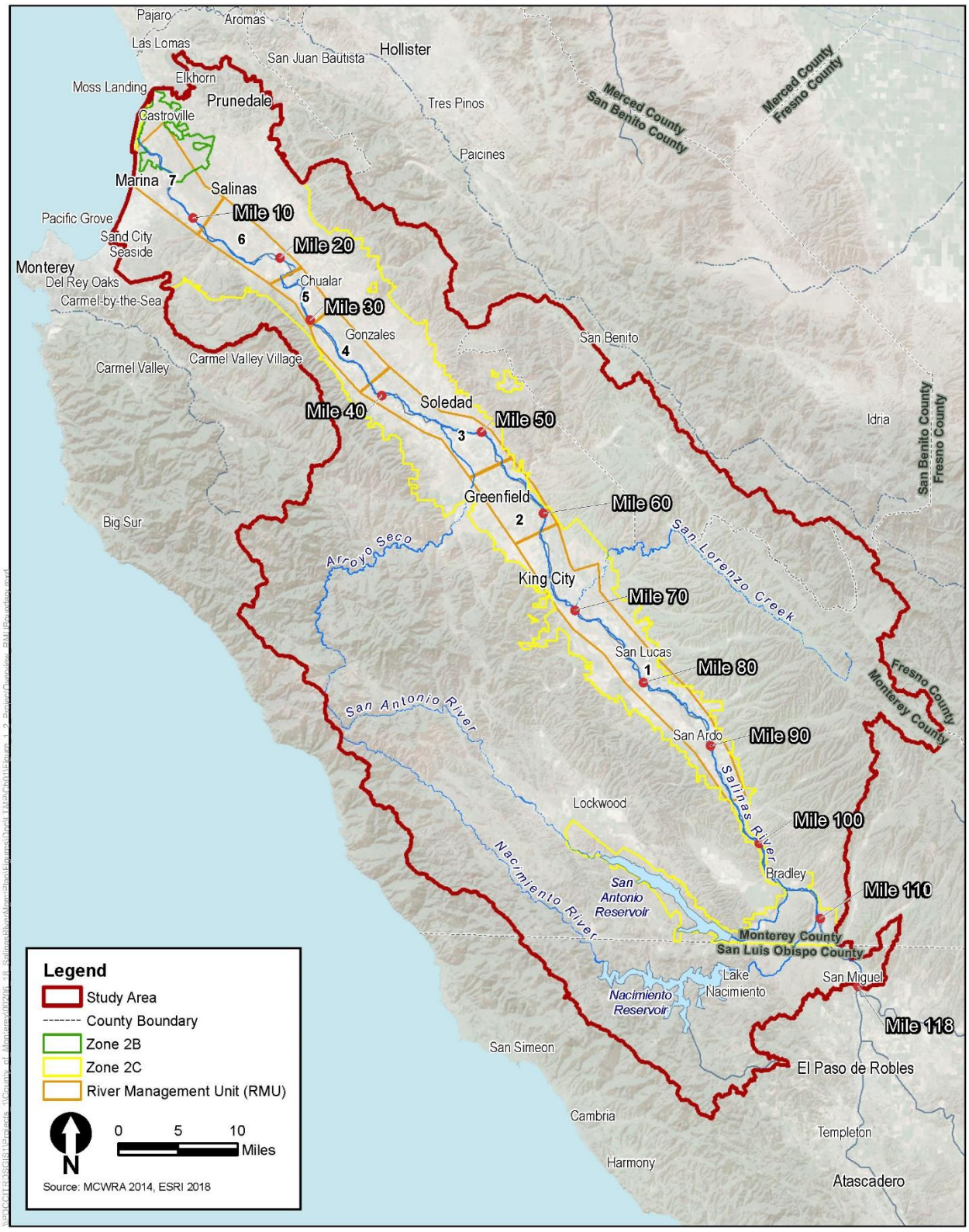


Figure 1-2. MCWRA Zones of Benefit and River Management Units

Figure 1-3. Study Area and Management Area Boundaries

Table 1-1. Acreage of Study Area by County

County Name	Study Area (acres)	Total County Size (acres)	% of County within Study Area
Monterey	1,447,994	2,120,907	68
San Luis Obispo	144,222	2,125,567	7
San Benito	146,435	889,358	16
Total	**1,738,671**[a]	**--**	**--**

[a] Total study area acreage does not round precisely due to Geographic Information System mapping differences in county boundaries vs. watershed boundaries. These differences result in a 20-acre discrepancy along the Monterey County and Fresno County border in the southeastern section of the study area.

The northwestern portion of the study area encompasses the entirety of the management area. The western half of the study area also includes the Santa Lucia Mountains, and the Arroyo Seco, Nacimiento, and San Antonio watersheds. The eastern section reaches into the Gabilan Range and its associated watersheds including the Chalone, San Lorenzo, and Sargent Creeks. The southernmost portion of the study area is characterized by lands owned by MCWRA in San Luis Obispo County along Nacimiento Reservoir and the Nacimiento River, which flows into the Salinas River just north of the county line (Figure 1-3).

1.3.2 Water Resource Management Activities Considered

The LTMP focuses on water resource management actions undertaken by MCWRA and other parties that may have an effect on how the Salinas River is managed. The management actions broadly include water supply management, groundwater recharge, flood management, and riverine habitat restoration. The LTMP also considers those natural resources related to the river, including wetland and riparian habitats and the species that rely on them, with particular consideration given to listed species that are known to rely on the Salinas River, such as South-Central California Coast steelhead (*Oncorhynchus mykiss*). Section 2.4.2, *MCWRA Partnership Projects and Programs*, describes a number of other projects and programs undertaken by MCWRA either as the lead or through a partnership that may have implications for this LTMP. These projects include operations and maintenance as well as capital projects and targeted studies, and form the basis of the actions considered in this LTMP in the context of long-term management needs and considerations for the Salinas River.

1.3.3 Planning Horizon

This LTMP was not developed for a specific (e.g., 20- or 30-year) timeframe. Rather, it contemplates the long-term management needs of the Salinas River within the LTMP management area. As described in Chapter 2, *Background*, such needs relate to programs and projects that are being implemented currently and will be well into the future. For example, the Salinas River SMP is in year 3 of a 5-year U.S. Army Corps of Engineers permit; however, MCWRA expects that the Salinas River SMP will be active for decades to come. This LTMP is intended to be flexible in considering management—as well as implementation—needs in both the short and long term.

1.4 Preparation Process

The planning process for the LTMP began in 2017 when MCWRA received funding from the State Coastal Conservancy. On June 19, 2017, MCWRA secured approval from its own Board of Directors to develop an HCP, with the LTMP as a first step in that process. MCWRA staff secured approval for the same actions from the MCWRA Board of Supervisors on August 29, 2017. In April 2018, after a public bid process, MCWRA selected a consulting team to prepare the LTMP. MCWRA and its Board of Directors, with coordination and support from MCWRA's senior managers, has led development of this LTMP. As part of this work, MCWRA established a robust process for gaining review and feedback from a number of technical experts and stakeholders. This section contains details regarding the LTMP development partners, as well as the planning and working groups.

1.4.1 LTMP Consulting Team

Developing the LTMP document and establishing a stakeholder engagement process were coordinated efforts by MCWRA and its team of consultants. The consulting team, led by ICF, consisted of scientific, planning, legal, and other technical staff. The members of the consulting team, along with the general responsibilities of each member, are as follows.

- ICF (San Jose and San Francisco): LTMP development lead and general public outreach.
- Central Coast Wetlands Group (Moss Landing): Stormwater management planning and extensive scientific research related to the lower Salinas River and Reclamation Ditch watershed.
- Consensus Building Institute (San Francisco): Stakeholder issue assessment, working and planning group facilitation.
- FISHBIO (Chico and Oakdale): Fish resources expertise and strategic planning.
- FlowWest (Oakland): Surface water hydrology expertise and strategic planning.
- Geosyntec (Oakland): Groundwater resources expertise and strategic planning.
- M.Cubed (Oakland): Policy analysis and financial planning.
- Wood Environment & Infrastructure Solutions (Oakland): Water resources expertise and strategic planning.

1.4.2 Stakeholder Engagement and Participation

Engaging technical experts, regulatory agencies, landowners, and other stakeholders was an integral part of the process of developing this LTMP. At the outset of LTMP development, the Consensus Building Institute conducted a stakeholder issue assessment. The purpose of the assessment was to understand the histories, perspectives, and opinions of a range of stakeholder interests. The Consensus Building Institute compiled the findings (without attribution to the interviewee) in a findings and recommendations report (Appendix B, *Salinas River Long-Term Management Plan Stakeholder Issues Assessment Report*), and the outcomes of the assessment were used to inform the content and development process of the LTMP. After the initial issue assessment interviews, stakeholders and members of the public were actively involved throughout the planning process and had opportunities to provide their input and influence the development of the LTMP. The Consensus Building Institute developed a communication and engagement plan to support active

engagement, deepen understanding of the LTMP development, and create transparency about plan development across the Salinas Valley.

A planning group and topic-specific working groups were formed by MCWRA, with support and facilitation by the Consensus Building Institute, to organize and focus stakeholder input.

1.4.2.1 Planning Group

The planning group consisted of approximately 30 members representing a wide variety of interests, including conservation organizations, business and development interests, landowners, agricultural interests, open space land-management organizations, and the general public. The planning group met four times between August 2018 and January 2019. The meetings were open to the public to promote transparency. The purpose of this group was to create a highly informed group of stakeholders to engage in a joint fact-finding processes (framing key questions and developing a high level of understanding of the planning process opportunities and technical approaches), and to advance the planning process in the larger communities among stakeholders. The planning group reviewed technical and policy issues and made recommendations to MCWRA. Organizations that agreed to serve on the planning group are as follows.

Regulatory Agencies

- California Coastal Commission
- California Department of Fish and Wildlife
- National Marine Fisheries Service
- Regional Water Quality Control Board, Central Coast
- U.S. Fish and Wildlife Service

Scientists and Interest Groups

- California State University, Monterey Bay
- Central Coast Wetlands Group
- Monterey Bay National Marine Sanctuary
- Resource Conservation District of Monterey County
- The Nature Conservancy
- The Otter Project
- Trout Unlimited
- Upper Salinas-Las Tablas Resource Conservation District

Agricultural Representatives and Landowners

- Braga Farms
- Costa Farms
- Farm Bureau of Monterey County
- Grower-Shipper Association of Central California

- Merrill Farms
- Ocean Mist Farms
- Rava Ranches
- Salinas River Stream Maintenance Program River Management Unit Association
- San Bernardo Rancho

Water Resource Management

- Greenfield/Arroyo Seco Groundwater Sustainability Agency
- Marina Coast Water District Groundwater Sustainability Agency
- MCWRA
- Monterey County Resource Management Agency
- Salinas Valley Basin Groundwater Sustainability Agency

Other

- San Luis Obispo County
- State Coastal Conservancy

1.4.2.2 Working Groups

Working groups were developed to delve into specific issues to provide insights and guidance to MCWRA, consultants, and the planning group. Working groups provided feedback on technical and scientific information and advised on LTMP development from technical, scientific, political, socioeconomic, and funding viewpoints. Working groups met as needed per recommendations of MCWRA, the consultants, or the planning group. Working group meetings sought consensus on recommendations for planning group consideration; when consensus was not attainable, all views were reported to MCWRA and the consultants. Working group members included experts from a range of disciplines that may or may not have been active in other aspects of the LTMP planning process. Four working groups met during LTMP development: lagoon management, stream maintenance, LTMP implementation, and groundwater. These working groups helped develop LTMP objectives and actions to ensure alignment with, and support of, related efforts.

1.4.2.3 Public Outreach Program

In addition to the groups identified previously, MCWRA developed a public outreach program targeted at the general public. The public was kept abreast throughout the planning process via email and website updates, and had the following opportunities to provide input and influence the development of the LTMP.

- One public meeting was hosted by MCWRA and held at MCWA's headquarters on June 20, 2018.
- The public was invited to attend planning group meetings.

In addition, MCWRA established a website for the LTMP: http://salinasrivermanagmentprogram.org. Public meeting notices, meeting materials, meeting summaries, and other LTMP informational items were posted to the website. Additionally,

individuals could submit a request through the website to be added to the email distribution. The Consensus Building Institute managed the LTMP interested persons list to directly send email updates. The list was broad and included anyone who wanted to stay informed about LTMP activities and anyone who the planning group or working groups thought should be informed about LTMP development.

1.5 Document Organization

This LTMP and its supporting information are presented in the following chapters and appendices.

- Chapter 1, *Introduction,* discusses the purpose, objectives, scope, and preparation process of the LTMP.
- Chapter 2, *Background,* describes MCWRA's mission, project activities, as well as the current regulatory setting.
- Chapter 3, *Historical and Existing Conditions,* describes the historical and existing conditions of the study area relevant to the LTMP.
- Chapter 4, *Management Plan,* identifies the management planning considerations raised throughout LTMP development, along with the potential management and project design strategies that will guide MCWRA towards long-term conservation solutions.
- Chapter 5, *Implementation,* offers options on how best to implement the LTMP.
- Chapter 6, *References,* lists the references cited in the LTMP by chapter.
- Appendix A, *Glossary*.
- Appendix B, *Salinas River Long-Term Management Plan Stakeholder Issues Assessment Report*.
- Appendix C, *Watersheds in the Study Area*.
- Appendix D, *Community and Land Cover Mapping Methods*.
- Appendix E, *Special-Status Species Potential to Occur Tables*.
- Appendix F, *Species Accounts*.
- Appendix G, *Data Collection and Data Gap Assessment*.
- Appendix H, *Regulatory Context*.
- Appendix I, *Grant Opportunities*.

Chapter 2
Background

This chapter describes the Monterey County Water Resources Agency's (MCWRA's) jurisdiction and authorities, water management responsibilities, projects and programs, and related planning activities to provide context for the *Salinas River Long-Term Management Plan* (LTMP).

MCWRA is a flood control and water agency whose mission and approach to water management balances water supply, flood protection, and environmental sensitivity. MCWRA owns and operates a range of flood control, water supply, groundwater augmentation, and hydroelectric facilities. The agency manages flood and stormwater through its operations at the Nacimiento and San Antonio Dams, conserves such waters through percolation and storage, monitors groundwater extraction, and supports groundwater recharge of the Salinas Valley. Under the Monterey County Water Resources Agency Act (Agency Act), MCWRA has jurisdiction over matters pertaining to water and water supply within the Salinas Valley and is authorized to work as a conjunctive-use agency, utilizing both aboveground and belowground storage facilities to ensure water supply reliability (Section 2.2, *Jurisdiction and Funding Mechanisms*).

One of MCWRA's highest priorities is water conservation operations, primarily by maximizing the amount of groundwater recharge into the Salinas Valley aquifers, largely achieved through timely reservoir releases and a reduction in groundwater pumping through the operation of the Salinas River Diversion Facility (SRDF) (Section 2.3.1.1, *Reservoirs*). As described in Section 2.3.1.2, *Groundwater Recharge*, management of Nacimiento and San Antonio Dams is now focused primarily on the regulated release of water from those reservoirs to maintain Salinas River streamflow to maximize groundwater recharge from the streambed, operate the SRDF, and provide flows for steelhead. MCWRA also operates both Nacimiento and San Antonio Dams to enhance the recreation benefits of the reservoirs to the extent compatible with release requirements and constraints. When making reservoir releases, however, MCWRA must consider established agreements and permits with other agencies, while still meeting the primary goals of groundwater recharge, SRDF operation, and flows for steelhead.

In addition to water supply operations, MCWRA also operates its two dams to provide for safe conditions for downstream communities (Section 2.3.2, *Flood Management*). This involves managing reservoir storage to ensure that there is adequate capacity to contain high levels of projected inflow during storm events. MCWRA coordinates maintenance activities along the Salinas River and its tributaries in partnership with and on behalf of landowners through a program known as the Salinas River Stream Maintenance Program (SMP).

MCWRA is implementing or involved in multiple projects and programs that may be relevant to short- and long-term management needs of the Salinas River in the LTMP study area, as described in Section 2.4, *MCWRA Projects and Programs*. In addition, there are several current research and planning efforts that are expected to have some bearing on how the Salinas River is managed in the long-term, which are described in Section 2.5, *Other Applicable Planning Efforts*.

2.1 Monterey County Water Resources Agency Mission

The mission of MCWRA is to manage, protect, store and conserve water resources in Monterey County for beneficial and environmental use, while minimizing damage from flooding to create a safe and sustainable water supply for present and future generations. This mission reflects MCWRA's current approach to water management that balances water supply, flood protection, and environmental sensitivity. MCWRA developed and implements several long-term programs to achieve its mission, including the Salinas River SMP and the Salinas Valley Water Project (SVWP).

2.2 Jurisdiction and Funding Mechanisms

MCWRA was formed in 1947 as the Monterey County Flood Control and Water Conservation District. In 1990, MCWRA's name was changed under the Agency Act. The Agency Act established MCWRA as a flood control and water agency and defines the authorities of MCWRA. These authorities include the following as necessary and proper to carry out the Agency Act.

- Establish zones within which MCWRA may institute projects with specific benefits for the zone.
- Amend zones, including elimination of zones, pending certain circumstances.
- Acquire, use, exchange, transport, or sell property of every kind, including water.
- Construct, repair, remove, or otherwise improve any work as authorized by the Agency Act.
- Store water in surface or underground reservoirs.
- Appropriate, conserve, or reclaim water.
- Act on behalf of landowners regarding water or water rights.
- Prevent unlawful exportation of water.
- Prevent degradation of water quality.
- Control flood and stormwater.
- Incur indebtedness and issue bonds.
- Levy taxes or assessments.
- Construct, maintain, improve, and operate public recreational facilities on reservoirs managed by MCWRA.
- Require the installation of flow meters on groundwater extraction facilities and water distribution system service connections in Monterey County for the purpose of collecting data or facilitating development of water management plans.

While MCWRA has broad authority under the Agency Act, it has not historically utilized all of its authorities.

MCWRA owns and/or operates a range of flood control, water supply, groundwater augmentation, and hydroelectric facilities. These include the Nacimiento and San Antonio Dams and Reservoirs, the Nacimiento Dam hydroelectric plant, the SRDF, the Castroville Seawater Intrusion Project (CSIP) and

the Salinas Valley Recycling Project. Descriptions of these and other projects and programs operated by MCWRA are provided in Section 2.4, *MCWRA Projects and Programs*, unless otherwise noted.

MCWRA is authorized to incur indebtedness, issue bonds, and levy and collect taxes or assessments in order to pay any obligations and carry out the purposes of its authorizing legislation. Revenues of MCWRA are comprised of multiple sources, which currently include the following sources.

1. Property assessments.
2. Ad valorem property taxes.
3. Water delivery service charges.
4. Hydroelectric sales.
5. Miscellaneous fees and income.
6. Grants from governmental and non-governmental entities.

The first five of these revenue sources represent relatively certain and long-term sources of revenue for MCWRA. Grants provide a much less certain and temporary source of revenue for MCWRA that may significantly fluctuate year to year.

Property assessments are the main source of revenue for MCWRA and, based on its proposed fiscal year (FY) 2018–19 budget, are projected to comprise 61% of MCWRA revenues this fiscal year (Raftelis Financial Consultants 2017). Grants are currently MCWRA's second largest source of revenue, constituting approximately 20% of projected MCWRA revenue in FY 2018–19. This is in part the result of the award of a $10 million grant for the Interlake Tunnel Project from the California Department of Water Resources (DWR) under Proposition 84. Historically, grant revenue has composed a much smaller share of MCWRA's total revenue. The remaining revenue sources are each less than 10% of the total, as shown in Table 2-1.

Table 2-1. FY 2018–19 MCWRA Revenue by Source

Revenue Source	Amount ($M)	% of Total
Long-Term Sources		
Property Assessments	15.2	61
Ad Valorem Property Taxes	1.9	8
Water Delivery Service Charges	1.1	5
Miscellaneous Fees & Income	1.1	4
Hydroelectric Sales	0.6	2
Temporary Sources		
Grants	5.1	20
Total	**25.0**	**100**

Source: Raftelis Financial Consultants 2017.

Property assessment revenue, MCWRA's principal source of income, is dedicated to the repayment of costs of specific projects or services that confer special benefits to the assessed properties. Each area in which groups of properties are assessed based on a given MCWRA project or service is called a *zone of benefit*. This revenue source must be used by MCWRA for the provision of identified special benefits and is therefore not general purpose revenue available to MCWRA for discretionary

purposes.[1] The majority of property assessment revenue (58%) is dedicated to the payment of operating and debt service costs for the Salinas Valley Recycling Projects, which are co-operated with Monterey County's regional wastewater agency, Monterey Regional Water Pollution Control Agency (now known as Monterey One Water). Approximately 34% of property assessment revenue is dedicated to the payment of flood control project costs. The remaining 8% is dedicated to repayment of construction and debt service costs of the SVWP.

MCWRA's property assessments are subject to Proposition 218, passed by California voters in 1996. Proposition 218 amended the California Constitution to require that all new or increased property assessments (as well as taxes and fees) follow prescribed assessment calculation and election requirements. As noted previously, property assessments can only be used for projects or services that confer special benefits to the properties assessed (i.e., zones of benefit). They cannot be used to pay for projects or services (or the subcomponents of these projects) that provide general public benefits. Additionally, Proposition 218 requires that the assessments be set so that they are proportional to the special benefits received by each property owner. Lastly, new or increased property assessments are subject to the approval of assessed property owners. The assessment may be imposed only if 50% or more of the ballots, weighted by assessed value, support the assessment.

Prior to Proposition 218, the burden of proof in a court proceeding to demonstrate that a fee or assessment was illegal rested with the plaintiff. Proposition 218 changed this so that the burden of proof now rests with the local government that imposed the fee or assessment. Proposition 218 also gives local residents the power to repeal or reduce any local tax, assessment, or fee through the initiative process.

The overall consequence of Proposition 218 has made adopting new assessments and increasing existing assessments by MCWRA far more difficult, expensive, and uncertain. It has also sharply restricted the discretionary use of assessment revenue by MCWRA and made it harder to accommodate unanticipated project costs.

This is especially pertinent to MCWRA in relation to the SVWP. Voters approved assessments to fund the SVWP in 2003. However, since the time these assessments were approved, MCWRA has incurred significant and unanticipated environmental monitoring and compliance costs and dam maintenance costs related to the project that are above and beyond the costs covered by the original assessments.[2]

Overall, MCWRA is currently operating with a structural budget deficit, meaning that its ongoing expenditures exceed its ongoing revenues. Historically, MCWRA has filled these funding gaps by drawing on its reserves or seeking supplemental funding through grants.[3] The goal of MCWRA is to eliminate its structural budget deficit through a combination of cost control and revenue enhancement. In the near term, MCWRA is reducing staffing levels and deferring maintenance and

[1] As defined by Article XIIID (Proposition 218) of the California Constitution, a special benefit is a particular benefit accruing to land and buildings, not a general benefit to the public or a general increase in property values. If a project or service would not provide such a special benefit, Proposition 218 states that it may not be financed by an assessment.

[2] Capital replacement and maintenance costs identified for the Nacimiento Dam total more than $6.2 million, of which $4.3 million are improvements that have been ordered by the Federal Energy Regulatory Commission or the Division of Safety of Dams. Capital replacement and maintenance costs identified for the San Antonio Dam total more than $8.3 million, of which $7.0 million are improvements that have been ordered by the Division of Safety of Dams.

[3] Statutorily, MCWRA is required to balance its budget, which it has traditionally done through use of reserves.

capital improvement projects. For example, MCWRA staff has been reduced by 16% in the last 4 years (FY 2013–14 to 2016–17). In another example, MCWRA's FY 2018–19 budget assumes the deferral of approximately $6 million in maintenance and capital improvements for the Salinas Valley Recycling Projects. These financial challenges and limited sources of predictable revenue illustrate some of the limitations facing MCWRA in leading comprehensive management of the Salinas River. In the longer term, MCWRA will need to develop new revenue sources in order to fund ongoing operations and maintenance, environmental compliance, and capital replacement costs. MCWRA will also need to secure a consistent funding source to implement the habitat conservation plan it anticipates developing following this LTMP.

2.3 Water Resource Management

MCWRA manages flood and stormwater through its operations at the Nacimiento and San Antonio Dams, conserves such waters through percolation and storage, monitors groundwater extraction, supports groundwater recharge of the Salinas Valley, and provides water to the agricultural and industrial communities of the Salinas Valley. Details on how MCWRA currently manages water resources in its jurisdiction are outlined in the following sections.

2.3.1 Water Supply Operations

MCWRA has jurisdiction over matters pertaining to water and water supply within Salinas Valley, including the northern and central sections of the Salinas River watershed and portions of the Gabilan/Tembladero and Moro Cojo watersheds. MCWRA is authorized to conserve water in any manner; to buy, sell, and purvey water; and to prevent the waste or diminution of the water extractions that are determined to be harmful to the groundwater basin (i.e., subsurface flows). Through this authorization, MCWRA works as a conjunctive-use agency utilizing both aboveground (reservoirs and diversions) and belowground (aquifer) storage facilities to ensure water supply reliability. Conjunctive use typically entails reservoir releases to groundwater recharge areas—which are either on-channel (i.e., in a natural streambed) or off-channel—where water percolates into the aquifer and is stored for later extraction. This conjunctive use strategy involves managing the available water resources and supply distribution system to meet ongoing demand for water from a variety of local and regional agricultural users (including water availability for irrigation during the growing season), as well as filling the reservoirs during the wet season.

One of MCWRA's highest priorities is water conservation operations, primarily by maximizing the amount of groundwater recharge into the Salinas Valley aquifers. MCWRA accomplishes this through timely reservoir releases and the operation of the SRDF (Monterey County Water Resources Agency 2018a). By storing winter inflow to Nacimiento and San Antonio Reservoirs, water is available for release during the irrigation season (April to October). Water is released from the dams into the Salinas River, where it flows downstream or is recharged into the aquifer from the river bed and its immediate floodplain. Groundwater is the main source of irrigation for the surrounding agricultural fields. As water flows northwest along the valley floor, MCWRA monitors river flow levels using several U.S. Geological Survey streamflow gages located along the mainstem of the Salinas River from Bradley to Spreckels (Figures 2-1a and 2-1b). These real-time data allow MCWRA to manage reservoir releases as well as operations at the SRDF throughout the year. The SRDF can only be operated between April 1 and October 31 to impound Salinas River flow and mix it with tertiary-treated recycled water at the regional wastewater treatment plant for distribution to growers in lieu of groundwater pumping in the CSIP area.

Figure 2-1a. Water Management Facilities on the Lower Salinas River

Figure 2-1b. Water Management Facilities on the Upper Salinas River

When making reservoir releases, MCWRA must consider established agreements and permits, while still meeting the primary goals of groundwater recharge and SRDF operation. For example, MCWRA developed a flow prescription to improve habitat for steelhead trout in the Salinas River as component of its federal Endangered Species Act permit issued by National Marine Fisheries Service (NMFS). When specific conditions are met, MCWRA provides releases from the reservoirs to enhance upstream or downstream passage conditions for migrating steelhead as well as maintain prescribed flows for spawning and rearing habitat in the Nacimiento River downstream of Nacimiento Dam.

2.3.1.1 Reservoirs

Water Releases

The highest priority of MCWRA's water conservation operations is to maximize the amount of groundwater recharge in the Salinas Valley aquifers through reservoir water releases and the operation of the SRDF. This is accomplished by storing winter inflow to Nacimiento and San Antonio Reservoirs so that water is available for release during the irrigation season. It is intended that reservoir releases be made in accordance with existing regulations and agreements in a manner that reduces impacts on both fish and recreation, while still meeting the primary goals of groundwater recharge and SRDF operation (Monterey County Water Resources Agency 2018a).

The average annual inflow into Nacimiento Reservoir between water years 1959 and 2015 was approximately 198,000 acre-feet (AF) per water year, which is approximately three times the average inflow to nearby San Antonio Reservoir. Total Nacimiento Reservoir releases for all purposes between water years 1959 and 2015 averaged approximately 191,000 AF per water year, of which an average of approximately 119,000 per water year was released for groundwater recharge and SRDF operations. Reservoir release averages between water years 1959 and 2015 were influenced by periods of different operational strategies that may not reflect current or future operations (Monterey County Water Resources Agency 2018a).

Releases may be made following the cessation of natural flow or to supplement natural flow for groundwater recharge (conservation releases) or SRDF operations. Impoundment of water at the SRDF can begin as early as April 1 and continue through October 31. As required by the NMFS biological opinion and detailed in MCWRA's flow prescription, the MCWRA will maintain flow to the Salinas River Lagoon during conservation releases or when the SRDF is operating (Monterey County Water Resources Agency 2005).

Recreation

Recreational use of the two reservoirs includes boating, swimming, fishing, and camping. These uses are managed by the Monterey County Resource Management Agency at both Nacimiento and San Antonio Reservoirs. MCWRA operates both dams to enhance the recreation benefits of the reservoirs to the extent compatible with release requirements and constraints. For example, to minimize the impact of reservoir releases on reservoir levels during peak recreational periods, MCWRA will, to the extent possible, adjust reservoir releases to equalize the rate of decline in elevation between both reservoirs during periods of highest recreational uses (e.g., Memorial Day weekend, 4th of July, and Labor Day weekend)(Monterey County Water Resources Agency 2018a).

2.3.1.2 Groundwater Recharge

An estimated 95% of all water used in Monterey County is derived from groundwater wells. With nearly 200,000 acres of land under cultivation in the Salinas Valley, agricultural pumping exceeds 495,000 AF per year. Combined with urban and other uses, total water pumped in the Salinas Valley is approximately 520,000 AF per year (Monterey County Water Resources Agency 2018b). Ensuring that there are sufficient quantities of good quality groundwater is the most important aspect of managing water resources in Monterey County today.

Prior to 1957, groundwater recharge in the valley occurred from a combination of precipitation, streamflow, and irrigation. After construction of Nacimiento Dam (in 1957) and San Antonio Dam (in 1967), MCWRA had the ability to actively manage groundwater recharge. Management of Nacimiento and San Antonio Dams is now focused primarily on the regulated release of water to maintain Salinas River streamflow to maximize groundwater recharge from the streambed. Since 1998, MCWRA and Monterey One Water have cooperated to implement the Salinas Valley Recycling Projects. These projects provide advanced treatment of municipal wastewater and deliver it to augment groundwater supplies for agricultural irrigation on approximately 12,000 acres near Castroville (Monterey County Water Resources Agency 2006).

2.3.2 Flood Management

In addition to water supply operations, MCWRA also operates its two dams to provide for safe conditions for downstream communities (Figures 2-1a and 2-1b). This involves managing reservoir storage to ensure that there is adequate capacity to contain high levels of projected inflow during storm events. Both Nacimiento and San Antonio Reservoirs are equipped to capture flows from the upper watershed (surface waters of the Nacimiento and San Antonio Rivers, respectively) and protect downstream reaches from flooding. MCWRA developed probability flood data which are used to determine how much flood storage is required prior to large storm events (Monterey County Water Resources Agency 2018a). When a large storm is predicted, reservoir storage is drawn down to a level that allows room to capture upstream flood flows, if necessary.

In addition, MCWRA coordinates maintenance activities along the Salinas River and its tributaries in partnership with and on behalf of landowners and interested parties through the Salinas River SMP (more detailed provided in Section 2.4.2.1, *Salinas River Stream Maintenance Program*). Routine maintenance consists of the construction of secondary channels through vegetation removal and sediment management measures to maximize flood flow capacity to ensure the system is in suitable condition throughout the year while maintaining or enhancing natural habitat and hydrological processes. This routine maintenance is especially important during the wet season when there are higher probabilities for flood events (Monterey County Water Resources Agency 2014).

In addition to the structural flood control provided by MCWRA-owned dams, reservoirs, and pump stations, MCWRA also provides flood warning services to Monterey County residents. MCWRA staff monitors countywide hydrologic conditions during every storm event. A real-time flood warning system allows MCWRA staff to provide hydrologic data as well as expertise to emergency managers and local law enforcement any hour of the day or night as needed for the protection of life and property in Monterey County (Monterey County Water Resources Agency 2018a).

2.3.3 Facilities

In addition to Nacimiento and San Antonio Dams and the SRDF, MCWRA operates and maintains drainage facilities (earthen channels) in 14 drainage maintenance zones and districts located throughout Monterey County. These drainages maintenance zones consist of approximately 57 miles of improved drainageway, eight pump stations, 9 miles of river levees, and numerous culverts, tide gates, and concrete structures. Figures 2-1a and 2-1b show these associated facilities in the management area.

2.3.3.1 Reservoirs

MCWRA owns and operates two dams and their associated reservoirs, Nacimiento and San Antonio (Figure 2-1b). Nacimiento and San Antonio Dams are managed for the combined goals of water conservation through groundwater recharge, flood protection, and recreation, with flood safety always being the primary consideration. MCWRA has water rights for the Nacimiento River to store 350,000 AF from October 1 of each year to July 1 of the succeeding year and to use 180,000 AF per year for irrigation, domestic municipal, industrial, and recreational uses. MCWRA also has water rights for the San Antonio River to store 220,000 AF and use 210,000 AF per year for similar annual uses. The operation of the reservoirs is guided by the Reservoir Operations Advisory Committee that provides recommendations to the MCWRA's Board of Directors (Monterey County Water Resources Agency 2018a). The Reservoir Operations Advisory Committee consists of three Board members, the Board Chair, and non-Director members. The Chair appoints non-Director members to the Reservoir Operations Advisory Committee as follows.

- One representative each of the Pressure, East Side, Forebay, and Upper Valley groundwater subareas.
- Three members of the public.
- One representative of the San Luis Obispo County Public Works Department.
- One representative of the Monterey County Parks Department.
- One representative of the lakes resort concessionaire.
- One representative of Nacimiento Regional Water Management Advisory Committee.
- One representative of the Salinas River Channel Coalition.

Nacimiento Dam and Reservoir

Nacimiento Dam and Reservoir are located in northern San Luis Obispo County, about 20 miles from the coast. Nacimiento Dam was completed in 1957. The dam crest elevation is 825 feet above mean sea level (amsl) with a spillway elevation of 787.75 feet that can be raised to an elevation of 800 feet by using an inflatable Obermeyer spillway gate. Specifications for Nacimiento Dam and Reservoir are provided in Table 2-2 and Figure 2-2.

Table 2-2. Nacimiento and San Antonio Reservoir and Dam Specifications

Specifications	Nacimiento Reservoir	San Antonio Reservoir
Reservoir length (maximum capacity)	18 mi	16 mi
Shoreline (maximum capacity)	165 mi	100 mi
Dam crest length	1,650 ft	1,433 ft
Dam height above streambed	215 ft	201 ft
Dam crest elevation	825 ft amsl	802 ft amsl
Spillway elevation	800 ft amsl	780 ft amsl
Maximum storage capacity	377,900 AF	335,000 AF
Dead pool elevation	670 ft amsl	645 ft amsl
Dead pool storage capacity	10,300 AF	10,000 AF
Operational minimum pool elevation	687.8 ft amsl	666 ft amsl
Operational minimum pool storage capacity	12,000 AF	13,000 AF
Conservation pool elevation	787.75 ft amsl	774.5 ft amsl
Conservation pool storage capacity	289,013 AF	282,000 AF
Flood pool elevation	801 ft amsl	780 ft amsl
Flood pool storage capacity	66,587 AF	30,000 AF

Source: Monterey County Water Resources Agency 2018a and 2018c.
mi = mile; ft = feet; amsl = above mean sea level; AF = acre-feet

Several operational pools were constructed to aid in the management of water being stored in the reservoir. The operational minimum pool retains water reserved for fish and wildlife habitat as well as a water entitlement belonging to the County of San Luis Obispo. The conservation pool, which extends from the minimum pool to the concrete spillway, is the operational pool used to store water for later release to the Salinas River for groundwater recharge, fish passage, and SVWP operations.

San Antonio Dam and Reservoir

The San Antonio Dam and Reservoir are located in southern Monterey County, about 16 miles northwest of Paso Robles. San Antonio Dam was completed in 1967. This earth-filled dam has a crest elevation of 802 feet amsl and a capacity of 335,000 AF. Specifications for San Antonio Dam and Reservoir are provided in Table 2-2 and presented in Figure 2-2.

Operational pools have been created to aid in the management of water being stored in the reservoir. The physical minimum pool or dead pool is at an elevation of 645 feet and has 10,000 AF of storage. Water below an elevation of 666 feet is reserved for fish and wildlife habitat. The conservation pool that extends from minimum pool is the operational pool used to store water for later release to the Salinas River for groundwater recharge, fish passage, and the operation of the SVWP.

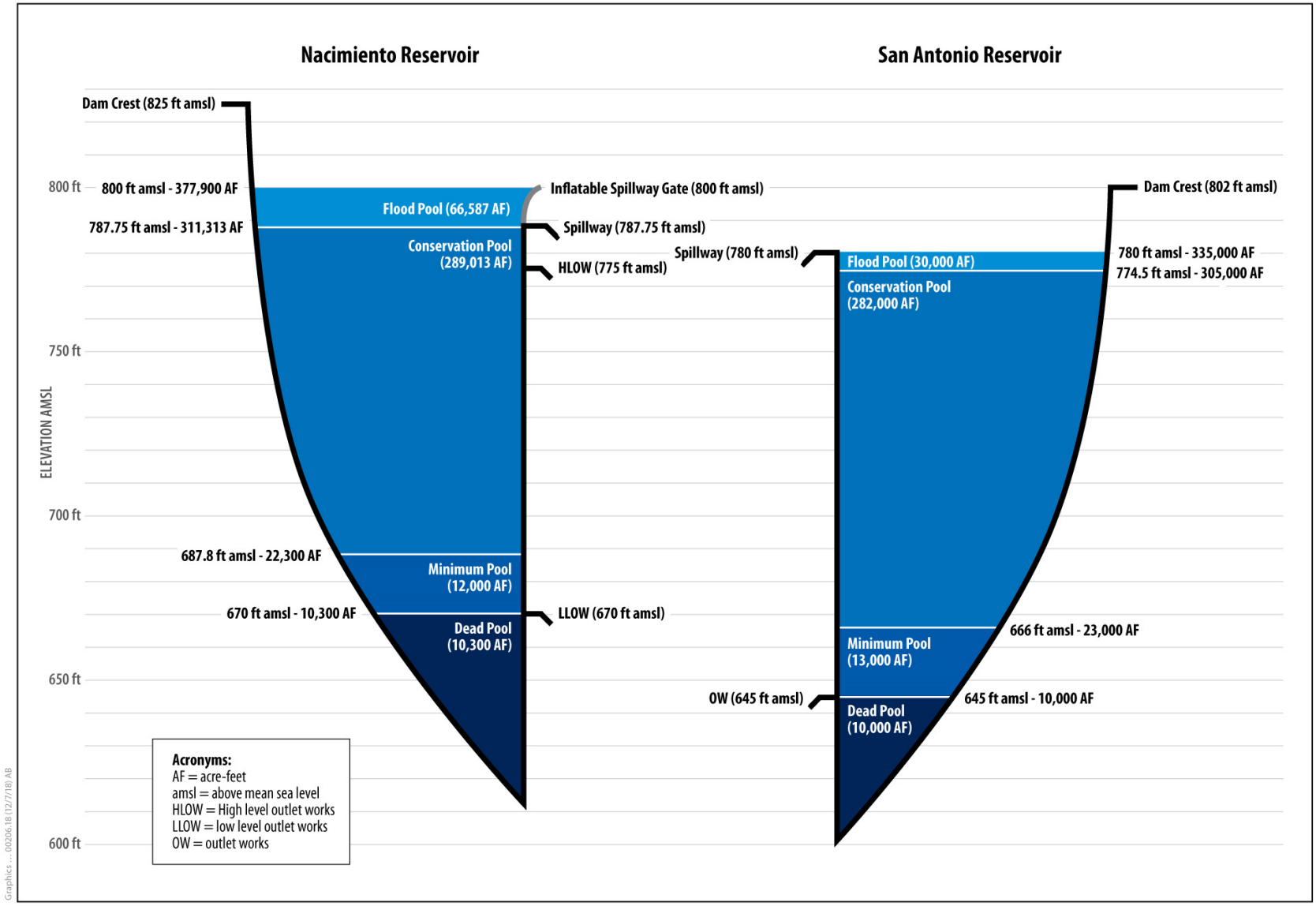


Figure 2-2. Nacimiento and San Antonio Reservoir and Dam Specifications

2.3.3.2 Salinas River Diversion Facility

The SRDF was constructed in 2010 as part of SVWP. Located near Marina (approximately 4.8 miles from the mouth of the Salinas River), this facility was built to impound water to provide additional irrigation water to nearby farms in the lower reaches of the river valley after being treated (filtered and chlorinated) and mixed with recycled wastewater. The facility includes an Obermeyer inflatable dam, which is approximately 9 feet high by 230 feet long and consists of a metal spillway gate and an inflatable air bladder. The facility also includes a screened intake and a pump station that transfers impounded water to the Salinas Valley Reclamation Project where it is filtered and disinfected prior to being blended with recycled water produced at the Salinas Valley Reclamation Project. The blended water then flows into the distribution piping for conveyance to the customers within the CSIP service area.

2.3.3.3 Other Facilities

Additional facilities owned or managed by MCWRA that play an integral part in the flood control and water supply operations in the management area are summarized below.

- **CSIP Irrigation Pipeline.** The CSIP irrigation pipeline is a 48-mile pipeline distribution system to supply irrigation water to areas most threatened by seawater intrusion. CSIP delivers a blend of groundwater, river water, and recycled water to growers within a 12,000-acre service area surrounding Castroville.
- **Blanco Drain Pump Station.** The Blanco Drain is a reclamation ditch that drains approximately 6,400 acres of agricultural lands near Salinas. The watershed is between the Salinas River and Alisal Slough. Blanco Drain discharges to the Salinas River at River Mile 5, upstream of the SRDF. A headwall and flap gate at the downstream end prevents seasonal high flows in the Salinas River from migrating up the Blanco Drain channel. In 2009–2010 as part of the SRDF construction, a pump station was installed at the downstream end to control backwater from the Salinas River impoundment area from entering the Blanco Drain. MCWRA maintains this pump station that lifts Blanco Drain flows past a slidegate and into the gravity portion of the channel.
- **Old Salinas River Slidegate.** MCWRA maintains and operates a slidegate where the Salinas River Lagoon discharges into the Old Salinas River (OSR). This slidegate is located in the northern portion of the lagoon and is operated to regulate lagoon water levels when the sandbar at the mouth of the river is closed. This slidegate controls flow from the Salinas River to the Pacific Ocean through the OSR channel. More details on this facility and its operations are provided in Section 2.4.1.2, *Salinas River Lagoon Management and Enhancement Plan*.
- **Potrero Road Tide Gates.** MCWRA maintains and operates the Potrero Road tide gates, which are located on the OSR downstream of the confluence with the Tembladero Slough on the access road to the Salinas River State Beach. The tide gates are box culverts with steel tide gates that are designed to prevent tidal waters from moving upstream and inundating farm land. This design restricts OSR discharge, including during storm events. The current structure was installed in the early 1980s.
- **Moss Landing Road Tide Gates.** MCWRA also manages the Moss Landing Road tide gates located on Moss Landing Road along the Moro Cojo Slough at the confluence with Moss Landing Harbor. The tide gates are cylindrical culverts with tide gates that prevent tidal waters from

moving upstream and inundating nearby residential and commercial lands. This design restricts Moro Cojo Slough discharge during storm events.

- **Reclamation Ditch System Pump Stations.** MCWRA is responsible for operations and maintenance of pump stations throughout the Reclamation Ditch system. The Reclamation Ditch (commonly referred to as the *Rec Ditch*) watershed consists of an area of approximately 157 square miles within Monterey County and a very small portion of San Benito County. The Rec Ditch flows southeast to northwest, draining a series of generally dry lake beds (e.g., Carr Lake and Merritt Lake) that are farmed when not flooded and are linked by a system of lateral ditches (tributaries) and pumping facilities. At the upstream end of this system is Smith Lake, southeast of Salinas. From Smith Lake, the Rec Ditch drains through Carr Lake and flows northwest towards Castroville. These lakes provide stormwater runoff detention before entering the Rec Ditch and are primarily farmed during the dry season. Near Castroville, the Rec Ditch flows into Tembladero Slough, which drains Merritt Lake. Tembladero Slough flows past Castroville into the OSR. The OSR discharges through tide gates at Potrero Road into Moss Landing Harbor and, ultimately, Monterey Bay.

2.4 MCWRA Projects and Programs

This section is a summary of current MCWRA projects and programs that may be relevant to short- and long-term management needs of the Salinas River in the study area. They are presented in chronological order of when projects were constructed and first operated.

2.4.1 MCWRA-Led Projects and Programs

2.4.1.1 Castroville Seawater Intrusion Project

Due to the growing threat to the region's water supply and the gradual increase of seawater intrusion into groundwater in northernmost portion of the Salinas Valley due to groundwater pumping, MCWRA enacted Ordinance No. 3635 in 1992 approving the CSIP. The CSIP is characterized as the distribution component of the Salinas Valley Reclamation Project, a wastewater reclamation facility built by Monterey One Water and maintained at the Monterey Regional Treatment Plant. After the reclamation facility was completed in 1994, MCWRA constructed a 48-mile pipeline distribution system to supply irrigation water treated from the Salinas Valley Reclamation Project to areas highly affected by seawater intrusion. The CSIP began construction in 1995, funded by assessment collections in zones of benefit 2A, 2B, and 2Y, and started delivering a blend of recycled (tertiary-treated) water and groundwater to agricultural fields within a 12,000-acre service area surrounding Castroville by 1998 (Monterey County Water Resources Agency 2018d).

By using recycled water pumped from Monterey One Water, farmers can safely irrigate their crops and reduce groundwater use. Each water user in the CSIP system has a delivery turnout with control and isolation valves and meters that allow the user to regulate flow and MCWRA to monitor total water use at each site. Total water deliveries to the CSIP system have varied between 16,663 and 21,982 AF per year from 1999 to 2007. The average water use over this monitoring period was 18,942 AF per year (RMC Water and Environment 2007).

Since its implementation, the CSIP system has contributed to halting the recent rates of seawater intrusion in portions of the region and groundwater levels from three of the four aquifers affected

are beginning to trend toward their historical levels (Monterey County Water Resources Agency 2018d). The results of the CSIP led to the next project to help slow and ultimately reverse seawater intrusion—the SVWP. Through the SVWP's installation of a rubber spillway gate at Nacimiento Dam and another rubber dam in 2010 on the Salinas River near Marina (the SRDF), seasonally stored river water can be pumped into the CSIP's pipelines for delivery as irrigation water, thus further reducing the need to pump groundwater. See more details on the SVWP in Section 2.4.1.3, *Salinas Valley Water Project*.

2.4.1.2 Salinas River Lagoon Management and Enhancement Plan

The *Salinas River Lagoon Management and Enhancement Plan* was adopted in 1997 to address issues and concerns relating to flood risk and ecological impacts on the Salinas River Lagoon (Monterey County Water Resources Agency 1997). The plan recommends several measures to restore and manage the existing hydrology, vegetation, wildlife, aquatic resources, and water quality of the lagoon. The plan was developed through consultation with the Salinas River Lagoon Task Force, which was composed of federal, state, and local agencies, along with local agricultural representatives.

The lagoon project area includes the lower end of the Salinas River starting at State Highway 1 at River Mile 2 downstream to the coastal sandbar that separates the river from the Monterey Bay. Over the last two decades, MCWRA, U.S. Fish and Wildlife Service (USFWS), and California State Parks have implemented many of the 27 recommended management measures stated in the plan, resulting in an increase of riparian and wetland vegetation recovery, water quality improvements, and steelhead passage. The 27 measures are listed in Table 2-3.

Table 2-3. Recommended Measures from Salinas River Lagoon Management and Enhancement Plan

Recommended Measures		Implementing Entity	Status
1	Accommodate higher winter lagoon water elevations, between 4 and 5 feet	MCWRA, Landowners, CCC	Ongoing
2	Install and operate the new Old Salinas River Slidegate system in accordance with breaching plan	MCWRA	Complete
3	Install a water level monitoring gage	MCWRA	Complete
4	Minimize short duration breaches by using OSR Channel when dredged	MCWRA	OSR was dredged once; short-duration breaches still undertaken
5	Encourage riparian enhancement measures by Highway 1 bridge	CCC, RCDMC, Lagoon Task Force	Unknown
6	Encourage program to enhance riparian habitat within the plan area	CCC, Lagoon Task Force, Landowners	Unknown
7	Implement enhancement and management measures within fore dunes and dune scrub	CCC, CDPR, USFWS	Ongoing
8	Maintain permitted facilities where necessary on north bank of slopes	MCWRA	Unknown
9	Monitor the sand gilia[4] population on public property	CDPR	Unknown

[4] Synonymous with *Monterey slender-flowered gilia* as referenced in the *Salinas River Lagoon Management and Enhancement Plan*.

Recommended Measures		Implementing Entity	Status
10	Implement habitat enhancement on a portion of the USFWS refuge	USFWS	Ongoing
11	Reduce hunting activity within sensitive areas on USFWS property	USFWS	Complete
12	Maintain the quality of Smith's blue butterfly habitat on public property	USFWS	Ongoing
13	Control public recreational use to avoid impacting wildlife	USFWS	Ongoing
14	Manage the pond on the USFWS refuge to maintain wildlife values	USFWS	Ongoing
15	Encourage management of boating activities to protect sensitive species	USFWS	Ongoing
16	Control red fox populations	USFWS, CDPR	Ongoing
17	Protect snowy plover habitat on public property in the study area	USFWS	Ongoing
18	Install bird nest boxes and bat roost boxes on public properties	USFWS	Measure replaced
19	Establish baseline salinity levels in the OSR to operate double weir and enhance freshwater fisheries habitat in the lagoon	MCWRA	Unknown
20	Evaluate the potential to reintroduce native freshwater species, enhance Sacramento blackfish/perch community	CDFW, USFWS	Unknown
21	Evaluate the potential to reintroduce tidewater goby into the lagoon	CDFW, USFWS	Complete
22	Establish a sediment and water quality monitoring program	MCWRA, Regional Water Board, Lagoon Task Force, AMBAG	Water quality monitoring ongoing; sediment monitoring unknown
23	Encourage participation in the Water Quality Protection Plan by Sanctuary	MCWRA, Regional Water Board, Lagoon Task Force, Sanctuary	Unknown
24	Develop a public use and access plan on public properties	Lagoon Task Force	Unknown
25	Recognize the ability of property owners to make necessary and permitted improvements	CDFW	Unknown
26	Operation of culvert shall not increase flooding or excess salinity along the OSR	MCWRA	Unknown
27	Form Interagency/Property Owners' Management Committee	MCWRA, CCC, CDPR, Lagoon Task Force, Landowners, USFWS	Unknown

Source: Monterey County Water Resources Agency 1997.

AMBAG = Association of Monterey Bay Area Governments; CCC = California Coastal Conservancy; CDPR = California Department of Parks and Recreation; CDFW = California Department of Fish and Wildlife; MCWRA = Monterey County Water Resources Agency; Sanctuary = Monterey Bay National Marine Sanctuary; OSR = Old Salinas River; RCDMC = Resource Conservation District of Monterey County; Regional Water Board = Central Coast Regional Water Quality Control Board; USFWS = U.S. Fish and Wildlife Service

As noted in Table 2-3, several assigned measures have been implemented over the last 20 years. The Old Salinas River Slidegate Project and the Salinas River Lagoon Sandbar Management Program, born from Measures 1 and 2, respectively, are in effect today and help manage river flows reducing the likelihood of flood events in the nearby adjacent agricultural lands and residential areas. In addition, a water monitoring gage was installed in 1996 to collect real-time precipitation and streamflow data, and a Lagoon Monitoring Program has been implemented since 2001 to comply with the plan (Measures 3 and 4). Each year, MCWRA assesses aquatic conditions in the lagoon by measuring water depth and clarity, temperature, dissolved oxygen, conductivity, and salinity (Hagar Environmental Science 2010). The intent of this data collection and annual monitoring is to provide more information on lagoon function and improved management to reduce flood risks and improve habitat quality (Monterey County Water Resources Agency 1997).

Old Salinas River Slidegate Project

One way MCWRA manages water levels in the Salinas River Lagoon is by releasing flows through an outlet gate to the OSR channel. The outlet gate is located at the base of Mulligan Hill and is known as the Old Salinas River Slidegate. The OSR channel, an earthen channel approximately 4.5 miles long and 8–200 feet wide, connects the Salinas River Lagoon to the mouth of Elkhorn Slough and the Moss Landing Harbor. MCWRA constructed a new slidegate at the mouth of the OSR channel in 1996 to replace a degraded slidegate and culvert built in 1990. The existing slidegate, equipped with a 60-inch box culvert, is typically closed when the sandbar at the lagoon mouth is open. The slidegate is typically open when the sandbar is in place to regulate lagoon water levels so that adjacent farmland and upstream areas are not flooded. Approximately 100 cubic feet per second is the maximum volume that can pass through the slidegate. Flow through the slidegate is limited by the capacity of the outlet structure and by capacity in the OSR channel. The OSR channel is tidally influenced (by the Potrero Road tide gates) and high inflows from other sources (primarily from Tembladero Slough) during winter storms severely restrict the amount of water that can drain through the slidegate, thus backing up the lagoon. Effective management of the slidegate continues to be a key issue for MCWRA.

Salinas River Lagoon Sandbar Management Program

MCWRA developed a sandbar management program[5] as a means of flood control in the Salinas River Lagoon (Monterey County Water Resources Agency 1997). This breaching plan defines criteria for managing the sandbar elevation to allow direct outflow to the ocean when water levels in the lagoon are high and flooding in the nearby uplands is imminent. Sandbar management activities involve either lowering the existing sandbar to an elevation that would likely promote natural breaching or excavating a drainage channel across the sandbar to drain the lagoon once it reaches a critical elevation. The latter approach is implemented when runoff from the Salinas River is expected to raise lagoon levels above 6 feet National Geodetic Vertical Datum. Natural breaching, if it occurs at all, typically occurs in conjunction with winter storms in November, December, or January. Mechanical opening undertaken by MCWRA can occur anytime between October and June. River flows typically recede in late spring to low levels between storms and, depending on tide and wave conditions, the mouth typically closes again by summer.

[5] Referred to as the *Salinas River Mouth Breaching Plan* in Appendix C of the *Salinas River Lagoon Management and Enhancement Plan*.

MCWRA has funded a lagoon monitoring program in the Salinas River Lagoon since 2001 (Hagar Environmental Science 2010) to support the sandbar management program. Monitoring over the years has included general habitat condition observations throughout the lagoon (i.e., water surface elevation, depth characteristics, salinity stratification, temperature, dissolved oxygen concentration, water clarity), river flows into the lagoon preceding and following sandbar opening, and closure and re-opening history following sandbar opening.

In December 2009, NMFS completed its consultation and issued a biological opinion for the U.S. Army Corps of Engineers permit for sandbar breaching at the mouth of the Salinas River (Hagar Environmental Science 2015). Following this consultation, the Lagoon Monitoring Program was altered in 2010 to be consistent with the monitoring measures in the biological opinion (National Marine Fisheries Service 2009). The monitoring of the lagoon now includes pertinent data on steelhead populations and their habitat conditions in the spring and summer, in addition to the fall samples that have been conducted previously for water quality monitoring (more details are provided in Section 3.5, *Environmental Pressures and Stresses*).

2.4.1.3 Salinas Valley Water Project

In 2003, MCWRA enacted Ordinance No. 4203, approving the SVWP to address the water resources management issues straining the Salinas Valley groundwater basin. The project is funded by collections of property tax assessments in zone of benefit 2C. The SVWP provides for the long-term management and protection of groundwater resources in the Salinas River groundwater basin.

The specific goals of the SVWP are to accomplish the following.

- Halt seawater intrusion.
- Continue conservation of winter flows for recharge of the basin through summer releases.
- Provide flood protection.
- Improve long-term hydrologic balance between recharge and withdrawal.
- Provide a sufficient water supply to meet water needs through the year 2030 (RMC Water and Environment 2007).

MCWRA is implementing the SVWP in two phases. Phase I, which was completed in 2010, included modifications to Nacimiento Reservoir spillway and construction of the SRDF to improve dam safety, enhance flood control, and recharge the watershed aquifers. The Nacimiento Reservoir spillway was enlarged and equipped with a new rubber spillway gate to preclude the dam from overtopping during a high flood event. By increasing the capacity of the spillway, more water can be stored during the winter and spring annually, while still providing for passage of potential high flood events, thus making more water available for release later in the year. The additional water can be used to supplement and/or replace groundwater use through a surface diversion and/or groundwater recharge (Monterey County Water Resources Agency 2018e).

The SRDF was constructed to provide irrigation water for farms in the lower reaches of the river valley after being treated (filtered and chlorinated). Diverted water is used to irrigate approximately 12,000 acres of agricultural lands, significantly reducing the need to pump groundwater (RMC Water and Environment 2003). Without these additions to the existing infrastructure, seawater intrusion would continue to advance and there would be an ongoing need for groundwater extraction to meet irrigation demands of the CSIP area. Currently, the SVWP supplies water the

quality of which equals, if not exceeds, the recycled water that has been distributed to the local agricultural industry for more than 20 years (Monterey County Water Resources Agency 2018e).

MCWRA has proposed Phase II of the SVWP to address additional water supply issues in the Salinas River groundwater basin. Phase II would put to beneficial use the water right allocated to MCWRA (by Water Right Permit 11043) to further develop surface water resources that would be used to offset groundwater pumping. Reduced groundwater extractions would, in turn, help to slow and ultimately halt seawater intrusion in the Salinas River groundwater basin. Phase II would also allow for further offsets of groundwater pumping by delivering additional surface water to the several subareas of the Salinas River groundwater basin. Up to 135,000 AF per year of water would be diverted from the Salinas River and supplied for municipal, industrial, and/or agricultural uses in these subareas (Geoscience 2013).

Phase II would encompass two surface water diversion points, most likely similar to the existing SRDF, for capture, conveyance, and delivery of the water: one located near Soledad, known as the East Side Canal Intake, and the other located south of Salinas, called the Castroville Canal Intake. The conveyance facilities would be either aboveground or belowground pipelines and pump stations. Delivery facilities may consist of injection wells (as part of an aquifer storage and recovery system), percolation ponds, or turnouts for direct use of the water. The delivery facilities may incorporate treatment of the water or, alternatively, MCWRA may deliver raw water to be treated by the end-user in a manner suitable for the intended application (for example, agricultural versus urban). Phase II is currently on hold; however, it will be evaluated in an environmental impact report (EIR), and a suitable alternative will be selected as result of the review process.

2.4.1.4 Interlake Tunnel and Spillway Modification Project

The Interlake Tunnel and Spillway Modification Project (referred to herein as *Interlake Tunnel Project*) proposes to divert water from the Nacimiento Reservoir to San Antonio Reservoir through an approximately 2-mile-long gravity flow tunnel with an intake structure in Nacimiento Reservoir and an exit outlet structure in San Antonio Reservoir (Monterey County Water Resources Agency 2016). A key component of the Interlake Tunnel Project is the spillway modification which, as proposed and currently under review for feasibility, would raise the current 780-foot-tall crest of the San Antonio Dam spillway approximately 7 feet to increase its capacity by approximately 60,000 AF (18%). The Nacimiento River watershed produces nearly three times the average annual inflow as compared to the San Antonio River watershed; accordingly, capturing and diverting high Nacimiento River flows to San Antonio Reservoir would increase the overall storage capacity within the two watersheds. Once implemented, the project will help conserve water for use during future drought years (Monterey County Water Resources Agency 2018f).

The project has been under consideration since the late 1970s and was included in MCWRA's 1991 *Water Capital Facilities Plan* as an approach to better manage flood and conservation flows in the Salinas River watershed. More recently, the project was included in the 2013 *Greater Monterey County Integrated Regional Water Management Plan*. In 2014, a group of Salinas Valley growers revitalized the urgency for the project due to the ongoing multi-year drought.

The Interlake Tunnel Project is divided into three phases: (1) project feasibility tasks, including preliminary engineering and water rights requirements analysis; (2) pre-construction tasks, including environmental review, permit applications, geotechnical and final design, right-of-way acquisition, and financing arrangements; and (3) construction. The project is currently in the first

phase of development. Depending upon several factors in the second phase, including the degree of environmental documentation required, the project construction could be completed by the end of 2021 (Monterey County Water Resources Agency 2016).

2.4.1.5 Operations and Maintenance Activities

MCWRA is responsible for inspection, operations and maintenance, and repair and replacement of facilities on properties within an approved zone of benefit, on properties it owns, or on properties for which it holds an easement. Facilities include Nacimiento and San Antonio Dams, SRDF, CSIP irrigation pipeline, Old Salinas River Slidegate, as well as other various pump stations, canals, drainageways, and reclamation channels that make up the Salinas River water supply and flood control system. To keep water moving to destinations throughout its jurisdiction and protect surrounding uplands, MCWRA conducts the following routine maintenance activities.

- Facility maintenance such as trash removal; fence installation; accumulated sediment removal; trail, road, and culvert repair or replacement; and minor bridge repair.
- Storm system maintenance including clearing outlets to restore stormwater flow. Work may entail trimming vegetation and/or clearing sediment around drain outlets.
- Storm damage repair and flood prevention projects including drainage improvements.
- Natural resource protection such as small bank stabilization projects (less than 100 feet), restoration to reduce erosion, and removal of debris deposited during flooding.
- Small-scale erosion control projects or storm damage prevention projects that do not create new permanent hardscape on the creek bank or channel including sandbag installation.
- Operation and maintenance of flood protection facilities such as armored channels, bypass channels, levees, access roads, and detention ponds.
- Vegetation management for exotic species removal, such as removal of giant reed.
- Vegetation management for public safety hazards including fire management and mosquito control activities.
- Precipitation and stream gage station maintenance.
- Operations and maintenance of water utility/water supply facilities including inflatable dams, diversion structures, groundwater recharge ponds, gages, pipelines, pumps, turnouts, slidegates, fish ladders, etc.

2.4.2 MCWRA Partnership Projects and Programs

This section is a summary of three interrelated projects and programs led by federal, state, or other local agencies in which MCWRA is a partner and that are relevant to short- and long-term management needs of the Salinas River in the study area.

2.4.2.1 Salinas River Stream Maintenance Program

In 2010, MCWRA developed the Salinas River SMP in collaboration with the Resource Conservation District of Monterey County (RCDMC), the Salinas River Channel Coalition, the Grower-Shipper Association of Central California, The Nature Conservancy, Conservation Collaborative, and other local entities and contractors. The Salinas River SMP is intended to help protect landowners and

farms along the Salinas River against flooding during and after moderate storm events while enhancing the habitat value of the Salinas River (Monterey County Water Resources Agency 2014). The Salinas River SMP, an adaptation from the Salinas River Channel Maintenance Program, facilitates vegetation and sediment management activities conducted voluntarily by individual property owners, growers, and municipalities. To effectively implement this program, these entities collectively formed a non-profit organization called the Salinas River Stream Maintenance Program River Management Unit Association.

The Salinas River SMP addresses management needs along the banks of the Salinas River mainstem from nearly the mouth to San Ardo (River Miles 2–94). The Salinas River SMP also addressed vegetation management needs in three tributaries: Gonzales Slough, Bryant Canyon Channel, and San Lorenzo Creek. With its collaborative and science-based approaches, the Salinas River SMP outlines measures to manage and remove vegetation and sediment in specific maintenance areas within the watershed to maximize flood flow capacity, minimize bank erosion, and minimize environmental effects (Monterey County Water Resources Agency 2018g). The RCDMC helps MCWRA administer the Salinas River SMP. The RCDMC also holds the Routine Maintenance Agreement permit from the California Department of Fish and Wildlife (CDFW) under the Lake or Streambed Alteration Program, and oversees the required biological monitoring for the program.

The Salinas River mainstem and the three select tributaries are collectively referred to as the Salinas River *SMP Program Area*. The Salinas River SMP Program Area is further divided into seven river management units (Figure 1-2). Approximately 129 designated maintenance areas within the seven river management units were identified and mapped based on available data such as topography, flood flows, and vegetation communities. Most work activities planned by Salinas River SMP participants are restricted to these designated maintenance areas and outside of the low-flow channel (Monterey County Water Resources Agency 2018g). Implementation of the Salinas River SMP occurs primarily through landowner and lessee participation in the Salinas River Stream Maintenance Program River Management Unit Association.

Work activities planned by Salinas River SMP participants include vegetation and sediment management. Vegetation management is focused on the following activities.

- Cutting and removal of flow-constricting vegetation (both native and nonnative) within the secondary channels to maintain flow conveyance capacity.
- Controlling invasive vegetation, mainly *Arundo donax* (Arundo) and *Tamarix parviflora* (tamarisk).
- Promoting a canopy of native riparian trees through restoration measures.

Vegetation removal activities are relatively consistent from year to year and involve mowing, disking, and herbicide applications through the prep-and-spray method (Monterey County Water Resources Agency 2018g). Sediment management is directed towards removing sediment accumulation in areas outside of the low-flow channel to increase stream capacity and minimize bank erosion. Sediment removal is accomplished using heavy equipment such as a large track excavator or bulldozer. Sediment removed from the maintenance area is moved outside the stream channel and either relocated on the adjacent property or hauled offsite using dump trucks (Monterey County Water Resources Agency 2018g). The typical timeframe in which most stream maintenance activities are conducted is September 1 to November 15.

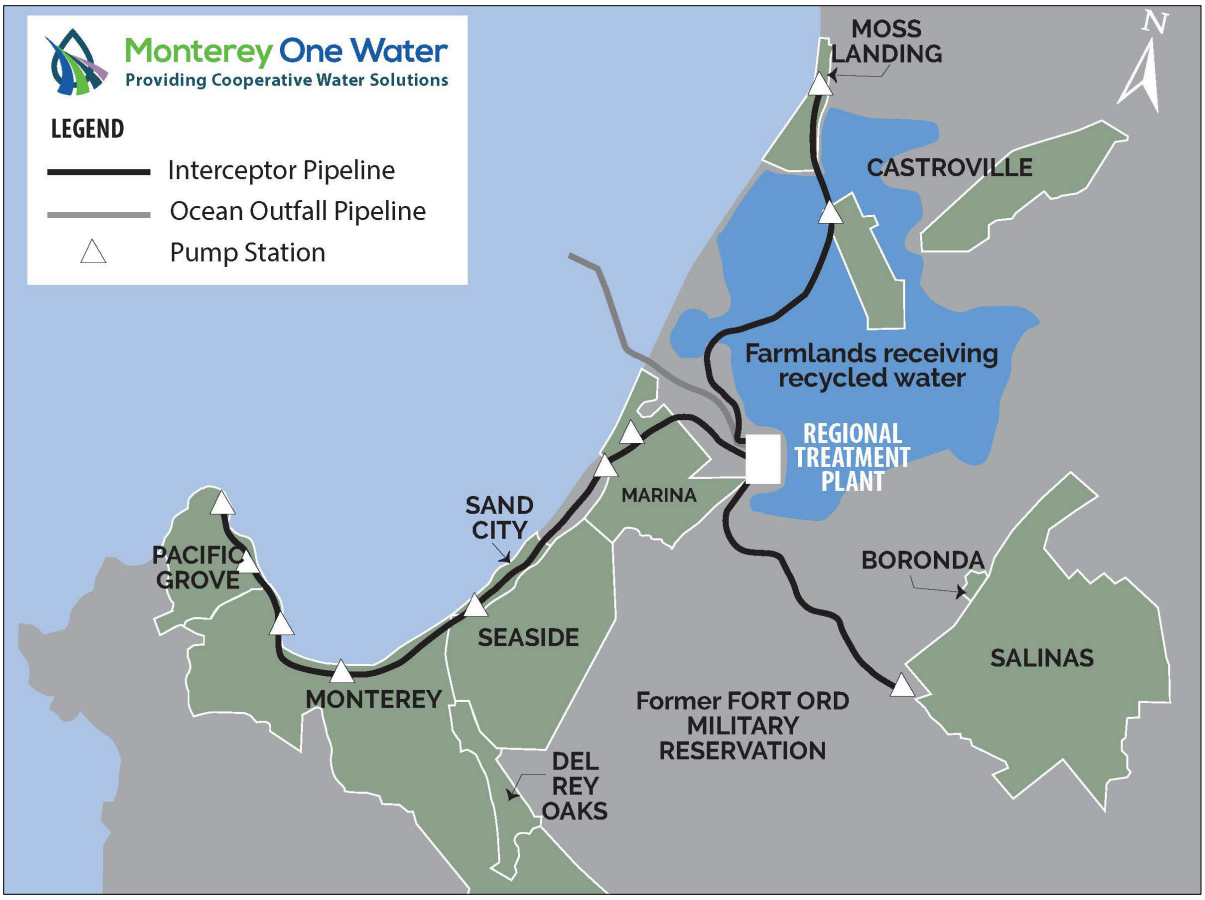
MCWRA oversees the Salinas River SMP Monitoring Program, tracking compliance of activities allowed by the programmatic EIR and associated permits, evaluating stream maintenance activities, and monitoring changes to the low-flow channel. The objectives of the Salinas River SMP Monitoring Program are to provide compliance monitoring to ensure that the proposed work is being performed as allowed under the EIR and permits and to provide physical process monitoring to evaluate the extent to which the stream maintenance activities are achieving the objectives of the Salinas River SMP for flood control capacity protection and habitat enhancement.

2.4.2.2 Pure Water Monterey

Pure Water Monterey is a water recycling and groundwater replenishment project developed by two public agencies: Monterey Peninsula Water Management District and Monterey One Water. The project, adopted by the two agencies in 2012, proposes to reduce water use from the Carmel River and the Seaside Basin and, in doing so, will restore reliability of surface water and groundwater in the region. The project plans to utilize existing infrastructure and construct new facilities to treat agricultural wash water, stormwater runoff, agricultural return water, and treated wastewater. The advanced purification process includes membrane filtration, reverse osmosis, oxidation with hydrogen peroxide, and ultraviolet light followed by natural percolation into the groundwater basin through injection wells. Operation and maintenance of these facilities will be funded by users and will primarily originate from property taxes in zones of benefit.

Treated water from this project will have many uses, including potable water, irrigation supply, and groundwater recharge (Denise Duffy & Associates 2016). MCWRA may participate in the Pure Water Monterey project by utilizing new source waters from the project for irrigation supply through the CSIP. Figure 2-3 shows the alignment of the recycled water pipeline. MCWRA participation, in turn, will reduce groundwater pumping by an estimated 2,000 AF per year in the Salinas Valley Basin, build and maintain a drought reserve for future use, and reduce costs for future capital improvement projects (Pure Water Monterey 2018).

Additional regional benefits of the project include increased water supply in the winter, reduction of stormwater runoff into the ocean, treatment of impaired agricultural surface waters, distribution of water rights acquisition costs among participating agencies, and overall improvement of water quality in the Salinas Valley. The project is currently under construction, with activities focused on constructing diversion facilities in the Rec Ditch and Blanco Drain, injection wells in the Seaside groundwater basin, and an advanced water purification facility at the Monterey Regional Treatment Plant. The project is expected to be fully operational by 2020 (Pure Water Monterey 2018).



Source: California State University Monterey Bay 2018.

Figure 2-3. Monterey Regional Treatment Plant and Recycled Water Irrigation Pipe Alignment

2.4.2.3 Groundwater Sustainability Plans

In 2014, California established the Sustainable Groundwater Management Act (SGMA). Within the study area, four groundwater sustainability plans (GSPs) are currently under development: the Salinas Valley Basin GSP, the Marina Coast Water District (MCWD) GSP, City of Marina GSP, and the Arroyo Seco GSP. Because the hydrology and geology of these four plans are somewhat intertwined due to proximity and subsurface characteristics, the groundwater sustainability agencies (GSAs) leading development of the four GSPs are working to coordinate their efforts, particularly in establishing a common water budget that will inform the projects proposed by each plan.

Salinas Valley Basin Groundwater Sustainability Plan

In December 2016, a joint powers agreement formed the Salinas Valley Basin GSA. The Salinas Valley Basin GSA has an 11-member board representing the beneficial users of groundwater in the basin, including Monterey County, cities, agriculture, private municipal water suppliers, small water systems, residential well owners, disadvantaged communities, and environmental uses. An advisory committee was formed in 2017 to provide input and recommendations to the Salinas Valley Basin GSA on a range of topics. The consensus-seeking advisory committee represents a broad range of interests within the Salinas Valley (Salinas Valley Basin Groundwater Sustainability Agency 2018).

SGMA requires that GSPs be developed to address each of six subbasins (all Salinas Valley Basin subbasins excluding the Seaside subbasin). Of the six subbasins, only the 180/400 Foot Aquifer subbasin has been identified as being in critical overdraft. This status triggers a requirement that the 180/400 Foot Aquifer subbasin GSP be submitted to DWR by January 1, 2020. To meet this requirement, and because groundwater management is a valley-wide challenge, the Salinas Valley Basin GSA has elected to initiate development of a Valley-Wide Integrated GSP to address the management of the Salinas Valley Basin in its entirety. The 180/400 Foot Aquifer subbasin will be addressed as a chapter within the Valley-Wide Integrated GSP. After the 2020 submittal of the Valley-Wide Integrated GSP, the Salinas Valley Basin GSA will continue development of the remaining five subbasin-specific plans, which are not due until January 1, 2022. As these additional subbasins' GSPs are developed, the Valley-Wide Integrated GSP will be updated for consistency. DWR has 2 years to review each submitted GSP.

The first quantitative analysis proposed by the Salinas Valley Basin GSA is to develop a water budget for the Salinas Valley. The Salinas Valley Basin GSA plans to use the forthcoming Salinas Valley Integrated Hydrological Model that is being developed by the U.S. Bureau of Reclamation, U.S. Geological Survey, and MCWRA.

Groundwater elevation data from the California Statewide Groundwater Elevation Monitoring Program (CASGEM) will be an integral part of monitoring under the GSP. Since 2010, MCWRA has been the designated monitoring entity for three high-priority and four medium-priority groundwater subbasins in the Salinas Valley Basin. High priority subbasins include the 180/400 Foot Aquifer, Eastside Aquifer, and Paso Robles Area subbasins (Figure 2-4). The medium-priority subbasins are Forebay Aquifer, Upper Valley Aquifer, Langley Area, and Corral de Tierra Area subbasins. In addition to these, MCWRA will monitor three low- or very-low priority groundwater subbasins in Monterey County at a later date: Cholame Valley, Lockwood Valley, and Peach Tree Valley subbasins. MCWRA developed a monitoring plan to meet the requirements of the CASGEM program, which details how participants will collect groundwater elevation data in those groundwater basins for which MCWRA is the designated monitoring entity. The subareas monitored comprise 48 wells, some of which are owned by MCWRA and others that are privately owned but whose owners have volunteered the well for inclusion in the CASGEM program (Monterey County Water Resources Agency 2015).

Marina Coast Water District Groundwater Sustainability Plan

The MCWD is the GSA for the MCWD GSP. MCWD's Central Marina and Ord Community water service areas overlie portions of the Monterey subbasin, the 180/400 Foot Aquifer subbasin, and part of the Seaside Adjudicated basin. Three of the district wells are located in Central Marina, and five wells are in the Ord Community.

DWR granted MCWD exclusive GSA status within its jurisdictional boundaries in the Monterey subbasin and the 180/400 Foot Aquifer subbasin. MCWD will be engaged in the development of GSPs for the entirety of these two subbasins, in coordination with other GSAs within these subbasins (Marina Coast Water District and Marina Coast Water District Groundwater Sustainability Agency 2018).

The 180/400 Foot Aquifer subbasin GSP will be prepared by January 31, 2020, and the Monterey subbasin GSP will be prepared by January 31, 2022.

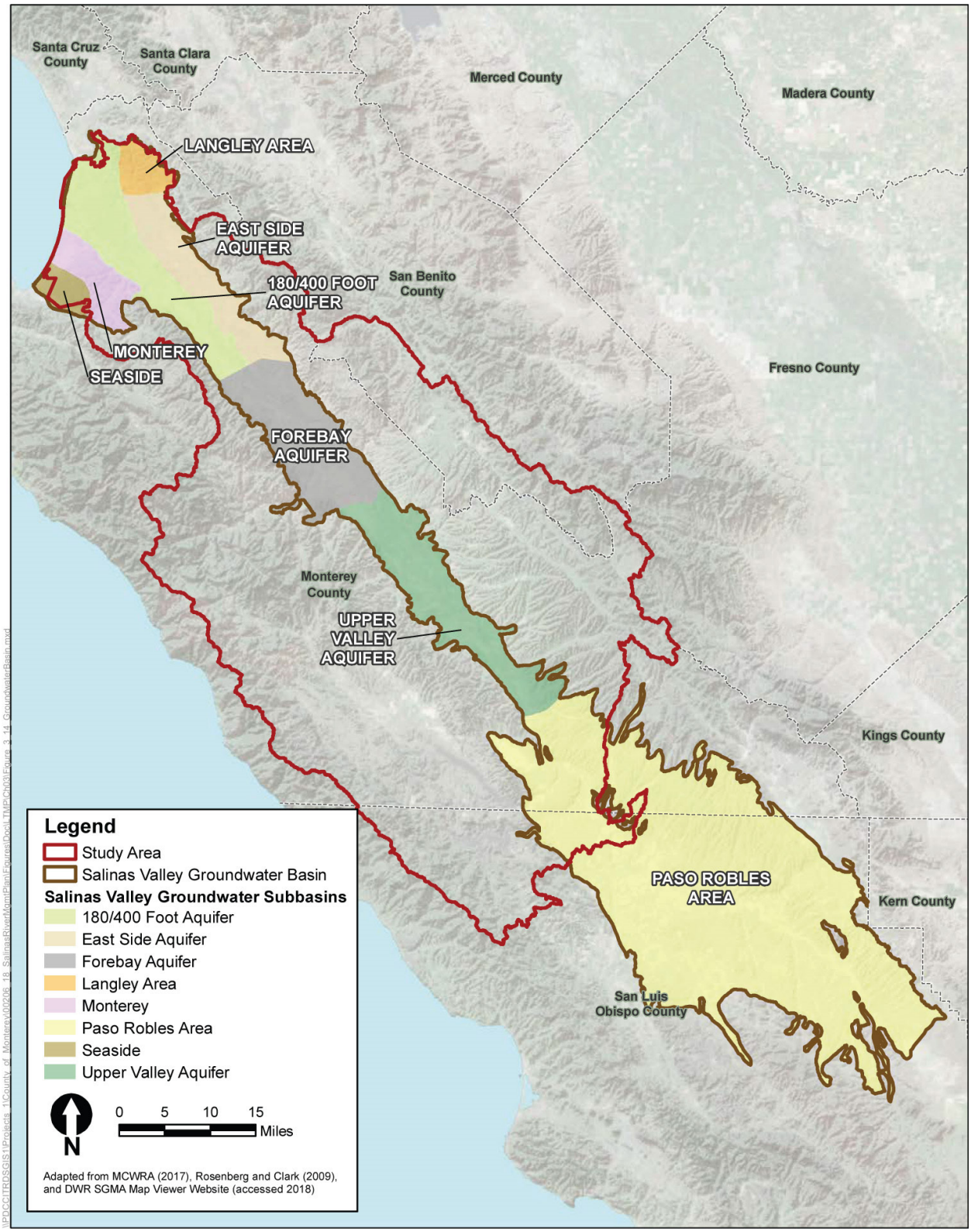


Figure 2-4. Salinas Valley Groundwater Basin

City of Marina Groundwater Sustainability Plan

The City of Marina is the GSA for the City of Marina GSP. The boundary of the City of Marina GSA overlies a small portion of the 180/400 Foot Aquifer subbasin located within city limits but outside of the MCWD service area. The 180/400 Foot Aquifer subbasin GSP will be prepared by January 31, 2020.

Arroyo Seco Groundwater Sustainability Plan

The Arroyo Seco GSA was founded in 2017. The Arroyo Seco GSA's mission is to develop a comprehensive GSP by 2022 and successfully implement the plan over SGMA's planning and implementation horizon of 50 years to demonstrate long-term groundwater basin sustainability. The Arroyo Seco GSA is governed by a five-member board representing diverse interests from the Arroyo Seco region. The Arroyo Seco GSA board is advised by a nine-member advisory committee comprised of individuals representing a cross section of varied social, environmental, and economic interests in the Arroyo Seco region (City of Greenfield 2018).

The Arroyo Seco GSA addresses the area geographically bound by Greenfield. The Arroyo Seco GSA is also seeking approval from DWR to include in its jurisdiction adjacent unincorporated lands that are the lower watershed of the Arroyo Seco. Both the city limits of Greenfield and the requested unincorporated areas overlaps with the Forebay Aquifer subbasin. Because the City of Greenfield has jurisdiction over a portion of the Forebay Aquifer subbasin and its interests are primarily tied to the lower Arroyo Seco (an area known as the *Arroyo Seco cone*), the City of Greenfield is seeking to develop a GSP specific to its jurisdiction and area of interest. The Arroyo Seco GSP, which is currently proposed as a standalone GSP from the Forebay Aquifer GSP, will be prepared by January 31, 2022.

2.4.2.4 WaterSMART Basin Study

The WaterSMART Basin Study for the Salinas River Basin (Basin Study) is a comprehensive water resources assessment of the Salinas River Valley funded by U.S. Bureau of Reclamation, MCWRA, Monterey Peninsula Water Management District, San Luis Obispo County Public Works, and Monterey One Water. The study, developed in 2017, is part of U.S. Bureau of Reclamation's Sustain and Manage America's Resources for Tomorrow (WaterSMART)[6] program that funds and oversees watershed basin studies nationwide.

The Basin Study will assess the general health of the Salinas River and Carmel River watersheds and groundwater basins and their abilities to provide sustainable water supplies into the future with respect to climate change over the next century. The study authors will downscale global models specifically to the Central Coast to predict what the hydrology of the Salinas River might look like in the future with a changing climate (U.S. Bureau of Reclamation 2017).

The Basin Study will be developed in coordination with the Monterey Peninsula Water Management District, which is simultaneously developing the *Monterey Peninsula Drought Contingency Plan*. Developed together and sharing hydrology, climate data and other common elements, these two studies will provide a robust view of how potential future climate conditions may impact water supplies and demands. Ultimately, these studies will be used to represent how imbalances between

[6] U.S. Bureau of Reclamation WaterSMART Program, available at https://www.usbr.gov/watersmart/.

future water supplies and demands may be mitigated or reduced by implementing various actions and adaptation strategies (U.S. Bureau of Reclamation 2017).

The objectives of the Basin Study are as follows.

1. Improve regional collaboration in the development of a comprehensive assessment of supplies and demands in each river basin and subbasins.
2. Identify a set of potential future climate conditions to year 2100 and assess the impacts of these future conditions to existing and projected future supplies and demands.
3. Identify solutions and adaptation strategies which respond to the imbalances projected between supplies and demands.

These objectives will help water managers make informed decisions on water use, plan for future water supplies, and propose adaptive strategies to mitigate for effects of climate change. The total funding needed for the Basin Study is projected to be $1.66 million. The U.S. Bureau of Reclamation will provide funding as the federal share, and the non-federal costs will be shared by the partners with in-kind services contributions.

The Basin Study encompasses the entire watersheds of the Salinas and Carmel River basins, including the Monterey Peninsula. Together, the two basins encompass an area of approximately 4,500 square miles (U.S. Bureau of Reclamation 2017).

2.4.2.5 Greater Monterey County Integrated Regional Water Management Plan

Integrated regional water management (IRWM) is an approach to water management that is being strongly promoted by state water managers and legislators as a way to increase regional self-sufficiency. IRWM encourages local water resource managers to take a proactive leadership role in solving water management problems on a local level through collaborative regional planning. This regional approach is considered necessary in order for water managers to cope with the impending water management challenges ahead. The IRWM Plan is congruent with local plans and includes current, relevant elements of local water planning and water management issues common to multiple local entities in the region (Figure 2-5). IRWM planning does not replace or supersede local planning; rather, local planning elements are used as the foundation for the regional planning effort.

The Greater Monterey County Regional Water Management Group (RWMG) is the entity tasked with developing and implementing the IRWM Plan, reviewing projects submitted to the plan, and choosing which projects to put forward for funding. The Greater Monterey County RWMG has no special legal authority or regulatory power; it is simply a group of local agencies and organizations that have volunteered to identify water resource management projects in the Greater Monterey County region and to submit grant applications to the state on behalf of the region.

The Greater Monterey County IRWM Plan was formally adopted by vote of the RWMG on April 17, 2013. Between 2017 and 2018, the plan was updated to comply with 2016 IRWM program guidelines. On September 19, 2018, at a regularly scheduled RWMG meeting that was open to the public, RWMG voted to approve the updated IRWM Plan.

Source: Regional Water Management Group 2018.

Figure 2-5. Greater Monterey County Integrated Regional Water Management Plan Region

The RWMG for the Greater Monterey County IRWM region includes government agencies, nonprofit organizations, educational organizations, water service districts, private water companies, and organizations representing agricultural, environmental, and community interests. The RWMG members were chosen to ensure balanced representation of the various resource areas, interests, and geographic areas throughout the Greater Monterey County region, and consist of the following 18 entities.

- Big Sur Land Trust
- California State University Monterey Bay
- California Water Service Company
- Castroville Community Services District
- Central Coast Wetlands Group (CCWG) at Moss Landing Marine Laboratories
- City of Salinas
- City of Soledad
- Elkhorn Slough National Estuarine Research Reserve
- Environmental Justice Coalition for Water
- MCWD
- Monterey Bay National Marine Sanctuary (Sanctuary)
- Monterey County Agricultural Commissioner's Office
- Monterey County Resource Management Agency
- MCWRA
- Monterey Regional Water Pollution Control Agency
- RCDMC
- Rural Community Assistance Corporation
- San Jerardo Co-Operative, Inc.

The Greater Monterey County IRWM region lies entirely within the Central Coast Regional Water Quality Control Board (Regional Water Board) district and is part of the IRWM Central Coast Funding Area. Adjacent IRWM regions are the Pajaro River Watershed IRWM region; Monterey Peninsula, Carmel Bay, and South Monterey Bay IRWM region; and San Luis Obispo County IRWM region. Together these four regions, plus the Northern Santa Cruz County and the Santa Barbara County IRWM regions, form the Central Coast IRWM Funding Area.

The Greater Monterey County IRWM region includes the entirety of Monterey County exclusive of the Pajaro River Watershed IRWM region and the Monterey Peninsula, Carmel Bay, and South Monterey Bay IRWM region established under Proposition 50. The Greater Monterey County IRWM region also includes a small portion of San Benito County where the Salinas River watershed extends outside of Monterey County. Generally, the region includes the entire Salinas River watershed north of the San Luis Obispo County line, all of the Gabilan/Tembladero and Bolsa Nueva watersheds in the northern part of the county, and all of the coastal watersheds of the Big Sur coastal region within Monterey County.

The IRWM Plan goals and objectives are at the very foundation of the IRWM planning process. The goals and objectives are the response to what the RWMG perceives to be the major water resource issues in the region and as such, reflect the RWMG's water resource management values and overall priorities for the region. The objectives give focus to the plan, provide the basis for determining which resource management strategies are appropriate for use in the region, guide project development, and are used to evaluate project benefits.

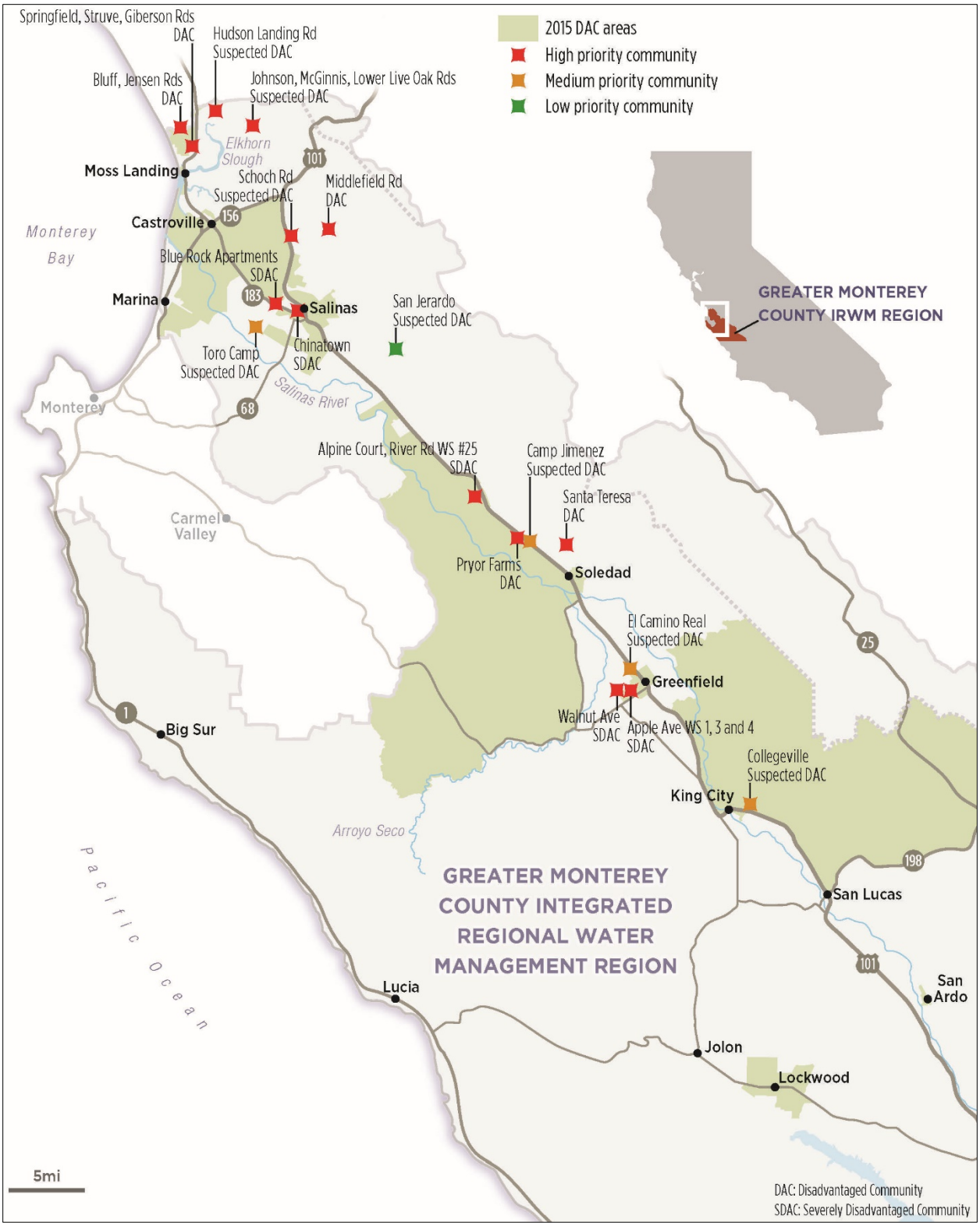
The goals for the Greater Monterey County IRWM planning region are as follows.

- **Water Supply**. Improve water supply reliability and protect groundwater and surface water supplies.
- **Water Quality**. Protect and improve surface, groundwater, estuarine, and coastal water quality, and ensure the provision of high-quality, potable, affordable drinking water for all communities in the region.
- **Flood Protection and Floodplain Management**. Develop, fund, and implement integrated watershed approaches to flood management through collaborative and community-supported processes.
- **Environment.** Protect, enhance, and restore the region's ecological resources while respecting the rights of private property owners.
- **Disadvantaged Communities**. Ensure the provision of high-quality, potable, affordable water and healthy conditions for disadvantaged communities.
- **Climate Change**. Adapt the region's water management approach to deal with impacts of climate change using science-based approaches and minimize regional causal effects. On November 8, 2017, the Greater Monterey County RWMG voted to approve the *Integrated Plan to Address Drinking Water and Wastewater Needs of Disadvantaged Communities in the Salinas Valley and Greater Monterey County IRWM Region*. This plan focuses on small disadvantaged communities, and communities suspected to be disadvantaged, in unincorporated areas that are served by state small water systems (5–14 connections), local small water systems (2–4 connections), and private domestic wells.

A new viewing platform, the Greater Monterey County Community Water Tool, has been created to show the locations of disadvantaged communities and suspected disadvantaged communities (Figure 2-6), geographic areas with water quality contamination (including nitrate, arsenic, and hexavalent chromium contamination), and the boundaries of nearby water districts.

2.4.2.6 Greater Monterey County Storm Water Resources Plan

The *Greater Monterey County Storm Water Resources Plan* (SWRP) is being drafted in accordance with the SWRP Guidelines and complies with all relevant Water Code provisions. The draft is anticipated to be finalized in June 2019. The geographic coverage area of Greater Monterey County SWRP is coterminous with the boundaries of the Greater Monterey County IRWM region, with a special focus for the purposes of stormwater planning in the Salinas River, Gabilan/Tembladero, Moro Cojo, Elkhorn, and McClusky watersheds (Figure 2-7).



Source: Regional Water Management Group 2018.

Figure 2-6. Disadvantaged and Suspected Disadvantaged Communities in the Greater Monterey County Integrated Regional Water Management Region

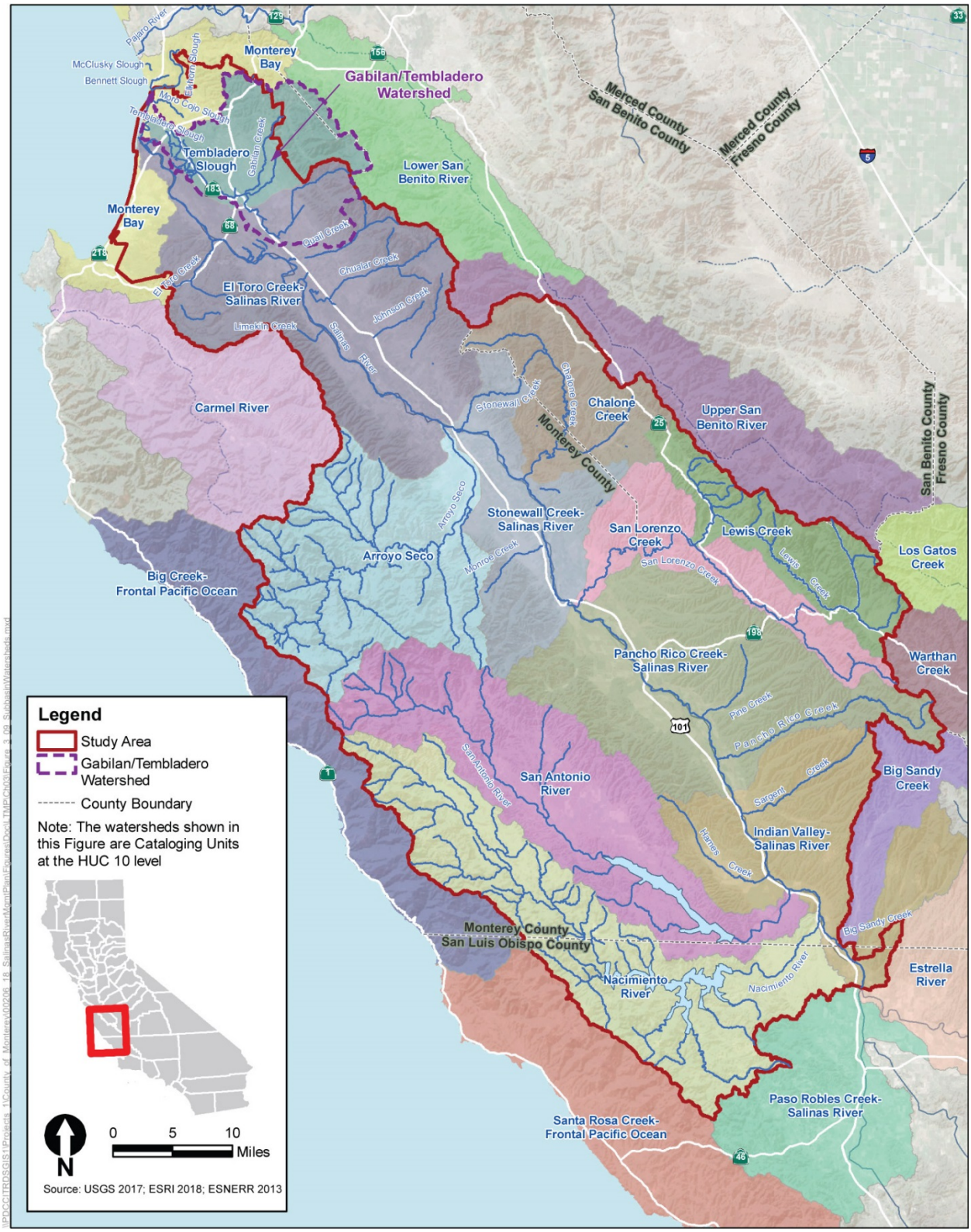


Figure 2-7. Watersheds in the Study Area

The purpose of the SWRP is to promote stormwater management implementation projects that provide regionally optimized benefits of increased water supply, improved water quality, better flood protection, enhanced environmental quality, and greater community opportunity. The SWRP achieves that purpose by (1) characterizing current stormwater dynamics in terms of sources, volume, flow, timing, quality, and rights and (2) identifying geographically and temporally specific opportunities to divert, capture, store, treat, recharge, and reuse this resource to guide the development of implementation projects that optimize regionally integrated benefits.

While traditional approaches to stormwater management consider stormwater and dry weather runoff as a problem to be addressed, this plan considers it as a potential resource. Projects that utilize stormwater and dry weather runoff as a resource can result in the following multiple benefits (Water Code §§ 10561(g), 10561(h), and 10562(b)(2)).

- Creation and restoration of wetlands.
- Enhanced riparian habitats.
- Increased instream flows.
- Increased park and recreation lands.
- Increased urban green space.
- Augmented recreation opportunities for communities.
- Increased tree canopy.
- Reduced heat island effect.
- Improved air quality.
- Improved water quality.
- Increased water supply.
- Improved flood management.
- Increased environmental benefits.

The SWRP uses a watershed-based approach to identify regionally integrated opportunities to beneficially reuse stormwater within the Greater Monterey County region, focusing on the Salinas River, Gabilan/Tembladero, Moro Cojo, Elkhorn, and McClusky watershed areas. Using modeling and other tools, the plan also identifies priority infiltration and recharge opportunity areas, urban bio-retention areas, and areas for potential floodplain and open space enhancement. Projects in the plan are prioritized by evaluating project benefits with respect to watershed-based stormwater management goals.

The SWRP contains the following five goals.

- **Water Supply**. Manage stormwater to increase water supply for urban, agricultural, and environmental uses.
- **Water Quality**. Improve water quality so that waters in the planning area are suitable for human and environmental uses.
- **Flood Management**. Manage stormwater systems to reduce surface water peak flows and flood risk.

- **Environment.** Protect, preserve, restore, and/or enhance watershed features and processes through stormwater management.
- **Community.** Enhance economic prosperity and quality of life through improved urban spaces, availability of clean water, and related job creation and training.

This plan will be considered a living document. By identifying both implementation projects and concept projects, the plan will provide a useful and comprehensive long-term planning tool for stormwater resource management in the Greater Monterey County region.

The Greater Monterey County RWMG is the entity responsible for decisions related to IRWM planning in the Greater Monterey County IRWM region. The RWMG has served as the Technical Advisory Committee for this SWRP and, as such, has participated in the decision-making during the plan's development. Upon completion of the SWRP in June 2019, the plan will be formally submitted to the RWMG per the Water Code provisions (Water Code § 10562, (b)(7)). Monterey Bay National Marine Sanctuary Water Quality Protection Partnership

The Sanctuary is a federally protected marine preserve established in 1992 by the National Oceanic and Atmospheric Administration under the authority of the National Marine Sanctuaries Act. It comprises Central California coastal waters, from Marin County to San Luis Obispo County, encompassing a shoreline length of 276 miles and 4,601 square miles of the Pacific Ocean. Containing extensive kelp forests and one of North America's largest underwater canyons, the Sanctuary supports an incredible array of marine life including 36 species of marine mammals, over 180 species of seabirds and shorebirds, over 525 species of fishes, and a bounty of invertebrates and algae (National Oceanic and Atmospheric Administration 2018).

Due to its proximity to the coastline, the Sanctuary is vulnerable to pollution from approximately 7,000 square miles of surface waters from the surrounding watersheds that distribute contaminants such as sediments, nutrients, fecal bacteria, pesticides, oil, grease, metals, and detergents. To ensure water quality protections for the Sanctuary, a memorandum of agreement was signed in 1992 and updated in 2006 by eight federal, state and local agencies to develop a water quality protection program. By using a collaborative approach involving key stakeholders for specific issues, the program committee has completed action plans for the following categories.

- Agriculture and rural land.
- Beach closure and microbial contamination.
- Citizen watershed monitoring network.
- Marinas and boating.
- Regional monitoring.
- Wetlands and riparian corridors.
- Urban runoff.

As part of the Urban Runoff Action Plan, MCWRA and the County of Monterey are collaborating with the Cities of Monterey, Pacific Grove, Seaside, Carmel, Marina, Del Rey Oaks, and Sand City to implement the Monterey Regional Storm Water Management Program (MRSWMP) for the Monterey Peninsula. The goal of the MRSWMP is to meet water quality standards for urban runoff required by the Clean Water Act to protect and enhance public health and natural water resources including watersheds, beaches, and the coastal waters of the Sanctuary. The MRSWMP identifies stormwater

capture projects within the jurisdiction of the partnering entities to collect, store, and treat stormwater runoff including dry weather flows from excess irrigation runoff (Monterey Regional Stormwater and Education Alliance 2018).

2.5 Other Applicable Planning Efforts

The following summarizes current research and planning efforts that are expected to have some bearing on how the Salinas River is managed in the long term.

2.5.1 Central Coast Wetlands Group

The CCWG is an affiliate research group at Moss Landing Marine Laboratories focused on the study, preservation, and restoration of Central Coast wetlands. The group was started in response to federal and state interests in coordinating wetland activities throughout California. The state and federal governments have adopted a *no net loss* policy for wetlands but currently have few mechanisms to track the implementation or success meant to achieve this policy. The CCWG has begun to build the necessary infrastructure, working closely with regional partners (U.S. Environmental Protection Agency, the Sanctuary, California State University Monterey Bay, Central Coast Regional Water Board, the RCDMC, MCWRA) who have active programs throughout the Central Coast. Four CCWG projects located within the Salinas River watershed are described below.

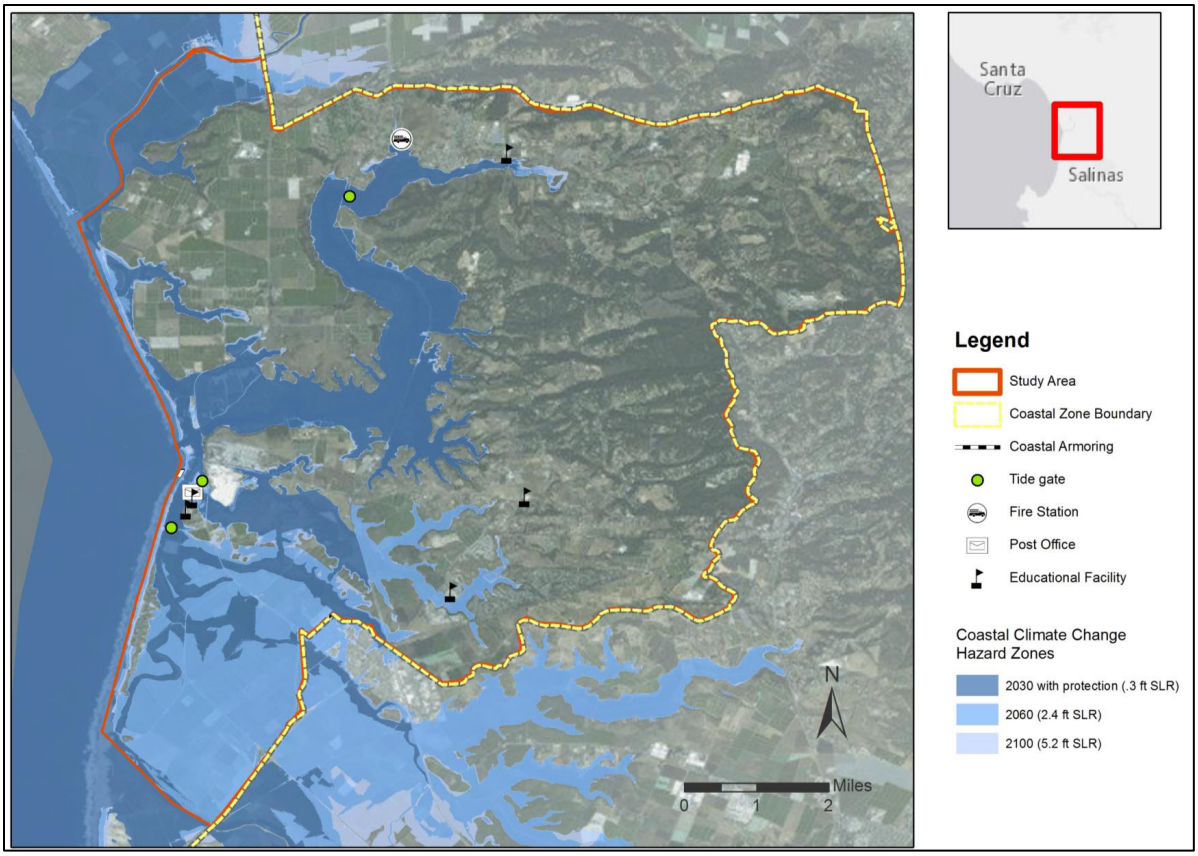
2.5.1.1 Moss Landing and Lower Salinas Valley Sea Level Rise Vulnerability Analysis

To benefit local coastal planning and foster discussions with state regulatory and funding agencies, the Moss Landing and Lower Salinas Valley sea level rise vulnerability report provides a predictive chronology of risks associated with future sea level rise and coastal climate change in the lower Salinas Valley. Estimates of the extent of assets at risk of various climate hazards were made using best available regional data. This approach allows planners to understand the full range of possible impacts and to understand the overall risk posed by sea level rise in this region (Central Coast Wetlands Group 2017).

The report's hazard maps show projected hazard zones for various climate scenarios for three planning horizons, and the report's hazard analysis focuses on a subset of those scenarios. Figure 2-8 illustrates the combined hazard areas for future sea level rise and coastal climate change.

The analysis achieved three key objectives to further regional planning for the inevitable impacts associated with sea level rise and its confounding effects on fluvial processes within the Moss Landing community and surrounding region (Central Coast Wetlands Group 2017). The analysis specifically determined the following.

- What critical coastal infrastructure may be compromised and when.
- How fluvial processes may increase flooding risk to coastal communities.
- Appropriate response strategies for these risks to discuss with regional partners the programmatic and policy options that can be adopted within community plans and updates to hazard mitigation plans.



Source: Central Coast Wetlands Group 2017.

Figure 2-8. Coastal Climate Change Hazard Zones in Northwestern Monterey County

2.5.1.2 Water Balance and Flood Modeling for the Greater Monterey County Storm Water Resources Plan

The CCWG and Environmental Science Associates developed modeling tools to enable quantitative assessment of project opportunities in the Greater Monterey County IRWM region. The models were developed to support a new stormwater resources plan (i.e., the SWRP) for this region. Environmental Science Associates developed two primary models to characterize current conditions and project benefits within the planning region. These include a water balance model, which simulates simple rainfall-runoff and routing processes within the entire Salinas River watershed, and a flood model which simulates channel and floodplain hydraulics capturing water level and flood inundation extents for parts of the Gabilan/Tembladero watershed (Environmental Science Associates and Central Coast Wetlands Group 2018).

2.5.1.3 Old Salinas River Enhancement Project

Enhancement of the OSR has been a long-term objective discussed within numerous watershed plans in the region. Enhancement goals for this drainage include flood attenuation and adjacent agriculture flood protection, water quality enhancements, lagoon flood management and habitat connectivity, fish migration, habitat enhancement, and coastal access. A key challenge to making progress on any of these objectives is that the lands adjacent to (and including the channel itself) are privately owned by local farmers. Other than working toward flood protection goals, the adjacent

landowners have not prioritized meeting these other environmental objectives for the OSR (Central Coast Watershed Studies 2006).

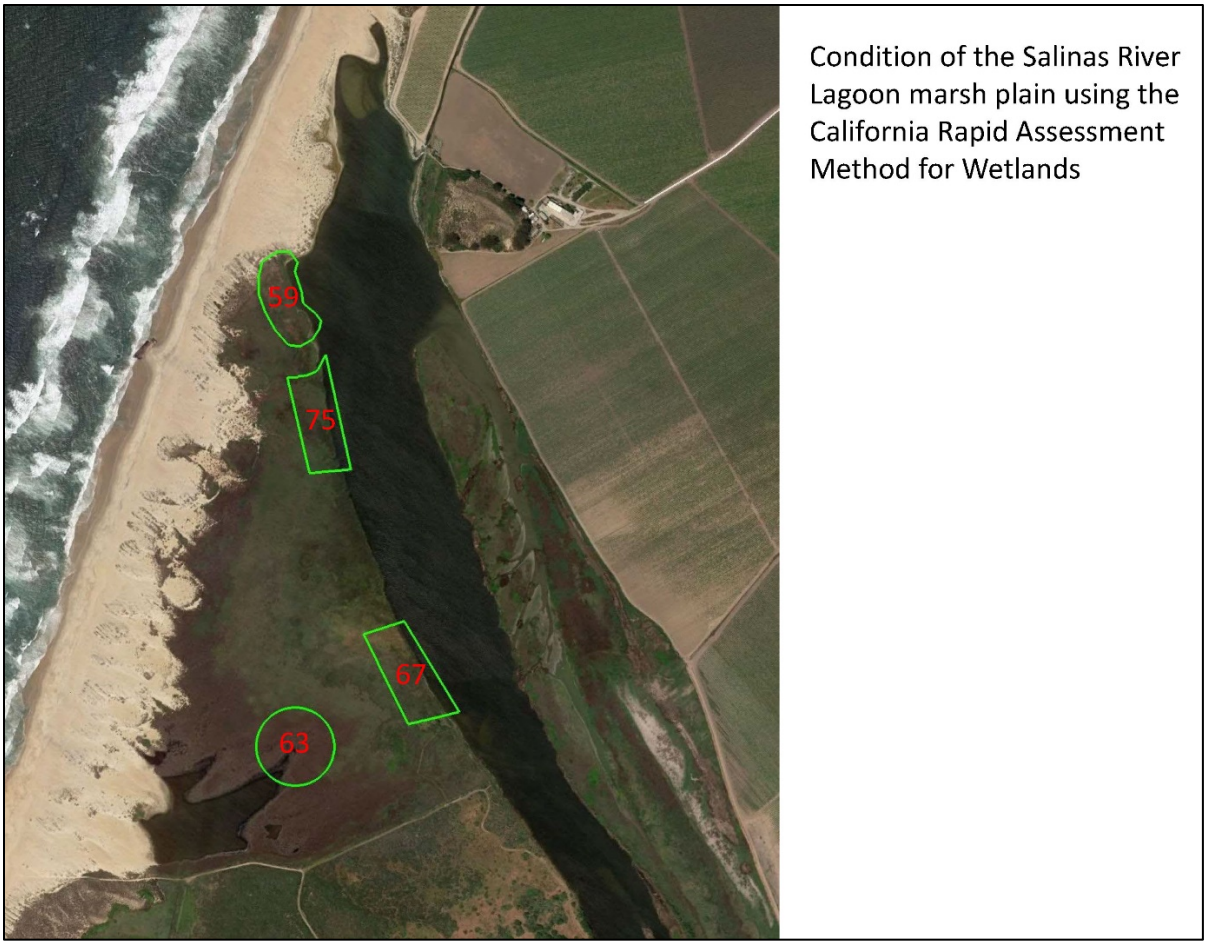
Recently, however, CCWG has worked with landowners on both sides of the OSR to integrate water quality and other environmental objectives into their farming operations, leading to the implementation of water quality enhancement projects on and adjacent to these farmers' lands. Positive water quality results of those projects have been documented and submitted to regulatory agencies for review and consideration. Current discussions with the Central Coast Regional Water Board regarding how to incentivize landowners to take further actions are underway, and landowners have identified other lands for water quality and possibly habitat enhancement efforts if regulatory incentives are established.

To demonstrate potential benefits of landowner collaboration to solve environmental goals, Scattini and Sons farms agreed to have initial habitat and water quality enhancement plans drafted for their portions of the OSR. The draft habitat enhancement designs are intended to improve water quality, increase flow and decrease flooding, and benefit fish habitat and fish passage objectives. The designs use local tidal action (documented at two locations within the OSR) to direct flows through linear treatment wetland areas, flowing back into the main channel downstream during subsequent low tides. Initial nitrate load reductions for this system are estimated to range between 500 and 4,000 kilograms per year.

2.5.1.4 California Rapid Assessment Method for Wetlands of the Salinas River Lagoon

Central Coast Wetlands Group assessed the condition of the Salinas River Lagoon marsh plain in 2012 and 2015. The California Rapid Assessment Method for Wetlands (CRAM) was used to conduct the assessments of existing vegetation and habitat at four sites on the marsh plain. CRAM measures quantity and quality of vegetation conditions of four main habitat attributes of the veg and habitat: Hydrology, Physical Structure, Biotic Structure and Buffer/Landscape Context. CRAM Index scores are divided into four categories: Excellent (82–100); Good (63–81); Fair (44–62); and Poor (25–43). During the analysis, CRAM Index scores ranged from 59 on the channel edge near the mouth to 75 farther east along the channel in a more established area of the marsh (Figure 2-9). The average score for the system is 66 (good). This puts the lagoon in the 33rd percentile of 94 similar bar-built estuaries assessed along the entire California coastline (Central Coast Wetlands Group 2015).

Several stressors were identified on the site during the assessments. While not factored into the CRAM scores, stressors can provide more detailed insight about what may be adversely affecting the ecological condition of the river, stream, or creek. Stressors that were consistently observed on the site include non-point sources from agricultural areas, nutrients and pesticides, and dikes and levees along the river (Central Coast Wetlands Group 2015).



Source: Central Coast Wetlands Group 2015.

Figure 2-9. Assessment Locations and Scores from the California Rapid Assessment Method for Wetlands

2.5.2 Resource Conservation District of Monterey County

As of 2008, the RCDMC is implementing the Salinas Watershed Invasive Nonnative Plant Control and Restoration Program, a large-scale invasive plant removal program across the Salinas River watershed, with a goal of eradicating Arundo and other invasive species along 90 infested river miles in 20 years (Resource Conservation District of Monterey County 2011). The program involves grant and mitigation funding to the RCDMC and its partners for the restoration of riparian habitat in the Salinas River watershed through the control of invasive nonnative plants (mainly Arundo) and the planting of native species. Current partners include Monterey County Agriculture Commissioner, and private landowners.

The project area encompasses the Salinas River and its tributaries within Monterey County and is predominately private land. No work occurs without a right-of-entry agreement signed by both the landowner and the RCDMC. Lands owned by the federal government are excluded from the program area (Resource Conservation District of Monterey County 2011).

The program's activities include intensive abatement including herbicide treatments and biomass reduction measures, such as aggressive mowing with heavy equipment and weeding by hand. The

program uses a systematic approach of starting upstream and working downstream to preclude any further dispersal of Arundo by clonal material (i.e., root balls) floating downstream. The herbicide treatment cycle typically involves foliar application of herbicide (aquatic approved herbicide formulations of glyphosate, imazapyr, or triclopyr). Treatments are applied from July to November. To avoid impacts on non-target plants, stands are prepped for spraying. The prepping creates a physical space between target and non-target plants. Arundo is pushed away from native shrubs and trees, and the natives may be trimmed (<6-inch diameter). Arundo is typically not cut, as this reduces treatment efficacy. A marking dye is added to the herbicide mix to allow applicators to see and minimize chemical drift and ensure thorough coverage of target plants. Crews apply targeted herbicide using hand-held sprayers (foliar application method). No broadcast applications are made from booms, aircraft, or other mechanical devices. Only target plants are treated with herbicide (Resource Conservation District of Monterey County 2011).

Active re-vegetation is another key component of the program for most project areas that have biomass reduction (i.e., mowing of invasive plants). Effective control of target plants is required prior to re-vegetation to avoid situations where re-treatments would harm a significant number of plantings. For areas that are treated first and then followed by biomass reduction, planting typically occurs immediately if conditions are suitable. Areas that have biomass reduction first and then have re-growth treated in multiple cycles will typically not be planted with natives until after the second year of treatment. Native seedlings derived from the Salinas River watershed are grown, planted, and monitored as part of the re-vegetation effort (Resource Conservation District of Monterey County 2011). In the first phase of the program between 2008 and 2009, Arundo, tamarisk, and tree tobacco were sprayed between the Monterey/San Luis Obispo County line to King City. The next phase of the program began in 2014, beginning near Greenfield and working downstream. As of August 2018, the program has implemented removal measures from Greenfield to Soledad (Zefferman pers. comm.).

The RCDMC's roles in administering the program are as follows.

- Fundraising.
- Securing required permits.
- Recruiting landowners into the program.
- Overseeing the implementation of weed control activities on private lands.
- Providing biological monitoring of treated areas.
- Ensuring regulatory compliance.
- Coordinating financial and technical assistance for private landowners interested in performing their own control efforts.

As a result of the program, over 450 acres of Arundo have been eradicated or are severely supressed (and being repeatedly treated). The RCDMC continues to seek funding and landowner cooperation to advance the program downstream.

Funding sources include grants from CDFW, Wildlife Conservation Board, California Department of Transportation, California Department of Food and Agriculture, USFWS, Natural Resources Conservation Service, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Forest Service, Monterey County, and the State Water Resources Control Board. Other sources include donations and in-lieu-fee type mitigation programs (Resource Conservation District of Monterey County 2018).

2.5.3 Transportation Agency of Monterey County

The Transportation Agency of Monterey County has initiated the development of a regional conservation investment strategy (RCIS) for Monterey County. The RCIS will identify areas of conservation priority for implementation of conservation actions and habitat enhancement actions by Transportation Agency of Monterey County to facilitate appropriate mitigation actions for its proposed transportation projects throughout Monterey County. The RCIS will assess the vulnerability of species and habitat to climate change–related stressors (e.g., drought, wildfire, and landslides); develop conservation strategies to improve resiliency from the identified stressors; and define a framework to finance the implementation of these conservation strategies as compensatory mitigation from new transportation improvements. The types of conservation strategies that are eligible to be included in an RCIS will both directly and indirectly contribute to the climate resiliency of Monterey County's transportation infrastructure, including wildlife crossings, wetlands restoration, and habitat acquisition and conservation, supporting several state initiatives and priorities. Some examples of potential conservation strategies that could be identified through the RCIS process are as follows.

- Wildlife crossings under or over state highways and highly travelled regional corridors, such as the Scenic State Route 68 between Monterey and Salinas, to preserve and improve habitat connectivity while reducing animal–vehicle conflict points.
- Wetlands protection and restoration that protects transportation infrastructure from the effects of flooding and stormwater impacts, such as State Route 156 in north Monterey County.
- Land acquisition for species and habitat restoration and conservation that results in more drought-tolerant and healthy habitat that in turn protects nearby infrastructure from climate-related events such as wildfires and landslides.

2.5.4 Upper Salinas–Las Tablas Resource Conservation District

Central Coast Salmon Enhancement (CCSE), in cooperation with the Upper Salinas–Las Tablas Resource Conservation District, is preparing several components of a future watershed management plan for the Salinas River that is intended to create a path to resilience in the watershed's communities and for its natural resources. These components will illuminate critical issues for watershed protection and management and identify knowledge gaps. One of these components is the Watershed Resources Inventory—an encyclopedic list of documents from projects, plans, guidance documents, and regulatory products paired with an annotated bibliography to act as a quick reference for individuals to learn about the current or historical status of the Salinas River watershed's most important features. The current status of the Salinas River watershed will also be reported in an existing conditions document, which will rely on many of the documents in the Watershed Resources Inventory, as well as information exchanged with CCSE partners (e.g., MCWRA) on current developments. The consolidation of this information will aid in future determinations of resource management priorities and actions, such as those involving steelhead trout in the Salinas River watershed (Wald pers. comm.).

CCSE is collaborating with Stillwater Sciences to create a conceptual model for steelhead in the Salinas River watershed based on historical information, data and observations of fish counts, river hydrology, fish passage barriers, and other physical parameters relevant to the survival and life

cycle of steelhead trout. The aim of these works is to bridge the jurisdictional divide between the upper and lower Salinas two-county decision-making paradigm and better coordinate upstream and downstream plans and actions for the watershed's protection and management. CCSE believes that this is an important step toward making the Salinas River and the communities that depend on it more resilient to change and improving the accuracy and speed of responses to change (Wald pers. comm.).

Chapter 3
Historical and Existing Conditions

This chapter describes the historical and existing abiotic and biotic conditions of the *Salinas River Long-Term Management Plan* (LTMP) study area, including the physical characteristics, land uses, water uses, and biological resources. Additionally, the chapter summarizes the environmental pressures and stresses on the river hydrology and natural communities within the study area.

The physical characteristics of the LTMP study area include the location, topography, geology, soils, climate, watersheds, hydrology and geomorphology, historical flooding, groundwater, and water quality. The LTMP study area includes 118 river miles of the Salinas River (69% of the total length of the Salinas River) and many of its primary tributaries: Arroyo Seco, Nacimiento River, San Antonio River, and San Lorenzo Creek. The topography of the study area is characterized by the high elevations of the Coast Ranges to the west and the Gabilan and Diablo Ranges to the east of the Salinas River down to the Salinas Valley, which comprises the lower elevations of the study area. Geologically recent tectonic activity, including movement on the Rinconada–Reliz Fault Zone (Rosenberg and Clark 2009) formed the Salinas Valley and Santa Lucia, Sierra de Salinas, Gabilan, and Diablo Mountain Ranges, which were uplifted to their present elevations in Quaternary time (2.6 million years ago [Ma] to present; Rosenberg 2001). The soils of the study area are derived from the underlying geologic formations. Productive agriculture of the Salinas Valley is supported by deep, dark, fertile soils, such as the Salinas clay loams. In addition, several classes of miscellaneous soils were mapped that included tidal marsh, peat, coastal beach and dune sands and the management area is dominated by the following four soil orders: mollisols, entisols, vertisols, and alfisols.

Climate in the study area is characterized by a Mediterranean climate with cool wet winters and warm dry summers. The Pacific Ocean influences the climate close to the coast, where the weather is often overcast or has coastal fog and cool temperatures. The inland areas are warmer in the summer and colder in winter. Precipitation in the study area varies from approximately 15 to 60 inches annually. The mountainous areas near the coast receive much more precipitation than the Salinas Valley, which has an annual average of approximately 15 inches of precipitation.

The bulk of the study area is located within the Salinas River watershed, with a small portion of the study area—near the mouth of the Salinas River—within the Monterey Bay watershed. Hydrology and geomorphology discussions in this chapter include historical and existing conditions of the upper watershed (River Mile [RM] 53 near Greenfield to RM 118 near San Miguel), Salinas River Valley (RM 53 to RM 7) and the Salinas River Lagoon (RM 7 to RM 0 from Blanco Road to Highway 1, downstream to the Salinas River Lagoon). Historical flooding in each watershed is also discussed.

The groundwater discussion of this chapter covers groundwater basins, groundwater recharge, and groundwater pumping. There are eight groundwater subbasins in the Salinas Valley Basin and these are described in geological terms. The ways groundwater recharge takes place in the groundwater basin is discussed. Groundwater is pumped to supply water for agricultural, residential, and municipal uses in the study area.

The water quality of the lower Salinas Valley is well documented by the Central Coast Regional Water Quality Control Board (Regional Water Board). Water quality issues range from groundwater contamination by nitrates and seawater intrusion to surface water contamination from agricultural

chemicals and urban runoff. The following listed impairments known from the study area are further discussed in the chapter: fecal indicator bacteria, nutrients, pesticides, pH, salinity, sediment toxicity, turbidity, mercury, and water temperature.

Land use is discussed in three sections: historical land use, current land use, and protected lands. Historically, the Ohlone, Salinan and Esselen people used the lands in the Salinas Valley for hunting and gathering. Currently, land use is designated as agricultural and open space in the study area, except when the Salinas River approaches cities and unincorporated communities, where land uses are in most cases designated residential, industrial, resource conservation, and public/quasi-public. Protected lands within the management and study areas include lands owned and managed by federal, state, and local agencies and include local neighborhood parks; large regional parks, including state and national parks; golf courses; and reservoirs.

Biological resources in the study area include ecoregions, natural communities, special-status species, and habitat connectivity. Ecoregions include Monterey Bay Plains and Terraces, Salinas Valley, Gabilan Range, Diablo Range, Salinas-Cholame Hills, Northern Santa Lucia Range, Interior Santa Lucia Range, and Southern Santa Lucia Range as well as Paso Robles Hills and Valley. Communities in the study area include coastal strand and dune, grasslands, shrublands, forests and woodlands, riparian, wetlands, riverine, marine, estuarine, aquatic, agriculture, barren, and developed. Special-status species include nine target species, which have been consulted on for prior projects and may be impacted by future management activities. Habitat connectivity is essential for maintaining biological diversity and species populations in the study area. Maintaining movement corridors on land, in streams, and along riparian corridors is essential to helping special-status species thrive. Connectivity between aquatic habitats in the Salinas River and tributaries is imperative to maintain populations of fish and other aquatic animals in the watershed.

The environmental pressures and stresses relevant to the Salinas River LTMP study area are described. The primary section headings—*Changes in Natural Communities*, *Altered River Hydrology*, and *Changes in Climate*—are considered the primary pressures in the study area and the subsections cover the resulting stresses—e.g., habitat loss, altered flow, sea level rise, prolonged drought. The discussion in each section explains the history and status of the pressure within the study area and details the stresses to relevant special-status species. Changes in natural communities include habitat loss, fragmentation and degradation, shifting distribution of natural communities, invasive species, and changes to the natural fire regime. Altered river hydrology includes altered flow from diversions and dams, which could degrade water quality in both the Salinas River and the Salinas River Lagoon. Changes in climate include sea level rise, prolonged drought, changes in average rainfall, changes in storm intensity and frequency, and change in summer fog. Sea level rise, prolonged drought, and the factors that contribute to drought—decreased rainfall, changes in storm intensity and frequency, and decreases in fog—are discussed in this section; Section 3.5.1, *Changes in Natural Communities*, discusses how invasive species and changes to the duration and intensity of wildfires as stresses other than climate change, such as development and land management, also influence those pressures.

3.1 Physical Characteristics

The following sections describe the physical characteristics of the LTMP study area.

3.1.1 Location

The Salinas River runs through a valley in the Coast Ranges and is bounded to the west by the Sierra de Salinas and Santa Lucia Mountains and to the east by the Gabilan Range and Diablo Range. The Salinas Valley is approximately 10 miles wide and 155 miles long. The Salinas River watershed covers approximately 4,200 square miles of Monterey and San Luis Obispo Counties (Figure 1-1). The Salinas River flows in a northwest direction through the Salinas Valley and empties into Monterey Bay. As described in Chapter 1, *Introduction,* the LTMP study area is defined as the portion of the Salinas River watershed[1] where subwatersheds[2] have a confluence with the Salinas River at or downstream of the confluence of the Nacimiento River and lands surrounding Nacimiento Dam that are managed by the Monterey County Water Resources Agency (MCWRA). This study area includes 118 river miles of the Salinas River (69% of the total length of the Salinas River) and many of its primary tributaries: Arroyo Seco, Nacimiento River, San Antonio River, and San Lorenzo Creek (Figure 3-1).

3.1.2 Topography

The topography of the study area is characterized by the high elevations of the Coast Ranges to the west and the Gabilan and Diablo Ranges to the east of the Salinas River, respectively. The study area is located along the western margin of the Coast Ranges of California, which span 400 miles from Humboldt County south to Santa Barbara County. This central portion of the range is defined by the Sierra de Salinas and Santa Lucia Mountains (Figure 3-1). The highest peaks in this range are Junipero Serra Peak, Pinyon Peak, and Cone Peak in the Santa Lucia Mountains with an elevation of 5,853, 5,256, and 5,154 feet, respectively. The Gabilan Range and Diablo Range characterize the eastern portion of the study area with elevations over 5,000 feet. San Benito Mountain is the highest peak in the Diablo Range, at 5,240 feet (Figure 3-1). The Salinas Valley comprises the lower elevations of the study area. The lowest points include the city of Salinas, portions of the Salinas River such as the Salinas River Diversion Facility (SRDF) and the Salinas River Lagoon, and the coastal dunes (Figure 3-1).

[1] As defined by the U.S. Geologic Survey (USGS) hydrologic unit code (HUC)-8 boundary (cataloging unit 18060005).

[2] As defined by the USGS HUC-10 boundaries.

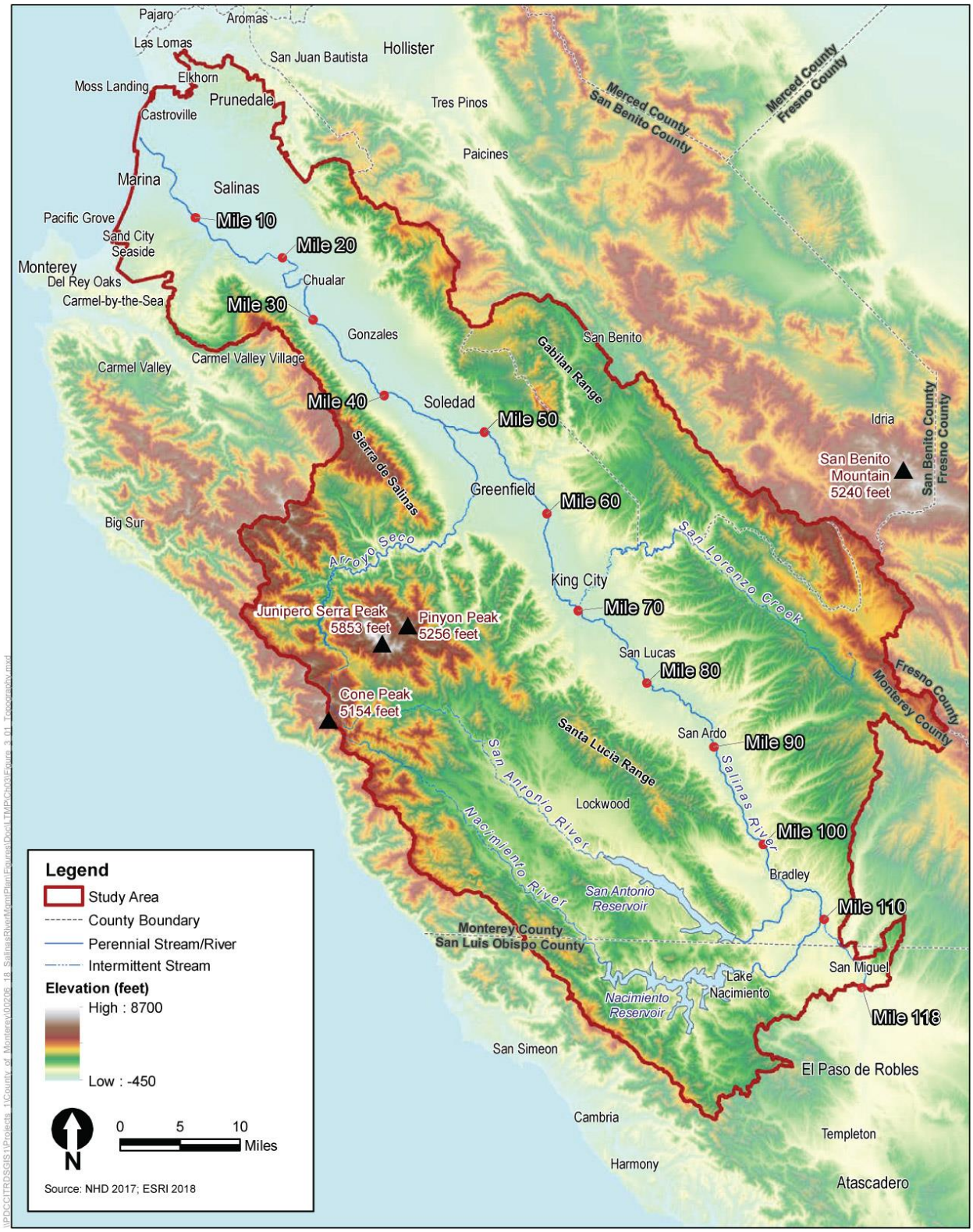


Figure 3-1. Topography

3.1.3 Geology

The Salinas Valley is underlain by the Salinian tectonic block, a geologic basement terrane consisting of metamorphic and granitic rock of Paleozoic to Mesozoic age. The Salinian Block is bordered on both east and west by tectonic blocks of the Franciscan Complex (Figure 3-2). The boundaries between these tectonic blocks are large-scale strike-slip faults: the San Andreas Fault Zone on the east, and the Sur-Nacimiento Fault Zone on the west (Figure 3-2). Millions of years of tectonic activity on these bounding fault systems transported the Salinan block hundreds of miles northward and inserted it between blocks of the Franciscan Complex.

Geologically recent tectonic activity, including movement on the Rinconada–Reliz Fault Zone (Figure 3-2) (Rosenberg and Clark 2009) formed the Salinas Valley and Santa Lucia, Sierra de Salinas, Gabilan, and Diablo Mountain Ranges, which were uplifted to their present elevations in Quaternary time (2.6 million years ago [Ma] to present; Rosenberg 2001).

Figure 3-3a presents a geologic map of the management and study areas, illustrating both the locations of faults and the geologic formations present at ground surface. The legend on Figure 3-3b presents the age sequence of the geologic materials from the youngest unconsolidated Quaternary sediments, labeled with "Q," to the oldest pre-Cambrian basement rock.

The combination of tectonically driven land movement and sea level changes has influenced the depositional environment in the ancestral Salinas Valley from the Cretaceous through Quaternary time. Over millions of years, the Salinas Valley Basin has been filled with 10,000 to 15,000 feet of marine and continental sediments. A major marine transgression in middle to late Miocene time (approximately 16 to 6 Ma) resulted in thick, multi-layer accumulations of fine-grained sediment known as the Monterey Formation, which is as much as 12,000 feet thick in the Salinas Valley. More recent, minor marine transgressions that occurred between 80 and 125 thousand years ago, and between 15 and 25 thousand years ago, resulted in a single, thick layer of fine-grained sediment, which impedes inter-aquifer exchange and thus confines the shallower aquifers (Erskine and Fisher 2002). Uplift of the Santa Lucia Range began in early Pliocene time (approximately 5 Ma).

Material eroded from the uplifted ranges has been transported and deposited by the ancestral Salinas River and tributaries as gravel, sand, silt, and clay that make up the Quaternary alluvial deposits (<2.5 Ma) in the Salinas Valley. In addition to the fluvial material transported and deposited along the Salinas River corridor, the Quaternary deposits include alluvial fans along portions of the margins of the Valley that were eroded from the Gabilan and San Lucia Mountains and deposited by tributaries to the Salinas River. The alluvial fans coalesce with fluvial deposits associated with the ancestral river. Active geologic processes continue today, including erosion and deposition of fluvial sediment, wind-blown coastal dunes, landslides in the hills, and tectonic motion on faults. Table 3-1 summarizes the geologic history of the Salinas Valley.

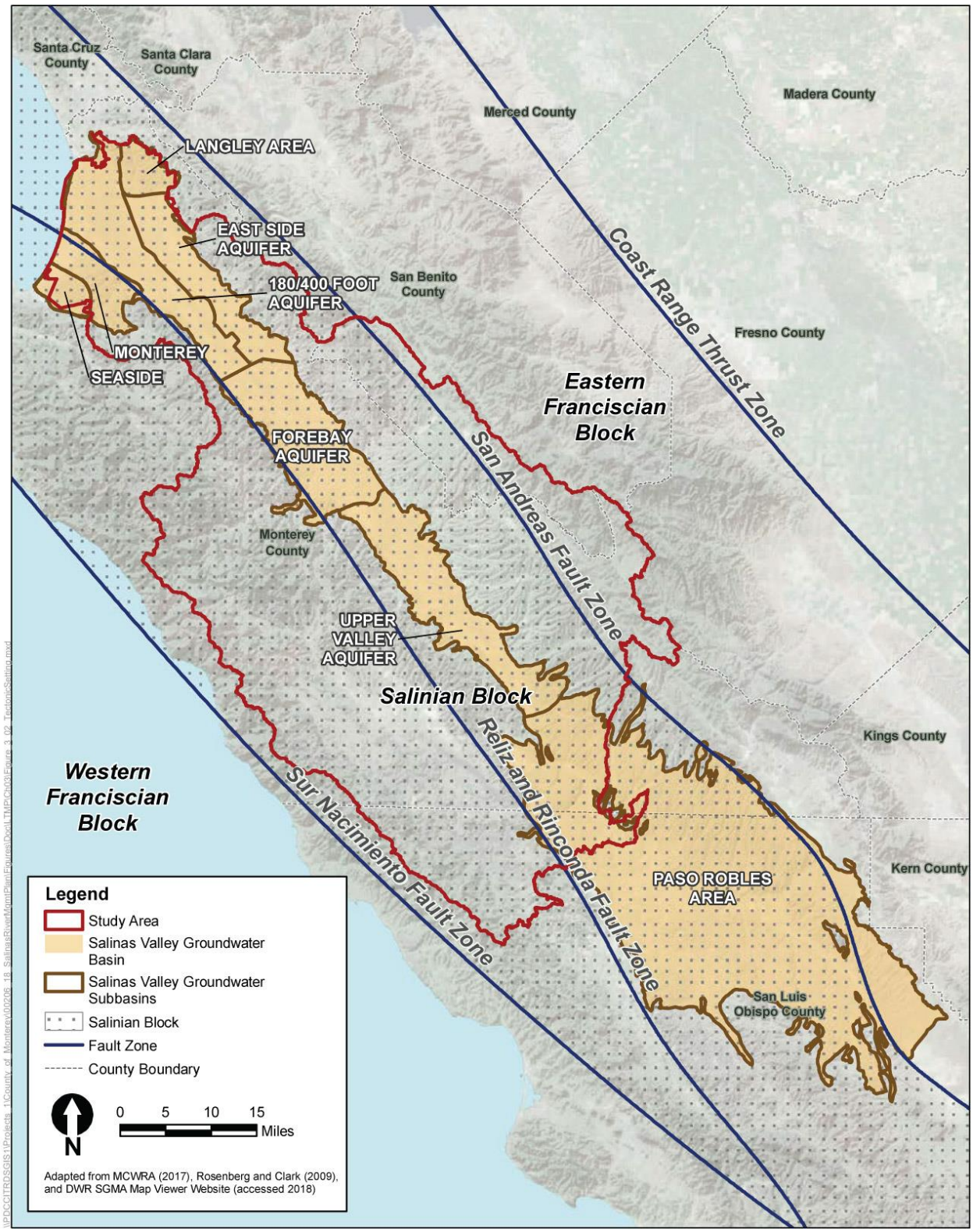


Figure 3-2. Tectonic Setting of Salinas Valley

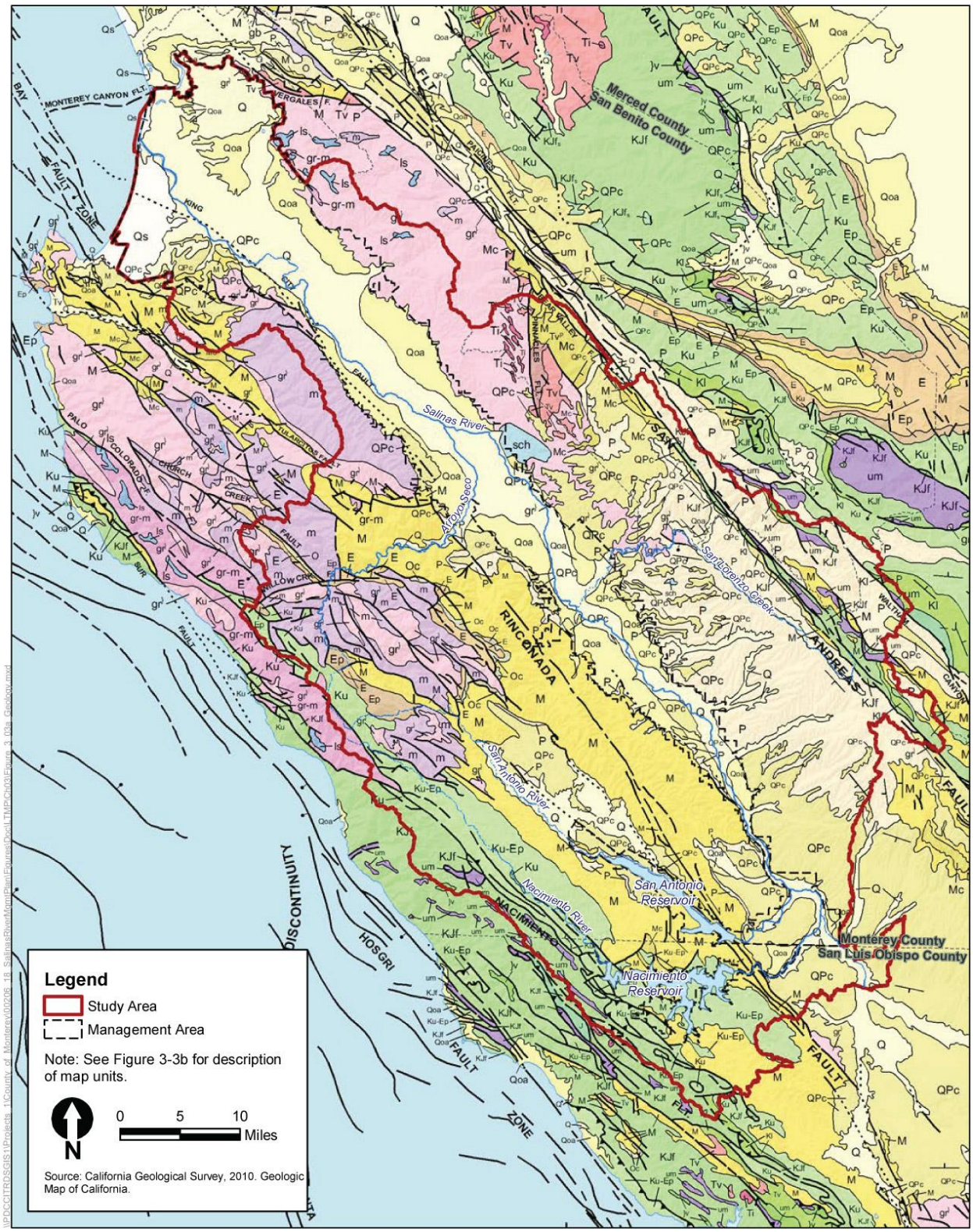


Figure 3-3a. Geologic Map

Figure 3-3b. Description of Geologic Map Units

Table 3-1. Geologic History of Salinas Valley

Era	Period, System, Subsystem	Epoch	Age Estimates of Boundaries in Millions of Years	Salinas Valley Geologic Events, Features, and Deposits
Cenozoic (Age of Mammals)	Quaternary	Holocene	0–0.010	Flood-plain deposits, landslides, beach deposits
		Pleistocene	0.010–1.6	Sea level fluctuates, sand dunes, marine terraces, Salinas Valley deposits
	Tertiary	Pliocene	1.6–5	Uplift of Santa Lucia Range
		Miocene	5–24	Seas advanced and retreated
		Oligocene	24–38	Seas retreated, lava flows
		Eocene	38–55	Uplift, deep basins, and isolated islands
		Paleocene	55–66	Seas advanced
Mesozoic (Age of Reptiles)	Cretaceous		66–138	Salinian granitic rocks intruded
	Jurassic		138–205	Franciscan rocks subducted and accreted
	Triassic		205–240	
Paleozoic (Age of Fishes)	Permian		240–290	Sur complex formed hundreds of miles south of Monterey County
	Carboniferous Systems	Pennsylvanian	240–290	
		Mississippian	330–360	
	Devonian		360–410	
	Silurian		410–435	
	Ordovician		435–500	
	Cambrian		500–570	
pre-Paleozoic	pre-Cambrian		570–4600	--

Sources: Rosenberg 2001, Monterey County Water Resources Agency 2017a. Age estimates from Hansen 1991.

3.1.4 Soils

The soils of the study area are derived from the underlying geologic formations, influenced by the historical and current patterns of climate and hydrology. Productive agriculture of the Salinas Valley is supported by deep, dark, fertile soils, such as the Salinas clay loams. The arable soils of Salinas Valley historically were classified into four groups (Carpenter and Cosby 1925): residual soils, old valley-filling soils, young valley-filling soils, and recent-alluvial soils. In addition, several classes of miscellaneous soils were mapped that included tidal marsh, peat, coastal beach and dune sands.

More recent surveys classify the soils into many more categories based on detailed soil taxonomy (U.S. Department of Agriculture 2018). Figure 3-4 is a composite soils map of the LTMP study area from the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) Gridded Soil Survey Geographic Database (2018) that is produced by the National Cooperative Soil Survey. The management area is dominated by the following four soil orders: mollisols, entisols, vertisols, and alfisols, each of which is summarized below.

3.1.4.1 Mollisols

Mollisols are the most widespread soil order in the management area and study area. Mollisols are characterized by the presence of a dark colored surface horizon, indicative of high organic content. The organic content often originates from roots of surficial grasses or similar vegetation. Mollisols are highly fertile and often alkaline rich (calcium and magnesium). They can have any moisture regime, but enough available moisture to support perennial grasses is typical. Mollisols are often found in climates where there are seasonal dry and wet periods. Examples of mollisols include the farmlands adjacent to the Salinas River from King City to the coast, in addition to east-facing slopes on the Santa Lucia Range and west-facing slopes on the Gabilan Range. Mollisols comprise 53% of the study area and 48% of the management area.

3.1.4.2 Entisols

Entisols are the predominant soil order along the active river corridor in addition to mountain slopes in the Santa Lucia and Gabilan Ranges. Entisols are mineral soils without distinct soil horizons because they have not been in place long enough for distinct horizons to develop. These soils are often found in areas of recent deposition such as active flood plains, river basins, and areas prone to landslides, and behind retreating glaciers where the rate of deposition is greater than the rate of soil development. Entisols comprise 28% of the study area and 26% of the management area.

3.1.4.3 Vertisols

Large areas of vertisols are present on the valley lowlands in the central and northern Salinas Valley. Vertisols are predominantly clayey soils with high shrink-swell potential. Vertisols are present in climates that have distinct wet and dry seasons. During the dry season these soils commonly have deep, wide cracks. During the wet season these soils tend to have water pooling on the surface due to the high clay content. Because these soils are sticky in wet season but hard in dry season, they require special cultivation practices. Vertisols are found within the management area in the lowland areas northwest of Salinas and west of Gonzales. Vertisols comprise 5% of the study area and 7% of the management area.

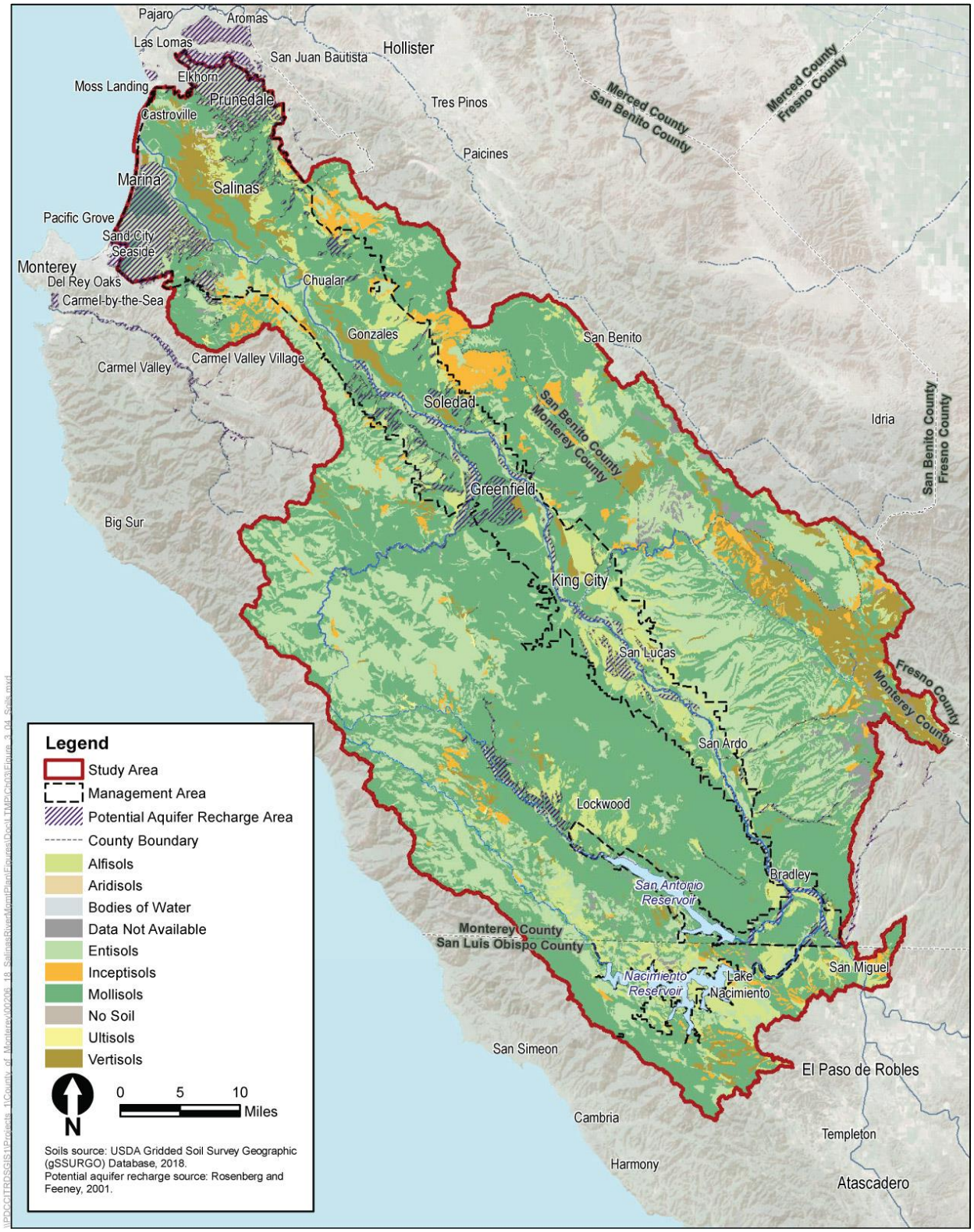


Figure 3-4. Soils Map

3.1.4.4 Alfisols

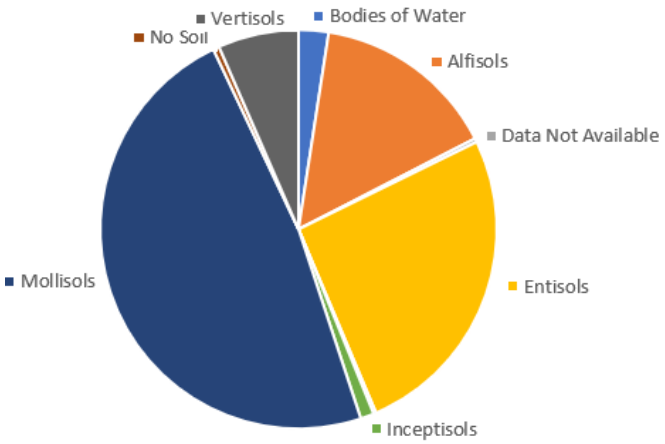
Alfisols are present along portions of the margin of the management area. Alfisols are known to have natural fertility both from clay accumulation in the subsurface horizons and from leaf litter when under forested conditions. This order of soils is commonly associated with high concentrations of base minerals such as calcium, magnesium, sodium, and potassium. Alfisols are commonly used for cultivation of crops, winter hayland (hardy), cattle pasture and ranging, and general forest use. Alfisols are found in the management area in large areas east of Gonzales, and north and southeast of King City. Alfisols comprise 8% of the study area and 15% of the management area.

The tables and pie charts below show the portions of different soil orders for both the management and study area (Tables 3-2 and 3-3; Figures 3-5 and 3-6). Other soil orders also present in the LTMP management area in small amounts, or present in the LTMP study area, that are not represented on the figures and tables below, include aridisols, inceptisols, and ultisols (Figure 3-4).

Table 3-2. Relative Areas of Soil Groups in the Management Area

Soil Order	Acres	Percent
Bodies of Water	16,858	2.4%
Alfisols	103,756	15.0%
Data Not Available	2,108	0.3%
Entisols	178,231	25.8%
Histosols	1,434	0.2%
Inceptisols	7,572	1.1%
Mollisols	331,333	48.0%
No Soil	3,452	0.5%
Vertisols	45,370	6.6%
Total	**690,113**	**100.0%**

Source: U.S. Department of Agriculture 2018.



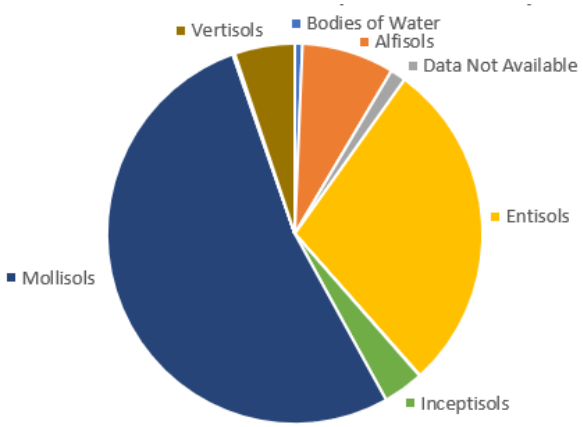
Source: U.S. Department of Agriculture 2018.

Figure 3-5. Chart of Relative Areas of Soil Groups in the Management Area

Table 3-3. Relative Areas of Soil Groups in the Study Area

Soil Order	Acres	Percent
Bodies of Water	17,437	0.7
Alfisols	212,893	8.0
Data Not Available	35,725	1.3
Entisols	760,185	28.4
Histosols	1,434	0.1
Inceptisols	93,117	3.5
Mollisols	1,409,517	52.7
No Soil	3,800	0.1
Ultisols	1,355	0.1
Vertisols	138,491	5.2
Total	**2,673,955**	**100.0%**

Source: U.S. Department of Agriculture 2018.



Source: U.S. Department of Agriculture 2018.

Figure 3-6. Chart of Relative Areas of Soil Groups in the Management Area

More detailed mapping and discussion of soils is available from the NRCS Gridded Soil Survey Geographic Database (2018) and from other specific studies of portions of the Salinas Valley (e.g., Harding Engineering and Environmental Sciences 2001).

3.1.5 Climate

The study area is characterized by a Mediterranean climate with cool wet winters, and warm dry summers. The Pacific Ocean influences the climate close to the coast, where the weather is often overcast or has coastal fog and cool temperatures. The maritime climatic influence dissipates with increasing distance from the ocean. As such, the inland areas are warmer in the summer and colder in winter. Below is summary of historical and current climatic conditions for the study area.

3.1.5.1 Temperature

Temperatures vary in the study area depending on location. Table 3-4 provides the average temperatures from 1981 to 2010 and from 1971 to 2000 at various locations within the study area. Areas near the coast, such as Monterey, generally have cooler summer temperatures. Areas within the Salinas Valley, such as near the cities of Salinas and King City have slightly higher temperatures because these areas have less fog cover and low clouds. Mountainous areas and areas that are located farther inland (and thus away from the fog layer), such as Paso Robles and Pinnacles National Monument, have hotter summer and colder winter temperatures. As shown in Table 3-4, winter day temperatures are generally the same throughout the study area.

Temperature in the study area is influenced by multiple factors, including the proximity to the coast and the amount of time an area is subject to fog and low clouds. The U.S. Geological Survey (USGS) completed detailed maps of fog and low cloud cover along the California Coast in 2016. This mapping shows the following.

1. Areas near the mouth of the Salinas River, including the cities of Monterey and Marina receive approximately 12 hours of fog and low clouds every 24 hours.
2. Areas in the Salinas Valley, including the cities of Salinas, Soledad, Greenfield, and King City receive approximately 5 hours of fog and low clouds every 24 hours.
3. Areas of higher elevations and areas inland, such as the mountainous regions of the Santa Lucia Mountains and Gabilan Range receive less than 2 hours of fog and low clouds every 24 hours. (Skibba 2016).

Table 3-4. Average Temperatures from 1981 to 2010 and 1971 to 2000

	Average Temperature (°F)									
	1981–2010					1971–2000				
		Summer		Winter			Summer		Winter	
Location	Year-Round	Day	Night	Day	Night	Year-Round	Day	Night	Day	Night
Coast										
Monterey	56	68	53	59	44	57	70	53	60	44
Salinas Valley										
Salinas	58	71	54	62	42	58	73	55	62	42
King City	60	84	52	64	38	60	85	52	64	38
Inland/Mountainous Regions										
Paso Robles	59	90	51	62	34	59	90	51	63	34
Pinnacles National Monument	56	93	44	62	28	59	93	50	64	34

Sources: National Climate Data Center 2000, 2010a, 2010b, 2010c, 2010d, 2010e.

Note: Based on long-term average data published by the National Weather Service (NWS). The NWS calculates long-term averages using climatic data over the most recent 30-year period ending in a decade. The current 30-year interval used by the NWS for this type of calculation goes from 1981 to 2010.

3.1.5.2 Precipitation

As shown on Figure 3-7, precipitation in the study area varies from approximately 15 to 60 inches annually. The mountainous areas near the coast receive much more precipitation than the Salinas Valley, which has an annual average of approximately 15 inches of precipitation. Table 3-5 identifies the annual precipitation from 1981 to 2010 and from 1971 to 2000 in various locations in the study area.

Table 3-5. Average Annual Precipitation from 1981 to 2010 and 1971 to 2000

	Average Annual Precipitation (inches)	
Location	**1981–2010**	**1971–2000**
Coast		
Monterey	21.1	20.4
Salinas Valley		
Salinas	12.8	12.9
King City	12.1	12.3
Inland/Mountainous Regions		
Paso Robles	15.2	14.7
Pinnacles National Monument	17.2	17.3

Sources: National Climate Data Center 2000, 2010a, 2010b, 2010c, 2010d, 2010e.
Note: Based on long-term average data published by NWS. The NWS calculates long-term averages using climatic data over the most recent 30-year period ending in a decade.

3.1.6 Watersheds

The United States is divided and subdivided into successively smaller hydrologic units which are classified into four levels: regions, subregions, accounting units, and cataloging units. The hydrologic units are arranged or nested within each other, from large geographic area (regions) to small geographic areas (cataloging units). Each hydrologic unit is identified by a unique hydrologic unit code (HUC) (U.S. Geological Survey 2017). Regions are identified by 2-unit HUCs, whereas subregions have 4-unit HUCs. Accounting units are categorized using 6-unit HUCs, and the cataloguing units are further divided into 8-, 10-, and 12-unit HUCs. An example of the watershed coding system is as follows.

1. California Region (HUC 18)
2. Central California Subregion (HUC 1806)
3. Central California Coastal Accounting Unit (HUC 180600)
4. Salinas Cataloging Unit (HUC 18060005) and Monterey Bay Cataloging Unit (HUC 18060015)

Figure 3-8 shows the cataloging unit watersheds characterized by 8-unit HUCs (also referred to as HUC-8) located within and near the study area. The bulk of the study area is located within the Salinas Cataloging Unit watershed (also referred to as Salinas River watershed herein), with a small portion of the study area—near the mouth of the Salinas River—within the Monterey Bay Cataloging Unit watershed. The 10-unit HUCs are shown in Figure 2-7 and listed in Appendix C, *Watersheds in the Study Area*, along with the associated 12-unit HUCs.

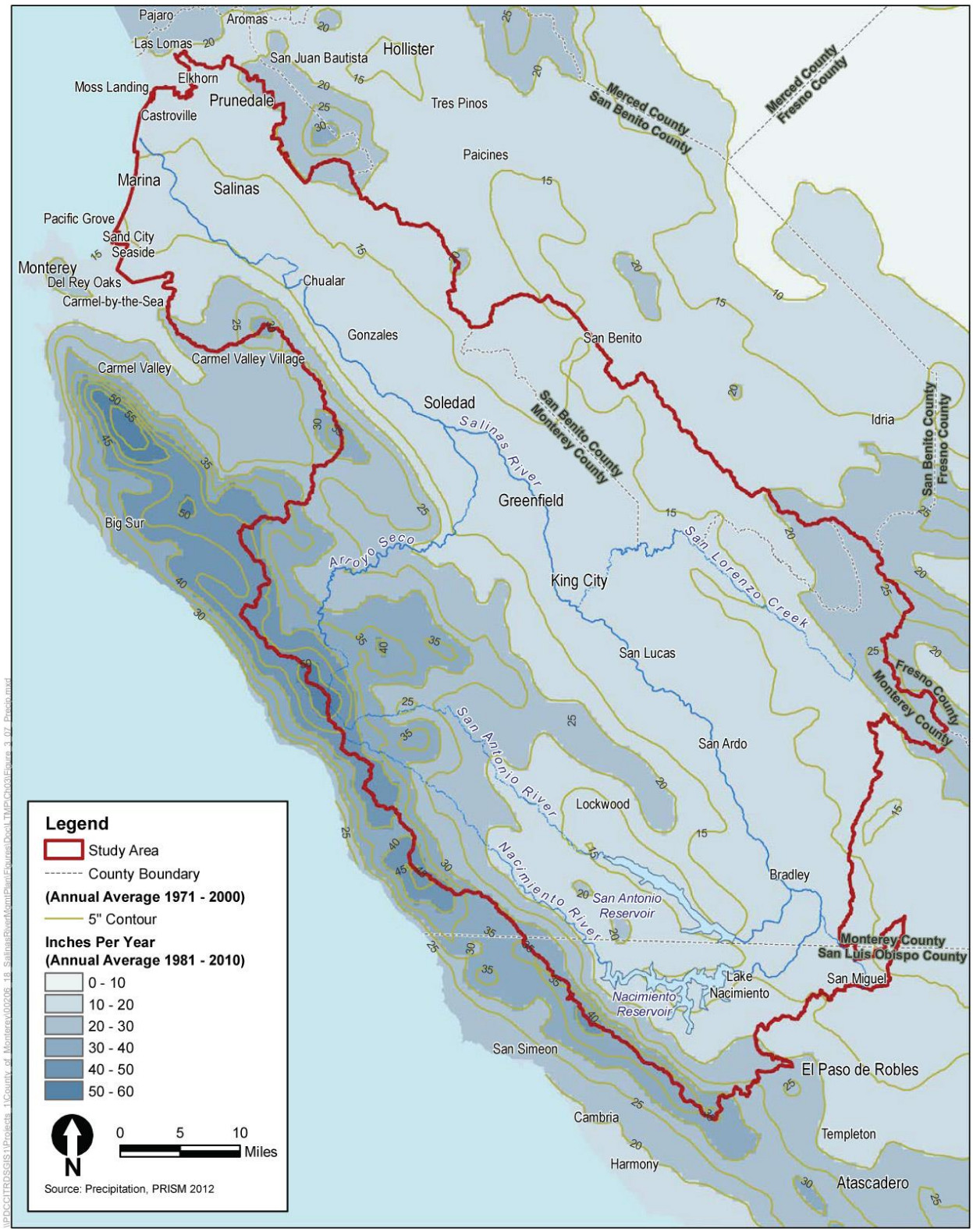


Figure 3-7. Distribution of Precipitation across the Study Area

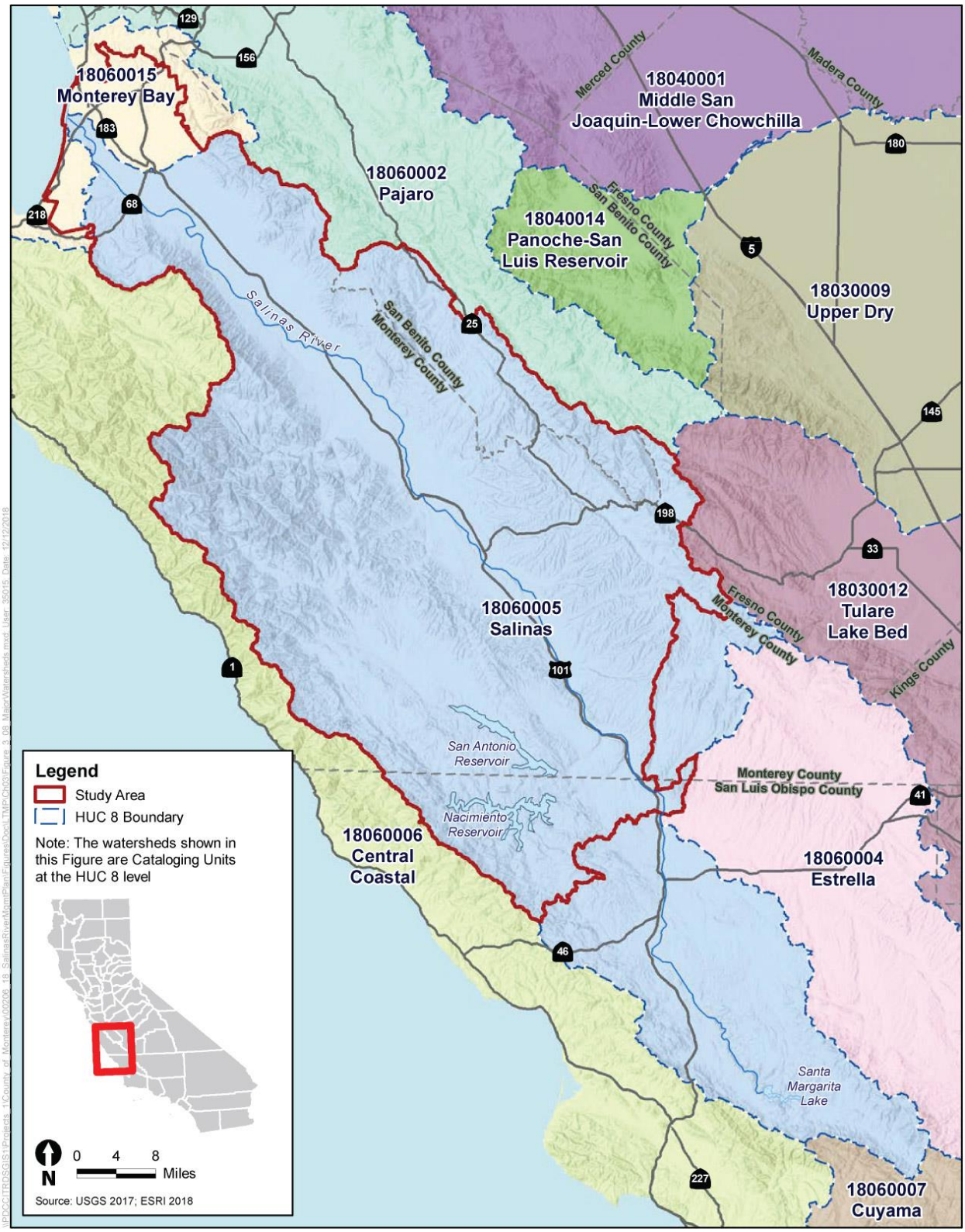


Figure 3-8. Major Watersheds in the Study Area

3.1.7 Hydrology and Geomorphology

The Salinas River watershed is the largest in the central coast of California draining approximately 4,240 square miles of land in Monterey and San Luis Obispo Counties (Monterey County Water Resources Agency 2014). Originating in the Los Padres National Forest, the headwaters of the Salinas River begin in the Santa Lucia and La Panza Mountain Ranges and flow approximately 184 river miles north-northwest through the Salinas Valley and into the Monterey Bay near Castroville (Monterey County Water Resources Agency 2014). The principal tributaries of the Salinas River floodplain within the study area are the Nacimiento River, the San Antonio River, San Lorenzo Creek, and the Arroyo Seco River (Figures 2-7 and 3-8).

Many of the tributaries to the Salinas River watershed are ungaged, meaning that streamflow generated within the watersheds is not monitored. Only a handful of stream gages exist in the watershed and are shown on Figures 2-1a and 2-1b. Streamflow temperature and water quality are not regularly monitored in the watersheds of the Salinas River, although flow at stream gage locations along the main stem of the river is frequently sampled for water quality.[3] For more details on water quality data, see Section 3.1.10, *Water Quality*. The Salinas Valley Integrated Hydrologic Model, currently under development by USGS and MCWRA, will be useful for simulating runoff generation in the watersheds' tributaries to the Salinas River.

In the study area, the Salinas River is approximately 118 miles long and can be roughly divided into three major reaches based on the dominant channel morphology: upper watershed, Salinas River Valley, and the Salinas River Lagoon. The upper watershed reach is located from River Mile (RM) 53 (near Greenfield) to RM 118 (near San Miguel) and characterized by Salinas River Stream Maintenance Program (SMP) river management units (RMUs) 1 and 2. The valley and river in the upper portions of this reach become increasingly narrow and confined. The second reach, from RM 53 to RM 7, is characterized by a channel width (as measured from top-of-bank to top-of-bank) ranging between 500 and 2,000 feet and contains the Salinas River SMP RMUs 3 through 6. This reach tends toward a weakly braided channel (i.e., a mainstem with side channels on either side that are separated by sandbars and riparian vegetation). The third reach includes RM 7 to RM 0 containing the perennial portion of the river from Blanco Road to Highway 1 (referred to as Salinas River SMP RMU 7) downstream to the Salinas River Lagoon. The lagoon is formed by a sandbar that separates the river from Monterey Bay (see Section 3.1.7.2, *Existing Conditions*, subheading *Salinas River Lagoon (RMU 7 to RM 0)* for additional information on the sandbar). The historical and existing conditions of these three reaches are discussed below in the context of these three major reaches.

3.1.7.1 Historical Conditions

Upper Watershed (San Miguel to RMU 2)

The upper watershed reach of the Salinas River as defined for this LTMP spans from San Miguel (RM 118) in northern San Luis Obispo County to RM 53, upstream of and near Greenfield in central Monterey County. The Salinas River channel is relatively narrow and confined in the upper portion of this reach as it passes through the narrow canyons of the coastal mountain ranges. The primary tributaries of this reach, the Nacimiento River and San Antonio River, originate in the Santa Lucia Range along the coast and enter the Salinas River from the southwest, upstream of Bradley. The Nacimiento River is 65 miles long and drains 360 square miles in the study area (U.S. Geological

[3] See https://water.usgs.gov/lookup/getwatershed?18060005.

Survey 2018). The Nacimiento Dam was built in 1957. The San Antonio River is 59 miles long and drains 350 square miles in the study area (U.S. Geological Survey 2018). The San Antonio dam was built in 1965. The peaks of the Santa Lucia Range from the southwestern boundary of these adjacent watersheds were historically capable of producing a substantial proportion of flow to the Salinas River (as indicated by early flow records in Nacimiento River [USGS gage station 11149500] and in Salinas at Bradley [USGS gage station 11150500] in Table 3-6). Historically, the Nacimiento River's winter flow regime supported spawning runs of steelhead (CALFED 1976). During the dry season, the lower Nacimiento River was often intermittent, resulting in long stretches of dry river bed between a few isolated pools. Dry water years were characterized by no surface flow for long periods of time (CALFED 1976).[4] North of San Ardo, the valley and river begin to widen, and the main stem begins to morph into a more braided channel where it meets another large tributary known as the San Lorenzo Creek. The San Lorenzo Creek drains a 261-square-mile watershed (Appendix C) that originates in the Diablo Mountain Range and runs through Peachtree Valley in southern San Benito County before entering eastern Monterey County and merging with the Salinas River from the northeast in King City.

Salinas River Valley (RMU 3 to RMU 6)

The Salinas River Valley reach as defined for this LTMP spans from upstream of Soledad (RM 53) downstream to Blanco Road (RM 7). The major tributary in this reach is the Arroyo Seco, which drains a 275-square-mile watershed that originates in the Santa Lucia Range and enters the Salinas from the west near the city of Soledad.

With the exception of the last 15 miles of the Salinas River Valley reach, the Salinas River bed was historically broad and sandy—spanning up to about a half mile wide. The active channel was bare or sparsely vegetated with willows and grasses, and punctuated with periodic low-flow channels (e.g., narrow and shallow channels characterized by decreased flows of the dry season) (San Francisco Estuary Institute 2009). It has long been characterized by lateral shifts in channel alignment, steep banks, and nested sets of broad benches and bluffs. The outermost bluffs defined the lateral migration limit and margin between the river corridor and the valley floor. The lowest elevation benches immediately adjacent to the riverbed, referred to as "bottomlands," were subject to periodic flooding and were generally well-vegetated with willows, cottonwoods, brush, grasses, and some oaks. Between the two were terraces, varying in number and extent (depending on the reach), which were drier than the bottomlands and represented previously abandoned river floodplains.

Historical records from eighteenth-century explorers and nineteenth-century surveyors often described the banks of the Salinas River as fairly steep or nearly vertical as it constantly scoured and rebuilt the channel bed and floodplain throughout much of the lower watershed (San Francisco Estuary Institute 2009). These geomorphic processes led to a diverse array of habitats, including meander cutoffs, oxbows, freshly scoured surfaces, riparian forest of varying ages, and wetlands occupying abandoned channel segments and along natural levees. Ponds and depressional wetlands were scattered throughout the Salinas Valley. Downstream of Spreckels, these features were widely distributed across the Salinas Valley due to frequent migrations of the river.

Prior to the construction of major reservoirs and diversion, Salinas River Valley reach experienced a considerable amount of variability in seasonal flows on both an average and inter-annual basis. During the wet season, the sediment-laden Salinas River would flood and overflow onto the adjacent

[4] Historical accounts of San Antonio River hydrology could not be found.

bottomlands, depositing sand as the river receded (San Francisco Estuary Institute 2009). During the dry season, the Salinas River was described as a discontinuous, shallow brook that regularly maintained baseflows and substantial summertime pools in many of the reaches (San Francisco Estuary Institute 2009). The presence of quicksand—mentioned in many early accounts of the river—indicates that near-surface flows were likely substantial, even during dry times.

Salinas River Lagoon (RMU 7 to RM 0)

Historically, the Salinas River Lagoon filled, opened, and closed according to seasonal variations in river flow and coastal wave action. During the low-flow summer months, littoral processes would build a sandbar at the river mouth, closing the direct connection between the Salinas River and the Monterey Bay (Hagar Environmental Science 2015). In late fall or winter, storms would increase Salinas River flow, filling the closed lagoon (Hagar Environmental Science 2015). As water levels continued to rise, inundating adjacent low lands bordering the lagoon, winter waves would work to erode the dune from the ocean side. At some point, water levels in the lagoon would increase enough to overtop the sandbar at the mouth, naturally opening the lagoon (Hagar Environmental Science 2015). The location of this opening to the Monterey Bay and the configuration of the lagoon was dynamic in nature. Historical accounts put the mouth at locations spanning from south of its present location (mapped by the U.S. Coast Survey in 1854) to as far north as Moss Landing (prior to 1908), which appears to have been the most prevalent route (see Figure 3-9) (San Francisco Estuary Institute 2009).

In 1947, the U.S. Army Corps of Engineers constructed the Moss Landing Harbor and opened the mouth of the Elkhorn Slough. The influence of freshwater was already markedly decreased by reclamation ditching and well pumping. Now the wetland complex was exposed to daily tidal scour. Extensive mudflats were exposed in the sloughs for the first time in recorded history. The old mouth was less than 2 feet deep in a narrow channel (15 feet wide). The mouth is now 25–30 feet deep and the channel is a large, dominant feature (ABA Consultants 1989). The artificial mouth increased tidal amplitude and velocity in the estuary, leading to substantial tidal scour and contributing to loss of wetland habitats (Elkhorn Slough Tidal Wetland Project 2012).

Near the time of the harbor entrance's completion, tide gates were put in place on several of the sloughs and wetland habitats to the south of Moss Landing, including the Moro Cojo Slough, Old Salinas River (OSR) and Tembladero Slough. This has limited the amount of erosion in these sloughs in addition to muting the tides and preventing salt water from intruding inland during high tides.

1854 Lagoon and River, with mouth located north near Moss Landing

Current Lagoon and River, with mouth located in its current location

Source: Central Coast Watershed Studies 2006.

Figure 3-9. Historical and Existing Terminus Location of the Salinas River

3.1.7.2 Existing Conditions

Over the past century and a half spanning from the first euro-American accounts to now, the Salinas River has gone through many changes that have impacted its hydrology and geomorphology. These changes began with the development of the Salinas Valley as a major agricultural region primarily dependent on groundwater for irrigation. As the amount of irrigated crops and pumping increased, the amount of fresh water removed from the groundwater basin exceeded the amount replenished through natural hydrologic processes. By the late 1930s, wells in the Salinas Valley Basin near

Monterey Bay had been abandoned due to excess salinity (California Department of Water Resources 1946). Accelerated encroachment of salinity into the groundwater basin was observed in 1943, which led to an investigation of the Salinas Valley Basin (California Department of Water Resources 1946) and ultimately to the construction of the Nacimiento Dam in 1957 followed by the San Antonio Dam in 1965. These reservoirs have been primarily operated to capture winter flows and release them at a low enough rate throughout the year to maximize groundwater recharge in the Salinas Valley aquifer (CALFED 1976) so that groundwater wells for irrigation continue to function.

Upper Watershed (San Miguel to RMU 2)

The Nacimiento and San Antonio Rivers, historically capable of producing large flows, are now regulated by dams operated by MCWRA (Monterey County Water Resources Agency 2014). The operation of these dams has significantly altered the seasonal distribution and magnitude of streamflow in the Salinas River by reducing wet season flows and increasing dry season flows.

Stream gages at three locations in the upper watershed were analyzed within the study area—two in Nacimiento River downstream of the current reservoir and one in the Salinas River at Bradley (Figures 2-1a and 2-1b). After construction of the Nacimiento Dam, the Nacimiento River gage at San Miguel (USGS 11149500) was decommissioned and replaced by a gage at Bradley (USGS 11149400, approximately 5 miles upstream of the San Miguel gage). Peak flow frequency analyses for all three gages in the upper watershed are shown in Table 3-6. Analysis at the Nacimiento River gages before and after dam construction showed significant reductions in peak return interval flows from between 78% (for the 100-year event) to 95% (for the 2-year event). These values were not adjusted to account for the 6% smaller watershed area reported at the post-dam gage (USGS 11149500) because this difference was deemed insignificant relative to the large decreases observed following construction of the dam. Downstream of the Nacimiento River and San Antonio River, the Salinas River gage at Bradley was installed in 1949, only 8 years before the Nacimiento Dam was completed. According to USGS guidelines for determining flow frequency (Bulletin No. 17B), a minimum of 10 years of peak flow data are required. Therefore, the flow frequency analyses at Bradley are only shown for post-dam years.

Table 3-6. Peak Flow Frequency Analyses for Gages in the Upper Watershed

		Peak Flow (cubic feet per second)					
Gage	**Years**	**2-Year**	**5-Year**	**10-Year**	**25-Year**	**50-Year**	**100-Year**
Nacimiento River near San Miguel[a]	1938–1956 (pre-dam)	20,000	37,000	51,000	69,000	83,000	98,000
Nacimiento River below Nacimiento Dam near Bradley[b]	1957–2018 (post-dam)	1,000 (-95%)	3,000 (-92%)	6,000 (-88%)	10,000 (-86%)	15,000 (-82%)	22,000 (-78%)
Salinas River near Bradley[c]	1957–2018	4,000	16,000	32,000	67,000	107,000	162,000

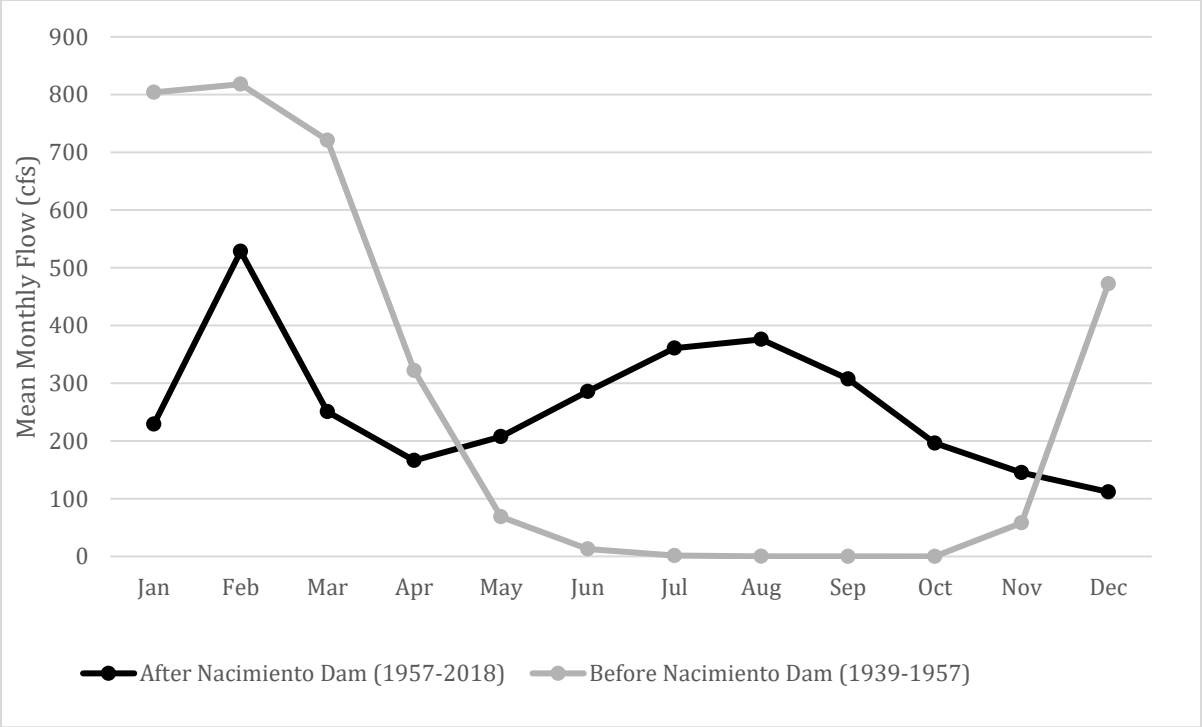
Source: U.S. Geological Survey 2018.

[a] USGS Gage 11149500 located near the San Luis Obispo/Monterey County border, approximately 7 river miles downstream of dam (Latitude 35°47'00", Longitude 120°47'24" NAD27).

[b] USGS Gage 11149400 located approximately 2 river miles downstream of dam (Latitude 35°45'41", Longitude 120°51'16" NAD27).

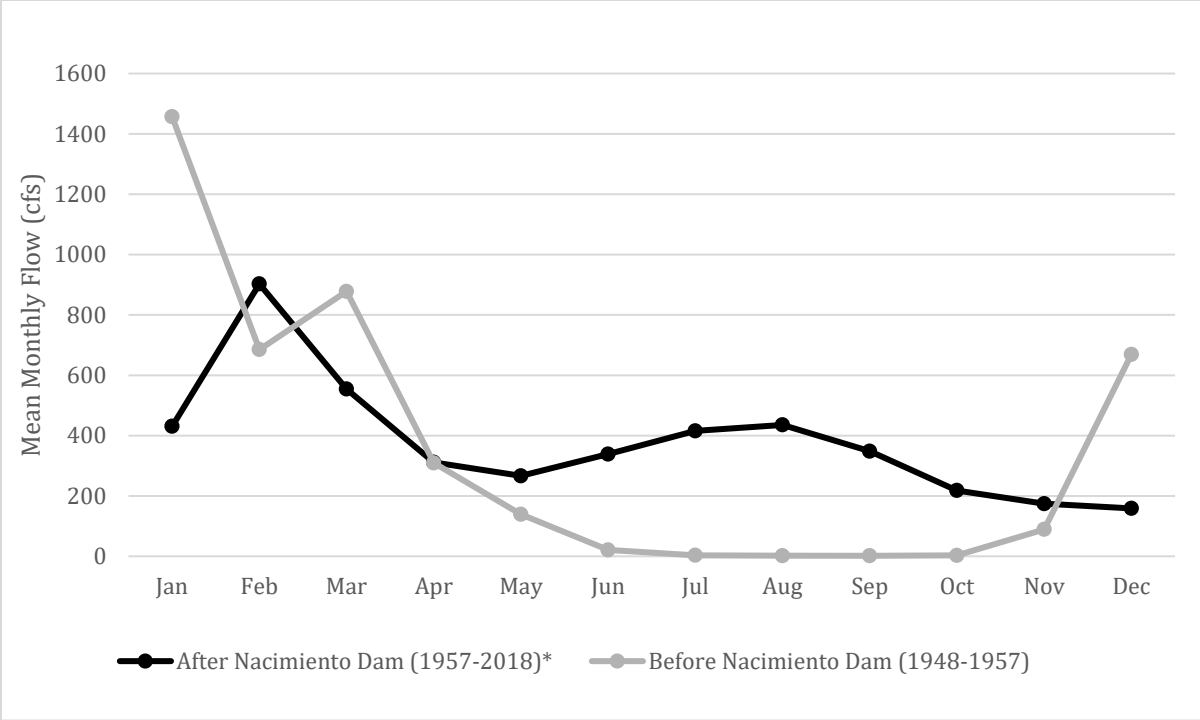
[c] USGS Gage 11150500 located approximately 6.5 river miles downstream of town of Bradley (Latitude 35°55'49", Longitude 120°52'04" NAD27).

Comparison of pre- and post-dam mean monthly flows can provide insights into shifts in average seasonal flow timing and magnitude. In the Nacimiento River, the natural flow prior to dam construction reflected the seasonal nature of rainfall in the watershed—with the majority of the stream flow occurring during the wet season from December to April (Figure 3-10). Following the completion of Nacimiento Dam, average stream flows during the winter and spring wet season were reduced in magnitude, and releases during the dry season increased substantially. Similar effects can be observed in the Salinas River at Bradley, which accounts for the combined effect of both upstream dams in addition to other upstream operations such as the Santa Margarita Dam (Figure 3-11). This gage shows a more pronounced delay in the timing of seasonal flows from January to February, greater reductions in average winter flows, and greater increases in average summer flows.



Source: U.S. Geological Survey 2018.

Figure 3-10. Mean Monthly Flow in Nacimiento River, Before and After Dam Construction (USGS 11149400 and 11149500)



Source: U.S. Geological Survey 2018.
*A portion of the analysis period also includes effects of San Antonio Dam (constructed in 1967).

Figure 3-11. Mean Monthly Flow in Salinas River at Bradley, Before and After Dam Construction (USGS 11150500)

Salinas River Valley (RMU 3 to RMU 6)

Relative to historical conditions, the channel bed in this reach has narrowed significantly and become more highly vegetated, with varying amounts of vegetation growing on bars and the channel bottom (Monterey County Water Resources Agency 2014). In the past, seasonal high flows regularly scoured the bars and channel bottom, transporting sediment and leaving the Salinas River channel bed largely bare. The combination of reduced peak flow and increased summer flows caused by the operation of the Nacimiento Dam starting in 1957 and the San Antonio Dam starting in 1967 has today allowed vegetation growth to expand onto the bars and channel bottom and largely persist there. This vegetation growth has increased since the revised operation of Nacimiento Dam in April 2010 (Monterey County Water Resources Agency 2014).

Today, agriculture occurs in what was once the riparian corridor (i.e., the bottomlands) of the Salinas River. As a result, significant narrowing of the riparian corridor has occurred throughout this reach. Landowners along much of the Salinas River have historically constructed levees to protect agricultural lands from flooding (Monterey County Water Resources Agency 2014) and continue to do so today. Many of these informal levee sections are not engineered, and are often composed of sand, broken concrete, and other construction materials (Monterey County Water Resources Agency 2014). The bank slopes below the levees are generally well-vegetated.

Flow frequency analyses for the gages located in this reach are presented in Table 3-7. While the Salinas River hydrology has been altered by dam construction and diversions, both San Lorenzo Creek and Arroyo Seco are unregulated. Therefore, the hydrologic patterns of these watersheds are

likely more similar to historical conditions than those in the mainstem of the Salinas River. These data show that San Lorenzo Creek contributes a much lower proportion of flow to the Salinas River than Arroyo Seco. Comparison of the return interval flows in the Salinas River at Bradley—before the inputs of San Lorenzo Creek, to the Salinas River at Soledad, after the inputs of San Lorenzo Creek but before Arroyo Seco (Table 3-7)—shows a drop in peak flows between the upper watershed and the Salinas Valley (i.e., upstream and downstream of San Lorenzo Creek). In other words, the small flows of San Lorenzo Creek are insufficient to offset the downstream water loss from groundwater infiltration and evaporation. In contrast, flows in the Salinas River downstream of Arroyo Seco (Salinas River at Chualar gage in Table 3-7) are considerably higher than flows upstream of the Arroyo Seco confluence (Salinas River at Soledad gage), despite losses likely to groundwater infiltration.

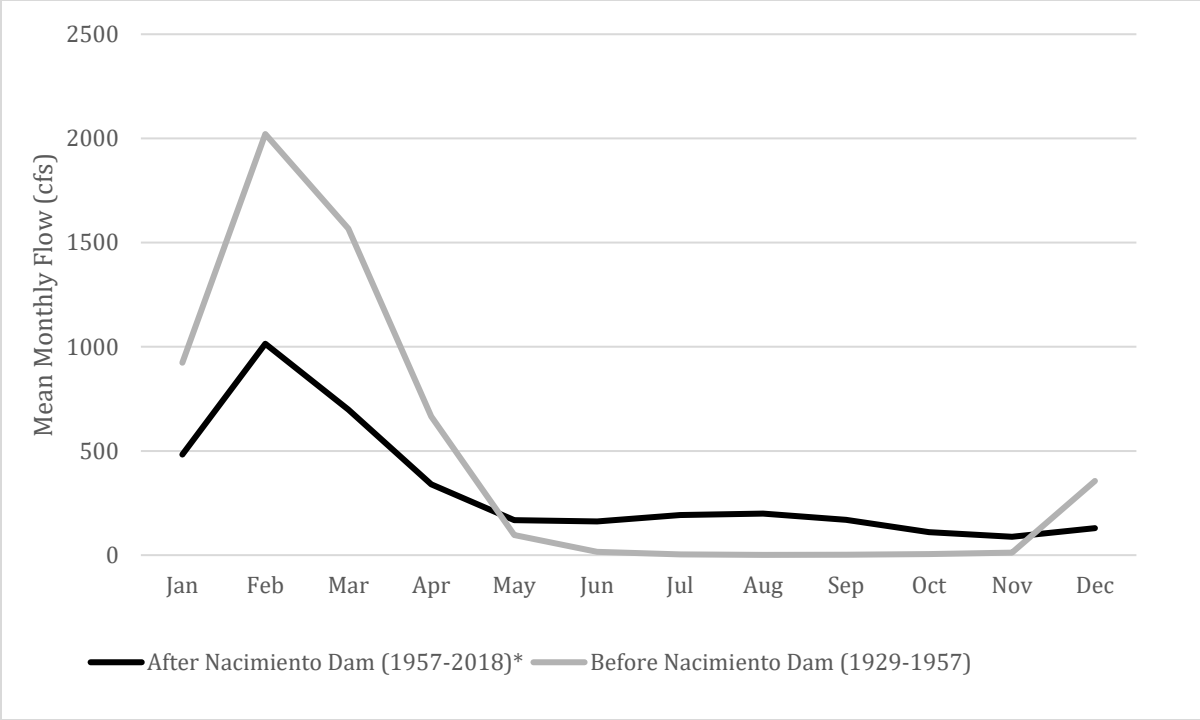
The farthest downstream gage near Spreckels contained a long enough period of record to compare flow frequencies before and after construction of the Nacimiento and San Antonio Dams (Table 3-7). These gages show reductions in peak flows between 3% (for the 50-year event) to 54% (for the 2-year event) and an increase in peak flows of 12% for the 100-year event for the period of record after dam construction. Although reductions in low to moderate peak flows would be expected as a result of upstream dam construction, some proportion of these changes may also be due to differences in the number of events and hydrologic characteristics represented by pre- and post-dams periods of record.

Comparisons of Salinas River mean monthly flows near Spreckels before and after dam construction show reductions by up to 50% from pre-dam conditions during the winter and spring wet season (December to April) and substantial increases during the dry season (Figure 3-12). However, the timing of peak wet season flows appears to have remained unchanged. This is likely related to the fact that the Arroyo Seco, a significant contributor to Salinas River flows, remains undammed.

Table 3-7. Peak Flow Frequency Analyses for Gages in the Salinas River Watershed in the Management Area

		Peak Flow (cubic feet per second)					
Gage	**Years**	**2-Year**	**5-Year**	**10-Year**	**25-Year**	**50-Year**	**100-Year**
Salinas River – Bradley (USGS 11150500)	1957–2018	4,000	16,000	32,000	67,000	107,000	162,000
San Lorenzo Creek – King City (USGS 11151300)	1959–2017	1,000	3,000	6,000	10,000	13,000	17,000
Salinas River – Soledad (USGS 11151700)	1969–2018	2,000	12,000	26,000	58,000	94,000	142,000
Arroyo Seco – Greenfield (USGS 11151870)	1962–2018	7,000	12,000	15,000	19,000	22,000	26,000
Arroyo Seco – Soledad (USGS 11152000)	1906–2018	8,000	14,000	18,000	24,000	28,000	32,000
Salinas River – Chualar (USGS 11152300)	1976–2018	5,000	15,000	27,000	52,000	80,000	120,000
Salinas River – Spreckels (USGS 11152500)	1930–1956 (pre-dams)	8,000	33,000	53,000	75,000	88,000	99,000
	1957–2018 (post-dams)	3,700 (-54%)	17,000 (-48%)	33,000 (-38%)	60,000 (-20%)	85,000 (-3%)	111,000 (+12%)

Source: U.S. Geological Survey 2018.

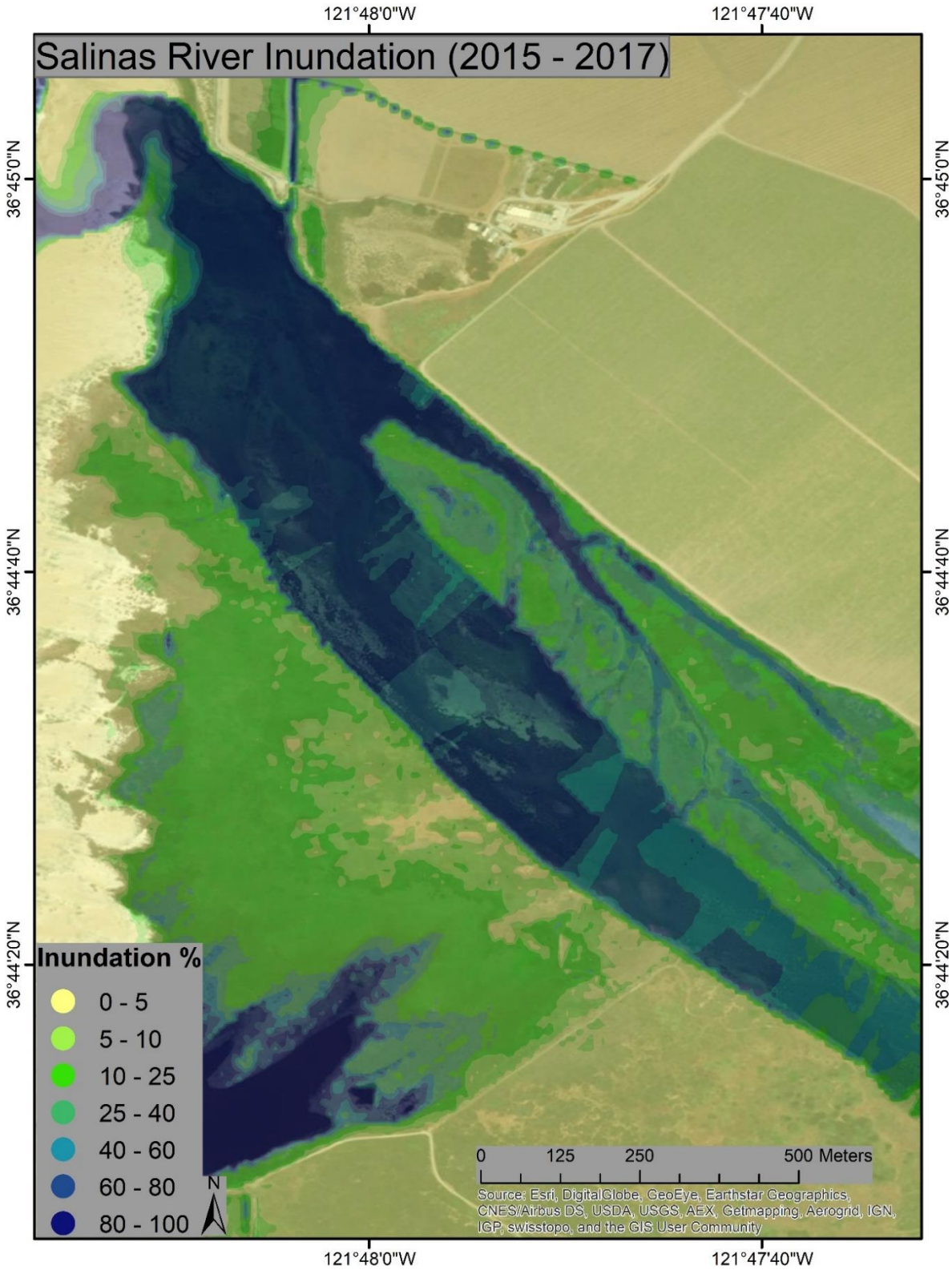


Source: U.S. Geological Survey 2018.
*A portion of the analysis period also includes effects of San Antonio Dam (constructed in 1967).

Figure 3-12. Mean Monthly Flow in Salinas River near Spreckels, Before and After Dam Construction (USGS 11152500)

Salinas River Lagoon (RMU 7 to RM 0)

Today, water levels in the Salinas River Lagoon are managed by MCWRA to limit flooding of adjacent agricultural lands and homes (Hagar Environmental Science 2015). These management actions include releasing flows through a slide gate to the OSR and periodically lowering the sandbar elevation to allow direct outflow to the ocean (Figure 2-1a). Sandbar management involves grading or excavating a drainage channel across the sandbar to drain the lagoon at the critical elevation. At a stage of about 6 feet- National Geodetic Vertical Datum 1929 (NGVD 29) (8.7 feet North American Vertical Datum 1988 [NAVD 88]), the lagoon begins to crest the south bank and floods an extensive area of low marsh vegetation in the Salinas National Wildlife Refuge to the south of the lagoon (Hagar Environmental Science 2015). There are low-lying agricultural fields on the north side of the lagoon that also begin to be inundated under these conditions. The initial breach usually occurs in conjunction with winter storms in November through January, but can occur anytime between October and June (Hagar Environmental Science 2015). River flow may recede to low levels between storms and, depending on tide and wave conditions, the mouth may close again for periods of time with subsequent natural or artificial opening (Hagar Environmental Science 2015) (Figures 3-13).



Source: Central Coast Wetlands Group 2015.

Figure 3-13. Percent of Time the Salinas River Lagoon Marsh Plain was Inundated by Water for 2015–2017

In April 2010, MCWRA began operation of the Salinas River Diversion Facility (SRDF) located at about RM 4.8 near the upper part of the Salinas River Lagoon as part of the Salinas Valley Water Project (SVWP). Water released from Nacimiento and San Antonio Dams are impounded and diverted at the SRDF throughout the irrigation season (April 1 to October 31). When the SRDF is in operation, MCWRA is required to provide bypass flows to the lagoon based on water year type. Before implementation of the SVWP, there was no requirement for provision of flow to the lagoon, and there was generally no flow to the lagoon after storm flows ceased in the spring (a pattern more consistent with natural river flow patterns before development of the Salinas Valley for agriculture).

3.1.8 Historical Flooding

The Salinas River and its valley have a long history of flooding because of the broad valley topography and the flashy hydrology characteristic of the area. As agricultural and urban development in the floodplain has increased over time, the adverse effects of flooding have grown. Flooding along the Salinas River has caused significant damage and economic impacts to the region. Significant floods occurred in the following years.

- March 1911: Described by the *Salinas Daily Index* paper as a disastrous event that destroyed over 2,000 acres of farmland.
- January and February 1969: Two floods each caused Monterey County to be declared a disaster area.
- February 1978: A series of storms caused extensive beachfront and coastal damage.
- March 1983: "El Niño" storms brought an extremely unusual series of high tides, storm surges, and storm waves along the coast, and heavy rains causing extensive flooding and erosion in the valley.
- March 1995: A significant winter storm brought devastating flooding and extensive damage throughout the county, including loss of life.
- February 1998: A series of "El Niño" winter storms caused flooding that impacted agricultural lands and the city of Salinas. Several communities were evacuated, and Monterey County was declared a disaster area. Countywide losses from these storms were estimated at over $38 million, with agriculture-related losses totaling over $7 million and involving approximately 29,000 damaged acres.

More minor flood events occurred in recent years such as 2005, 2011, and 2017, causing minor flood damage. Flood propensity by reach is described in the sections below.

Upper Watershed (San Miguel to RMU 2)

The upper watershed from San Miguel to RM 94 is characterized by a narrow channel form compared to the Salinas Valley. There is little development along the mainstem or Nacimiento and San Antonio Rivers in this reach, and therefore flooding and flood risk are not significant. As the river widens and the valley supports more development including King City and the San Lorenzo Creek from RM 94 to RM 53, flooding becomes a risk. Because of this development, and the fact that the channel is generally shallow with a broad floodplain, this portion of the reach is more prone to flood risk.

Salinas River Valley (RMU 3 to RMU 6)

The Salinas Valley as characterized within RMU 3 to RMU 6 is highly developed, with agriculture throughout its length as well as the cities of Greenfield, Soledad, Gonzales, Chualar, and Salinas. Because of this development, and the fact that the channel is generally shallow with a broad floodplain, the Salinas Valley is an area of major flood risk. Flood risk and historical flood damage tends to be greatest at the northern end of the valley, with the communities of Gonzales, Chualar, and Salinas subject to the greatest flood risk.

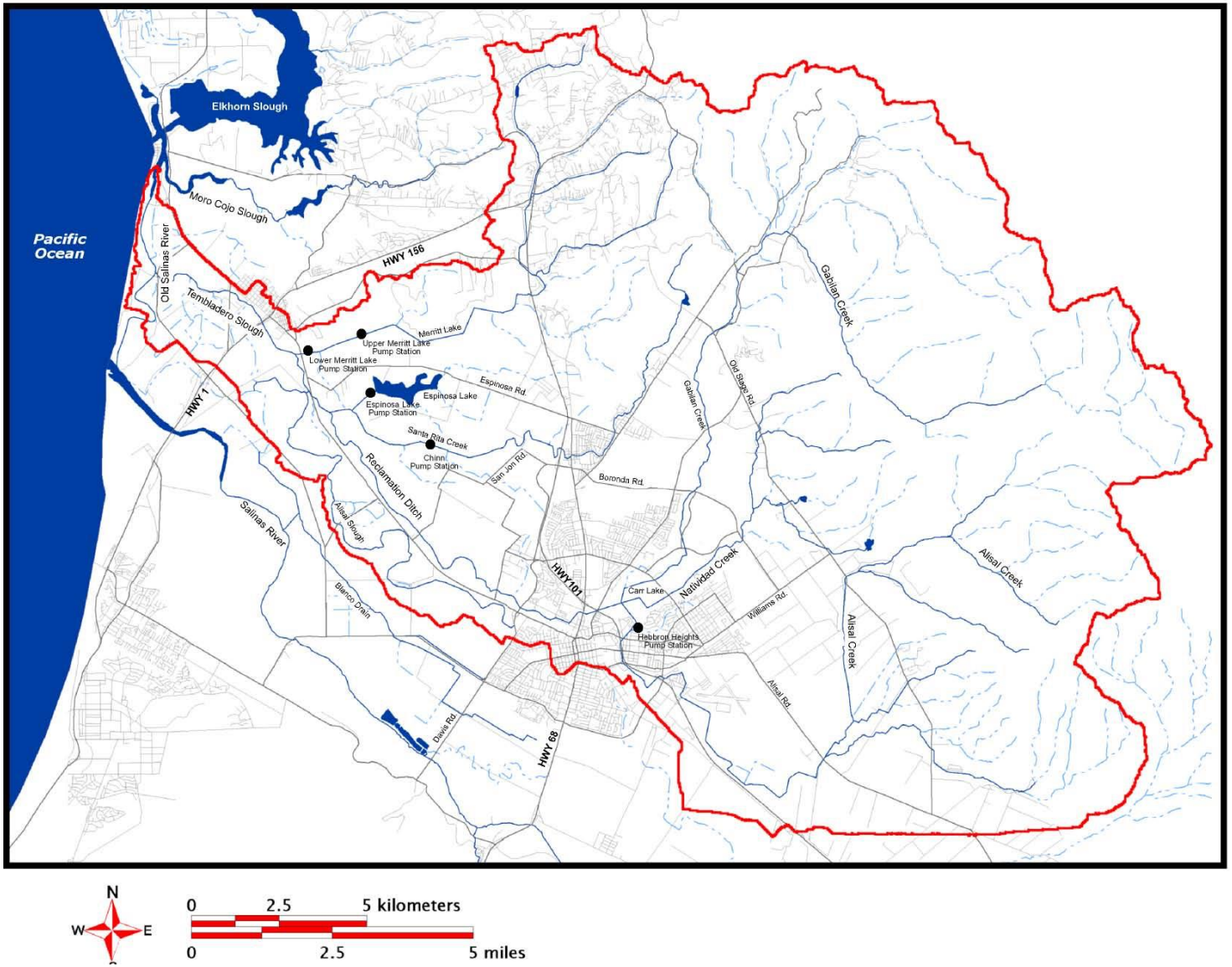
Salinas River Lagoon (RMU 7 to RM 0)

This reach encompasses the mouth of the river and lagoon from Blanco Road downstream, and includes the communities of Marina, Moss Landing, and Castroville. Flood risk is extremely high in this area due to low land surface elevations, the potential for storm surges from the ocean, and the influence of the sand bar on flooding. When tidal conditions limit Salinas River outflows via the sand bar or the OSR, this reach can be subject to extreme flood risk.

3.1.8.2 Additional Flooding Sources

The Gabilan/Tembladero watershed is a 157-square-mile drainage (also known as the Reclamation Ditch System) located to the northeast of the Salinas River watershed and is known to cause localized flooding (Figures 2-7 and Figure 3-14). The watershed includes the following subwatersheds: Tembladero Slough, Merritt Lake, Santa Rita Creek, Espinosa Lake, Gabilan Creek, Natividad Creek, Alisal Slough, and Alisal Creek. The watershed drains the Gabilan mountain range west through the city of Salinas and the agriculture lands of the Lower Salinas Valley (northern end of the watershed) through multiple drainages before joining the OSR halfway between the lagoon and Moss Landing Harbor.

The hydrologic regime of the water bodies in the Gabilan/Tembladero watershed varies markedly. The streams are non-perennial in the uppermost sections, perennial or near-perennial in certain reaches mid-way down the range, and then again non-perennial in the lowest parts of the watershed as the streams begin to flow over old alluvium at the foot of the range. Upon entering the broad system of alluvial plains that is the Salinas Valley, most of the streams are non-perennial, sparsely vegetated, and relatively small. As they near the cities of Salinas and Castroville, the drainages become wider, with perennial standing water (urban runoff, agricultural tailwater, and permitted discharges) in the dry season and storm runoff in the wet season. Finally, within a few miles of the coast, the streams flow into an extended brackish, sub-tidal slough. The lowest reaches are joined by overflow (slide gate–controlled) from the Salinas River Lagoon to become a back-beach swale that runs behind the dunes toward Moss Landing Harbor (Figure 3-14). The whole system is highly episodic; flooding of managed lands adjacent to streams and channels is not uncommon.



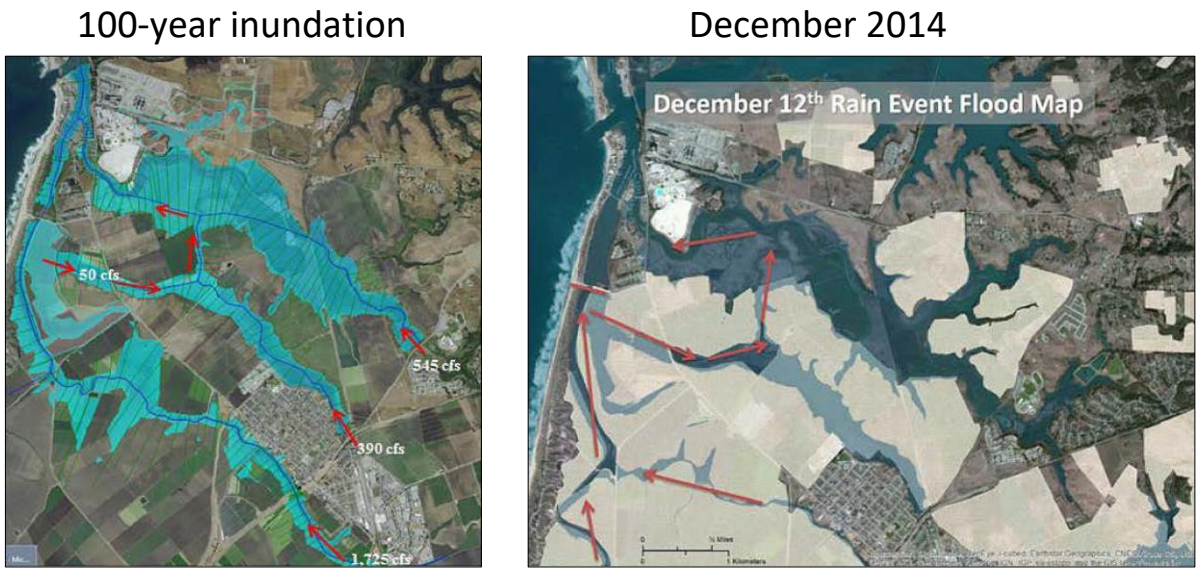
Source: Central Coast Watershed Studies 2006.

Figure 3-14. Locations of Major Surface Water Pump Stations in the Gabilan/Tembladero Watershed

Since pre-European times, the hydrology of the study area has been dramatically altered. An extensive system of interconnected sub-tidal lakes and swamps existed where the drainages exist today. Most of the lakes are now farmed but still flood regularly during winter storm events, providing valuable detention storage. The impervious area has increased significantly with the expansion of the cities of Salinas and Castroville. The final result in the middle to lower sections of the watershed is that there is less standing water in the dry season and more runoff in the wet season.

Following the dewatering of the original lakebeds, land subsidence (Bechtel Corp 1959) of up to several feet was observed, resulting in poor natural drainage of surface waters. To prevent flooding of both agricultural and urban lands, surface water pump stations have been installed throughout the system. Today, MCWRA operates and maintains several pump stations in the Gabilan/Tembladero watershed as shown in Figure 3-14 and described in Chapter 2, Section 2.3.3.3, *Other Facilities*.

During high discharge events (especially before the river mouth sand berm is breached), the combined discharge of the OSR and the Gabilan/Tembladero watershed can cause localized flooding. Recent flooding events resembled projections by the Federal Emergency Management Agency (FEMA) Flood Hazard maps (Figures 3-15a and 3-15b). On December 12, 2014, localized rainfall within the Gabilan hills caused discharges of almost 700 cfs within the Gabilan/Tembladero watershed (specifically from Gabilan Creek) while, during that same period, the Salinas River flow at Spreckels did not surpass 10 cfs. River flows increased during winter king tides, reducing discharge capacity through the Potrero Road and Moss Landing tide gates, causing significant flooding of agriculture lands within the lower Salinas Valley (Figure 3-15a). Crop losses were estimated at more than $2 million (Central Coast Wetlands Group 2017).



Source: Central Coast Wetlands Group 2017.
*Red arrows indicate water flow direction.

Figure 3-15a. FEMA 100-Year Inundation Areas Compared to the December 2014 Flooding in the Gabilan/Tembladero Watershed

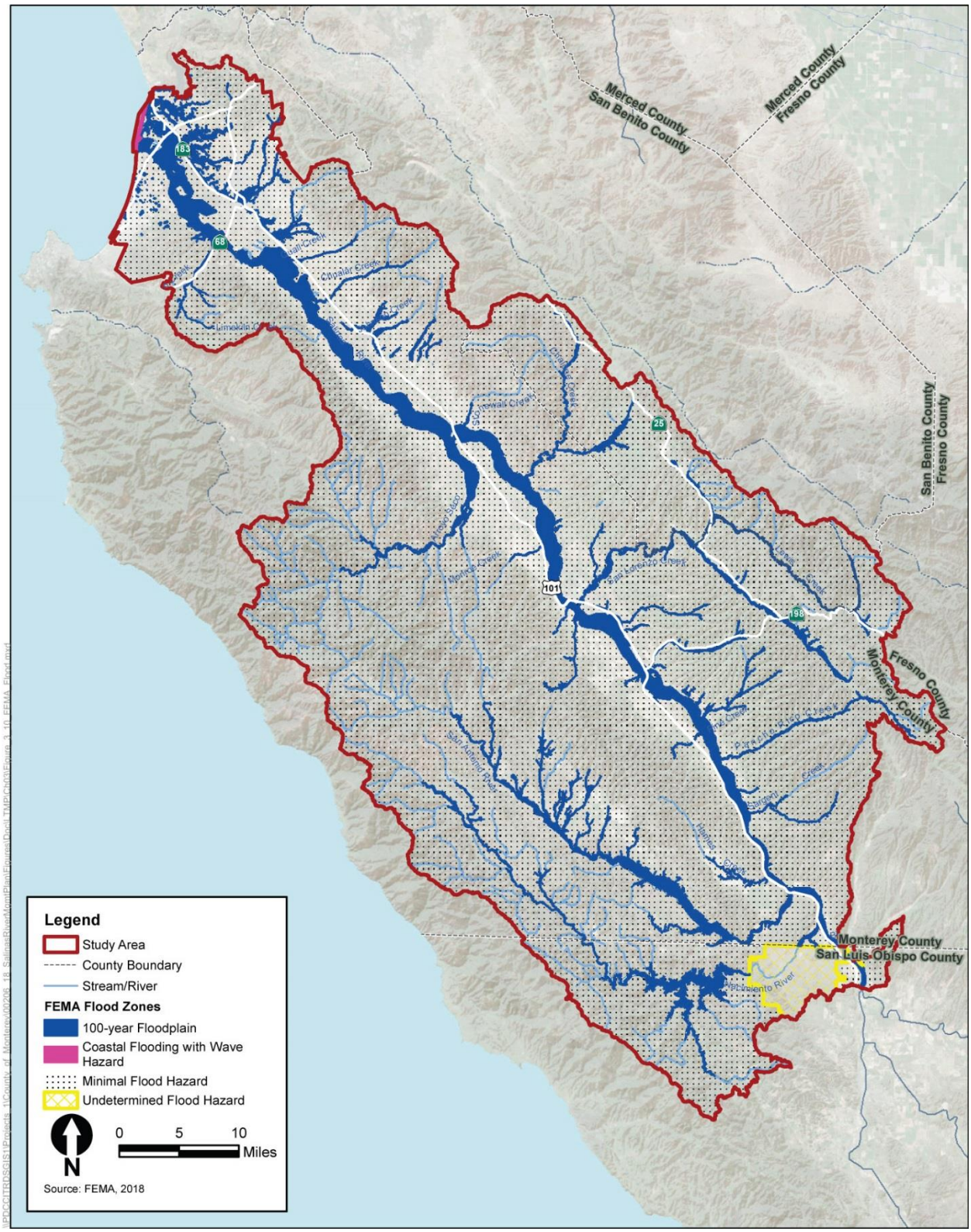


Figure 3-15b. FEMA Flood Zones in the Study Area

A significant area that includes agriculture, residences, and businesses around Moss Landing is currently vulnerable to flooding from the Gabilan/Tembladero watershed and OSR. Many of the farm fields vulnerable to flooding within the Moro Cojo Slough have been purchased for wetland restoration or conservation. Other historical wetland areas within the Gabilan/Tembladero watershed between Castroville and Salinas remain in agriculture production through the aid of water lift stations that pump water from drainage systems in the low-lying areas. Water elevation within these basins can be more than 8 feet below sea level. Obviously, these areas are vulnerable to flooding in the winter and have provided flood attenuation service to downstream resources during flood events.

Projected impacts from coastal flooding (wave overtopping dunes and levees causing inland flooding) demonstrate the dire vulnerabilities that agricultural lands, Moss Landing's coastline, and the surrounding area face in the future. By 2100 several portions of the protective dunes complex are projected to no longer restrict ocean waves, leading to significant flooding within the lower Salinas Valley. The long-term preservation of the Salinas State Beach dunes complex and the effective restriction of storm surge inland of Potrero Road are critical to the future viability of the southern Moss Landing region. The potential for inward migration of these dunes is likely but will come in conflict with present land use of those properties.

3.1.9 Groundwater

The Salinas Valley Basin is the largest coastal groundwater basin in Central California, and groundwater is a valuable resource for the valley's agriculture-based economy. Although the Salinas River is ultimately the primary water supply for the valley, most of the water used first infiltrates from the Salinas River into the underlying sediments before being extracted for use through groundwater pumping. Therefore, the Salinas Valley Basin serves as a critical reservoir for seasonal water storage, filled by wet season flows and depleted during the dry season when the agricultural water supply demand is greatest. The groundwater reservoir also provides critical storage during multi-year droughts, providing water supply when surface water resources are depleted. Nevertheless, conveyance of groundwater is a slow process. Typical time for groundwater to flow a mile down the valley within the alluvial aquifers is in the range of 10 to 20 years. The local rate of groundwater recharge and the aquifer thickness influence the quantity of available groundwater locally.

The following sections provide an overview of the groundwater basins present in the study area, the sources of groundwater, and groundwater pumping in the Salinas Valley.

Groundwater Basins

For groundwater management purposes, the California Department of Water Resources (DWR) (2003) divided the Salinas Valley Basin into groundwater subbasins.

- 180/400-Foot Aquifer (also referred to as Pressure).
- East Side Aquifer.
- Forebay Aquifer.
- Upper Valley Aquifer.
- Paso Robles Area.

- Seaside Area.
- Langley Area.
- Corral de Tierra Area (also referred to as Monterey subbasin).

Groundwater within the Salinas Valley is present in a sequence of water-bearing alluvial deposits that range in age from Pliocene through Quaternary, each of which can be up to 2,000 feet thick (California Department of Water Resources 2003, Monterey County Water Resources Agency 2017a). The stratigraphic (rock layer stratification) and hydrostratigraphic (hydrologic characteristics relating to groundwater flow) nomenclature of the Salinas Valley Aquifer System is summarized below (from oldest to youngest) and illustrated on Figure 3-4.

- Deep Aquifers, which are present in the northern Salinas Valley, include portions of the Santa Margarita, Purisima or Pancho Rico, and Paso Robles Formations, and range in age from late Miocene to early Pliocene (approximately 12 to 4 million years). The deep aquifer system sometimes is called the 900-foot aquifer.
- The Paso Robles Formation consists of alluvium deposited in Pliocene and Pleistocene time and is an important aquifer for the entire valley. In the northern portion of the valley this aquifer is known as the 400-Foot Aquifer (also called the Pressure 400-Foot Aquifer). In many locations between the city of Salinas and the coast, fine-grained, low permeability zones within the Paso Robles Formation collectively function as an aquitard[5] called the 400-Foot/Deep Aquitard that limits the hydraulic connection between the 400-Foot Aquifer and the underlying Deep Aquifers.
- Near the coast, upper portions of the 400-Foot Aquifer consist of the Aromas Sands, which are Pleistocene wind-blown dune sand deposits that overlie the Paso Robles Formation. Farther south in the Salinas Valley, the Aromas Sands transition to the Paso Robles Formation.
- Pleistocene Valley Fill deposits and upper portions of the Aromas Sands near the coast comprise the 180-Foot Aquifer. Fine-grained intervals within the Aromas Sands near the coast comprise the 180/400-Foot Aquitard that limits the hydraulic connection between the 180-Foot and 400-Foot Aquifers.
- Discrete aquitard intervals are not present within the aquifer systems in the East Side Subarea. Consequently, the upper portions of the aquifer system are unconfined; however, the cumulative influence of local fine-grained intervals within the coalescing alluvial fans results in semi-confined to confined conditions at depth.
- The Salinas Valley Aquitard (SVA) consists of fine-grained, low permeability clayey sediments that were deposited in an estuary environment during high sea-level conditions in late Pleistocene time. The extent of the SVA is limited to the 180/400-Foot Aquifer subarea. It is over 100 feet thick near the Monterey Bay Coast but thins to 25 feet near the city of Salinas and pinches out farther south near the cities of Chualar and Gonzales. The SVA is an important limitation to hydraulic connection between surface water or shallow groundwater and the underlying aquifer system.
- In the Forebay Aquifer and Upper Valley Aquifer subbasins, the Plio-Pleistocene stratigraphy is similar to and correlates with the northern portion of the valley; however, the extensive aquitard intervals are not present. The result is an unconfined aquifer system and greater

[5] An aquitard is a bed of low permeability that slows but does not prevent vertical groundwater flow.

hydraulic connection between the aquifer system and the Salinas River and higher recharge rates. The thickness of the aquifer system also decreases in the Upper Valley Aquifer subbasins.

- Recent deposits (<10,000 years) include fluvial deposits along portions of the Salinas River Corridor and sand dunes near the coast (Table 3-8).

Table 3-8. Stratigraphy and Hydrostratigraphy for the Salinas River

<table>
<tr><th colspan="2">Period/Epoch</th><th>Formation</th><th>Hydrostratigraphy</th></tr>
<tr><td rowspan="8">Quaternary
2.5 MYA to present</td><td>Holocene</td><td>Recent Alluvium</td><td>Shallow Aquifer</td></tr>
<tr><td rowspan="7">Pleistocene</td><td rowspan="2">Valley Fill</td><td>Salinas Valley Aquitard</td></tr>
<tr><td rowspan="2">Pressure 180-Foot Aquifer</td></tr>
<tr><td rowspan="2">Aromas Sands
(near coast)</td></tr>
<tr><td>Pressure 180/400-Ft Aquitard</td></tr>
<tr><td rowspan="3">Paso Robles</td><td rowspan="2">Pressure 400-Foot Aquifer</td></tr>
<tr><td>Pressure 400-Foot/Deep Aquitard</td></tr>
<tr><td rowspan="4">Tertiary
23 to 2.5 MYA</td><td rowspan="2">Pliocene</td><td rowspan="2">Purisima/
Pancho Rico</td><td rowspan="4">Deep Aquifers</td></tr>
<tr><td rowspan="3">Miocene</td></tr>
<tr><td rowspan="2">Santa Margarita</td></tr>
<tr><td>Monterey</td><td>Minimally water-bearing</td></tr>
<tr><td colspan="2">Mesozoic</td><td>Granitic basement</td><td>Non water-bearing</td></tr>
</table>

Not to scale.

MYA = Million Years Ago

Source: Kennedy and Jenks 2004.

Groundwater Recharge

Precipitation in the Salinas River watershed (HUC-8 Cataloging Unit) results in runoff and streamflow, which subsequently enters the Salinas Valley Basin through percolation, primarily in streambeds where flow is concentrated. Streamflow from the surrounding subwatersheds represents a major source of recharge to the aquifers of the Salinas Valley Basin (California Department of Water Resources 1946, California State Water Resources Board 1956, Brown and Caldwell 2015a). The amount of runoff generated by individual subwatersheds depends on the amount of precipitation, topography, vegetative cover, and ability of soils to absorb water. The Santa Lucia Mountains, on the west side of the Salinas Valley Basin, contribute approximately 70% of the total runoff to the Salinas Valley Basin (California State Water Resources Board 1956).

The soil type and timing of precipitation and river flows are critical factors for recharge. In areas with soil of low permeability (e.g., clayey soils), infiltration of water is slow and the majority of rainfall or river flow runs off over land. In areas with soil of high permeability (e.g., gravel) water can infiltrate rapidly into the ground. Recharge is also influenced by the water-holding capacity (specific retention) of soil. Generally, fine-grained soils (e.g., clay) retain larger amounts of water than coarse-grained soil (e.g., sand). Water retained by the soil matrix is utilized by root systems to meet evapotranspiration demands of plants and is critical to support native vegetation and "dry-farming" crops during the dry summer months.

Recharge to groundwater (deep percolation) only occurs when the retention capacity of the root-zone is exceeded and water infiltrates below the depth of roots. Like much of the western states with semi-arid climate, deep percolation of rainfall in the Salinas Valley only occurs episodically. Under natural conditions, the Salinas Valley Basin aquifer system is recharged by infiltration from the Salinas River and tributaries and by direct infiltration of rainfall. Based on modeling for MCWRA, infiltration of rainfall accounts for approximately 24% of natural recharge, and the infiltration from the Salinas River system accounts for the balance, approximately 76% (Rosenberg 2001).

In agricultural areas, some additional recharge occurs as infiltration of irrigation (return flows). However, the source of most of the irrigation is pumping of groundwater. Although the irrigation return flows could be considered an additional groundwater recharge source, it is generally more useful to treat it as a decrease in the net pumping (i.e., the net agricultural water use is equal to groundwater pumping minus return flow infiltration).

Areas identified by Rosenberg (2001) as being favorable for recharge are shown on Figure 3-4 and are based on the following criteria.

- Area must overlie a demonstrated aquifer system.
- Surficial soils must have moderate to high infiltration capacity and low to moderate retention capacity (e.g., sandy soils).
- The land is undeveloped (as noted above, agricultural return flow infiltration is not treated as recharge).

Many of the alluvial deposits along the Salinas River corridor are favorable recharge areas. However, much of the valley fill in the Salinas Valley is not favorable due to finer-grained texture, which results in relatively low permeability and high retention. The alluvial fans of the Arroyo Seco area and on the east side of the valley have high recharge potential, as does the alluvial fill in the San Antonio Valley area and soils of the Fort Ord and Seaside areas.

Recharge is also sensitive to the total and temporal distribution of rainfall over the year. For semi-arid climates similar to Salinas Valley, Blaney (1933) estimated threshold rainfall totals of 17 inches per year on native soils, and 11 inches per year on irrigated fields for significant amounts of recharge to occur. The threshold is lower for irrigated land because the soils are wetter at the beginning of winter so less rainfall is required to exceed the retention capacity of the soils. Rosenberg (2001) concludes that because most of Salinas Valley has average annual rainfall of less than 17 inches, even for favorable soil conditions, recharge of groundwater from rainfall is likely a rare occurrence.

Relative to natural conditions, irrigation increases the amount of deep percolation from rainfall, but the typical increase in recharge is more than offset by the evapotranspiration during the growing season. The groundwater pumping to meet irrigation needs typically exceeds the deep percolation enhancement by 20 to 30 times (Rosenberg 2001).

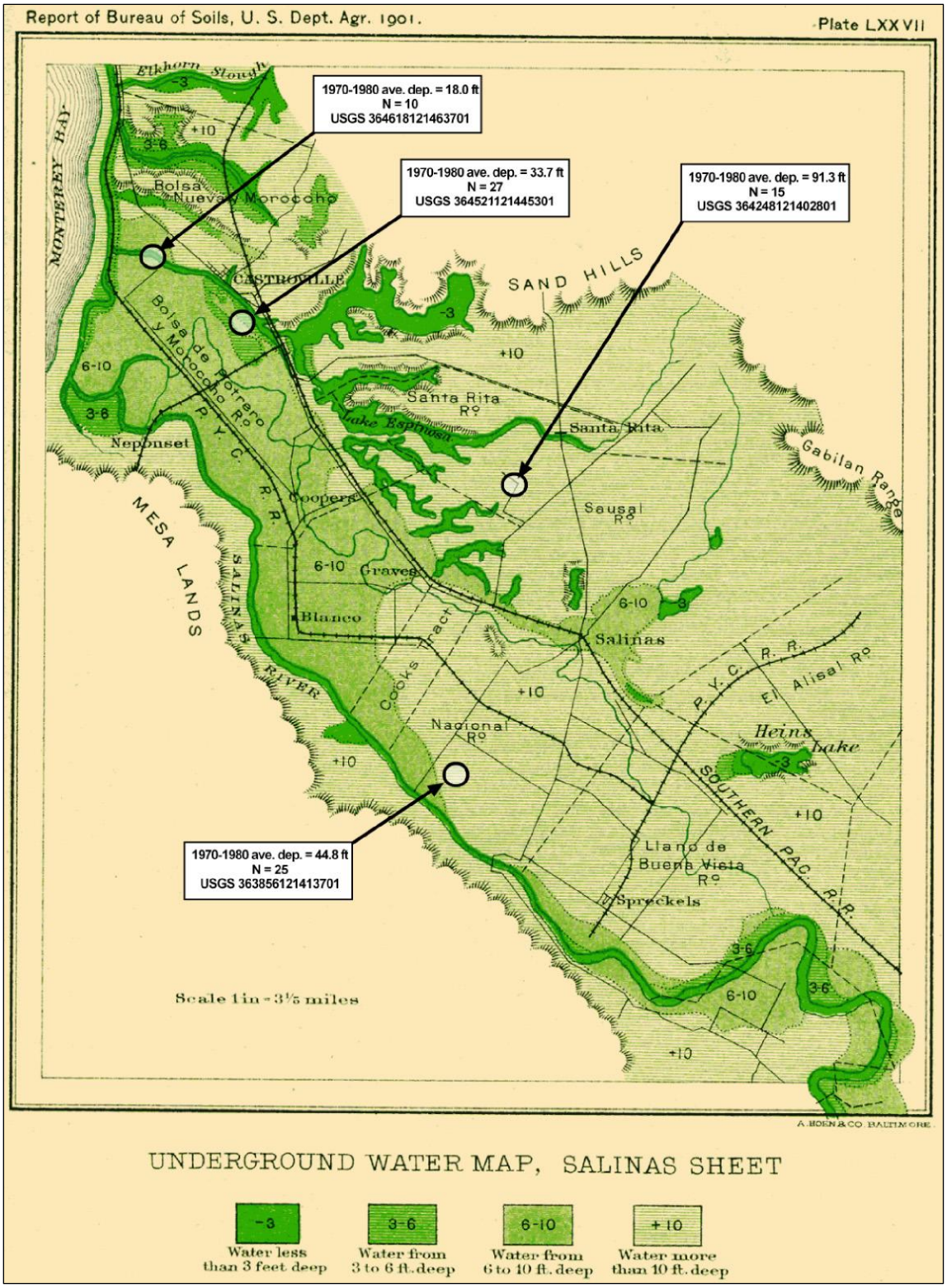
Groundwater Pumping

Water was diverted from the Salinas River for irrigation as early as 1797. As agriculture expanded, the Salinas River could no longer meet water demands and growers began pumping groundwater in the late 1800s. In the early 1900s USGS reported 270 wells in the alluvial basin from the coast up to about King City (Hamlin 1904). The USGS study also noted several pumping plants along the Salinas River that each extracted as much as 10,000 gallons per minute, which equates to 16,000 AFY,[6] from the river and wells along the river. According to records during census investigations, the number of reported active wells in the Salinas Valley increased from 102 in 1909 to 606 in 1919 and 1,176 in 1929 (Brown and Caldwell 2015b).

By 1944, groundwater pumping in the entire valley was estimated to be 350,000 AFY (Brown and Caldwell 2015b). Since the late 1940s, irrigated acreage within the valley has increased substantially, with steady increases in the 1940s and 1950s and rapid increases in the 1960s and 1970s (Figure 3-16). Groundwater use in the Salinas Valley peaked in the early 1970s, then started declining due primarily to changes in crop patterns, continued improvements in irrigation efficiency, and some conversion of agricultural lands to urban land uses. Total irrigated acreage has remained relatively constant since the 1980s (Monterey County Water Resources Agency 2006). Urban development, however, is experiencing continued growth, predominantly in the Castroville, Gonzales, Greenfield, King City, Marina, Salinas, and Soledad areas. The increases in urban water use, particularly on non-irrigated lands in the northern portion of the Salinas Valley, place additional pressure on groundwater pumping. The reported total irrigated acreage in the Salinas Valley in 2016 was 181,610 acres (Monterey County Water Resources Agency 2017b).

According to the analysis of historical storage changes in the Salinas Valley Basin (Brown and Caldwell 2015b), the overdraft of groundwater that occurred in the mid-1940s and 1950s was mitigated in part by the management of the flows in the Salinas River by the reservoirs. In particular, early groundwater storage losses in the Forebay Aquifer and Upper Valley Aquifer subbasins were entirely recovered once both reservoirs were in operation (starting water year 1967). However, operation of the reservoirs provided little mitigation of storage losses in the 180/400-Foot Aquifer and East Side Aquifer subbasins because aquifers in these areas are largely disconnected from the Salinas River.

[6] One acre-foot is equal to 325,851 gallons. One acre-foot/year is equal to 0.62 gallon per minute.



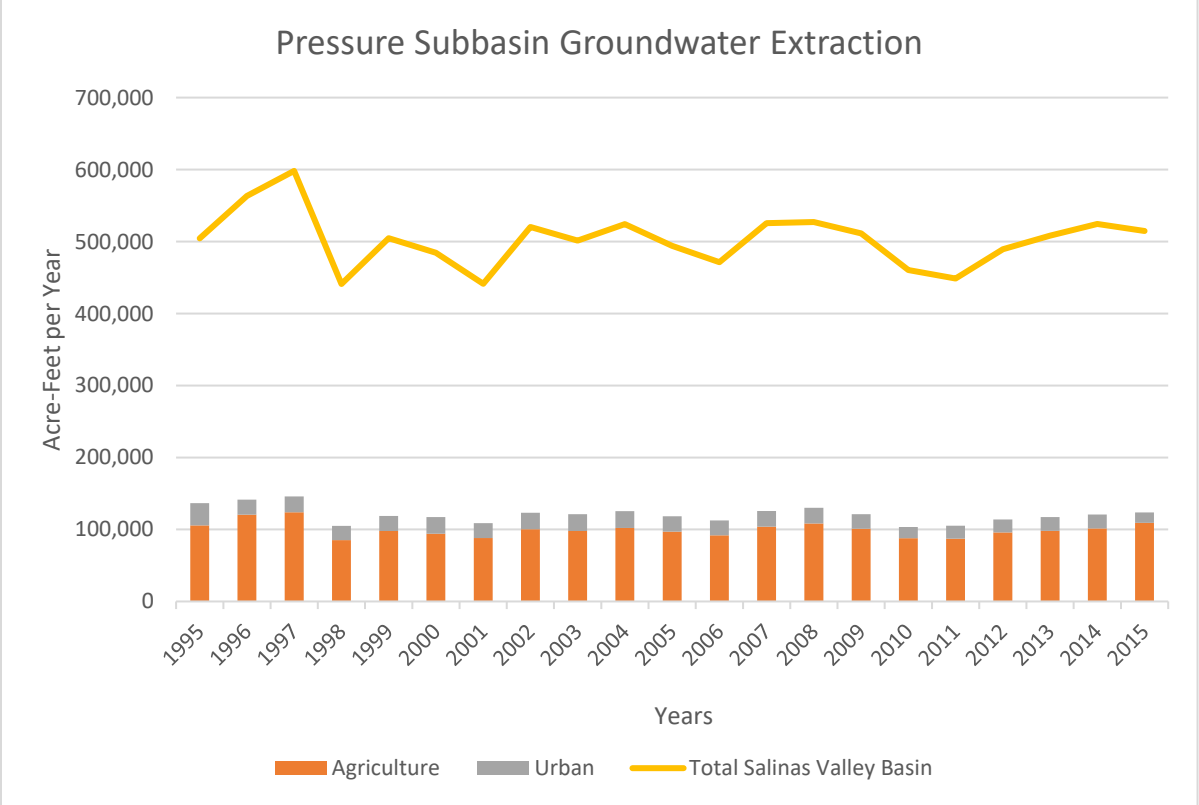
Source: Watson et al. 2003.

Figure 3-16. Groundwater Elevation in the Northern Salinas Valley Based on USGS Groundwater Well Data (1970–1980) with Wells Containing at Least 10 or More Measurements (=N) during that Time

Today, groundwater meets almost all agricultural and municipal water demands in the Salinas Valley, with agriculture constituting approximately 90% of the demand. In 2015 MCWRA reported an estimated total pumping of 509,000 AFY in the Monterey County portion of the Salinas Valley, with the following distribution by subareas[7] (Brown and Caldwell 2015b).

- 23% in the Pressure Subarea (180/400-Foot).
- 19% in the East Side Subarea.
- 29% in the Forebay Subarea (including the Arroyo Seco cone).
- 28% in the Upper Valley Subarea.

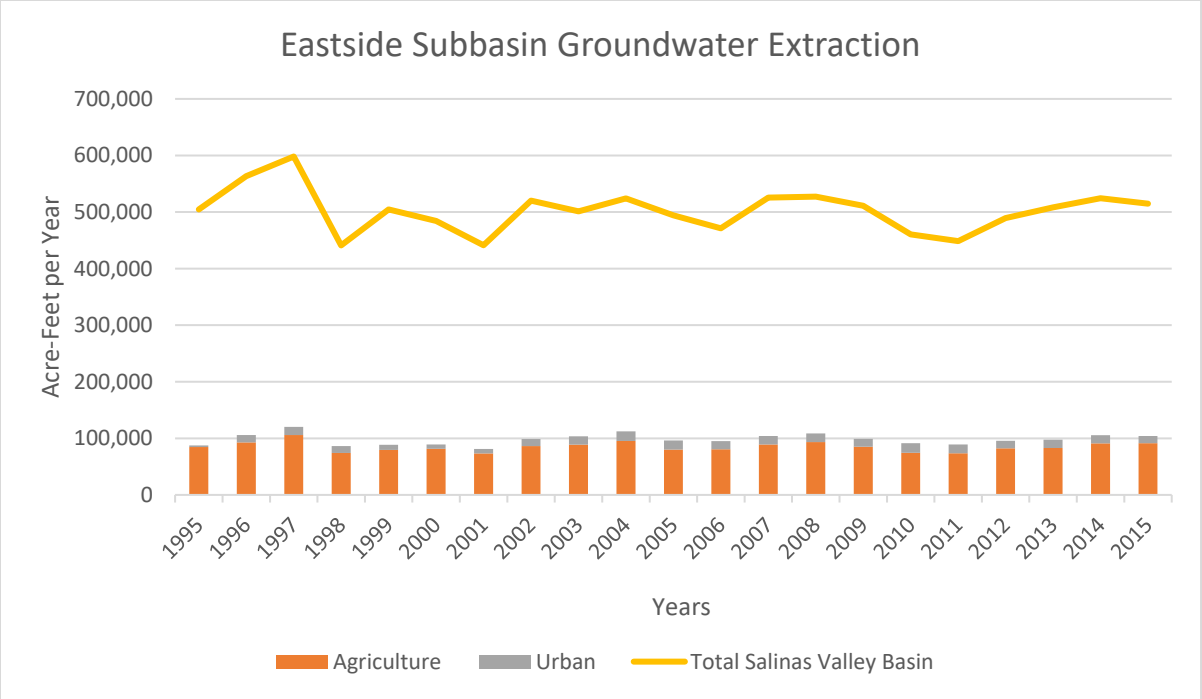
Since 1993, to help manage groundwater resources in the management area, owners of wells with a discharge pipe of 3 inches in diameter or greater have been required to report annual pumped quantities to MCWRA. The annual agricultural pumping totals are reported from November through October, and the urban pumping data is reported for each calendar year. MCWRA compiles the pumping data and provides a report each year (Monterey County Water Resources Agency 2018a). The groundwater pumping data reported by MCWRA by the four major subbasins are presented on Figures 3-17 through 3-20.



Source: Monterey County Water Resources Agency 2018a.

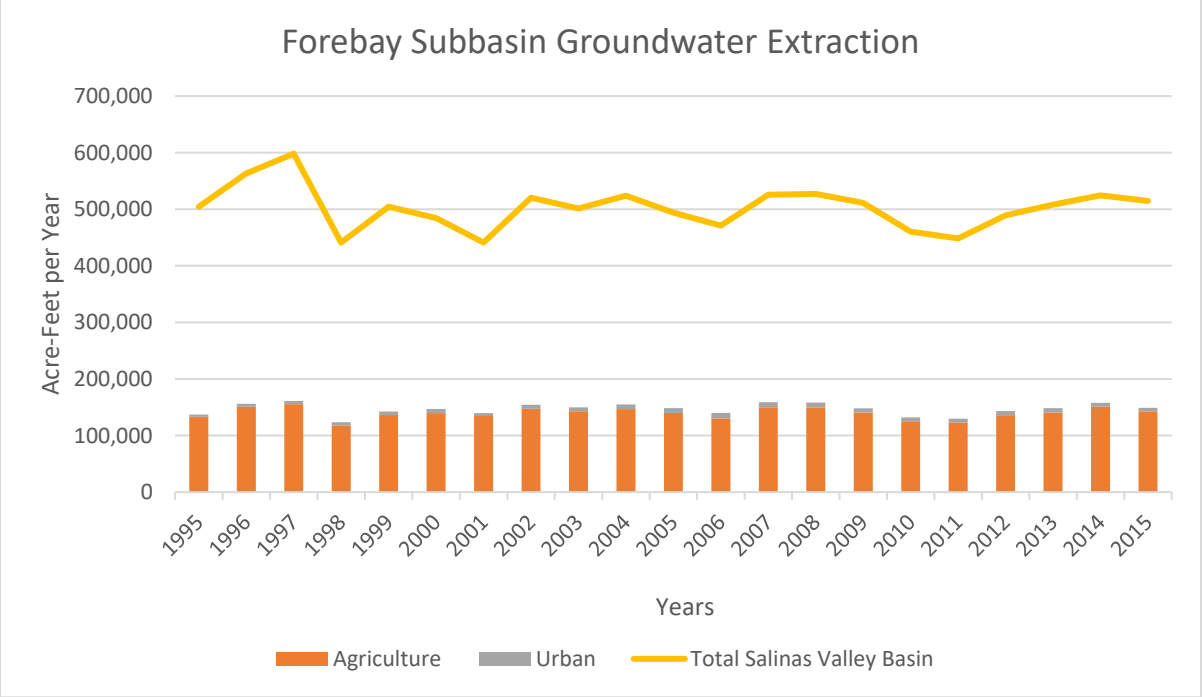
Figure 3-17. Total Reported Groundwater Extraction in the Pressure Subbasin

[7] MCWRA compiles and reports groundwater pumping data by subareas. The MCWRA subareas and DWR subbasins are similar but not identical in extent.



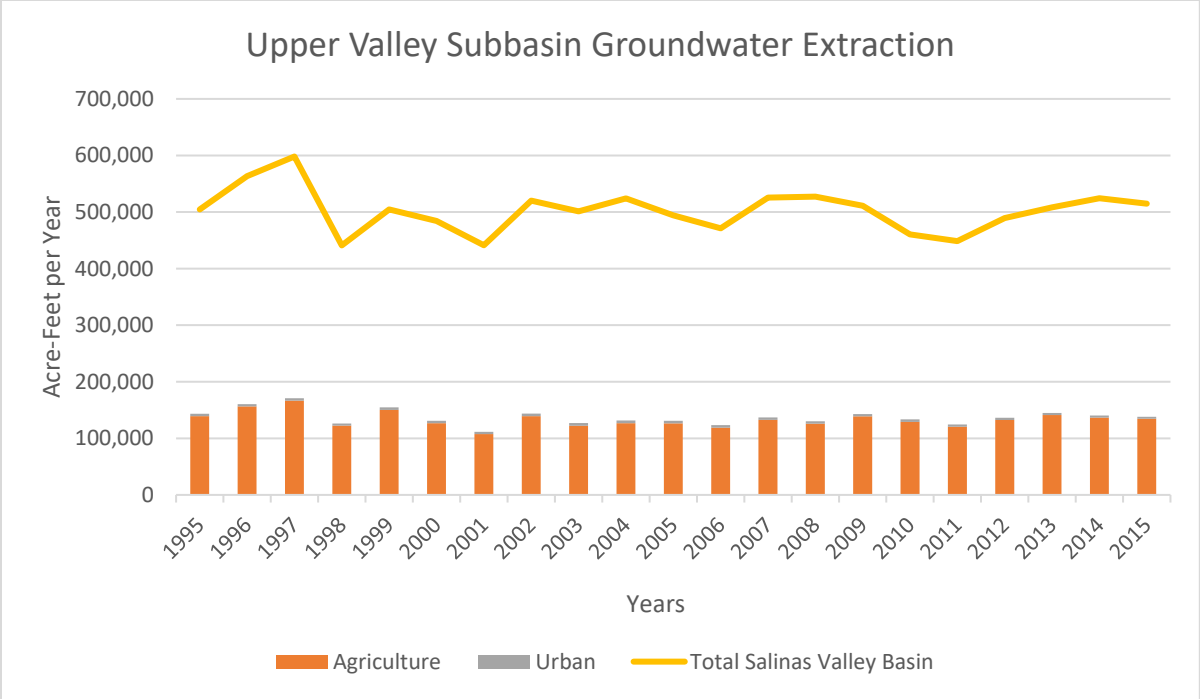
Source: Monterey County Water Resources Agency 2018a.

Figure 3-18. Total Reported Groundwater Extraction in the Eastside Subbasin



Source: Monterey County Water Resources Agency 2018a.

Figure 3-19. Total Reported Groundwater Extraction in the Forebay Subbasin



Source: Monterey County Water Resources Agency 2018a.

Figure 3-20. Total Reported Groundwater Extraction in the Upper Valley Subbasin

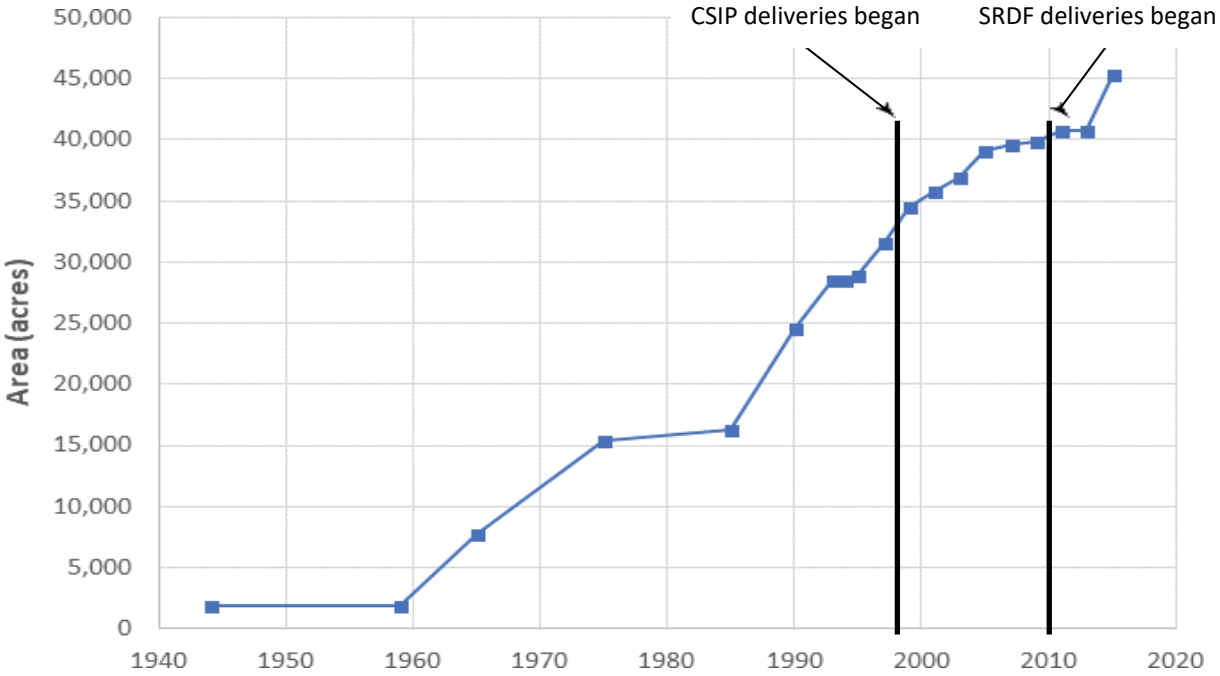
In the Upper Valley Subarea, groundwater wells are relatively shallow, and the aquifers system is unconfined. The wells are mostly close to the Salinas River. Compared to the deeper wells in the northern subareas, the production rates from wells in the Upper Valley Subarea are more influenced by short-term fluctuations in recharge, which influences depths to groundwater.

Shallow groundwater in the Forebay and East Side Subareas also is unconfined, but semi-confined at depth. Because of the greater thickness of the aquifer system and deeper wells, groundwater pumping rates in the Forebay and East Side Subareas are relatively stable. However, continued overdraft of groundwater in the East Side Subarea has contributed to the lowering of groundwater levels well below sea level north of Salinas.

Groundwater production in the Pressure (180/400-Foot) Subarea is mainly from the 180-Foot and 400-Foot Aquifers, which are generally under confined conditions. Because of groundwater levels below sea level, seawater has been intruding the 180-Foot and 400-Foot Aquifers for many decades. Seawater intrusion of the coastal margin aquifers of Salinas Valley was first documented in 1946 (Monterey County Water Resources Agency 2017a). MCWRA has monitored groundwater levels since the 1940s. Water levels are measured monthly at approximately 94 wells and annually at approximately 400 wells in the Salinas Valley. MCWRA monitors the extent of seawater intrusion by measuring the chloride content[8] in a network of wells in the northwestern portion of Salinas Valley. Today, seawater intrusion extends approximately 7 miles inland within the 180-Foot Aquifer and 4

[8] MCWRA defines the seawater intrusion front as the inland extent at which the concentration of chloride in groundwater is at least 500 mg/L. A chloride concentration of 500 mg/L is twice the National Secondary Drinking Water Regulation (250 mg/L) and exceeds the chloride concentration of 350 mg/L, which is considered by the U.S. Department of Agriculture to be of "Class III - injurious or unsatisfactory" quality for agricultural irrigation (Monterey County Water Resources Agency 2018a).

miles inland in the 400-Foot Aquifer (e.g., Monterey County Water Resources Agency 2012, 2017a). Figure 3-21 shows a time series of the cumulative area of the 180-Foot and 400-Foot Aquifers with chloride concentrations exceeding 500 milligrams per liter (mg/L).



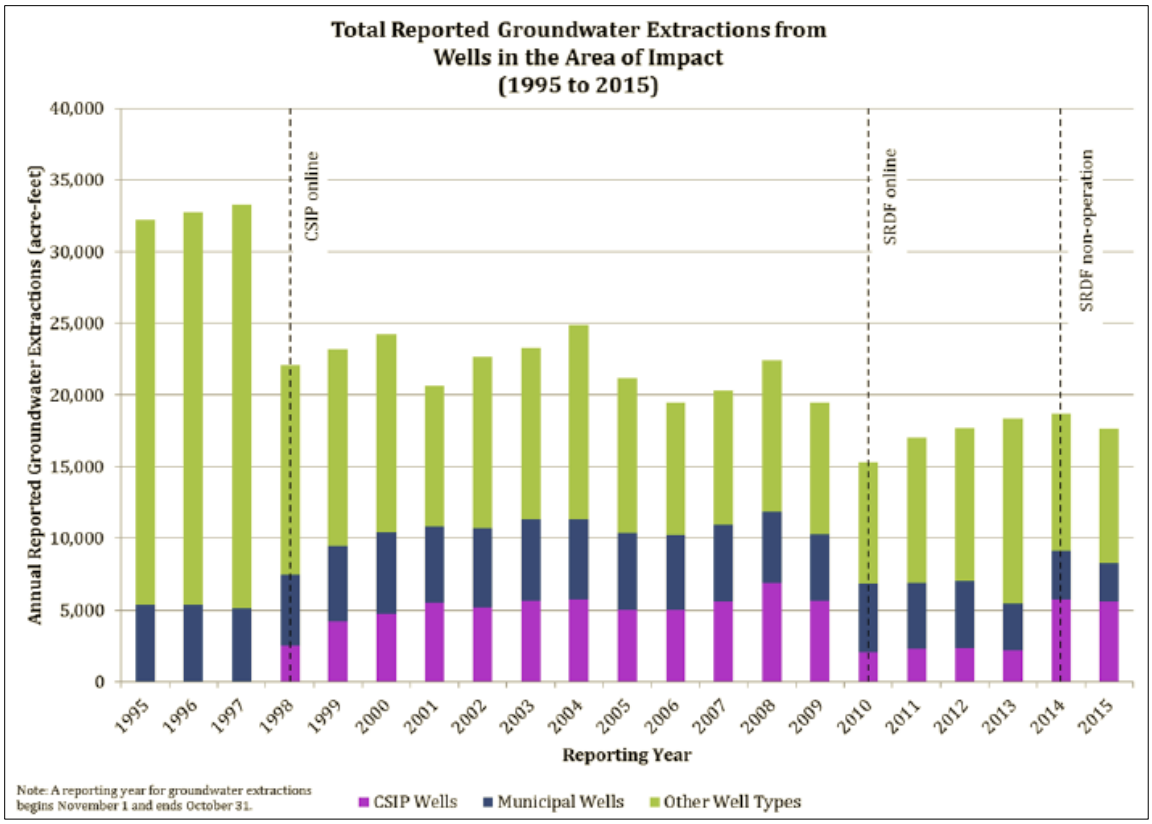
Source: Monterey County Water Resources Agency 2017b.

Figure 3-21. Cumulative Area with Time of Seawater Intrusion in 180- and 400-Foot Aquifers (areas with chloride exceeding 500 mg/L)

To help decrease the rate of seawater intrusion, since 1998 the Castroville Seawater Intrusion Project (CSIP) has delivered recycled water and groundwater pumped from supplemental wells to the Castroville area for irrigation to facilitate a decrease in pumping rates near the coast. Since 2010the CSIP has been supplemented with treated surface Salinas River water released from the reservoirs, which is a component of the SVWP. Average annual pumping in the Pressure (180/400-Foot) Subarea was 134,068 AFY from 1970 to 1997 (Montgomery Watson 1997), and 117,330 AFY from 1998 to 2015 (Monterey County Water Resources Agency 2017a; data provided by MCWRA). These data reflect a 12% decrease in average pumping in the Pressure Subarea after CSIP deliveries began.

For management recommendations, MCWRA also has defined an area impacted by incipient seawater intrusion based on a threshold chloride concentration in either the 180-Foot or 400-Foot Aquifer of 250 mg/L, which is the National Secondary Drinking Water Regulation for chloride (Monterey County Water Resources Agency 2017b). As illustrated by Figure 3-22 (Monterey County Water Resources Agency 2017b), the decrease in pumping within the "area of impact" since the CSIP and SRDF deliveries began is substantial: approximately a 32% decrease in the annual rate of pumping since CSIP deliveries began in 1998, and 46% since the additional deliveries from the SRDF, relative to pumping the 3 years (1995–1997) before CSIP came online.

A decrease in the rate of advancement of seawater intrusion because of replacement of some pumping by CSIP and the SRDF water deliveries can be seen on Figure 3-21. However, groundwater levels are still below sea level in aquifers near the coast and therefore seawater intrusion continues.



Source: Monterey County Water Resources Agency 2017b.

Figure 3-22. Annual Reported Groundwater Extractions in the Pressure Subbasin "Area of Impact" from 1995 to 2015

3.1.10 Water Quality

Water quality is a measure of the physical, chemical, and biological characteristics of water. The water quality of a stream is controlled by multiple factors, including the chemical and physical nature of streambed material (e.g., erodibility, grain size, rock type) and influences from outside the stream corridor, such as quality of groundwater and upstream runoff that may be recharging the stream system (Monterey County Water Resources Agency 2014). The California Porter-Cologne Water Quality Control Act of 1969, which became Division Seven of the State Water Code, establishes the responsibilities and authorities of the nine Regional Water Boards and the State Water Resources Control Board to coordinate and control water quality. Each Regional Water Board is directed to "...formulate and adopt water quality control plans for all areas within the region." For each water body in the regional jurisdiction, these plans are required to designate beneficial uses that are to be protected, water quality objectives that protect those uses, and an implementation plan that accomplishes those objectives (Central Coast Regional Water Quality Control Board 2017a).

The Salinas River is in the jurisdiction of the Central Coast Regional Water Board. Table 3-9 summarizes designated beneficial uses for a selected subset of waterbodies in the study area from the Basin Plan for the Central Coastal Region (Central Coast Regional Water Quality Control Board 2017a), and Table 3-10 outlines the U.S. Environmental Protection Agency 303(d) listings that are impairing the beneficial uses for each water segment (U.S. Environmental Protection Agency 2018). Figure 3-23 portrays the impaired waterbodies in the Gabilan/Tembladero watershed.

Table 3-9. Designated Beneficial Uses by Waterbody

Waterbody	MUN	AGR	PROC	IND	GWR	REC1	REC2	WILD	COLD	WARM	MIGR	SPWN	BIOL	RARE	EST	FRSH	COMM	SHELL
Nacimiento River (downstream of reservoir)	X	X			X	X	X	X	X	X		X		X		X	X	
San Antonio River (downstream of reservoir)	X	X		X	X	X	X	X		X	X	X		X			X	
Salinas River (Nacimiento to Chualar)	X	X	X	X	X	X	X	X	X	X	X	X		X			X	
San Lorenzo Creek	X	X			X	X	X	X		X		X					X	
Salinas River (Chualar to Spreckels)	X	X	X	X	X	X	X	X	X	X	X						X	
Arroyo Seco	X	X		X	X	X	X	X	X	X	X	X		X			X	
Salinas River (Spreckels to Lagoon)	X	X				X	X	X	X	X	X					X	X	
Salinas River Lagoon (North)						X	X	X	X	X	X	X	X	X	X		X	X
Salinas River Refuge Lagoon (South)						X	X	X	X	X	X	X	X	X			X	X

Source: Central Coast Regional Water Quality Control Board 2017a.

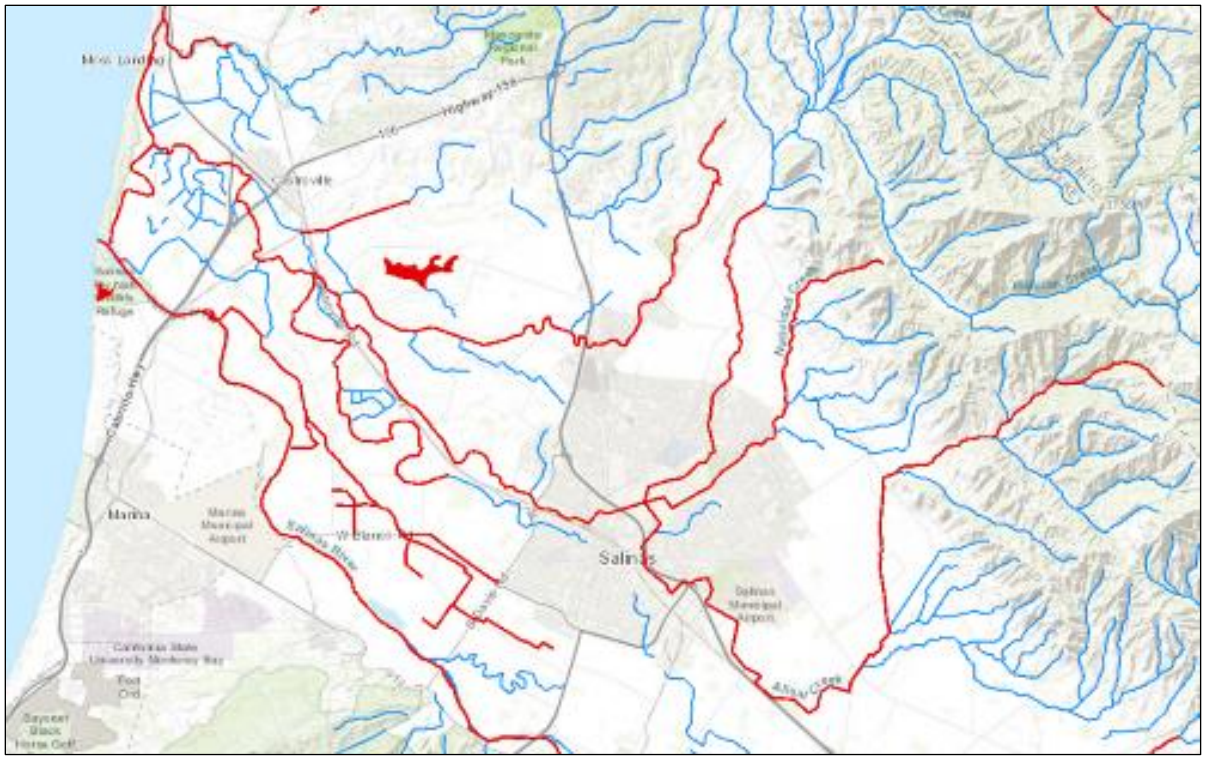
Key to beneficial uses:

AGR – Agricultural Supply
BOIL – Preservation of Biological Habitats of Special Significance
COLD – Cold Fresh Water Habitat
COMM – Commercial and Sport Fishing
EST – Estuarine Habitat
FRSH – Fresh Water Replenishment
GWR – Groundwater Recharge
IND – Industrial Service Supply
IGR – Migration of Aquatic Organisms
MUN - Municipal and Domestic Supply
PROC – Industrial Process Supply
RARE – Rare, Threatened, or Endangered Species
REC1 – Water Contract Recreation
REC2 – Non-Contact Water Recreation
SHELL – Shellfish Harvesting
SPWN – Spawning, Reproduction, and/or Early Development
WARM – Warm Fresh Water Habitat
WILD – Wildlife Habitat

Table 3-10. Listed Impairments by Waterbody

Waterbody	303(d) List Constituents
Nacimiento Reservoir	Mercury
San Antonio Reservoir	Mercury
San Antonio River (downstream of reservoir)	Fecal Indicator Bacteria, Escherichia coli
Salinas River (Nacimiento to Chualar)	Fecal Indicator Bacteria, pH, Toxicity, Turbidity, Water Temperature
San Lorenzo Creek	Boron, Chloride, Escherichia coli, Fecal Indicator Bacteria, pH, Sodium, Specific Conductivity
Salinas River (Chualar to Spreckels)	Benthic Community Effects, Chlordane, Chloride, Chlorpyrifos, Enterococcus, Escherichia coli., Fecal Indicator Bacteria, Nitrate, PCBs, pH, Salinity, Toxicity, Turbidity
Arroyo Seco	Fecal indicator bacteria and Water Temperature from the confluence with Tassajara Creek downstream to the confluence with the Salinas River.
Salinas River (Spreckels to Lagoon)	Benthic Community Effects, Chlordane, Chloride, Chlorpyrifos, DDE, DDT, Diazinon, Dieldrin, Escherichia coli, Fecal Indicator Bacteria, Nitrate, PCBs, pH, Sodium, Total Dissolved Solids, Toxaphene, Toxicity, Turbidity
Salinas River Lagoon (North)	Chlorpyrifos, DDE, Nutrients, pH, Toxicity, and Water Temperature
Salinas River Refuge Lagoon (South)	pH and Turbidity
Old Salinas River	Chlorophyll-a, Chlorpyrifos, Diazinon, Escherichia coli, Fecal Indicator Bacteria, Nitrate, Oxygen, dissolved, pH, Toxicity, Turbidity
Reclamation Ditch System	Ammonia, Chlorpyrifos, Copper, Diazinon, Escherichia coli, Fecal Indicator Bacteria, Malathion, Nitrate, Oxygen, Dissolved, Permethrin, pH, Priority Organics, Toxicity, Turbidity

Sources: State Water Resources Control Board 2018, U.S. Environmental Protection Agency 2018. https://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2014_2016.shtml



Source: Central Coast Watershed Studies 2006.

Figure 3-23. Impaired Waterbodies in the Gabilan/Tembladero Watershed

All of the pollutants listed in Table 3-10 require the development of a Total Maximum Daily Load (TMDL) to bring the associated water segments into compliance at levels that protect designated beneficial uses. The following TMDLs are in development or have been approved by the Central Coast Regional Water Board for the Salinas River watershed.

- Fecal coliform TMDL—approved September 2, 2010.
- Chlorpyrifos and diazinon TMDL—approved May 5, 2011.
- Nutrient TMDL—approved March 14, 2013.
- Sediment toxicity TMDL—approved July 14, 2017.
- Turbidity TMDL—in development.
- Salts TMDL—in development.
- Mercury TMDL in reservoirs—in development.

3.1.10.1 Fecal Indicator Bacteria

Many waterbodies in the Salinas River watershed from Chualar into the Salinas River Lagoon are impaired due to exceedances of Basin Plan (Central Coast Regional Water Quality Control Board 2017b) water quality criteria for fecal indicator bacteria concentrations affecting the beneficial uses of water contact recreation (REC-1) and shellfish harvesting (SHELL) (State Water Resources Control Board 2018, U.S. Environmental Protection Agency 2018). The fecal coliform TMDL (Central Coast Regional Water Quality Control Board 2010) attributes exceedances to specific sources by

water segment and establishes numeric targets for reducing discharges to the affected watersheds in order to restore beneficial uses by 2023. Generally, the primary sources include domestic animals/livestock discharges in areas that do not drain to municipal separate storm sewer systems, discharges from municipal separate storm sewer systems, illegal dumping, and sanitary sewer collection system leaks (Central Coast Regional Water Quality Control Board 2010).

3.1.10.2 Nutrients

Many waterbodies in the Salinas River watershed from Chualar into the Salinas River Lagoon are impaired due to exceedances of Basin Plan (Central Coast Regional Water Quality Control Board 2017b) water quality criteria for nitrate, unionized ammonia, and associated nutrient-related problems such as excessive orthophosphate, dissolved oxygen imbalances, microcystin toxicity, and excess algal biomass (Central Coast Regional Water Quality Control Board 2013). These exceedances have affected designated beneficial uses including municipal and domestic supply (MUN), agricultural supply (AGR), groundwater recharge (GWR), water contact recreation (REC-1), cold fresh water habitat (COLD), and warm fresh water habitat (WARM). The Nutrient TMDL, established in 2013, identifies sources of these water quality impairments and describes a plan to achieve water quality objectives and ultimately restore the designated beneficial uses of surface waters by 2043. The primary source of nutrients to the watershed is fertilizer application on irrigated cropland (Central Coast Regional Water Quality Control Board 2013). Other sources include urban stormwater sewer system discharge (minor source at basin-scale but locally significant), and livestock and domestic animal manure (minor source, currently meeting load allocations). Proposed actions include minimization of nutrient loading to receiving waters from irrigated lands through using restored or created wetland and riparian habitat as water quality management areas (which involve low-cost, highly effective ecological engineered watershed restoration techniques) in the lower Salinas Valley, implementation of the Central Coast Water Board Agricultural Order, incorporation of waste load allocations into municipal separate storm sewer systems National Pollutants Discharge Elimination System permits, and maintenance of existing water quality by supporting self-monitoring activities for owners of livestock and domestic animals with technical guidance from existing rangeland water quality management plans (Central Coast Regional Water Quality Control Board 2014).

3.1.10.3 Pesticides

Many waterbodies in the Salinas River watershed are also impaired due to exceedances of Basin Plan (Central Coast Regional Water Quality Control Board 2017b) water quality criteria for pesticide concentrations from Chualar into the Salinas River Lagoon affecting the beneficial uses of wildlife habitat (WILD), cold fresh water habitat (COLD), warm fresh water habitat (WARM), migration of aquatic organisms (MIGR), spawning, reproduction and/or early development uses (SPWN), rare, threatened, or endangered species (RARE), and estuarine habitat (EST) (Central Coast Regional Water Quality Control Board 2011). Discharges from irrigated agriculture were identified as the primary source of pesticides within the watershed. The Lower Salinas River watershed Chlorpyrifos and Diazinon TMDL (Central Coast Regional Water Quality Control Board 2011) established numeric targets for the application of the two targeted organophosphate pesticides, chlorpyrifos and diazinon. The TMDL implementation schedule calls for achieving TMDL numeric targets for chlorpyrifos and diazinon by 2025. Since the establishment of the TMDL and restrictions of these pesticide uses by the California Department of Pesticide Regulation, significant reductions in chlorpyrifos and diazinon application and water column concentrations have been observed

according to the 2016 TMDL report card. However, the report also indicates some of these reductions could be offset by a possible switch in types of organophosphate pesticides (e.g., malathion).

3.1.10.4 pH

Surface waters in the Salinas River watershed from the confluence with Nacimiento River into the Salinas River Lagoon are impaired for high pH. These surface waters do not meet the Basin Plan (Central Coast Regional Water Quality Control Board 2017a) objectives for pH affecting municipal and domestic supply (MUN), water contact recreation (REC-1), non-contact recreation (REC-2), cold freshwater habitat (COLD), and warm freshwater habitat (WARM) beneficial uses (U.S. Environmental Protection Agency 2018). A pH TMDL is required, but has not yet been started.

3.1.10.5 Salinity

Surface waters in the Salinas River watershed from the Spreckels to the Salinas River Lagoon are impaired for salinity as measured by sodium, chloride, and total dissolved solids concentrations. These surface waters do not meet the Basin Plan (Central Coast Regional Water Quality Control Board 2017a) objectives for salinity affecting agricultural supply (AGR) and wildlife habitat (WILD) beneficial uses (U.S. Environmental Protection Agency 2018). Development of a Salinity TMDL is currently underway.

3.1.10.6 Sediment Toxicity

Surface waters in the Salinas River watershed from the City of Gonzales into the Salinas River Lagoon are impaired for sediment toxicity to the aquatic invertebrate (*Hyalella azteca*) and for pyrethroid pesticides in sediment. These surface waters do not meet the Basin Plan (Central Coast Regional Water Quality Control Board 2017b) general narrative objectives for toxicity and pesticides affecting aquatic life beneficial uses cold freshwater habitat (COLD) and warm freshwater habitat (WARM). The Sediment Toxicity and Pyrethroid Pesticides in Sediment TMDL, established in 2017, identifies sources of toxicity and describes a plan to achieve water quality objectives that will ultimately restore the designated beneficial uses of surface waters by 2032. Source analysis presented in the TMDL indicates the most likely source of sediment toxicity is pyrethroid pesticides that are commonly used in urban and agricultural areas to control insect pests, and both land uses are sources of pyrethroids in sediments and associated sediment toxicity impairments in the Salinas River watershed (Central Coast Regional Water Quality Control Board 2017b). Implementation actions include requiring operators of municipal separate storm sewer systems to develop a Waste Load Allocation Attainment Plan and enforcement of existing implementation actions enacted by the Central Coast Regional Water Board (i.e., Agricultural Order No. R3-2012-011) and the U.S. Environmental Protection Agency regarding pesticide use and surface water monitoring.

3.1.10.7 Turbidity

Surface waters in the Salinas River watershed from the confluence with Nacimiento River into the Salinas River Lagoon are impaired for turbidity. These surface waters do not meet the Basin Plan (Central Coast Regional Water Quality Control Board 2017a) general narrative objectives for turbidity affecting aquatic life beneficial uses cold freshwater habitat (COLD) and warm freshwater habitat (WARM). Development of a Turbidity TMDL is currently underway.

3.1.10.8 Water Temperature

Surface waters in the Salinas River watershed from the confluence with Nacimiento River into the Salinas River Lagoon are impaired for water temperature. These surface waters do not meet the Basin Plan (Central Coast Regional Water Quality Control Board 2017a) objectives for water temperature affecting cold freshwater habitat (COLD) beneficial uses (U.S. Environmental Protection Agency 2018). A water temperature TMDL is required but has not yet been started.

3.1.10.9 Mercury

Mercury is negatively impacting the beneficial uses of many waters of the state by making fish unsafe for human and wildlife consumption. Although mercury occurs naturally in the environment, concentrations exceed background levels because of human activities. Gold and mercury mines and atmospheric deposition are the predominant sources of mercury, with minor contributions from industrial and municipal wastewater discharges and urban run-off. The State and Regional Water Board staff are developing a statewide water quality control program for mercury in reservoirs. The Statewide Mercury Control Program for Reservoirs will address 131 reservoirs identified as mercury-impaired in the state as of January 2018. Nacimiento and San Antonio Reservoirs are being monitored, and development of a Mercury TMDL is currently underway. As of December 2018, both reservoirs are under a fish consumption advisory by the State Office of Environmental Health Hazard Assessment.

3.2 Land Use

The study area is in Monterey County and a portion of San Luis Obispo County, and consists of land within the Salinas Valley near the Salinas River (Figure 3-24). There are incorporated cities and unincorporated communities within the study area and near the Salinas River. Incorporated cities within the study area include King City, Greenfield, Soledad, Gonzales, Salinas, and Marina. Unincorporated communities within the study area include San Miguel, Bradley, San Ardo, San Lucas, Chualar, Boronda, Spreckels, Castroville, and Moss Landing. The Salinas River flows through or near the following Monterey County planning areas: South County, Central Salinas Valley, Toro, Greater Salinas, Greater Monterey Peninsula, and North County.

3.2.1 Historical Land Use

A historical ecology reconnaissance of the lower Salinas River indicates that prior to human alteration, the historical river was a dynamic and complex system with a broad array of habitat types, including riparian forests around the Salinas River (San Francisco Estuary Institute 2009). Before the Spanish arrived in Monterey County, the Ohlone, Salinan, and Esselen people used the lands in the Salinas Valley for hunting and gathering. The Spanish established a mission in Monterey County in the 1770s and began awarding land grants to ranchers and farmers to use the land for agricultural purposes. Subsequent to the Spanish settlement in Monterey County, agriculture developed with greater intensity in the Mexican period (1822–1848) and after California became a part of the United States (1850) (Monterey County Parks Department 2011).

The land in Monterey County, particularly surrounding the Salinas River, has historically been used for agricultural purposes. Table 3-11 shows the number of farms in Monterey County, as well as the area in Monterey County that was used for farming operations. Table 3-11 and Figure 3-25 show that overall the number of farms has decreased since 1900, while the area farmed has increased; however, it should be noted that total area farmed today is less than what it is was at its peak in the 1950s. Between 1900 and 2012 the area of farms has ranged between 1.1 and 1.6 million acres.

Table 3-11. History of Agricultural Use in Monterey County

	Year											
	1900	**1910**	**1920**	**1930**	**1940**	**1950**	**1959**	**1969**	**1978**	**1992**	**2002**	**2012**
Number of Farms	1,850	1,658	1,712	1,891	1,999	1,893	1,438	1,344	1,253	1,245	1,216	1,179
Land Used in Farming (million acres)	1.1	1.1	1.1	1.3	1.3	1.6	1.6	1.5	1.4	1.4	1.3	1.3

Sources: U.S. Department of Agriculture 1910, 1930, 1940, 1950, 1959, 1969, 1978, 1992, 2012a, 2012b.

The history of urban development in the Salinas Valley is linked to the history of agricultural development and the development of roads, railroads, and other infrastructure that facilitated both agricultural and urban development. Rail (Southern Pacific Railroad) came to Monterey County in 1871. The Southern Pacific rail line reached Salinas in 1871 and Soledad in 1872, and, after 1886, the rail line extended south through King City, San Lucas, San Ardo, and Bradley (Monterey County Parks Department 2011). In Monterey County, the railroad facilitated the expansion of agriculture; fostered land speculation; transported agricultural laborers throughout the region; and helped spur community development, including communities like Aromas, Pajaro, Las Lomas, Castroville, Salinas, Spreckels, Chualar, Gonzales, Soledad, Greenfield, King City, San Lucas, San Ardo and Bradley (Monterey County Parks Department 2011).

In addition to rail, roadways were historically built near the Salinas River. Early during the Spanish occupation of Monterey County, transportation routes were built to follow natural low lands and waterways (Monterey County Parks Department 2011). This is evident today by the multiple bridge locations for vehicles and rail that cross the Salinas River. Many of these bridges are near cities and unincorporated communities, including Castroville, Marina, Blanco, Salinas, Chualar, Gonzalez, Soledad, Greenfield, King City, San Lucas, San Ardo, Bradley, and San Miguel.

Furthermore, the Salinas Valley has also been affected by the implementation of water infrastructure. Ranchers and farmers in the Salinas Valley relied on water from the Salinas River for their agricultural operations. By 1901, farmers had filed 70 water claims for the Salinas River and its tributaries; they also claimed water from the Arroyo Seco, San Lorenzo, and San Antonio Rivers (Monterey County Parks Department 2011). Monterey County farmers have used many canals and dams to deliver water to their crops. For example, the 9-mile Salinas Canal drew water from the Salinas River. Dams held water impounded from smaller streams, and ditches carried the water to the fields. The Salinas Dam was built in 1941 in the upper Salinas Valley to supply the water needs of Camp San Luis Obispo and the city of San Luis Obispo. More dams followed in the 1950s and 1960s (Monterey County Parks Department 2011).

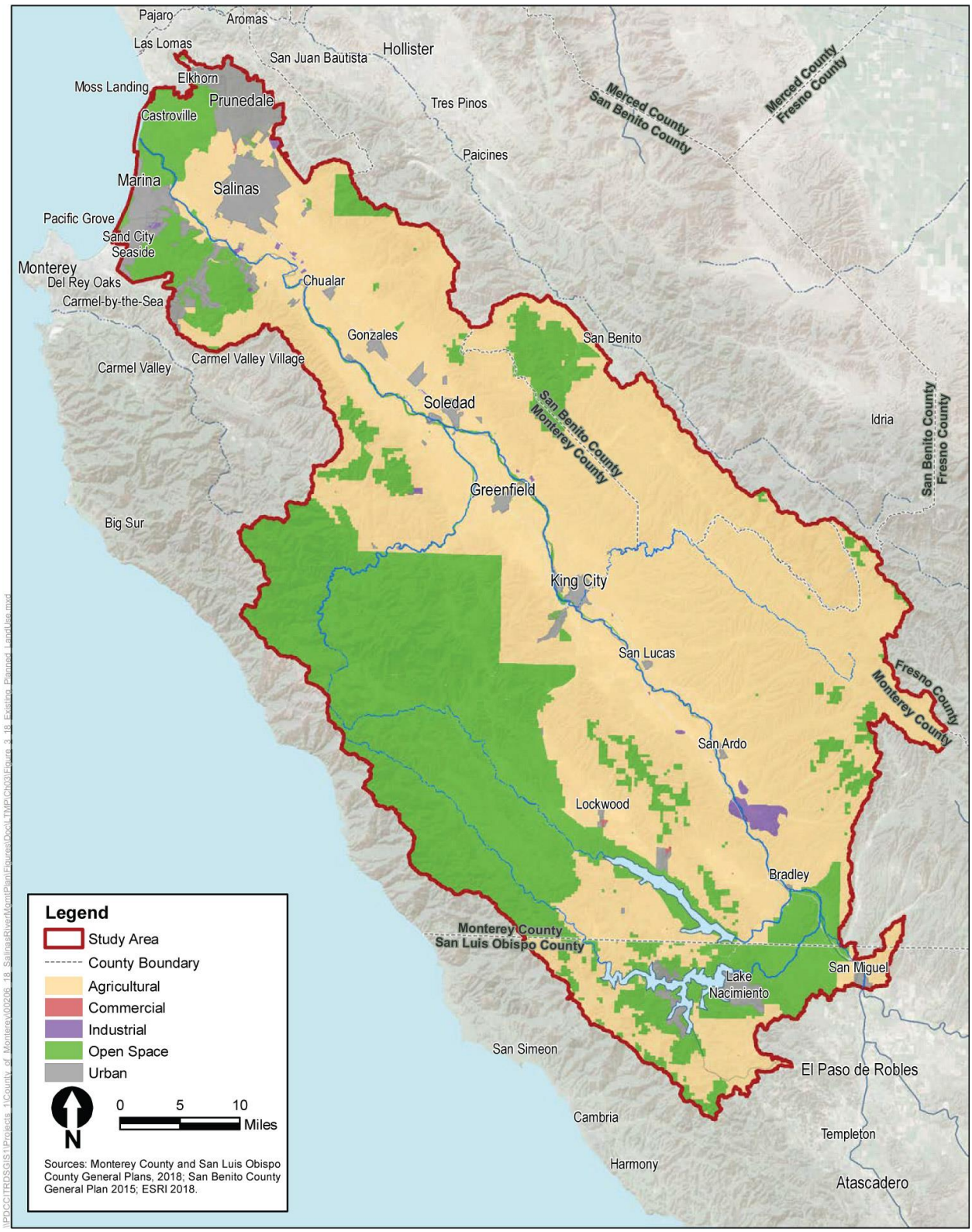
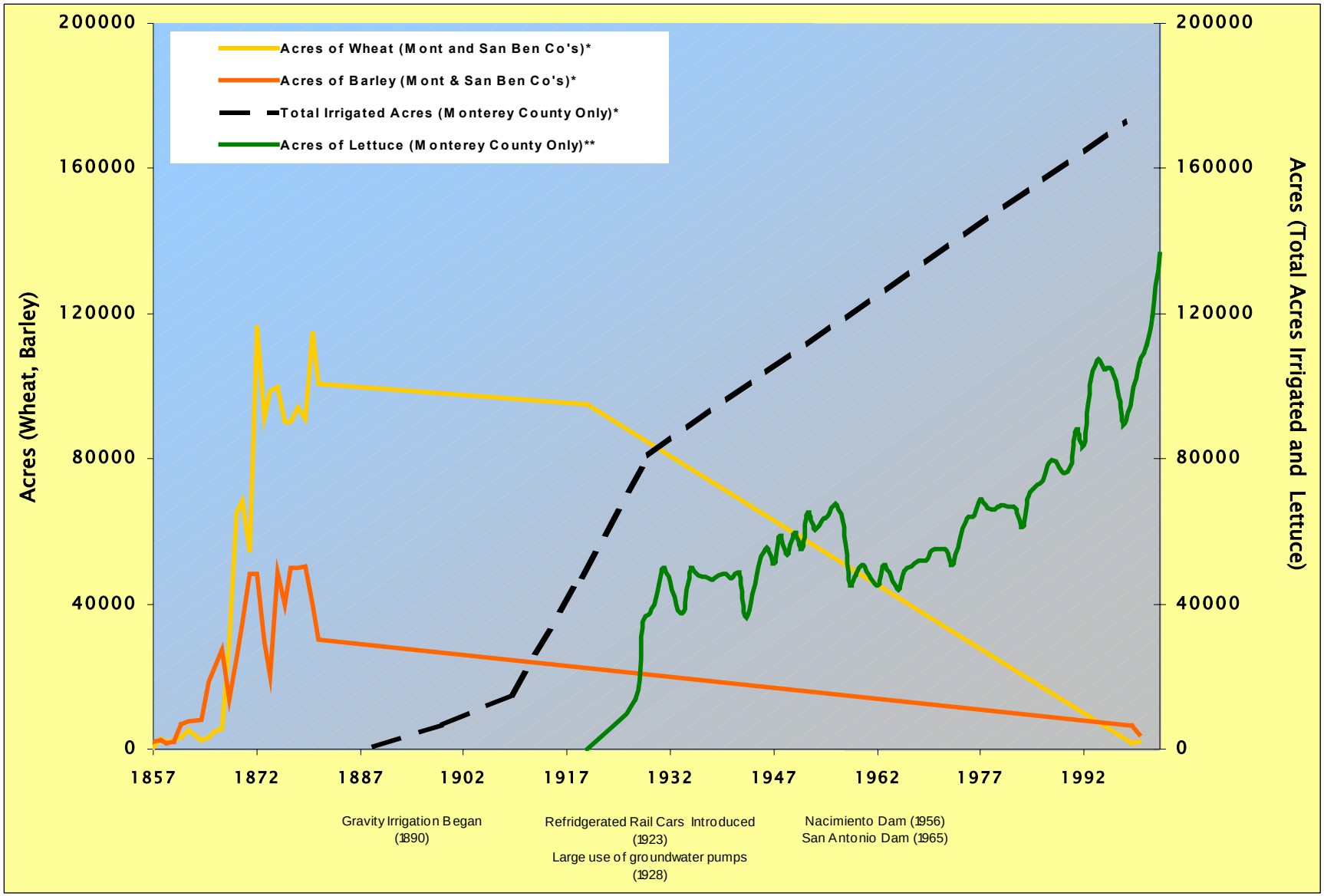


Figure 3-24. Land Use Designations



Original data source: *Breschini et al. 2000, **Monterey County Agricultural Commissioner Crop Reports (1929 data).

Figure 3-25. History of Agricultural Use in Monterey County

3.2.2 Current Land Use Designations and Land Uses

3.2.2.1 Introduction

Land use designations indicate both current and potential future land uses as defined by local land use plans. The current land use designations in the study area were identified by reviewing mapping in the general plans for the Counties of Monterey, San Luis Obispo, and Sen Benito (County of Monterey 2018, County of San Luis Obispo 2018, County of San Benito 2015). Agricultural and open space are the primary land use designations in the study area, as shown on Figure 3-24. When the Salinas River approaches cities and unincorporated communities, the land use changes from agricultural to urban uses more typical of cities and communities, including residential, industrial, resource conservation, and public/quasi-public land uses. Figure 3-24 maps these land uses as *urban*. Furthermore, there is one area south of Bradley classified as mineral extraction, which is shown on Figure 3-24 under the industrial land use designation. Table 3-12 summarizes the percentage of land cover that is classified for agricultural, open space, urban, industrial, and commercial uses.

Table 3-12. Area of Land Use Designations in the Study Area

Land Use Designation	Area (acres)	Percent Land Cover
Agricultural	1,046,954	60.6%
Open Space	590,476	34.3%
Urban	77,925	4.5%
Industrial	7,743	0.5%
Commercial	657	0.1%
Total	**1,720,755**	**100%**

Sources: County of Monterey 2018, County of San Luis Obispo 2018, County of San Benito 2015, GreenInfo Network 2016.

Note: The area does not sum to the total study area due to overlaps and gaps in the available source data.

3.2.2.2 Agricultural Land Use

The land use adjacent to the Salinas River is primarily classified as farmlands. The Monterey County General Plan identifies that farmlands are typically 40-acre minimum sites and allow a range of uses to conserve and enhance the use of the important farmlands while also providing opportunity to establish necessary support and ancillary facilities for those agricultural uses (County of Monterey 2018). Permanent grazing land use is located east and west of the farmland land uses. The Monterey County General Plan identifies that permanent grazing lands are typically 40- to 160-acre minimums and allow a range of land uses to conserve and enhance the productive grazing lands in the county (County of Monterey 2018).

> Agriculture consisting of crop farming and livestock grazing is the largest industry in the County and contributes a significant amount of money to Monterey County's economy. Out of approximately 1.3 million acres of County land dedicated to agriculture, most of this area (approximately 80%) is used for grazing. The most productive and lucrative farmlands in the County are located in the North County, Greater Salinas, and Central Salinas Valley Planning Areas. The main type of crop production

in the County consists of cool season vegetables, strawberries, wine grapes and nursery crops. (County of Monterey 2018, Agriculture Element).

Crop types are more difficult to quantify and map because of their dynamic nature and differences in classification schemes between regional and statewide datasets. Based on recent data available from 2017, the extent of each crop type within the LTMP management area in 2014 is shown in Table 3-13. The mix of crops in the Salinas Valley changes annually, but this snapshot in 2014 provides an indication of the dominant crops currently being produced.

Table 3-13. Area of Crops within the Management Area in 2014

Crop Classification	Crop	Area (acres)	Percent Cover
Citrus and Subtropical Fruits	Avocados	89	1.3%
	Citrus	855	
	Miscellaneous Subtropical Fruits	1,499	
	Olives	19	
Deciduous Fruits and Nuts	Apples	4	0.2%
	Kiwis	2	
	Miscellaneous Deciduous	25	
	Walnuts	321	
Grain and Hay	Miscellaneous Grain and Hay	229	0.1%
Idle	Idle	6,054	3.2%
Pasture	Alfalfa and Alfalfa Mixtures	95	0.1%
	Miscellaneous Grasses	9	
	Mixed Pasture	81	
Truck Nursery and Berry Crops	Bush Berries	1,316	72.3%
	Carrots	99	
	Cole Crops	14,817	
	Flowers, Nursery and Christmas Tree Farms	151	
	Greenhouse	549	
	Lettuce/Leafy Greens	19,013	
	Melons, Squash and Cucumbers	44	
	Miscellaneous Truck Crops	91,898	
	Onions and Garlic	38	
	Peppers	45	
	Potatoes and Sweet Potatoes	579	
	Strawberries	9,818	
Vineyard	Grapes	43,666	22.8%
Young Perennial	Young Perennial	25	0.01%
	Total	**191,341**	**100%**

Source: Land IQ LLC 2017.

Important Farmlands

The Farmland Mapping and Monitoring Program (FMMP) was established in 1982 under the California Department of Conservation, Division of Land Resource Protection. FMMP is a non-regulatory program, whose purpose is to assess the location, quality, and quantity of the state's agricultural lands and to identify changes in use on those lands. The program classifies farmland throughout the state based on soil ratings and current land use. The latest FMMP mapping (Figure 3-26) shows that most of the agricultural lands in the Salinas Valley are concentrated around the Salinas River, including agricultural lands classified as prime farmland, farmland of statewide importance, and unique farmland (California Department of Conservation 2014, 2016a, 2016b, 2016c). Furthermore, grazing lands are mapped east and west of the Salinas River (California Department of Conservation 2014, 2016a, 2016b, 2016c). Table 3-14 provides a summary of the agricultural lands mapped in the FMMP within the management area and the study area.

Table 3-14. FMMP in Study Area and Management Area

Land Use Category	Management Area (acres)	Study Area (acres)
Prime Farmland	152,576	157,467
Farmland of Statewide Importance	37,792	42,040
Unique Farmland	21,803	26,854
Farmland of Local Importance	0	3,394
Farmland of Local Potential	417	8,726
Grazing Land	123,070	952,211

Sources: California Department of Conservation 2014, 2016a, 2016b, 2016c.

Williamson Act Lands and Farmland Security Zones

Agricultural lands in California may also be protected under the California Land Conservation Act, commonly called the Williamson Act. Local governments can enter into contracts with private landowners for the purpose of restricting specific parcels of land to agricultural or related open-space use. Landowners receive substantially reduced property tax assessments in return for enrollment under Williamson Act contracts. Landowners can also enter into Farmland Security Zones, whose contracts are of longer duration than Williamson Act lands. Similar to the FMMP mapping, the latest mapping of Williamson Act lands in Monterey County shows protected areas concentrated around the Salinas River. The Williamson Act lands around the river are primarily classified as Prime Williamson Act lands and Farmland Security Zone lands. Non-Prime Williamson Act lands are mapped east and west of the Salinas River (California Department of Conservation 2016d).

3.2.3 Protected Lands

The California Protected Areas Database and the California Conservation Easement Database were reviewed to identify protected lands in the study area (California Protected Areas 2018). A total of 32 different conservation and agricultural easements are located within the management area and study area. Table 3-15 identifies the 12 largest easements located within the management area and/or study area. Table 3-15 also identifies the rivers and creeks that are crossed by these easements. Other easements within the management area and study area are shown on Figure 3-27.

There are 162 different protected areas within the management and study areas, with 207,789 acres of protected lands in the study area and 48,571 acres of protected lands in the management area. This totals approximately 256,360 acres of protected lands, or approximately 15% percent of the study area. Approximately 3% of the management area includes protected lands. These protected areas are a combination of lands that are owned and managed by federal, state, and local agencies and include local neighborhood parks; large regional parks, including state and national parks; golf courses; and reservoirs. Many of the large protected areas are in the mountainous areas surrounding the Salinas River, including the Los Padres National Forest, Pinnacles National Park, and Fort Ord National Monument. Some large protected areas are near the Salinas River and other waterbodies, including Bureau of Land Management land, the Lake San Antonio Recreation Area, Nacimiento County Recreation Area, and Toro Regional Park. Table 3-16 identifies the 12 largest protected areas located within the management area and study area, listed from largest to smallest. Table 3-16 also identifies the rivers and creeks that are crossed by these protected areas. Other protected areas within the management and study area are shown on Figure 3-27.

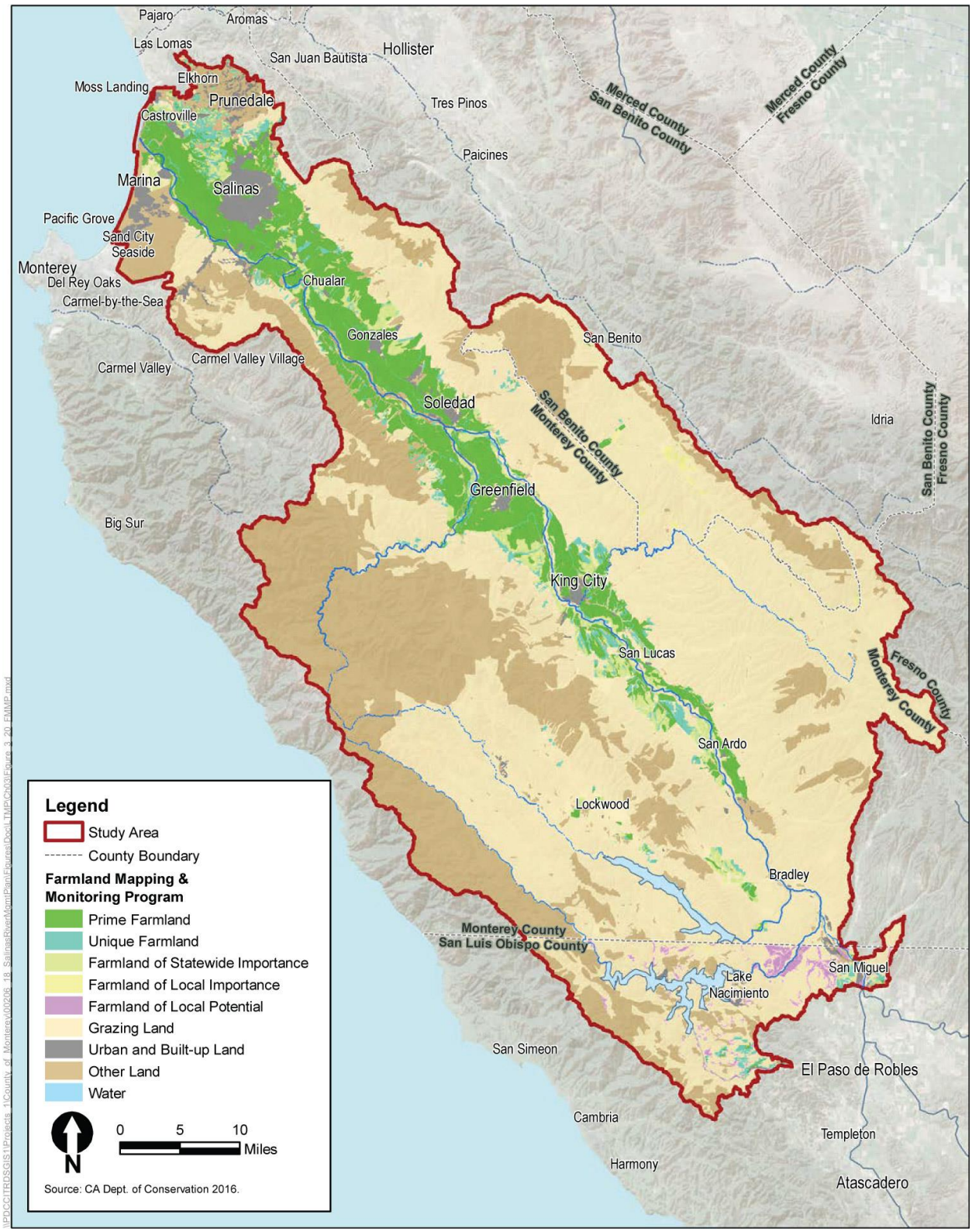


Figure 3-26. Farmland Mapping and Monitoring Program

Table 3-15. Conservation and Agricultural Easements within the Management Area and Study Area

No.	Easement	Agency	Easement Type	Area in Management Area (acres)	Area in Study Area Outside Management Area (acres)	Rivers/Creeks that Intersect Easements
1	Hearst Ranch Conservation Area	California Rangeland Trust	Agricultural/ Conservation	17	14,923	Caballada, Gould, Little Burnett, Tobacco, and Waterdog Creeks
2	Conservation Easement	Land Conservancy of San Luis Obispo County	Agricultural/ Conservation	1	6,784	N/A
3	Arroyo Seco Easement	The Nature Conservancy	Conservation	0	2,876	Arroyo Seco, Sweetwater Creek, Vaqueros Creek
4	Monterey County Agricultural Land Trust Conservation Easement	Monterey County Agricultural Land Trust	Agricultural	2,263	0	N/A
5	Tularcitos Oaks	The Nature Conservancy	Conservation	0	2,805	N/A
6	Arroyo Seco River Conservation Easement	California Department of Fish and Wildlife	Conservation	0	1,596	Arroyo Seco, Horse Creek, Piney Creek
7	Grasslands Reserve Program (GRP) 83910405013DM	United States Natural Resource Conservation Service	Conservation	0	1,478	Las Tablas Creek
8	Phillip S. Berry – Morellini Creek	Rocky Mountain Elk Foundation	Conservation	0	1,442	Morellini Creek
9	Johnson Ranch	Monterey County Agricultural Land Trust	Agricultural	921	0	Salinas River
10	Monterey County Agricultural Land Trust	Monterey County Agricultural Land Trust	Agricultural	813	0	Salinas River
11	Oreggia Conservation Easement	Monterey County Agricultural Land Trust	Agricultural	617	0	Salinas River
12	Tan Oak Canyon Ranch	Monterey County Agricultural Land Trust	Agricultural	544	0	N/A
Total				**5,176**	**31,904**	

Source: GreenInfo Network 2017, U.S. Geological Survey 2016.

Figure 3-27. Protected Lands

Table 3-16. Protected Areas within the Management Area and Study Area

No.	Protected Area	Agency	Area in Management Area (acres)	Area in Study Area outside of Management Area (acres)	Rivers/ Creeks that Intersect Protected Area
1	Los Padres National Forest	U. S. Forest Service	0	148,650	Arroyo Seco, Calaboose Creek, Camp Creek, Carrizo Creek, Carrizo Creek, Church Creek, Forest Creek, Higgins Creek, Horse Run, Lost Valley Creek, Nacimiento River, Negro Fork, Negro Fork Nacimiento River, North Fork San Antonio River, Paloma Creek, Pinal Creek, Pinalito Creek, Piney Creek, Rattlesnake Creek, Reliz Creek, Rocky Creek, Roosevelt Creek, Salsipuedes Creek, San Antonio River, Santa Lucia Creek, Shovel Handle Creek, Slickrock Creek, South Fork Santa Lucia Creek, Sweetwater Creek, Tan Oak Creek, Tassajara Creek, Vaqueros Creek, Willow Creek, Zigzag Creek
2	BLM	U.S. Bureau of Land Management	56	27,448	Basin Creek, Hames Creek, Hepsedam Creek, Horse Creek, Lewis Creek, Sand Creek, Sargent Creek, Sweetwater Creek, Vaqueros Creek
3	Pinnacles National Park	U.S. National Park Service	0	26,524	Chalone Creek, North Fork Chalone Creek, West Fork Chalone Creek
4	Fort Ord National Monument	U.S. Bureau of Land Management, U.S. Dept. of Defense, County of Monterey, City of Marina	15,524	2	El Toro Creek, Salinas River
5	Lake San Antonio Recreation Area	Monterey County Water Resource Agency	7,426	336	Copperhead Creek, Harris Creek, San Antonio River
6	Monterey County Recreation Area	County of San Luis Obispo	6,181	378	Nacimiento River, Town Creek

No.	Protected Area	Agency	Area in Management Area (acres)	Area in Study Area outside of Management Area (acres)	Rivers/ Creeks that Intersect Protected Area
7	Toro Regional Park	County of Monterey	5,526	3	Harper Creek
8	Lake San Antonio	Monterey County Water Resource Agency	4,700	0	Copperhead Creek, Harris Creek, San Antonio River
9	Big Sur Land Trust	Mueller	0	1,712	Arroyo Seco, Horse Creek, Piney Creek
10	California State Lands Commission	California State Lands Commission	0	1,126	Chalone Creek
11	Fort Ord Dunes State Park	California Department of Parks and Recreation	1,034	0	N/A
12	Fort Ord Natural Reserve	University of California	762	0	N/A
Total			**41,209**	**206,179**	

Source: GreenInfo Network 2017, U.S. Geological Survey 2016.

3.3 Water Budget

A water budget is an accounting of the total groundwater and surface water entering and leaving a groundwater basin, including the changes in the amount of water stored. MCWRA and USGS are currently developing the Salinas Valley Integrated Hydrologic Model that, once completed, will be used to develop a current and detailed accounting of the water budget in the Salinas River basin.

3.4 Biological Resources

This section summarizes the biological resources of the LTMP study area and management area, including ecoregions, communities, special-status species, and habitat connectivity.

3.4.1 Ecoregions

Ecoregions are areas that exhibit general similarity in their ecosystems and in the composition of their biotic and abiotic phenomena, including geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. Ecoregions have been designated in California to help structure and implement management strategies for federal and state agencies and other organizations responsible for resource management. The state of California is home to 13 level III ecoregions and 177 level IV ecoregions (hierarchical levels are indicated by Roman numerals such that levels I and II are broad and may span multiple state boundaries; Griffith et al. 2016). The Salinas Valley encompasses several diverse ecoregions, all of which are included in the Central California Foothills

and Coastal Mountains Level III Ecoregion. This ecoregion is defined by its Mediterranean climate (hot dry summers and cool moist winters) and associated vegetation comprised primarily of chaparral and oak woodlands, grasslands in lower elevations, and patches of pine at high elevations. Surrounding the Salinas Valley, the region consists of open low mountains or foothills, with some areas of irregular plains and narrow valleys. Natural vegetation includes coast live oak woodlands, Coulter pine, and unique native stands of Monterey pine. The LTMP study area overlaps with seven ecoregion subregions (level IV) in the Salinas Valley, each of which is described in more detail below and shown on Figure 3-28.

3.4.1.1 Monterey Bay Plains and Terraces

The Monterey Bay Plains and Terraces subregion (6w) occurs near the mouth of the Salinas River along the coast and consists of alluvial plains and terraces that wrap around Monterey Bay. The climate is cooler and wetter than adjacent subregions farther upstream in the watershed due to the marine-influenced climate, which receives more precipitation and consistent summer fog. Its geology is shaped by quaternary marine and non-marine deposits, and elevations range from about 0–400 feet above sea level. Extensive sand dunes are present along the coast and support some herbaceous plant communities with coastal scrub and sage common on stabilized dunes in the southeast of Monterey Bay. The surrounding plains are home to species such as coast live oak and California oatgrass. Soil moisture regimes are mostly xeric with some aquic regimes on floodplains. Soluble salts have accumulated in some soils near the ocean. In estuaries, including the Salinas River Lagoon, pickleweed is common.

3.4.1.2 Salinas Valley

The Salinas Valley subregion (6af) is inland and farther upstream along the Salinas River from the Monterey Bay Plains and Terraces subregion (6w), and includes gently sloping alluvial plains, stream terraces, and lowland floodplains. Pleistocene and some Plio-Pleistocene non-marine deposits and recent alluvium predominate the geologic strata. Soils are mostly well drained, although some poorly drained soils are present on floodplains. Soil temperature regimes are thermic and soil moisture regimes are xeric, with some aquic soils on floodplains. The climate in the northwestern portion of the ecoregion has more coastal influence, leading to cooler summer temperatures and milder winter temperatures compared to the greater climate extremes in the upper valley to the southeast. Cropland is the dominant land cover in the subregion, with some valley oak and cottonwood-willow riparian forest in undeveloped areas.

3.4.1.3 Gabilan Range

The Gabilan Range subregion (6y) consists of steep mountains sandwiched between the San Andreas Fault to the northeast and the Salinas Valley to the southwest. These mountains are made of granitic, metamorphic, and volcanic rocks and are steeper and have more coastal oaks than the sedimentary-dominated Salinas-Cholame hills subregion (6al) to the southeast. Although Mesozoic granitic rocks are found in most of the region, Miocene rhyolite and pyroclastic rocks are exposed in the hills of Pinnacles National Park. Coast live oak is common on north-facing slopes in the northwestern portion of the ecoregion, with more blue oak to the south and east. Some black oak and mixed conifers occur on north-facing slopes at high elevations. Chamise is common on shallow soils.

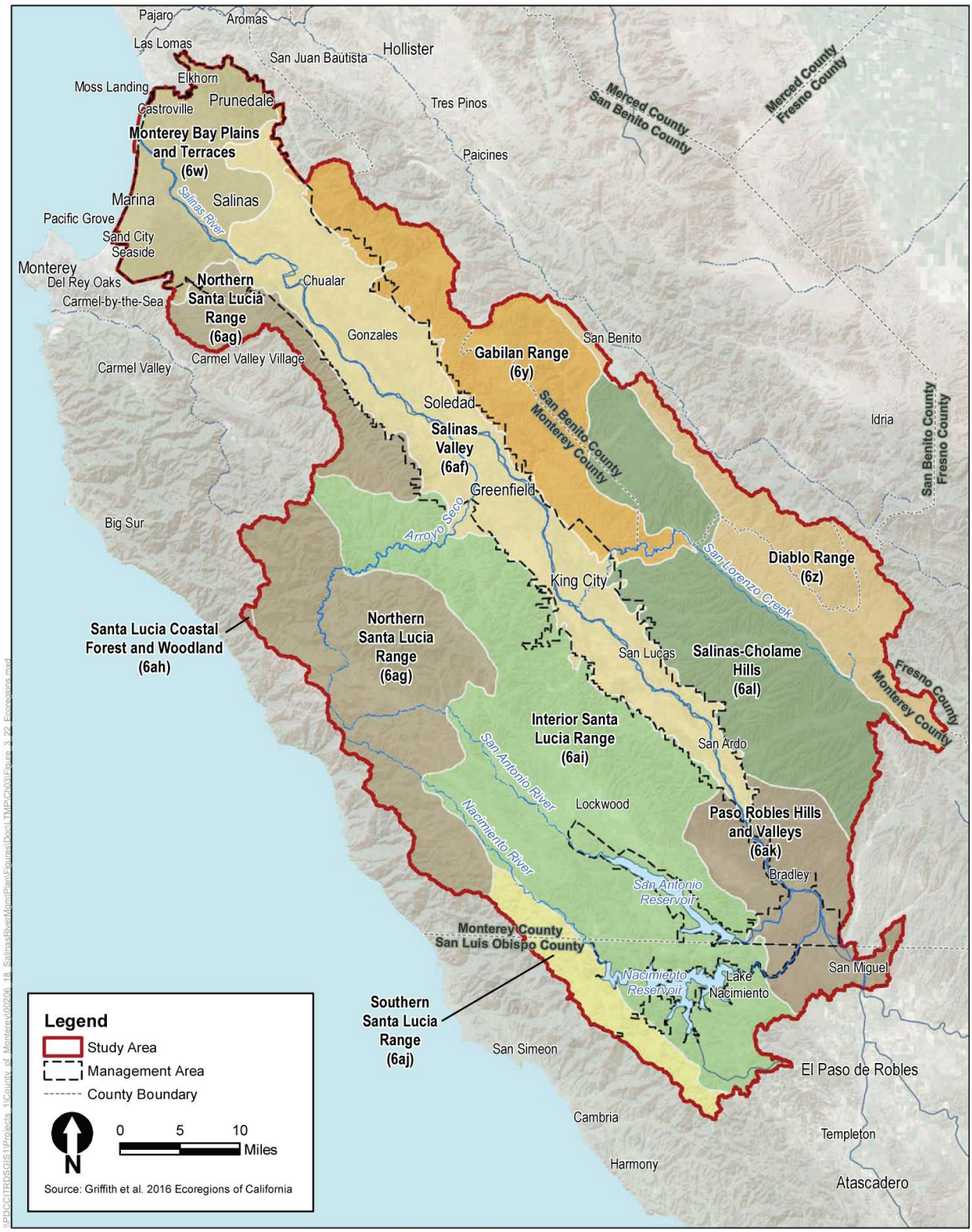


Figure 3-28. Central California Foothills and Coastal Mountains Level III Ecoregions

3.4.1.4 Diablo Range

The Diablo Range subregion (6z) consists of mountains with rounded ridges and steep sides, as well as narrow canyons and valleys. This ecoregion has different geology and vegetation compared to the Gabilan Range and the Salinas-Cholame Hills to the west. The Diablo Range is dominated by Cretaceous-Jurassic Franciscan sedimentary, minor volcanic, and metamorphic rocks that are intensely folded and faulted. Ultramafic rocks are also widely scattered throughout the region. Elevations range from about 600 feet near San Luis Reservoir up to about 5,000 feet in the mountains, with a peak of 5,248 feet on San Benito Mountain. The natural plant communities include blue oak woodlands and savannas. Leather oak occurs on serpentine soils and mixed chaparral shrublands, and Jeffrey pine occurs on serpentine soils on San Benito Mountain. Some black oak and mixed conifers are on north-facing slopes at high elevations. Soil temperature regimes are mostly thermic, and soil moisture regimes are xeric. All but the larger streams are dry through most of the summer.

3.4.1.5 Salinas-Cholame Hills

The Salinas-Cholame Hills subregion (6al) occurs on Pliocene and Miocene marine and nonmarine sediments, as well as Plio-Pleistocene unconsolidated sedimentary materials. This sedimentary geology separates it from the igneous and metamorphic rocks of the Gabilan Range subregion (6y) to the northwest. In addition, the Salinas-Cholame Hills are less steep than the Gabilan Range subregion (6y), and the soils tend to be more calcareous. Vegetation is predominantly grassland and blue oak woodland, with relatively fewer coast live oaks. The soil temperature regime is thermic and soil moisture regime is xeric. Elevations range from about 600 to 2,600 feet above sea level.

3.4.1.6 Northern Santa Lucia Range

The Northern Santa Lucia Range subregion (6ag) is located along the northern and western side of the Santa Lucia Range and consists of mountains with rounded ridges, steep sides, and narrow canyons. It is made up predominantly of Mesozoic granitic and pre-Cretaceous metamorphic rocks, as well as some Miocene marine sedimentary rocks. Coast live oak is common, especially on north-facing slopes, and California sagebrush-black sage is common on south-facing slopes near the northwestern end of the Santa Lucia Range and inland. Canyon live oak can be found on steep canyon slopes, and chamise and live oak shrublands are found on shallow soils inland and at higher elevations. Soil temperature regimes are thermic and mesic at high elevations, and soil moisture regimes are xeric and ustic. There are fewer Douglas-fir, tanoak, and redwood compared to more coastal subregions.

3.4.1.7 Interior Santa Lucia Range

The Interior Santa Lucia Range and subregion (6ai) is a steep, mountainous part of the Santa Lucia Range that is more inland that other ecoregions of the Santa Lucia, and as a result, has relatively little marine influence on its climate. It stretches southeast from near Greenfield in the Salinas Valley subregion (6af), to near the Sisquoc River, east of the Santa Maria Valley subregion (6aq). Cretaceous sedimentary rocks and Miocene marine sediments (calcareous shales, sandstone, and mudstone) define the geology. Vegetation is predominantly blue oak and coast live oak woodlands, chamise or mixed chaparral shrublands, and annual grasslands.

3.4.1.8 Southern Santa Lucia Range

The Southern Santa Lucia Range subregion (6aj) is located along the southern and western side of the Santa Lucia Range and consists of mountains with rounded ridges, steep sides, and narrow canyons. Along the coast are narrow benches on marine terraces. It is made up predominantly of Mesozoic-age metamorphic rocks of the Franciscan Complex and Miocene sandstone. Elevations range from sea level to 3,408 feet on Pine Mountain. Coast live oak woodlands and chaparral shrublands are the dominant vegetation types. Open patches and lower elevation terraces are often dominated by annual grasslands. Soil temperature regimes are thermic and mesic at high elevations, and soil moisture regimes are xeric.

3.4.1.9 Paso Robles Hills and Valleys

The Paso Robles Hills and Valleys subregion (6ak) is a dissected plain with low, rolling to moderately steep hills. It is lower, drier, and has less relief than the adjacent Interior Santa Lucia (6ai) and Salinas-Cholame Hills (6al) subregions. The geology is predominantly Plio-Pleistocene nonmarine sediments, with areas of Quaternary alluvium on the flatter plains. Some small areas of Miocene and Pliocene marine sediments occur. The soil temperature regime is thermic and soil moisture regime is xeric. Common vegetation includes blue oak savannas and annual grasslands, with some valley oak occurring on deep soils and a few small areas of chamise chaparral on shallow or dry soils. Ranching and livestock grazing is a dominant land use, with some pasture, hay, and cropland in the valleys.

3.4.2 Communities

The LTMP uses the terms *community* and *land cover type* to classify and describe the biological setting of the study area. The term *community* means land cover types that are grouped together because of similarity in vegetation type, vegetation structure, ecological function, and current land use. The LTMP recognizes three types of communities: natural communities, semi-natural communities, and non-natural communities. Communities are composed of land cover types. Natural communities are an assemblage of species (plant and animal) that co-occur in the same habitat or area and interact through trophic and spatial relationships. Communities are typically characterized by reference to one or more dominant species (Lincoln et al. 1998). The wide range of climatic, topographic, and soil conditions in the study area contribute to the variety and uniqueness of the natural communities present. Ten broad categories of natural communities in the study area are coastal strand and dune, grasslands, shrublands, forests and woodlands, riparian, wetlands, riverine, marine, estuarine, and aquatic (ponds, lakes). Three other semi-natural or human-made habitats described herein are agriculture, barren, and developed. Following are descriptions of the components of these communities. The approximate location and extent of each community is depicted on Figure 3-29.

Figure 3-29. Natural, Semi-Natural, and Developed Communities

Natural community and land cover types were mapped for the study area using six GIS datasets.

- Salinas River Generalized Land Use/Land Cover Mapping (The Nature Conservancy et al. 2014).
- Salinas River Vegetation (The Nature Conservancy 2008).
- Salinas River Arundo–mapping of extent along river corridor[9] (California Invasive Plant Council 2011).
- CALVEG (U.S. Forest Service 2017).
- Fire Resource and Assessment Program (FRAP) Vegetation (Cal Fire 2015).
- National Wetlands Inventory (U.S. Fish and Wildlife Service 2018a).

The majority of the study area was mapped using a combination of CALVEG and FRAP vegetation data; where CALVEG data were not available, FRAP data were used. Because of the better resolution and more recent data, the Salinas River corridor was mapped using vegetation mapping conducted by The Nature Conservancy in 2008 and 2014, supplemented by more recent detailed mapping of patches of invasive Arundo. Besides the two Nature Conservancy data sets, detailed wetland mapping was used from the National Wetlands Inventory. Appendix D, *Community and Land Cover Mapping Methods,* provides more detail about these land cover types, including the photography type and resolution, as well as the rationale for choosing the final land cover datasets. This appendix also describes the specific decision rules used to combine these data sets into a single composite vegetation layer for this project, when GIS data sets overlapped.

Terrestrial and wetland vegetated mapping types for each dataset were compared in a crosswalk to the National Vegetation Classification System (NVCS) macrogroups consistent with the State Wildlife Action Plan (California Department of Fish and Wildlife 2015). Agricultural mapping types were compared in a crosswalk to naming convention at the NVCS cultural formation level. Aquatic types were compared to the National Wetlands Inventory naming convention at "system" level. In addition, a number of unique naming conventions were created for a number of developed land cover types. The methods and assumptions employed to perform the crosswalk are further described in Appendix D. Table 3-17 presents the amounts of natural communities and land cover types in the management and study areas.

[9] The Monterey Resource Conservation District also maintains datasets of Arundo stands that have been treated or mowed (2017 data). These data were not incorporated into the land cover layer for the LTMP.

Table 3-17. Extent of Communities[a] and NVCS Land Cover Types in the Management and Study Areas

Salinas River Communities and Land Cover Type	Amount in Management Area (acres)	Amount in Study Area (acres)[a]
Coastal Strand and Dune Communities	**2,285**	**2,311**
Pacific coastal beach and dune	1,638	1,664
North Pacific coastal ruderal grassland and shrubland	647	647
Grasslands	**81,975**	**545,962**
California annual and perennial grassland	81,975	545,962
Shrublands	**30,334**	**495,133**
Californian chaparral	23,089	417,521
Californian coastal scrub	5,341	74,391
Cool interior chaparral	0	2
Warm and cool desert alkaline-saline marsh, playa and shrubland	154	777
Western North American ruderal grassland and shrubland	1,750	2,442
Forests and Woodlands	**44,816**	**375,160**
Californian forest and woodland	43,485	371,671
Californian ruderal forest	1,310	1,349
Intermountain singleleaf pinyon – juniper woodland	0	185
Southern Vancouverian montane-foothill forest	21	1,955
Riparian	**5,639**	**9,180**
Interior warm and cool desert riparian forest	3,870	4,852
Interior west ruderal flooded swamp forest and woodland	0	35
North American warm-desert xeric-riparian scrub	7	97
Vancouverian flooded and swamp forest	307	2,741
Arundo donax	1,455	1,455
Wetlands	**11,783**	**12,674**
North American Pacific coastal salt marsh	917	931
Vancouverian lowland marsh, wet meadow and shrubland	33	47
Warm desert lowland freshwater marsh, wet meadow and shrubland	9,596	10,219
Western North American montane-subalpine-boreal marsh, wet meadow and shrubland	1,237	1,477
Riverine	**2,522**	**3,097**
Riverine	2,522	3,097
Marine	**127**	**933**
Marine	127	933
Estuarine	**141**	**147**
Estuarine	141	147
Aquatic (Ponds, Lakes, Reservoirs)	**10,362**	**10,881**
Artificial lake or pond	1,932	2,013
Lacustrine	8,006	8,359
Water feature	424	509

Salinas River Communities and Land Cover Type	Amount in Management Area (acres)	Amount in Study Area (acres)[a]
Agriculture[b]	**210,949**	**230,708**
Dairy and other bovine confined feeding operations	171	171
Fallow field and weed vegetation	157,888	158,316
Forest plantation and agroforestry	14	14
Pasture and hay field crop	1,165	1,887
Row and close grain crop	4,427	11,793
Woody horticultural crop	47,284	58,527
Barren[b]	**5,498**	**8,661**
Barren	5,496	8,635
Western North American cliff, scree and rock vegetation	2	26
Developed[c]	**40,040**	**43,700**
Urban/developed	40,040	43,700
Total	**446,471**	**1,738,547**

[a] Inclusive of the LTMP management area.

[b] Agriculture and Barren are considered semi-natural communities.

[c] Developed is considered a non-natural community.

3.4.2.1 Coastal Strand and Dune Communities

Coastal strand and dune scrub habitats of the coastal dunes are dynamic plant communities that respond to a moving sand substrate, wind and wave patterns, and changing dune and beach configurations. Blowing sand undermines and buries plants, but most dune plants are adapted to shallow burial and blasting by sand. Large areas of destabilized sand, called "blowouts," result in large-scale removal of vegetation and change in dune structure. As plants reinvade the bare sand they stabilize the dune. Dune structure creates a variety of habitats. The foredune is more exposed to wind and salt spray than the rear dune. Dune crests are subject to high winds and substrate removal, while interdune valleys are protected from wind, have higher soil moisture, and experience sand deposition. North-facing dune slopes are usually moister and cooler than south-facing dune slopes. Native plants likely to be found in healthy coastal strand and foredune habitats on Monterey Bay include coastal sand verbena (*Abronia latifolia*), pink sand verbena (*Abronia umbellata* var. *umbellata*), beach sagewort (*Artemisia pycnocephala*), beach bur (*Ambrosia chamissonis*), beach evening primrose (*Camissonia cheiranthifolia* ssp. *cheiranthifolia*), beach morning-glory (*Calystegia soldanella*), live-forever (*Dudleya* ssp.), woolly paintbrush (*Castilleja lanata*), coastal paintbrush (*Castilleja affinis*), Douglas' bluegrass (*Poa douglasii*), mock heather (*Ericameria ericoides*), sea thrift (*Armeria maritima* ssp. *californica*), coast buckwheat (*Eriogonum latifolium*), seacliff buckwheat (*Eriogonum parvifolium*) and cudweed aster (*Corethrogyne filaginifolia*).

There are an estimated 2,311 acres (<1%) of coastal strand and dune communities, all in the northwestern portion of the study area, north and south of the Salinas River Lagoon. Of this total, approximately 99% (2,285 acres) occurs within the management area (Table 3-17, Figure 3-29). Historically, this coastal community likely occurred farther inland to the north and south of the current river mouth location. Due to several accounts of frequent changes in the river mouth

configuration, dune communities were noted in these exposed coastal areas (San Francisco Estuary Institute 2009).

The majority of this habitat today occurs on protected lands such as Salinas River State Beach, Salinas River National Wildlife Refuge, Marina State Beach, and Fort Ord Dunes State Park. Much of the habitat is composed of beaches, bluffs, blowouts, and disturbed dunes that are generally devoid of vegetation because of frequently moving substrates. The vegetation that does establish in these areas consists of species tolerant of frequent ground disturbance such as sea rocket (*Cakile maritima; C. edentula*), beach primrose (*Camissonia cheiranthifolia* ssp. *cheiranthifolia*), soft chess (*Bromus hordeaceus*), ripgut brome (*Bromus diandrus*), annual fescue (*Festuca* ssp.) and kikuyu grass (*Pennisetum clandestinum*). Some areas support a stabilized dune community dominated by the nonnative, aggressive ice plant, which forms extensive mats. While it provides cover for some wildlife, it crowds out native plant species and provides very little forage material for wildlife.

Common wading birds, such as sanderlings (*Calidris alba*), plovers (*Charadrius* ssp.), and godwits (*Limosa* ssp.), occur along the beaches; California ground squirrels (*Spermophilus beecheyi*), deer mice (*Peromyscus maniculatus*), gray fox (*Urocyon cinereoargenteus*), red-tailed hawk (*Buteo jamaicensis*), red-shouldered hawk (*Buteo lineatus*), American kestrel (*Falco sparverius*), loggerhead shrike (*Lanius ludovicianus*) and red foxes (*Vulpes vulpes*) occur in the disturbed dune habitats. Healthy coastal strand and dune scrub communities in the study area contain native perennial herbs, shrubs and subshrubs including wild buckwheat, seaside painted cup (*Castilleja latifolia*), Douglas' bluegrass, bush lupine (*Lupinus albifrons*), Chamisso bush lupine (*Lupinus chamissonis*), mock heather, poison oak (*Toxicodendron diversilobum*), coyote bush (*Baccharis pilularis*), bracken fern (*Pteridium aquilinum*), and deer weed (*Acmispon glaber*). Wildlife diversity increases in the central dune scrub relative to other dune communities because soils are more stable and vegetation is more abundant.

Special-status species most strongly associated with coastal strand and dune scrub in the study area are Smith's blue butterfly (*Euphilotes enoptes smithi*), western snowy plover (*Charadrius nivosus* ssp. *nivosus*), black legless lizard (*Anniella pulchra nigra*), sand gilia (*Gilia tenuiflora* ssp. *arenaria*), Monterey spineflower (*Chorizanthe pungens* var. *pungens*), seaside bird's beak (*Cordylanthus rigidus* var. *littoralis*), and coast wallflower (*Erysimum ammophilum*).

3.4.2.2 Grasslands

Approximately 545,962 acres (31%) of the study area is dominated by grasslands (Table 3-17, Figure 3-29). The majority of these areas support grassland comprised of non-native annual grasses, although there are some areas in the western section of the study area supporting a good component of native perennial bunchgrasses. Annual grasslands in the study area are dominated by mostly non-native annual grasses such as foxtail chess (*Bromus madritensis*), Harding grass (*Phalaris aquatica*), hare barley (*Hordeum murinum* ssp. *leporinum*), nit grass (*Gastridium phleoides*), oats (*Avena barbata* and *A. fatua*), rattail sixweeks grass (*Festuca myuros*), ripgut grass, rye grass (*Festuca perennis*), silver hair grass (*Aira caryophyllea*), small fescus (*Festuca microstachys*), soft chess, barbed goat grass (*Aegilops triuncialis*) and water beard grass (*Polypogon viridis*). The associated herbaceous cover includes native and nonnative forbs. Common herbaceous species in the study area include black mustard (*Brassica nigra*), California poppy (*Eschscholzia californica*), clover species (*Trifolium* spp.), common fiddleneck (*Amsinckia menziesii*), common yarrow (*Achillea millefolium*), filaree species (*Erodium* spp.), four-spot (*Clarkia purpurea* ssp. *quadrivulnera*), Ithuriel's spear (*Triteleia laxa*), knapweed species (*Centaurea* spp.), lupine species (*Lupinus* spp.),

purple owl's-clover (*Castilleja exserta*), and soap plant (*Chlorogalum pomeridianum*). Of this total, approximately 15% (81,975 acres) occurs in the management area (Figure 3-29).

Perennial grasslands are of two types in the study area: valley needlegrass (*Stipa pulchra*) and blue wildrye (*Elymus glaucus*). Perennial grasslands support native perennial grass species as dominant or important components of the vegetative cover and intergrade with annual grassland, oak savanna, and oak woodland on hills along the western portion of the study area. Small occurrences of perennial grassland are also in grassland areas characterized by mima mound topography associated with wetland areas in the central lands of the Fort Ord National Monument.

Historically, much of the valley above the active river channel was characterized by grasslands. Prior to European settlement, perennial grasslands dominated the upper terraces of the river valley as well as openings in shrublands, woodlands, and forests in the study area (San Francisco Estuary Institute 2009). Today, much of this habitat has been converted to agricultural fields or overran by nonnative annual grasses. The remnant patches of perennial grasslands dominated by valley needlegrass and blue wildrye in the study area are considered sensitive by the California Department of Fish and Wildlife (CDFW) (California Department of Fish and Wildlife 2018a).

Grasslands provide nesting and foraging habitat and movement areas for a variety of wildlife species including reptiles, amphibians, small and large mammals, and raptors. Common wildlife species include California ground squirrel, Heerman's kangaroo rat (*Dipodomys heermanni*), narrow-faced kangaroo rat (*Dipodomys venustus*), western meadowlark (*Sturnella neglecta*), and American kestrel. In addition, grasslands provide one of the primary upland habitats for special-status species like the California tiger salamander (*Ambystoma californiense*) and the California red-legged frog (*Rana draytonii*). Grasslands also protect the soil from erosion and provide the primary source of forage for grazing domestic livestock.

3.4.2.3 Shrublands

The shrublands natural community is composed of chaparral and scrub land cover types. Chaparral occurs on rocky, porous, nutrient-deficient soils on steep slopes up to 6,562 feet in elevation (Keeley 2002). Chaparral communities are dominated by densely packed and nearly impenetrable drought-adapted evergreen woody shrubs with small, thick, leathery sclerophyllous (hard-leaved) leaves (Hanes 1988, Keeley 2002). In comparison, the scrubland cover types generally consist of low "soft" shrubs in open to dense shrublands, interspersed with grassy openings or little to no herbaceous layer usually found at elevations below approximately 1,640 feet (Holland and Keil 1995).

Chaparral habitats include a variety of shrubs with thick, stiff, sclerophyll leaves where no one species is clearly dominant. At maturity, this community can be dense and nearly impenetrable. Stand structure is dependent on age since last burn, precipitation, aspect, and soil type. Dominant species include chamise (*Adenostoma fasciculatum*), birchleaf mountain mahongany (*Cercocarpus betuloides*), silktassle (*Garrya* spp.), coyote bush, hollyleaf cherry (*Prunus ilicifolia*) and several species of ceanothus (*Ceanothus cuneatus C. leucodermis,*), manzanita (*Arctocstaphylos glandulosa, A. glauca*), redberry (*Rhamnus ilicifolia*, *R. crocea*) and oak (*Quercus chrysolepis, Q. dumosa, Q. berberidifolia, Q. wizlizenii*) (U.S. National Vegetation Classification System 2017, Mayer and Laudenslayer 1988, Holland 1986). Chamise chaparral supports pure or nearly pure stands of chamise. Due to the density of the vegetation, there is usually little or no understory. This community generally occurs below 3,000 feet elevation along the Sierra de Salinas, Santa Lucia, and

the Gabilan Ranges accounting for 95% (417,521 acres) of the study area. Of this total, approximately 7% (30,334 acres) is located in the management area (Table 3-17, Figure 3-29).

Maritime chaparral is another coastal form of chaparral associated with specific soil conditions. Two forms are recognized in the northwestern portion of the study area based on the substrate that supports them: sand hill maritime chaparral occurs on relict dunes of the late Pleistocene Epoch, and Aromas formation maritime chaparral occurs on weakly consolidated red sandstone that is a relic of mid-Pleistocene dunes located along the Central Coast Ranges. The occurrence of maritime chaparral may be limited to the summer fog zone. It is characterized by a wide variety of evergreen, sclerophyllus shrubs occurring in moderate to high density on sandy, well-drained substrates. This community is primarily dominated by woollyleaf manzanita (*Arctostaphylos tomentosa* subsp. *tomentosa*). Other species found in the shrub layer include chamise, Toro manzanita (*Arctostaphylos montereyensis*), sandmat manzanita (*Arctostaphylos pumila*), toyon (*Heteromeles arbutifolia*), blue blossom ceanothus (*Ceanothus thyrsiflorus*), and Monterey ceanothus (*Ceanothus rigidus*).

Coastal scrublands are typically dominated by California sagebrush (*Artemisia californica*) and black sage (*Salvia mellifera*), with associated species including coyote brush, California buckwheat (*Eriogonum fasciculatum*), poison oak, and sticky monkeyflower (*Mimulus aurantiacus*) (Holland 1986). The dominant woody plants in this land cover type are nearly the same among different soil types. Northern coastal scrub occupies approximately 74,391 acres (17%) of the study area and is located in small, scattered patches dispersed throughout the mixed chaparral land cover types in the coastal and interior ranges on sandy or shallow soils.

The greatest diversity of wildlife species in the study area occur in the chaparral. Birds such as orange-crowned warbler (*Vermivora celata*), spotted towhee (*Pipilo maculatus*), and California quail (*Callipepla californica*) nest in the chaparral. Small mammals such as the California mouse (*Peromyscus californicus*) and brush rabbit (*Sylvilagus bachmani*) forage in this habitat and serve as prey for gray fox, bobcat (*Lynx rufus*), spotted skunk (*Spilogale gracilis*), and western rattlesnake (*Crotalus viridus helleri*). In addition, special-status species like the California tiger salamander, California red-legged frog, and San Joaquin kit fox (*Vulpes macrotis mutica*) may use shrubland areas for movement and upland habitat, especially in relative proximity to breeding habitats.

3.4.2.4 Forests and Woodlands

The forest and woodland natural community is an upland vegetation community dominated by hardwood tree species. This broad community consists of savannas, woodlands, and forests dominated by warm-temperate and Mediterranean climate–endemic oak and conifer species within California below approximately 8,200 feet in elevation. In the region, this community includes characteristic taxa such as various oak species (*Quercus* spp.), various pines (*Pinus* spp.), California bay (*Umbellularia californica)*, and tanoak (*Lithocarpus densiflorus)* (U.S. National Vegetation Classification 2018). Understory species found in this community include sticky monkeyflower, California coffeeberry (*Frangula californica*), California sagebrush, and spiny redberry (*Rhamnus crocea*) (Allen-Diaz et al. 1999). In addition, bugle hedge nettle (*Stachys ajugoides*), California blackberry (*Rubus ursinus*), California wood fern (*Dryopteris arguta*), and poison oak are often present. Across the Central Coast Ranges, stands of this community occur at lower elevations (200 to 3,250 feet) on north and northeast aspects. Slopes are generally steep, and parent material is primarily sedimentary sandstone and shale, with loam soils. Forest and woodlands account for 84% (375,160 acres) of the study area. Of this total, approximately 12% (44,816 acres) occurs in the management area (Table 3-17, Figure 3-29).

Throughout the study area, oak woodlands and forests are characterized by either coast live oak (*Quercus agrifolia*), blue oak (*Q. douglasii*), black oak (*Q. kelloggii*), or valley oak (*Q. lobata*) from the eastern slopes of the Santa Lucia Mountains to the Gabilan Range. In the management area, coast live oak is the dominant oak type found from King City downstream to Salinas (Monterey County Water Resources Agency 2014). Black oak is also present along the upland transition zones between the riparian corridor and inland areas. Valley and blue oaks are present in the driest areas of the four oak woodlands observed, often lining seasonal drainages on north- and west-facing slopes in inland portions of the study area. In most oak-dominated areas, an understory of California blackberry, poison oak, and invasive annual grasses are common (Monterey County Water Resources Agency 2014). Blue oak woodland is considered a sensitive natural community by the CDFW (2018) when blue oak and valley oak are present.

The study area also includes low- to mid-montane elevation forests dominated by conifer trees, either with one dominant species or as mixed-conifer forests. Montane hardwood forests occur on a wide range of slopes with soils that are rocky, alluvial, coarse textured, poorly developed, and well drained. Characteristic species in the region include Coulter pine (*Pinus coulteri*), gray pine (*P. sabiniana*), Ponderosa pine (*P. ponderosa*), Douglas fir (*Pseudotsuga menziesii*), and coast redwood (*Sequoia sempervirens*) (U.S. National Vegetation Classification 2018). The scattered understory vegetation can consist of manzanita (*Arctostaphylos* spp.), mountain mahogany (*Cercocarpus betuloides*), and poison oak, as well as patches of forbs and grasses.

The western portion of the study area, north of Nacimiento and San Antonio, consists of dense mixed coniferous forest found along the western slopes of the Santa Lucia Range. Conifers that characterize this forest type include Ponderosa pine, Douglas fir, coast redwood, Coulter pine, gray pine, and a local endemic, Santa Lucia fir (*Abies bracteata*). Other associates include coast live oak, tanoak, white alder (*Alnus rhombifolia*), California bay, Pacific madrone (*Arbutus menziesii*), black oak, and knobcone pine (*Pinus attenuata*). In the management area, a native stand of Monterey pine (*Pinus radiata*) is known to occur near Salinas (Monterey County Water Resources Agency 2014).

Ruderal forests are also present near coastal cities and inland valley towns of the study area. Ruderal forests are those areas where ruderal and other introduced species of trees, including *Eucalyptus* species, have been planted or naturalized and dominate, forming a dense forest-like canopy. Ruderal forest can be an important feature of this community as some stands could provide suitable nesting habitat for raptors in the region.

The forest and woodland community is considered an important natural community because it provides a variety of ecological, aesthetic, and economic values. Forests and woodlands support a variety of plant and wildlife species, including multiple special-status species. They provide nesting sites, cover, forage, habitat connectivity, and other ecological values important to regional wildlife. Common wildlife species in coast live oak woodlands include black-tailed deer (*Odocoileus hemionus columbianus*), California mouse, raccoon (*Procyon lotor*), California quail, scrub jay (*Aphelocoma californica*), and Nuttall's woodpecker (*Picoides nuttallii*). Red-tailed hawks and great-horned owls (*Bubo virginianus*) nest and roost in this community as well. Some special-status species associated with forests and woodlands in the study area include California tiger salamander, California red-legged frog, and arroyo toad.

3.4.2.5 Riparian

The riparian natural community consists of a multilayered woody plant community dominated by a hydrophytic tree overstory and diverse shrub layer associated with riverine water sources. In mature riparian forests, canopy heights reach up to 100 feet and canopy cover ranges from 20 to 80%. The riparian habitats of the Central Coast are found in and along the margins of the active channel of intermittent and perennial streams including the Salinas River. Many vegetation alliances dominated by riparian species are considered sensitive by CDFW (2018a).

Generally, no single species dominates the canopy, and composition varies with elevation, aspect, hydrology, and channel type. Canopy species include Fremont cottonwood (*Populus fremontii* ssp. *fremontii*), arroyo willow (*Salix lasiolepis*), red willow (*Salix laevigata*), box elder (*Acer negundo*), white alder, and coast live oak (U.S. National Vegetation Classification 2018). Associated trees and shrubs include western sycamore (*Platanus racemosa*), northern California black walnut (*Juglans hindsii*), California bay, bigleaf maple (*Acer macrophyllum*), and Goodding's black willow (*Salix gooddingii*). California grape (*Vitis californica*) creates a dense network of vines in the canopy. In areas that are disturbed by frequent flooding, fire, or human activity, this natural community often consists of smaller trees, more shrubs, and more invasive nonnative species such as giant reed (*Arundo donax*), salt cedar (*Tamarix ramosissima*), and Himalayan blackberry (*Rubus armeniacus*). The understory is disturbed by winter flows, and herbaceous vegetation is typically sparse or patchy. Typically, plants such as mule fat (*Baccharis salicifolia*), California buckeye (*Aesculus californica*), poison oak, California mugwort (*Artemisia douglasiana*), California blackberry, common chickweed (*Stellaria media*), coyote brush, goose grass (*Galium aparine*), and Italian thistle (*Carduus pycnocephalus* ssp. *pycnocephalus*) populate the stream banks (Monterey County Water Resources Agency 2014). The riparian natural community accounts for 2% (9,180 acres) of the study area. Of this total, 61% (5,639 acres) occurs in the management area (Table 3-17, Figure 3-29).

Historically, riparian communities were vast and dense throughout the valley floor often immediately adjacent to the river extending over 0.5 mile on one or both sides of the main channel (e.g., referred to as "bottomlands" by early explorers). Willows dominated the tree canopy; however, several species of cottonwoods (e.g., Fremont and black) were also reported by many of the early explorers in the region. A diverse list of trees was noted in scattered patches such as sycamore, maple, and buckeye, while native shrubs (e.g., California rose, gooseberry, and poison oak) and grasses (described as tufts of grass 6 to 8 inches tall creating a dense mat over the valley floor in some areas) characterized the understory of these forests (San Francisco Estuary Institute 2009). Aerial photography dating back to 1937 shows a channel of varying widths, from 100 to 2,600 feet wide with little riparian vegetation growing on large bars and the channel bottom (San Francisco Estuary Institute 2009). This shift was likely caused by major flood events that scoured the bars and channel bottom, removing vegetation and transporting sediments downstream (San Francisco Estuary Institute 2009).

Since operation of the Nacimiento Dam beginning in 1957 and the San Antonio Dam in 1967, reduced flood peaks along with summer flow releases have allowed for both native and nonnative vegetation growth to expand onto the bars and channel bottom. Growth has further increased since the reoperation of the Dams in April 2010, the intention of which was to provide sufficient flows to the SRDF at RM 5 to meet agricultural demands and fish bypass flow requirements during the dry season. With more water present year-round, riparian vegetation persists throughout the valley and downstream to the lagoon.

As mapped currently, the riparian natural community is composed of four vegetation types (Table 3-17), reflecting the diversity of riparian conditions. These types represent recognizably different abundances of the main constituent tree and shrub species (i.e., willow, cottonwood, sycamore, and alder) and several shrub types, including those dominated by the highly invasive nonnative giant reed and salt cedar. The riparian community occurs most extensively along the Salinas River floodplain as well as its tributaries including its many tributaries such as San Antonio River, Nacimiento River, Sargent Creek, Chalone Creek, Arroyo Seco, San Lorenzo Creek, and El Toro Creek.

A mix of willow-dominated riparian scrub also occurs in the management area and is characterized by various species of native willows (*Salix* sp.), primarily sandbar willow (*Salix exigua*) and arroyo willow. Scattered deciduous trees, such as Fremont cottonwood, white alder, box elder, and oaks are also present. The mixed willow riparian forests are commonly observed along sandbars, mid-channel islands, and upland areas with sandy soils that receive some seasonal flooding. Poison oak and California sagebrush (*Artemisia californica*) formed a dense understory in upland areas where this community was present. Bush lupines, especially Chamisso bush lupine, were observed in some sandy areas in the downstream reaches of the management area. Giant reed is also common in riparian scrub throughout the management area (Monterey County Water Resources Agency 2014). The giant reed and salt cedar currently found along the Salinas River are extensive, and efforts are under way to eliminate these nonnative invasive species throughout the watershed (Monterey County Water Resources Agency 2014).

Riparian forests also occur in the upper elevations of the Santa Lucia and Gabilan Ranges in the study area along major stream courses (i.e., Arroyo Seco, Nacimiento River, San Lorenzo Creek) and include broadleaf dominant species such as California sycamore, big-leaf maple*,* red alder (*Alnus rubra*)*,* black cottonwood (*Populus balsamifera* ssp. *trichocarpa*)*,* shining willow (*Salix lucida* ssp. *lasiandra*), and/or Oregon ash (*Fraxinus latifolia*) (U.S. National Vegetation Classification 2018).

Riparian communities are important wildlife habitat because they typically support the highest diversity of wildlife and provide movement corridors between different communities. Riparian habitat provides important forage, cover, and water to resident black-tailed deer, and serves as travel corridors for predators such as mountain lions (*Puma concolor*) and coyotes (*Canis latrans*). Other wildlife species associated with this community include Pacific tree frog (*Pseudacris regilla*), California slender salamander (*Batrachoseps attenuatus*), Wilson's warbler (*Wilsonia pusilla*), dark-eyed junco (*Junco hyemalis*), striped skunk (*Mephitis mephitis*), and coyote. Special-status species that utilize this community include the South-Central California Coast steelhead (*Oncorhynchus mykiss*), arroyo toad (*Anaxyrus californicus*), California red-legged frog, least bell's vireo (*Vireo bellii pusilus*), bank swallow (*Riparia ripiaria*), Abbott's bush-mallow (*Malacothamnus abbottii*), and Davidson's bush-mallow (*Malacothamnus davidsonii*). Species known to occur in the Salinas River riparian zone include gray fox, coyote, American badger (*Taxidea taxus*), coast horned lizard (*Phrynosoma coronatum*), western pond turtle (*Actinemys marmorata*), Monterey dusky-footed woodrat (*Neotoma fuscipes luciana*), bobcat, mountain lion, and numerous avian species, including some species of special concern.

Arundo donax

Arundo donax (giant reed; referred to herein as Arundo) is known as one of the worst plant invaders of California's riparian and wetland communities. It is a fast-growing, tall grass species that spreads easily, consumes large amounts of water, forms dense monotypic stands, crowds out native vegetation, degrades wildlife habitat, increases fire frequencies, and causes flooding into adjacent

upland areas during high flow events. As of 2011, approximately 8,907 acres of Arundo were mapped in coastal California watersheds from Monterey to San Diego (California Invasive Plant Council 2011). Of this total, the Salinas River supported 2,006 acres (23% of known Arundo stands mapped in all of coastal California) in 2011. After extensive and continuing eradication efforts by the Resource Conservation District of Monterey County (RCDMC) and the implementation of MCWRA's Salinas River SMP projects in the management area, approximately 1,455 acres of Arundo is currently present (Table 3-17, Figure 3-29).

Similar to bamboo, Arundo is a clonal grass species native to eastern Asia. It can reproduce sexually (i.e., cross pollination) and asexually (i.e., vegetative propagation) originating from a large fleshy rhizome that forms dense mats underground. With its high reproductive fitness, the species is very successful in colonizing habitats where water is easily accessible and establishing thick stands over short timeframes. It was introduced to California by Spanish colonists in the 1700s and used as erosion control in drainage canals in the early 1800s. By the late 1990s Arundo was abundant in the watersheds of California, distributed mainly through disturbance events such as flooding, fire, and grading/clearing activities where stem and rhizome fragments were transported to new favorable locations in the watersheds where they quickly formed into new colonies.

These dispersal events—along with the plant's average daily growth rate of 1.65 feet/week, average height of 21 feet, and lateral growth up to 10 inches/year—allowed for rapid expansion of the species throughout much of the coastal watersheds in California. As a result, Arundo has developed into a major threat to California's riparian communities and the endemic species that rely on them. Recent data compiled by the California Invasive Plant Council (2011) shows how Arundo negatively impacts natural communities in several ways.

- Decreases native species richness and diversity.
- Decreases native forest canopy and understory plant cover.
- Decreases habitat for native fauna through a reduction in food resources.
- Decreases native wildlife opportunities for nesting or denning.
- Acts as physical migration barriers for native wildlife.

Moreover, Arundo is known to utilize up to 1.6 inches of water per day, negatively impacting groundwater supply and exacerbating coastal rates of seawater intrusion (California Invasive Plant Council 2011).

Once a system is occupied by dense stands of Arundo, it typically will have higher fire frequencies and intensity, as well as altered flooding patterns. Native riparian vegetation displacement by Arundo exacerbated by flood and fire events results in alterations in natural riparian successional patterns, and generally leads to more dominance of Arundo. These abiotic and biotic impacts have been documented in the Salinas River watershed and are the main driving force that propelled local groups like the RCDMC and MCWRA's efforts to try to eradicate Arundo from the management area.

3.4.2.6 Wetlands

The wetland natural community includes habitats subject to seasonal or perennial flooding or ponding and may have hydrophytic herbaceous vegetation. Salt marsh and freshwater wetlands generally differ in their surface area to volume ratio, water level fluctuations, and vegetation cover. Salt marsh wetlands typically support halophytic (i.e., plants that grow in high salinity water)

vegetation, while freshwater wetlands do not. Historically, much of the wetland communities in the study area dominated the coastal sloughs and lagoons in the form of salt or brackish marshlands (as they do today) as well as in abandoned channels of the Salinas River adjacent to the active floodplain. In addition, freshwater wetlands were also reported throughout the valley behind natural levees of the river, especially along the northeast margin of the valley (San Francisco Estuary Institute 2009). Unable to access the active channel directly, runoff from some of the local tributaries created a chain of wetland habitats along the landward margins of the river's natural levees. Today, wetlands occur predominantly along the coastline, including portions of the Salinas River Lagoon, Moro Cojo Slough, and Elkhorn Slough totaling approximately 3% (12,674 acres) of the study area. Of this total, approximately 93% (11,783 acres) of wetland habitat is located within the management area (Table 3-17, Figure 3-29).

Coastal salt marsh contains halophytic wetland vegetation below the high tide line, subject to the ebb and flow of daily tides. Coastal salt marsh vegetation colonizes microhabitats within tidal areas dependent upon tidal elevations and drainage patterns. Salt marsh vegetation in the lowest, wettest portion of the marsh, where inundation/saturation is nearly permanent, typically includes California cordgrass (*Spartina foliosa*), pickleweed (*Salicornia* spp.), saltmarsh bulrush, and tules (*Schoenoplectus* spp.). Coastal salt marsh vegetation is typically most expansive in the middle marsh. In these broad, nearly flat areas, dense woody pickleweed vegetation dominates the landscape mixed with scattered patches of salt marsh dodder (*Cuscuta salina*), jaumea (*Jaumea carnosa*) alkali-heath (*Frankenia salina*), and saltgrass (*Distichlis spicata*). Many of the coastal salt marsh alliances are considered sensitive by CDFW (2018a).

Often referred to as tidal plains, the middle marsh typically floods during higher tides but is not continually inundated/saturated. Higher marsh occurs in drier areas of the marsh above the mean high water level along elevated or better-drained sediment deposits. These areas can be dominated by marsh gumplant, nonnative grasses, marsh baccharis, and coyote brush, and can integrate with the coastal freshwater community (U.S. Fish and Wildlife Service 2013).

The perennial freshwater marsh land cover type is dominated by emergent herbaceous plants (e.g., reeds, sedges, grasses) with either intermittently flooded or perennially saturated soils. Perennial freshwater marshes are found throughout the coastal drainages of California wherever flowing water slows down and accumulates, even on a temporary or seasonal basis. A perennial freshwater marsh usually features shallow water that is often clogged with dense masses of vegetation, resulting in deep peaty soils. Plant species common to perennial freshwater marsh predominantly consist of cattails (*Typha* spp.), bulrushes (*Schoenoplectus* and *Bolboschoenus* spp.), sedges (*Carex* spp.), and rushes (*Juncus* spp.). Dominant species in perennial freshwater marsh in the study area include beard grass (*Polypogon* sp.), tall cyperus (*Cyperus eragrostis*), willow weed (*Persicaria lapathifolia*), yellow cress (*Rorippa* spp.), and false loosestrife (*Ludwigia* spp.). Dominant species in nontidal perennial freshwater marsh are narrow-leaved cattail (*Typha angustifolia*), broadfruit bur-reed (*Sparganium eurycarpum*), and perennial pepperweed (*Lepidium latifolium*). Many of the freshwater wetland alliances are considered sensitive by CDFW (2018a).

Perennial brackish marsh is characterized by having both freshwater and salt marsh species dominate the landscape. These types of wetlands usually occur at the upper tidal reaches of stream channels and are dominated by bulrushes, sedges, rushes, saltgrass, alkali-heath, and marsh baccharis.

Seasonal wetlands are freshwater wetland habitats that support ponded or saturated soil conditions during winter and spring, but dry through the summer and fall until the first substantial rainfall. Seasonal wetlands consist of relatively low-growing vegetation similar to perennial freshwater marsh, such as rushes, sedges, and grasses. The vegetation may also consist of wetland generalists, such as hyssop loosestrife (*Lythrum hyssopifolia*), cocklebur (*Xanthium* spp.), and Italian ryegrass (*Festuca perennis*) that typically occur in frequently disturbed sites, such as along streams.

Fresh emergent wetlands support a number of common wildlife species, including the great blue heron (*Ardea herodias*), American bittern (*Botaurus lentiginosus*), great egret (*Ardea alba*), snowy egret (*Egretta thula*), black-crowned night heron (*Nycticorax nycticorax*), sora (*Porzana carolina*), American coot (*Fulica americana*), song sparrow (*Melospiza melodia*), mallard (*Anas platyrhynchos*), red-winged blackbird (*Agelaius phoeniceus*), marsh wren (*Cistothorus palustris*), and many species of wintering waterfowl in large numbers.

3.4.2.7 Riverine

Riverine communities in the study area (Figure 2-7) include perennial, intermittent, and ephemeral watercourses characterized by a defined bed and bank, commonly referred to as streams. Perennial streams support flowing water year-round in normal rainfall years. These streams are often marked on USGS quadrangle maps with a blue line, and are known as blue-line streams. Intermittent (seasonal) streams carry water through some of the dry season (May–October) in a normal rainfall year. More specifically, in the wet season, intermittent streamflow occurs when the water table is raised, or rejuvenated, following early season rains that fill shallow subsurface aquifers. Ephemeral streams carry water only during or immediately following a rainfall event.

The study area is characterized by the Salinas River, the third largest riverine system in California, and accounts for approximately 3,097 acres (<1%) of the study area. Of this total, approximately 81% (2,522 acres) of riverine habitat is within the management area (Table 3-17, Figures 3-8 and 3-29). Historically, the river was characterized by a dynamic, vegetated floodplain about a half a mile wide surrounded by a complex set of lower and higher terraces that ranged from 75 to 150 feet above the river bed (San Francisco Estuary Institute 2009). Channel migration was common, but dramatic lateral shifts in channel alignment occurred in the river's lowest 15 miles. Many old channels in this downstream section are identified as lowland sloughs today, such as Tembladero and Alisal Sloughs. Early explorers also reported sustained perennial baseflows throughout the dry season (San Francisco Estuary Institute 2009).

Today, the Salinas River, as well as some of its major tributaries (i.e., Arroyo Seco and Nacimiento River) have some perennial reaches due to a combination of high groundwater levels, agriculture runoff, and releases from dams in the valley floor reaches. For instance, the portion of the Salinas River where the SRDF is located (RM 5) is perennial. However much of the floodplain is dry throughout the dry season, with baseflows in the low-flow channel artificially sustained by upstream reservoir releases during parts of the year. The upper reaches of the Arroyo Seco are also perennial due to high groundwater levels and provide accessible spawning habitat for native fish, including steelhead, in the study area (Figure 2-7).

Streams in the study area are associated with riparian plants described in Section 3.4.2.5, *Riparian*. The riparian plant composition and the width of the riparian corridor varies depending on channel slope, magnitude and frequency of channel and overbank flows, and the frequency and duration of flooding flows that inundate the broader floodplain. Similarly, wildlife supported by riverine

communities are similar to those species described in Section 3.4.2.5. Additional wildlife include South-Central California Coast steelhead, arroyo toad, Pacific tree frog (*Pseudacris regilla*), California slender salamander (*Batrachoseps attenuatus*), belted kingfisher (*Megaceryle alcyon*), and Cooper's hawk (*Accipiter cooperii*).

3.4.2.8 Marine

The marine environment of Monterey Bay is widely recognized as important habitat for an array of marine wildlife and has been approved for federal protection as part of the Monterey Bay National Marine Sanctuary. Most species of marine mammals and seabirds that occur in the Monterey Bay occur as non-breeding residents or spring and fall migrants. Special-status birds may fly over the marine range area or float in the open water, and southern sea otters (*Enhydra lutris nereis*) may occasionally feed in the marine range area, but there are no important marine mammal haul-out or breeding areas (EMC Planning Group and EDAW 1997). In addition to the aforementioned special-status species associated with the coastal strand and dune communities, other species in the marine environment known to occur in the study area include harbor seals (*Phoca vitulina*), sea lions (*Zalophus californianus*), and aquatic species such as the South-Central California Coast steelhead and tidewater goby (*Eucyclogobius newberryi*). Approximately 933 acres of the Monterey Bay occur along the coastline of the study area (<1%). Approximately 14% (127 acres) of marine habitat is designated in the management area (Table 3-17, Figure 3-29).

3.4.2.9 Estuarine

The estuarine natural community consists of tidally influenced aquatic areas below the topographical contour that corresponds to the maximum possible extent of the tides. This natural community is subject to tidal fluctuations in water height that may be natural or muted by human-made structures such as tidal gates or culverts. An estuary is a semi-enclosed body of water where two other waterbodies, usually saltwater and freshwater, meet and mix. Examples of estuaries include bays, lagoons, sounds, and sloughs.

There are three estuarine natural communities immediately adjacent to the Monterey Bay in the northwestern portion of the study area: Elkhorn Slough, Moro Cojo Slough, and the Salinas River Lagoon. Approximately 147 acres of estuarine habitat (<1%) occur in the study area. Of this total, approximately 97% (142 acres) of this habitat is within the management area (Table 3-17, Figure 3-29). Historically, these main estuaries were noted by explorers in addition to smaller estuarine-like features near Spence, Salinas, and Castroville (San Francisco Estuary Institute 2009).

The Salinas River Lagoon is a bar-built estuary, which is the dominant estuary type in California. Many of these small estuaries are subject to closure with a sand barrier separating a lagoon estuary from the ocean for days, months, or even years. In the lagoon impounded behind the sand barrier, water levels may rise or fall depending on net water budget, and water quality extremes may develop. The frequency and duration of inlet closure varies naturally across bar-built estuary s and across years, and can be altered by mouth management (i.e., breaching). The mouth state is not binary (fully open or fully closed) as these systems transition among multiple mouth states, including non-tidal phases (closed mouth), perched overflow, tidal choking (muted tides relative to ocean), and fully tidal (fully open mouth). The salinity regime of a bar-built estuary can be highly variable, exhibiting tidal fluctuations when open; also, different bar-built estuary s can be entirely fresh, vertically stratified, or entirely hypersaline when closed, dependent on the hydrological balance and the condition of the sand barrier at the mouth of the system.

Elkhorn Slough, Moro Cojo Slough, and the Salinas River Lagoon are currently the coastal nurseries of the study area, as they support a vast array of marine and estuarine fauna that depend on them for food and spend a portion of their life cycle there. In the region, species such as tidewater goby, southern sea otter, western snowy plover, California tiger salamander, California brackish water snail (*Tryonia imitator*), and brown pelican (*Pelecanus occidentalis*) can be found in this community. Estuarine habitats are also a major stopover point for a multitude of migratory waterfowl like western sandpiper (*Calidris mauri*), American avocet (*Recurvirostra americana*), black-necked stilt (*Himantopus mexicanus*), marbled godwit (*Limosa fedoa*), long-billed curlew (*Numenius americanus*), and Caspian tern (*Hydroprogne caspia*).

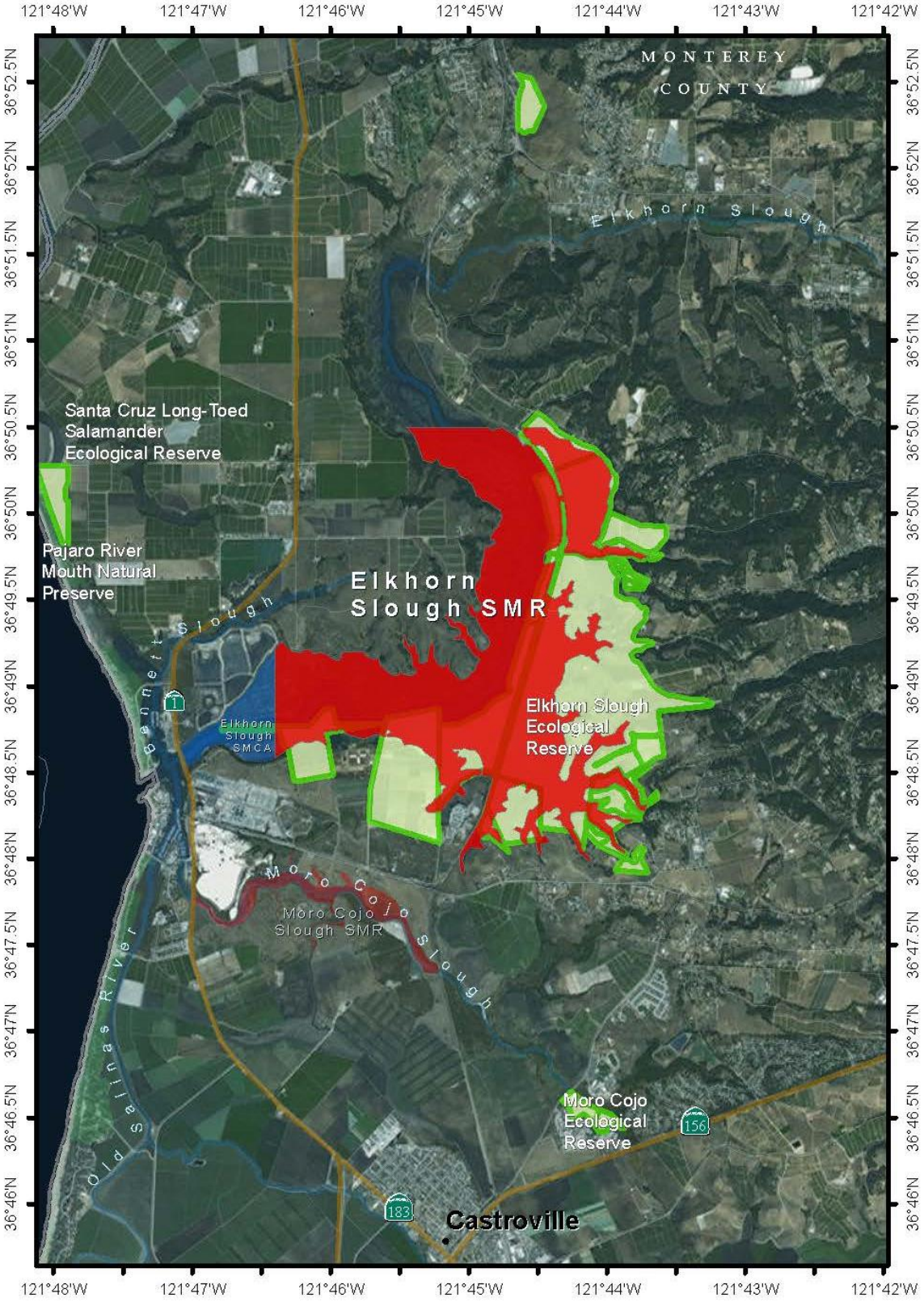
All three estuaries have some level of management and protection. The Moro Cojo and Elkhorn Sloughs both have State Marine Reserves, while the Elkhorn Slough also has a State Marine Conservation Area (Figure 3-30). The Salinas River Lagoon is within the Salinas River National Wildlife Refuge as well as Salinas River State Beach (Figure 3-31).

Estuarine communities are associated with coastal saltmarsh and brackish marsh plants described in Section 3.4.2.6, *Wetlands*. The wetland plant composition and the width of the estuarine corridor vary depending on slope, magnitude, and frequency of estuarine flows, and the frequency and duration of flooding flows that inundate the estuary. Common plants found in study area estuaries include pickleweed (*Salicornia pacifica*), cordgrass (*Spartina foliosa*), alkali heath, jaumea, saltgrass, alkali bulrush (*Bolboschoenus maritimus*), creeping ryegrass (*Leymus tritichoides*), fat hen (*Atriplex patula*), and rabbitsfoot grass (*Polypogon monspeliensis*).

3.4.2.10 Aquatic (Ponds, Lakes, Reservoirs)

Historically, the study area supported natural aquatic features such as seasonal ponds, swales, and lakes, both in the valley and the surrounding terraces and hillsides (San Francisco Estuary Institute 2009). These features were likely associated with topographic lows that may have been former segments of the Salinas River along the valley floor or intermittent waterways of the Santa Lucia and Gabilan Ranges. These features were likely subject to seasonal or perennial flooding or ponding that supported hydrophytic herbaceous vegetation.

The aquatic community in the study area today includes artificial lakes, ponds, and reservoirs that are typically devoid of vegetation and primarily used for flood control and water resource management. Features generally differ in their surface area to volume ratio, vegetation cover (if any), and water level fluctuations. Approximately 10,881 acres (2%) of the aquatic community occur in the study area. Of this total, approximately 95% (10,362 acres) occurs in the management area (Table 3-17, Figure 3-29).



Source: California Department of Fish and Wildlife 2019.

Figure 3-30. Moro Cojo and Elkorn Slough Protected Areas

Source: Google Earth Pro 2018.

Figure 3-31. Salinas River Lagoon Protected Lands. Salinas River State Beach (solid green), Salinas River National Wildlife Reserve (open green)

Artificial lakes (i.e., reservoirs) are large, open water bodies that are highly managed for water storage, water supply, flood protection, or recreational uses. Depending on lake temperature, water level, and other environmental conditions, algal blooms may occur, resulting in thick algal mats on the surface of the lake. Where lake edges are shallow, plant species similar to those found in ponds may be present (see below). If a lake has steeper edges, water depth and fluctuations in height may prevent the establishment of vegetation. Upland and riparian trees that were not removed during the construction of the artificial lake, or that were planted afterwards, may be present around the perimeter. In the management area, two major artificial lakes were built in the mid-twentieth century: Nacimiento and San Antonio (Figure 3-29).

The pond land cover type is characterized by small perennial or seasonal water bodies with little or no vegetation. If vegetation is present, it is typically submerged, floating, or growing along the margins. Ponds may occur naturally or may be created or expanded for livestock use (stock ponds). Pond vegetation is influenced by surrounding land use, livestock and wildlife activity, and site soil and hydrology. Plants often associated with ponds include floating plants such as duckweed (*Lemna* spp.) or rooted plants such as cattails, bulrushes, sedges, rushes, watercress, and water-primrose. Stock ponds are often surrounded by grazing land with grazing livestock. Immediately adjacent to a

stock pond, soil may be exposed due to the continued presence of livestock or wildlife (e.g., feral pigs). Other open water features including retention basins are also known from the study area.

The aquatic natural community in the study area supports a number of common wildlife species including migratory birds. When ponds and reservoirs are full, mallards, cinnamon teal (*Anas cyanoptera*), canvasback (*Aythya valisineria*), northern pintail (*Anas acuta*), bufflehead (*Bucephala albeola*), ruddy duck (*Oxyura jamaicensis*), American coot, osprey (*Pandion haliaetus*), and California gull (*Larus californicus*) can easily be seen out on the water. Ponds and other smaller open water features can support northern rough-winged swallow (*Stelgidopteryx serripennis*) and red-winged blackbird, as well as garter snake (*Thamnophis sirtalis*), California red-legged frog, and California tiger salamander.

3.4.2.11 Agriculture

Agriculture was introduced to the study area in the 1770s by the Spanish settlers. Over the next century, agriculture developed with greater intensity, first during the Mexican period (1822–1848) and even more so after the state of California was established (1850) (Monterey County Parks Department 2011). Cattle ranching and small-scale croplands were historically common in the Monterey County region.

Over the last 150 years, the agricultural community of the region diversified into an array of cultivated row crops, horticultural crops, vineyards, orchards, dairies, and pastures that require either soil tillage or other land maintenance activities. In the study area, agriculture is located throughout the valley floor surrounding the Salinas River corridor from San Miguel to Moss Landing. Approximately 230,708 acres of agricultural lands occur in the study area (52%). Of this total, approximately 210,949 acres (91%) occur in the management area (Table 3-17, Figure 3-29).

This land cover type is predominantly characterized by tilled land supporting various fruits, vegetables, and hay crops. Row crops are those areas tilled and cultivated for common agricultural crops such as strawberries, lettuce, artichoke, and cauliflower. Irrigated or dry, these crops are usually harvested in rows as edible or useful herbaceous products for stock or human use. Agricultural crop fields are also occasionally planted for both animal forage and to improve nitrogen levels, as with legumes such as alfalfa (*Medicago sativa*) or sweet clovers (*Melilotus* spp.). This land cover type includes ruderal areas and areas that have been left fallow for several growing seasons. Ruderal sites may be dominated by weeds such as black mustard or thistles.

Hay is also produced in Salinas Valley for grain. Common vegetation includes fast-growing forage grasses, such as oats (*Avena* spp.) and Italian rye grass, as well as irrigated legumes such as alfalfa, sweet clover, and clover (*Trifolium* spp.). In some areas, nonnative weedy vegetation, such as thistles, mustards, and a variety of other weedy forbs are also common.

About 10% of this land cover type consists of other agricultural uses such as vineyards, orchards, dairies, and pastures. Vineyard is characterized by row production pattern and open canopy, where vines or shrubs dominate the land use and include grapes, kiwi, blueberries, and raspberries. Orchards are those areas planted for fruit-bearing trees. Orchards are generally characterized by evergreen or deciduous small trees producing fruit or nut crops, such as apples, walnuts, and olives, usually planted in rows with or without irrigation channels. Orchard is distinguished on the basis of its tree cover, canopy characteristics, and distinctive production rows. Dairies and pastures are lands used to support bovine species for milk and meat production.

Most agricultural lands are accompanied by the presence of large buildings or other developed lands such as greenhouses, shadehouses, or nurseries. Equipment storage and farm worker housing is usually preset but accounts for only a small percentage of the area. Dairies and pastures typically have corrals, barns, and equipment storage structures. These uses occur within agricultural areas, rather than urban settings.

Herons, egrets, and hawks often congregate in large numbers to forage on insects, voles, and other prey found in these areas. Other common wildlife species found in agricultural lands include the American kestrel, western meadowlark, red-winged blackbird, house finch (*Carpodacus mexicanus*), California vole (*Microtus californicus*), house mouse (*Mus musculus*), brown rat (*Rattus norvegicus*), and cottontail rabbit (*Sylvilagus floridanus*). Special-status species, such as western burrowing owl, may utilize agricultural lands to breed and forage, whereas others such as American badger and San Joaquin kit fox could migrate through it.

3.4.2.12 Barren

The barren land cover type includes nonagricultural areas that are devoid of vegetation. Barren areas are historically and recently disturbed land in urban or rural areas. Land uses in barren areas can include aggregate facilities and mine tailings. Rock areas are nonserpentine rock outcrops, which are exposures of bedrock that typically lack soil and have sparse vegetation. Within the study area, several types of rock outcrops are present and are derived from sedimentary, volcanic, and metamorphic sources. These rock outcrops can support native species and provide important habitat for wildlife.

The barren land cover type occupies approximately 2% (8,661 acres) of the study area. Approximately 64% (5,498 acres) of this total is located within the management area (Table 3-17, Figure 3-29). It is primarily found as barren or rocky patches within grassland, although this land cover type can also be present in shrublands, forests, and woodlands. Like agricultural lands, special-status species, such as the western burrowing owl, American badger, and San Joaquin kit fox may move through these areas.

3.4.2.13 Developed

Since the early twentieth century, when small rural communities were scattered across the study area, the Salinas Valley has hosted the slow advance into urban communities with densely populated town centers connected by major transportation highways. Today, the urban communities within the valley consist of areas where native vegetation has been replaced with residential, commercial, industrial, and transportation uses; or with structures, paved and impermeable surfaces, horticultural plantings, turf, and lawn; or other developed land use elements such as highways, city parks, and cemeteries. Vegetation found in the urban land cover type is typically cultivated vegetation associated with landscaped residences, nonnative planted street trees (i.e., elm, ash, liquidambar, pine, palm), and parklands. Approximately 43,700 acres of urban lands occur in the study area (10%). Of this total, approximately 92% (40,040 acres) occurs in the management area (Table 3-17, Figure 3-29).

Ornamental woodlands are also present in this community and are those areas where ornamental and other introduced species of trees, including *Eucalyptus* (usually species *globulus*) and Monterey pine (*Pinus radiata*) species, have been planted or naturalized and dominate, forming an open-to-dense canopy. Ornamental woodland is an important feature of the urban community as some

stands could provide suitable nesting habitat for raptors in the region. Ornamental woodlands occur in small patches mainly in and around the cities and towns of the Salinas Valley.

Depending on their specific conditions, urban areas can support a number of common wildlife species, including the acorn woodpecker (*Melanerpes formicivorus*), barn swallow (*Hirundo rustica*), western scrub-jay (*Aphelocoma californica*), ruby-crowned kinglet (*Regulus calendula*), northern mockingbird (*Mimus polyglottos*), American robin (*Turdus migratorius*), cedar waxwing (*Bombycilla cedrorum*), yellow-rumped warbler (*Dendroica coronata*), white-crowned sparrow (*Zonotrichia leucophrys*), dark-eyed junco, house finch, raccoon (*Procyon lotor*), and numerous nonnative species, including the European starling (*Sturnus vulgaris*), house sparrow (*Passer domesticus*), North American opossum (*Didelphis virginiana*), eastern fox squirrel (*Sciurus niger*), house mouse, and black rat.

3.4.3 Special-Status Species

The CDFW (2018b) California Natural Diversity Database and U.S. Fish and Wildlife Service (USFWS) Information, Planning, and Conservation (IPaC) System (2018b) were queried for plants and animals in California that have special regulatory or management status and could occur in the study area. A complete list of the plant and animal species that were reviewed is provided in Appendix E, *Special-Status Species Potential to Occur Tables*, including scientific nomenclature, regulatory status, and habitat requirements.

The special-status species list was reviewed with the following considerations to develop a list of target species for the LTMP: (1) species known to occur in the proposed management area, (2) species that are federally or state-listed or have potential to become listed in the foreseeable future, (3) species that have potential to be impacted by management actions, (4) species with sufficient data to adequately evaluate potential impacts in the study area, and (5) species with the potential for beneficial effects through improved management.

Based on this analysis, the species listed in Table 3-18 are recommended for inclusion as target species in the LTMP. Table 3-18 summarizes the status, range, habitat requirements, and distribution in the study area for each of the target species. Detailed species accounts for nine target species, which have been consulted on for prior projects and may be impacted by future management activities, are included in Appendix F, *Species Accounts*. Each account includes details on species life history, distribution, abundance, population trends, conservation and recovery status. The LTMP target species are also those most likely to be considered for or included in a habitat conservation plan.

Table 3-18. Target Species with the Potential to Occur in the Management Area and Study Area

Common Name *Scientific Name*	Status Federal/ State/Other[a]	General Habitat Description	Potential in the Management Area	Potential in the Study Area
South-Central California Coast steelhead *Oncorhynchus mykiss*	FT/–/–	Cool, clear, fast-flowing rivers and streams containing numerous riffles and cover. While these waterways are generally forested, snow-fed streams, steelhead are also found in rain-fed, intermittent streams.	**Present.** Known to occur in the Salinas River, Arroyo Seco, Nacimiento River, and San Antonio River.	**Present.** Known from the upper reaches of Arroyo Seco, which contains the majority of spawning habitat and half of the rearing habitat in the study area (National Marine Fisheries Service 2007).
Tidewater goby *Eucyclogobius newberryi*	FE/SSC/–	Found primarily in waters of coastal lagoons, estuaries, and marshes.	**Present.** Known to occur in the Salinas River Lagoon and in the OSR (Hellmair et al. 2018).	**Present.** Known from Bennett Slough located in the northern end of Elkhorn Slough (Hagar Environmental Science 2014).
Vernal pool fairy shrimp *Branchinecta lynchi*	FT/–/–	Primarily found in vernal pools or seasonal wetlands that fill with water during fall and winter rains and dry up in spring and summer.	**Present.** Known to occur on Fort Hunter Liggett. Critical habitat is designated near Nacimiento Creek on Fort Hunter Liggett (U.S. Fish and Wildlife Service 2007).	**Present.** Known from Fort Hunter Liggett and Camp Roberts (California Department of Fish and Wildlife 2018b).
Arroyo toad *Anaxyrus californicus*	FE/–/SSC	Low gradient, medium-to-large streams and rivers with intermittent and perennial flow. Inhabits semi-arid regions near washes or intermittent streams, including valley foothill and desert riparian, desert wash, rivers with sandy banks, willows, cottonwoods, and sycamores, as well as loose, gravelly areas of streams in drier parts of the range.	**Present.** Several occurrences known from the San Antonio River on Fort Hunter Liggett (California Department of Fish and Wildlife 2018b).	**Present.** Known from Fort Hunter Liggett along the San Antonio River (California Department of Fish and Wildlife 2018b).

Common Name *Scientific Name*	Status Federal/ State/Other[a]	General Habitat Description	Potential in the Management Area	Potential in the Study Area
California red-legged frog *Rana draytonii*	FT/–/SSC	Permanent and semi-permanent aquatic habitats, such as creeks and cold water ponds, with emergent and submergent vegetation; may aestivate in rodent burrows or cracks during dry periods.	**Present.** Known to occur in the Salinas River, Arroyo Seco, Fort Ord, and Elkhorn Slough (California Department of Fish and Wildlife 2018b).	**Present.** Known throughout from stock ponds and waterways in Salinas, Oakdale, and Prunedale. Also found in Elkhorn Slough, Natividad Creek, Los Vaqueros Creek, upper Gabilan Creek, Chalone Creek, and Dorrance Ranch in the foothills east of Spence and Chualar (California Department of Fish and Wildlife 2018b, McGraw 2008).
California tiger salamander *Ambystoma californiense*	FT/ST/–	Small ponds, lakes, or vernal pools in grasslands and oak woodlands for breeding; rodent burrows, rock crevices, or fallen logs for upland cover during dry season.	**Present.** Known to occur in Fort Ord and Elkhorn Slough. Also known from Chualar, Gonzales, and Soledad (California Department of Fish and Wildlife 2018b).	**Present.** Known throughout from stock ponds and waterways in Castroville, Salinas, Prunedale, and San Juan Bautista. Also found in Elkhorn Slough, and Fort Hunter Liggett (California Department of Fish and Wildlife 2018b).
Bank swallow *Riparia ripiaria*	–/ST/–	Nests in bluffs or banks, usually adjacent to water, where the soil consists of sand or sandy loam.	**Present.** Known from the Salinas River near Moss Landing, Greenfield, and King City. Also known from Seaside (California Department of Fish and Wildlife 2018b).	**Present.** Known from north of Castroville (California Department of Fish and Wildlife 2018b).
California least tern *Sterna antillarum browni*	FE/SE/ FP	Nests along the coast; colonial breeder on bare or sparsely vegetated flat substrates, such as sand beaches, alkali flats, landfills, or paved areas.	**Present.** Known as an occasional spring migrant in the Salinas River Lagoon (U.S. Fish and Wildlife Service 2002a).	**Potential.** Last nesting pair observed in study area in the 1930s (U.S. Fish and Wildlife Service 2002a).
Least Bell's vireo *Vireo bellii pusillus*	FE/SE/–	Riparian thickets either near water or in dry portions of river bottoms; nests along margins of bushes and forages low to the ground; may also be found using mesquite and arrow weed in desert canyons.	**Present.** Known as a rare summer resident in the Salinas River watershed. Recent sightings have been recorded near San Ardo, San Lucas, San Juan Bautista, and Bradley (Roberson 2002).	**Present.** Recent sightings in the Salinas Valley and Santa Clara Valley indicate this species may be expanding back into its historical range to the north of current populations (U.S. Fish and Wildlife Service 2006).

Common Name *Scientific Name*	Status Federal/ State/Other[a]	General Habitat Description	Potential in the Management Area	Potential in the Study Area
Western snowy plover *Charadrius alexandrinus nivosus*	FT/–/SSC	Coastal beaches above the normal high tide limit in flat, open areas with sandy or saline substrates; vegetation and driftwood are usually sparse or absent.	**Present.** Known from mouth of the Salinas River and along sand bars of the Salinas River Lagoon in addition to surrounding coastal dune and beach areas managed on state and federal park lands (California Department of Fish and Wildlife 2018b).	**Present.** Known from Moss Landing State Beach, Elkhorn Slough salt ponds, Salinas River State Beach, Salinas River National Wildlife Refuge, Monterey Dunes, Fort Ord, and Marina State Beach (California Department of Fish and Wildlife 2018b).
Southern sea otter *Enhydra lutris nereis*	FT/FP/–	Nearshore marine environments. Needs canopies of giant kelp and bull kelp for rafting and feeding. Prefers rocky substrates with abundant invertebrates.	**Present.** Known from coastal waters of Monterey Bay including Elkhorn Slough, Moro Cojo Slough, and Moss Landing Harbor (U.S. Fish and Wildlife Service 2015).	**Present.** Known from coastal waters along Moss Landing State Beach, Elkhorn Slough, Salinas River State Beach, Salinas River National Wildlife Refuge, Monterey Dunes, Fort Ord, and Marina State Beach (U.S. Fish and Wildlife Service 2015).
San Joaquin kit fox *Vulpies macrotis mutica*	FE/ST/–	Saltbush scrub, grassland, oak, savanna, and freshwater scrub.	**Present.** Known from the Salinas River Valley from Soledad to Bradley (California Department of Fish and Wildlife 2018b).	**Present.** Known from Camp Roberts and Fort Hunter Liggett (California Department of Fish and Wildlife 2018b).
Monterey spineflower *Chorizanthe pungens* var. *pungens*	FT/–/1B.2	Coastal dunes, chaparral, cismontane woodland, and coastal scrub; sandy soils in coastal dunes or more inland within chaparral or other habitats; 10–1,500 feet. Blooms: April–August.	**Present.** Known from 28 occurrences along the coastal habitats of the management area including Salinas River State Beach, Salinas River National Wildlife Refuge, Fort Ord, and Marina State Beach. Two are known from the coastal plain of the Salinas River Valley (California Department of Fish and Wildlife 2018b).	**Present.** Known from 28 occurrences along the coastal habitats of the study area including Salinas River State Beach, Salinas River National Wildlife Refuge, Fort Ord, and Marina State Beach, and the Salinas River Valley (California Department of Fish and Wildlife 2018b).

Common Name *Scientific Name*	Status Federal/ State/Other[a]	General Habitat Description	Potential in the Management Area	Potential in the Study Area
Sand gilia *Gilia tenuiflora* ssp. *arenaria*	FE/ST/ 1B.2	Coastal dunes, coastal scrub, chaparral (maritime), cismontane woodland; bare, wind-sheltered areas often near dune summit or in the hind dunes; two records from Pleistocene inland dunes; 0–800 feet.	**Present.** Known from 19 occurrences along the coastal habitats of the management area including Salinas River State Beach, Salinas River National Wildlife Refuge, Fort Ord, and Marina State Beach (California Department of Fish and Wildlife 2018b).	**Present.** Known from 19 occurrences along the coastal habitats of the study area including Salinas River State Beach, Salinas River National Wildlife Refuge, Fort Ord, and Marina State Beach (California Department of Fish and Wildlife 2018b).
Abbott's bush-mallow *Malacothamnus abbottii*	–/–/1B.1	Riparian scrub; among willows near rivers and along roadsides; 400–1,600 feet; blooms: May–October.	**Present.** Known from the Salinas River, Sargent Creek, Nacimiento, and San Antonio (California Department of Fish and Wildlife 2018b).	**Present.** All 13 occurrences for this species are located in the study area along the Salinas River, Sargent Creek, Nacimiento, and San Antonio, and along unnamed creeks in the Santa Lucia Mountains (California Department of Fish and Wildlife 2018b).
Davidson's bush-mallow *Malacothamnus davidsonii*	–/–/1B.2	Chaparral, cismontane woodland, coastal scrub and riparian woodland, sandy washes; 600–2,800 feet; blooms June–January.	**Present.** Known from the Nacimiento and San Antonio Reservoirs (California Department of Fish and Wildlife 2018b).	**Present.** Known from 16 occurrences in the study area including within Camp Roberts, Fort Hunter Liggett, Pine Canyon, and along unnamed creeks in the Santa Lucia Mountains (California Department of Fish and Wildlife 2018b).
Santa Lucia purple amole *Chlorogalum purpureum var. purpureum*	FT/–/1B.1	Chaparral, cismontane woodland, valley and foothill grassland often in grassy areas with blue oaks in foothill woodland on gravelly clay soils; 700–. 1,300 feet; blooms: April-June.	**Present.** Known from Fort Hunter Liggett (California Department of Fish and Wildlife 2018b). Critical habitat is designated on Fort Hunter Liggett (U.S. Fish and Wildlife Service 2002b).	**Present.** Known from Fort Hunter Liggett and Camp Roberts (California Department of Fish and Wildlife 2018b).

[a] FE = Federally Endangered; FT = Federally Threatened; SE = State Endangered; ST = State Threatened; FP = State Fully Protected; SSC = State Species of Special Concern; 1B = California Native Plant Society Ranked rare or endangered in California and elsewhere; .1 = seriously endangered in California; .2 = fairly endangered in California.

3.4.4 Habitat Connectivity

Modification of natural habitats, including habitat fragmentation, is considered the most severe threat to the persistence of global biodiversity and affects all taxonomic groups (Fischer and Lindenmayer 2007). Habitat connectivity is essential for maintaining biological diversity and species populations in the study area. Maintaining connectivity between different habitats can improve population fitness and promote genetic diversity that is critical for adapting to environmental disturbances. In addition, connectivity among subpopulations can bolster resiliency and prevent inbreeding. For species with limited dispersal abilities, such as arroyo toad or tidewater goby, any habitat disturbances or habitat loss can affect the survival of a local population unless individuals are able to migrate to refugia habitat. Connectivity is also necessary for the recolonization of habitats following disturbances. For larger, more mobile species, habitat connectivity is critical to access resources that are heterogeneously distributed over the landscape. Many of the special-status species in the study area are limited in their range or only occupy specific habitats and, therefore, rely upon connectivity between suitable habitats to maintain their populations.

Several regional and local connectivity planning efforts have studied habitat connectivity, particularly where urbanization and agriculture have resulted in fragmented habitats. Connectivity has two components: structural and functional. Structural connectivity includes the physical landscape attributes along a dispersal corridor and is fairly easy to measure and observe. Functional connectivity includes an organism's response to those landscape attributes and is much more difficult to measure (Kindlmann and Burel 2008, Hughes et al. 2013). Maintaining and enhancing functional connectivity between fragmented habitats in the Central Coast Ecoregion is critical for protecting biodiversity in the Salinas River watershed. Spencer et al. (2010) used a focal species approach to determine Essential Connectivity Areas between landscape blocks across California, including the Salinas River watershed. Penrod et al. (2013) refined this effort for the San Francisco Bay Area and surrounding counties, including Monterey, and identified critical linkages for wildlife in the Salinas River watershed.

The California Essential Habitat Connectivity Project (Spencer et al. 2010) proposed 24 Essential Connectivity Areas for the Central Coast Ecoregion, which encompasses the Salinas River watershed, to connect 129 highly fragmented Natural Landscape Blocks. The Natural Landscape Blocks are large areas of undeveloped land mostly in rugged areas, with some smaller, more fragmented blocks on the region's gentler slopes, terraces, and valleys. The proposed Essential Connectivity Areas are diverse in land cover composition but tend to cover more urban and agricultural land uses and are crossed by numerous major and secondary roads.

Priorities for Salinas Valley Essential Connectivity Areas include maintaining potential movement corridors for endangered San Joaquin kit fox from Camp Roberts Military Reservation to the Carrizo Plain and the San Joaquin Valley and northeast toward the Cholame Hills area. The project also identified an important corridor for wide-ranging species along the Pajaro River and adjacent lands from the Santa Cruz Mountains to the Santa Lucia Mountains (Figure 3-32; Bunn et al. 2007 as cited by Spencer et al. 2010).

Figure 3-32. Essential Connectivity Areas

The Critical Linkages Project (Penrod et al. 2013) built upon the Essential Habitat Connectivity Project and was designed to provide live-in and move-through habitat for multiple species, support metapopulations of smaller species, ensure availability of key resources, buffer against edge effects, reduce contaminants in streams, allow natural processes to operate, and allow species and natural communities to respond to climatic changes. Based on these desired processes, a series of three linkages were proposed in and through the study area to connect the Santa Lucia Range and the Inner Coast Range for four target species: American badger, Tule elk, black-tailed deer, and California quail (Figure 3-32). The linkages encompass 286,688 acres, with over half (155,744 acres) consisting of rangeland or agriculture lands enrolled in the Williamson Act program, and an additional 11,899 acres protected in fee or conservation easements.

Conservation actions in this linkage may benefit several threatened, endangered, or sensitive species. Roughly 10% of the land in the linkage (29,170 acres) is designated as critical habitat for California red-legged frog, California tiger salamander, vernal pool fairy shrimp, or purple amole. The linkage design for the Santa Lucia Range-Inner Coast Range also incorporates the Salinas River Key Riparian Corridor, which provides 50 miles of streams and rivers designated as critical habitat for steelhead. Additional streams (not designated as critical habitat for steelhead) also serve as critical linkages for focal species and provide habitat connections between landscape blocks.

In total, about 80% of all animals use riparian resources and habitats during some life stage, and many animals have shown preferences for moving along riparian corridors (Beier 1995, Dickson et al. 2004), particularly when moving through rugged landscapes. Critically, riparian corridors provide connectivity between habitats and across elevational zones, which will allow species to respond and adapt to climate change in the future (Seavy et al. 2009). Maintaining and enhancing wildlife movement in several key areas across the Salinas River and surrounding valley will be key to ensuring habitat connectivity in the study area as many farmers have erected fences along the river to keep wildlife out of their fields.

Connectivity between aquatic habitats in the Salinas River and tributaries is imperative to maintain populations of fish and other aquatic animals in the watershed. Several riparian impediments exist in the watershed (see Figure 3-33), the majority of which are from anthropogenic sources: natural barriers, dams, culverts, vegetation clearing, invasion of nonnative species, accumulation of pollutants in streambeds, farming in channels, gravel mining, and high intensity livestock grazing.

Connectivity between the ocean and upstream spawning habitat is necessary for steelhead to complete its life history. While steelhead have a varied life history that is adapted to annual fluctuations in flow and connectivity between habitat types, connectivity between ocean rearing and upstream spawning habitat in most years is necessary for the species to persist in the watershed. One of the main impediments to migration in the Salinas River watershed is the disruption of flow (dry riverbed) over the long distances between the lagoon to suitable spawning and rearing habitat in the upper Salinas and its tributaries.

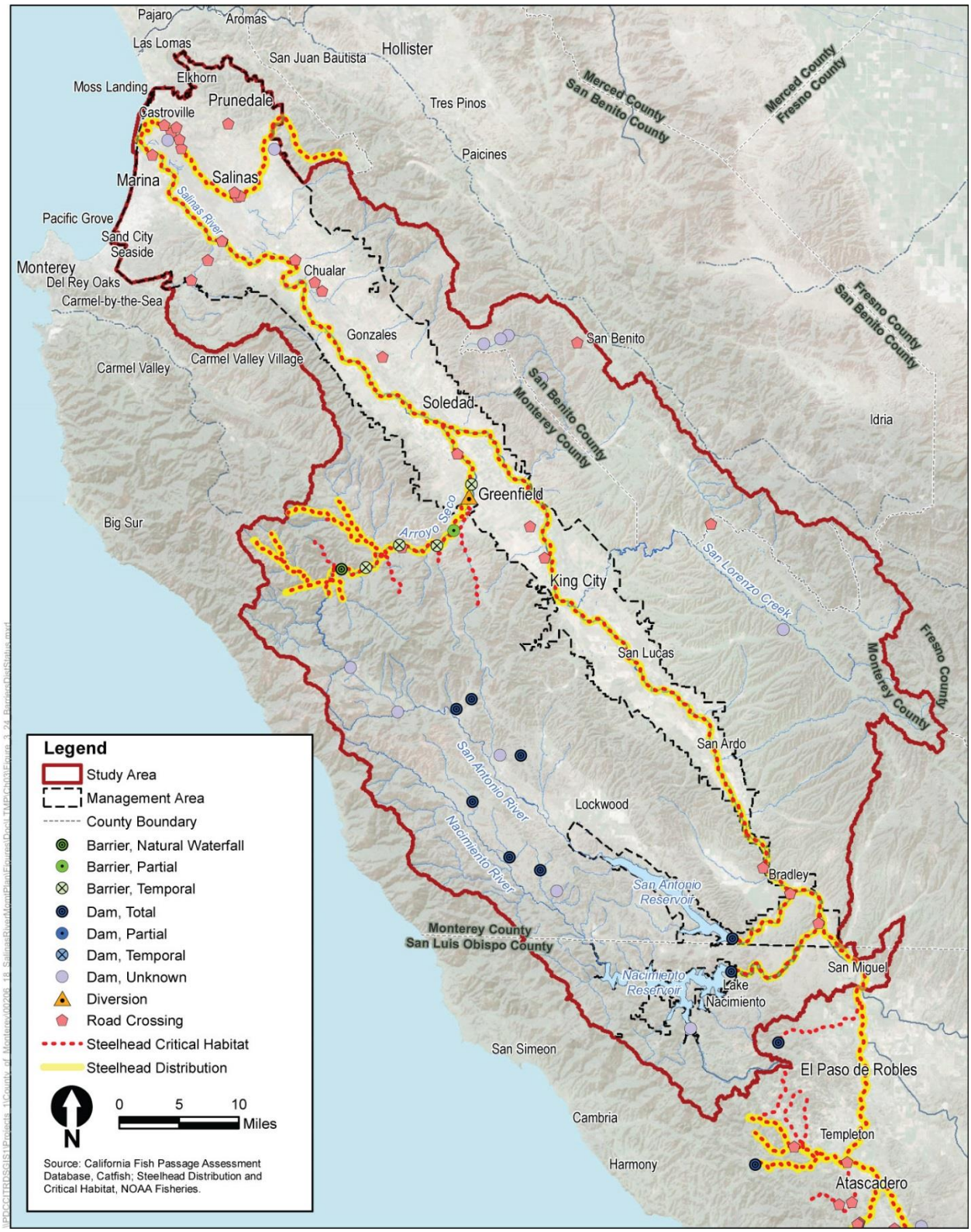


Figure 3-33. Stream Classifications, Barriers, and Native Fish Habitat in the Salinas River Watershed

The Salinas River, along with its major tributaries the Arroyo Seco, San Antonio River, and Nacimiento River, are all designated as critical habitat for steelhead (Figure 3-33; Appendix F, Figure F1-1). However, of these tributaries, only Arroyo Seco is not blocked by a major dam. The other two rivers are intensely regulated by the Nacimiento Dam (located along the Nacimiento River at RM 10; created in 1957) and San Antonio Dam (located along the San Antonio River at RM 8; completed in 1967). Arroyo Seco, the farthest downstream of the three tributaries that supports steelhead habitat, has at least 31 miles of suitable spawning and rearing habitat for the species. Arroyo Seco has a natural waterfall barrier to migration at approximately RM 31, although steelhead may be able to pass this waterfall at high flows. There are other temporal and partial barriers to migration along the waterway upstream of the confluence with the Salinas River, including culverts and old irrigation dams (Figure 3-33). In addition, the lower reaches are intermittent and typically dry up in the summer and fall months adding another barrier to migration to perennial habitat upstream. Nacimiento Dam blocks an estimated 38 miles of the river upstream of the reservoir (Becker and Reining 2008), much of which is likely suitable steelhead habitat. Similarly, San Antonio Dam blocks an estimated 32 miles of the river upstream of the reservoir (Becker and Reining 2008). Historically, these three tributaries were the "principal [steelhead] spawning areas and comprised some of the best spawning and rearing habitats in the watershed" (Snyder 1913; Titus et al. 2002; Good et al. 2005, as cited in National Marine Fisheries Service 2007). Currently, the majority of suitable habitat in the watershed, above the Nacimiento and San Antonio Dams, is not connected to the lower Salinas River and the ocean, limiting accessible spawning and rearing habitat for anadromous species in the watershed.

3.5 Environmental Pressures and Stresses

The California State Wildlife Action Plan (California SWAP) provides a framework for an ecosystem approach to the conservation and management of the state's native species and their habitats (California Department of Fish and Wildlife 2015). This framework identifies and describes ecosystem *pressures* and *stresses* and then proposes a wildlife management strategy that focuses on creating an ecological condition capable of withstanding those pressures and stresses. The California SWAP definitions for pressures and stresses are provided below and adopted for the LTMP.

- **Pressure:** an anthropogenic or natural driver that could result in changing the ecological conditions of the target. Pressures can be positive or negative, depending on the intensity, timing, and duration. Negative or positive, the influence of the pressure to the target may be significant.
- **Stress:** a degraded ecological condition of a target that resulted directly or indirectly from negative impacts of pressures defined above (e.g., habitat fragmentation).

This section identifies and discusses the pressures and stresses relevant to the Salinas River LTMP study area. The primary section headings—*Changes in Natural Communities*, *Altered River Hydrology*, and *Changes in Climate*—are considered the primary pressures in the study area. Section subheadings—e.g., habitat loss, altered flow, sea level rise, prolonged drought—are the resulting stresses. The discussion in each section explains the history and status of the pressure within the study area and details the stresses to relevant special-status species.

3.5.1 Changes in Natural Communities

Changes in the extent, distribution, and quality of natural communities occur as a result of climate change, land conversion, invasive species, and changes to the natural fire regime. Climate change allows certain natural communities to colonize new regions but if isolated by inhospitable habitat or development, climate change can lead to the loss or degradation of the community. Conversion of natural communities to agricultural, rural, or urban development results in a loss of community function and a degradation to remaining, adjacent patches. Invasive species can alter community structure and function and make the community more susceptible to wildfire. Changes to the natural fire regime caused by invasive species and land management practices interrupt or prolong typical fire cycles, which affects plant succession rates, reproductive cycles, and overall community diversity (California Department of Fish and Wildlife 2015). The sections below discuss each of these mechanisms of natural community shift in more detail.

3.5.1.1 Habitat Loss, Fragmentation, and Degradation

Habitat loss and fragmentation is by far the greatest stressor to biological resources in California and the study area. Indeed, the State Wildlife Action Plan calls habitat loss and fragmentation a "founding reason" for historical and current impacts on habitat and functioning ecosystems (California Department of Fish and Wildlife 2015). Habitat loss and fragmentation result in the degradation of remaining habitat by increasing the length of "edge" (boundaries between habitat and non-habitat), decreasing the overall size of natural habitats, and isolating patches of habitat. An increase in the total length of edge increases the potential for invasive or domestic predatory species (e.g., cats, dogs) to enter and colonize native communities. Habitat patches, because of their reduced size, typically support smaller populations of species, and as populations decrease in size, they become more vulnerable to disease, stochastic events, predation, and inbreeding. Fragmentation of habitat has a similar effect; the greater distance between patches of habitat, the greater potential there is for resource competition, genetic isolation, and inbreeding. Fragmentation of habitat can also separate populations from important, seasonal foraging and breeding habitat.

In the Salinas Valley, habitat loss and fragmentation have primarily occurred as a result of agricultural development, including ranchlands, and urban development, including cities, highways, railroads, and military bases. Prior to development of the river valley, the lands surrounding the Salinas River were primarily composed of riparian forests, but also included wetlands, floodplain, grasslands, and scrublands (San Francisco Estuary Institute 2009). The riparian forest is now concentrated along the river as a thin, linear strip. The reduction in the extent of the riparian forest is likely the primary cause of local extirpations of species such as the least Bell's vireo and the yellow-billed cuckoo that require larger patches of riparian forest with mixed canopy structure. Similarly, the loss and degradation of wetland and grassland habitats within the Salinas Valley is likely the primary cause of the reduction in occurrence of wetland-dependent species such as California red-legged frog and California tiger salamander.

Development and human-induced pressures from recreation and pollution can further degrade remaining, fragmented habitats, especially where patch sizes are relatively small. Within the Salinas Valley, natural communities persist primarily as dune, coastal strand, and wetland communities near the coast and as riparian and scrubland communities farther inland. Recreational visitors trample vegetation, disturb local wildlife (with noise primarily), and leave behind trash and garbage. Pollution, especially in the form of agricultural and urban runoff, also degrades the quality and

composition of communities as some vegetation types, particularly invasive types, may be more tolerant of degraded conditions than native species.

How the combined effects of habitat loss, fragmentation, and degradation affect species is well illustrated by the western snowy plover. Dune habitat, where western snowy plovers nest, has been lost and fragmented over time as a result of development, road infrastructure, and sea level rise. The remaining habitat is greatly affected by predation, much of which is from nuisance species associated with human development (e.g., cats, crows, raccoons, fox), and disturbance from human recreation (including domestic dogs). The decrease in habitat, coupled with predation and recreational stresses, has led to the decline in the western snowy plover population.

3.5.1.2 Shifting Distribution of Natural Communities

Shifts in natural community distribution and extent are primarily related to climate change, altered hydrology, invasive species, and changes to the natural fire regime. Changes related to the fire regime are discussed in Section 3.5.1.4, *Changes to the Natural Fire Regime*, below. Climate-related shifts in natural communities are not expected to be the primary driver of habitat degradation for Salinas Valley species; however, they are expected to exacerbate existing degraded conditions.

Climate change is expected to affect natural communities in California through the following mechanisms, as described in Section 3.5.3, *Changes in Climate:* sea level rise, prolonged drought, more intense rain events, and a decrease in coastal fog. Warmer temperatures are also expected to affect the distribution of natural communities.

Sea level rise will change the average salinities and hydrologic regime in nearshore and coastal environments, particularly for dune, coastal strand, wetland, and riparian communities. Increased erosion will also affect these communities. This will likely result in the inland shift of salt-tolerant vegetation and a reduction in riparian forest canopy in the coastal areas. The reduction in the frequency of coastal fog is also expected to reduce the extent of scrub and forest communities that persist near the coast and rely upon fog-related precipitation.

Prolonged drought is expected to cause shifts in natural community distribution and extent, particularly in the riparian community. With lower average rainfall, reduced river flows, and shortened hydroperiods, natural community composition will shift to communities with greater drought tolerance. Natural communities may also shift upward in elevation, where there are cooler temperatures. Grassland and scrubland communities may be able to adapt with an increase in elevation, but woodland and forest communities that exist in the upper elevations may see an overall decline in extent, at least in the southern portions of their distribution. The stress to natural communities as a result of drought can also create vulnerabilities to disease, wildfire, and invasion by nonnative, drought-tolerant species.

More intense rain events may cause increased erosion, especially when coupled with prolonged drought that dries soils and weakens root structures that hold vegetation in place. Vegetation communities in the higher elevations, especially in areas that are moderately or steeply sloped, will be most vulnerable to rain-related erosion and landslide events.

3.5.1.3 Invasive Species

Human introduction of nonnative species to the environment is a critical environmental stressor in the Salinas Valley, and one that is expected to be exacerbated by climate change. Invasive nonnative species are loosely defined as any kind of living organism that causes economic and/or ecological harm, specifically species that grow and reproduce quickly and have a propensity to outcompete native flora and fauna. Invasive species were introduced in California as early as the first European settlement, with some introductions occurring intentionally and others occurring unintentionally as a result of people and goods moving throughout the state. Often, invasive species lack any natural predators or controls because native wildlife cannot evolve defenses against the invader. Direct threats from invasive species include preying on native species, outcompeting native species for food or other resources (i.e., habitat, water), causing or carrying diseases, and preventing a native species from reproducing. Indirect threats from invasive species include reducing habitat areas, altering the food web by replacing or destroying a native food source, and altering the abundance or diversity of species that are important for natural ecological processes.

Invasive Plant Species

Anthropogenic disturbances (e.g., modified flow regime, agriculture, urbanization) have created conditions that favor invasions globally (Lockwood et al. 2013). Prior to dam construction in the watershed, seasonal high flows and natural floods caused flushing and scouring of the Salinas River channel, and the lack of dry season flow prevented excess growth of vegetation in the channel (ENTRIX and EDAW 2002). Following a reduction in naturally occurring flood disturbances, hundreds of exotic species have been able to find a niche in riparian corridors, with a few becoming significant problems, like Arundo and salt cedar (*Tamarisk* spp.). Removing stressors and reestablishing natural flow regimes can help bring riparian communities back into balance; however, some exotics are persistent and physical eradication is necessary to restore degraded systems (Shafroth et al. 2008, Stromberg et al. 2007).

Photo courtesy of the Resource Conservation District of Monterey County

Among the most problematic invasive plant species is Arundo, which covers approximately 1,455 acres in the Salinas River watershed, the second-largest infestation in California (Figure 3-29). Arundo is a nonnative perennial grass, similar to bamboo, which forms dense stands along riverbanks and can grow over 30 feet tall. It crowds out native vegetation, degrades wildlife habitat, consumes large amounts of water, increases flood risk to surrounding areas, and poses a fire hazard (Resource Conservation District of Monterey County 2018). Arundo is known to draw over three times as much water as native vegetation, and provides no riparian stream cover, leading to increased water temperatures and reduced habitat quality for aquatic wildlife.

Although the cumulative impact of Arundo in the Salinas River watershed is moderate, many of the target species in this LTMP—such as steelhead, tidewater goby, arroyo toad, California red-legged frog, California tiger salamander, and others—are expected to be negatively impacted by Arundo in

some part of their range (California Invasive Plant Council 2011). Arundo changes the structure of a native community's habitat matrix by outcompeting and replacing native vegetation. This is the primary mode in which it affects terrestrial species. For example, Arundo infestation can degrade the quality of woody vegetation and food resources in riparian woodland habitats used by southwestern willow flycatcher (California Invasive Plant Council 2011). The primary impact on aquatic species relates to high water usage, high water temperatures, bank stabilization, and accumulation of dead Arundo biomass. The ability of Arundo to stabilize banks causes stream channels to become incised and disconnected from floodplains, which can affect arroyo toad's food resources and breeding habitat. Arundo crowds out native riparian vegetation, resulting in a lack of shady stream cover and increased water demands, both of which may decrease freshwater inputs into the Salinas River Lagoon and affect the habitat quality for steelhead and tidewater goby. Degrading accumulated Arundo litter can also increase biological oxygen demand in the water, further decreasing water quality for steelhead and tidewater goby. Also, Arundo litter can form dense mats and potentially cover spawning habitat for goby and other fish species if washed downstream (California Invasive Plant Council 2011). Therefore, it is possible for a species to be impacted by Arundo, even if there is not an infestation in its distribution. Cumulative impact scores for species to be affected within the Salinas River watershed are provided in Table 3-19 (Monterey County Water Resources Agency 2014).

The infestation of Arundo has prompted two removal programs in the watershed: the Salinas River Watershed Invasive Non-Native Plant Control Program and the Salinas River SMP. More information on these programs can be found in Section 2.4.2, *MCWRA Partnership Projects and Programs*.

The rich soils and moderate climate of Monterey County have facilitated the colonization and spread of invasive weedy species. Grasslands occur throughout the Salinas River watershed in open areas of valleys and foothills, and these grasslands are often dominated by nonnative annual grasses and forbs. Common nonnative annual grasses include ripgut brome, soft chess, rattail fescue, slender oat, barnyard foxtail, and perennial ryegrass. Although nonnative grasses can outcompete native species, these grasslands also provide habitat for a number of wildlife species, including rodents, reptiles, and birds. Wildlife species that have the potential to occur within the nonnative grasslands include American badger, Monterey ornate shrew, western burrowing owl, California horned lark, California legless lizard, coast horned lizard, white-tailed kite, and pallid bat.

Table 3-19. Arundo Impacts on Threatened and Endangered Species in the Salinas River Watershed

Category	Federal Listing	Scientific Name	Common Name	Impact
Mammal	FE	*Vulpes macrotis mutica*	San Joaquin kit fox	Very low impact expected because Arundo is not abundant on the upper Salinas River where San Joaquin kit fox is most likely to occur.
Amphibian	FE	*Ambystoma californiense*	California tiger salamander	Very low impact expected as there is little overlap between California tiger salamander and Arundo distributions.
Amphibian	FE	*Bufo californicus*	Arroyo toad	High impact expected on arroyo toad habitat, breeding, and diet.

Category	Federal Listing	Scientific Name	Common Name	Impact
Amphibian	FT	*Rana aurora draytonii*	California red-legged frog	Low impact expected due to moderate overlap in distributions.
Fish	FE	*Eucyclogobius newberryi*	Tidewater goby	High impact expected on tidewater goby habitat, breeding, and movement.
Fish	FT	*Oncorhynchus mykiss*	Steelhead	High impact expected on ecological needs due to its impacts on water use, channel form, and sediment transport.

Source: California Invasive Plant Council 2011.
FE = federally listed as endangered; FT = federally listed as threatened

Invasive Animal Species

Direct and indirect effects of invasive species pose several threats to special-status species in the study area. Barred tiger salamanders (*Ambystoma tigrinum mavortium*) were introduced to California in the Salinas Valley over 50 years ago and now threaten native California tiger salamanders (*Ambystoma californiense*) through hybridization between the two species. Since their introduction, the number and range of hybrid progeny has expanded and may have negatively impacted the populations of native California tiger salamanders (Ryan et al. 2009; see Appendix F for more detail). Another example of the impacts of invasive species is parasitism by invasive brown-headed cowbirds on least Bell's vireo, a federally endangered species. Brown-headed cowbirds lay their eggs into the nests of least Bell's vireo (as well as numerous other species) and often remove and destroy the eggs of the host bird, greatly reducing the reproductive success of the vireo (Sharp and Kus 2006; see Appendix F for more detail).

The expansion of the range and population sizes of urban predators has also impacted special-status species in the study area. Red fox (*Vulpes vulpes*), an introduced species, has become a significant threat to many endangered species as well as other vulnerable native animals. Red foxes are known to present problems for birds that nest in the dunes along the coast as they will feed on the eggs of nesting birds, and they have been identified as a major limiting factor for reproductive success of western snowy plover (Neuman et al. 2004) and California least tern (Jurek 1992). Red foxes are also known to prey upon the smaller San Joaquin kit fox (Ralls and White 1995), as well as compete with them for the limited available prey.

Nonnative species can indirectly impact native species by spreading diseases and parasites. For example, the endangered San Joaquin kit fox has been especially vulnerable to sarcoptic mange, a highly contagious skin disease caused by parasitic mites that is potentially fatal. The outbreak of mange in San Joaquin kit foxes is thought to have first occurred among an urban population of the species living in Bakersfield, California. It is not clear if infected individuals have been observed in the study area, but there is potential for this disease to spread to the area through a number of canid hosts. In addition, parasites and bacteria (e.g., *Toxoplasma gondii*) that are commonly found in cat feces have been linked to sea otter deaths in Central California (Kreuder et al. 2003), with these protozoans often found near locations that discharge urban runoff into the ocean. Sea otters can also be infected by another brain parasite, the protozoan *Sarcocystis neurona,* which is commonly found in the feces of opossums.

Invasive Aquatic Plant and Animal Species

The presence of nonnative aquatic species, some of which can be highly invasive and difficult to control, are increasingly common in coastal habitats worldwide. Aquatic nuisance species are common throughout the Salinas River Lagoon, especially farther downstream in the watershed where flows are maintained year-round. Invasive aquatic species in the lagoon and other perennial water bodies include water hyacinth (*Eichhornia crassipes*), Brazilian Elodea (*Egeria densa*), Eurasian watermilfoil (*Myriophyllum spicatum*), and hydrilla (*Hydrilla verticillata*), as well as several species of algae. These species, although they vary morphologically, tend to form dense mats at the water's surface that can inhabit movements of other aquatic species. In addition, these species can overtake habitats and outcompete native aquatic plants. Invasive aquatic plants may also be unsuitable for providing shelter, food, and nesting/rearing habitat for native species, including steelhead and tidewater goby. In addition, approximately 40 nonnative species are known to exist in Elkhorn Slough (Denise Duffy and Associates 2016). Elkhorn Slough, which occurs in a small portion of the study area, is indirectly connected to the Salinas River through the Moss Landing Harbor and OSR. Introduced species include terrestrial plants and algae (European dune grass, sea rocket, brown alga), invertebrates (sponges, anemone, snails, mussel, clams), and several species of fish.

Several invasive fish species inhabit the Salinas River and its tributaries. Fisheries monitoring conducted since 2010 in the mainstem Salinas River, Nacimiento River, Arroyo Seco, and Salinas River Lagoon has revealed populations of nonnative common carp (*Cyprinus carpio*), goldfish (*Carassius auratus*), golden shiner (*Notemigonus crysoleucas*), bluegill sunfish (*Lepomis macrochirus*), green sunfish (*Lepomis cyanellus*), black crappie (*Pomoxis nigromaculatus*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), white bass (*Morone chrysops*), striped bass (*Morone saxatilis*), channel catfish (*Ictalurus punctatus*), white catfish (*Ictalurus catus*), and western mosquitofish (*Gambusia affinis*) (FISHBIO 2014a, 2014b; Hagar Environmental Science 2014). The vast majority of these species are known to either prey upon native species, including juvenile steelhead, or compete with native species for food resources. In general, the most impactful nonnative species, with respect to steelhead and tidewater goby, are large-bodied piscivorous fish including striped bass, largemouth and smallmouth bass, and channel and white catfish. Of these species, striped bass are the most commonly observed and likely present the biggest threat to steelhead given their prevalence in the Salinas River watershed and their propensity to prey upon salmonids (National Marine Fisheries Service 2013). Although predation and nonnative species were identified in the South-Central California Coast Steelhead Recovery Plan (National Marine Fisheries Service 2013) as a high threat in the Salinas, Nacimiento, and San Antonio Rivers and Arroyo Seco, the impacts of nonnative species on naturally reproducing *O. mykiss* are not well known, and the removal of nonnative fish species was not included as a critical recovery action for any of the rivers (National Marine Fisheries Service 2013) (Table 3-20).

Extensive Growth of Floating Aquatic Plants and Algae in the Salinas River Lagoon during October

Table 3-20. Nonnative Fish Species Observed in the Salinas River Watershed and Its Associated Tributaries

Common Name	Scientific Name	Reclamation Ditch System [a]	Old Salinas River[b]	Salinas Lagoon[c]	Salinas River[d]	Nacimiento River[d]	Arroyo Seco[d]
American shad	*Alosa sapidissima*					x	
Threadfin shad	*Dorosoma patenense*			x		x	
Goldfish	*Carassius auratus*	x			x	x	
Common carp	*Cyprinus carpio*	x	x	x	x	x	
Golden shiner	*Notemigonus chrysoleucas*	x			x	x	x
Fathead minnow	*Pimephales promelas*	x					
Bullhead	*Ameiurus* sp.	x					
Western mosquitofish	*Gambusia affinis*	x	x	x	x		
Green sunfish	*Lepomis cyanellus*	x			x		x
Bluegill sunfish	*Lepomis macrochirus*	x			x	x	x
Largemouth bass	*Micropterus salmoides*	x			x		
Smallmouth bass	*Micropterus dolomieu*					x	x
Striped bass	*Morone saxatilis*			x	x		
White bass	*Morone chrysops*					x	
Black crappie	*Pomoxis nigromaculatus*	x	x		x	x	
White catfish	*Ameiurus catus*					x	
Channel catfish	*Ictalurus punctatus*					x	
Inland silverside	*Menidia beryllina*					x	
Yellowfin goby	*Acanthogobius flavimanus*			x			

[a] Central Coast Watershed Studies 2006.
[b] Hagar Environmental Science 2001.
[c] Hagar Environmental Science 2014.
[d] Hellmair et al. 2018.

The frequency and intensity of nonnative species invasions and the distribution of nonnative species in the study area will likely be affected by climate change. Changes in species growth, reproduction, and mortality are all expected as a result of climate change. In general, many species are moving towards the poles and up in elevation where temperatures are lower (Parmesan and Yohe 2003); however, shifts in species distribution may be constrained by interactions with other species and surrounding forest cover (Van der Putten et al. 2010, Guo et al. 2018). The effects of climate change on the abundance and distribution of invasive species in the Salinas River watershed are difficult to predict given the uncertainty in climate change scenarios and our understanding of how species will respond to those changes. In general, for plant and vertebrate species, climate change is expected to more frequently contribute to a decrease in species range rather than an increase in overall area occupied. Alternatively, the range of invertebrates and pathogens is expected to increase (Bellard et al. 2018). Invasive species often have short generation times, strong dispersal abilities, and broad environmental tolerances, which allow them to cope with rapid environmental changes. Climate change will lead to range shifts for native species, which may allow invasive species to succeed in environments with abundant resources and relatively few competitors.

3.5.1.4 Changes to the Natural Fire Regime

The duration, frequency, intensity, and timing of wildfires describe a landscape's fire regime, which is a major factor that determines the natural vegetative community composition (Pausas and Keeley 2009). For example, grassland and shrubland communities have historically experienced frequent, small, lightning-induced wildfires, and as a result many plants in these communities have evolved to germinate after fires. Vegetation types that depend on fire, meaning they are fire-prone and fire-adapted, cover over half the surface area of California and more than half of Monterey County. According to the Monterey County Community Wildfire Protection Plan (Monterey Fire Safe Council 2010), fuels such as grass, light brush, grass/woodland, and hardwood litter account for 80.5% of land cover in the county. Within the study area, grassland, shrubland, and forest/woodland make up 81% of the natural communities (Table 3-17). Therefore, changes to natural fire regimes in these land cover types could influence large sections of the study area.

Monterey County has had an active fire history, owing to the topography, vegetation, climatic conditions, and expansion of the wildland-urban interface (Figure 3-34). Some areas of the county are more fire prone than others. Specifically, the western side of the county along the Los Padres National Forest has exhibited the most frequent fires over recorded history (Monterey Fire Safe Council 2010). Based on fire perimeter data from CAL FIRE and U.S. Forest Service, there have been 28 fires greater than 10 acres in size between 1950 and 2000 in the county. These fires ranged in size from the 160-acre Morse-Pebble Beach Fire (1987) to the 173,000-acre Marble-Cone Fire (1977). Notably, the damage from the smaller Morse-Pebble Beach Fire was approximately $18,000,000 because it burned within the wildland-urban interface, destroying 31 homes.

Throughout the study area, there have been numerous fires since 2000 that have together burned approximately 235,951 acres (Table 3-21). Two years (2008 and 2016) experienced particularly large burns, at 141,995 and 59,375 acres, respectively. Although the management area along the Salinas River riparian corridor has experienced fewer fires and less area burned during this time, the management area is composed mostly of the wildland-urban interface.

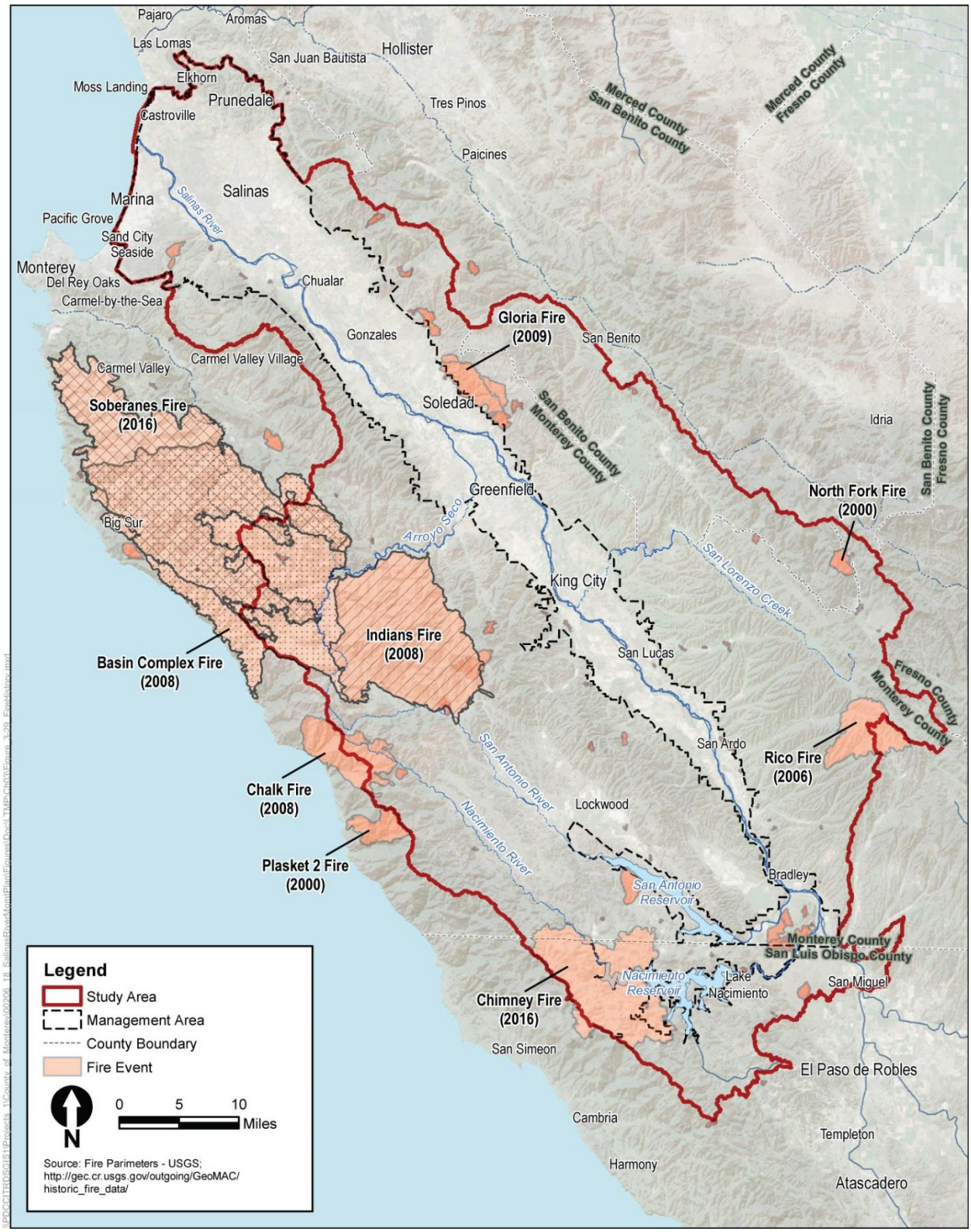


Figure 3-34. Past Fire Events

Table 3-21. Annual Wildfire Burned Area in the LTMP Study and Management Areas from 2000 through 2016

Year	Management Area Only (acres)	Study Area Only (acres)	Total
2000	2,747	2,811	5,558
2001	581	--	581
2003	951	744	1,695
2004	18	1,250	1,268
2005	175	1,633	1,808
2006	17	10,998	11,015
2007	38	87	124
2008	102	141,995	142,096
2009	808	14,246	15,054
2010	2	345	348
2011	475	1,426	1,901
2012	--	104	104
2013	--	411	411
2014	--	476	476
2015	135	50	185
2016	4,045	59,375	63,420
Total	**10,094**	**235,951**	**246,045**

A number of factors can lead to an altered fire regime, including climate-induced changes in weather patterns, direct suppression by forestry management practices, or invasive species and pathogens creating increased fuel loads (Hurteau et al. 2014). As discussed in Section 3.5.3, *Changes in Climate*, the projected changes to the Mediterranean climate will be an increase in prolonged droughts, decreased fog, warmer temperatures, and changes to the predominant wind patterns, which together will exacerbate the dry conditions currently experienced during the fire season. Primary changes in fuels come from forestry management practices (particularly fire suppression without active fuel management), invasive plants such as Arundo creating new fuel sources, or tree die-offs either from drought or disease spreading pests. Coupled with an expanding wildland-urban interface, the frequency of large, intense wildfires causing economic damage is likely to increase (Moritz et al. 2012).

The alteration of natural fire regimes is an important ecological stress, particularly in forest and shrub-dominated habitats (California Department of Fish and Wildlife 2015). During the latter part of the twentieth century, policy-driven suppression of fire frequency was implemented for the purposes of protecting natural resources (trees used for lumber, paper, and recreation) and human development in the wildland-urban interface. This has led to many forest types experiencing changes in vegetation structure, in addition to fuel accumulation (Marlon et al. 2012). Fire suppression has led to dense, even-aged forests that lack the complexity that helps reduce fire potential and intensity. In these biological communities the changes to the frequency of fires alter natural successional dynamics.

Invasive species have also altered the natural fire regime. Invasive species are more likely to occur in higher densities, as a result of low competition from native species, and can then become an

unnatural fuel source. The lack of habitat complexity associated with invasive-dominated vegetation communities makes these communities more vulnerable to fire. In the Salinas River, Arundo is an invasive species that has increased the potential for wildfire in the riparian community. This is primarily related to two factors: Arundo is highly productive as a fuel source, and stands of Arundo retain significantly higher amounts of dry, dead biomass compared to native woody and herbaceous vegetation types (California Invasive Plant Council 2011). Arundo contains a significant amount of energy and aboveground plant biomass in the form of dry primary and secondary leaves both on the plant and the ground.

After a fire, Arundo begins to immediately (within 2 weeks) grow from its rhizomes whereas native species can remain dormant for months. High mortality of native trees and shrubs is frequent in comparison to Arundo, and, in addition, Arundo grows more quickly (up to 3 or 4 times faster) than native riparian plants. This fire-adapted phenology, in combination with high growth rates and increased nutrient levels after fires, creates an "invasive plant-fire regime cycle" that can hasten the conversion of a mixed-Arundo/native vegetation stand to an Arundo-dominated stand (California Invasive Plant Council 2011).

Increased frequency and severity of droughts are predicted over the next 30 to 90 years (Dai 2013) and will pose multiple challenges to terrestrial and aquatic biota. Increased frequency and intensity of wildfires have been documented during past Holocene warming periods (Pierce et al. 2004). Wildfires can have short- and long-term effects on aquatic species. Short-term negative effects of wildfires include intense temperatures while burning through the riparian corridor, toxicity from flame retardants, and ash and debris sediment flows that reduce dissolved oxygen and cause acute ammonia toxicity. Long-term negative consequences from wildfires can include increased water temperatures from decreased stream shading, increased run-off and flash floods, and reduced woody debris inputs. Although the negative effects of wildfires on stream biota vary due to proximity to wildfires and post-fire precipitation events, many western salmonid populations evolved physiology and behavioral mechanisms to tolerate wildfires. Habitat fragmentation appears to be a principle component in how salmonids respond demographically and genetically to intense wildfires (Neville et al. 2009); the loss of mature, native streamside vegetation as a result of development (i.e., habitat fragmentation) can increase the intensity of fire and thus increase the loss of vegetation and the potential for erosion, both of which can negatively affect the quality of salmonid habitat. In Mediterranean climates, global warming is expected to increase the numbers of fires, but their impacts on the landscape may be mitigated through fire and landscape management (Turco et al. 2014).

3.5.2 Altered River Hydrology

Altered river hydrology can lead to changes in flow, water quality, and the sediment deposition and erosion regime (California Department of Fish and Wildlife 2015). These changes can affect the presence and persistence of wildlife in a watershed. For example, reduced flows can affect connectivity between spawning and rearing habitat for steelhead. Reduced groundwater levels can shorten the hydroperiod in rivers that support freshwater fish assemblages such as steelhead and breeding ponds for wetland species such California red-legged frog and California tiger salamander. An altered sediment deposition and erosion regime can reduce the quality of spawning and rearing habitat for steelhead and alter the quality of riparian habitats. This discussion of altered river hydrology as a pressure is separated into two major stressors, altered flow and degraded water quality, each of which is described in detail below.

3.5.2.1 Altered Flow

Flows in the Salinas River have been altered substantially by two primary mechanisms, upstream reservoir management and in-stream diversions. Groundwater pumping meets almost all agricultural and municipal water demands in the Salinas Valley with agriculture constituting approximately 90% of the demand. One of the methods for offsetting the decrease in groundwater table elevation due to pumping is to increase the efficiency for groundwater table "recharge" by storing winter flows for release during the dry season. To achieve this goal, MCWRA manages two large dams within the study area—Nacimiento Dam and San Antonio Dam, which create Nacimiento and San Antonio, respectively.

Another method for offsetting groundwater extraction is to divert water off channel for irrigation, alleviating some pressure on the groundwater table. There are two major diversions within the Salinas River basin: one on the Arroyo Seco and one on the Salinas River mainstem (known as the SRDF). The Arroyo Seco diversion takes water during the growing season to supply small-scale agriculture at Clark Colony. Diversions from the Arroyo Seco reduce the extent and duration of wetted stream habitat in the Arroyo Seco as well as limit the number of days the Arroyo Seco is connected to the Salinas, and thus the number of days steelhead migration is possible. The SRDF supplies treated Salinas River water to agricultural users to reduce groundwater pumping and decrease seawater intrusion. The SRDF diverts water released from the reservoirs during the dry season.

The management of reservoir releases and diversions alter historical hydrology in two primary ways: decreasing flows during the wet season and increasing flows during the dry season. These stresses are discussed in the following sections.

Decreased Flow during the Wet Season

Winter and spring storms, and associated peak flood velocities, created complex habitat (backwaters, deep holes, undercut banks, log jams), moved sediment downstream, and eroded the river mouth. These flows created connectivity between oceanic, estuarine, and riverine habitats for steelhead in the winter and spring when adult and juvenile migration takes place. The unique life history of steelhead was developed to take advantage of this flow regime. Changes to the flow regime may have altered the timing of sandbar formation and opening, disconnected habitat types, and degraded water quality and quantity in the river and the lagoon. Each of these factors has had negative effects on the steelhead population as well as on other native fish populations.

Minimizing peak flood flows reduces the erosive power of rivers and streams; it is the erosive power of peak flood flows that creates complex habitat (i.e., deep pools, undercut banks, piles of large woody debris) for aquatic species such as steelhead. With fewer and weaker peak flood flows, large boulders and woody debris are moved less frequently, minimizing the amount of new, complex habitat that is created.

Minimizing peak flood flows also reduces the sediment carrying capacity of a river system, a reduction in channel forming processes that provides for habitat features. Reduced flows minimize the amount of fine- and medium-sized sediment particles (clay, silt, and sand) that can be carried downstream, where they can be deposited onto a floodplain. Fine- and medium-sized sediment that remains in the upper watershed can fill in important deep pool habitat and may degrade the quality of run and riffle habitat. Run and riffle habitat is typically composed of large gravel and small- and medium-sized cobbles. These habitat types provide important habitat niches for spawning and

primary habitat for aquatic macroinvertebrates, the primary food source for rearing steelhead. Clay, silt, and sand fill the spaces between rocks, prohibiting water flow and oxygen from reaching steelhead eggs, and macroinvertebrate eggs and larvae, which primarily live in these small spaces.

Minimizing peak flood flows also affects sandbar dynamics at the river mouth. Large storm events are needed to move large quantities of sand away from the river mouth where it is stored offshore until wave events bring the sand back ashore. Without the large flow events, less sand is moved offshore, likely resulting in the sandbar forming sooner and persisting longer. The modification of sandbar dynamics can affect connectivity between oceanic and riverine steelhead habitat; if the sandbar is in place for long durations, migrating adults and juveniles have fewer and shorter opportunities to enter or leave the system.

Increased Flow during the Dry Season

Dams not only affect peak winter flows but also affect flows during the dry season. Historically, flows in the Salinas River and its tributaries in the dry season (summer and fall) have been very low to non-existent. Since the building of the dams, flows that are released during the dry season to maximize groundwater percolation and recharge adversely affect the riparian community, river hydrology, and species habitat. Groundwater pumping and reservoir releases managed to recharge groundwater tables have changed natural flow and dynamics.

Releasing stored water in the summer has the effect of artificially extending the wet season. This results in a prolonged growing season for streamside vegetation and allows for nonnative species like Arundo to become invasive. The prolonged growing season results in not only a loss of water (to plants) that would otherwise be available for downstream use but also to a loss in the stream's ability to convey flood flows through increased constriction. In addition, when reservoir flows are reduced during drought conditions, this vegetation dies back and is transported downstream where it further reduces the flood flow carrying capacity by increasing the stream's "roughness" or resistance to flowing water (i.e., increased constriction). Dry season flows are also subject to greater evapotranspiration rates; smaller amounts of water that move more slowly during warm weather conditions evaporate more quickly, further decreasing available water rates for downstream uses.

Prolonged low flows during the dry season can extend the duration and extent of wetted habitat for aquatic species such as steelhead. However, low reservoir flows are typically warm and hold fine suspended sediments. Small sediment particles, primarily clay and silt, remain suspended for long periods of time within reservoirs. When water is released from reservoirs, these fine sediments settle out of the water column and deposit onto gravels and cobbles, an important habitat niche that supports spawning and the food web for rearing juvenile steelhead. Warmer temperatures also increase the metabolic rates of resident fish. Higher metabolic rates require a greater abundance of food; without additional food to compensate for the metabolic increase, the fish will starve. If water temperatures get high enough to exceed certain physical tolerances, fish will die.

The reduction in habitat complexity and degradation of habitat quality caused by a reduction in peak flows and prolonged low flows may also reduce the number of ecological niches or habitat types within the river. Deep pools and gravel and cobble beds fill with sediment, becoming shallow, sandy habitat types. Complex habitat types such as backwater channels, undercut banks, and large piles of wood debris are formed less frequently. This affects habitat suitability for native freshwater fish species such as the Sacramento sucker, Sacramento perch, and Sacramento blackfish communities. While the suitability for native fish decreases, warmer temperatures improve the suitability for predatory species such as bass and bluegill (which escape from reservoirs where they are often

planted for recreational purposes) that prefer or tolerate warmer water. These warm water fish assemblages, once established, can prey upon native species and outcompete them for resources.

3.5.2.2 Degraded Water Quality

Decreased river flows and reduced groundwater levels, coupled with the effects of climate change, may result in degraded water quantity and quality (California Department of Fish and Wildlife 2015). River habitat is, on average, shallower, narrower, less complex, and warmer compared to historical conditions. Lagoon habitat has also declined in extent and quality with a decrease in overall surface water elevation, an increase in average salinity, and a decrease in average dissolved oxygen concentrations (Hagar Environmental Science 2015). In addition, inflows from agricultural and urban sources contribute pollutants and nutrients to the river and lagoon systems, causing further degradation.

River

Altered river hydrology has the potential to affect water temperature, chemistry, and pollutant/nutrient concentrations and dynamics (California Department of Fish and Wildlife 2015). As discussed above, prolonged low flows created as part of a reservoir release strategy to maximize groundwater recharge results in shallow, warm water that puts additional metabolic pressure on the native cold water fish assemblages and favors predatory, warm water fish assemblages. In the lower parts of the Salinas Valley, runoff and return flows from agricultural and urban sources can deliver chemical fertilizers, pesticides, and other chemicals that can further degrade water quality.

Chemical fertilizers include nitrogen, phosphorus, and other chemical constituents meant to aid in plant production. When these fertilizers enter the river system, they stimulate growth of algae and rooted aquatic plants. Both warmer temperatures and increased nutrient concentrations can increase primary productivity. While plants contribute oxygen to the water column during the daytime, oxygen levels can become depleted at night as animal respiration continues but primary productivity does not. This effect is most severe in low flow or isolated pools that are not receiving enough new, oxygenated water. In these instances, aquatic organisms such as fish are at increased risk for predation, starvation, or suffocation.

Pesticides can be toxic to aquatic species, especially in low flow situations where organisms may experience prolonged exposure times and increased concentrations. Pesticides can cause neurological or physiological complications that impair an organism's overall fitness and make it more vulnerable to predation or disease. In high enough concentrations, pesticides can be lethal to riverine organisms such as macroinvertebrates and fish. Prolonged exposure to pesticides can also alter the aquatic community as some species have higher tolerances for toxicity than others.

Lagoon

The Salinas River, like most central California coastal river systems, terminates in a seasonal lagoon. The lagoon forms when the estuary is separated from the ocean by the formation of a sandbar, which forms as a result of seasonal sand deposition onto the beach combined with reduced river outflows. For a typical or average water year, sandbars form across central California coast estuaries in late spring or summer and remain intact until high river flows due to winter rain and wave events breach it. In wet water years, the sandbar may form later in the summer or in the fall, while in dry years the bar may form in the late winter or early spring (Smith pers. comm.). Modification of the river mouth, diking of adjacent wetlands, management of surface water elevation, and the diversion

of river inflows also have potential to affect the timing of sandbar formation. The timing of sandbar formation and the quantity and quality of freshwater inflows determine the quality of water in the lagoon (Hagar Environmental Science 2015, Smith pers. comm.).

Historically, the Salinas River Lagoon was a complex of natural dune, scrub, riparian, wetland, and riverine communities (San Francisco Estuary Institute 2009). The river mouth was likely "meandering," with the river mouth moving north and south along the beach in response to oceanic and river processes. In the late nineteenth and early twentieth centuries the Salinas River flowed north, along the dune community, until it joined Elkhorn Slough and opened to the ocean near Moss Landing (San Francisco Estuary Institute 2009). With the construction of Moss Landing Harbor, in addition to agricultural and residential development beginning in the 1950s, the northward connection to the ocean was severed and the river mouth now opens to the ocean in its current position just southwest of the small, unincorporated town of Castroville.

The OSR is now a tidal channel with a 48-inch culvert and slide gate located at the northeast corner of the lagoon. The slide gate allows lagoon water to discharge into the OSR when water surface elevations reach 3 feet (NGVD 29 [4.3 feet NAVD 88]) (Hagar Environmental Science 2005). The slide gate is closed when the river mouth is open and open when the river mouth is closed (H. T. Harvey & Associates 2009). However, the volume of water that can flow through the slide gate is limited by the capacity of the outlet structure and the channel. Capacity in the channel is also limited by tidal influence (from Moss Landing) and flows from other sources, primarily Tembladero Slough (Hagar Environmental Science 2015). These limitations can cause localized flooding and root zone saturation.

When the water surface elevation in the lagoon rises quickly in response to a rain event, the discharge capacity through the slide gate is typically exceeded and water surface elevations can quickly rise to flood levels (6 feet NGVD 29 [8.7 feet NAVD 88] above sea level or greater). To relieve this flooding pressure, MCWRA lowers the sandbar in a small section to alleviate flooding pressure. Typically, once the channel is created and surface water begins to drain, the sandbar erodes and a more natural connection to the ocean is established. However, there are times when outflows are not strong enough to erode the mouth and keep wave-deposited sand from reestablishing the sandbar; in these instances, the mouth closes soon again after artificial opening. Artificial opening can occur anytime between October and June (Hagar Environmental Science 2010a and 2015).

Managing the sandbar and lagoon elevation is made complicated by the presence of rare and special-status species and degraded water quality. The sandbar and beach provide nesting habitat for western snowy plovers and roosting habitat for brown pelicans. The dune and scrub communities provide habitat for northern California legless lizard and Smith's blue butterfly (H. T. Harvey & Associates 2009). The lagoon provides rearing and migratory habitat for steelhead and year-round habitat for the tidewater goby (Hagar Environmental Science 2015). The

Old Salinas River Slide Gate Looking Southwest Toward the Salinas River Lagoon

lagoon is not known to provide suitable breeding habitat for California red-legged frogs due to high flow rates during the winter breeding season and increased salinity levels. However, there is suitable upland habitat adjacent to the southern boundary of the lagoon in the Salinas River National Wildlife Refuge, which is within the Salinas River-Pajaro River Recovery Core Area designated for the species (U.S. Fish and Wildlife Service 2007). In addition, there are occurrences to the north of the lagoon near Prunedale and Elkhorn Slough Reserve. Historically the California red-legged frog occurred in fresh, backwater wetlands surrounding the lagoon and it likely still persists in small patches of habitat upstream of the lagoon.

Another complication is managing water quality in the Salinas River Lagoon. When the sandbar is in place, the quality of water in the lagoon decreases (Central Coast Wetlands Group 2015, Hagar Environmental Science 2015). A halocline forms, with higher salinity and heavier seawater sinking to the bottom layer of the lagoon and a lighter freshwater layer on top. The force of the salinity stratification is strong and can remain in place for some time after artificial sandbar breaching events (Central Coast Watershed Studies 2001). This is likely a result of low energy scouring at the mouth and thus reduced tidal volume; that is, the breach event may not have enough energy to reduce elevations at the mouth such that the typical volume of seawater can enter and exit the lagoon. Because the saltwater layer is not mixing with surface waters it will typically become hypoxic (<5 mg/L dissolved oxygen) or anoxic (< 1 mg/L dissolved oxygen) (Hagar Environmental Science 2015, Central Coast Wetlands Group 2015, Central Coast Watershed Studies 2001) as a result of respiration of benthic organisms.

In addition to hypoxia and anoxia, non-point source agricultural runoff also contributes to poor water quality in the lagoon. Nutrients such as phosphorus and nitrogen are applied to crops to help improve yields, but these nutrients also promote the growth of plankton, filamentous algae, and rooted aquatic vegetation when they enter the watershed as runoff. This excess in nutrients and the subsequent "bloom" in primary productivity is known as *eutrophication*.

In a stratified lagoon system with limited mixing, very little to no tidal interaction, and low freshwater inflows, increased primary productivity can further exacerbate low dissolved oxygen conditions caused by salinity stratification. On sunny days, aquatic plant respiration can saturate the top, fresh layer of water with dissolved oxygen concentrations greater than 15 mg/L (150% saturation) (Hagar Environmental Science 2015, Central Coast Wetlands Group 2015). However, at night, or on foggy or cloudy days when plant respiration is low and animal respiration continues, dissolved oxygen levels can quickly decline, even in the fresh, surface waters. This diurnal fluctuation in surface dissolved oxygen occurs primarily in the late summer and early fall when plant biomass, temperatures, and solar radiation are high (Sloan 2006).

In addition to contributing to swings in surface dissolved oxygen concentrations, the abundant mass of dead plant matter, or dead organic matter, delivered to the benthos also further exacerbates hypoxia and anoxia in the isolated bottom layer. Sulfur-reducing microbes in the sediment consume plant matter and create hydrogen sulfide as a byproduct of anaerobic respiration—a process that garners energy by reducing sulfate, SO_4^{-2}, to hydrogen sulfide, H_2S. Hydrogen sulfide concentrations in the saline layer increase over time and can reach toxic levels (> 5 mg/L). When the bottom layer is finally mixed with the surface layer, the H_2S quickly oxidizes, further depleting oxygen from the water column (Sloan 2006).

Monitoring of the Salinas River Lagoon illustrates a wide variation in the timing and duration of sandbar formation and of water quality (Monterey County Water Resources Agency unpublished

data; Central Coast Wetlands Group 2015; Hagar Environmental Science 2010a, 2010b, 2012, 2013, 2014, 2015). The timing and duration of sandbar closure has been recorded since 1964; dates and duration of closures and openings since 2004 are presented in Table 3-22. Water quality, flow, and fisheries data has been collected in the lagoon for the years between 2009 and 2016; the most recent years reported are summarized in the paragraphs below.

Table 3-22. Opening and Closing Dates of Sandbar at the Mouth of the Salinas River

Water Year	Date Sandbar Open	Date Sandbar Closed	Duration of Lagoon Open to Ocean (days)
2017/2018	3/25/18	4/22/18	29
2016/2017	1/13/17	10/2/17	264
2015/2016	Lagoon did not open	Lagoon did not open	0
2014/2015	Lagoon did not open	Lagoon did not open	0
2013/2014	Lagoon did not open	Lagoon did not open	0
2012/2013	12/26/12	1/28/13	33
2012/2013	12/4/12	12/21/12	17
2011/2012	4/13/12	5/5/12	22
2010/2011	4/26/11	10/22/11	179
2009/2010	6/11/10	7/18/10	37
2009/2010	5/23/10	6/4/10	12
2009/2010	1/21/10	5/21/10	120
2008/2009	6/20/09	8/18/09	59
2008/2009	3/4/09	6/17/09	105
2007/2008	5/6/08	5/28/08	22
2007/2008	1/23/08	5/2/08	100
2006/2007	1/9/07	1/26/07	17
2005/2006	1/4/06	7/24/06	201

Source: Monterey County Water Resources Agency 2018b.

Two general lagoon water quality regimes for closed conditions during the summer and fall emerge from the recent data: a strongly stratified system with reasonably extensive bottom water hypoxia and anoxia and a freshwater system with some, but likely much less by volume, bottom water hypoxia and anoxia. Freshwater conversion appears to be related to freshwater inflows after sandbar closure. This was seen in the water quality data from 2013 through 2017. Freshwater flows reached the lagoon all spring, summer, and fall in 2013 such that by the fall, the system had largely converted to freshwater. This was important in the years that proceeded when the sandbar remained closed with no freshwater inflow during the spring, summer, and fall. While warmer temperatures and dissolved oxygen fluctuations were recorded primarily during the summer, steelhead and goby present in the lagoon during these times would have found suitable conditions. If the lagoon had remained stratified during this prolonged closure, the extent of suitable habitat for steelhead would have been limited to the fresh surface water layer. Though this “freshening” of the lagoon could be perceived as positive, the sandbar remaining in place during times of adult and juvenile steelhead migration for multiple years in a row, as occurred between January 2013 and January 2017, most likely has a negative effect on the local steelhead population; however, prolonged closures likely benefit the tidewater goby and local nesting plover populations.

In addition to low dissolved oxygen in lagoon bottom waters and potential barriers to migration caused by the sandbar, chemical loads from non-point sources also pose additional stresses to lagoon and estuary species. In 2004, a report found concentrations of chlorpyrifos and diazinon (commonly used insecticides) above levels that are acutely toxic to aquatic organisms in the lagoon at Del Monte Road. Without the mixing and flushing of the lagoon, these chemicals can persist in plant material and in the sediment for a year or more (though the typical half-life of these chemicals is less) (Kozlowski et al. 2004).

Degraded water quality and sandbar management present different stresses to the special-status species in the lagoon. Roosting sea and shorebirds, like the brown pelican, are likely only temporarily disturbed by the construction equipment used to create the artificial channel. Western snowy plovers breed and nest between March 1 and September 30; artificial sandbar breaches during this time have potential to disturb nesting or injure or kill individuals (particularly nestlings). However, with the careful implementation of precautions and pre-construction measures by MCWRA (Monterey County Water Resources Agency 2018b, 2013) the threats related to sandbar management are considered reasonably low.

Sandbar management and degraded water quality are unlikely to stress dune species like the northern California legless lizard or Smith's blue butterfly. The sandbar, where management activities occur, is a wet, unvegetated strip that does not provide habitat for these two species. Degraded water quality is isolated to bottom waters, and the dune plant community, which is the habitat niche primarily occupied by most dune species, is only likely to experience exposure to the fresh, surface layer of water.

There is no evidence of California red-legged frog presence in the lagoon or surrounding wetlands areas. This is much more likely to be related to the lack of suitable habitat types than it is to sandbar management and degraded water quality. Relative to other Central Coast lagoon systems and the historical condition, Salinas River Lagoon has only a small extent of natural (undeveloped) upland habitat—where the necessary combination of aquatic and terrestrial habitat types to support California red-legged frog could occur—remaining. These patches of potentially suitable habitat are likely too small to support a population of California red-legged frog and are exposed too frequently to flood flows and increased salinity.

In addition to degraded water quality that may be exacerbated by sandbar management, steelhead populations are also likely threatened from the physical presence of the sandbar. The presence of a sandbar between late December and early May has potential to block riverine access for returning adults and oceanic access to out-migrating juveniles. Steelhead have a life cycle adapted to the variable environmental conditions and access to the upper watershed on the Central Coast but because the population has been so greatly reduced, the threat posed by sandbar presence, reduced river inflows, and the resulting degraded water quality could potentially be considerable. As of 2014, recent fish surveys have not found any rearing steelhead in the lagoon (Hagar Environmental Science 2015); however, summer surveys have been hampered by aquatic vegetation. Past surveys have found a total of five steelhead in the lagoon in May, August, and October of 2011, April 2012, and October 2013 (Hagar Environmental Science 2013).

The productivity of a lagoon can lead to increased growth rates and increased fish sizes compared to growth rates in upstream riverine habitats; increased size of juvenile steelhead at the time of ocean entry increases survivability (Bond 2006). Smith (pers. comm.) has found this to be true primarily of well-mixed, freshwater lagoons. The degradation of water quality in the lagoon likely limits productivity of the macro-invertebrate prey base and the extent of suitable rearing habitat (Smith

pers. comm.). In addition, sudden mixing of the water column caused by an artificial or natural sandbar event can create temporary, but lethal water quality events that can cause the mortality of organisms in the lagoon, including steelhead (Sloan 2006). Sudden drops in water surface elevation caused by the breach can also strand fish on previously flooded areas, especially where there are physical barriers that prohibit fish from escaping to the lagoon (Hagar Environmental Science 2010a, 2010b). It is not known what contribution toxic chemical exposure makes to the degradation of steelhead populations rearing in the lagoon, but the effects are likely exacerbated with the reduced frequency of mixing events (that can flush and dilute the lagoon) that occur as the result of decreased river inflows.

Tidewater gobies breed and rear on shallow, sandy habitat in Central and Southern California lagoons and estuaries but rely on backwater, low flow habitats to provide overwintering refuge habitat from high flow, riverine events that can sweep gobies out to the ocean where survivability is greatly decreased. Tidewater goby populations have historically persisted in coastal California systems by taking advantage of calm, warm summer lagoon habitats to fuel population explosions (mating pairs are capable of producing multiple, large broods a season) that create enough individuals to increase the potential for overwinter survivability. The presence of calm, backwater habitat that does not experience high flows is also very important for overwinter survival.

The lack of backwater lagoon habitat is likely the greatest factor that currently limits the persistence of tidewater gobies in the Salinas River Lagoon. Before their recent rediscovery in 2013 (Hagar Environmental Science 2005), tidewater gobies had been absent from the Salinas River Lagoon since 1951 (H. T. Harvey & Associates 2009). The recent increase in the frequency of sandbar presence, and the associated calm lagoon waters that provides, has potential to benefit tidewater goby during the breeding season. Tidewater gobies occupy shallow surface waters during calm conditions, so they are less likely to be threatened by hypoxic or anoxic water conditions; also, tidewater gobies have a high tolerance for low dissolved oxygen conditions.

While the presence of the sandbar may benefit breeding gobies in the summer, over the long-term, the opening of the sandbar during winter storm events may allow dispersing individuals from northerly systems to enter the lagoon (and recolonize if the existing population is extirpated). However, even during periods when the sandbar is present, tidewater gobies do have potential to enter the lagoon through the OSR. Also, thick mats of filamentous algae and rooted aquatic plants that occur in the summer and fall (when the sandbar is typically in place) may limit habitat availability for breeding tidewater gobies, and chemical toxicity may increase the potential for direct (acute toxicity) or indirect (e.g., reduced survivability) effects.

Sandbar management that occurs any time between late spring and early fall has potential to threaten the Salinas River Lagoon tidewater goby population. Breaching events during this time period can result in reduced recruitment due to the low tolerance of juvenile tidewater goby to drastic changes in salinity that may result from such an event. In addition, a reduction in surface water elevation could expose tidewater goby nests and injure or kill individuals. This disruption of the summer-time population "explosion" also likely reduces overwintering survivability by limiting the number of individuals produced during the breeding season.

3.5.3 Changes in Climate

Climate change will affect ecological communities and wildlife habitat throughout California (California Department of Fish and Wildlife 2015). Significant recent changes to California's environments as a result of climate change have been documented: sea level rise, prolonged

drought, natural community shifts, increased prevalence of invasive species, and increased duration and intensity of wildfires. Climate-induced stresses on wildlife, in combination with other known stresses and pressures, have the potential to affect wildlife species and habitat and must be considered when developing management strategies (California Department of Fish and Wildlife 2015). Sea level rise, prolonged drought, and the factors that contribute to drought—decreased rainfall, changes in storm intensity and frequency, and decreases in fog—are discussed in this section; Section 3.5.1, *Changes in Natural Communities*, discusses how invasive species and changes to the duration and intensity of wildfires as stresses other than climate change, such as development and land management, also influence those pressures.

Many global climate change models have been developed over the years to predict potential changes in ocean and land temperature, rain frequency and intensity, coastal wave exposure, and sea level rise (Regional Water Management Group 2013). The Scripps Institute of Oceanography has used a statistical technique called Localized Constructed Analogs (LOCA) to downscale these low-resolution global projections to high-resolution local projections (Pierce et al. 2016). The California Energy Commission Cal-Adapt website (http://cal-adapt.org/) provides access to projections from 10 of the 32 LOCA downscaled global climate models selected for performance in the California/Nevada region. The website allows users to view and download results of these 10 models for a specific area of interest under the two future greenhouse gas concentration scenarios, Representative Concentration Pathway (RCP) 4.5 and RCP 8.5, as well as a historical modeled scenario through the Cal-Adapt Application Programming Interface (API). Under scenario RCP 4.5, greenhouse gas emissions peak around 2040, after which they begin to decline. Under scenario RCP 8.5, emissions continue to rise strongly through 2050 and plateau around 2100.

Climate patterns can have a profound effect on survival and fecundity of various species, particularly for those whose physiology and behaviors are adapted to local environmental conditions (Ficke et al. 2007). These locally adapted traits may vary systematically among populations and include traits such as age, timing of reproduction, and heat and drought tolerance. These traits often have a significant plastic (non-genetic) component, which allows species to respond to environmental change. Yet these traits also differ genetically among populations (Carlson and Seamons 2008). The interaction of plastic and genetic based traits along with the environment has recently been termed *adaptive capacity* and represents the ability of species and biological communities to adapt to changing environmental conditions (Nicotra et al. 2015). However, rapid directional climate change could still drive many populations to decline in abundance, productivity, and even extirpation, if populations do not possess the necessary genetic and plastic trait diversity to adapt.

In many cases, directional climate change exacerbates existing anthropogenic threats. Examples include streams or rivers where stream temperatures are already elevated due to land-use modifications (Battin et al. 2007) or where flow is reduced due to water diversions (Walters et al. 2013). For example, in the Columbia River, dams have altered the hydrological regime by causing an earlier and smaller freshet, which is the same type of effect expected from climate change (Naik and Jay 2011a, 2011b). Any of these stressors in combination with one another or with climate impacts will present pressures of much greater concern than they would individually.

The California State Wildlife Action Plan (2015) identifies “Species of Greatest Conservation Need.” Vulnerability to climate change is an important criterion for identifying these species. The following listed species with potential to occur in the Salinas River system were identified as “climate vulnerable”: steelhead, tidewater goby, western snowy plover, California red-legged frog, and California legless lizard (California Department of Fish and Wildlife 2015).

Steelhead and other salmonids have been identified as optimal focal species for examining the effects of climate change because they are vital indicators of overall watershed health due to their use of entire river systems throughout their life cycle and the fact that they require clean, cool water year-round (Penrod et al. 2013). Steelhead can also be a key food resource for vertebrate predators and scavengers in some regions, and can have major effects on the productivity, phenology, and metapopulation dynamics of wildlife and regional biodiversity as a whole (Willson and Halupka 1995).

Climate change is expected to affect steelhead populations though a number of common mechanisms, including both direct and indirect effects. The direct effects of temperature and flow regime are expected to result in mortality from heat stress, as well as changes in growth and development rates, disease resistance, and behavior. Behavioral responses from these effects are thought to include shifts in seasonal timing of important life-history events (i.e., adult migration, spawning, fry emergence, and juvenile migration). In addition, movement patterns of juvenile steelhead between upstream tributary reaches and the estuary may also be disrupted by changes in seasonal base flows (Hayes et al. 2011, Boughton et al. 2009). Indirect effects from changes in the freshwater habitat structure and the invertebrate and vertebrate community are expected to result in changes to steelhead growth rates and movement behavior as well as mortality (Crozier et al. 2008).

The sections that follow relate the climate change projections to anticipated pressures within the study area.

3.5.3.1 Sea Level Rise

The most well-known and demonstrable effect of global climate change is the onset of accelerated sea level rise. The overall effect of this phenomenon varies by location depending on a multitude of factors, including the actual rate of sea level elevation rise, the local rates of land subsidence, and the local rates of tectonic uplift. To aid local jurisdictions in preparing and planning for sea level rise, the California Coastal Commission adopted Sea Level Rise Policy Guidance (California Coastal Commission 2015). In accordance with this document, the City of Monterey has adopted the National Research Council's worst case scenario projections for South of Cape Mendocino, 62.6 inches (5.2 feet) of sea level rise between 2010 and 2100, for coastal planning efforts (Revel Coastal 2016). Current tide levels and projected tide levels by 2100 (based on 5.2 feet of projected sea level rise adopted by the City of Monterey) are presented in Table 3-23.

Table 3-23. Current and Predicted Future Monterey Tidal Elevations

	Tidal Elevations (feet NAVD 88)	
Tide	**Current**	**With Sea Level Rise (by 2100)**
Mean High Water	4.78	9.98
Mean Tide Level	3.01	8.21
Mean Sea Level	2.97	8.17
Mean Low Water	1.23	6.43
Mean Lower Low Water	0.14	5.34

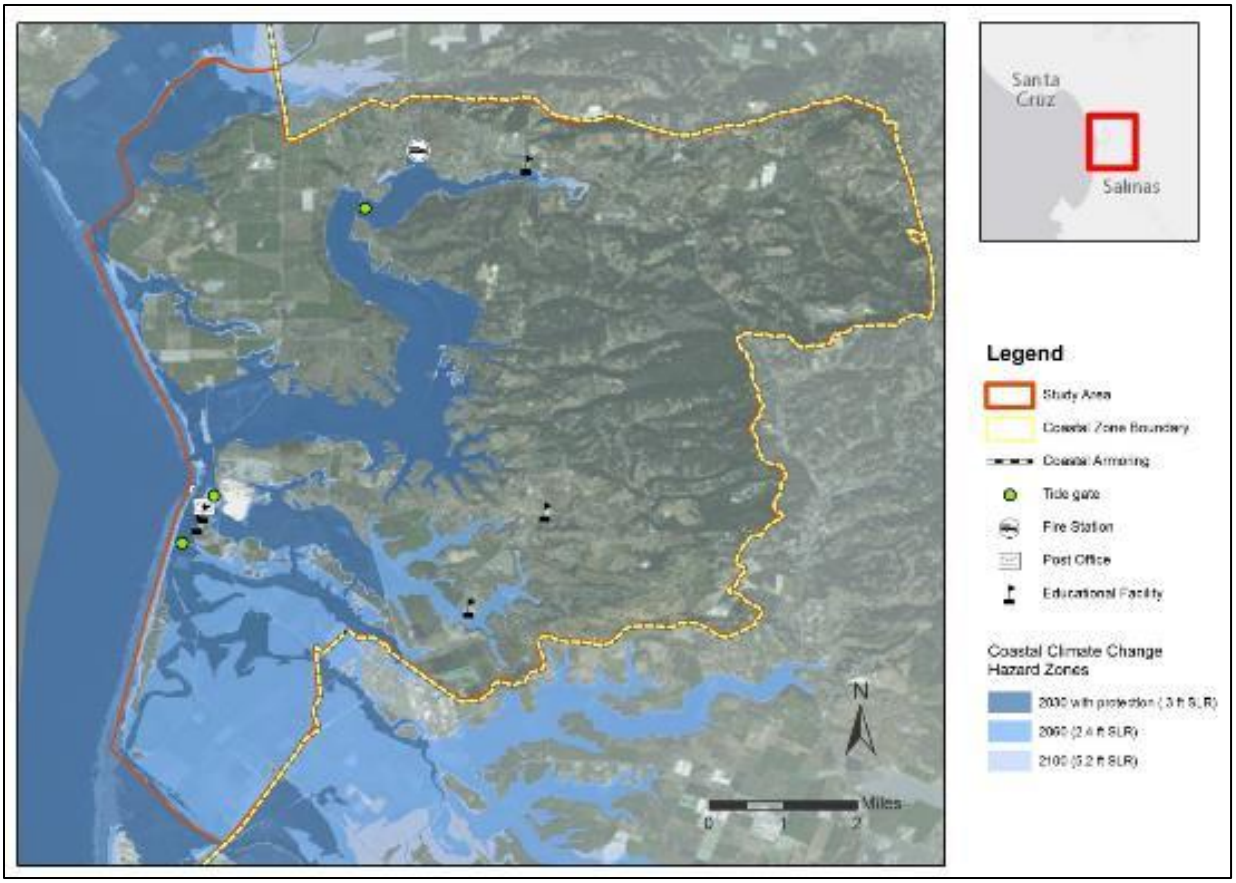
Source: National Oceanic and Atmospheric Administration Tides and Currents datums for station 9413450.

According to a recent assessment of Monterey Bay vulnerabilities to sea level rise, hazards resulting from projected increases in sea level include dune erosion, cliff erosion, coastal flooding, wave run-up, tidal inundation, and storm erosion (Environmental Science Associates and Pacific Watershed Associates 2014, Central Coast Wetlands Group 2017). Under natural conditions, the breaching dynamics of the Salinas River Lagoon are seasonally controlled by two opposing forces—ocean waves that build up the sandy beach, causing lagoon closure and filling during the summer/fall, and river flow that breaches the lagoon berm during the winter/spring allowing impounded water to flow into the ocean. As sea level continues to rise and sediment supplies remain consistent with existing conditions, a commensurate rise in beach berm elevation would be expected (Environmental Science Associates and Pacific Watershed Associates 2014). This means the maximum flood elevation in the closed lagoon would be expected to rise at the same rate as sea level, increasing flooding under natural conditions (Environmental Science Associates and Pacific Watershed Associates 2014). However, water surface elevations in the Salinas River Lagoon are managed by MCWRA to limit flooding of adjacent agricultural lands and homes once the lagoon water surface elevation reaches 6 feet NGVD 29 (8.7 feet NAVD 88)(Monterey County Water Resources Agency and Hagar Environmental Science 2015). Taking into account the sea level rise predictions, more material would need to be excavated from the sandbar to drain the lagoon and maintain the existing level of protection to adjacent lands.

Expected sea level rise may result in more frequent breaching of the sandbar at the mouth of the Salinas River, potentially increasing connectivity for steelhead between the Salinas River and the ocean (Rich and Keller 2011, Jacobs et al. 2010). Habitat conditions for tidewater goby in the lagoon may decline with sea level rise, as the lagoon becomes more brackish and breaches more frequent, two factors that are known to lead to unfavorable habitat conditions for tidewater goby (Hellmair et al. 2014). In addition, the brackish zone preferred by the tidewater goby has been modified in the Salinas River by human-created barriers (e.g., dikes and levees). As a result, the water in the lagoon tends to be saltier than it would be in the absence of these barriers because of reduced freshwater inflow, increased evaporation, opening of the barrier sandbar to the ocean, and saltwater intrusion. The net result is a narrowing of the low-salinity zone of the lagoon, which is expected to increase as ocean levels rise (Swift et al. 1989, Ferren et al. 1995). Information on the economic and social consequences of sea level rise is presented in Section R of the Greater Monterey Integrated Regional Water Management Plan (Regional Water Management Group 2013).

Projected impacts from coastal flooding (wave overtopping dunes and levees causing inland flooding) demonstrate the dire vulnerabilities that agricultural lands, Moss Landing's coastline, and the surrounding area face in the future (Figure 3-35). By 2100 several portions of the protective dunes complex are projected to no longer restrict ocean waves, leading to significant flooding within the lower Salinas Valley (Central Coast Wetlands Group 2017). The long-term preservation of the Salinas State Beach dunes complex and the effective restriction of storm surge inland of Potrero Road are critical to the future viability of the southern Moss Landing region. The potential for inward migration of these dunes is likely but will come in conflict with present land use of those properties.

The Central Coast Wetlands Group report (2017) notes that by 2060 erosion of the dunes near Potrero Road and near the Salinas River mouth are at risk of wave overtopping during storms, leading to ocean waves flowing into the OSR, bypassing the coastal flood protections provided by the tide gates and flood control structures at the lagoon.



Source: Central Coast Wetlands Group 2017.

Figure 3-35. Coastal Climate Change Hazards in the Coastal Zone

3.5.3.2 Prolonged Drought

According to DWR (2015), climate change is expected to lead to more frequent and extended droughts. Droughts would increase stress on water demand, which could impact both groundwater and surface water supplies (Monterey County Water Resources Agency 2014).

Increased frequency and severity of droughts are predicted over the next 30 to 90 years (Dai 2013) and will pose multiple challenges to terrestrial and aquatic biota. Increased frequency and intensity of wildfires has been documented during past Holocene warming periods (Pierce et al. 2004). Wildfires can have short-term and long-term effects on aquatic species. Short-term negative effects of wildfires include intense temperatures while burning through the riparian corridor, toxicity from flame retardants, and ash and debris sediment flows that reduced dissolved oxygen and cause acute ammonia toxicity. Long-term negative consequences from wildfires can include increased water temperatures from decreased stream shading, increased run-off and flash floods, and reduced woody debris inputs. Although the negative effects of wildfires vary due to proximity to wildfires and post-fire precipitation events, many western salmonid populations evolved physiology and behaviors mechanisms to tolerate wildfires. Habitat fragmentation appears to be a principle component in how salmonids respond demographically and genetically to intense wildfires (Neville et al. 2009). In Mediterranean climates, global warming is expected to increase the numbers of fires,

but their impacts on the landscape may be mitigated through fire and landscape management (Turco et al. 2014).

The physical effects of drought on aquatic species include reduced flows and increased water temperatures. In addition to reducing the number of days of migration flows, drought impacts may result in more frequent and prolonged closures of the Salinas River mouth (Rich and Keller 2011, Jacobs et al. 2010). Delayed or prolonged river closures have limited the upstream migration of adults and the downstream emigration of juveniles or adults salmonids; low flows may have also interrupted the natural periodic movement of sub-adults between the estuary and the ocean. Additionally, if smolts migrate at a smaller size because they leave freshwater habitat earlier, they might have lower ocean survival due to size-selective predation (Thompson and Beauchamp 2014). Marine arrival timing has been historically synchronized with the timing and predictability of favorable ocean conditions (Spence and Hall 2010). Extended droughts have, in part, been attributed to the Pacific Decadal Oscillation and Atlantic Decadal Oscillation, which has been a key factor of ocean survival for California salmonids (Lindley et al. 2009). Given the uncertain effects of climate change on upwelling timing and intensity, impacts on juvenile survival from shifts in migration timing are also difficult to predict.

Both freshwater and marine productivity tend to be lower in warmer years for most populations of steelhead. These trends suggest that the Salinas River watershed sub-population might decline as mean temperature rises. According to Boughton (2010), the Interior South-Central California Coast steelhead biogeographic population group will likely be more vulnerable to climatic changes as a result of increased ambient temperatures and less predictable rainfall patterns. However, the persistence of many southern populations is reason for optimism and warrants considerable effort to restore the natural climate resilience and adaptive capacity of these species. The South-Central California Coast Steelhead Recovery Plan recognizes the broad spatial extent of droughts and the inherent difficulty in predicting habitat response to climate changes. Therefore, it takes a precautionary role in protecting key biological parameters needed to ensure long-term resilience of the population through four key principles.

1. Expand opportunities for fish to exploit a wide variety of habitats.
2. Maximize connectivity within and between habitats.
3. Promote the evolutionary potential of populations and metapopulations by restoring natural diversity of habitat types that support a wide diversity of life history expressions.
4. Maintain the capacity to detect and respond sustainably to ecosystem changes as they occur.

3.5.3.3 Changes in Average Rainfall

On average, the climate model projections anticipate drier conditions in Southern California and wetter conditions in Northern California, but little change in total annual precipitation statewide (California Department of Water Resources 2015, California Energy Commission 2018). However, local changes in precipitation are more difficult to predict (Regional Water Management Group 2013). According to the California Energy Commission Cal-Adapt website, possible increases in mean annual precipitation ranging from 0.3 to 5 inches might be expected for the Greater Monterey County Integrated Regional Water Management Region by 2100 when considering the high emissions scenario (RCP 8.5) for three out of four models selected by California state agencies as "priority models for research contributing to California's Fourth Climate Change Assessment" (California Energy Commission 2018). The fourth model (MIROC5) predicts a decrease of

approximately 2 inches in mean annual precipitation by 2100. On an average basis, increases in mean precipitation would increase surface water and groundwater supplies. Decreases in mean precipitation would reduce surface water and groundwater supplies.

Numerous climate model projections point to increased frequency of extreme weather events as a result of increasing greenhouse gasses (Stenseth et al. 2003, Kelly and Gore 2008. Mantua et al. 1997). The extreme droughts punctuated by extreme wet years experienced in California during the last decade suggests weather patterns are already transitioning to a "new normal"; however, there is uncertainty in what the "new normal" is expected to look like. Under a low emissions scenario, climate models are predicting about 10% loss of precipitation for the state of California (Cayan et al. 2009, 2006). Yet, these models have shown sensitivity to underlying model assumptions suggesting that both outcomes of a drier or wetter future are possible. This is because California is geographically located in a transition zone between regions that are predicted to experience a net increase and regions that will experience a net loss of water availability (Hayhoe et al. 2004).

According to the U.S. Environmental Protection Agency (1997), it is anticipated that temperatures in California could increase by about 5°F (with a range of 2–9°F) in the winter and summer and slightly less in the spring and fall by 2100. The Salinas River is a precipitation-driven system and it is anticipated that overall precipitation may decrease (Model MIROC5). However, there could be an increase in the number of long wet spells, along with a corresponding increase in storm events and potential flooding. If a decrease in precipitation persists, these conditions are anticipated to truncate the period of time that suitable cool temperatures occur in the system below existing reservoirs and dams. Without the necessary cold-water pool, late summer and fall temperatures below reservoirs may rise above thermal tolerances for juvenile steelhead that rear below the dam over the summer and fall periods. In addition, the period of aquatic connectivity between various habitats in the watershed is expected to decrease because of reduced runoff and higher temperatures.

The combined effects of reduced connectivity and higher temperatures in the Salinas River would truncate the available migration window for both juveniles and adult steelhead, which will affect the timing of smolt migrations and spawning (Crozier and Hutchings 2014, Hayes et al. 2014). Below normal precipitation and reduced runoff would adversely affect aquatic habitats for steelhead in the following ways: (1) depleted groundwater tables, which provide base flows that support critical over-summering habitat for rearing *O. mykiss*; (2) reduced hydrological connectivity between seasonally wet and dry stream sections in intermittent streams; (3) restricted instream movement of rearing *O. mykiss*; and (4) reduced frequency and shorter duration of connectivity to the ocean, affecting water quality, and limiting both the upstream migration of adult *O. mykiss* and the downstream emigration of juveniles and kelts. Riparian habitat may also be adversely affected by the reduction in groundwater levels and the reduction of surface flows, affecting water temperatures and food availability.

3.5.3.4 Changes in Storm Intensity and Frequency

There is a general consensus among climate scientists that precipitation patterns (including the intensity and frequency of storms) will change, but there is less agreement regarding the nature of those changes (Regional Water Management Group 2013). According to DWR (2015), climate change can be expected to bring more extreme precipitation events to California with extended, more frequent droughts and more intense rainfall events. In the study area, the effect could be an increase in downstream flooding potential if the water resources infrastructure is unable to capture the increased flow resulting from the higher intensity rainfall events.

Broad-scale climatic factors, such as summer air temperatures, annual precipitation, and severity of winter storms influence the distribution of *O. mykiss* in the region (National Marine Fisheries Service 2013). The severity of winter storms dictates the severity of high flow events, which in turn influence the distribution and extent of instream steelhead habitat. Depending on changes in land-use practices and fire regime, increased storm severity has the potential to alter the geo-fluvial processes including scouring and deposition that maintain steelhead spawning and rearing habitat. The integrity and extent of riparian area will play a key role in moderating the effects of more frequent, intense storms. Unimpacted riparian areas can prevent scouring and erosive forces from degrading spawning substrate while producing large-woody debris that helps to form habitat complexity. Riparian and wetland areas can also act as a filter to prevent run-off from depositing large quantities of fine sediments into streams. This can be particularly important following a wildfire for preventing ash and debris-laden floods, which can cause fish kills (Dunham et al. 2003, Whitney et al. 2015).

Changes to the winter storm regime may also have an effect on species inhabiting the lagoon. Increasing storm severity could result in increased frequency of breaching the Salinas River Lagoon. However, precipitation events will be less predictable, thus flows to the lagoon could become less consistent and predictable. Depending on the timing of lagoon breaches and steelhead response to warming temperatures, there could be a mismatch between when salmon migrate to spawning habitat and connectedness of the lagoon to the bay. On the other hand, increased frequency of breaching could increase connectivity for migrating steelhead. In addition to the effects on connectedness, lagoon resident species will experience more frequent fluctuations in water quality parameters such as temperature and salinity as a result of increased breaching and increased surface run-off.

3.5.3.5 Change in Summer Fog

Research conducted by various universities and climate scientists suggests that periods of summertime fog along parts of the California coast have declined significantly over the past century, and climate change may be a contributing factor (Johnstone and Dawson 2010, Regional Water Management Group 2013). Coastal fog occurs primarily in the summer months and plays an important role in preventing evaporation and maintaining cooler temperatures (Regional Water Management Group 2013). Warmer temperatures with increased summer evaporation may lead to an increase in agricultural and landscape water use in the region, putting increased demand on both groundwater and surface water supplies (Regional Water Management Group 2013).

Regional climate projections for the South-Central California watersheds suggest a future of longer, hotter summers, with a potentially higher incidence of fog along the immediate coastline. These projections also suggest more extreme heat waves and droughts, but with perhaps more intense precipitation events in some areas (Karl et al. 2009, Cayan et al. 2008, Snyder and Sloan 2005). However, fog is expected to decrease in inland areas as a result of climate change, which may affect Salinas River watershed species in a variety of ways. Changes in fog frequency and related climate variables may have important implications for plant physiology and ecosystem function. A decrease in the frequency and persistence of fog increases transpiration rates (the rate at which water is lost from a plant), which reduces a plant's ability to conserve water.

The most likely effect of fog decline in inland areas is increased drought sensitivity for native plant species (Fischer et al. 2009). Fog is a dominant climatic factor on the California coastal region, and long-term reductions inland will likely continue to impact the physiology and growth of coastal

endemic species. Several kinds of coastal forest, shrub, and desert ecosystems are strongly associated with coastal marine fog. For example, maritime chaparral is a rare vegetation community in California that is dependent on fog (Vasey et al. 2012). In addition, coastal redwoods and 80% of their understory species—including swordferns, California bay, and Douglas-fir—have evolved to move water from coastal moisture directly into their tissues through leaf pores and surfaces using direct foliar uptake (Limm, et al. 2009). These vegetation communities, and the fauna that are associated with them, are expected to decline with the predicted decrease in fog in inland areas.

Chapter 4
Management Plan

This chapter begins by listing the foundational assumptions, or drivers, that underpin the *Salinas River Long-Term Management Plan* (LTMP) and which were developed though significant discussion and collaboration with stakeholders and the public. These drivers have helped guide the direction, scope, and development of the LTMP and have created the basis for its management objectives and associated actions, as identified in this chapter (Tables 4-1 and 4-2).

Comprising the management strategy, the LTMP's objectives and actions are the next step in the process of establishing comprehensive solutions to the complex water resource management challenges along the Salinas River. Accordingly, they were designed to be flexible and may be adapted over time. Management objectives and actions are identified for six categories: general (applying to all of the Salinas River), the Salinas River Lagoon, stream maintenance, water resource management (surface and ground water), habitat and connectivity, and South-Central California Coast steelhead (steelhead).

Developing these objectives and actions required considering the important constraints, limitations, key issues, and needs that determine what can and should be achieved—these planning considerations are described in detail and help illustrate the unique environmental, engineering, and economic circumstances of the Salinas River system.

4.1 Management Plan Drivers

LTMP development was directed by the program goals established at the start of the development process (Section 1.2, *Purpose and Goals*). The stakeholder engagement process was also a critical component of LTMP development. Discussions and issues raised at the planning group and working group meetings helped form management objectives and actions, illuminating planning considerations and overarching needs for river management. These discussions raised various issues that set foundational assumptions—or drivers—underpinning the LTMP, as listed below.

- The LTMP should propose an approach to protect species viability and habitat while supporting a strong economy and the people that make it so.
- LTMP success is contingent on the participation of those who own portions of the river; accordingly, it is critical that these individuals be involved in developing solutions.
- Compliance with state and federal laws and regulations requires certain needs to be met, including actions which support recovery of steelhead in the study area.
- Management actions (projects and activities) must not put other listed species at risk.
- The LTMP will focus on management of small to moderate flood flows.
- The LTMP will focus on management to provide multiple benefits.

- Future planning efforts will utilize and build on the information developed for the LTMP, ensuring alignment of all river planning efforts.
- Funding opportunities will be sought to update the LTMP in the future as management needs and priorities change.

It is important to consider these drivers when considering the recommended management actions below. These drivers also help inform LTMP implementation, discussed in Chapter 5, *Implementation Recommendations*.

4.2 Management Objectives and Actions

This section describes the process by which the LTMP management objectives and actions were developed, assigns definitions to terminology established to describe the management actions, and how the management objectives and actions are organized.

4.2.1 Approach

Several management focus areas were identified through the stakeholder engagement process: lagoon management, stream maintenance, integration with the groundwater sustainability planning, implementation, stormwater management, and special-status species conservation. Of these, working group meetings were held to discuss the first four focus areas, and draft lists of management objectives and actions. For the lagoon working group, the draft list integrated lagoon management measures developed during management planning efforts conducted in the 1990s if still applicable. Objectives and actions for stormwater management were included in the LTMP primarily through collaboration with Central Coast Wetlands Group, which is actively involved in stormwater planning efforts in the county (Section 2.4.2.6, *Greater Monterey County Integrated Regional Water Management Plan* and Section 2.4.2.7, *Greater Monterey County Storm Water Resources Plan*). The planning group reviewed these draft lists and recommended revisions.

While a working group meeting was not held for listed species, or for steelhead specifically, the planning group did recommend that objectives and actions be developed for targeted listed species that are likely to be affected by Salinas River management (Table 3-18). Listed species management objectives and actions were developed based primarily on recovery plans, if available, with additional input from existing permitting efforts, the objectives and actions developed for lagoon management, and from the LTMP consulting team.

In addition to the management actions identified through the stakeholder engagement process, a small number of data gaps were identified through the literature review process, described in Appendix G, *Data Collection and Data Gap Assessment*, and based on technical team recommendations. These data gaps (listed in Appendix G, Section G.2 *Data Gap Assessment*) were not explicitly discussed with the planning group and thus are not included in the recommended management actions. However, there may be value in considering these data gaps as potential management actions during LTMP implementation.

4.2.2 Definitions of Key Terms

The following terms and definitions are defined specific to the LTMP to help characterize the different types of management objectives and actions proposed. (A complete LTMP glossary is included in Appendix A.)

Management objective. Targets that will be sought to achieve a given goal. Objectives are typically quantitative or at least measurable. Objectives describe a specific desired outcome.

Management action. Tasks proposed to meet an associated objective. Actions describe how objectives can be achieved, and a single action can support multiple objectives. For the purposes of the LTMP, actions are divided into one of four subcategories: research and analysis, planning tasks, projects, and activities.

Research and Analyses. For the purposes of the LTMP, research and analyses constitute a type of management action that calls for new research or new analysis of existing data.

Planning tasks. For the purposes of the LTMP, planning tasks are a type of management action that call for additional planning efforts to identify projects or activities. Planning efforts generally result in development of a document that may require environmental analysis (CEQA) or regulatory permits prior to implementation.

Projects. For the purposes of the LTMP, projects are a type of management action that require substantial capital or construction. Examples of projects include construction or replacement of water management infrastructure, implementation of large-scale restoration, or land acquisition by willing parties.

Activities. For the purposes of the LTMP, activities are a type of management action that have some direct effect on one or more natural resource, but that do not rise to the level of being a project. Examples include field monitoring, moderate vegetation management, facility maintenance, and implementation of best management practices.

4.2.3 Organization

All management objectives and actions were compiled and organized into Table 4-1, *Salinas River LTMP Management Objectives and Actions*, and Table 4-2, *Salinas River LTMP Listed Species Objectives and Actions*. Management objectives and actions for steelhead are included in Table 4-1, as steelhead management is a key driver for the LTMP.

Table 4-1 is divided into categories roughly corresponding to the overarching LTMP goals. The categories are listed and briefly summarized below.

- **General.** This category includes those objectives and actions that apply across multiple management focus areas.
- **Lagoon management.** These objectives and actions apply primarily to lagoon management. Objectives and actions that were developed as part of the lagoon management working group discussions may be reassigned to other categories. This is primarily true of steelhead-related objectives and actions.
- **Stream maintenance.** These objectives and actions apply primarily to stream maintenance.

- **Water resource management.** These objectives and actions were developed as an outcome of the groundwater sustainability planning working group and subsequent planning group discussion. The category is titled to reflect language used in the LTMP goals.
- **Habitat and connectivity.** This category includes the objectives and actions focused most directly on improvements for habitat quality and connectivity, and these objectives and actions were compiled based on several working group and planning group meetings.
- **South-Central California Coast steelhead.** This category is focused on management objectives and actions specific to steelhead.

Objectives and actions were assigned to the category under which they primarily apply, although some apply to other categories as well. Within each category, objectives and actions are further organized into four subcategories: research and analysis, planning tasks, projects, and activities (definitions are in Section 4.2.2, *Definitions of Key Terms*). The implementation of research and analyses management actions is intended to resolve outstanding questions about river management. Because of their importance to inform future actions, these research and analysis actions should generally be prioritized in LTMP implementation.

Each management action in Table 4-1 is tied back to the LTMP goals in the column titled *LTMP Goals Addressed*. Shorthand abbreviations were developed to address all LTMP goals (Section 1.2, *Purpose and Goals*), or components of goals, with the exception of goals for documenting and describing the historical and existing condition in the Salinas River watershed, which are addressed by Chapter 3, *Historical and Existing Conditions*. The shorthand abbreviations, together with excerpted text from the goal, are provided below.

- FLOOD = "Identify long-term solutions for management of the Salinas River that include flood reduction…" and "Investigate the Salinas River Lagoon for the potential of reducing flooding…."
- SUPPLY = "Identify long-term solutions for management of the Salinas River that include… water resource management…."
- MAINT = "Identify long-term solutions for management of the Salinas River that include… stream maintenance…."
- HAB = "Identify long-term solutions for management of the Salinas River that include… habitat management for threatened and endangered species…" and "Investigate the Salinas River Lagoon for the potential of… improving habitat conditions."
- SPECIES = "Identify long-term solutions for management of the Salinas River that include… habitat management for threatened and endangered species…" and "Identify potential improvements to steelhead migration issues in the Salinas River…."
- SCCCS = "Identify potential improvements to steelhead migration issues in the Salinas River…."
- WQ = "Identify long-term solutions for management of the Salinas River that include… habitat management for threatened and endangered species…" "Investigate the Salinas River Lagoon for the potential of… improving habitat conditions," and "Identify potential improvements to steelhead migration issues in the Salinas River…."
- IMP = "Develop the framework for implementing the LTMP that meets a variety of multi-benefit management goals…," and "Inform development of a future MCWRA habitat conservation plan (HCP) and other planning documents"

- PARTNER = "Build upon and incorporate public/private partnerships, compatible with existing land, water rights and uses."

Finally, Table 4-1 includes a column titled *Responsible Party(ies)*. This column indicates one or more entities or organizations that are expected to be involved in implementation of the management action. If the responsible party is unknown, the cell is assigned a value of *TBD* to indicate that the responsible party will be identified during LTMP implementation.

Table 4-2 is organized by species. A column is not included for *LTMP Goals Addressed*, as all proposed species management objectives and actions meet the LTMP goal of, "[i]dentify long-term solutions for management of the Salinas River that include… habitat management for threatened and endangered species." Similarly, a column is not included for *Responsible Party(ies)* because it is expected that these management actions will primarily be implemented as part of a permitting process. These may also be implemented by a yet-to-be identified conservation-oriented organization. It is also important to note that while these management actions were developed primarily based on recovery plans, it is likely that they will be revised in the future as more specific needs for certain species are identified (i.e., through an adaptive management process).

4.2.4 Recommended Management Objectives and Actions

The recommended management actions in Table 4-1 and Table 4-2 are designed to form a collective approach to river management. It is a goal of the LTMP to, "[d]evelop the framework for implementing the LTMP that meets a variety of multi-benefit management goals…." As such, while a single objective or action may have a relatively limited scope, the intent for LTMP implementation is that suites of management actions be considered and implemented together to meet "a variety of multi-benefit management goals." For example, Lagoon management action A-LAG-3 calls for an evaluation of new engineered solutions for flood management, while A-LAG-11 calls for development of a sandbar management approach that is considerate of listed species habitat. Neither of these actions is proposed to take priority over the other, but rather be implemented in concert to consider multiple approaches to addressing multiple needs.

Similarly, it is important to acknowledge that most management actions will have implications for other actions or future management needs. For example, changes to the flow prescription in support of steelhead connectivity will affect, and have been affecting, management of riparian vegetation and sediment. Construction of new facilities to support flood management are likely to affect listed species and native vegetation communities. Management projects and activities that touch land or water will have potential effects requiring environmental review (CEQA or NEPA) and regulatory permits (Appendix H provides an overview of regulations and permitting requirements likely to be triggered by stream management actions).

Table 4-1. Salinas River LTMP Recommended Management Objectives and Actions[1]

Management Objectives	Management Actions	LTMP Goal(s) Addressed	Responsible Party(ies)
General			
Research and Analysis			
O-GEN-1. Conduct research and analyses to gain a better understanding of the details surrounding flood flow management.	A-GEN-1. Investigate the potential for flood flow attenuation through reservoir management and by retaining flood flows upstream of the Lagoon during storm events greater than a 5-year return interval. Investigation should consider establishment or enhancement of on- or off-channel groundwater percolation zones for percolation of floodwater into the groundwater basin, and the reintroduction of floodplains along the length of the river. For off-channel sites, investigation should also consider the potential adverse effects of retaining surface flows, such as introduction of weed seed to new sites, degradation or loss of topsoil, restrictions on producing food crops following flooding, and changing the chemistry of flooded soils.	FLOOD	MCWRA; others (TNC did previous work)
	A-GEN-2. Conduct a study to better understand the relationship between retention of sand in the reservoirs and replenishment of the sand dunes at the mouth of the Salinas River. Based on the results of the study, consider adaptive management approaches to reduce the adverse effects of reduced sediment in the Salinas River system.	HAB	TBD
Planning Tasks			
O-GEN-2. Establish a geographic planning framework within which river management planning and implementation will be organized, including—but not limited to—groundwater management, stream maintenance, control of nonnative species, and conservation actions.	A-GEN-3. Expand the geographic extent of the RMU designations (developed for the Salinas River Stream Maintenance Program) to provide a planning framework for the entire management area. RMU designations will reflect the different management and/or conservation considerations of given reaches throughout the Salinas River watershed.	All	MCWRA

Management Objectives	Management Actions	LTMP Goal(s) Addressed	Responsible Party(ies)
O-GEN-3. Ensure the LTMP is a driver in the development of future programs and projects (e.g., HCP, GSPs).	A-GEN-4. Participate in stakeholder processes or programs that will have an effect on, or be affected by, the management of the Salinas River and ensure that the management objectives and actions of the LTMP are considered.	PARTNER; IMP	TBD
O-GEN-4. Develop a floodwater management program focused on reducing erosion and reducing flooding frequency, extent, and duration.	A-GEN-5. Inform development of the floodwater management program using the results of research conducted under A-GEN-1 and O-LAG-1.	FLOOD; MAINT	MCWRA; others
	A-GEN-6. Develop guidance on managing debris, both natural (e.g., fallen trees) and human-made (e.g., shopping carts, telephone poles, tires), to enhance in-channel habitat conditions and improve flow capacity.	FLOOD; MAINT; HAB; WQ	MCWRA; others
	A-GEN-7. Develop a suite of voluntary bioengineered bank stabilization designs and accompanying guidance on the appropriate use of each design that considers site conditions and constraints. Guidance will include information as to whether hydraulic analysis is necessary for each design. Designs will be applicable to a range of conditions encountered within the management area.	FLOOD; MAINT; HAB; WQ	MCWRA; others
O-GEN-5. Develop programs to support implementation of the Lagoon floodwater management program.	A-GEN-8. Investigate the potential for establishing flood easements (payment to landowners in exchange for the ability to flood lands under certain conditions) or land exchanges on targeted agricultural lands. Assess the implications of flooding agricultural lands including issues related to food safety standards.	FLOOD; IMP; PARTNER	TBD
	A-GEN-9. Based on analyses identifying areas most vulnerable to flooding, conduct outreach to landowners to investigate willingness of landowners to sell, rent, or swap lands for short-term flooding or restoration.	FLOOD; HAB; IMP; PARTNER	TBD

Management Objectives	Management Actions	LTMP Goal(s) Addressed	Responsible Party(ies)
O-GEN-6. Develop a recreation management plan.	A-GEN-10. Develop a public use and access plan on public properties, including measures to avoid and minimize potential effects on sensitive habitats and wildlife. (Source: Adapted from Salinas River Lagoon MEP, adapted from Measure 13 and 24.) Consider restrictions on motorized boats on the Lagoon.	HAB; SPECIES; PARTNER	TBD
Projects			
[None identified]			
Activities			
O-GEN-7. Implement the recreation management plan.	A-GEN-11. Better manage public recreational use, and illegal trespass, to avoid impacting wildlife.	HAB; SPECIES; PARTNER	USFWS; State Parks; others
Lagoon Management			
Research and Analysis			
O-LAG-1. Conduct research and analyses to better define and evaluate the trade-offs of Lagoon management options.	A-LAG-1. Conduct an assessment of different Lagoon management elevations drawing from available data sources that consider the implications for natural resources and surrounding agriculture. Based on the assessment, establish a Lagoon elevation management approach.	FLOOD; HAB	CCWG
	A-LAG-2. Evaluate the condition of current infrastructure, including if it is in good operating condition and if the infrastructure is providing the service for which is was designed. Consider infrastructure adjustments that could help better manage water levels or salinity in the Lagoon and OSR, and allow fish passage. (Source: Partially adapted from Salinas River Lagoon MEP, Measure 26.)	FLOOD; MAINT; HAB; SPECIES; WQ	MCWRA; CCWG
	A-LAG-3. Explore the viability of new engineered solutions for flood management (e.g., levees, deeper/wider OSR, secondary channel along the OSR). Include an assessment of existing infrastructure affected by flooding (e.g., Twin Bridges).	FLOOD	MCWRA; CCWG

Management Objectives	Management Actions	LTMP Goal(s) Addressed	Responsible Party(ies)
	A-LAG-4. Evaluate the effects of downstream flooding related to impermeable surface run-off, including plastic tarps used for agricultural purposes. Consider relative contribution of different runoff sources and the associated effects of higher peak flows and velocities. Identify approaches to reduce the effects of increased surface runoff.	FLOOD; WQ	CCWG
	A-LAG-5. Conduct a comprehensive study of Lagoon and OSR bathymetry and changes to the bathymetry over the period of the study to better understand how the sediment levels of the Lagoon and OSR shift over time. Identify if there are opportunities to increase the capacity of the Lagoon and OSR. Assess how much capacity could be gained from dredging (deepening) or widening the OSR. Compare with survey data for water quality and target species to understand better how Lagoon bathymetry affects water quality and how species use the Lagoon.	FLOOD; MAINT; HAB; SPECIES;	MCWRA; CCWG; others
	A-LAG-6. Review the water quality monitoring programs currently being implemented by MCWRA and other agencies, and consider if changes are needed. Adapt, as needed, the current monitoring plan to include an assessment of how water quality in the Lagoon changes over the course of a breaching event (before, during, and after). Continue monitoring water quality in the Lagoon based on the most current monitoring plan.	HAB; WQ	MCWRA; CCWG; others
	A-LAG-7. Identify areas most vulnerable to flooding based on current conditions and under various sea level rise scenarios.	FLOOD	In process by CCWG
	A-LAG-8. Conduct an assessment of inflows to the OSR from both the Lagoon and Tembladero Slough to better understand where flooding occurs under different scenarios.	FLOOD	In process by CCWG

Management Objectives	Management Actions	LTMP Goal(s) Addressed	Responsible Party(ies)
	A-LAG-9. Conduct an assessment of inter-annual variability in Lagoon conditions, including changes in water quality and bathometry.	FLOOD; HAB	MCWRA; CCWG; others
O-LAG-2. Investigate and identify locations for potential restoration projects that would achieve a diversity of habitat types while also supporting management of flood flows.	A-LAG-10. Investigate potential wetland restoration for flood attenuation in the Lagoon.	FLOOD; HAB; SPECIES	CCWG; others
Planning Tasks			
O-LAG-3. Develop a feasible and implementable (i.e., can be permitted by regulatory agencies) floodwater management program for the Lagoon that reduces flooding while allowing MCWRA to meet all of its jurisdictional and regulatory obligations.	A-LAG-11. Develop a sandbar management approach that provides clear guidelines and triggers for implementing a breach that is considerate of listed species habitat needs. Include the potential to conduct periodic breaches at times that are most favorable to natural resources including sediment flushing, water quality, and species migration. Evaluate the most favorable conditions under which breaching could occur.	FLOOD; SPECIES; PARTNER	MCWRA; USFWS; State Parks; NMFS; CCWG; others
O-LAG-4. Develop programs to support implementation of the Lagoon floodwater management program.	A-LAG-12. Investigate the potential for establishing flood easements (payment to landowners in exchange for the ability to flood lands under certain conditions) or land exchanges on targeted agricultural lands. Assess the implications of flooding agricultural lands including issues related to food safety standards.	FLOOD; MAINT; IMP; PARTNER	CCWG; others
	A-LAG-13. Based on analyses identifying areas most vulnerable to flooding, conduct outreach to landowners to investigate willingness of landowners to sell, rent, or swap lands for the purpose of restoration.	FLOOD; HAB; IMP; PARTNER	CCWG; others
O-LAG-5. Identify approaches to reduce pollutant sources.	A-LAG-14. Based on the results of analyses conducted under A-LAG-6, identify best management practices that could help better manage pollutants in the Lagoon.	HAB; SPECIES; WQ	CCWG; others
O-LAG-6. Establish a process for coordination among stakeholders.	A-LAG-15. Engage property owners regarding necessary permitted improvements. (Source: Salinas River Lagoon MEP, Measure 25.)	FLOOD; IMP; PARTNER	TBD

Management Objectives	Management Actions	LTMP Goal(s) Addressed	Responsible Party(ies)
	A-LAG-16. Consider the establishment of a Salinas River Lagoon management committee. (Source: Salinas River Lagoon MEP, adapted from Measure 27.)	IMP; PARTNER	TBD
	A-LAG-17. Encourage participation in the Water Quality Protection Program, which is run by the Monterey Bay National Marine Sanctuary. (Source: Salinas River Lagoon MEP, Measure 23.)	WQ; IMP; PARTNER	MCWRA (currently participating); others
Projects			
O-LAG-7. Implement restoration projects in the Lagoon to achieve a diversity of habitat types while also supporting management of flood flows.	A-LAG-18. Establish marsh plain and backwater refugia habitat for steelhead and tidewater goby that provide foraging habitat for juvenile steelhead and freshwater refugia habitat for tidewater goby.	FLOOD; HAB; SPECIES	USFWS; State Parks; CCWG; others
Activities			
O-LAG-8. Manage the Lagoon to provide suitable habitat for multiple species, including tidewater goby and rearing steelhead.	A-LAG-19. Establish baseline salinity levels in the OSR and enhance freshwater fisheries habitat in the Lagoon. (Source: adapted Salinas River Lagoon MEP, Measure 19.)	HAB; SPECIES	MCWRA; CCWG; ESNERR
O-LAG-9. Improve aquatic and upland habitat in and surrounding the Lagoon.	A-LAG-20. Enhance riparian habitat around the Lagoon, including by the Highway 1 bridge. (Source: Salinas River Lagoon MEP, Measures 5 and 6 combined.) Consider ways to encourage floodwaters to inundate areas of marsh habitat in the Lagoon that historically flooded, and if there are physical impediments to flooding of marshland.	HAB; SPECIES	TBD
	A-LAG-21. Enhance fore dunes and dune scrub to improve ecosystem function.	HAB; SPECIES	CCWG; State Parks; USFWS; others
O-LAG-10. Manage USFWS National Wildlife Refuge to support sensitive habitats and wildlife.	A-LAG-22. Implement habitat enhancement on a portion of the USFWS refuge. (Source: Salinas River Lagoon MEP, Measure 10.)	HAB; SPECIES	USFWS
	A-LAG-23. Manage hunting activity within sensitive areas on USFWS property. (Source: Salinas River Lagoon MEP, Measure 11.)	HAB	USFWS

Management Objectives	Management Actions	LTMP Goal(s) Addressed	Responsible Party(ies)
	A-LAG-24. Maintain the quality of Smith's Blue Butterfly habitat on public property. (Source: Salinas River Lagoon MEP, Measure 12.)	HAB	USFWS
	A-LAG-25. Manage the pond on the USFWS refuge to maintain wildlife habitat. (Source: Salinas River Lagoon MEP, Measure 14.)	HAB	USFWS
Stream Maintenance			
Research and Analysis			
O-MAINT-1. Conduct research and analyses to gain a better understanding of issues related to stream maintenance.	A-MAINT-1. Conduct additional research into the historic ecology of the Salinas River to inform what is the "natural" state of the river, particularly after removal of extensive stands of invasive vegetation, including how sandbars shift during high flows. Use the results of the research to inform adaptive management under the vegetation management program.	FLOOD; SUPPLY; MAINT; HAB; SPECIES	TBD[2]
Planning Tasks			
O-MAINT-2. Establish an equitable funding mechanism for implementing stream maintenance activities that allocates cost of maintenance and associated mitigation across all beneficiaries.	A-MAINT-2. Collaborate with programs with funding mechanisms (e.g., the Salinas Valley Basin GSA in development of the Salinas Valley Basin GSP) to consider stream maintenance needs and, where appropriate, incorporate stream maintenance objectives and actions.	SUPPLY; MAINT; PARTNER	TBD
O-MAINT-3. Develop a practical and implementable (i.e., able to be permitted by the regulatory agencies) vegetation management program for the entire Salinas River main stem and select tributaries within the LTMP management area.	A-MAINT-3. Work with the regulatory agencies to confirm information required to develop a vegetation management program that meets regulatory requirements. Once confirmed, identify funding opportunities to develop identified information.	FLOOD; SUPPLY; MAINT; HAB; PARTNER	MCWRA; RMU Association; RCDMC; regulators

Management Objectives	Management Actions	LTMP Goal(s) Addressed	Responsible Party(ies)
	A-MAINT-4. Conduct a site visit with members of each regulatory agency, discussing the key vegetation management needs, identifying differences between each RMU, and how the river is a dynamic system, with changing vegetation characteristics reflecting the amount of water in the basin (either as a result of reservoir operation or by water year type).	PARTNER	MCWRA; RMU Association; RCDMC; regulators
	A-MAINT-5. Collaborate with organizations and agencies conducting vegetation management throughout the Salinas River watershed (including in San Luis Obispo County) on a cohesive approach to vegetation management, focused on invasive plant management.	FLOOD; SUPPLY; MAINT; HAB; PARTNER	MCWRA; RMU Association; RCDMC; Las Tablas RCD
	A-MAINT-6. Compile and organize information on vegetation management into a program document. Include an analysis of how the vegetation management program will affect regulated natural resources and water quality.	FLOOD; SUPPLY; MAINT; HAB; SPECIES; PARTNER	MCWRA; RMU Association; RCDMC
	A-MAINT-7. Develop a mitigation strategy that minimizes the short-term adverse impacts of a management action and takes into account the long-term benefits of those actions on regulated resources, ecological processes, and flood risk reduction. Continue the current option of coordinated mitigation led by one or more agencies on behalf of multiple landowners.	FLOOD; SUPPLY; MAINT; HAB; PARTNER	MCWRA; RMU Association; RCDMC; regulators
	A-MAINT-8. Use the information learned regarding the "natural" state of the Salinas River (A-MAINT-1) to inform adaptive management for the vegetation management program.	FLOOD; SUPPLY; MAINT; HAB; PARTNER	MCWRA; RMU Association; RCDMC; regulators
	A-MAINT-9. Conduct outreach to landowners along the Salinas River mainstem and select tributaries to educate them on the benefits of the vegetation management program and increase participation.	FLOOD; SUPPLY; MAINT; HAB; PARTNER; IMP	MCWRA; RMU Association; RCDMC

Management Objectives	Management Actions	LTMP Goal(s) Addressed	Responsible Party(ies)
	A-MAINT-10. Develop and make available of a suite of best management practices that would help avoid and minimize impacts on sensitive resources, and in some cases, provide guidance on appropriate mitigation.	FLOOD; SUPPLY; MAINT; HAB	MCWRA; RMU Association; RCDMC
	A-MAINT-11. Incorporate results of Long-Term Effectiveness Assessment of current stream maintenance activities when available.	FLOOD; SUPPLY; MAINT; HAB; IMP	MCWRA
O-MAINT-4. Develop a practical and implementable (i.e., able to be permitted by the regulatory agencies) invasive species (plant and animal) management program for the entire Salinas River main stem and select tributaries within the LTMP management area.	A-MAINT-12. Conduct a comprehensive assessment of the current status of invasive species.	FLOOD; SUPPLY; MAINT; HAB; SPECIES	TBD
	A-MAINT-13. Coordinate with land management agencies and private landowners in the study area in development of the invasive species management program to guide consistency with existing programs and approaches.	FLOOD; SUPPLY; MAINT; HAB; SPECIES; PARTNER	TBD
Projects or Activities			
[None identified]			
Water Resource Management			
Research and Analysis			
O-WAT-1. Conduct analyses to gain a better understanding of how flows travel through the Salinas River basin (i.e., the interaction of surface and groundwater).	A-WAT-1. Model different scenarios for re-operating (flow management) the river and reservoirs to evaluate how a more natural flow regime can be established, and the associated costs and benefits. Consider interactions of groundwater and surface water. Include scenarios that evaluate flow regimes under different vegetation and sediment management regimes.	SUPPLY; MAINT; HAB; SPECIES	MCWRA; GSAs; NMFS

Management Objectives	Management Actions	LTMP Goal(s) Addressed	Responsible Party(ies)
	A-WAT-2. Identify the required flows and the right time of year for salmonids at key points in the system that, if met, will provide sufficient passage flows for steelhead during wet, normal, dry, and consecutive dry years.	SPECIES	MCWRA; NMFS
Planning Tasks			
O-WAT-2. Operate the Salinas River and reservoirs in the study area to achieve a balance between environmental and economic needs, while ensuring regulatory requirements for fish and water rights are met.	A-WAT-3. Identify potential activities, the implementation of which could help achieve a balanced approach to river management.	SUPPLY; MAINT; HAB; SPECIES	MCWRA
	A-WAT-4. Develop a portfolio of projects, where the purpose and need, complete cost (e.g., design, permitting, construction, mitigation, operation), and benefits are clearly described such that one or more projects can be put on the ballot for voter approval as required by Proposition 218. Cost and benefit analysis must, at a minimum, be quantitative.	SUPPLY; MAINT; HAB; SPECIES; IMP	MCWRA; GSAs; others
	A-WAT-5. Identify funding sources—in addition to voter-approved funding—for GSP projects that have multiple benefits including, but not limited to, Proposition 68 (approved in June 2018), the California State Revolving Fund, and California Department of Water Resources.	SUPPLY; MAINT; HAB; SPECIES; IMP	GSAs
O-WAT-3. Achieve sustainable groundwater management as defined by SGMA in the Salinas Valley Basin.	A-WAT-6. Use the GSPs as a mechanism for meeting some, if not all, water management needs in a manner that is financially equitable.	SUPPLY; MAINT; HAB; SPECIES; IMP	GSAs
	A-WAT-7. Projects developed under the GSPs should utilize information provided in the LTMP to inform and guide the goals and parameters of the project.	SUPPLY; MAINT; HAB; SPECIES	GSAs
	A-WAT-8. Develop the GSPs based on best available data to be consistent and compatible with a future potential HCP. Identify projects in the GSPs that could become covered activities under an HCP.	SUPPLY; MAINT; HAB; SPECIES	GSAs

Management Objectives	Management Actions	LTMP Goal(s) Addressed	Responsible Party(ies)
Projects or Activities			
[None identified]			
Ecosystem Health and Habitat Connectivity			
Research and Analyses			
O-HAB-1. Conduct research to gain a better understanding of various ecosystem health issues in the Salinas River watershed.	A-HAB-1. Assess the potential benefits of releasing managed pulse flows from the reservoirs to support stream channel and stream bank habitat restoration, and to push sediment through the Lagoon to the dunes and into the bay.	HAB	MCWRA
	A-HAB-2. Evaluate the potential to reintroduce native freshwater species. (Source: adapted from Salinas River Lagoon MEP, Measure 20.)	HAB	TBD
	A-HAB-3. Conduct research on the life history of naturalized populations of nonnative species such as striped bass to identify approaches to eliminate, reduce, or control nonnative and/or invasive species.	HAB; SPECIES	TBD
	A-HAB-4. Survey and monitor the distribution and abundance of nonnative species plants and animals that degrade natural habitats or compete with native species, and reduce and/or control such nonnative invasive species.	HAB; SPECIES	CCWG
	A-HAB-5. Utilize current technology to conduct a complete wetland and stream inventory, including an assessment of overall health and condition of these resources, in the study area.		CCWG
Planning Tasks			
O-HAB-2. Develop programs to support habitat conservation.	A-HAB-6. Develop a public education program addressing watershed health issues including, but not limited to, species habitat, pollutant reduction, and responsible recreation.	HAB	CSUMB; CCWG
	A-HAB-7. Consider aquatic and terrestrial habitat connectivity when identifying potential restoration sites.	HAB; SPECIES	All

Management Objectives	Management Actions	LTMP Goal(s) Addressed	Responsible Party(ies)
	A-HAB-8. Develop a plan for watershed-scale restoration with the intent of minimizing loss of, and restoring where feasible, riparian habitats.		CCWG
Projects			
[None identified]			
Activities			
O-HAB-3. Protect and restore sensitive habitats.	A-HAB-9. Work with landowners to minimize loss of channel and riparian areas.	FLOOD; HAB	TBD
	A-HAB-10. Implement a public education program addressing watershed health issues including, but not limited to, species habitat, pollutant reduction, and responsible recreation.	HAB	TBD
South-Central California Coast Steelhead			
Research and Analysis			
O-SCCCS-1. Conduct or support necessary research to monitor the population on the Salinas River and its tributaries, and to develop a better understanding of the habitat requirements and population responses of the species related to management actions.	A-SCCCS-1. Support implementation of the California Coastal Salmonid Population Monitoring Plan on the Salinas River and its tributaries.	SPECIES	TBD
O-SCCCS-2. Conduct or support necessary research to evaluate existing or potential habitat connectivity for steelhead during all life stages.	A-SCCCS-2. Evaluate alternative steelhead migration corridors, including through the OSR, when the sandbar is closed.	SPECIES	MCWRA; CCWG; others
	A-SCCCS-3. Determine if there are water quality barriers to fish migration (i.e., reaches where there may be flow connectivity, but where water quality conditions would deter fish from passing).	SPECIES	MCWRA; CCWG; others
Planning Tasks			
O-SCCCS-3. Stabilize and increase abundance of steelhead to viable population levels, including the expression of all life-history forms and strategies and maintenance of current distribution in the watershed.	A-SCCCS-4. Collaborate with U.S. Forest Service and CalFire to ensure that fire-suppression and post-fire suppression activities are conducted in a manner which is protective of steelhead and steelhead habitats.	SPECIES; PARTNER	TBD

Management Objectives	Management Actions	LTMP Goal(s) Addressed	Responsible Party(ies)
	A-SCCCS-5. Collaborate with local, state, and federal agencies on local flood control and management programs to ensure projects and activities that affect steelhead incorporate appropriate steelhead habitat protection and restoration provisions.	SPECIES; PARTNER	TBD
Projects			
O-SCCCS-4. Protect lands for steelhead conservation and recovery.	A-SCCCS-6. Collaborate with local, state, and federal agencies, as well as non-governmental organizations, in the acquisition (fee-title or easement) of lands or long-term management agreements to protect steelhead migratory, spawning, and rearing habitats.	SPECIES; PARTNER	TBD
O-SCCCS-5. Restore suitable habitat conditions and characteristics for all life-history stages, thereby preserving the diversity of life-history stages that allow for adaptation to a highly variable environment.	A-SCCCS-7. Assess the condition of and restore estuarine habitats through the control of fill, waste discharges, and establishment of buffers.	SPECIES	MCWRA; others
O-SCCCS-6. Restore the species to historically occupied areas.	A-SCCCS-8. Based on the result of habitat connectivity studies (O-SCCCS-2), physically modify fish passage impediments, including concrete road crossing and diversion structure, to allow steelhead natural rates of migration to upstream spawning and rearing habitat, and passage of smolts and kelts downstream to the estuary and ocean. Focus passage improvements on the Arroyo Seco and the Salinas mainstem downstream of the Arroyo Seco.	SPECIES	MCWRA; others
Activities			
O-SCCCS-7. Maintain flows and habitat conditions, taking into consideration the timing of steelhead migration, in the Salinas River sufficient to maintain connectivity for steelhead between the Lagoon and areas in the upper watershed suitable for spawning.	A-SCCCS-9. Reduce the need for artificial breaching by minimizing Lagoon level fluctuation through prolonged low-volume discharge through the OSR. (Source: Salinas River Lagoon MEP, Measure 4.)	SPECIES	MCWRA

Management Objectives	Management Actions	LTMP Goal(s) Addressed	Responsible Party(ies)
	A-SCCCS-10. Evaluate the existing reservoir flow prescription and propose changes when monitoring and adaptive management indicate that desired results are not being achieved.	SPECIES	MCWRA; NMFS
	A-SCCCS-11. Manage instream mining to minimize impacts to migration, spawning, and rearing habitat, and protect spawning and rearing habitat in major tributaries, including the Arroyo Seco. Identify, protect, and where necessary, restore estuarine rearing habitats, include management of artificial breaching of the sandbar at the river's mouth.	SPECIES	TBD
	A-SCCCS-12. Enhance protection of natural in-channel and riparian habitats, including appropriate management of flood-control activities, off-road vehicle use, and in-river sand and gravel mining practices.	SPECIES	TBD
	A-SCCCS-13. Collaborate with riparian landowners to minimize and manage withdrawals from wells in the riparian zone.	SPECIES	TBD
O-SCCCS-8. Maintain suitable habitat conditions and characteristics for all life-history strategies, thereby preserving the diversity of life-history strategies that allow for adaptation to a highly variable environment.	A-SCCCS-14. Reduce water pollutants such as fine sediments, pesticides, herbicides, and other non-point source waste discharges.	SPECIES	TBD

Management Objectives	Management Actions	LTMP Goal(s) Addressed	Responsible Party(ies)

[1] Abbreviations

LTMP Goals

FLOOD = flood management
HAB = improved habitat conditions
IMP = implementation (framework and approaches)
MAINT = stream maintenance
PARTNER = public/private partnerships
SCCCS = steelhead conservation (including migration)
SPECIES = listed species
SUPPLY = water resource management (surface water and groundwater management)
WQ = water quality

Other

CalFire = California Department of Forestry and Fire Protection
CCWG = Central Coast Wetlands Group
CSUMB = California State University, Monterey Bay
ESNERR = Elkhorn Slough National Estuarine Research Reserve
GSA = groundwater sustainability agency
GSP = groundwater sustainability plan
HCP = habitat conservation plan
Lagoon = Salinas River Lagoon
MCWRA = Monterey County Water Resources Agency
MEP = Management and Enhancement Plan
NMFS = National Marine Fisheries Service
OSR = Old Salinas River
RCDMC = Resource Conservation District of Monterey County
RMU = River Management Unit
RMU Association = Salinas River Stream Maintenance Program River Management Unit Association
SFEI = San Francisco Estuary Institute
State Parks = California Department of State Parks
TBD = to be determined during implementation
TNC = The Nature Conservancy
USFWS = U.S. Fish and Wildlife Service

[2] SFEI developed the report *Historical Ecology Reconnaissance for the Lower Salinas River*, addressing the portion of the Salinas River from the confluence with Arroyo Seco to the Monterey Bay. With funding, SFEI has expressed interest in expanding this analysis.

Table 4-2. Salinas River LTMP Listed Species Objectives and Actions

Listed Species Objectives	Listed Species Actions	Action Type			
		Research	Planning	Project	Activity
Tidewater Goby					
O-TIGO-1. Protect and enhance currently occupied tidewater goby habitat.	A-TIGO-1. Assess and monitor the current status of extant tidewater goby populations and their habitats.	X			
	A-TIGO-2. Develop and implement water facility management (surface and groundwater) strategies to minimize habitat degradation and, if feasible, to enhance habitat.		X		X
	A-TIGO-3. Develop and implement strategies to breach the Lagoon in ways that optimize habitat for tidewater goby, or at least minimize adverse effects.		X		X
	A-TIGO-4. Develop and implement strategies for managing water quality within current or improved parameters for tidewater goby.		X		X
	A-TIGO-5. Develop and implement strategies to manage deleterious exotic fish at current or reduced levels.		X		X
California Red-Legged Frog					
O-CRLF-1. Confirm extant populations of California red-legged frog and identify areas for potential population expansion.	A-CRLF-1. Assess the locations of known occurrences of California red-legged frog and evaluate suitable habitat near occupied areas.	X			
	A-CRLF-2. Conduct surveys at sites with previously known occurrences of California red-legged frog and in other areas supporting suitable habitat to confirm extant populations of California red-legged frog.	X			
O-CRLF-2. Protect existing populations, suitable habitat, and habitat connectivity.	A-CRLF-3. Acquire lands in fee title or conservation easements from willing sellers or develop and fund long-term management agreements with willing landowners where these actions may protect existing populations.			X	

Listed Species Objectives	Listed Species Actions	Action Type			
		Research	Planning	Project	Activity
	A-CRLF-4. Acquire lands in fee title or conservation easements from willing sellers or develop and fund long-term management agreements with willing landowners where these actions may protect suitable breeding and nonbreeding aquatic habitat to allow for the expansion of metapopulations within the range of the species.			X	
O-CRLF-3. Manage and enhance occupied habitat or suitable habitat near occupied areas.	A-CRLF-5. Evaluate the management needs of California red-legged frog on protected lands and develop site-specific management strategies to address identified needs.	X	X		
	A-CRLF-6. Implement site-specific management strategies developed under A-CRLF-5.				X
California Tiger Salamander					
O-CTS-1. Confirm extant populations of California tiger salamander and identify areas for potential population expansion.	A-CTS-1. Assess the locations of known occurrences of California tiger salamander and evaluate suitable habitat near occupied areas.	X			
	A-CTS-2. Conduct surveys at sites with previously known occurrences of California tiger salamander and in other areas supporting suitable habitat to confirm extant populations of California tiger salamander.	X			
O-CTS-2. Protect existing populations, suitable habitat, and habitat connectivity.	A-CTS-3. Acquire lands in fee title or conservation easements from willing sellers or develop and fund long-term management agreements with willing landowners where these actions may protect existing populations.			X	
	A-CTS-4. Acquire lands in fee title or conservation easements from willing sellers or develop and fund long-term management agreements with willing landowners where these actions may protect suitable breeding and nonbreeding habitat to allow for the expansion of metapopulations within the range of the species. Ensure connectivity between managed occupied areas to promote cross-breeding.			X	

Listed Species Objectives	Listed Species Actions	Action Type			
		Research	Planning	Project	Activity
O-CTS-3. Manage and enhance occupied or suitable habitat near occupied areas.	A-CTS-5. Plant native emergent vegetation around the perimeter of ponds and wetlands that have little to no vegetation to provide aquatic cover and substrate for attaching eggs. Pond vegetation should be managed to maintain suitable habitat quality (U.S. Fish and Wildlife 2017).				X
	A-CTS-6. Improve the hydroperiod and water quality of natural ponds and stock ponds for California tiger salamander by clearing dense stands of nonnative vegetation, repairing eroding dams and spillways, and removing sediment, where appropriate (Ford et al. 2013).				X
	A-CTS-7. Improve upland habitat through the reduction of invasive plant growth and by promoting land management practices that will benefit California ground squirrels and other fossorial mammals that create burrows used by California tiger salamander.				X
	A-CTS-8. Remove exotic wildlife species such as bullfrogs, mosquitofish, other nonnative predatory fish, and nonnative turtles and salamanders from managed breeding sites.				X
	A-CTS-9. Monitor ponds to assess the presence of hybrid tiger salamanders. If found, identify and implement management approaches appropriate to the level of hybridization present.	X	X		X
O-CTS-4. Reduce or eliminate the current threats to the species to conserve a healthy ecosystem supportive of California tiger salamander populations.	A-CTS-10. Identify potential threats to California tiger salamander on protected lands and management approaches to reduce or eliminate the threats.	X	X		
	A-CTS-11. Reduce potential that ranaviruses, chytrid, or other pathogens are introduced to existing populations of the management area. Ensure early detection of pathogens if they are introduced to California tiger salamander populations in the future.				X

Listed Species Objectives	Listed Species Actions	Action Type			
		Research	Planning	Project	Activity
	A-CTS-12. Ensure that other threats from predation, contaminants, and road mortality are controlled, reduced, or eliminated, if feasible.				X
Least Bell's Vireo					
O-LBV-1. Identify if populations of least Bell's vireo occur in the management area.	A-LBV-1. Implement a monitoring program, in coordination with local conservation groups such as the Monterey Audubon Society, to survey for least Bell's vireo nesting populations in accessible areas most likely to be occupied (i.e., best breeding and foraging habitat in the management area), to detect occupancy and inform management actions.	X			
O-LBV-2. If found, protect and manage least Bell's vireo occupied habitat in the management area.	A-LBV-2. Acquire lands in fee title or conservation easements from willing sellers or develop management agreements with willing landowners where these actions may protect existing populations of least Bell's vireo.			X	
	A-LBV-3. Assess the management needs of the occupied habitat and develop a management plan to support the continued occupancy of the site.		X		
	A-LBV-4. If least Bell's vireos are nesting, establish a brown-headed cowbird control program if needed to help maintain the breeding population and to encourage its expansion.				X
O-LBV-3. If not found, protect and manage least Bell's vireo suitable habitat in the management area to support the repopulation of the management area by this species.	A-LBV-5. Incentivize private landowners to promote riparian land management practices that will maintain and, if possible, improve least Bell's vireo suitable breeding and foraging habitat in the management area.				X
	A-LBV-6. Participate the weed abatement program led by Monterey County Resource Conservation District including the removal of giant reed and tamarisk to restore suitable nesting habitat for least Bell's vireo.				X

Listed Species Objectives	Listed Species Actions	Action Type			
		Research	Planning	Project	Activity
Western Snowy Plover					
O-LAG-4. Work with private and public landowners to protect and manage snowy plover habitat (Source: adapted from Salinas River Lagoon MEP, Measure 17) to reduce or eliminate threats and maximize survival and productivity of the regional population in the management area (U.S. Fish and Wildlife Service 2007).	A-WSP-1. Develop and implement a management plan for public access of to protect western snowy plover during its nesting period, typically March–September.		X		X
	A-WSP-2. Evaluate the need to manage predatory species (e.g., red fox, skunk) populations to reduce predation of snowy plover and, if needed, implement predator control program. (Source: adapted from Salinas River Lagoon MEP, Measure 16.)				
	A-WSP-3. Coordinate with an existing monitoring program to survey for western snowy plover nesting populations in suitable breeding and foraging habitat in the management area to inform habitat protection, enhancement, restoration, and management, as well as to determine progress of recovery actions to maximize survival and productivity.	X			X
	A-WSP-4. Incentivize private landowners to promote coastal land management practices that will improve western snowy plover breeding habitat and maintain foraging habitat in the management area.				X
	A-WSP-5. Develop a weed abatement plan including the removal of European beachgrass to restore suitable nesting habitat for western snowy plover.		X		X
	A-WSP-6. Develop and implement strategies to breach the Lagoon in ways that optimize habitat for western snowy plover, or at least minimize adverse effects.		X		X

Listed Species Objectives	Listed Species Actions	Action Type			
		Research	Planning	Project	Activity
San Joaquin Kit Fox					
O-SJKF-1. Determine if San Joaquin kit fox occurs in the management area and if so, where.	A-SJKF-1. Implement a monitoring program to detect San Joaquin kit fox in suitable habitat.	X			
O-SJKF-2. Protect, manage, and enhance San Joaquin kit fox movement habitat and important regional linkages for the species in the management area.	A-SJKF-2. Incentivize private landowners in the southern portion of the management area to maintain or enhance connectivity for San Joaquin kit fox across their property.				X
	A-SJKF-3. Continue to restore the Salinas River corridor by Arundo removal and other actions that will enhance connectivity for San Joaquin kit fox within the floodplain.			X	X
	A-SJKF-4. Design and implement a cost-effective monitoring program with remote wildlife cameras to determine most likely movement routes for San Joaquin kit fox and other species in suitable habitat in the southern portion of the management area, to inform habitat protection, enhancement, restoration, and management.	X			
Monterey Spineflower					
Objective-MOSP-1. Preserve and maintain or enhance Monterey spineflower populations within the management area.	A-MOSP-1. Protect and maintain or increase the distribution of Monterey spineflower within the management area.			X	X
	A-MOSP-2. Maintain or increase the abundance of Monterey spineflower within the management area.				X
	A-MOSP-3. Protect populations from anthropogenic factors which negatively impact Monterey spineflower, including exotic plants, unnatural disturbances, and erosion.				X

Listed Species Objectives	Listed Species Actions	Action Type			
		Research	Planning	Project	Activity
	A-MOSP-4. Through targeted research, increase our understanding of the ecological factors influencing the distribution, abundance, and population persistence of the Monterey spineflower within the management area in order to improve the effectiveness of management actions.	X			
Sand Gilia					
O-SAGI-1. Preserve and maintain or enhance sand gilia populations within the management area.	A-SAGI-1. Protect and maintain or increase the distribution of sand gilia within the management area.			X	X
	A-SAGI-2. Maintain or increase the abundance of sand gilia within the management area.				X
	A-SAGI-3. Protect populations from anthropogenic factors which negatively impact sand gilia, including exotic plants and erosion.				X
	A-SAIG-4. Monitor the sand gilia population on public property (source: Salinas River Lagoon MEP, Measure 9) and identify habitat enhancement needs.	X			
	A-SAGI-5. Through targeted research, increase our understanding of the ecological factors influencing the distribution, abundance, and population persistence of the sand gilia within the management area in order to improve the effectiveness of management actions.	X			

4.3 Planning Considerations

Development of the management objectives and actions was driven by a variety of important constraints, limitations, key issues, and needs regarding what should be achieved and what is feasible. These *planning considerations* are described below and help illustrate the unique circumstances of the Salinas River system. Planning considerations are not management objectives or actions in and of themselves, but they do greatly inform the management objectives and actions, as well as other aspects of the LTMP, including the implementation framework. In some cases, the recommended management objectives and actions seek to help solve the problems stated in the planning considerations. In other cases, the planning considerations articulate constraints beyond the scope of the LTMP.

Many planning considerations were raised by MCWRA, stakeholders, and consultants throughout the LTMP development process. Planning considerations described below were drawn from discussions held at four planning group meetings, five working group meetings, one public meeting, various written comments on meeting materials provided by stakeholders following the meetings, and by the LTMP consulting team.

4.3.1 Opportunities Exist for LTMP Development

Planning and coordination efforts over the last several decades have brought the stakeholders of the Salinas River to a point in time where there is a collective understanding of the need to collaborate on management of the Salinas River. Listening exercises conducted by MCWRA in 2013 and the Issues Assessment developed by Consensus Building Institute (Appendix B) show that most stakeholders believe a comprehensive management solution for the Salinas River is needed. Perhaps not surprising then is that the stakeholder and public outreach meetings for LTMP development have been well-attended. Approximately 40 people attended the June 20, 2018, public meeting, and over 30 organizations and individuals have collectively participated in 11 LTMP development meetings.

There is also a lot known about the management needs of the Salinas River basin. Data from a strong and growing body of research, permits, and management plans is available from which to draw guidance and recommendations. Additionally, MCWRA must develop an HCP to comply with the federal Endangered Species Act, and MCWRA has time to develop a thoughtful conservation strategy for species that meets regulatory needs while also supporting the needs of landowners/growers. Development of the LTMP is the next step in a process to establish a comprehensive solution to management on the Salinas River and the Salinas River Lagoon.

4.3.2 Regulations May Drive Management Actions

Appendix A includes an overview of various regulations that are likely to affect design and implementation of LTMP management actions that require ground or vegetation disturbance. These regulations provide for the protection of streams, floodplains, wetland and riparian vegetation, special-status species, and water quality. As identified in the LTMP goals, and described in Section 2.4.1.3, *Salinas Valley Water Project*, steelhead conservation is a central focus of the LTMP. The interim biological opinion for steelhead is expected to result in management requirements not yet identified in this LTMP.

Similarly, the Central Coast Regional Water Quality Control Board (Regional Water Board) is in the process of developing the region's next Agricultural Order (4.0)[1], with a targeted adoption date of March 2020. Based on an analyses of surface water and groundwater data and trends in water quality status, Regional Water Board staff have concluded that, overall, water quality objectives are not being achieved and beneficial uses are not being protected in many agricultural areas of the Central Coast, primarily due to the impacts from agricultural discharges (Central Coast Regional Water Quality Control Board 2018 [Staff Report]).

The groundwater sustainability plan (GSP) development process has also identified groundwater quality as a concern. The Seaside, 180/400 Foot Aquifer, and Eastside subbasins are affected by seawater intrusion; the 180/400 Foot Aquifer and Eastside subbasins are affected by elevated nitrate and organic compounds from agricultural runoff, and the Upper Valley subbasin is affected by large dissolved solids (sulfate). Water quality is one of the sustainability criteria required to be addressed in GSPs.

Management actions implemented in support of the LTMP will be subject to these regulatory requirements.

4.3.3 The Time is Ripe for Collaborative Implementation

The land use authorities of the Salinas Valley include multiple cities, County of Monterey, and state and federal agencies. The Salinas River channel and floodplain is owned by hundreds of private parties. Accordingly, no single entity currently has the authority to implement, or simply oversee, all the different types of management actions identified in the LTMP.

The Monterey County Water Resources Agency Act (Agency Act) establishes MCWRA as a flood control and water agency, and defines the authorities of MCWRA. These authorities are listed in Section 2.2, *Jurisdiction and Funding Mechanisms*. While MCWRA has broad authority under the Agency Act, it has not historically exercised all of its authorities. MCWRA may have to develop new sources of funding if certain additional authorities were to be exercised for implementation of the LTMP. Additionally, exercising these authorities would require the support and cooperation of the community.

Under the forthcoming GSPs, the associated Groundwater Sustainability Agencies (GSAs) will have broad authority and flexibility in approach to ensure the Salinas Valley Basin achieves sustainable groundwater management. While the primary focus of GSPs is groundwater, there could (and should) be coordination with long-term basin management. As such, GSPs may be a good tool to incorporate aspects of the LTMP.

Stakeholders expressed interest in establishing a coalition of agencies, a new a non-profit, or other impartial agency to lead implementation of the LTMP. These approaches are further explored in Chapter 5, *Implementation*.

[1] A Conditional Waiver of Waste Discharge Requirement regulating discharges from irrigated agricultural lands to protect surface water and groundwater, which applies to owners and operators of irrigated land used for commercial crop production (Central Coast Regional Water Quality Control Board 2019).

4.3.4 Management Funding Sources are Needed

New funding sources will be needed for LTMP implementation. Several new funding mechanisms are currently becoming available that could be used to fund infrastructure projects, particularly those with components benefiting the environment (including Proposition 68, passed in June 2018). Implementation of the GSPs is also expected to provide a program through which many actions directly or indirectly proposed by this LTMP can be implemented. Funding of these projects is anticipated to require a Proposition 218 vote. The Salinas Valley, often called "the Salad Bowl of the World," supports a $9 billion agricultural industry. Growers have indicated their willingness to vote in favor of a package of actions to support improved water resource management, so long as the package contains a clear connection to the benefits for the greater community.

A number of grant programs exist to support design and implementation of environmental enhancement activities. While these programs are typically competitive, projects included in a comprehensive management plan are often more competitive because they support implementation of a thorough and stakeholder-supported process.

4.3.5 Re-Think Water Management Facility Needs

MCWRA owns and/or manages many facilities to help move water through the management area. Key facilities include the Nacimiento and San Antonio Dams, the Salinas River Diversion Facility (SRDF), the Castroville Seawater Intrusion Project, the Old Salinas River (OSR) Slidegate, and various pumping facilities along the Reclamation Ditch system. Much of the infrastructure owned and operated by the MCWRA is aging and in need of costly repair and maintenance. Additionally, the existing infrastructure was not contemplated to be used for comprehensive management of the basin and needs to be adapted and/or improved to be useful for implementation of the LTMP. In particular, there are relatively few canals or pipelines in the management area with which to move surface water around. As such, the Salinas River acts as the primary "trunk line" for the entire system. If the goals of the LTMP are to be met, infrastructure needs to be re-evaluated for maintenance, retrofit, or replacement.

4.3.6 Share the Costs and Benefits of River Management

The costs of management projects and activities are typically born by the agency or individual responsible for implementing the action without consideration of larger benefit to the community. This is particularly true for the private landowners who are members of the Salinas River Stream Maintenance Program River Management Unit Association and participants in the Salinas River Stream Maintenance Program. The costs of implementing stream maintenance actions includes not only conducting the work, but also reporting on the work conducted and, for some activities, funding mitigation projects. These private individuals are not only preventing flooding and erosion on their own lands and adjacent lands, but they are creating channel capacity to accommodate floodwaters. These actions have significant benefits for flood management and groundwater recharge throughout the watershed, yet the cost of implementing these actions fall on a limited group of individuals and agencies.

New permits or permitting programs are needed (e.g., long-term biological opinions for reservoir operation and sandbar breaching) to remain in compliance with existing laws and regulations. Implementation of the LTMP should include identification of mechanisms for equitable cost distribution that align the cost of management actions across those that benefit from the work. This

should be done in concert with identification of new funding mechanisms as discussed in Section 4.4.4, *Management Funding Sources are Needed*.

4.3.7 Flooding Affects the Community

Addressing flooding is one of the primary goals of the LTMP. As such, it is important to understand all the issues surrounding flooding, as well as existing programs that are designed to address flooding. Various forms of flooding from extreme events (such as those experienced in 1995 and 1997), to smaller 5- and 10-year storms coupled with drought conditions, require the community to rethink how it approaches stormwater management, including capture and recharge.

The location of flooding is highly variable—it is driven by where precipitation falls, tides, available capacity of local watercourses, infrastructure built along or into the channel, and quantity of debris moving through the system—and can present location-specific consequences. When flooding occurs on agricultural lands, it can destroy or degrade crops such that they cannot be sold. It can also wash away topsoil and/or change the chemical composition of the soil. Food safety standards (e.g., California Leafy Green Products Handler Marketing Agreement [LGMA], buyer's agreements) may prohibit replanting for a given amount of time after flooding, reducing a farmer's ability to recover economic losses in a single growing season.

During large storm events, flooding can also inundate homes and threaten infrastructure including roads and bridges, which affects the livelihood and transportation needs of the community. Storms can further damage infrastructure by increasing the volume of debris moving through the system. During times of drought, vegetation dies back and is washed down the river creating flood hazards (e.g., tree trunks or large branches catch on bridges or tide gates and back up the channel).

A considerable amount of stormwater runoff could be captured—if projects designed to do so were implemented—instead of flowing out to the ocean. Others acknowledge the ecological benefits of letting water flow to the ocean. These benefits include repelling saltwater that could back up into the lagoon and transporting sediment (i.e., fine sediments and sand) out of the lagoon into the ocean and thus maintaining flood management capacity in the lagoon.

Consideration should be given to redesigning flow pathways so that progress in reducing flooding and improving water quality is realized. It is recommended that the known and likely future flood zones (water pathways) be evaluated, and that this information is used to inform where flood management projects can be installed. A storm water resource plan (SWRP) for the Greater Monterey County Integrated Regional Water Management (IRWM) Region is under development with an expected completion date in June 2019 (Section 2.4.2.7). As required by regulations, the SWRP will include approaches for diverting runoff from existing storm drains, channels, or conveyance structures to sites (particularly publicly owned sites) that can clean, store, infiltrate and/or use the runoff. This SWRP will identify specific projects to address flooding.

Additionally, when planning for the future, it is important to acknowledge current weather projections, which anticipate prolonged periods of drought and increased intensities of storms. Projections also indicate that average mean sea level is increasing; together with increased intensity of storms, this may result in flooding beyond that caused by precipitation alone.

4.3.8 Wildlife Needs Well-Connected Habitat in Good Condition

4.3.8.1 Connecting the Ocean and the River

Steelhead are anadromous fish, having a lifecycle that begins in freshwater streams, transitioning to the ocean then returning to freshwater. Steelhead entering the Salinas River from Monterey Bay can use one of two routes: direct access from the ocean to the Salinas River if the sandbar at the mouth of the river is open; or through Moss Landing Harbor, south to the Potrero Road tide gates, up the OSR channel , and finally through the OSR Slidegate opening to the lagoon. The mouth of the Salinas River is often separated from the sea by a sandbar, which requires flows high enough to naturally breach the sandbar, or manual efforts to open it. Natural breaches generally do not occur until the water level is sufficiently high to also flood the neighboring agricultural lands (see Section 4.4.9.1, *Lagoon Elevation, Sandbar Management, and Flooding*, for details). Neither the Potrero Road tide gates nor the Old Salinas River Slidegate were designed to support fish passage, although fish passage is likely possible under certain conditions. However, the use of this pathway as a migration corridor for steelhead deserves further study.

As such, the timing of sandbar breach affects successful migration into the river and is a key focus of ongoing steelhead management discussions. If the sandbar is not breached until later in the winter or spring season, this can delay adult steelhead migration, which primarily occurs from the end of December through April. Similarly, if the sandbar closes early in the spring, the number of out-migrating juveniles that reach the ocean will be limited. In dry years, river flow events may not be large enough to trigger sandbar breaching (natural or artificial), leaving the sandbar in place for a year or more. This most recently occurred when the sandbar was closed between January 2013 to January 2017.

Sandbar management during the late spring or early summer may affect tidewater goby recruitment due to the low tolerance of juvenile tidewater goby to drastic changes in salinity that may result from a breaching event. In addition, tidewater goby overwintering survival is highly dependent on a large population going into the fall and winter; because large flood events may sweep individuals out to the ocean, a large population increases the potential for some individuals to survive winter events (U.S. Fish and Wildlife Service 2005). These survivors comprise the initial breeding population the following summer.

The management of the Old Salinas River Slidegate has likely helped to bolster the population of tidewater goby by providing a colonization pathway to the lagoon, providing refuge or permanent habitat in the OSR, and by establishing and maintaining a salinity gradient in the lagoon that allows tidewater gobies to distribute along the gradient according to their physiological preference. A less saline lagoon would likely increase local abundance of nonnative predators such as largemouth bass and bluegill in the downstream areas of the lagoon, and a more saline lagoon would likely increase the abundance of competitors such as arrow goby and yellowfin goby (FISHBIO 2018).

Tidewater goby has been consistently found near the Old Salinas River Slidegate and in the OSR since 2014 (FISHBIO 2018). Any attempts to utilize the OSR for steelhead migration, including widening the channel or updating infrastructure, may alter the habitat quality for tidewater goby by altering water velocities in the channel—tidewater goby are very poor swimmers—or altering salinity levels.

As lagoon management actions extend into the future, it will be important to attempt to identify approaches to improve steelhead connectivity while minimizing the effects on other listed species. Additionally, the implications for sea level rise and how it might affect lagoon management (and associated issues of flooding and sandbar breaching) needs to be understood.

Future management of the lagoon and sandbar will need to balance habitat needs (e.g., migrating fish), flood control options and infrastructure, and community concerns related to flooding and salinity intrusion.

4.3.8.2 Connecting the Lagoon to Headwaters

Once in the Salinas River, steelhead must also be able to migrate to headwater streams (particularly the Arroyo Seco) which support the only spawning habitat in the river (i.e., habitat with gravel substrate, well-oxygenated flows, cold water, and cover). Steelhead generally migrate inland December–March annually and out-migrate February–April. Consequently, they need surface flow connectivity during the winter months in order to travel between the ocean and headwaters.

Starting in 2010, as part of the Salinas Valley Water Project (SVWP) permitting process, San Antonio and Nacimiento Dams have been operated according to the *Salinas Valley Water Project Flow Prescription for Steelhead Trout* (MCWRA 2005) to meet multiple goals, including adult migration passage for steelhead. The flow prescription defines the steelhead upstream migration season as beginning on January 1 and continuing through March 31 of each year, during which time passage flow requirements are defined as "five or more consecutive days of a mean daily stream flow of at least 260 cubic feet per second (cfs) as measured at the [U.S. Geological Survey] stream flow gage Salinas River near Chualar, when the Salinas River Mouth at the Salinas River Lagoon is open to the ocean." The MCWRA submits annual reports summarizing operational and fish flow data relevant to implementation of the flow prescription to the National Marine Fisheries Service (NMFS). However, connectivity challenges for steelhead persist and are a key focus of the interim biological opinion (Section 2.4.1.3, *Salinas Valley Water Project*).

Other factors may affect connectivity for steelhead as well. In 2005, the National Oceanic and Atmospheric Administration (NOAA) conducted a fish passage study that analyzed the extent, frequency, and morphological characteristics of Salinas River sand dune formations (Cluer and McKeon 2005). The study found in-channel sand dunes to be a prominent feature occurring over the majority of the Salinas River in the study area, which likely presented sequential and repetitive fish passage impediments for migratory steelhead during low flow conditions. The study concluded with flow regime recommendations to create and maintain a passable migratory low-flow channel through the dunes. Additionally, stakeholders noted that the increased presence of vegetation supported by summer-time flows might also be affecting connectivity for steelhead.

Water quality conditions should also be considered as a potential impediment to steelhead passage. The water quality of a stream is controlled by multiple factors including the chemical and physical nature of the streambed material, groundwater quality, and upstream runoff from adjacent lands. Portions of the Salinas River watershed are listed as impaired for boron, fecal indicator bacteria, nutrients, PCBs, and pesticides. These contaminants are transported from their agricultural and urban points of origin to the Salinas River by way of surface runoff (e.g., storm sewers, agricultural drainage systems, small tributaries) and shallow sub-surface flow (e.g., leaks from sanitary sewer systems). However, the degree to which these contaminants affect steelhead passage is unknown.

Steelhead passage is likely more affected by additional water quality parameters such as temperature, dissolved oxygen pH, salinity, and turbidity (Section 3.1.9 provides additional detail). As flows subside in the spring, temperatures and dissolved oxygen concentrations may approach lethal thresholds (24-27°C, and 1.5–2.0 mg/L, respectively; Moyle 2002; Mathews and Berg 1997). High salinity and turbidity levels may affect fish passage as well, although it is not clear to what extent these factors limit fish passage opportunities in the watershed.

4.3.8.3 Restoring Riparian Habitat

Areas along the Salinas River are believed to have once supported wooded riparian areas thousands of feet wide, and in some places as much as a mile wide (San Francisco Estuary Institute 2009). Today, however, much of the historical riparian areas have been converted to agricultural fields (and continue to be converted), and the river is affected by an extensive invasive plant management problem. *Arundo donax* (Arundo) is one of the worst plant invaders of California's riparian and wetland communities. As of 2011, the Salinas River supported 23% of known Arundo stands in all of coastal California (California Invasive Plant Council 2011). Thick stands of Arundo are impenetrable for many wildlife species and prevent movement across the Salinas River corridor.

While some riparian vegetation remains, there are opportunities for restoration. LTMP stakeholders noted that riparian restoration, focused on removal of Arundo and replanting or natural recruitment of native species, provides an excellent opportunity to meet the multi-objective goals of the LTMP. Along with re-establishment of native vegetation, removal of Arundo creates additional flood flow capacity in the channel, reduces the amount of vegetative debris that is moved downstream during floods, and may reduce the amount of water used by vegetation.

Riparian restoration will also support regional objectives to improve habitat connectivity. The Salinas River was included as a "potential riparian connection" to important habitat regions throughout the Central Coast in the *California Essential Habitat Connectivity Project Plan* (2010), and the upper valley areas are designated "essential connectivity areas." The Resource Conservation District of Monterey County has begun preliminary studies (working with Pathways for Wildlife) to collect wildlife use data as part of the *Long-Term Effectiveness Plan for the Salinas River Stream Maintenance Program*. It is expected that the data will reveal that the Salinas River riparian zone is an important corridor for wildlife movement between the Gabilan Range and the Santa Lucia Mountains, using Salinas River tributaries (pers. comm. E. Zefferman).

Restoration of riparian habitat may support a return of listed species rarely seen today, including least Bell's vireo. Restoration, particularly removal of large, dense Arundo stands, may allow for enhanced wildlife movement, and could also lead to an increase in surface water presence in off-stream and backwater areas. Allowing water to persist on the landscape during and following high-flow events, in a planned for and management approach, could provide habitat for amphibians and a water source for terrestrial wildlife.

4.3.9 Ensure Lagoon Sandbar Management is Multi-Benefit

MCWRA has been managing the lagoon consistent with the *Salinas River Lagoon Management and Enhancement Plan*, the 2007 USFWS biological opinion, and the draft 2009 NMFS biological opinion. However, key management issues persist. The sections below detail current considerations for lagoon management.

Discussions with the LTMP stakeholders have concluded that future management of the lagoon and sandbar will need to balance habitat needs (e.g., for steelhead and tidewater goby), flood control options and infrastructure, and community concerns related to flooding and salinity intrusion.

4.3.9.1 Lagoon Elevation, Sandbar Management, and Flooding

When the sandbar is in place, lagoon elevation is managed between 3.0 and 3.5 feet above sea level; flooding of adjacent lands begins when elevation reaches approximately 5.5 feet National Geodetic Vertical Datum of 1929 (NGVD 29). Lagoon elevation is primarily controlled by the Old Salinas River Slidegate and Potrero Road tide gates. An adjacent waterway, the Tembladero Slough, drains a significant watershed and outlets into the OSR upstream of the Potrero tide gates. This can limit outflow from the lagoon, causing lagoon elevations to rise with limited inflow from the Salinas River. Currently, when water elevation reaches 5 feet NGVD 29 and inflows to the lagoon are predicted to increase (as a result of a storm event), MCWRA begins preparations for an emergency breach of the lagoon. During preparations for sandbar breaching, lagoon elevation can reach 7 or 8 feet NGVD 29.

Flooding primarily affects agricultural lands to the north of the lagoon. As noted previously, when agricultural lands are flooded, it destroys or degrades crops such that they cannot be sold, and it washes away topsoil and can change the chemical composition of the soil. Food safety regulations also prohibit replanting for a period of 60 days or more for certain crop types. During large storm events, flooding can also inundate homes and threaten infrastructure including roads and bridges.

Breaching of the sandbar is performed during a storm event as high flows increase the scour potential at the mouth; if the flows are not high enough to scour the sand out of the river mouth, the sandbar has increased potential to form again soon after the breach. As discussed previously, the timing of sandbar breach is also an important consideration for steelhead as their life history requires ocean connectivity. If the sandbar is not breached until later in the winter or spring season, this can delay adult steelhead migration, which primarily occurs from the end of December through April. Similarly, if the sandbar closes early in the spring, the number of out-migrating juveniles that reach the ocean will be limited. In dry years, river flow events may not be large enough to trigger sandbar breaching (natural or artificial), leaving the sandbar in place for a year or more. This most recently occurred when the sandbar was closed between January 2013 to January 2017.

There may be some potential for steelhead migration to occur through the OSR when the sandbar is closed; however, there is no evidence that this occurs. Given the Potrero Road flap gates are closed during high tide events, if migration is occurring in the OSR, it is most likely juvenile outmigration (rather than adults migrating to the river from the ocean). This is because the Potrero Road flap gates are closed at high tide when the optimal connectivity between the OSR and the Moss Landing Harbor would exist.

The timing and location of an artificial sandbar breach must also consider the western snowy plover nesting season. Plovers nest on the beach near the mouth of the Salinas River between March 1 and September 30. If artificial sandbar breaching occurs during this time, the presence of people and construction equipment may cause plovers to either not nest or abandon their nests, or it may result in destruction of nests if they are washed away as the breach occurs.

Tidewater gobies benefit from a relatively stable surface water elevation provided when the sandbar is in place and have a tolerance for a wide range of salinities and oxygen concentrations. However, if there is a need for sandbar management during the late spring or early summer, or the lagoon stays open for most or all of the summer, this could disrupt the goby breeding season, which

begins in late spring and continues through to early fall. Because goby live an average of one year, the loss of one breeding season could limit overall survival potential in the Salinas River Lagoon.

4.3.9.2 Infrastructure

Water management infrastructure around the lagoon affects how the lagoon is managed. The Old Salinas River Slidegate separates the Salinas River Lagoon from the OSR, and the OSR drains to Moss Landing Harbor through the Potrero Road tide gates. The Old Salinas River Slidegate is used to maintain surface water elevations in the lagoon. The slidegate is opened when the sandbar closes. The slidegate allows water from the Salinas River to "spill out" when it reaches approximately 3 feet. The slidegate is not ideal for surface water management because it allows the fresh, oxygenated surface water to exit the lagoon. Allowing freshwater to exit the lagoon slows or stops the conversion of the lagoon from a salinity stratified system with poor bottom water quality to a more uniformly freshwater system; allowing the freshwater to remain within the lagoon could slowly convert the lagoon to a freshwater system and thus maximize habitat quantity and quality for rearing steelhead. Tidewater gobies have a wide range of salinity tolerance and are generally able to reproduce so long as the lagoon is formed and relatively stable in elevation.

The Potrero Road tidegates are a series of flap gates that are located at the northern end of the OSR. Water exits the channel and enters the harbor through these gates. The purpose of these gates is to reduce the amount of saltwater that can enter the OSR, because salinity and inundation from high tides can degrade the quality of surrounding agricultural lands. The Potrero Road tidegates limit the volume of water that can exit the lagoon because the function of the gates is subject to tidal levels: at high tides, the surface water elevation is raised and the pressure from the water flow caused by the rising tide keeps the flapgates closed. Thus, the function of the OSR as a mechanism for controlling surface water elevations is limited during high tides.

The size of the OSR channel, together with the diameter of the culverts at the Old Salinas River Slidegate and the Potrero Road tidegates, limit the volume of water that can be transported out of the lagoon. Consequently, MCWRA's ability to manage surface water elevations during large storm events is limited; water cannot be carried out of the lagoon quickly enough to keep pace with inflow, and the water elevation rises. To compound this management issue, Tembladero Slough also contributes water to the OSR. During dry weather, most of this discharge is in the form of agricultural runoff returns. However, during storm events, the flows from Tembladero Slough increase dramatically. It has even been observed that with low inflow from the Salinas River, flows from the Tembladero Slough are capable of causing flooding.

4.3.9.3 Water Quality

Water quality conditions vary with water year and the status of the sandbar; when the sandbar is open and when freshwater inflows are high, water quality is good. When the sandbar is closed and freshwater inflows are low or absent, water quality can be poor.

Water quality degradation occurs, primarily as the result of water column stratification, particularly in the summer. The water column stratifies with the more dense saline water on the bottom becoming isolated from the fresh surface water layer. As a result of no mixing between layers in the water column, bottom water becomes hypoxic (<2 mg/L) or anoxic (0 mg/L) and surface waters experience diurnal (daily) fluctuations in dissolved oxygen concentrations. These diurnal fluctuations are a result of oxygen levels becoming "super saturated" (>15 mg/L) during the day as a

result plant respiration and then dropping at night when microbial and animal respiration continue without the oxygen input from plants.

Warm temperatures and stagnant water fosters "blooms" of rooted and floating vegetation which is exacerbated by nutrient inputs from agricultural and urban sources. Prior to 2010, freshwater inflows from the upper watershed were typically low or non-existent in the summer and fall. Since 2010 and the operation of the SRDF, freshwater inflows to the lagoon are a requirement of the SVWP permits, conditions allowing.

4.3.10 What Happens to Flood Flows and Reservoir Releases?

Understanding how water moves throughout the study area (aboveground and belowground) is critical to meet the goals of the LTMP. At the most basic level, the relationship between the Salinas River and the Salinas Valley groundwater basin is controlled by annual cycles of precipitation and groundwater pumping. Rain falling within the Salinas Valley watershed can enter and recharge underlying aquifers through direct rainfall on the land surface and subsequent infiltration/ percolation, or through infiltration once the runoff reaches the streambed of the Salinas River and its tributaries. When groundwater levels in the aquifers are high enough, groundwater can contribute to surface streamflow. Groundwater is lost from aquifers when it is pumped for municipal or agricultural uses, particularly during the summer irrigation season. In general, the subbasins are pumped during the dry season when the agricultural water supply demand is greatest, and they are recharged in the wet season—although the amount of recharge varies depending on the amount and timing of precipitation and how low the subbasin water levels are at the start of the wet season.

In years of plentiful rainfall, the abundance contributes to groundwater recharge and helps maintain surface flows in the Salinas River. During dry years, there is not always sufficient runoff to recharge aquifers and maintain stream flows. San Antonio and Nacimiento Reservoirs store runoff that can be used to both augment flows in the Salinas River and recharge the aquifers. How effective this management approach is at maintaining streamflow depends primarily on how these reservoirs are operated (timing and volume of releases) and the level of depletion in the aquifers (which varies with season and pumping activity). The greater the depletion of the aquifers, the more flow will be required in the Salinas River to maintain surface flow connectivity to the Monterey Bay. If the reservoirs do not have sufficient storage and/or if the aquifers are depleted such that any surface flows readily percolate into the ground, then stream flows may not be maintained. As such, under existing conditions, the successful management of the Salinas River within the study area is dependent, in part, on how groundwater is managed. Figure 4-1 provides a conceptual model depicting these interactions.

Managing water resources along the Salinas River is challenging due to differences in when water is naturally plentiful (typically during the winter) and when it is generally needed for irrigation (during the dry season). Compounding this challenge is the lack of data regarding flow along the Salinas River and inflow from its tributaries. There are only four gages on the mainstem of the Salinas River. Of the Salinas River's undammed tributaries in the study area, only the Arroyo Seco and San Lorenzo are gaged.

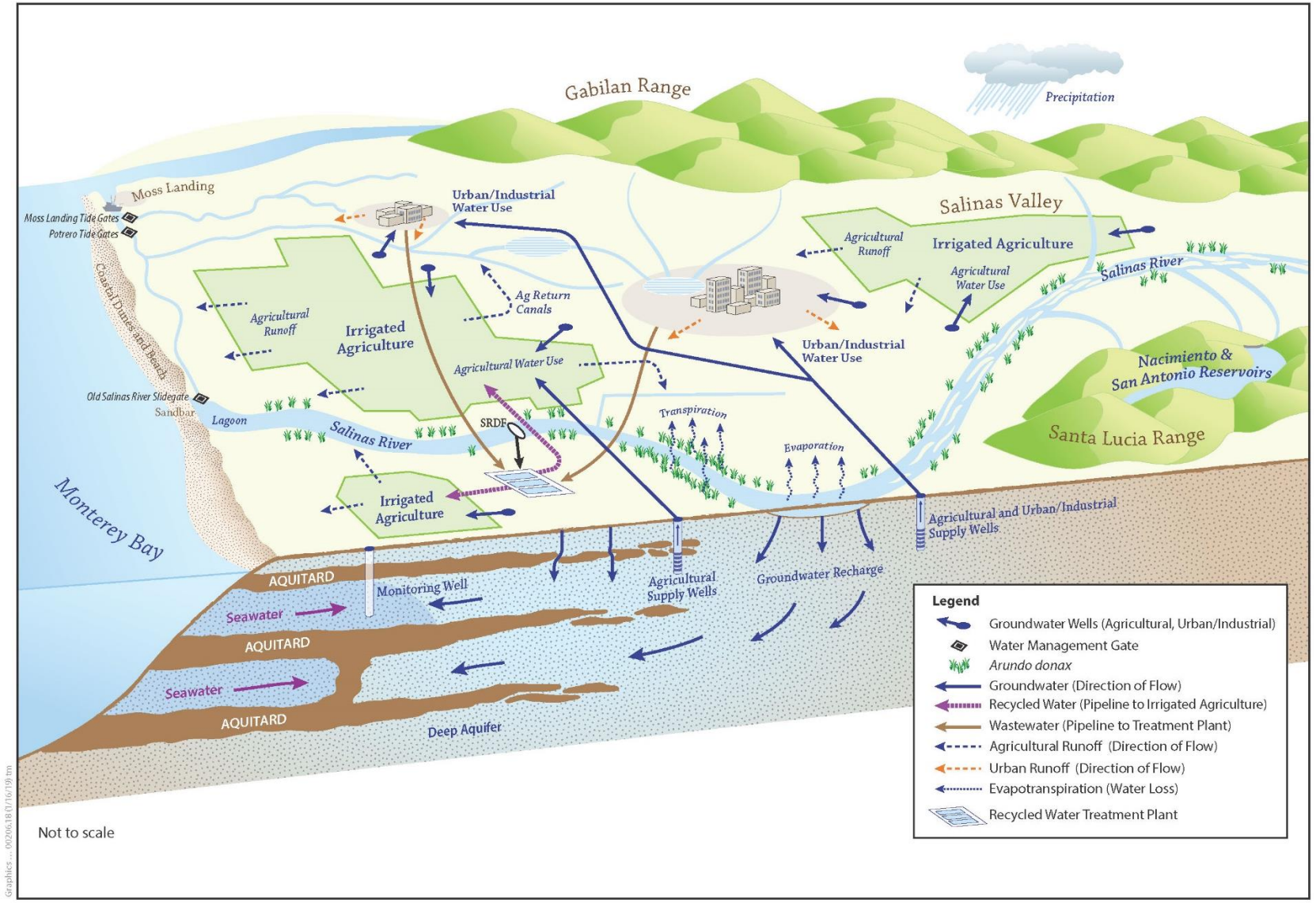


Figure 4-1. Salinas Valley Water Management System Conceptual Model

Groundwater is a valuable resource to the agriculture-based economy of the Salinas Valley. Although the Salinas River is ultimately the primary water supply for the valley, most of the water used first infiltrates from the Salinas River into the underlying sediments before being extracted for use through groundwater pumping. The Salinas Valley groundwater subbasins serve as critical reservoirs for seasonal water storage between the wet and dry seasons, providing an estimated 16.4 million acre-feet of storage as compared to 0.7 million acre-feet in Nacimiento and San Antonio Reservoirs combined. The groundwater reservoir also provides critical storage over multiple-year climatic cycles with groundwater levels in the Salinas Valley Basin being drawn down during drought periods and replenished during wet periods.

While the general mechanics of surface and groundwater interaction are known, the details along the Salinas River are not fully understood. For example, the level at which aquifers must be maintained in order to maintain surface flow along the length of the Salinas River is not known. To address this uncertainty, MCWRA is working with the U.S. Geological Survey to develop the Salinas Valley Integrated Hydrological Model. This model combines a rainfall-runoff model (simulating the generation of runoff from input climate data) with a groundwater-surface water model (simulating the movement of water in the groundwater and surface water systems, as well as the dynamic operation of the linked reservoirs) to attempt to quantify the interaction of surface water and groundwater in the Salinas Valley.

With passage of the Sustainable Groundwater Act, which requires GSPs for each basin, information will be developed that will support groundwater basin management for the first time. It is expected that GSPs will be informed by the Salinas Valley Integrated Hydrological Model.

4.3.11 The River Changes Over Time

Many stakeholders expressed an interest in returning the river to a more “natural” state.

Over the past 150 years, the Salinas River has gone through many changes that have affected its hydrology and geomorphology. These changes began with the development of the Salinas Valley as a major agricultural region, including construction of the first railroad connecting the Salinas Valley to Monterey and the incorporation of the City of Salinas. Around the turn of the century, the use of groundwater pumping for irrigation expanded quickly. As the amount of irrigated crops increased, the amount of freshwater removed from the groundwater basin exceeded the amount replenished through natural hydrologic processes. By the late 1930s, wells in the Salinas Basin near Monterey Bay had been abandoned due to excess salinity (California Department of Water Resources 1946). Accelerated encroachment of salinity into the groundwater basin was observed in 1943, which led to an investigation of the Salinas Basin (California Department of Water Resources 1946) and ultimately to the construction of the Nacimiento Dam in 1957, followed by the San Antonio Dam in 1965. These reservoirs have been primarily operated to capture winter flows and release them at a low enough rate throughout the year to maximize groundwater recharge in the Salinas Valley aquifer (CALFED 1976) so that groundwater wells for irrigation continue to function.

Prior to the construction of major reservoirs and diversion, the Salinas River experienced a dynamic system where seasonal high flows regularly scoured the sandy bars and channel bottom, transporting sediment and creating a wide and largely bare channel bed (San Francisco Estuary Institute 2009). Anecdotal records cited by San Francisco Estuary Institute (2009) from the 1700s and 1800s indicate that the Salinas River had an extensive riparian corridor along the active channel, as well as in the overbank floodplains, surrounding a broad and sandy river bed. The

earliest available aerial photography from 1937 (by which time the agricultural industry was well developed) shows a wide riverbed and very little-to-scattered vegetation growing on large sand bars within the channel, and with pockets of more dense vegetation growing towards the outside margin of the riverbed (Monterey County Water Resource Agency 2014). Today, the operations of the Nacimiento Reservoir and the San Antonio Reservoir have reduced flow peaks and increased summer flows, allowing vegetation growth to expand onto the bars and channel bottom by reducing scouring events and maintaining water supplies throughout the study area during the summer. This vegetation growth has tended to "armor" sandbars, reduce or eliminate multi-channel braiding, and create the typically heavily vegetated, single-threaded channel form in the lower Salinas River.

Balancing the operation of the river and reservoirs with the existing need and desire for the river to operate more naturally must be considered. Returning to this "natural" state of the 1700 and 1800s is no longer possible due to conversion of riparian corridors to agricultural fields and population growth that has driven a need to manage the river for flood control. However, a "naturalized" management approach, particularly regarding reservoir releases, could help reestablish some of the historical Salinas River characteristics while still meeting flood control, irrigation, groundwater recharge, and fish migration needs.

4.3.12 There is Support for Recreation

LTMP stakeholders have expressed a desire to maintain access for recreation on public lands, including the Salinas River Lagoon and in the Nacimiento and San Antonio Reservoirs. Where recreation opportunities overlap with natural lands, access must be carefully managed to ensure that it does not result in adverse effects on sensitive plant or animal species. To address this issue, projects implemented in support of the LTMP should consider potential interactions with recreation.

Chapter 5
Implementation

This chapter provides a discussion of how the *Salinas River Long-Term Management Plan* (LTMP) could be implemented. Throughout development of the LTMP, stakeholders emphasized that successful implementation of the LTMP would depend on multiple agencies, organizations, and other stakeholders coming together to manage the resources of the Salinas River. Because no entity has been identified to coordinate such collaboration, many stakeholders advocate the formation of a regional entity—possibly a special district, joint powers authority, state conservancy, nonprofit organization, or a coalition—that could not only manage the LTMP, but also support other planning efforts in the region. This entity would also serve as a conduit for funding and hold responsibilities for coordinating and/or executing LTMP actions, tracking progress of LTMP implementation, reviewing and revising the LTMP through adaptive management, and retaining and managing all data associated with implementation.

This chapter concludes with a discussion of the LTMP's relationship to other planning efforts in the region and summarizes regulations that may apply to LTMP implementation.

5.1 Administration

The issue of LTMP implementation oversight was raised throughout the LTMP development process. The December 5, 2018 working group meeting focused on this issue. Participants discussed that while the Monterey County Water Resources Agency (MCWRA) does currently have extensive authorities under the Agency Act, its current funding is limited and targeted at a narrower set of responsibilities. Some stakeholders suggested that MCWRA develop additional funding and increase staffing to take on the new responsibilities.

Several stakeholders (at both the working group meeting and during planning group meetings) also advocated for a regional entity to oversee river management and whose responsibilities would go beyond implementing the LTMP, namely supporting implementation of other local planning efforts such as groundwater sustainability plans (GSPs), the *Greater Monterey County Integrated Regional Water Management Plan* (IRWM Plan), and the forthcoming *Greater Monterey County Storm Water Resources Plan* (SWRP). Ideally, this entity would address the collective water management needs of rural and urban communities, agriculture, and the environment—including listed species—through coordinated water resource management (surface and groundwater supply) and flood management. Establishing such an entity would constitute a regional, systemic approach to water resource management, acknowledging that all water resources are connected.

The potential responsibilities of an implementation entity and potential governance options are discussed in Section 5.1.1, *Responsibilities*.

5.1.1 Responsibilities

The vision described previously for a single, regional water management entity is expected to take significant time and effort to establish. There is a strong desire by stakeholders to establish, in the short term, a structure to more efficiently communicate and coordinate the overlapping projects of

different entities that work along the Salinas River. Such a structure could improve project efficiency and avoid duplication or conflict. Some stakeholders preferred that a single entity provide this organizational support. This entity would, at a minimum, act as the convener of the many parties involved in river management and support collaboration among these parties. Additional short-term responsibilities of this entity could include the following.

- Draft a Salinas River watershed agreement to guide LTMP implementation.
- Engage academics, landowners, growers, environmental groups, and regulatory agency staff to participate in LTMP implementation.
- Participate in other stakeholder processes or programs that will have an effect on, or be affected by, the management of the Salinas River, and ensure that the management objectives and actions of the LTMP are considered (A-GEN-4).
- Facilitate the establishment of a Salinas River Lagoon management committee (A-LAG-16).
- Encourage participation in the Water Quality Protection Program, which is run by the Monterey Bay National Marine Sanctuary (A-LAG-17).
- Support development of a portfolio of projects, where the purpose and need, complete cost (e.g., design, permitting, construction, mitigation, operation), and benefits are clearly described such that one or more projects can be put on the ballot for voter approval as required by Proposition 218. Cost and benefit analysis must, at a minimum, be quantitative (A-WAT-4).
- Identify funding opportunities for management action implementation (Section 5.2, *Funding*, provides discussion).
- Build from existing efforts of the Greater Monterey County Regional Water Management Group to provide structure and organizational support to grant development efforts so that multiple stakeholders do not submit conflicting applications to the same program. Identify appropriate grant partnerships and ensure consistent messaging for LTMP implementation.
- Serve as the fiscal agent and grant administrator for secured grants.
- Track implementation of LTMP management actions, including management projects and activities (Section 5.1.1.1, *Monitoring and Adaptive Management,* provides discussion).
- Engage property owners regarding necessary permitted improvements (A-LAG-15).
- Provide regulatory compliance guidance to landowners seeking to implement management actions.
- Consider creating a long-term structure to maximize all Salinas River management planning efforts and implementation.

There was no firm agreement on the appropriate structure of a long-term administrative approach to LTMP implementation, but many stakeholders agreed that the approach could—and likely would—evolve over time. The success of a single entity leading LTMP implementation would depend on the entity's ability to add value to existing organizations. Stakeholders also advocated strongly for the entity to be established only after a clear purpose and need are defined. Once established, this entity could—in addition to the responsibilities listed previously—work to prioritize, schedule, advocate, facilitate, and monitor the implementation of the LTMP and other river management activities.

5.1.1.1 Monitoring and Adaptive Management

Management is an ongoing process that should be monitored, evaluated, and adjusted as needed. Accordingly, as management evolves, the LTMP will likely need to be reviewed and revised. Having the ability to monitor these changes is critical to the successful implementation of the LTMP, and to guide future LTMP revisions. The following sections describe three types of monitoring recommended by stakeholders during the LTMP development process.

Effectiveness Monitoring

The process of tracking the success or failure of management actions is called *effectiveness monitoring*. Effectiveness monitoring helps determine if a management action is achieving the desired outcome(s) and, if not, how that management action could be altered to improve chances of success.

In order to assess accurately the outcome of a management action, an effectiveness monitoring approach needs to be established that likely includes monitoring protocols, target indicators, a monitoring schedule, and success criteria. These factors are typically addressed through a monitoring program established for one or more specific management actions at the time the action is implemented or shortly thereafter.

In recent years, state resource agencies have begun establishing programs and tools to monitor implementation and effectiveness of conservation projects, particularly as related to aquatic resource monitoring. The Wetland and Riparian Area Monitoring Plan is one such program developed through a collaboration of the California Environmental Protection Agency and the California Natural Resources Agency. The Wetland and Riparian Area Monitoring Plan is a plan for comprehensive monitoring and assessment of aquatic resources using a watershed or landscape context, and it utilizes other existing data monitoring and management tools including the California Rapid Assessment Method and EcoAtlas. Monitoring the implementation of LTMP management actions may be facilitated through use of such existing frameworks.

Adaptive Management

Adaptive management is a decision-making process that adjusts actions as uncertainties become better understood or as conditions change. Monitoring the outcomes of management is the foundation of an adaptive approach, and thoughtful monitoring can both advance scientific understanding and modify management actions iteratively (Williams et al. 2007).

The cornerstone of an adaptive management program is an approach in which effectiveness monitoring yields scientifically valid results that inform management decisions. Information collected through monitoring, experiments, and ongoing regional planning efforts should be used to inform progress toward LTMP goals and objectives. Furthermore, because new information is becoming available on an ongoing basis, it is important to ensure that this information is shared broadly, and that it is interpreted and applied to ongoing planning efforts, including potential future revisions to this LTMP.

Data Management

When management actions are successful, it is important that the information gained be tracked and used to improve other components of LTMP implementation. On the other hand, when management

actions are implemented but do not achieve the desired outcome, it is equally important to record those failures, learn from them, and not repeat them. During LMTP implementation, it will be important to track the status of management action implementation and newly identified management approaches. At a minimum, stakeholders recommended maintaining a spreadsheet identifying the status of all management actions currently in progress or completed. However, for a program such as that envisioned for Salinas Valley water resource management (i.e., a regional, systemic approach), a much more robust data tracking system will be needed. The Conservation Action Tracker for California's Central Coast[1] is an example of a web-based platform that tracks projects in the region. EcoAtlas[2] is another web-based tool used by many regulatory agencies for tracking conservation and mitigation projects. It would also be helpful to consolidate and make publically available the extensive GIS-based data used in developing this LMTP, as well as the geographic data used for other planning projects.

The Salinas River watershed benefits from an abundance of information that has been developed, or is in development, regarding its many resources. Appendix G, *Data Source Summary and Data Gaps Identification,* identifies many of these data sources and reports. As new studies are completed, and as other planning efforts advance, additional information related to Salinas River management will be developed. Stakeholders recommended establishment of a data clearinghouse. Local stakeholders, including the Central Coast Wetlands Group, have developed such platforms in other parts of California to help manage program data and make that data available to partners and other interested parties.

5.1.2 Governance Options

There are several options of how to structure the governance of a new entity that could serve the functions described previously. During a working group meeting held on December 5, 2018, several possible governance options were discussed. These options are summarized briefly in this section.

Special District

California Special Districts are local government agencies that local residents form when they want their community to have new or better services and/or infrastructure. Each special district focuses on providing specific types of services. Local examples include MCWRA, the Resource Conservation District of Monterey County, Castroville Community Services District, Northern Salinas Valley Mosquito Abatement District, and Moss Landing Harbor District.

Joint Powers Authority

As authorized under California Government Code Section 6502, a *joint powers authority* is an entity formed by two or more public agencies by agreement, that jointly exercise any power common to the contracting parties, including, but not limited to, the authority to levy a fee, assessment, or tax. Local examples include the Fort Ord Reuse Authority (the entity redeveloping the former Fort Ord and preparing a habitat conservation plan [HCP]); Monterey Bay Community Power (the Community Choice Aggregation set up to provide energy to Monterey, Santa Cruz, and San Benito Counties); and the Salinas Valley Basin Groundwater Sustainability Agency (GSA).

[1] https://www.ccactiontracker.org/

[2] https://ptrack.ecoatlas.org/

State Conservancy

A *state conservancy* is an agency established to promote and protect a certain part of the California landscape that is deemed by the California legislature to be of particular importance. Conservancies fall under California's Natural Resources Agency, although each is governed by its own board composed of individuals representing federal, state, local agency, and non-governmental interests. The San Diego River Conservancy is an example of a watershed-based state conservancy established to meet needs of the environment, cultural resources, floodwater management, and local economies. The Sierra Nevada Conservancy is an example of a state conservancy established to meet multi-benefit needs of the environment, local economies, and social well-being.

Nonprofit Organization

Established under U.S. Internal Revenue Code Section 501(c)(3), a *nonprofit organization* qualifies for federal tax exemption and is usually considered a public charity, private foundation, or private operating foundation. Nonprofit organizations also include unincorporated associations. Examples of local nonprofit organizations include the Salinas River Stream Maintenance Program River Management Unit Association, Community Foundation for Monterey County, Communities for Sustainable Monterey County, Elkhorn Slough Foundation, and the Steinbeck Center Foundation. Examples of nonprofit organizations focused on watershed health include the Sacramento River Watershed Program, Eel River Watershed Improvement Group, and the San Joaquin River Parkway and Conservation Trust.

Coalition

A *coalition* is an alliance for combined action for a specific purpose. Coalitions can be legislatively established or can be voluntary with varying degrees of binding commitment.

- *Legislatively established coalitions* are state, federal, or state/federal agencies formed through legislation. Examples include the San Francisco Estuary Partnership and the Puget Sound Partnership.
- *Voluntary coalitions* are not bound by jurisdictional or regulatory requirements. Often these types of coalitions establish their purpose, roles, and responsibilities through a memorandum of understanding. Examples include the Santa Clara River Floodplain Protection Program and the San Lorenzo River Committee.

5.2 Funding

Identifying and securing implementation funding is a critical challenge for any management plan. Section 2.2, *Jurisdiction and Funding Mechanisms,* and Section 4.3.4, *Management Funding Sources are Needed*, discuss some of the funding challenges specific to the LTMP. Nonetheless, funding opportunities do exist and can also be created. Throughout the LTMP development process, various funding opportunities were suggested by stakeholders. During the special meeting of the MCWRA Board of Directors on January 11, 2019, opportunities for funding development of the forthcoming HCP were discussed. The sources of funding identified by LTMP stakeholders, and during the special meeting of the MCWRA Board of Directors, are summarized in Table 5-1, together with specific approaches relevant to each source.

Table 5-1. Potential Implementation Funding Sources

Funding Source	New/ Existing	Previously Used	Notes
MCWRA Board of Directors and County Board of Supervisors	New	Yes	Approaches could include: • funding commitment through an adopted resolution • annual budgetary funding
Voter-approved (Proposition 218) assessments, taxes, and/or fees	New	Yes	• Applicable to project-specific funding needs, although projects can be large-scale and broadly described • Would likely require a sunset date • Highest support would be for those projects that are multi-benefit, supporting the needs of the entire community
Federal, state, and local partnerships	New; possibly existing	Yes	• Work directly with elected officials at all levels, including the new governor, to: ○ Appropriate Salinas River-specific funds (federal or state) ○ Include as a line-item on next state water bond • Work with state and federal agencies that are landowners or oversee management of the Salinas River • Apply for funding through the Clean Water State Revolving Fund • Establish a new fee based on the approach used for Salinas Valley Basin GSP development • Establish connection to GSP implementation
Grants	Existing; possibly new	Yes	• Engage trade associations and other nongovernmental organizations to apply for and implement grants • Hire an administrator to help apply for and administer grants • Identify sources of matching funds (often needed for grants)

MCWRA = Monterey County Water Resources Agency; GSP = groundwater sustainability plan

Other opportunities for funding include:

- Private and nonprofit sources (e.g., foundations, land trusts, The Nature Conservancy, partnering with landowners and growers).
- MCWRA land or other assets to sell or use as collateral to secure a loan.
- Engaging the County of San Luis Obispo for possible contributions.

The LTMP stakeholders anticipate that funding for the LTMP will come from many of the previously listed opportunities.

Appendix I, *Grant Opportunities* provides a list of grant programs that may be applicable to management needs of the Salinas River.

5.3 Relationship to Other Planning Efforts

In addition to identifying a lead entity—or convener—for implementation, stakeholders were clear that successful implementation of the LTMP would depend on many partners coming together to collectively manage the Salinas River's many resources. This will require coordination between LMTP implementation and other efforts.

Several existing planning efforts are expected to implement many of the management actions identified in Tables 4-1 and 4-2. Because these other planning efforts have different goals and are being led by different agencies and stakeholders, there is a risk that they may implement management actions inconsistent from this LMTP. Indeed, throughout LTMP development, stakeholders raised concerns that the LTMP and other ongoing or future planning efforts need to be consistent with one another. Stakeholders also said that ideally, each new plan would build on the information and approaches developed during previous planning efforts. This concern was captured in management objective O-GEN-3, "Ensure the LTMP is a driver in the development of future programs and projects (e.g., HCP, GSP)." MCWRA's anticipated HCP and the development of the GSPs (Section 2.4.2.3, *Groundwater Sustainability Plans*) are of primary concern; each of these is briefly described below. Other programs also provide opportunities for implementation partnerships and are also briefly described below.

5.3.1 Habitat Conservation Plan

Operation of MCWRA facilities and management of the sandbar at the mouth of the Salinas River Lagoon may cause "take" of several listed species. The development of an HCP, under Section 10 of the federal Endangered Species Act (ESA), will address long-term water operations and maintenance. The HCP will provide a more comprehensive and durable take authorization than would biological opinions under Section 7 of the ESA, with permits expected to last 30 years or more. The HCP will be based, in part, on the LTMP and the existing biological opinions.

MCWRA anticipates beginning development of the HCP and environmental impact report (EIR)/environmental impact statement (EIS) in 2019, if funding is secured to support the effort. The HCP and EIR/EIS will take approximately 3 years to complete.

5.3.2 Groundwater Sustainability Plans

Strong support for consistency between the in-development GSPs (Section 2.4.2.3, *Groundwater Sustainability Plans*) and the LTMP was raised repeatedly throughout the LTMP development process. Several planning task management actions were developed (Table 4-1), providing guidance on how the GSP and LTMP may be linked. These are excerpted below.

- **A-MAINT-2.** Collaborate with programs with funding mechanisms (e.g., the Salinas Valley Basin GSA in development of the Salinas Valley Basin GSP) to consider stream maintenance needs and, where appropriate, incorporate stream maintenance objectives and actions.

- **A-WAT-5.** Identify funding sources—in addition to voter-approved funding—for GSP projects that have multiple benefits including, but not limited to, Proposition 68 (approved in June 2018), the California State Revolving Fund, and California Department of Water Resources.
- **A-WAT-6.** Use the GSPs as a mechanism for meeting some, if not all, water management needs in a manner that is financially equitable.
- **A-WAT-7.** Projects developed under the GSPs should utilize information provided in the LTMP to inform and guide the goals and parameters of the project.
- **A-WAT-8.** Develop the GSPs based on best available data to be consistent and compatible with a future potential HCP. Identify projects in the GSPs that could become covered activities under an HCP.

As described in Section 2.4.2.3, the Salinas Valley Basin GSA is developing the Integrated Valley-Wide GSP. The first deadline for this plan is January 2020; however, it will be updated to include additional subbasins by January 2022. Stakeholders recommend that the subsequent 2022 Integrated Valley-Wide GSP consider the implementation successes or failures of LTMP management actions that are implemented over the next 3 years.

5.3.3 Implementation Partnerships

The LTMP stakeholders expressed support for embracing the inevitable partnerships between MCWRA, landowners, growers, and all other parties working toward better management of the Salinas River. Several existing or soon-to-be-adopted programs provide excellent partnership opportunities in implementation of management actions. In addition to GSP development, some programs that are likely to present such opportunities include the following.

- Salinas River Stream Maintenance Program (Section 2.4.2.1, *Salinas River Stream Maintenance Program*).
- Salinas Watershed Invasive Nonnative Plant Control and Restoration Program (Section 2.5.2, *Resource Conservation District of Monterey County*).
- Greater Monterey County IRWM Plan (Section 2.4.2.5, *Greater Monterey County Integrated Regional Water Management Plan*).
- Greater Monterey County SWRP (Section 2.4.2.6, *Greater Monterey County Storm Water Resources Plan*).

For management actions that achieve similar goals and objectives across multiple plans, partnerships to acquire funding are expected to be particularly compelling and competitive, and are encouraged.

5.4 Regulatory Compliance

The management actions presented in Table 4-1 and 4-2 are brief statements about proposed river management. As any individual project or activity is advanced, robust consideration and evaluation will be needed to ensure compliance with local, state, and federal laws and regulations. When undertaking any type of ground-disturbing or vegetation-manipulating activities, it is important to consider that the action may affect resources regulated by one or more agency and may require one

or more regulatory permits. Long-term management solutions for the Salinas River, including flood, water resource, and threatened and endangered species management will require compliance with various environmental regulations. Appendix H, *Regulatory Context*, provides a brief overview of the permitting agencies and key environmental regulations that are likely to apply to implementation of the Salinas River LTMP. These regulations provide for the protection of streams, floodplains, wetland and riparian vegetation, special-status species, and water quality. Table 5-2 summarizes the laws and regulations that are commonly associated with the regulatory permitting process triggered by ground-disturbing activities. The laws and regulations summarized in this table do have caveats regarding their applicability to a given project; this table provides overarching guidance but should not be considered exhaustive in its content.

Table 5-2. Regulatory Permit Requirements for Ground Disturbance in Jurisdictional Areas

Laws and Regulations	Permit	Responsible Agency	Triggers	Key Information
Federal				
Clean Water Act Section 404 and Rivers and Harbors Act Section 10	Nationwide Permit; Regional General Permit; or Individual Permit	U.S. Army Corps of Engineers (USACE)	Discharge of dredged or fill material into waters of the United States (Clean Water Act); the construction of any structure in or over any navigable water of the United States (Rivers and Harbors Act)	May provide a federal nexus for the USACE to initiate consultation with U.S. Fish and Wildlife Service and/or National Marine Fisheries Service under Section 7 of the federal Endangered Species Act (for species within USACE jurisdictional waters).
Clean Water Act Section 401	Water Quality Certification	Regional Water Quality Control Board	Clean Water Act Section 404 permit	Certifies that Section 404 permits for discharges into waters of the United States meet State water quality standards. The federal permit cannot be issued if the State denies certification.
Endangered Species Act Section 7	Biological Opinion and Incidental Take Statement	U.S. Fish and Wildlife Service and/or National Marine Fisheries Service	Likelihood that an activity may adversely affect species listed as endangered or threatened under the Endangered Species Act where a federal nexus (authorization, funding, implementation by a federal agency) exists	Ensures that any action authorized (including issuance of any federal permits), funded, or carried out is not likely to jeopardize the continued existence of any species listed as threatened or endangered, or result in the destruction or adverse modification of habitat critical to the survival of such species.
Endangered Species Act Section 10	Habitat Conservation Plan and Incidental Take Permit	U.S. Fish and Wildlife Service and/or National Marine Fisheries Service	Potential "take" of species listed as threatened or endangered under the federal Endangered Species Act where a federal nexus does not exist	Projects that take listed species and have no federal nexus must prepare a habitat conservation plan. The habitat conservation plan explains how the project proponent will mitigate take related to activities and species covered by the incidental take permit.

Laws and Regulations	Permit	Responsible Agency	Triggers	Key Information
State				
California Endangered Species Act Section 2081	Incidental Take Permit	California Department of Fish and Wildlife	Potential "take" of species listed as threatened, endangered, or candidate under the California Endangered Species Act	Ensures that any action authorized is not likely to jeopardize the continued existence of any state listed or candidate species. Cannot obtain take authorization for fully protected species.
California Fish and Game Code Section 1602	Lake or Streambed Alteration Agreement	California Department of Fish and Wildlife	Actions that would alter any river, stream, or lake in California, or their associated riparian or wetland habitats	Ensures that any actions within rivers, streams, or lakes in California are conditioned to conserve existing fish and wildlife resources.
California Coastal Act	Coastal Development Permit	California Coastal Commission	Development actions within the Coastal Zone boundary	Ensures scenic and visual qualities of coastal areas are protected, as well as minimize the alteration of natural land forms and maintains existing public access.
Porter-Cologne Water Quality Control Act	Waste Discharge Requirement	Regional Water Quality Control Board	Point source discharges to Waters of the State not otherwise regulated under the federal Clean Water Act	

Notes:

[1] Additional permit requirements may exist based on resources affected by specific activities. These include, but are not limited to, local ordinances (e.g., for grading), State lands leasing, Federal Emergency Management Act requirements for certain work within the 100-year floodplain, and Monterey Bay Air Resources District permits.

Definitions:

Waters of the United States are generally defined as streams and wetlands that connect to navigable waterways. The Code of Federal Regulations Title 33 Part 328 (abbreviated "33 CFR 328") defines *Waters of the United States* as it applies to the jurisdictional limits of the authority of the U.S. Army Corps of Engineers under the Clean Water Act. *Navigable waters* is a term used within the *Waters of the United States* definition. *Navigable waters* are defined in 33 CFR 329.

Under California Water Code Section 13050 (e), *Waters of the state* means any surface water or groundwater, including saline waters, within the boundaries of the state.

Under federal Endangered Species Act, Section 3 (19), *take* means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct."

Under California Fish and Game Code Section 86, *take* means to "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill."

Chapter 6
References

6.1 Chapter 1, Introduction

Monterey County Water Resources Agency. 2013. Salinas River Management Program Comments from Public Meeting. December.

Monterey County Water Resources Agency. 2014. Salinas River Stream Maintenance Program Revised Final Environmental Impact Report. State Clearing House #2011041066. June. 332 pp.

U.S. Geological Survey. 2017. National Hydrography Dataset, Watershed Boundaries. Available: https://www.usgs.gov/core-science-systems/ngp/national-hydrography/watershed-boundary-dataset?qt-science_support_page_related_con=4#qt-science_support_page_related_con. Accessed: April 2018.

6.2 Chapter 2, Background

California Department of Water Resources. 2018. Sustainable Groundwater Management Program Data Viewer. Available: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer. Accessed: July 2018.

California State University Monterey Bay. 2018. Monterey One Service Area Map. Available: http://ccows.csumb.edu/wiki/index.php/File:Montereyonewaterservicearea_downloaded180406.jpg. Accessed: November 2018.

Central Coast Watershed Studies. 2006. Final Monterey County Water Resources Agency Reclamation Ditch Watershed Assessment and Management Strategy: Part A Watershed Assessment. The Watershed Institute, Earth Systems Science and Policy. California State University, Monterey Bay.

Central Coast Wetlands Group. 2015. Salinas River Lagoon marsh plain condition assessment. Summary report. Prepared for: Monterey County Water Resources Agency. November. 13 pp

Central Coast Wetlands Group. 2017. Moss Landing Community Coastal Climate Change Vulnerability Report. June. 87 pp.

City of Greenfield. 2018. Arroyo Seco Groundwater Sustainability Agency. Greenfield, California. Available: http://ci.greenfield.ca.us/379/ASGSA. Accessed: November 2018.

Denise Duffy & Associates. 2016. Pure Water Monterey Groundwater Replenishment Project Consolidated Final Environmental Impact Report. Prepared for the Monterey Regional Water Pollution Control Agency. Available: http://purewatermonterey.org/reports-docs/cfeir/. Accessed: July 2018.

Elkhorn Slough National Estuarine Research Reserve. 2013. Boundary of the Elkhorn Slough watershed and its sub-watersheds. Available: https://www.elkhornslough.org/research-program/mapping-gis/. Accessed: November 2018.

Environmental Science Associates and Central Coast Wetlands Group. 2018. Greater Monterey County Stormwater Plan, Water Balance, and Flood Modeling. Draft. December. 47 pp.

Geoscience. 2013. Protective Elevations to Control Sea Water Intrusion in the Salinas Valley. Technical Memorandum. November. 36 pp.

Hagar Environmental Science. 2010. Salinas River Lagoon Breach Monitoring Report 2008-2009. Prepared for the Monterey County Water Resources Agency. July. 43 pp.

Hager Environmental Science. 2015. Salinas River Lagoon Monitoring Report 2014. Prepared for Monterey County Water Resources Agency. June. 46 pp.

Marina Coast Water District and Marina Coast Water District Groundwater Sustainability Agency. 2018. MCWD Groundwater Sustainability Agency. Marina Coast Water District. Available: https://www.mcwd.org/gsa_about.html. Accessed: November 2018.

Monterey County Water Resources Agency. 1997. Salinas River Lagoon Management and Enhancement Plan. Prepared with assistance from John Gilchrist & Associates, Habitat Restoration Group, Phillip Williams & Associates, and Wetland Research Associates. March. 232 pp.

Monterey County Water Resources Agency. 2005. *Salinas Valley Water Project Flow Prescription for Steelhead Trout in the Salinas River*. October. 140 pp.

Monterey County Water Resources Agency. 2006. Monterey County Groundwater Management Plan. May. 76 pp. Prepared with assistance from with assistance from RMC Water and Environment and Luhdorff & Scalmanini Consulting Engineers Available: http://www.co.monterey.ca.us/home/showdocument?id=22563. Accessed July 2018.

Monterey County Water Resources Agency. 2014. Salinas River Stream Maintenance Program Revised Final Environmental Impact Report. State Clearing House #2011041066. June. 332 pp.

Monterey County Water Resources Agency. 2015. CASGEM Monitoring Plan for High and Medium Priority Basins in the Salinas Valley Groundwater Basin. March. 65 pp.

Monterey County Water Resources Agency. 2016. Interlake Tunnel and Spillway Modification Project Notice of Preparation/Initial Study. April. 65 pp.

Monterey County Water Resources Agency. 2017. Recommendations to Address the Expansion of Seawater Intrusion in the Salinas River Groundwater Basin. Special Reports Series 17-01. October. 244 pp.

Monterey County Water Resources Agency. 2018a. Nacimiento Dam Operation Policy. Available: https://www.co.monterey.ca.us/Home/ShowDocument?id=63151. Accessed: July 2018.

Monterey County Water Resources Agency. 2018b. Groundwater Level Monitoring Overview. County of Monterey. Available: http://www.co.monterey.ca.us/government/government-links/water-resources-agency/programs/groundwater-level-monitoring/overview#wra. Accessed: July 2018.

Monterey County Water Resources Agency. 2018c. Dams and Reservoirs: Overview. County of Monterey. Available: http://www.co.monterey.ca.us/government/government-links/water-resources-agency/projects-facilities/dams-and-reservoirs#wra. Accessed: July 2018.

Monterey County Water Resources Agency. 2018d. Monterey County Recycling Projects (CSIP/SVRP). County of Monterey. Available: http://www.co.monterey.ca.us/government/government-links/water-resources-agency/projects-facilities/castroville-seawater-intrusion-project-salinas-valley-reclamation-project-csip-#wra. Accessed: July 2018.

Monterey County Water Resources Agency. 2018e. Salinas Valley Water Project. County of Monterey. Available: http://www.co.monterey.ca.us/government/government-links/water-resources-agency/projects-facilities/salinas-valley-water-project-svwp#wra. Accessed: July 2018.

Monterey County Water Resources Agency. 2018f. Interlake Tunnel. County of Monterey. Available: http://www.co.monterey.ca.us/government/government-links/water-resources-agency/projects-facilities/interlake-tunnel#wra. Accessed: July 2018.

Monterey County Water Resources Agency. 2018g. Salinas River Stream Maintenance Program (SMP). County of Monterey. Available: http://www.co.monterey.ca.us/government/government-links/water-resources-agency/programs/salinas-river-stream-maintenance-program#wra. Accessed: July 2018.

Monterey Regional Stormwater and Education Alliance. 2018. Monterey Regional Stormwater and Education Alliance Stormwater Planning. Available: http://montereysea.org/about-us/. Accessed: December 2018.

National Marine Fisheries Service. 2009. Biological Opinion for Sandbar Breaching at the Mouth of the Salinas River. National Marine Fisheries Service Southwest Region, Long Beach, California, December 21, 2009.

National Oceanic and Atmospheric Administration. 2018. Monterey Bay National Marine Sanctuary. Available: https://montereybay.noaa.gov/intro/welcome.html. Accessed December 2018.

Pure Water Monterey. 2018. About Pure Water Monterey. Pure Water Monterey. Available: http://purewatermonterey.org/. Accessed: July 2018.

Raftelis Financial Consultants. 2017. Monterey County Water Resources Agency Rate Study. March. 14 pp.

Regional Water Management Group. 2018. Greater Monterey County Integrated Regional Water Management Plan regional map. Available: http://www.greatermontereyirwmp.org/. Accessed: November 2018.

Resource Conservation District of Monterey County. 2011. Initial Study for the Salinas Watershed Invasive Non-native Plant Control and Restoration Program. September. 58 pp.

Resource Conservation District of Monterey County. 2018.

RMC Water and Environment. 2003. Salinas Valley Water Project: Engineer's Report. Prepared for the Monterey Water Resources Agency. January. 55 pp.

RMC Water and Environment. 2007. Zone 2B Proposition 218 Engineer's Report. Prepared for the Monterey Water Resources Agency. November. 23 pp.

Rosenberg, Lewis I., and Joseph C. Clark. 2009, Map of the Rinconada and Reliz Fault Zones, Salinas River Valley, California: U.S. Geological Survey Scientific Investigations Map 3059, scale

1:250,000 with pamphlet. Available at: https://pubs.usgs.gov/sim/3059/. Accessed: January 2019.

Salinas Valley Basin Groundwater Sustainability Agency. 2018. What is the Salinas Valley GSA. Salinas Valley Basin Groundwater Sustainability Agency. Available: https://svbgsa.org/about-us/. Accessed: October 2018.

U.S. Bureau of Reclamation. 2017. Plan of Study: Carmel and Salinas Rivers Basin Study. Bureau of Reclamation, Mid-Pacific Region. January. 91 pp.

6.2.1 Personal Communications

Wald, Steph. 2018. Program Coordinator. Upper Salinas–Las Tablas Resource Conservation District. Watershed management plan for the upper Salinas River. Email to Danielle Tannourji—Biologist. ICF. December 13.

Zefferman, Emily. 2018. Ecologist. Resource Conservation District of Monterey County. Salinas Watershed Invasive Nonnative Plant Control and Restoration Program. Email to Danielle Tannourji—Biologist. ICF. August 27.

6.3 Chapter 3, Historical and Existing Conditions

ABA Consultants. 1989. Elkhorn Slough Wetland Management Plan. Prepared for California State Coastal Conservancy and Monterey County Planning Department. December. 198 pp.

Allen-Diaz, B., J. W. Bartolome, and M. P. McClaran. 1999. California oak savanna. Chapter 20 in: R. C. Anderson, J. S. Pralish, and J. M. Baskin (eds.). Savannas, barrens, and rock outcrop plant communities of North America. Cambridge University Press.

Battin, J., M. W. Wiley, M. H. Ruckelhaus, R. N. Palmer, E. Korb, K. K. Bartz, and H. Imaki. 2007. Projected impacts of climate change on salmon habitat restoration. Proceedings of the National Academy of Sciences of the United States of America 104:6720-6725.

Bechtel Corp. 1959. Preliminary Planning Report on Flood Control for Area Tributary to Main Reclamation Ditch Between Alisal Creek Watershed and Monterey Bay, Prepared for Monterey County Flood Control and Water Conservation District Zone 2 Salinas, California. 37 pp.

Becker, G.S. and I.J. Reining. 2008. Steelhead/rainbow trout (*Oncorhynchus mykiss*) resources south of the Golden Gate, California. Cartography by D.A. Asbury. Center for Ecosystem Management and Restoration. Oakland, CA.

Beier, P. 1995. Dispersal of juvenile cougars in fragmented habitats. Journal of Wildlife Management 5:228-237.

Bellard, C., J.M. Jeschke, B. Leroy, and G.M. Mace. 2018. Insights from modeling studies on how climate change affects invasive alien species geography. Ecology and Evolution. 2018; 8:5688–5700. Available at: https://doi.org/10.1002/ece3.4098.

Blaney, H. R. 1933. Rainfall penetration in Ventura County Investigation. California Department Public Works, Division of Water Resources. Bull. 46. pp 82-91.

Bond, M.H. 2006. The importance of estuary rearing to Central California steelhead (*Oncorhynchus mykiss*) growth and marine survival. Master's thesis. University of California, Santa Cruz.

Boughton, D. A. 2010. A Forward-Looking Frame of Reference for Steelhead Recovery on the South-Central and Southern California Coast. NOAA Technical Memorandum NMFS-SWFSC TM-466.

Boughton, D., H. Fish, J. Pope and G. Holt. 2009. Spatial patterning of habitat for Oncorhynchus mykiss in a system of intermittent and perennial stream. Ecology of Freshwater Fish 18:92-105.

Breschini, G., T. Haversat, and M. Gudgel. 2000. 10,000 Years on the Salinas Plain. Heritage Media Corporation, Carlsbad, CA 92009. 208 pp.

Brown and Caldwell. 2015a. State of the Salinas River Groundwater Basin. Prepared for Monterey County Water Resources Agency. January. 240 pp.

Brown and Caldwell. 2015b. Technical Memorandum No. 2: Storage Change Analysis. Prepared for Monterey County Water Resources Agency. January. 31 pp.

Bunn, D., A. Mummert, M. Hoshovsky, K. Gilardi, and S. Shanks. 2007. California Wildlife: Conservation Challenges California's Wildlife Action Plan. Prepared by University of California, Davis, Wildlife Health Center for California Department of Fish and Game. 597 pp.

Cal Fire. 2015. Fire Resource and Assessment Program (FRAP) website. Available at: http://frap.fire.ca.gov/. Accessed: January 2019.

CALFED. 1976. Nacimiento Dam and Nacimiento River Case Study Report #79. Available at: http://www.calwater.ca.gov/Admin_Record/C-064356.pdf.

CalFish. 2018. California Fish Passage Assessment Database. California Fish Passage Forum. Available: https://www.calfish.org/tabid/420/Default.aspx. Accessed June 2018.

California Coastal Commission. 2015. California Coastal Commission on Sea Level Rise Policy Guidance Interpretive Guidelines for Addressing Sea Level Rise in Local Coastal Programs and Coastal Development Permits. August 2015. Available at: https://www.coastal.ca.gov/climate/slrguidance.html

California Conservation Easement Database. 2018. Available at: https://www.calands.org/cced/. Accessed: January 2019.

California Department of Conservation. 2010. Statewide Geological Map of California. Available at: https://www.conservation.ca.gov/cgs/maps-data/rgm. Accessed: August 2018.

California Department of Conservation. 2014. Fresno County Important Farmland. Available at: ftp://ftp.consrv.ca.gov/pub/dlrp/FMMP/2014. Accessed August 2018.

California Department of Conservation. 2016a. Monterey County Important Farmland. Available at: ftp://ftp.consrv.ca.gov/pub/dlrp/FMMP/2016. Accessed: August 2018.

California Department of Conservation. 2016b. San Benito County Important Farmland. Available at: ftp://ftp.consrv.ca.gov/pub/dlrp/FMMP/2016. Accessed: August 2018.

California Department of Conservation. 2016c. San Luis Obispo County Important Farmland. Available at: ftp://ftp.consrv.ca.gov/pub/dlrp/FMMP/2016. Accessed: August 2018.

California Department of Conservation. 2016d. Monterey County Williamson Act FY 2015/2016. Available at: ftp://ftp.consrv.ca.gov/pub/dlrp/wa/. Accessed: May 2018.

California Department of Fish and Wildlife. 2015. State Wildlife Action Plan. 2015 Update. A conservation legacy for Californians. Available at: https://www.wildlife.ca.gov/SWAP/Final. Accessed: January 2019.

California Department of Fish and Wildlife. 2018a. California Natural Communities List. Available at: https://www.wildlife.ca.gov/Data/VegCAMP/Natural-Communities#natural%20communities%20lists. Accessed: January 2019.

California Department of Fish and Wildlife. 2018b. California Natural Diversity database. Version 5.2.14. Available at: https://map.dfg.ca.gov/rarefind/view/RareFind.aspx. Accessed: January 2019.

California Department of Fish and Wildlife. 2019. Data Portal. Moro Cojo and Elkorn Slough Protected Areas. Available at: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=117403&inline. Accessed January 2019.

California Department of Forestry and Fire Protection. 2015. FRAP Vegetation. Available: http://frap.fire.ca.gov/data/statewide/fveg15_1.zip. Accessed: March 2016.

California Department of Water Resources. 1946. Salinas Basin Investigation Summary Report. Bulletin 52. Available at: https://digitalcommons.csumb.edu/hornbeck_cgb_1/6/.

California Department of Water Resources. 2003. California's Groundwater. Bulletin No. 118, 2003 Update. October. 265p. Available at: https://www.water.ca.gov/LegacyFiles/pubs/groundwater/bulletin_118/california's_groundwater__bulletin_118_-_update_2003_/bulletin118_entire.pdf.

California Department of Water Resources. 2015. California Climate Science and Data for water resources management. June. Available at: https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/All-Programs/Climate-Change-Program/Climate-Change-And-Water/Files/California-Climate-Science-and-Data-for-Water-Resources-Management.pdf. Accessed: January 2019.

California Department of Water Resources. 2018. Sustainable Groundwater Management Program Data Viewer. Available: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer. Accessed: July 2018.

California Department of Water Resources. 2019. Land Use surveys. Online land use and soil maps. Available at: https://water.ca.gov/Programs/Water-Use-And-Efficiency/Land-And-Water-Use/Land-Use-Surveys. Accessed: January 2019.

California Energy Commission. 2018. Cal-Adapt. Annual Averages. Available at: http://cal-adapt.org/tools/annual-averages/#climatevar=tasmax&scenario=rcp45&lat=36.21875&lng=-121.15625&boundary=locagrid&units=fahrenheit. Accessed: June 2018.

California Invasive Plant Council. 2011. Arundo donax. Distribution and impact report. March. Agreement No. 06-374-559-0 State Water Resources Control Board. Available at: https://www.cal-ipc.org/wp-

content/uploads/2017/11/Arundo_Distribution_Impact_Report_Cal-IPC_March-2011_small.pdf. Accessed: January 2019.

California Invasive Plant Council. 2014. Salinas Arundo. GIS data transfer from Emily Zefferman, Resource Conservation District of Monterey County to Danielle Tannourji, ICF

California Protected Areas. 2018. California Protected Areas Data Portal. Available at: www.calands.org/map. Accessed: June 2018.

California State Water Resources Board. 1956. Salinas River Basin Investigation, Bulletin 19, February 1956, 225p.

Carlson, S. M. and T. R. Seamons. 2008. A review of quantitative genetic components of fitness in salmonids: Implications for adaptation to future change. Evolutionary Applications 1(2):222-238.

Carpenter, E.J. and S.W. Cosby. 1925. Soil Survey of the Salinas Area, California, United States Department of Agriculture, Bureau of Chemistry and Soils in Cooperation with the University of California Agricultural Experiment Station, 92 p.

Cayan, D. 2006. Scenarios of Climate Change in California. 2006. California Climate Change Center. University of California, Berkeley.

Cayan, D., E Maurer, M. Dettinger, M. Tyree, K. Hayhoe. 2008. Climate change scenarios for the California region. Climatic Change 87(Suppl. 1):21-42.

Cayan, D., M. Tyree, M. Dettinger, H. Hidlago, T. Das, E. Maurer, P. Bromirski, N. Graham, and R. Flick. 2009. Climate Change Scenarios and Sea Level Rise Estimates for the California 2009 Climate Change Scenarios Assessment. California Climate Change Center, University of California, Berkeley.

Central Coast Regional Water Quality Control Board. 2010. Lower Salinas River Fecal Coliform TMDL. Available at: https://www.waterboards.ca.gov/centralcoast/water_issues/programs/tmdl/docs/salinas/lower_fecal/.

Central Coast Regional Water Quality Control Board. 2011. Lower Salinas River Watershed Chlorpyrifos and Diazinon TMDL. Available at: https://www.waterboards.ca.gov/centralcoast/water_issues/programs/tmdl/docs/salinas/pesticide/.

Central Coast Regional Water Quality Control Board. 2013. Amending the water quality control plan for the central coastal basin to adopt total maximum daily loads for nitrogen compounds and orthophosphate in the lower Salinas River and Reclamation Canal Basin and the Moro Cojo Slough subwatershed. Available at: https://www.waterboards.ca.gov/centralcoast/water_issues/programs/tmdl/docs/salinas/nutrients/att1_res_signed_bpa_approved_fin.pdf. Accessed: January 2019.

Central Coast Regional Water Quality Control Board. 2014. Lower Salinas River Watershed Nutrient TMDL. Available at: https://www.waterboards.ca.gov/centralcoast/water_issues/programs/tmdl/docs/salinas/nutrients/.

Central Coast Regional Water Quality Control Board. 2017a. Water Quality Control Plan for the Central Coastal Basin. September 2017. Available at: https://www.waterboards.ca.gov/centralcoast/publications_forms/publications/basin_plan/.

Central Coast Regional Water Quality Control Board. 2017b. Salinas River Watershed Sediment Toxicity and Pyrethroid Pesticides in Sediment TMDL. Available at: https://www.waterboards.ca.gov/centralcoast/water_issues/programs/tmdl/docs/salinas/sed_tox/.

Central Coast Watershed Studies. 2001. Winter Water Quality of the Carmel and Salinas Lagoons, Monterey, California: 2000/2001. Report No. WI-2001-01. March 29.

Central Coast Watershed Studies. 2006. Final Monterey County Water Resources Agency Reclamation Ditch Watershed Assessment and Management Strategy: Part A Watershed Assessment. The Watershed Institute, Earth Systems Science and Policy. California State University, Monterey Bay.

Central Coast Wetlands Group. 2015. Salinas River Lagoon marsh plain condition assessment. Summary report. Prepared for: Monterey County Water Resources Agency. November. 13 pp.

Central Coast Wetlands Group. 2017. Moss Landing Community Coastal Climate Change Vulnerability Report. June. 87 pp.

County of Monterey. 2010. Monterey County General Plan. October 26. Available at: http://www.co.monterey.ca.us/government/departments-i-z/resource-management-agency-rma-/planning/resources-documents/2010-general-plan. Accessed: May 2018.

County of Monterey. 2018. County of Monterey Open Data. Available at: https://montereycountyopendata-12017-01-13t232948815z-montereyco.opendata.arcgis.com. Accessed: August 2018.

County of San Benito. 2015. San Benito County 2035 General Plan. Available at: http://cosb.us/wp-content/uploads/Adopted-2035-GPU.pdf. Accessed: August 2018.

County of San Luis Obispo. 2018. County of San Luis Obispo Open Data. Available at: http://opendata.slocounty.ca.gov/datasets/general-plan-land-use-designations. Accessed: August 2018.

Crozier, L. G. and J. A. Hutchings. 2014. Plastic and evolutionary responses to climate change in fish. Evolutionary Applications 7(1):68-87.

Crozier, L. G., A. P. Hendry, P. W. Lawson, T. P. Quinn, N. J. Mantua, J. Battin, R. G. Shaw, and R. B. Huey. 2008. Potential responses to climate change in organisms with complex life-histories: evolution and plasticity in Pacific salmon. Evolutionary Applications 1:252-270.

Dai, A. 2013. Increasing drought under global warming in observations and models. Nature Climate Change, 3(1), p.52.

Denise Duffy and Associates. 2016. Pure Water Monterey Groundwater Replenishment Project Consolidated Final Environmental Impact Report. Prepared for the Monterey Regional Water Pollution Control Agency. Available at: http://purewatermonterey.org/reports-docs/cfeir/. Accessed: July 2018.

Dickson, B.G., J.S. Jenness, and P. Beier. 2004. Influence of vegetation, roads, and topography on cougar movement in southern California. Journal of Wildlife Management 69(1):264-276.

Dunham, J.B., M.K. Young, R.E. Gresswell and B.E. Rieman. 2003. Effects of fire on fish populations: landscape perspectives on persistence of native fishes and nonnative fish invasions. Forest Ecology and Management, 178(1-2), pp.183-196.

Elkhorn Slough Tidal Wetland Project. 2012. Large-Scale Restoration Alternatives for Elkhorn Slough: Summary of Interdisciplinary Evaluations and Recommendations. 44pp.

EMC Planning Group and EDAW. 1997. Fort Ord Reuse Plan Environmental Impact Report. Prepared for the Fort Ord Reuse Authority. SCH No. 96013022. June.

ENTRIX and EDAW. 2002. Biological Assessment for the Salinas Valley Water Project Salinas River, California. Prepared for the U.S. Army Corps of Engineers, by ENTRIX, Inc., on behalf of Monterey County Water Resources Agency, Walnut Creek, California and EDAW, Inc., Sacramento, California.

Environmental Science Associates and Pacific Watershed Associates. 2014. Monterey Bay Sea Level Rise Vulnerability Study: Technical Methods Report. June 2014. Available at: https://nmsmontereybay.blob.core.windows.net/montereybay-prod/media/resourcepro/resmanissues/pdf/140616erosion-vuln_tech-methods.pdf.

Erksine, J. A. and A. T. Fisher. 2002. Implications of geometry, age and depositional history of a shallow confining layer in a coastal groundwater basin, Monterey County, California, USA. Geophysical Research Letter, Vol. 29, No. 24, 2178. Available at: https://pdfs.semanticscholar.org/6997/9cefb8c8e0e6da0b68165338fe5b44510285.pdf. Accessed: January 2019.

Federal Emergency Management Agency. 2018. Enterprise GIS Services. FEMA Flood Zone Boundaries. Available: https://gis.fema.gov/. Accessed: July 2018.

Ferren, W., P. L. Fiedler, and R. A. Leidy. 1995. Wetlands of the central and southern California coast and coastal watersheds. A methodology for their classification and description. Final Report to U.S. Environmental Protection Agency, Region IX, San Francisco, CA and Environmental Report. No. 1, Museum of Systematics and Ecology, University of California, Santa Barbara, ix + 500 pp.

Ficke, A. D., C. A. Myrick and L. J. Hansen. 2007. Potential impacts of global climate change on freshwater fisheries. Reviews in Fish Biology and Fisheries, 17(4), pp.581-613.

Fischer, J. and D. B. Lindenmayer. 2007. Landscape modification and habitat fragmentation: a synthesis. Global ecology and biogeography, 16(3), pp.265-280.

Fischer D.T., C.J. Still, and A.P. Williams. 2009. Significance of summer fog and overcast for drought stress and ecological functioning of coastal California endemic plant species. Journal of Biogeography 36:783–799.

FISHBIO. 2014a. Salinas River Basin Adult Steelhead Escapement Monitoring. 2014 Annual Report. June. 18 pp. Submitted to the Monterey County Water Resources Agency.

FISHBIO. 2014b. Salinas River Basin Juvenile O. mykiss Downstream Migration Monitoring. 2014 Annual Report Final. June. 21 pp. Submitted to the Monterey County Water Resources Agency.

Good, T.P., R.S. Waples, and P. Adams, editors. 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-66. Santa Cruz, California.

Google Earth Pro. 2018. Salinas River National Wildlife Refuge and Salinas River State Beach boundaries. Google Earth Pro. Version 7.3.2.5491. Image data: CSUMB SFML, CA OPC; TerraMetrics and U.S. Fish and Wildlife Service. Accessed: November 2018.

GreenInfo Network. 2016. California Conservation Easement Database 2016. Available at: http://www.calands.org/uploads/docs/CCED2016.zip. Accessed: August 2018.

GreenInfo Network. 2017. California Protected Areas Database 2017a. Available at: https://data.cnra.ca.gov/dataset/california-protected-areas-database-2017a. Accessed: August 2018.

Griffith, G.E., J.M. Omernik, D.W. Smith, T.D. Cook, E. Tallyn, K. Moseley, and C.B. Johnson. 2016, Ecoregions of California (poster): U.S. Geological Survey Open-File Report 2016–1021, with map, scale 1:1,100,000. Available at: http://dx.doi.org/10.3133/ofr20161021. Accessed: July 2018.

Guo, Fengyi, J. Lenoir, and T.C. Bonebrake. 2018. Land-use change interacts with climate to determine elevational species redistribution. Nature Communications, 2018; 9 (1) Available at: 10.1038/s41467-018-03786—9.

H.T. Harvey & Associates. 2009. Salinas River Lagoon Fisheries Enhancement Project Biological Assessment for the Western Snowy Plover, California Brown Pelican, Steelhead, Smith's Blue Butterfly, and Essential Fish Habitat. June. 76 pp.

Hagar Environmental Science. 2001. Salinas River Lagoon Water Quality and Fish Populations. Appendix C-3 to EIR/EIS for the Salinas Valley Water Project. Prepared for the Monterey County Water Resources Agency and the U.S. Army Corps of Engineers.

Hagar Environmental Science. 2005. Salinas River Lagoon. 2003-2004 Breach Monitoring Report. Prepared for the Monterey County Water Resources Agency.

Hagar Environmental Science. 2010a. Salinas River Lagoon Breach Monitoring Report 2008-2009. Prepared for the Monterey County Water Resources Agency. July. 43 pp.

Hagar Environmental Science. 2010b. Salinas River Lagoon Breach Monitoring Report 2009-2010. Prepared for the Monterey County Water Resources Agency. July. 40 pp.

Hagar Environmental Science. 2012. Salinas River Lagoon Monitoring Report 2011. Prepared for the Monterey County Water Resources Agency. February. 53 pp.

Hagar Environmental Science. 2013. Salinas River Lagoon Monitoring Report 2012. Prepared for the Monterey County Water Resources Agency. February. 53 pp.

Hagar Environmental Science. 2014. Salinas River Lagoon Monitoring Report 2013. Annual Report. Submitted to the Monterey County Water Resources Agency.

Hager Environmental Science. 2015. Salinas River Lagoon Monitoring Report 2014. Prepared for Monterey County Water Resources Agency. June. 46 pp.

Hamlin, H. 1904. Water Resources of the Salinas Valley, California, U.S. Geological Survey Water-Supply and Irrigation Paper 89, 1904, 123p.

Hanes, T. A. 1988. California chaparral. Chapter 12 in M.G. Barbour and J. Major, eds. Terrestrial Vegetation of California. Special publication number 9, California Native Plant Society, Sacramento.

Hansen, W.R., ed., 1991. Suggestions to authors of the reports of the United States Geological Survey (7th ed.): Washington, D.C., U.S. Geological Survey, 289 p. Available at: https://pubs.er.usgs.gov/publication/70058737. Accessed: January 2019.

Harding Engineering and Environmental Sciences. 2001. Final Report. Hydrogeologic investigation of the Salinas Valley Basin in the vicinity of Fort Ord and Marina. Salinas Valley, California. Prepared for Monterey County Water Resources Agency. April. Available at: http://www.co.monterey.ca.us/home/showdocument?id=19570. Accessed: January 2019.

Hayes, S. A., M.H. Bond, C.V. Hanson, A.W. Jones, A.J. Ammann, J.A. Harding, Al. L. Collins, J. Perez, and R.B. MacFarlane. 2011. Down, up, down and "smolting" twice? Seasonal movement patterns by juvenile steelhead (Oncorhynchus mykiss) in a coastal watershed with a bar closing estuary. Can. J. fish. Aquat. Sci. Vol. 68, 2011. Available at: https://swfsc.noaa.gov/uploadedFiles/Events/Meetings/Fish_2015/Document/6.1_Hayes_2011.pdf. Accessed: January 2019.

Hayes, D.B., B.J. Bellgraph, B.M. Roth, D.D. Dauble, and R.P. Mueller. 2014. Timing of redd construction by fall Chinook salmon in the Hanford Reach of the Columbia River. River Research and Applications 30(9):1110-1119.

Hayhoe, K., D. Cayan, C.B. Field, P.C. Frumhoff, E.P. Maurer, N.L. Miller, S.C. Moser, S.H. Schneider, K.N. Cahill, E.E. Cleland, L. Dale, R. Drapek, R.M. Hanemann, L.S. Kalkstein, J. Lenihan, C.K. Lunch, R.P. Neilson, S.C. Sheridan, and J.H. Verville. 2004. Emissions pathways, climate change, and impacts on California. Available at: https://www.pnas.org/content/pnas/101/34/12422.full.pdf. Accessed: January 17, 2019.

Hellmair, M., and A.P. Kinziger. 2014. Increased extinction potential of insular fish populations with reduced life history variation and low genetic diversity. PLoS ONE. 9(11): e113139. doi:10.1371/journal.pone.0113139.

Hellmair, M., D. Lee, and D. Demko. 2018. Salinas River Lagoon Fish Distribution Study, Summary of Recent Tidewater Goby Surveys. Report prepared for the Monterey County Water Resources Agency. November. 21 pp.

Holland, R.F. 1986. Preliminary descriptions of the terrestrial natural communities of California. Prepared for the California Department of Fish and Game, Nongame-Heritage Program and Natural Diversity Database, Sacramento. 156 pp. Available at: file:///C:/Users/19278/Downloads/Holland%201986%20Preliminary%20Descriptions%20of%20Terrestrial%20Natural%20Communities.OCRed.pdf.pdf. Accessed: January 2019.

Holland, V.L. and D. Keil. 1995. California Vegetation. Kendall Hunt Publishing Company. ISBN 0787226858.

Hughes, J.M., Huey, J.A. and D.J. Schmidt. 2013. Is realised connectivity among populations of aquatic fauna predictable from potential connectivity? Freshwater Biology, 58(5): 951-966.

Hurteau, M.D., J.B. Bradford, P.Z. Fulé, A.H. Taylor, and K.L. Martin. 2014. Climate change, fire management, and ecological services in the southwestern US. Forest Ecology and Management, 327, pp.280-289.

Jacobs, D.K., E.D. Stein, T. Longcore. 2010. Classification of California Estuaries Based on Natural Closure Patterns: Templates for Restoration and Management. Southern California Coastal Water Research Project. Technical Report 619.a. August 2011.

Johnstone and Dawson. 2010. Climatic context and ecological implications of summer fog decline in the coast redwood region. Proceedings of the National Academy of Sciences 107.10 (2010): 4533–4538.

Jurek, Ronald. 1992. Nonnative red foxes in California. Nongame Bird and Mammal Section Report, 92-04. California Department of Fish and Game.

Karl, T.R., J.M. Melillo, and T.C. Peterson (eds.). 2009. Global Climate Change Impacts in the United States. Cambridge University Press.

Keeley, J.E. 2002. Native American impacts on fire regimes of the California coastal ranges. Journal of Biogeography 29:303-320.

Kelly, M.H. and J.A. Gore. 2008. Florida river flow patterns and the Atlantic Multidecadal Oscillation. River Research and Applications 24: 598-616.

Kennedy and Jenks. 2004. Hydrostratigraphic Analysis of the Northern Salinas Valley. Prepared for Monterey County Water Resources Agency. May. 98 pp.

Kindlmann, P. and F. Burel. 2008. Connectivity measures: a review. Landscape Ecology, 23, 879–890.

Kozlowski, D.F., F.M. Watson, Angelo, and S. Gilmore. 2004. Legacy pesticide sampling in impaired surface waters of the lower Salinas region. The Watershed Institute Report WI-2004-02. Available at: http://ccows.csumb.edu/pubs/reports/CCoWS_LPs_040304_dk.pdf. Accessed: January 2019.

Kreuder C., M.A. Miller, D.A. Jessup, L.J. Lowenstein, M.D. Harris, J.A. Ames, T.E. Carpenter, P.A. Conrad, and J.A.K. Mazet. 2003. Patterns of mortality in southern sea otters (Enhydra lutris nereis) from 1998–2001. J. Wildl. Dis. 2003; 39: 495–509.

Land IQ, LLC. 2017. 2014 Crop Mapping. Available at: https://gis.water.ca.gov/app/CADWRLandUseViewer/downloads/atlas_i15_CropMapping2014.gdb.zip. Accessed: October 2017.

Limm, E.B., K.A. Simonin, A.G. Bothman, and T.E. Dawson. 2009. Foliar water uptake: a common water acquisition strategy for plants of the redwood forest. Oecologia. 2009 161:449-459. Available at: https://link.springer.com/content/pdf/10.1007%2Fs00442-009-1400-3.pdf. Accessed: January 2019.

Lincoln, R., G. Boxshall, and P. Clark. 1998. A Dictionary of Ecology, Evolution and Systematics. Second Edition. Cambridge University Press, Cambridge, UK.

Lindley, S.T., C.B. Grimes, M.S. Mohr, W.T. Peterson, J.E. Stein, J.J. Anderson, L.W. Botsford, D.L. Bottom, C.A. Busack, T.K. Collier, and J.W. Ferguson. 2009. What caused the Sacramento River fall Chinook stock collapse? U.S. Department of Commerce, National Oceanic and Atmospheric

Administration, National Marine Fisheries Service, Southwest Fisheries Science Center, Fisheries Ecology Division.

Lockwood, J.L., M.F. Hoopes, and M.P Marchetti. 2013. Invasion Ecology. 2nd edition. John Wiley & Sons.

Mantua, N.J., S.R. Hare, Y. Zhang, J.M. Wallace, and R.C. Francis. 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. Bulletin of the American Meteorological Society 78: 1069-1079.

Marlon, J.R., P.J. Bartlein, D.G. Gavin, C.J. Long, R.S. Anderson, C.E. Briles, K.J. Brown, D. Colombaroli, D.J. Hallett, M.J. Power, E.A. Scharf, and M.K. Walsh. 2012. Long-term perspective on wildfires in the western USA. Available at: https://www.pnas.org/content/pnas/early/2012/02/09/1112839109.full.pdf. Accessed: January 2019.

Mayer, K.E. and W.F. Laudenslayer, Jr. 1988. A guide to wildlife habitats of California. Available at: https://www.wildlife.ca.gov/Data/CWHR/Wildlife-Habitats. Accessed: January 2019.

McGraw, J. 2008. Rapid Biological Resource Assessment for the Salinas River, Monterey County, California. Prepared for The Nature Conservancy, San Francisco, CA.

Monterey County Agricultural Commissioner. 1929. Monterey County Agricultural Commission Crop Report Year 1929. Available at: http://www.co.monterey.ca.us/government/departments-a-h/agricultural-commissioner/forms-publications/crop-reports-economic-contributions#ag. Accessed: January 2019.

Monterey County Parks Department. 2011. Agricultural Resources Evaluation Handbook, Monterey County, California. Available at: http://www.co.monterey.ca.us/planning/docs/plans/Agricultural_Resources_Evaluation_Handbook.pdf. Accessed: May 2018.

Monterey County Water Resources Agency. 2006. Monterey County Groundwater Management Plan. May. 76 pp. Available at: http://www.co.monterey.ca.us/home/showdocument?id=22563. Accessed: July 2018.

Monterey County Water Resources Agency. 2012. Ground Water Summary Report 2011. October. 16 pp.

Monterey County Water Resources Agency. 2013. Sandbar Management Activities 2012. April. 4 pp.

Monterey County Water Resources Agency. 2014. Salinas River Stream Maintenance Program Revised Final Environmental Impact Report. State Clearing House #2011041066. June. 332 pp. Available at: http://www.co.monterey.ca.us/home/showdocument?id=19196. Accessed April 2018.

Monterey County Water Resources Agency. 2017a. Recommendations to Address the Expansion of Seawater Intrusion in the Salinas River Groundwater Basin. Special Reports Series 17-01. October. 244 pp.

Monterey County Water Resources Agency. 2017b. 2015 Groundwater Extraction Summary Report. April.

Monterey County Water Resources Agency. 2018a. California Statewide Groundwater Elevation Monitoring Program Data by Subarea from 1995-2015. October.

Monterey County Water Resources Agency. 2018b. Salinas River Sandbar Management Activities. March 23-25, 2018. 4 pp.

Monterey County Water Resources Agency. Salinas River Sandbar Closure Date. Unpublished Data. Last updated: April 22, 2018.

Monterey County Water Resources Agency and Hagar Environmental Science. 2015. Salinas River Lagoon Monitoring Report 2014. June.

Monterey Fire Safe Council. 2010. Monterey County Community Wildfire Protection Plan. Available at: http://www.firesafemonterey.org/mccwpp.html. Accessed: September 2018.

Montgomery Watson. 1997. Salinas Valley Integrated Ground Water and Surface Model Update. Final Report. Prepared for Monterey County Water Resources Agency.

Montgomery Watson. 1998. Salinas Valley Historical Benefits Analysis (HBA). Final Report. April 1998. Prepared for the Monterey County Water Resources Agency.

Moritz, M.A., M.A. Parisien, E. Batllori, M.A. Krawchuck, J. Van Dorn, D.J. Ganz, and K. Hayhoe. 2012. Climate change and disruptions to global fire activity. Ecosphere 3:1–22.

Naik, P.K., and D.A. Jay. 2011a. Distinguishing human and climate influences on the Columbia River: Changes in mean flow and sediment transport. Journal of Hydrology 404(3-4):259-277.

Naik, P.K., and D.A. Jay. 2011b. Human and climate impacts on Columbia River hydrology and salmonids. River Research and Applications 27(10):1270-1276.

National Center for Atmospheric Research. 2012. The Climate Data Guide: PRISM High-Resolution Spatial Climate Data for the United States: Max/min temp, dewpoint, precipitation. Available: https://climatedataguide.ucar.edu/climate-data/prism-high-resolution-spatial-climate-data-united-states-maxmin-temp-dewpoint. Accessed: July 2018.

National Climate Data Center. 2000. Climatography of the United States No. 81. Monthly Normals of Temperature, Precipitation, and Heating and Cooling Degree Days. 1971-2000. California. 73 pp.

National Climate Data Center. 2010a. Data Tools 1981-2010 Normals, King City, CA US. Available at: https://www.ncdc.noaa.gov/cdo-web/datatools/normals. Accessed: May 2018.

National Climate Data Center. 2010b. Data Tools 1981-2010 Normals, Monterey, CA US. Available at: https://www.ncdc.noaa.gov/cdo-web/datatools/normals. Accessed: August 2018.

National Climate Data Center. 2010c. Data Tools 1981-2010 Normals, Paso Robles, CA US. Available at: https://www.ncdc.noaa.gov/cdo-web/datatools/normals. Accessed: August 2018.

National Climate Data Center. 2010d. Data Tools 1981-2010 Normals, Pinnacles NM, CA US. Available at: https://www.ncdc.noaa.gov/cdo-web/datatools/normals. Accessed: August 2018.

National Climate Data Center. 2010e. Data Tools 1981-2010 Normals, Salinas Airport, CA US. Available at: https://www.ncdc.noaa.gov/cdo-web/datatools/normals. Accessed: May 2018.

National Marine Fisheries Service. 2007. Biological Opinion for the Salinas Valley Water Project. File Number: SWR/2003/2080. Prepared for Monterey County Water Resources Agency. Issued on June 2007. 125 pp.

National Marine Fisheries Service. 2013. South-Central California Steelhead Recovery Plan. West Coast Region, California Coastal Area Office, Long Beach, California.

National Marine Fisheries Service. 2018. South-Central California Steelhead Distribution and Critical Habitat. GIS Spatial Data DS0122_20050901. Available: https://map.dfg.ca.gov/metadata/ds0122.html. Accessed June 2018.

Neuman, K., G. Page, L. Stenzel, J. Warriner, and J. Warriner. 2004. Effect of Mammalian Predator Management on Snowy Plover Breeding Success. Waterbirds: The International Journal of Waterbird Biology, 27(3), 257–263. Available at: http://www.jstor.org/stable/1522499.

Neville, H., J. Dunham, A. Rosenberger, J. Umek, and B. Nelson. 2009. Influences of wildfire, habitat size, and connectivity on trout in headwater streams revealed by patterns of genetic diversity. Transactions of the American Fisheries Society, 138(6), pp.1314-1327.

Nicotra, A.B., E.A. Beever, A.L. Robertson, G.E. Hofmann, and J. O'leary. 2015. Assessing the components of adaptive capacity to improve conservation and management efforts under global change. Conservation Biology, 29(5), pp.1268-1278.

Parmesan, C. and G. Yohe. 2003. A globally coherent fingerprint of climate change impacts across natural systems. Nature. 421:37-42.

Pausas, J.G. and J.E. Keeley. 2009. A burning story: the role of fire in the history of life. BioScience, 59(7), pp.593-601.

Penrod, K., P.E. Garding, C. Paulman, P. Beier, S. Weiss, N. Schaefer, R. Branciforte and K. Gaffney. 2013. Critical Linkages: Bay Area & Beyond. Produced by Science & Collaboration for Connected Wildlands, Fair Oaks, CA www.scwildlands.org in collaboration with the Bay Area Open Space Council's Conservation Lands Network www.BayAreaLands.org.

Pierce, J.L., G.A. Meyer, and A.T. Jull. 2004. Fire-induced erosion and millennial-scale climate change in northern ponderosa pine forests. Nature, 432(7013), p.87.

Ralls, K., and P.J. White. 1995. Predation on San Joaquin Kit Foxes by Larger Canids, Journal of Mammalogy, Volume 76, Issue 3, 18 August 1995, Pages 723-729, Available at: https://doi.org/10.2307/1382743.

Regional Water Management Group. 2013. Integrated Regional Water Management Plan for the Greater Monterey County Region. Section R Climate Change. Available at: http://www.greatermontereyirwmp.org/documents/plan/. Accessed: on June 2018.

Resource Conservation District of Monterey County. 2018. Arundo Removal Project Information. Available at: https://www.rcdmonterey.org/salinas-river-arundo-and-tamarisk-control

Revel Coastal. 2016. City of Monterey Final Sea Level Rise and Vulnerability Analyses, Existing Conditions and Issues Report. Created for the City of Monterey. March 2016. Available at: https://monterey.org/Portals/0/Policies-Procedures/Planning/WorkProgram/LCP/16_0316_FINAL_Monterey_ExistingConditions_wAppendixA_WEB.pdf.

Rich, A. and E.A. Keller. 2011. Watershed controls on the geomorphology of small coastal lagoons in an active tectonic environment. Estuaries and Coasts DOI 10.1007/s12337-011-9439-x.

Roberson, D. 2002. Monterey Birds: Status and Distribution of Birds in Monterey County, California. Monterey Peninsula Audubon Society, Carmel, California.

Rosenberg, Lewis I. 2001. Geologic Resources and Constraints, Monterey County, California, A Technical Report for the Monterey County 21st Century General Plan Update Program, County of Monterey Environmental Resource Policy Department, April, 176 pgs.

Rosenberg, Lewis I., and Martin B. Feeney. 2001. Potential Aquifer Recharge Areas of Monterey County, California.

Rosenberg, Lewis I., and Joseph C. Clark. 2009. Map of the Rinconada and Reliz Fault Zones, Salinas River Valley, California: U.S. Geological Survey Scientific Investigations Map 3059, scale 1:250,000 with pamphlet. Available at: https://pubs.usgs.gov/sim/3059/. Accessed: January 2019.

San Francisco Estuary Institute. 2009. Historical Ecology Reconnaissance for the Lower Salinas River. Prepared for The Nature Conservancy Monterey County Project. August 2009. Available at: http://www.sfei.org/projects/lower-salinas-river-historical-ecology-reconnaissance#sthash.AmbvCtsW.dpbs.

Seavy, N.E., T. Gardali, G.H. Golet, F.T. Griggs, C.A. Howell, R. Kelsey, S.L. Small, J.H. Viers and J.F. Weigand. 2009. Why Climate Change Makes Riparian Restoration More Important than Ever: Recommendations for Practices and Research. Ecological Restoration 27(3): 330-338.

Shafroth, P.B., V.B. Beauchamp, M.K. Briggs, K. Lair, M.L. Scott, and A.A. Sher. 2008. Planning riparian restoration in the context of Tamarix control in western North America. Restoration Ecology, 16(1), pp.97-112.

Sharp, B.L. and B.E. Kus. 2006. Factors influencing the incidence of cowbird parasitism of least Bell's vireos. The Journal of wildlife management, 70(3), pp.682-690.

Skibba, Ramin. 2016. Mapping Fog: Charting the Comings and Goings of the Coast's Frequent Visitor. Available at: http://www.montereyherald.com/environment-and-nature/20160218/mapping-fog-charting-the-comings-and-goings-of-the-coasts-frequent-visitor. Accessed: August 2018.

Sloan, R.M. 2006. Ecological investigations of a fish kill in Pescadero Lagoon, California. Master's Thesis. San Jose State University, San Jose, California.

Snyder, J.O. 1913. The fishes of the streams tributary to Monterey Bay, California. Bulletin of the United States Bureau of Fisheries 32(1912):47-72.

Snyder, M.A. and L.C. Sloan. 2005. Transient future climate over the western United States using a regional climate model. Earth Interactions 9(11).

Spence, B.C., and J.D. Hall. 2010. Spatiotemporal patterns in migration timing of coho salmon (Oncorhynchus kisutch) smolts in North America. Canadian Journal of Fisheries and Aquatic Sciences 67(8):1316-1334.

Spencer, W.D., P. Beier, K. Penrod, K. Winters, C. Paulman, H. Rustigian-Romsos, J. Strittholt, M. Parisi, and A. Pettler. 2010. California Essential Habitat Connectivity Project: A Strategy for

Conserving a Connected California. Prepared for California Department of Transportation, California Department of Fish and Game, and Federal Highways Administration.

State Water Resources Control Board. 2018. State 2014 and 2016 California Integrated Report. Available at: https://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2014_2016.shtml. Accessed: January 2019.

Stenseth, N.C., G. Ottersen, J.W. Hurrell, A. Mysterud, M. Lima, K.S. Chan, N.G. Yoccoz, and B. Adlandsvik. 2003. Studying climate effects on ecology through the use of climate indices: the North Atlantic Oscillation, El Niño Southern Oscillation and beyond. Proceedings of the Royal Society of London, B 270: 2087-2096.

Stromberg, J.C., S.J. Lite, R. Marler, C. Paradzick, P.B. Shafroth, D. Shorrock, J.M. White, and M.S. White. 2007. Altered stream-flow regimes and invasive plant species: the Tamarix case. Global Ecology and Biogeography, 16(3), pp.381-393.

Swift C.C., J.L. Nelson, C. Maslow, T. Stein. 1989. Biology and distribution of the tidewater goby, Eucyclogobius newberryi (Pisces: Gobiidae) of California. Contributions in Science 404. Natural History Museum of Los Angeles County, Los Angeles.

The Nature Conservancy. 2008. Vegetation – Salinas River, 2008 [ds615]. Available at: https://data.cnra.ca.gov/dataset/vegetation-salinas-river-2008-ds615. Accessed: January 2019.

The Nature Conservancy. 2012. Land use and land cover: Salinas Valley, Monterey County, California, 2012. Available at: https://searchworks.stanford.edu/view/cn773xf9654. Accessed: January 2019.

The Nature Conservancy, Aerial Information Systems, and Stanford University. 2014. Salinas Generalized Land Use/Land Cover Mapping. GIS data transfer from Bethany Hackenjos, FlowWest to Danielle Tannourji, ICF.

Thompson, J. N. and D.A. Beauchamp. 2014. Size-selective mortality of steelhead during freshwater and marine life-stages related to freshwater growth in the Skagit River, Washington. Transactions of the American Fisheries Society 143(4):910-925.

Titus, R.G., D.C. Erman, and W.M. Snider. 2002. History and status of steelhead in California coastal drainages south of San Francisco Bay. July 5. Draft manuscript.

Turco, M., M.C. Llasat, J.V. Hardenberg, and A. Provenzale. 2014. Climate change impacts on wildfires in a Mediterranean environment. Climatic Change, 125(3-4), pp.369-380.

U.S. Bureau of Reclamation. 2017. Plan of Study: Carmel and Salinas Rivers Basin Study. Bureau of Reclamation, Mid-Pacific Region. January. 91 pp.

U.S. Department of Agriculture. 1910. Percent of Land Area in Farms, and Average Value of Farm Land Per Acre, In California by Counties.

U.S. Department of Agriculture. 1930. Agriculture-California. County Table 1. Farms and Farm Acreage.

U.S. Department of Agriculture. 1940. Census of Agriculture-California. County Table 1. Farms and Farm Acreage.

U.S. Department of Agriculture. 1950. Statistics for Counties. County Table Farms and Farm Acreage.

U.S. Department of Agriculture. 1959. Statistics for Counties. County Table Farms and Farm Acreage.

U.S. Department of Agriculture. 1969. County Summary–1969 Census of Agriculture. County Table Farms and Farm Acreage.

U.S. Department of Agriculture. 1978. Number, Land, and Value of Farms: 1978 and 1974. County Table Farms and Farm Acreage.

U.S. Department of Agriculture. 1992. County Summary Highlights: 1992. County Table Farms and Farm Acreage.

U.S. Department of Agriculture. 2012a. 2012 Census of Agriculture, County Data. Available at: https://www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_2_County_Level/California/st06_2_001_001.pdf. Accessed May 2018.

U.S. Department of Agriculture. 2012b. 2012 Census of Agriculture, United States Data. Available at: https://www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_1_US/st99_1_001_001.pdf. Accessed May 2018 .

U.S. Department of Agriculture. 2017. Existing Vegetation Mid Region 5 Central Coast—CALVEG, Pacific Southwest Region. Available: https://data.fs.usda.gov/geodata/edw/edw_resources/fc/S_USA.EVMid_R05_CentralCoast.gdb.zip. Accessed: June 2018.

U.S. Department of Agriculture. 2018. Gridded Soil Survey Geographic Database. Web Soil Survey. Available at: https://websoilsurvey.nrcs.usda.gov/.

U.S. Department of the Interior. 2018. Geospatial Multi-Agency Coordination Wildland Fire Support. Historical and Current Fire Perimeter Data. Available: https://rmgsc.cr.usgs.gov/outgoing/GeoMAC/. Accessed: July 2018.

U.S. Environmental Protection Agency. 1997. Climate change and California. EPA, Office of Policy, Planning and Evaluation Publication No. 230-F-97-008e.

U.S. Environmental Protection Agency. 2018. 2014 and 2016 California Integrated Report (Clean Water Act Section 303(d) List and 305(b) Report). Last updated: April 2018. Available at: https://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2014_2016.shtml.

U.S. Fish and Wildlife Service. 2002a. Salinas River National Wildlife Refuge Comprehensive Conservation Plan Summary. Sacramento, CA. December.

U.S. Fish and Wildlife Service. 2002b. Endangered and threatened wildlife and plants; final designation of critical habitat for Chlorogalum purpureum, a plant from the south coast ranges of California. Fed. Register, 67:65414–65445.

U.S. Fish and Wildlife Service. 2006. Least Bell's Vireo (*Vireo bellii pusillus*) 5-Year Review Summary and Evaluation. September. Carlsbad Fish and Wildlife Office, Carlsbad, CA.

U.S. Fish and Wildlife Service. 2007. Draft Biological Opinion on Issuance of Department of the Army Permits to the Monterey County Water Resources Agency for Construction of a Surface Water Diversion Structure in the Salinas River, Near the City of Salinas (Corps File Number 24976S) and for Breaching of the Salinas River Lagoon (Corps File Number 16798S) in Monterey County, California (1-8-06-F-54). July 2007.

U.S. Fish and Wildlife Service. 2013. Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California. Sacramento, CA. xviii + 605 pp.

U.S. Fish and Wildlife Service. 2015. Southern Sea Otter (*Enhydra lutris nereis*) 5-Year Review: Summary and Evaluation. Ventura Fish and Wildlife Office Ventura, California. September 2015.

U.S. Fish and Wildlife Service. 2018a. National Wetlands Inventory. Available at: https://www.fws.gov/wetlands/Data/Data-Download.html. Accessed: June 2018.

U.S. Fish and Wildlife Service. 2018b. Information, Planning, and Conservation (IPaC) System. Available at: https://www.fws.gov/ipac/. Accessed: June 2018.

U.S. Forest Service. 2017. Existing Vegetation Mid Region 5 Central Coast—CALVEG, Pacific Southwest Region. Available at: https://data.fs.usda.gov/geodata/edw/edw_resources/fc/S_USA.EVMid_R05_CentralCoast.gdb.zip. Accessed: June 2018.

U.S. Geological Survey. 2016. California National Hydrography Dataset (NHD). Available at: http://prd-tnm.s3-website-us-west-2.amazonaws.com/?prefix=StagedProducts/Hydrography/NHD/State/ HighResolution/GDB. Accessed: August 2018.

U.S. Geological Survey. 2017. National Hydrography Dataset, Watershed Boundaries. Available: https://www.usgs.gov/core-science-systems/ngp/national-hydrography/watershed-boundary-dataset?qt-science_support_page_related_con=4#qt-science_support_page_related_con. Page Last Modified: August 23, 2017. Accessed: August 2018.

U.S. Geological Survey. 2018. USGS Water Data for USA. Available at: https://nwis.waterdata.usgs.gov/nwis. Accessed: August 2018.

U.S. National Vegetation Classification System. 2017. United States National Vegetation Classification Database. V2.01. Federal Geographic Data Committee, Vegetation Subcommittee, Washington DC. Available at: http://usnvc.org/explore-classification. Accessed: January 2019

Van der Putten, W.H., M. Macel, and M.E. Visser. 2010. Predicting species distribution and abundance responses to climate change: why it is essential to include biotic interactions across trophic levels. Philosophical Transactions of the Royal Society B: Biological Sciences, 365(1549), 2025–2034. Available at: http://doi.org/10.1098/rstb.2010.0037.

Vasey, M.C., M.E. Loik, and V.T. Parker. 2012. Influence of summer marine fog and low cloud stratus on water relations of evergreen woody shrubs (Arctostaphylos: Ericaceae) in the chaparral of central California. Oecologia, 170(2), 325-337.

Walters, A.W., K.K. Bartz, and M.M. McClure. 2013. Interactive effects of water diversion and climate change for juvenile Chinook salmon in the Lemhi River Basin (U.S.A.). Conservation Biology 27(6):1179-189.

Watson, F., M. Angelo, T. Anderson, J. Casagrande, D. Kozlowski, W. Newman, J. Hager, D. Smith, B. Curry. 2003. Salinas Valley Sediment Sources. Report No. WI-2003-06, The Watershed Institute, California State University Monterey Bay. Prepared for the Central Coast Regional Water Quality Control Board. 239 pp. Available at: http://science.csumb.edu/%7Eccows/pubs/reports/CCoWS_SalSedReport_030530c.pdf

Whitney, J.E., K.B. Gido, T.J. Pilger, D.L. Propst, and T.F. Turner. 2015. Consecutive wildfires affect stream biota in cold-and warmwater dryland river networks. Freshwater Science, 34(4), pp.1510-1526.

Willson, M.F. and K.C. Halupka. 1995. Anadromous fish as keystone species in vertebrate communities. Conservation Biology 9(3):489-497.

6.3.1 Personal Communications

Smith, Jerry J. Associate Professor. San Jose State University, San Jose, CA. March 3, 2004—*Lagoon Ecology of Central Coast Steelhead and Tidewater Goby* Handout in Fisheries Science to Rebecca Sloan, Master's Student, San Jose State University, San Jose, California.

6.4 Chapter 4, Management Plan

California Department of Water Resources. 1946. Salinas Basin Investigation Summary Report. Bulletin 52. Available at: https://digitalcommons.csumb.edu/hornbeck_cgb_1/6/.

CALFED. 1976. Nacimiento Dam and Nacimiento River Case Study Report #79. Available at: http://www.calwater.ca.gov/Admin_Record/C-064356.pdf.

California Invasive Plant Council. 2011. Arundo donax. Distribution and impact report. March. Agreement No. 06-374-559-0 State Water Resources Control Board. Available at: https://www.cal-ipc.org/wp-content/uploads/2017/11/Arundo_Distribution_Impact_Report_Cal-IPC_March-2011_small.pdf. Accessed: January 2019.

Central Coast Regional Water Quality Control Board. 2018. Staff Report for Regular Meetings of Novemeber 18-19, 2018. Available: https://www.waterboards.ca.gov/centralcoast/board_info/agendas/2018/november/item5/item5_stfrpt.pdf. Accessed: February 15, 2019.

Ford, L.D., P.A. Van Hoorn, D.R. Rao, N.J. Scott, P.C. Trenham, and J.W. Bartolome. 2013. Managing Rangelands to Benefit California Red-legged Frogs and California Tiger Salamanders. Livermore, California: Alameda County Resource Conservation District. Available: http://www.rangelandconservation.com/Documents/ManagingRangelandsCRLF_CTS.pdf. Accessed: February 15, 2019.

Cluer, B. and J. McKeon. 2005. The Problem of Repetitive Sand Dunes in the Salinas River: With Recommended Flows to Create Fish Passage through the Sand-Dune Field.

Matthews, K. R. and N. H. Berg. 1997. Rainbow trout responses to water temperature and dissolved oxygen stress in two southern California stream pools. Journal of Fish. Volume 50, Issue 1. January.

Monterey County Water Resources Agency. 2005. Salinas Valley Water Project Flow Prescription for Steelhead Trout in the Salinas River. October. 140 pp.

Monterey County Water Resources Agency. 2014. Salinas River Stream Maintenance Program Revised Final Environmental Impact Report. State Clearing House #2011041066. June. 332 pp.

Moyle, P.B. 2002. Inland Fishes of California. University of California Press, Oakland.

San Francisco Estuary Institute. 2009. Historical Ecology Reconnaissance for the Lower Salinas River. Prepared for The Nature Conservancy Monterey County Project. August 2009. Available at: http://www.sfei.org/projects/lower-salinas-river-historical-ecology-reconnaissance#sthash.AmbvCtsW.dpbs.

Spencer, W.D., P. Beier, K. Penrod, K. Winters, C. Paulman, H. Rustigian-Romsos, J. Strittholt, M. Parisi, and A. Pettler. 2010. California Essential Habitat Connectivity Project: A Strategy for Conserving a Connected California. Prepared for California Department of Transportation, California Department of Fish and Game, and Federal Highways Administration.

U.S. Fish and Wildlife Service. 2005. Recovery Plan for the Tidewater Goby (*Eucyclogobius newberryi*). U.S. Fish and Wildlife Service, Portland, OR. 199 pp.

U.S. Fish and Wildlife Service. 2007. Draft Biological Opinion on Issuance of Department of the Army Permits to the Monterey County Water Resources Agency for Construction of a Surface Water Diversion Structure in the Salinas River, Near the City of Salinas (Corps File Number 24976S) and for Breaching of the Salinas River Lagoon (Corps File Number 16798S) in Monterey County, California (1-8-06-F-54). July 2007.

6.4.1 Personal Communications

Zefferman, Emily. 2018. Ecologist. Resource Conservation District of Monterey County. Long-Term Effectiveness Plan for the Salinas River Stream Maintenance Program. Email to Kathryn Gaffney—Project Manager. ICF. November 26.

6.5 Chapter 5, Implementation

Williams, B. K., C. Szaro, and D. Shapiro. 2007. Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group. Department of the Interior. Washington, D.C. Available at: https://www.doi.gov/sites/doi.gov/files/migrated/ppa/upload/openingpgs.pdf.