VENTURA WATER SUPPLY PROJECT

Pre-Construction Assessment Program and Monitoring, Assessment, and Adaptive Management Plan

Prepared for
City of Ventura
501 Poli Street, Room 120
Ventura, CA 93001

June 2021
OUR COMMITMENT TO SUSTAINABILITY

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<td>°C</td>
<td>degrees Celsius</td>
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<tr>
<td>°F</td>
<td>degrees Fahrenheit</td>
</tr>
<tr>
<td>BMI</td>
<td>benthic macroinvertebrate</td>
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<tr>
<td>CDL</td>
<td>continued discharge level</td>
</tr>
<tr>
<td>cfs</td>
<td>cubic feet per second</td>
</tr>
<tr>
<td>City</td>
<td>City of San Buenaventura (Ventura)</td>
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<tr>
<td>cm</td>
<td>centimeter(s)</td>
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<tr>
<td>DO</td>
<td>dissolved oxygen</td>
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<tr>
<td>DPS</td>
<td>Distinct Population Segment</td>
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<tr>
<td>EC</td>
<td>electrical conductivity</td>
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<tr>
<td>EIR</td>
<td>environmental impact report</td>
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<tr>
<td>FESA</td>
<td>federal Endangered Species Act</td>
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<tr>
<td>FR</td>
<td><em>Federal Register</em></td>
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<tr>
<td>GPS</td>
<td>global positioning system</td>
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<tr>
<td>km</td>
<td>kilometer(s)</td>
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<td>MAAMP</td>
<td>Monitoring, Assessment, and Adaptive Management Program</td>
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<tr>
<td>mg/L</td>
<td>milligrams per liter</td>
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<tr>
<td>mgd</td>
<td>million gallons per day</td>
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<td>MMRP</td>
<td>mitigation monitoring and reporting plan</td>
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<td>North American Vertical Datum of 1988</td>
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<td>National Marine Fisheries Service</td>
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<td>National Pollutant Discharge Elimination System</td>
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<td>Pre-Construction Assessment Program</td>
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<tr>
<td>ppt</td>
<td>parts per thousand</td>
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<td>Project</td>
<td>VenturaWaterPure Project</td>
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<td>Regional Water Quality Control Board</td>
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<td>Santa Clara River Estuary</td>
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<td>standard operating procedure</td>
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<td>Scientific Review Panel</td>
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CHAPTER 1
Introduction

1.1 Project Background

The City of San Buenaventura (City) has proposed the VenturaWaterPure Project (Project) to recycle and beneficially reuse tertiary-treated water that currently is discharged into the Santa Clara River Estuary (SCRE). The Project, which is one element of the City’s Ventura Water Supply Projects, will develop an advanced water purification facility and an indirect potable reuse system. The Project is designed both to augment the City’s potable water supply and to enhance the ecosystem of the SCRE by reducing the discharge of tertiary-treated water from the existing Ventura Water Reclamation Facility (VWRF) into the SCRE (Ventura Water 2019a, 2019b).

The SCRE is situated along the coastline of Ventura County, within the City of Ventura (Figure 1). The VWRF is located on the north edge of the SCRE, and currently discharges 4.7 million gallons per day (mgd) on an average annual basis. The SCRE and surrounding marshes and riparian areas constitute the 160-acre SCRE Natural Preserve. The McGrath State Beach and campground are located on the south side of the SCRE. The Pacific Ocean is approximately 2,000 feet from the point of the VWRF discharge.

The SCRE is a lagoon-type estuary at the mouth of the Santa Clara River that is periodically disconnected from the Pacific Ocean by a sand berm, that forms during low discharge periods, especially during the dry summer months. When the berm is intact, water from surface flows (including Santa Clara River inflow and VWRF discharge), groundwater, seepage and wave overwash fills the lagoon, floods the mudflats, and inundates the adjacent marsh and low-lying vegetation. During these periods, water depth in the SCRE can be several feet. When the berm is breached, the lagoon discharges directly into the ocean and drains, and the SCRE is subject to tidal influence and marine water (saltwater) influx. The berm is breached naturally during winter storms (Stillwater Sciences 2018:73, 246). However, unauthorized manual breaches by parties unrelated to the City are common during the summer months, when lagoon water elevations are high due to VWRF discharge, making manual breaches relatively easy to accomplish. These unseasonal breaches significantly alter the lagoon ecosystem.

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Figure 1
Regional Location
The City has conducted extensive analysis of the SCRE, including estimated ecological effects of reduced discharges on the SCRE, compiled in a series of Special Studies referred to as “Phase 1,” “Phase 2,” and “Phase 3 Estuary Studies.” Collectively, these studies provided the basis of scientific understanding of the SCRE’s unique ecosystem and informed the development of the Project evaluated in the EIR. One of the Project’s objectives is improving the conditions within the SCRE to support special-status wildlife species that use the SCRE, and/or for which critical habitat has been designated in the SCRE, including:

- Tidewater goby (*Eucyclogobius newberryi*), federal endangered species, and designated critical habitat
- Southern California steelhead (*Oncorhynchus mykiss*) Distinct Population Segment (DPS), federal endangered species, and designated critical habitat
- Western snowy plover (*Charadrius nivosus nivosus*), federal threatened species, and designated critical habitat
- California least tern (*Sternula antillarum browni*), federal and state endangered species
- Southwestern willow flycatcher (*Empidonax trailii extimus*), designated critical habitat

To enhance quality of habitat for these species, including the quality of designated critical habitats, VWRF discharges would be reduced in two phases:

- **Phase 1a** would divert approximately 60 percent of discharge from the VWRF to the advanced water purification facility, resulting in an average annual continued discharge level (CDL) of 1.9 mgd during closed-berm conditions by the end of the year 2025.
- **Phase 1b** includes further discharge reductions to a closed-berm average annual CDL of 0–0.5 mgd by the end of the year 2030. This would represent approximately 90–100 percent of 2016 discharge levels. As VWRF flows increase in the future, the CDLs would be maintained and more flow would be diverted.

The EIR included two mitigation measures to evaluate ecosystem conditions within the SCRE as discharges are reduced. Mitigation Measure BIO-5 requires the City to prepare and implement a Pre-construction Assessment Program (PCAP) that outlines a data collection program needed to establish the existing baseline conditions before implementation of Phase 1a:

**BIO-5:** The City shall prepare and implement a Pre-Construction Santa Clara River Estuary (SCRE) Monitoring Program that will confirm and update the existing baseline hydrological, chemical and biological conditions of the SCRE for a period of 3 years. The City shall coordinate preparation of the monitoring program with the RWQCB, USFWS, NMFS, and CDFW [Regional Water Quality Control Board, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and California Department of Fish and Wildlife]. The purpose of the program shall be to collect specific ecological monitoring data. This data will be used to inform the development of the Post-Construction Monitoring, Assessment, and Adaptive Management Plan, which shall identify action criteria and management measures that will guide and confirm that the implementation of Phase 1b reductions in discharges (to an average annual of 0–0.5 MGD in closed-berm conditions) avoids and minimizes significant adverse environmental impacts.
The core elements of the PCAP are outlined in Mitigation Measure BIO-6, which requires the City to prepare a Monitoring, Assessment, and Adaptive Management Program (MAAMP) that will continue data collection in the SCRE during implementation of Phase 1a. The monitoring elements should be the same for the PCAP and MAAMP to allow comparison between pre-construction and post-construction periods. BIO-6 states:

**BIO-6:** The City shall prepare and implement a Post Construction Santa Clara River Estuary (SCRE) Monitoring, Assessment, and Adaptive Management Program (MAAMP) that will continue data collection in the SCRE, and will evaluate and confirm post-discharge diversion SCRE habitat values and conditions for SCRE listed species. The SCRE MAAMP will consist of the following core elements at a minimum:

- Water depth measurements;
- Aquatic species surveys within the SCRE to document occurrence and abundance of tidewater goby and juvenile steelhead;
- Bird and nesting surveys to document the occurrence and abundance of snowy plover and California least tern using or occupying, or foraging of nesting within the SCRE and its vicinity;
- Acreage and qualitative evaluation of vegetation associations (habitat types) within the SCRE and its vicinity;
- SCRE receiving water quality monitoring, including regular measurements for temperature, salinity, dissolved oxygen, and nutrients collected vertically and horizontally to inform stratification and spatial patterns understanding;
- Documentation of eutrophication episodes within the SCRE;
- SCRE berm condition monitoring including berm heights and breaching events; and
- Continuous VWRF discharge flow data, and instantaneous VWRF discharge water quality data.

The monitoring effort will be initiated following implementation of Phase 1a when discharges have been reduced to a CDL of 1.9 MGD.

The City shall submit annual monitoring reports to the CDFW, USFWS, and NMFS that compile the data collected for a period of five years. The City shall consult with CDFW, USFWS, and NMFS to evaluate the data and trends shown in the monitoring data. In the event that based on the information and analysis provided by the MAAMP, NMFS, USFWS, and or CDFW notifies the RWQCB and the City in writing that reducing the average annual discharge flows below 1.9 MGD in closed berm conditions would result in an unauthorized “take” (as defined in the state or federal Endangered Species Act, as applicable) of one or more listed species contrary to the permits or authorizations those agencies have issued, then the actions specified in the MAAMP shall be implemented to further avoid and minimize adverse impacts to, and take of listed species within the SCRE resulting from Phase 1b reductions, until and unless and until the Regional Board and the wildlife agency [SIC] with jurisdiction authorize lower discharge.
The National Pollutant Discharge Elimination System (NPDES) permit for the VWRF also requires the development of the PCAP and MAAMP in coordination with CDFW, USFWS, NMFS, Heal the Bay, and Wishtoyo Foundation’s Ventura Coastkeeper Program, and submission to the RWQCB. Both the PCAP and MAAMP will be implemented in coordination with USFWS, NMFS, CDFW, and the RWQCB to ensure that the reduction in VWRF discharge to the SCRE does not significantly adversely affect listed species or designated critical habitats within the SCRE.

1.2 Purpose of Document

This PCAP outlines the monitoring required to document and assess baseline hydrological, chemical and biological conditions of the SCRE for a period of 3 years prior to commencement of Phase 1a discharge reductions. Additionally, the PCAP provides the initial framework, which can be adjusted in light of PCAP data and findings, for future monitoring and long-term management of the Project. Chapter 5 of this document maps out the framework for the MAAMP, which is part of Mitigation Measure BIO-6 and will be provided in a separate and subsequent document once this PCAP is approved by regulators.

This PCAP is designed to assess primary physical and biological features of habitats that are important to tidewater goby, southern California steelhead, western snowy plover, and California least tern based on their status as listed species by measuring key indicators of habitat quality in the SCRE. These species are collectively referred to as focal species. In addition, since the SCRE encompasses designated critical habitat for the tidewater goby (Eucyclogobius newberryi) and the southwestern willow flycatcher (Empidonax trailii extimus), this PCAP supports evaluation on the potential for significant adverse effects to the designated critical habitat within the SCRE.

The reduction in VWRF discharges is expected to maintain or improve:

1. Suitability of rearing habitat for out-migrating juvenile southern California steelhead.
2. Suitability of habitat for tidewater goby.
3. Suitability of foraging, breeding and roosting habitats for western snowy plover.
4. Suitability of foraging, breeding and roosting habitats for California least tern.
5. Suitability of foraging, breeding and roosting habitats for Southwestern flycatcher.
6. Water quality in the SCRE suitable to support tidewater goby and steelhead.
7. Habitat structure and extent (including within designated critical habitats) suitable to support species native to the SCRE.

These attributes are based on an understanding of the primary biological features of designated critical habitats; the physical dynamics of the SCRE environment; the focal species’ life history patterns, habitat requirements, drivers and stressors, and seasonal distribution; and the expected effects of discharge reduction on listed species and critical habitat as measured with key indicators including the following:
1.0 Introduction

- Establishment of a more “natural” or “seasonal” hydrological pattern including seasonal berm breaching dynamics;
- Improved water quality, particularly reduction in nutrient loads and reductions in periods of very low dissolved oxygen (DO);
- Ability of habitats to support foraging and refuge for listed species;
- Increased estuarine habitat types, including willow riparian, riverwash riparian, and salt marsh, with retention of foredune and open beach, and re-establishment of mudflat and nearshore/shoreline habitat at a lower elevation within the SCRE.

These key indicators, as summarized in Chapter 2, are based on the Phase 3 studies (Stillwater Sciences 2018), the Scientific Review Panel Recommendations Report (June 2018) (SRP Report) (Revell et al. 2018), and other supporting scientific literature and expertise.

To track the status of these attributes, monitoring parameters were identified to measure factors affecting the most critical (or limiting) life stage of the focal species and habitat primary biological features. Chapter 3 presents the core monitoring elements with parameters, methods, locations, and sampling frequency, which are designed to collect sufficient data to detect ecologically relevant changes in response to discharge reductions. Ventura Water will be responsible for implementation, data management, and reporting (Chapter 4).

The MAAMP (Chapter 5) outline provides a preliminary framework for assessing SCRE species and habitat parameters relevant to evaluating significant adverse effects on critical habitat and reasonable potential for Phase 1a discharge reductions to result in “take” of a listed species as defined under the federal Endangered Species Act (FESA) or California Endangered Species Act.
CHAPTER 2
Conceptual Understanding

2.1 Site Setting

The SCRE is located at the interface between the Santa Clara River and the Pacific Ocean. The SCRE subwatershed is defined as the floodplain area surrounding the lagoon where estuary infilling during closed-mouth, low river flow conditions is known to affect water-table elevation and influence sensitive habitat and human recreation. This includes areas at the mouth of the Santa Clara River upstream of the sand berm, where the ground surface is equal or less than an elevation of approximately 11 feet\(^2\) (North American Vertical Datum of 1988 [NAVD88]), or the maximum SCRE stage currently reached during closed-berm, low-flow conditions. This area extends north to the VWRF and Ventura Harbor inlet, south into McGrath State Beach and to the southern edge of McGrath Lake, and east approximately 0.8 mile upstream of Harbor Boulevard bridge (ESA 2019) (Figure 2).

Land uses within the SCRE-adjacent floodplain includes open beach/dunes, agriculture, park land (McGrath State Beach), oil exploration, golf course, and the VWRF. Other lagoons and estuaries within close proximity of the SCRE include Ventura River Estuary (4 miles north), Carpinteria Lagoon (20 miles north), Ormond Lagoon (~7.5 miles south), and Mugu Lagoon (12 miles south).

2.2 Topography

The SCRE is separated from the Pacific Ocean by a set of elevated sand dunes (14 feet to 27 feet) that mostly parallel the coast and a sand berm; which periodically forms and then opens in response to high river flows. The central portion of the main SCRE extends from Harbor Boulevard to the seasonal sand berm. The majority of the SCRE bed is located at elevations below seven feet, with deeper channels as low as elevation one foot. The existing McGrath Beach campground area (located to the south of the SCRE) is relatively flat, and is located at elevations ranging from nine feet to 13 feet with an overall average elevation of 11.4 feet. To the east of the site, Harbor Boulevard is located at elevations ranging from a low point of around 13 feet at the southern end of the SCRE near the intersection with West Gonzales Road, to 15.5 feet at the current campground entrance, to a high point above 20 feet at the southern estuary bridge embankment (CBEC, Inc. 2015).

\(^2\) Vertical datum of all elevations in this document are North American Vertical Datum of 1988 (NAVD88)
2.3 Hydrology

2.3.1 Santa Clara River

The Santa Clara River is the largest river in the Ventura Basin, flowing 84 miles from the San Gabriel Mountains west to the Pacific Ocean. Current anthropogenically modified streamflow in the river and its tributaries varies from perennial in the upper reaches to intermittent and ephemeral in portions of the lower main channel. River flow is punctuated by “flashy” high-flow events in which high-intensity precipitation events cause rapid increases and decreases in river flows to the estuary. During the dry season that typically lasts through the summer and fall, the Santa Clara River is generally dry in segments between the Freeman Diversion and the SCRE, with minimal or no contributions of surface water flow into the lagoon, though percolated groundwater sometimes remerges as trickle flow into the channel close to the head of the estuary.

Historically, or in “natural” conditions, the Scientific Review Panel (SRP) found that river flows into the SCRE were naturally low during dry weather, and in all except very wet years, and the majority of the freshwater input to the SCRE comes from groundwater flow (Revell et al. 2018:11).

2.3.2 Santa Clara River Estuary/Lagoon Hydrology and Geomorphology

The SCRE is composed of an estuary/lagoon system. The SCRE loses connectivity to the ocean for much of the year due to the formation in dry weather of a barrier beach (sandbar berm) across the estuary mouth, forming a temporary lagoon separated from the marine environment. The main SCRE lagoon contains a network of channels and bars that are formed and reworked during storm events and subsequent tidal exchange while the berm remains open. The total inundated area, defined by the maximum inundation extent within the river channel and main lagoon under closed-berm, low-flow conditions, is currently about 180 acres (ESA 2019). During closed-berm periods, the lagoon fills, causing the ponded water to rise and extend upstream of the Harbor Boulevard bridge.

The SCRE receives water from groundwater upwelling, precipitation, and four additional sources: Santa Clara River flow, local runoff, VWRF discharge, and tidal flow. Flows into and out of the SCRE vary seasonally, inter-annually, and over longer timescales, due to both natural and anthropogenic influences. Highest monthly river/runoff inflows occur in February (~750 cubic feet per second [cfs] in the lower river), and lowest flows occur in August and September (~1 cfs in the lower river) (Stillwater Sciences 2018). These patterns closely follow seasonal variability of precipitation. During normal and wet water-year types, river flows typically dominate water inputs to the SCRE from fall to spring, while VWRF discharge (~5–10 cfs and an average annual discharge of 9 mgd) is the predominant source during closed berm conditions in the summer. Long-term daily averages show Santa Clara River inflow to the SCRE is typically low (<80 cfs, 90 percent of the time), but is punctuated by large storm events. During these low-flow conditions, the SCRE fills gradually, typically over a period of weeks. VWRF discharge can maintain the SCRE at a quasi-equilibrium “full” stage that can be maintained for extended
periods. When storm-induced river flows enter the SCRE during closed-berm periods in winter, the filling rate is much more rapid and the stage associated with berm breaching can be higher than the breaching stage during low-flow conditions. Water outputs from the SCRE occur through outflow to the ocean during open-berm conditions as well as evaporation, subsurface outflow seeping through the sand berm, and groundwater seepage to the semi-perched aquifer.

The SRP identified important historical, more “natural” hydrologic characteristics of the SCRE, which it recommends should be replicated to the extent feasible:

- Seasonally high flows and episodic high sediment discharges providing mineral and organic matter to shape the estuary and the beach, as well as to open the berm seasonally and provide flushing.
- Gradual mouth closure due to the combination of declining winter and spring freshwater flows from the Santa Clara River, reducing, tidal prism and mouth building sedimentary processes due to longer period waves inducing bar formation.
- A longer freshening of the SCRE over the spring and summer due to lower seepage during closed berm conditions, with reduced surface and groundwater inputs (Revell et al. 2018:14–15).

Berm-breaching and the duration of open-mouth conditions are primarily a function of SCRE water surface elevation, coastal storm influence, and tidal conditions, but VWRF discharge levels do influence the timing of berm breaching and the resulting duration of open-mouth conditions, primarily for wet water year conditions. The timing of the wet weather initial berm breach is primarily controlled by the timing of storms that cause the SCRE to fill to the level that triggers a breach. Higher VWRF discharge levels are generally predicted to result in slightly (less than one day) earlier berm breaching during wet water years because the additional water volume from VWRF discharge results in the SCRE water surface elevation being at a higher level when a storm event causes rapid filling and triggers breaching. The closure of the beach berm following a breaching event usually occurs at approximately the same time regardless of VWRF discharge levels during a given water-year type since the timing of berm closure is primarily driven by tidal conditions and SCR and SCRE outflows through the breach. Variations in the VWRF discharge do not generally influence the timing of berm closure since VWRF discharges do not alter tidal influences that encourage berm closure and the SCRE outflow that maintains open-mouth conditions during a breach is only negligibly increased by VWRF discharges under most conditions (Stillwater Sciences 2018:247).

Unseasonal breaches (i.e., breaches in dry weather typically between June through October) are usually caused by unauthorized manual trenching of the beach berm by unknown parties attempting to reduce high water conditions during closed berm conditions in neighboring areas (Stillwater Sciences 2018). Increasing the difference in SCRE water surface elevation and berm height will make manual breaching more difficult [and will reduce the likelihood of breaches from small, unseasonal precipitation events.] Reducing VWRF discharge is expected to decrease unseasonal breach frequency and duration of open-berm conditions (Stillwater Sciences 2018).

The morphology of the estuary is influenced by both large watershed flow events and by beach and berm processes, and in turn affects the habitat for aquatic and other species by changing the
amount of deep and shallow water, sandbars and riparian edge habitat. In general, the estuary responds to large watershed flows that “reset” the lagoon by depositing sediment in some areas while scouring out deeper water in others, and in large events by pushing the shallow water and beach towards the ocean. In years with low river flows or significant waves (such as the recent El Niño event), powerful waves can alter the bed of the lagoon by overtopping the beach and carrying fans of beach sediment landward. This sediment can then be removed in subsequent years when river flows are high and remove sediment from the lagoon. Stillwater Sciences studied the frequency with which the SCRE “resets” and concluded that events of around 50,000 cfs caused the process (approximately a 5-year average recurrence flow), with slower evolution of the beach and berm between events.

2.3.3 Groundwater

The SCRE lies atop the Oxnard Plain, a broad alluvial, coastal plain formed at the lower reaches of the Santa Clara River and Calleguas Creek before each waterway flows into the Pacific Ocean. The SCRE and the lowermost reach of the Santa Clara River (extending 0.7 mile upstream of the Harbor Boulevard bridge) overlie the Mound Subbasin (CDWR 2006a), while the river reach situated immediately upstream overlies the Oxnard Plain Subbasin (CDWR 2006b). Beneath the SCRE and lower river are several lateral aquifers separated by clay layers that together extend to depths of approximately 2,400 feet before contacting non-water-bearing bedrock (Hanson et al. 2003). Generally, water flows from the upper perched aquifers in these areas southwesterly towards the SCRE. The aquifer located directly below the SCRE (referred to as the “Semi-perched aquifer”) is shallow (<100 ft) and underlain by a clay layer, thereby disconnecting the SCRE from the deeper subbasin aquifers (Turner 1975, Hanson et al. 2003, CDWR 2006a). The semi-perched aquifer consists of geologically young (i.e., Holocene age), fine-to-medium sand with interbedded clay layers (Turner 1975, Hanson et al. 2003). The low storage capacity of this relatively thin, semi-perched aquifer reportedly leads to frequent saturation by infiltrated precipitation and agricultural irrigation in the surrounding floodplain areas (Hanson et al. 2003, Stillwater Sciences 2018).

Groundwater additionally enters the SCRE on the north side from seepage through soils beneath the VWRF Wildlife/Polishing Ponds, located just north of the SCRE. The surface-water level in the ponds is controlled by a weir near the effluent discharge point that maintains a relatively constant head in the ponds of approximately 19 feet NAVD88 (Stillwater Sciences 2018).

2.4 Water Quality

Physical and chemical water quality conditions within the SCRE are highly variable on an annual basis due to the combination of VWRF discharge, river and runoff surface flows and groundwater inflows, seasonal variability in the SCRE mouth conditions, wave overwash and open-berm ocean exchanges, as well as seasonal meteorological variations.

Water quality conditions have both direct and indirect impacts on listed species and designated critical habitats in the SCRE, and both the VWRF discharge and ambient water quality of surface and groundwater inflows contribute to the water quality conditions of the SCRE, including Santa
Conceptual Understanding

Clara river flows, surface water runoff, groundwater from banks around the SCRE, wave overwash, and tidal exchanges. Physical and chemical water quality conditions in the SCRE have been characterized from NPDES monitoring data and the Estuary Studies monitoring data and analyses (Stillwater Sciences 2011, 2014, 2018), the Technical Review Team Reports (Hammersmark et al. 2017, 2018), and the SRP Report (Revell et al. 2018), including spatial and temporal patterns and the relative contributions of various sources to observed conditions.

Water quality conditions vary on annual, seasonal, and daily timescales. Variability in water quality is driven by climatic conditions as well as seasonal changes in the predominant source of SCRE water inputs. During open-berm conditions, tidal exchange exerts strong control on water quality conditions. Upon berm closure, mineral salts and observed nutrient levels approach those of the dominant water source as the SCRE fills, which varies seasonally between VWRF discharge and surface water inflows. Although VWRF discharges to the SCRE exhibit low nutrient concentrations, the combination of high nutrient concentrations in groundwater inflows and the magnitude of VWRF tertiary treated flows discharged into the SCRE (ranging from ~5 to 10 cfs) result in concerns regarding nutrient loading to the SCRE, particularly in light of hypoxia observed in the SCRE (Revell et al. 2018:11, 15).

Salinity within the SCRE is temporally variable, with levels during closed berm periods typical of freshwater or oligohaline brackish environments (brackish water with a salinity of 0.5 to 3.0 parts per thousand [ppt]), and periods of higher salinity primarily driven by tidal exchange during open berm conditions. Wave overwash also contributes to salinity during closed berm conditions. Reducing VWRF discharge is expected to increase the peak salinity and duration of higher salinity conditions, since salinity will be diluted less and more slowly by VWRF discharge relative to current conditions, and wave overwash will have greater effect when the SCRE fills to a lower elevation and fresh-water volume in the SCRE is reduced. Lower fresh water discharge from the VWRF will help to promote an increase in relative volume of salt water as compared to fresh water during wave overwash, particularly in the spring (Revell et al. 2018:19–20). Increased salinity and reduced spatial heterogeneity in the SCRE, particularly at certain times of the year, can create refugia for species from the pressures of invasive and/or predatory species (Revell et al. 2018:11).

SCRE water temperatures vary from wintertime lows near 8°C (46°F) with the berm open and 10.5 ° (51°F) with the berm closed, to summertime highs of near 26°C (79°F) during berm open condition, and nearer 28°C (82°F) with the berm closed. Continuous records of water temperature collected during closed mouth conditions in 2015–2016 show median temperatures between 17.1°C to 25.5°C.

Water column profiles, as well as limited spatial analysis of SCRE water quality, indicate generally well-mixed conditions much of the time, with some stratification and spatial variation in temperature, dissolved oxygen (DO), and conductivity during other periods. The VWRF outfall channel exhibited generally lower temperatures and conductivity from winter into early summer with some evidence of warmer surface temperatures in summer and early fall.

The SCRE is subject to eutrophic episodes particularly in warm weather, most likely resulting from high nutrient loading from groundwater, VWRF effluent, and riverine and local runoff.
Phase 3 monitoring data found high algal biomass in the SCRE and elevated concentrations of nitrate in upstream groundwater wells, indicating that upstream sources also contribute to nitrate loading in the SCRE.

Fast-growing phytoplankton (floating microscopic plants) and macroalgae (larger species such as *Ulva* and *Enteromorpha* [Stillwater Sciences 2011]) can grow to nuisance abundances due to high nutrient concentrations. Macroalgae are often the dominant primary producer in eutrophic conditions in most southern California bar-built estuaries, with biomass several orders of magnitude higher than phytoplankton (McLaughlin et al. 2013; Sutula et al. 2016). These fast-growing species produce oxygen in daylight hours, but also use oxygen during non-daylight. Therefore, levels of DO in nutrient-enriched waterbodies typically exhibit patterns of both higher high values and lower low values than the patterns seen in lower nutrient situations. Low DO values can reduce ecosystem health by creating anoxic conditions that preclude native and/or non-native species. **Figure 3** shows diurnal fluctuations in DO as recorded in the Phase 3 Study (Stillwater Sciences 2018).

![Example of Daily Dissolved Oxygen Fluctuations](source: Stillwater Sciences 2018)

Benthic macroinvertebrate (BMI) communities can respond to the effects of water quality, habitat conditions and various anthropogenic stressors in an aquatic system with changes in population abundance and species composition (Sutula et al. 2016; ABC Laboratories 2016). Macroinvertebrates are also important food resources for many fish species, including tidewater goby and steelhead. BMI abundance and diversity in the SCRE are likely influenced by complex interactions of several variables in this dynamic system (Stillwater Sciences 2018). The BMI community in the SCRE tends to be dominated by a few species that prefer freshwater but are tolerant of variable and brackish conditions (Stillwater Sciences 2018). BMI abundance and diversity was low during Phase 3 sampling, which might be due in part to drought conditions, resulting in extended periods of closed-berm, low salinity conditions, as well as the lack of sediment scouring that typically occurs during high winter flows.
Toxicity results from the Phase 3 quarterly testing during 2015–2016, as well as NPDES permit monitoring results, indicated no significant toxicity effects on test organisms of water collected in SCRE or VWRF sites. Trace metal analysis shows some periods of elevated zinc and copper concentrations, with no exceedances in the VWRF discharge, but occasionally higher concentrations in the outfall channel and in an upstream SCRE location.

2.5 Habitats

The land cover and habitats categorized within the SCRE include Developed/Disturbed, Foredune, Freshwater Wetland, Ocean, Ocean Beach, Open Water, Riparian, and Salt Marsh. Vegetation community types are shaped by water levels in SCRE, salinity tolerances, and disturbance due to channel scour and SCRE berm breaching. The approximate acreages of habitats within the SCRE, as assessed from 1977 through 2016, are summarized in Table 1 and depicted on Figure 4.

<table>
<thead>
<tr>
<th>Habitats Type</th>
<th>1977</th>
<th>2002</th>
<th>2009</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developed/Disturbed</td>
<td>75.16</td>
<td>53.78</td>
<td>55.54</td>
<td>55.08</td>
</tr>
<tr>
<td>Foredune</td>
<td>60.75</td>
<td>95.26</td>
<td>87.60</td>
<td>77.36</td>
</tr>
<tr>
<td>Freshwater Wetland</td>
<td>10.20</td>
<td>29.23</td>
<td>42.99</td>
<td>40.09</td>
</tr>
<tr>
<td>Ocean</td>
<td>95.18</td>
<td>46.93</td>
<td>30.68</td>
<td>75.67</td>
</tr>
<tr>
<td>Open Beach</td>
<td>52.08</td>
<td>49.22</td>
<td>46.28</td>
<td>48.85</td>
</tr>
<tr>
<td>Open Water</td>
<td>123.91</td>
<td>102.43</td>
<td>127.79</td>
<td>114.06</td>
</tr>
<tr>
<td>Riparian</td>
<td>202.20</td>
<td>258.18</td>
<td>246.29</td>
<td>228.34</td>
</tr>
<tr>
<td>Salt Marsh</td>
<td>23.53</td>
<td>7.99</td>
<td>4.15</td>
<td>3.58</td>
</tr>
</tbody>
</table>

SOURCE: Stillwater Sciences 2018: Figure 3-45

NMFS has designated critical habitat for the Southern California Coast steelhead under the FESA. The USFWS has designated critical habitat for the tidewater goby, southwestern willow flycatcher, and western snowy plover under the FESA. These critical habitat ranges are provided in Figure 5. Each of these critical habitat areas have been designated based on their potential to support habitat values critical for the support of listed species. These habitat values are represented within the habitat types inventoried and listed in Table 1.
Figure 4
Habitat Types within SCRE under Existing Conditions, 2017

SOURCE: Stillwater Sciences, 2018

Ventura Water Supply Projects
Figure 5
Designated Critical Habitat in the Project Area

Critical Habitat
- Southwestern willow flycatcher
- Steelhead
- Tidewater goby
- Western snowy plover

SOURCE: ESRI
2.6 Special-Status Fish and Wildlife

The focal species for the PCAP are special-status fish and wildlife known to use the SCRE: tidewater goby, Southern California steelhead, western snowy plover, and California least tern. As the SRP Report explained (Revell et al. 2018:3–4):

The SRP selected the tidewater goby as the most sensitive indicator for the ecology of the SCRE ecosystem. Of the four species, the tidewater goby is the most reliant on the SCRE for all aspects of its life history. Although the other sensitive species (i.e., the birds and steelhead) rely on the estuary for critical period of their life history, they also spend part of their lives outside of the estuary. Thus the SRP focused first on the life history of the tidewater goby in the SCRE, and examined how discharges from the VWRF may affect the various life history stages and completion of its life cycle (Table 1).

At the same time, the SRP Report (Revell et al. 2018: 4) explained:

The SRP also evaluated effects of VWRF discharge on steelhead, western snowy plover and California least term for the life states supported by the SCRE *(Tables 2, 3, and 4). Recommendation developed for the goby were examined carefully against the life history needs of the other identified sensitive species for the life stages dependent on the SCRE and the SRP recommendations were adjusted as necessary to ensure that all critical sensitive species life history needs are considered in arrives at the SRP’s [VWRF discharge reduction recommendations.]

The subsections below review key aspects of life history, habitat requirements and distribution of the focal species based on these conceptual models developed and recommended by the SRP, in order to focus the PCAP data collection on the most ecologically relevant parameters that would be affected by reductions in VRWF discharge. The SRP developed conceptual models of key needs for the four sensitive species occupying the SCRE, focusing on the habitat related beneficial drivers and negative stressors associated with each life history stage or each species. (Revell et al. 2018, p. 6). These life stage conceptual models have been reformatted slightly in the subsections below to better accommodate identification of related PCAP measures developed to monitor and assess critical factors or indicators related to listed species success, and related critical habitat quality.

2.6.1 Tidewater Goby

Life History Conceptual Model and Habitat Needs

The population in the SCRE is federally listed as endangered under the FESA (62 FR 43937, August 18, 1997). California has also designated the tidewater goby as a species of special concern (CDFG 1995:79, 235).3 The U.S. Fish and Wildlife Service (USFWS) has designated the SCRE as critical habitat for the tidewater goby under the FESA (73 FR 5920, January 31, 2008), and also published a Recovery Plan for the endangered fish (USFWS 2005), which is a plan required by Section 4(f) of the FESA that delineates reasonable actions that are believed to be required to recover and/or provide future protections for a listed species. Threats to tidewater

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3 Species of special concern are those with low, scattered, or highly localized populations and require active management to prevent them from becoming threatened or endangered. (CDFG 1995:3.)
goby include lack of freshwater due to diversions, pollution, siltation, and competition and predation by invasive non-native species, such as the western mosquitofish (*Gambusia affinis*), which is a competitor, and green sunfish and the African clawed frog (*Xenopus laevis*), which are predators (USFWS 2005; Lafferty et al. 1999). According to the USFWS, the key threats to the tidewater goby that are relevant to the Santa Clara River watershed include agricultural discharges, sewage treatment effluent, water diversions, and exotic species (USFWS 2005).

Tidewater goby inhabit the SCRE year-round for their entire life-cycle, and typically live just one year. The SRP’s life stage conceptual model for the SCRE with drivers and stressors (Revell et al. 2018) is summarized in Table 2.

### Table 2

<table>
<thead>
<tr>
<th>Life Stage</th>
<th>Time of Year</th>
<th>Negative Stressor</th>
<th>Positive/beneficial driver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg</td>
<td>Peak spawning activity during spring (April–early June) and late summer (August). Potential range January–November. Spawns in burrows in soft sediments (e.g., sand silt and mud) Duration 9–11 days</td>
<td>1) Unseasonal breaching 2) Low dissolved oxygen (DO) 3) Toxics</td>
<td>1) Stable estuary water surface elevation (WSE) 2) Substrate suitable for burrows 3) Low salinities (0–15 ppt) 4) Low velocity</td>
</tr>
<tr>
<td>Larvae</td>
<td>Peak April–June and August–September. Potential range March–October. Duration 1–3 days</td>
<td>1) Unseasonal breaching 2) Rapid salinity change 3) High velocity 4) Low DO 5) Toxics</td>
<td>1) Stable estuary WSE 2) Low salinities (0–15 ppt) 3) Low velocity</td>
</tr>
<tr>
<td>Juvenile</td>
<td>Potentially present year-round, probably reach maturity a few months after hatching.</td>
<td>1) Unseasonal breaching 2) Rapid salinity change 3) High velocity 4) Low DO 5) Toxics 6) Predation/competition by nonnative species</td>
<td>1) Stable estuary WSE 2) Low salinities (0–15 ppt) 3) Low velocity 4) Submerged and emergent vegetation</td>
</tr>
<tr>
<td>Adult</td>
<td>1-year life span typically. Main die-off occurs in May/June after spring spawning season.</td>
<td>1) Unseasonal breaching 2) High velocity 3) Low DO 4) Toxics 5) Predation/competition by nonnative species</td>
<td>1) Stable estuary WSE 2) Low velocity 3) Submerged and emergent vegetation 4) Tolerant of high salinity</td>
</tr>
</tbody>
</table>

**Sources:** Revell et al. 2018; Swenson 1999; USFWS 2005; Hellmair and Kinziger 2014

Breeding occurs in slack shallow waters of seasonally disconnected or tidally muted lagoons, estuaries, and sloughs (Stillwater Sciences 2018:159). Tidewater goby require shallow habitat (0.1 to 2 m) with sandy substrate for spawning burrow construction (critical habitat designation, 73 FR 5920, January 31, 2008). The male constructs a burrow in soft sediment (usually sand, also mud) where a female lays her eggs. The male remains in the burrow caring for the eggs for 9–11 days until the larvae hatch. Adults can spawn multiple times. Spawning can potentially occur between January and November, with peak activity in spring (April–early June) and a smaller...
peak in late summer (August) (Swenson 1999, USFWS 2005). This reflects the 1-year lifespan of this species: spring spawning by adults that were spawned the previous year (most adults die around May-June), and late summer spawning by juveniles born early in the year that reached sexual maturity before fall.

After hatching, larvae are planktonic for a few days before settling onto the bottom. Juveniles and adults live on the bottom and feed on benthic invertebrates. Tidewater goby are frequently associated with emergent vegetation (critical habitat designation, 73 FR 5920, January 31, 2008), possibly to avoid predation by wading birds and piscivorous fish (Moyle 2002). However, in the SCRE, where emergent vegetation has historically been sparse, tidewater goby have been frequently observed in areas lacking vegetative cover (Stillwater Sciences 2018:160). Tidewater goby are frequently associated with widgeon grass (*Ruppia maritima*) (Brenton Spies, UCLA unpublished). This submerged aquatic vegetation has wide tolerance of salinity and water level fluctuations and often harbors abundant invertebrates (Swenson unpublished). Tidewater goby may also use other emergent vegetation (*Scirpus*) for cover.

Anthropogenic breaching of lagoons during the dry season may adversely affect tidewater gobies in a variety of ways (USFWS 2005). In general, after a lagoon has been breached it reforms in a week or so, but often stabilizes at a lower level. Usually the level of the lagoon falls by a meter (3.3 feet) or more, which can strand many tidewater gobies in shallow pools and leave breeding burrows above the water level, subject to desiccation and predation (Swift et al. 2018). The salinity increases considerably because freshwater inflow is low or absent in the dry season at many sites (USFWS 2005). The transition to tidal and/or more saline conditions can also affect prey abundance as benthic invertebrate populations crash due to a sudden change in salinity (e.g., Netto et al. 2012 in Largier et al. 2019).

Dispersal, colonization and genetic exchange have been documented among populations in adjacent estuaries, although not specifically at the SCRE. Adults, which have a wide salinity tolerance, are presumably the dispersive life stage. Dispersal and colonization appear to be limited to years with high winter outflow, as seen in 1995 (Lafferty et al. 1999), when all of the nearby estuaries breach simultaneously, and freshwater plumes along the coast can guide dispersing adults to adjacent estuaries and allow recolonization or genetic exchange (Revell et al. 2018:20). Unseasonal breaching during summer, however, does not promote successful dispersal because nearby estuaries would be closed and freshwater plumes would be lacking. (Revell et al. 2018:20.)

Analysis of tidewater goby capture data does not indicate that open berm conditions reduce abundance (Stillwater Sciences 2018:160–161). This apparent decoupling of tidewater goby abundance (as represented by capture data) from wet weather berm breaching dynamics indicates that there is sufficient flow refuge during open berm conditions in the SCRE (Stillwater Sciences 2018:160–161). Further, natural breaching of the berm at the proper time, in winter and early spring resulting from increased river flows not only in the SCR, but also in other nearby estuaries, is likely to support dispersal of adults to other estuaries, providing for recolonization or genetic exchange (Lafferty et al. 1999).
Tidewater goby distribution in SCRE has been documented by beach seine surveys over the years. Surveys for the Phase 3 Study found a few gobies in September 2015 and 2016 near McGrath Beach, along the berm, and near the outfall of the VWRF channel (but not within the channel), but none in March and June 2015 (Stillwater Sciences 2015a, 2015b, 2016). Surveys in recent years (2017–2019) have found tidewater goby near the berm, but not at the Harbor Boulevard Bridge (Cardno 2017, 2019).

The SCRE aquatic community includes both native and invasive non-native species tolerant of fresh to brackish conditions (Stillwater Sciences 2018, Swift et al. 2018). Native species include tidewater goby, staghorn sculpin (*Leptocottus armatus*), prickly sculpin (*Cottus asper*), striped mullet (*Mugil cephalus*), threespine stickleback (*Gasterosteus aculeatus*), California killifish (*Fundulus parvipinnis*), and southern steelhead (*Oncorhynchus mykiss*). Non-native fishes included mosquitofish (*Gambusia affinis*), arroyo chub (*Gila orcutti*), fathead minnow (*Pimephales promelas*), Mississippi silverside (*Menidia audens*), carp (*Cyprinus carpio*), and green sunfish (*Lepomis cyanellus*). In addition, red swamp crayfish (*Procambarus clarki*) and African clawed frog larvae (tadpole) (*Xenopus laevis*) have been documented (Swift et al. 2018).

Analysis of recent fish survey data (2008–2016) indicates that while native fish were typically more abundant than non-native fish from 2008 through 2012, a shift in the fish assemblage composition toward non-native species began in 2013. This shift coincided with low breach frequency conditions that persisted from 2012–2015 (Stillwater Sciences 2018).

Some of these non-native species can affect tidewater gobies through competition, predation, or habitat disruption. Green sunfish (USFWS 2005) and African clawed frog are documented predators (Lafferty and Page 1997). Common carp, which feed by rooting in substrate for plants and invertebrates, could disturb tidewater goby breeding and foraging habitat. Carp can also contribute to increased turbidity and nutrient release from sediments (Fofonoff et al. 2018).

The SCRE contains suitable estuarine breeding and rearing habitat for all life stages of tidewater goby (Table 2) (Stillwater Sciences 2011, 2015, 2018; Revell et al. 2018; Hammersmark et al. 2017, 2018). The species has the following habitat needs and threats in SCRE:

- Tidewater goby require stable shallow habitat with sandy substrate for spawning burrow construction. Tidewater goby need low velocity conditions, stable water surface elevations, and low salinities (<15 ppt) during egg, spawning and early larval and juvenile life stages (spring through summer).
- Adults are relatively tolerant of salinity fluctuations, but eggs, juveniles and larvae need lower salinities 0–15 ppt) in spring through late summer because they are more sensitive (Hellmair and Kinziger 2014).
- Extended periods of low DO may be unsuitable for all life stages of tidewater goby.
- Tidewater goby juvenile and adult life stages prefer areas with emergent vegetation such as widgeon grass (*Ruppia*), but have been observed in the SCRE historically in areas without vegetation given historical paucity of emergent vegetation in the SCRE.
Unseasonal breaching threatens all tidewater goby life stages because it can result in dispersal of juvenile to the ocean at times that are likely fatal to the species, and in dewatering of burrows after larvae or juveniles are present, but unable to move to areas of refugia.

Major threats in the SCRE include unseasonal breaches; high nutrient concentrations that may result in adverse water quality conditions including algal growth, low DO and hypoxic conditions; and suppression of salinity changes resulting in fresher conditions during summer and fall, which favors invasive non-native species that prey on or constitute competition for adult tidewater gobies (Revell et al. 2018).

Monitoring Priorities

The reduction in VWRF discharge will result in lower water levels in the lagoon during closed berm conditions compared to existing conditions. This will reduce the frequency of unseasonal breaches of the sand berm that would drain the lagoon during seasons that coincide with early life stages of the species, and will allow for more stable estuary surface elevation. Unseasonal open berm conditions result in the stranding of tidewater gobies in shallow pools or asynchronous dispersal events. Lower water levels are also expected to improve the quantity and quality of shallow spawning habitat and deeper, open-water juvenile and adult habitat. Changes in VWRF discharge also have the potential to improve water quality conditions in the SCRE, mainly by reducing nutrient loading that promotes high algal productivity, which can lead to low DO conditions, and also by providing for somewhat more saline conditions during late summer and fall, due to wave overwash patterns and suppression of dry weather freshwater inputs (Revell et al. 2018).

Distribution and abundance of tidewater gobies in SCRE is a direct measure of population status, but given the current low abundance in SCRE, other parameters should also be assessed. Key parameters to monitor for tidewater goby include:

- Suitability of suitable habitat, including aquatic and emergent vegetation (especially *Ruppia*);
- Extent or duration of low DO;
- Unseasonal breaching of the sand berm (anthropogenic in summer), which can lead to dispersal to the ocean, dewatering of burrows, and sudden salinity fluctuations which may affect juveniles in particular and disrupt the invertebrate community (prey); and
- General aquatic community composition (occurrence of non-native fish and amphibians)

Sandy substrate also provides suitable habitat for tidewater goby, but further monitoring of substrate conditions is not proposed under the PCAP. The SCRE substrate, which is generally sandy, is created by the flow dynamics of the Santa Clara River and is regularly re-set during flood flows. The VWRF discharge has little effect on this sediment supply and distribution.

Monitoring of benthic macroinvertebrates is already required by NPDES permit monitoring requirements and that data will be incorporated into evaluations and assessments pursuant to the PCAP, so no additional sampling is recommended. Previous assessments have found limited diversity in benthic organisms (Stillwater Sciences 2018).
2.6.2 Southern California Steelhead

Life History Conceptual Model and Habitat Needs

Steelhead found in the SCRE and Santa Clara River belong to the Southern California Coast steelhead (*O. mykiss*) Distinct Population Segment (DPS), which extends from the Santa Maria River bordering Santa Barbara and San Luis Obispo counties to the U.S.-Mexico border (NMFS 2006). This DPS is listed as endangered under the FESA (NMFS 2006). In addition, the National Marine Fisheries Service (NMFS) designated the SCRE as critical habitat for the Southern California steelhead under the FESA (70 FR 52488, September 2, 2005 [designating, among other areas, the SCRE as critical habitat for steelhead]).

A life stage conceptual model for Southern California steelhead in the SCRE (Revell et al. 2018) is summarized in Table 3. The SCRE provides a migration corridor for winter-run steelhead adults migrating upstream to spawn as soon as Santa Clara River depths allow, and post-spawning adults and smolts (juveniles that have undergone physiological changes to prepare for marine life) migrating out to the ocean (Stillwater Sciences 2018:152–153). The SCRE is a transition zone for acclimation between marine and freshwater environments. Finally, although previous research in the SCRE in 2008 suggested that juvenile steelhead tend to rear in upstream locations and spend only limited time in the lagoon (< 3 days) prior to outmigration (Kelley 2008), more recent studies document the importance of juvenile rearing in estuaries as a life history strategy, in that it allows the fish to grow larger and become adapted to surviving the ocean migration. These studies include Bond et al. (2008), Hayes et al. (2008), Hayes et al. (2011), and Revell et al. (2018:22). The Phase 3 Study concluded that SCRE provides potential rearing habitat for juvenile (young-of-the-year) steelhead not yet ready for ocean entry (Stillwater Sciences 2018:153).

### Table 3

**Southern California Steelhead Life Stage Conceptual Model for the Santa Clara River Estuary**

<table>
<thead>
<tr>
<th>Life Stage</th>
<th>Time of Year</th>
<th>Negative Stressor</th>
<th>Positive/beneficial driver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young-of-the-Year</td>
<td>Enters estuary between January and June to rear.</td>
<td>1) Unseasonal breaching</td>
<td>1) Stable Estuary WSE</td>
</tr>
<tr>
<td>Rearing</td>
<td>Usually enters later than smolts (May-June).</td>
<td>2) Shallow water &lt;1 m/lack of deep water cover</td>
<td>2) Deep water/cover habitat &gt;1m</td>
</tr>
<tr>
<td></td>
<td>Once in estuary when mouth closes and stream is intermittent, must remain</td>
<td>3) Water quality:</td>
<td>3) Water quality:</td>
</tr>
<tr>
<td></td>
<td>until mouth opens naturally</td>
<td>1) Low DO (&lt;4 mg/L)</td>
<td>• High DO (&gt;4 mg/L),</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2) Unsuitable temperature conditions (&lt;25°C),</td>
<td>• Non-lethal temperature (&lt;25°C),</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3) High salinity when not acclimated (&gt;28 ppt)</td>
<td>• Lower salinities (0–15 ppt)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4) Toxics</td>
<td></td>
</tr>
<tr>
<td>Smolts</td>
<td>Enters estuary between January and June. Early outmigrants (January-April)</td>
<td>1) Shallow water/lack of deep water cover</td>
<td>1) Deep water/cover habitat &gt;1 m</td>
</tr>
<tr>
<td>Migration, possibly</td>
<td>are usually larger and usually do not stay long in estuary.</td>
<td>2) Water quality:</td>
<td>2) Water quality:</td>
</tr>
<tr>
<td>rearing</td>
<td>May get trapped if berm closes. Then smolts are</td>
<td>1) Low DO (&lt;4mg/L)</td>
<td>• High DO (&gt;4 mg/L),</td>
</tr>
</tbody>
</table>

Ventura Water Supply Project
Pre-Construction Assessment Program and MAAMP

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ESA 160685
June 2021
TABLE 3
SOUTHERN CALIFORNIA STEELHEAD LIFE STAGE CONCEPTUAL MODEL FOR THE SANTA CLARA RIVER ESTUARY

<table>
<thead>
<tr>
<th>Life Stage</th>
<th>Time of Year</th>
<th>Negative Stressor</th>
<th>Positive/beneficial driver</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Unsuitable temperature conditions (&gt;25°C)</td>
<td>Non-lethal temperature (&lt;25°C)</td>
</tr>
<tr>
<td>3) Toxics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td>November-May</td>
<td>1) Closed mouth/berm during kelt downstream migration (kelts cannot return to ocean)</td>
<td>1) Open mouth/berm during kelt downstream migration (kelts can return to the ocean)</td>
</tr>
<tr>
<td>Migration</td>
<td>Adults migrate upstream to spawn, post-spawning adults (kelts) migrate downstream to ocean</td>
<td>2) Lack of connected flow to spawning habitat when berm open</td>
<td>2) Connected flow to spawning habitat</td>
</tr>
</tbody>
</table>

SOURCES: Adapted from Revell et al. 2018; NMFS 2005; Boughton et al. 2017; Alley 2014; Booth 2016

Winter-run adult steelhead enter spawning streams from late fall to spring (November to May), following the first storm flows (aka “fresheats”) resulting in breaching of the sand berm (Shapovalov and Taft 1954; Behnke 1992). Adult steelhead are known to stray from their natal streams to spawn in nearby streams. In more hydrologically variable streams of the central and southern California coast, straying is often more prevalent than in more northern streams (Clemento et al. 2009; Pearse et al. 2009). Peak spawning activity occurs between January and March, based on other populations in the southern California steelhead DPS (Busby et al. 1996). Juvenile steelhead usually remain in freshwater for one to three years before emigrating to the ocean (Shapovalov and Taft 1954; Quinn 2005).

Southern steelhead outmigration typically occurs between January and June, with a peak from late March through mid-May (NMFS 2012). Outmigration depends on when adequate flow conditions are present to open the streams and lagoons to the ocean, since sand berms build up and seal off many confluences, including the SCRE, in low flow conditions (Stoecker 2002). Studies in Central California suggest the earlier migrations in February through April are composed of larger fish moving through estuaries very quickly (1 to a few days) (Hayes and Kocik 2014) and heading straight to sea (Hayes et al. 2011).

In some Central California streams, smaller/younger fish migrate downstream later in May and June to recruit to estuarine habitat, where they grow for extended periods of time on the order of weeks to months during the summer (Manning and Lamb 2012; Shapovalov and Taft 1954). Juvenile steelhead that rear in estuaries can attain a larger size in a single rearing season than freshwater-reared juveniles, which enhances their survival in the ocean and returns as adults to spawn (Bond et al. 2008; Hayes et al. 2008; NMFS 2012). Compared to central California, Hayes and Kocik (2014) suggested that steelhead use of coastal lagoons seems less prevalent in southern California, where it is likely that temperature increases, and water quality and quantity decline to the point of lagoons being uninhabitable to even steelhead (Hayes and Kocik 2014).

Steelhead in the Santa Clara River have the potential to express both patterns of juvenile life history, with outmigration of larger fish occurring with minimal stay in the estuary, as well as
smaller/younger fish migrating downstream to the estuary where they grow for an extended period of time before out-migrating. The steelhead trapping facilities at Vern Freeman Diversion Dam documented downstream migration by kelts (spawned-out adult steelhead returning to the ocean) and juveniles, of which approximately 10 percent were smaller, young-of-the-year juveniles (Booth 2016 in Revell et al. 2018). Typically, United Water transported these young-of-the-year juveniles back upstream to tributaries. If not for this practice, these young-of-the-year juveniles likely would have reared in the SCRE if sufficient flows remained in the SCR for downstream migration (Revell et al. 2018). As other evidence, several stranded steelhead in the size range of 10–12 inches were found dead in the flowing river channel from about 300 feet above to 1,200 feet below Harbor Boulevard Bridge following an unauthorized third-party breaching event in September 2010 (Swift et al. 2018), indicating that sub-adult steelhead may use the lagoon for more extended periods of rearing (Stillwater Sciences 2018).

During summer and fall months, young-of-the-year juvenile steelhead, as well as any smolts and kelts unable to enter the ocean, may rear in the closed lagoon. Smaller juveniles may utilize vegetated margin habitats containing instream or overhead cover (Quinones and Mulligan 2005) if available, and larger fish may occupy deeper water along steep banks or in open water areas.

Suitable estuarine habitat conditions for lagoon-rearing young-of-the-year steelhead include lower salinity (<15 ppt), relatively high DO (>4 mg/L), refuge from excessive water temperatures (>25°C), and adequate depths or instream or overhead cover to avoid avian predation (Raleigh et al. 1984; Stillwater Sciences 2018; Revell et al. 2018). Poor water quality conditions, including very low DO or excessive water temperatures (>25°C) temperatures without refuge areas can impact growth rates through reduced feeding efficiency and competition with other aquatic species (Reeves et al. 1987; Brown and Moyle 1991; Revell et al. 2018). The ability to move into different aquatic microenvironments is likely important for juveniles to survive poor habitat conditions (Moyle et al. 2017). However, fish cannot access habitats upstream of SCRE given the lack of sufficient river flows and connectivity during summer.

**Monitoring Priorities**

The reduction in VWRF discharge will result in lower water levels in the lagoon during closed berm conditions compared to existing conditions. This will reduce the frequency of unseasonal breaches of the sand berm that would drain the lagoon. Unseasonal breaches outside of the migratory period can harm or kill rearing juvenile steelhead, which are not physiologically prepared to enter the ocean. Lower water levels are also expected to affect the quantity and quality of vegetated margin habitat and deeper, open-water habitat available for juvenile or adult steelhead occupying the lagoon. Reductions in VWRF discharge also have the potential to change water quality conditions in the SCRE, mainly by reducing nutrient loading that promotes high algal productivity, which can lead to low DO conditions.

Consequently, key factors to monitor for lagoon-rearing juvenile steelhead include:

- Availability and changes in suitable habitat and cover, including water depth and vegetated margins;
- Extent or duration of low DO (<4 mg/L) and/or high water temperatures (>25°C); and
- Unseasonal breaching of the sand berm, which can drain the lagoon and harm or kill rearing juvenile steelhead.

### 2.6.3 Western Snowy Plover

The western snowy plover is a small shorebird closely associated with sandy beaches. Pacific coastal populations of western snowy plover are federally listed as threatened (58 FR 12864, March 5, 1993 [listing the Pacific Coast population as threatened throughout its range]), while interior populations are a state species of special concern. Further, USFWS has designated the SCRE as critical habitat for western snowy plover under the FESA (64 FR 68508, December 7, 1999; 77 FR 36727, June 19, 2012).

#### Life History

In California, breeding habitat primarily includes coastal dune-backed beaches, barrier beaches, and salt-evaporation ponds, and less commonly bluff-backed beaches, dredged material disposal areas, salt ponds, and river bars (Page et al. 2009; USFWS 2007). Wintering habitat includes the same beaches used for nesting, as well as non-nesting beaches and flats. Western snowy plover occur near the SCRE during both breeding and non-breeding (winter) seasons. They occupy open beach and foredune habitats for nesting and foraging. Breeding, nesting and rearing typically occurs between March and August, with peak nesting activity in May or June (USFWS 2007) (Table 4). Nesting takes place on the ground above the high tide line on barren to sparsely vegetated beaches. Hatching occurs from early April through mid-August, and chicks take approximately one month to fledge (USFWS 2007). Western snowy plover forage by gleaning invertebrates such as insects and crustaceans from the sand, stranded seaweed on the beach, or low-growing plants. They have also been observed within the SCRE foraging on exposed mudflats after a breach event (Ventura Audubon reported in Stillwater Sciences 2018).

<table>
<thead>
<tr>
<th>Life Stage</th>
<th>Time of Year</th>
<th>Negative Stressor</th>
<th>Positive/beneficial driver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult nesting, eggs, and chicks</td>
<td>Breeding season March-August, with peak nesting May-June</td>
<td>1) Unseasonal breaching can scour nests on the beach berm</td>
<td>1) Stable estuary WSE</td>
</tr>
<tr>
<td>Breeding</td>
<td></td>
<td>2) Extensive vegetation</td>
<td>2) Seasonal breaching in winter can scour vegetation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3) Lack of food resources</td>
<td></td>
</tr>
</tbody>
</table>

SOURCES: Adapted from Revell et al. 2018; USFWS 2012; Powell 2001

Primary threats to western snowy plover include human disturbance (e.g., off-road vehicles, pets, or direct harassment of eggs or chicks), loss of breeding and wintering habitat from development, expanding predator populations, and introduced beachgrass (*Ammophila* spp.) (USFWS 2007).

Western snowy plover have been observed nesting at McGrath State Beach, on the banks of McGrath lake, and on the SCRE berm (State Parks 2013, 2014, 2015; Stillwater Sciences 2018), usually on the ocean-facing side. The primary cause of nest failure is often human disturbance:
people taking, moving, or stepping on eggs, or people vandalizing nest enclosures placed by biologists for protection from predators (Smith 2009). Other documented causes of failed nest sites at McGrath State Beach include: dogs, predators (coyotes, crows, gulls, ravens \textit{[Corvus corax]}, red-tailed hawks \textit{[Buteo jamaicensis]}, northern harriers, great blue herons, American kestrels \textit{[Falco sparverius]}, merlins \textit{[F. columbarius]}, coyotes, ground squirrels, and loggerhead shrikes \textit{[Lanius ludovicianus]}), and fluctuating water (More 2008, Smith 2009). Anthropogenic dry season breaching could affect nests or chicks if present in the location of the breach. The reduction in VWRF discharge will result in lower water levels in the lagoon during closed berm conditions, and thereby reduce the frequency of unseasonal berm breaches during the plover breeding season.

**Monitoring Priorities**

The key monitoring parameter for western snowy plover is the location of any nesting activity near the berm (for vulnerability to breaching) (Revell et al. 2018).

### 2.6.4 California Least Tern

The California least tern, a small seabird generally associated with lagoons, estuaries, rivers, and the coast, is the smallest of North American terns, and the only subspecies of least tern found in California. The California least tern is federally listed (35 FR 8491, June 2, 1970) and state listed (June 27, 1971) as endangered throughout its range. The California least tern is also designated for protection as a California Fully Protected Species.

**Life History**

California least tern occurs only during summer (breeding), beginning as early as late April or May, with peak activity typically in June or July (Table 5) (USFWS 2006). Fall migration begins in late July or early August. Nesting habitat is typically sand or gravel beaches above high tide that are relatively free of vegetation as a result of scour from periodic high storm tides.

| Table 5 | California Least Tern Life Stage Conceptual Model for the Santa Clara River Estuary |
|---|---|---|
| Life Stage | Time of Year | Negative Stressor | Positive/beneficial driver |
| Adult nesting and foraging, eggs, and chicks | Breeding season April through summer, peak activity June-July. Migration in late July-early August. | 1) Unseasonal breaching can scour nests on the beach berm 2) Toxics | 1) Stable estuary WSE 2) Higher water surface elevations support foraging in top 1 m of water column |

SOURCES: Adapted from Revell et al. 2018; USFWS 2006

Least tern forage in both saltwater and freshwater habitats where small bait fish are abundant, including shallow estuaries, lagoons, coastal ponds, or nearshore waters (Thompson et al. 1997). A significant amount of foraging also occurs offshore in deep-water habitats (Keane and Smith 2016). Foraging studies near three nesting sites (Venice Beach, Huntington Beach, and Santa...
Margarita River) concluded that 75 percent of least tern foraging occurred within 1.2 km (0.75 mile) of nesting sites, and occurred up to 3 km (1.86 miles) distant (Atwood and Minsky 1983 in Keane and Smith 2016). Least terns at three colonies in San Diego Bay foraged throughout San Diego Bay, the nearshore area of the ocean, and pelagically (Baird 2010). They stay closest to the colony during the chick stage and expand foraging bouts more pelagically during the fledge stage. They forage beyond 24 nautical miles throughout all stages of the breeding season, and likewise continue to use mooring and inlets preferentially during all stages (Baird 2010).

California least tern take an assortment of fish and aquatic invertebrates that occur in the upper 15 centimeters (cm) of water (Thompson et al. 1997). They feed on small (10 cm or less) fish, including northern anchovy (Engraulis mordax), topsmelt (Atherinops affinis), jacksmelt (A. californiensis), shiner perch (Cymatogaster aggregata), rough silversides (Membras martinica), flat croaker (Leiostomus xanthurus), deep-body anchovy (Anchoa compressa) or slough anchovy (A. delicatissima), among other species (Atwood and Kelly 1984 in Keane and Smith 2016). Baird (2010) found that a few species dominated the prey taken by least tern adults and brought back for courtship feeding and for chicks at San Diego Bay colonies. The most common adult prey were anchovies, silverside smelt, and kelpfish (collectively 85 percent of all adult prey), plus shiner perch (12 percent) and sardines (4 percent). The most common prey fed to chicks were anchovies and silverside smelt (75 percent of all chick prey) (Baird 2010). A CDFW study using stable isotope analyses of egg membranes and albumen from salvaged eggs (Lewison and Deutschmann 2014) determined that breeding females’ diet included rockfish, squid, saury, anchovy, perch, topsmelt, staghorn sculpin, goby, blue mud shrimp, yellow shore crab and krill, with the largest proportional contribution from krill, saury, rockfish and topsmelt (mostly marine fish species).

California least tern are also known to eat freshwater species, including killifish (Fundulus parvipinnis) and mosquito fish (Gambusia affinis) (Atwood and Kelly 1984 in Keane and Smith 2016). Terns breeding at Anaheim Bay fished mainly in shallow saltmarsh channels adjacent to the colony, where Klingbeil et al. (1975) found topsmelt and California killifish to be common (Atwood and Kelly 1984 in Lewison and Deutschmann 2014). At Bolsa Chica and Batiquitos Lagoon, where terns foraged mainly in tidal estuaries, fish dropped at colonies were dominated by topsmelt and California killifish (Atwood and Kelly 1984 in Lewison and Deutschmann 2014).

Following the breeding season, Atwood and Minsky (1983) noted that family groups from Venice Beach and Huntington Beach nesting areas disperse to freshwater and estuarine habitats. This increased use of freshwater and estuarine marsh areas during post-fledging dispersal, when juveniles are developing their foraging skills, suggests that such calm, protected waters may be of major significance during this period.

It has been hypothesized that least tern foraging habitat within the SCRE increases with the extent of open water (Stillwater Sciences 2018), presuming that prey fish occupy all wetted areas equally. Least terns in the area can also forage in the ocean (USFWS 1985, Keane and Smith 2016) and McGrath Lake, leading the SRP (Revell et al. 2018) to conclude that a decrease in estuary habitat is unlikely to have an adverse effect. Moreover, although least tern has not been observed to show sensitivity or adverse reaction to current water quality conditions within the SCRE, sight feeding success may be impaired by periodic development of algal blooms or
floating mats associated with excess nutrients in the SCRE (Stillwater Sciences 2011). As such, reductions in the discharge contribution to SCRE nutrient loads have the potential to decrease algal growth and to provide a well-oxygenated and food-rich environment, resulting in not only improved water quality conditions, but also improved foraging habitat for least tern.

Major threats to California least tern include habitat loss and degradation as a function of invasive plants, urban development, and recreational use of beaches. Human interference, nest abandonment, and predation are common causes of nest failure in the SCRE (Stillwater Sciences 2018).

California least tern have been observed nesting just south of the SCRE, at McGrath State Beach, and on the SCRE berm (Smith 2009; Stillwater Sciences 2018), usually on the ocean-facing side. Anthropogenic dry season breaching could affect nests or chicks if present in the location of the breach. The reduction in VWRF discharge will result in lower water levels in the lagoon during closed berm conditions, and thereby reduce the frequency of unseasonal berm breaches during the breeding season.

**Monitoring Priorities**

The key monitoring parameter for California least tern is the location of any nesting activity near the berm (for vulnerability to breaching) (see Revell et al. 2018). In addition, foraging activity in and near the lagoon, the adjacent ocean, and the wildlife/water quality ponds will also be observed and evaluated.

### 2.7 Conclusions

In summary, the stressors currently facing the focal species that rely on the SCRE ecosystem are:

- altered SCRE hydrology due to volume of VWRF freshwater discharge, which maintains the SCRE at “full” stage for extended periods.
- unseasonal breaching (June–October) of the berm by unauthorized parties, which drains and shrinks the lagoon, results in sudden, high velocity flows that destabilize habitat and rapid, major changes in salinity during summer months when aquatic species are at a vulnerable lifestage.
- excess nutrient loading, which leads to eutrophication and poor water quality (low DO).
- invasive non-native species of freshwater fish and amphibians, which negatively affect tidewater goby and steelhead juveniles through predation, competition, and habitat disturbance.

The reduction of VWRF discharge is expected to improve SCRE ecosystem health and maintain or enhance habitat for the four special-status species by reducing stressors and maintaining beneficial drivers (Revell et al. 2018).
CHAPTER 3
Monitoring Methods

3.1 Monitoring Categories

This PCAP is designed to assess habitat attributes that are important to tidewater goby, southern California steelhead, western snowy plover, and California least tern based on their status as sensitive species and indicators of overall ecosystem health of the SCRE. The PCAP will monitor the following six categories of parameters:

1. Physical Processes and Hydrology
2. Water Quality
3. Food Web
4. Fish (tidewater goby and steelhead)
5. Birds (western snowy plover and California least tern)
6. Habitat/Vegetation

Data collection methods include the following types:

- Fixed instrumentation for continuous data collection
- Periodic field surveys with grab sampling
- Periodic visual inspections, mapping
- Aerial imagery mapping

Table 6 outlines the monitoring categories, parameters, methods, timing and frequency of data collection, and locations. Figures 6 and 7 provides locations for data collection points for each method identified in Table 6.

The following sections describe for each parameter the rationale, data collection methods and protocol, sampling frequency and timing, and location of sampling. The details summarized in Table 6 and described in this section are recommended to achieve a data set that supports an informed assessment of the conditions in the SCRE. The methods, frequency, location, and number of samples may be modified by Ventura Water, in coordination with the regulatory agencies, Coastkeeper and Heal the Bay, to better support the study objectives.
### TABLE 6
**MONITORING PARAMETERS AND METHODS**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Method</th>
<th>Time of Year, Frequency</th>
<th>Location and Samples¹</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical Processes and Hydrology</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bathymetry</td>
<td>Boat-based bathymetric survey</td>
<td>At start of study and as needed to capture changes after large flow events</td>
<td>Inundated SCRE</td>
</tr>
<tr>
<td>Ocean Berm Height</td>
<td>Ground-based GPS survey</td>
<td>Three times yearly</td>
<td>Ocean berm</td>
</tr>
<tr>
<td>Water Level (depth)</td>
<td>Water level loggers</td>
<td>Continuous</td>
<td>2 locations in lagoon plus 1 atmospheric reference site</td>
</tr>
<tr>
<td>Breach Morphology</td>
<td>Ground based GPS</td>
<td>Event triggered</td>
<td>Beach (when breaching occurs)</td>
</tr>
<tr>
<td>Depth to Groundwater</td>
<td>Existing Piezometers and Wells</td>
<td>Continuous</td>
<td>3 locations (existing wells near McGrath campground and VWRF ponds)</td>
</tr>
<tr>
<td>Santa Clara River Flow</td>
<td>County gage and supplemental flow depth sensor if possible and visual monitoring</td>
<td>Continuous; monthly for visual observations</td>
<td>Victoria Avenue</td>
</tr>
<tr>
<td>VWRF Discharge</td>
<td>Metered at overflow from ponds to SCRE</td>
<td>Continuous</td>
<td>Outfall</td>
</tr>
<tr>
<td><strong>Water Quality²</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature, DO, pH, EC</td>
<td>Data sonde</td>
<td>Continuous at monitoring stations</td>
<td>4 sonde stations (2 lower lagoon, 1 center lagoon, 1 near Harbor Blvd)</td>
</tr>
<tr>
<td>Temperature, DO, pH, EC, turbidity</td>
<td>Vertical water column profile by boat</td>
<td>1–3 times annually (spring, summer, fall)</td>
<td>6 locations including 4 sonde stations</td>
</tr>
<tr>
<td>Nutrients (TN, TP)</td>
<td>Spatial coverage grab samples in open water, lab analysis</td>
<td>1–3 times annually (spring, summer, fall)</td>
<td>6 locations including 4 sonde stations</td>
</tr>
<tr>
<td>Chlorophyll-a</td>
<td>Spatial coverage grab samples in open water, lab analysis</td>
<td>1–3 times annually (spring, summer, fall)</td>
<td>6 locations (same as nutrient grab samples)</td>
</tr>
<tr>
<td>Benthic Macroalgae</td>
<td>1-meter quadrats (3 replicates per sample location)</td>
<td>1–3 times annually (spring, summer, fall)</td>
<td>6 locations (general vicinity of nutrient grab samples). May be adjusted depending on accessibility to bottom.</td>
</tr>
<tr>
<td>Groundwater Quality</td>
<td>Grab samples from existing wells.</td>
<td>1–3 times annually (spring, summer, fall)</td>
<td>5 locations (existing wells near Harbor Blvd and Victoria Ave. and at ponds)</td>
</tr>
<tr>
<td><strong>Fish³</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General fish survey</td>
<td>Beach seine and dip net</td>
<td>1–4 times annually (fall and spring preferably)</td>
<td>Seining at a minimum of 15 accessible locations around SCRE perimeter and in VWRF outflow channel. Adapt after first year, depending on feasibility and utility. Subject to ability to obtain scientific research permits for southern California steelhead and tidewater goby.</td>
</tr>
</tbody>
</table>
### TABLE 6
**MONITORING PARAMETERS AND METHODS**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Method</th>
<th>Time of Year, Frequency</th>
<th>Location and Samples$^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Birds</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western snowy plover, California least tern, and southwestern willow flycatcher</td>
<td>Bird use counts, area-transect counts, general visual surveys, foraging observations and limited nest monitoring (nesting, tern foraging)</td>
<td>Weekly during nesting season (March-July) and juvenile dispersal period (August-October)</td>
<td>Foredune, beach and SCRE</td>
</tr>
<tr>
<td><strong>Habitat/Vegetation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Habitat Assessment surveys within SCRE</td>
<td>Boat-based visual surveys of edge habitat and aquatic habitat for fish cover</td>
<td>1–2 times per year (spring and fall)</td>
<td>Edge habitat of SCRE and VWRF channel (point-intercept method)</td>
</tr>
<tr>
<td><strong>Habitat Mapping</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Habitat Mapping</td>
<td>Current aerial imagery (Google Earth, drone or helicopter) and site walk</td>
<td>Annually, late spring/summer</td>
<td>Entire SCRE</td>
</tr>
</tbody>
</table>

**NOTES:**

1. Location and Samples—Sampling locations shown on Figures 6 and 7. Sampling locations may be adjusted depending on stage/inundation of the lagoon.

2. Water Quality—Sampling intensity for grab samples will depend on variability of the data. Recommend 6 samples per sampling event/visit, then do power analysis of Year 1 results to determine if number of samples can be reduced in subsequent sampling events.

3. Fish—Frequency of surveys include fall (September) consistent with long-term tidewater goby monitoring, then adding spring sampling (April) and finally summer (July) if appropriate.
Figure 7
Up Stream Sample Locations
3.2 Physical Processes and Hydrology

3.2.1 Bathymetric Survey

**Rationale:** Bathymetric surveys will be conducted of the lagoon to estimate the relationship between water level and open water area and depth. In conjunction with water level monitoring, this information is relevant to assessing tidewater goby and steelhead habitat availability. This survey will also confirm the locations of the deepest scour holes of the SCRE.

**Method:** Bathymetric survey measurements will be collected from a watercraft (e.g., non-motorized flat bottom boat, canoe with a small electric trolling motor) using a RTK GPS survey device (or other appropriate differential GPS device) linked to a survey grade single beam echo sounder. Points will be taken in 1-second intervals (a maximum of a point every 6 feet) along north-south profiles across the lagoon that are spaced approximately 150 feet apart, as well as along a profile that follows the deepest river channel.

**Timing:** A bathymetric survey will be performed at the start of the project. If a large SCR flow event occurs (e.g., exceeding 50,000 cfs), or if obvious morphological change is observed following a smaller event, a new survey will be performed. Satellite imagery may be used to determine whether a new bathymetry survey is needed.

3.2.2 Berm Height Survey

**Rationale:** Berm height surveys will be conducted to assist with assessing unseasonal berm breaching risk and to understand when wave overtopping occurs. Unseasonal breaching affects focal species.

**Method:** Berm height measurements will be collected using a RTK GPS survey device (or other appropriate differential GPS device) at the apex of the sand berm at appropriate intervals down the coast to document the shape of the berm. Data and location will be recorded into an electronic pad.

**Timing:** The surveys will be conducted three times a year: (1) within a month of seasonal closure (or June 1, whichever comes first); (2) in September; and (3) after the first seasonal breach (or December 1, whichever comes first).

This information will be supplemented by information collected during daily observations on weekdays year round and during storm events (subject to safety considerations) in anticipation of breaching events.

3.2.3 Water Level Monitoring

**Rationale:** Lagoon water level monitoring will be conducted to assess and build a time series of lagoon depth. When combined with the lagoon bathymetry data this information will allow open water area as a function of depth to be calculated. This will inform assessment of breach likelihood, fish habitat availability, and least tern open water bird foraging habitat availability.
3.0 Monitoring Methods

Method: Water level will be continuously monitored at two locations within the SCRE using depth sensors anchored to the bed of the lagoon. Two non-vented pressure transducers will be used for redundancy as a guard against damage and/or loss of a sensor (e.g., during a flood or breach event). The elevation of the sensors and the corresponding water surface elevation will be surveyed using RTK GPS during installation and at each download/service visit (monthly, unless daily telemetered uploading by cell phone signal is employed). A third sensor will be placed at a secure location above ground (e.g., within the VWRF complex) to measure barometric air pressure, required for barometric compensation of the non-vented pressure transducer.

Timing: The sensors will record data every 10 minutes and service/download visits will occur monthly (unless daily telemetering via cell phone signal is employed). A reduced service schedule will be used in the event that telemetry is installed.

3.2.4 Berm Breach Observation

Rationale: Berm breach surveys will be conducted to assist with determining cause and effect of berm breaching. Unseasonal breaching affects all focal species.

Method: The surveys will consist of daily visual inspections during breach events. Surveyors will collect photographs of the breach and record the weather at the time of the breach. The surveyors will record when the breach stops and will describe the condition of the lagoon and berm when the ocean connection ceases.

Timing: The surveys will be conducted when a breach occurs.

This information will be supplemented by information collected during daily observations on weekdays year round and during storm events (subject to safety considerations) in anticipation of breaching events.

3.2.5 Groundwater Levels

Rationale: Groundwater level monitoring will be conducted to better understand groundwater contributions to the estuary, especially from the Polishing Ponds and from McGrath State Beach Campground. Groundwater inputs affect lagoon water levels, which influence fish habitat availability and berm breaches.

Method: Water level data will be collected from existing groundwater monitoring wells, and from functioning piezometers used in the Phase 3 study. The existing piezometer wells and casings will be reused if feasible, and new water level sensors will be installed. Sensors will measure and log depth continuously at 30 minute intervals. The following five wells will be used if access is granted by the State Parks: GW1 and GW2 south of the SCRE at the campground, and GW14 north of the SCRE next to the Polishing Ponds. Periodic groundwater level measurements will be collected at wells GW9 and GW10, when water quality grab samples are collected at these locations. If necessary, the elevation of the sensors and the corresponding water surface elevation will be surveyed using RTK GPS during installation, and well depth measurements will be taken during each download/service visit.
Timing: Groundwater depth measurements within each instrumented well will be recorded continuously at 30 minute intervals, and downloaded/serviced monthly, to the extent that the existing wells are available.

### 3.2.6 Ventura Water Reclamation Facility Flow

**Rationale:** The continuous monitoring of VWRF discharge inflow into the SCRE supports the understanding of the water balance of the system.

**Method:** A fixed flow meter will be installed at the discharge point from the treatment ponds to the SCRE.

**Timing:** Discharge flow rate will be monitored continuously.

### 3.2.7 Santa Clara River Flow

**Rationale:** Inflow from the Santa Clara River assists in understanding the water balance of the SCRE, the connectivity of the lagoon to upstream habitat for steelhead and other species, and potential for nutrient inputs from upstream sources.

**Method:** Santa Clara River flow is monitored continuously by Ventura County but may not capture very low flows. Flow within the SCR channel upstream of the SCRE will be visually monitored to identify periods of zero flow/lagoon disconnection from the SCR. Visual observations will be conducted at Victoria Avenue to record the presence or absence of a wetted channel in this location. Flow velocity measurements may also be collected with a hand-held instrument so long as measurements are feasible given the flow volume and access constraints. The location of the river flow data collection point shown on Figure 7 may change over time reflective of observed flow frequencies and accessibility. However, the location will remain between Harbor Boulevard and Victoria Avenue bridges.

**Timing:** Monthly visual observations will be conducted at a minimum.

### 3.3 Water Quality

Water quality monitoring will focus on the spring (April) through fall (October), when key stressors (unseasonal breaching, low dissolved oxygen due to eutrophication due to algal growth, high temperatures that stress fish and exacerbate low oxygen conditions) are most likely and/or have greatest potential for impact on focal fish species (juvenile steelhead rearing if present in closed lagoon, tidewater goby spawning and rearing).

The PCAP continuously measures the most ecologically significant outcome of eutrophication, i.e., low DO concentrations. The proposed program will monitor for the occurrence (if any) of eutrophication events through the combination of monitoring levels of phytoplankton biomass (in units of chlorophyll-a) and macroalgae, as well as phenomena related to eutrophication, such as subsequent hypoxia (by monitoring dissolved oxygen concentration). This information will supplement the information collected as part of its annual bioassessment monitoring conducted.
under the NPDES Permit Monitoring and Reporting Plan, which requires monitoring for algal assemblages and algal biomass.

3.3.1 Basic Water Quality

**Rationale:** Water quality measurements will be conducted to augment receiving water sampling conducted to comply with the VWRF NPDES Permit, and will be supplemented by monitoring pursuant to this Plan. Continuous monitoring provides important data on processes at ecologically meaningful time and spatial scales, such as DO fluctuations during the day and night, as well as changes in water quality following breaches and lagoon closure. This supplements data collected pursuant to the NPDES permit monitoring requirements.

**Method:** Temperature, electrical conductivity (EC, an indicator of salinity), turbidity, pH, and dissolved oxygen (DO) will be recorded continuously at four sampling stations within the lagoon utilizing unattended, multi-parameter sondes. Figure 6 identifies the proposed station locations. The four continuous water quality monitoring stations will each consist of one or two multi-parameter sondes. Each station will consist of buoys anchored to the bed of the lagoon, with submerged sensors attached to the bouy line, and positioned either at the bed or near the surface along the buoy line. Three of the locations will have a single multi-parameter sonde located near the bed. The station located in the deepest scour hole in the lagoon shall be equipped with two sondes, one near the surface and one near the bed. The exact locations of the four stations will depend on the findings of the bathymetric survey, but two locations near the beach (one in the deepest scour hole, and another in a shallower area), and two locations upstream near the bridge are anticipated. The upstream station may consist of the same submerged multi-parameter sonde anchored to the Harbor Boulevard Bridge pier. Typical sensors may include: YSI EXO Series; In-Situ Aqua Troll 600. These devices will require regular calibration and maintenance, on a service schedule of approximately 1–3 months depending on site conditions (i.e., biofouling) and sampling interval.

In addition to the continuous monitoring stations, vertical profiles of the same water quality parameters will be measured through the water column at the four sampling stations and at two additional locations. The water quality sampling will provide insight into water stratification and mixing, and will allow for greater spatial coverage in a cost effective manner. Vertical profiles will be obtained by drawing a cabled multi-parameter sonde through the water column from a boat. In addition to a vertical profile sample that mixes the water column, a grab sample will be collected at depth and a second sample collected at the surface in sample locations where stratification is possible.

**Timing:** Continuous measurements will be made at the four stations every 15 minutes, downloading monthly. Vertical profiles will be made three times in year 1 (April, July, September/October), and one to three times per year thereafter at the four stations plus two other locations in the lagoon.

**Other Considerations:** Two of the sondes will be placed to match the locations of the Phase 3 Study (South Sonde and Central Sonde locations). However, the placement of sondes may need to
be adjusted depending on the extent of lagoon inundation, velocity of SCR flows, and risk of vandalism or loss. Sondes may be removed from the lagoon at certain periods to reduce the risk of damage (e.g., during breach events). In addition, the depths of the sensors at each station may vary either at the deepest point or at the surface. The sensor depths may vary depending on location and stage of the lagoon. Where station locations exhibit depths suitable for stratification, sensors will be located at depth.

### 3.3.2 Nutrients

**Rationale:** Nutrients will be measured to determine nutrient concentrations and, in turn, the likelihood for algal blooms to occur. Algal blooms lead to reduced DO levels, which are harmful to tidewater goby and steelhead. This supplements data collected pursuant to the NPDES permit monitoring requirements.

**Method:** Grab samples will be collected from boats, in coordination with the vertical water column sampling described above. Six grab samples will be taken within the lagoon at the four water quality sampling stations shown on Figure 6 and two additional locations. All sample locations will be recorded by GPS. Samples will be collected in bottles and stored in a cooler. Samples will be taken to an accredited and pre-approved laboratory within 8 hours of collection under a standard chain of custody procedure. Samples will be analyzed for nutrients including total organic and inorganic nitrogen and total organic and inorganic phosphorus. Data will be reported electronically by the laboratory to Ventura Water.

**Timing:** Data collection will occur three times in year one (April, July, September/October), and one to three times per year thereafter.

### 3.3.3 Chlorophyll-a

**Rationale:** Chlorophyll-a concentration is an indicator of phytoplankton abundance and biomass. Surface waters that have high chlorophyll concentrations are typically high in nutrients, which can cause algal blooms that lead to low DO conditions that can stress fish and possibly benthic macroinvertebrates. This supplements data collected pursuant to the NPDES permit monitoring requirements.

**Methods:** Grab samples will be collected from boats, in coordination with vertical water column sampling and nutrient sampling described above. Collected samples will be preserved in a solution of 95 percent ethanol. Field crews will fill a 2.8-liter bottle approximately half full with water pumped from a depth of one meter, withdraw two 100-milliliter sub-samples and aspirate them through 47-millimeter-diameter glass fiber filters of 0.3 micrometer pore size. An assessment of algal species including the potential for harmful algal bloom (HAB) algal species will not be routinely conducted. However, if algal blooms persist in the SCRE, the City may submit a sample to be analyzed for HAB by a qualified expert.

**Timing:** Data collection will occur three times in year one (April, July, September/October), and one to three times per year thereafter.
3.3.4  Benthic Macroalgae

**Rationale:** Benthic macroalgae abundance appears to be linked to the low and highly variable levels of dissolved oxygen that are characteristic of the SCRE, which is stressful to steelhead, tidewater goby, and overall ecosystem health. Benthic macroalgae and phytoplankton are the forms of nuisance aquatic vegetation that are most likely to respond to decreases in nutrient loads to the SCRE.

**Methods:** Three permanent sites will be sampled using a 1-meter by 1-meter quadrat (three samples per site, for a total of 9 samples per period). These sites will be established in the first year where macroalgae are usually abundant, in order to provide a good baseline (i.e., high density) for detecting algal response to decreasing nutrient loads due to decreased discharge. At each of the sites, three quadrat samples will be collected, and percent cover will be estimated by counting the number of 1 cm by 1 cm cells occupied in each of the quadrats. Macroalgae will be characterized down to the level of genera, if not species. For each quadrat, the algae will be collected and quantified to constant wet weight. Literature values will be used for percent dry weight for each genus, as well as tissue N and tissue P content. In combination, these data will be used to develop an estimate of the nitrogen and phosphorus pools represented by macroalgae in the SCRE, and results tested for both seasonality and any potential changes over time.

**Frequency:** Data collection will occur three times in year one (April, July, September/October) during the seasons when algal growth is high and anoxia may occur, and one to three times thereafter.

3.3.5  Groundwater Quality

**Rationale:** Groundwater quality sampling will be conducted to better understand groundwater contributions of nutrients to the estuary.

**Method:** Grab samples will be collected from existing monitoring wells used in the Phase 3 study that are upstream of the SCRE as well as in functioning piezometers adjacent to the wildlife ponds as shown on Figure 6. The following existing wells will be used: GW9, GW10 located near Harbor Boulevard, GW6 and GW7 located upstream near Victoria Avenue, and piezometer GW14, located adjacent to the wildlife ponds. Groundwater will be analyzed for nutrients including total organic and inorganic nitrogen and total organic and inorganic phosphorus.

**Timing:** Water quality samples will be one to three times per year to the extent that the existing wells are available.

**Other Considerations:** The existing wells identified in Figure 7 will be used to the extent they are suitable to support periodic grab sampling and temperature probes.
3.3.6 Algal Bloom Observations

**Rationale:** The occurrence of algal blooms within the SCRE reflect water quality components including DO, temperature, and nutrient availability. Recording algal bloom events when they occur will assist in correlating the events with water quality conditions.

**Method:** During routine visual observations of the SCRE conducted by VWRF staff, evidence of algal blooms will be confirmed and recorded in the annual PCAP monitoring report.

**Timing:** Observations occur weekly.

3.4 Fish

The effects of reducing VWRF discharge are expected to be seen more immediately in habitat conditions that fish will experience, such as water quality and physical habitat structure. Monitoring of the SCRE fish community has typically been by direct sampling via nets (beach seine, dip net). Other methods such as visual observations and environmental DNA could be considered, but are not included in this study plan because of physical habitat constraints, gear selectivity, detection effectiveness, permits, and cost relative to the value of the information gained.

Because both the tidewater goby and California steelhead are federally listed species, survey sampling methods must be covered under appropriate federal authorizations, such as a Scientific Collection 10(a)(A) permit, issued for each of the fish. According to NMFS, no 10(a)(1)(A) permit has been issued for the southern California steelhead population potentially occurring within the SCRE. The methods described below will be conducted only after NMFS, USFWS, and CDFW have approved the activities by issuing an appropriate permit or other authorization. No survey activities will be conducted that might potentially harass or otherwise “take” California steelhead without the necessary permit.

**Rationale:** Direct sampling by seine net or dip net can document distribution and relative abundance of target fish species (tidewater goby and possibly steelhead) around the SCRE. Furthermore, fish surveys will characterize the overall fish community, including non-native species, which is expected to change over time as conditions shift to higher salinity during low-flow seasons.

**Methods:** Beach seining is the most traditional sampling method employed in lagoon estuary systems (e.g., Cardno 2017, Stillwater Sciences 2016). The perimeter of the estuary will be sampled at 15–24 locations, using similar sites as Stillwater Sciences (2016). This will include three existing receiving water sampling sites for NPDES permit compliance (RSW-003, RSW-004, RSW-005) (Cardno 2017), as well as the outfall channel from the VWRF.

Beach seine sampling will occur during daylight hours. Two different methods may be used, depending on the length of the seine net and the site conditions. Nearshore sampling targeting tidewater goby will use a beach seine similar to previous surveys (Stillwater Sciences and Cardno used a 3-foot by 10-foot seine with 1/8-inch [3-millimeter] mesh; Swift et al. 2018 used a
3.2 × 1.2 m seine with 3-millimeter mesh), consistent with USFWS protocols (USFWS 2005). Two biologists will each hold a pole attached to one end of the seine net, one standing near the water’s edge and the other walking perpendicular from shore into shallow water (no deeper than 3 feet). Both biologists will then walk parallel to the shoreline, keeping the bottom of the net with the lead-weighted line on the bottom. At the end of a seine haul (approximately 30 feet depending on site conditions), the nearshore biologist will stop and the offshore biologist will pivot around and drag the net toward shore. When the shoreline is reached, both biologists will push the net bottom flat up onto shore while keeping the float line elevated so captured fish will not escape under or over the net back into the water. The area sampled will be quantified for each seine haul.

Beach seining is very effective for tidewater goby and other nearshore small fishes, but not as effective for larger, faster fish that tend to use deeper/open water. A longer bag seine net (e.g., up to 100-foot by 6-foot) deployed via a small boat may be used to sample deeper water and enclose a larger area. This method is effective for capturing multiple size classes of bottom-oriented, mid-water, and near-shore species, and would be more likely than the beach seine to capture juvenile steelhead if present.

All captured fish and amphibians will be removed from the net and immediately placed in buckets of ambient water. All individuals will be identified to species and released back the place of capture. Locations of seine hauls will be recorded with a hand-held GPS unit. Other attributes recorded will include size of sampled area, maximum sample depth, dominant substrate, vegetation, and cover type. Water quality parameters (temperature, DO, pH, and salinity) will also be measured and recorded at each sample location using a portable YSI multi-parameter probe (Stillwater Sciences 2016).

**Timing:** Fish surveys will be conducted two to four times per year, at similar times of year as past surveys to maintain continuity with previous surveys (September 2008–2014 by Cardno ENTRIX 2014; March, June, and September 2015 by Stillwater Sciences; April/May and September by Brenton Spies UCLA4) and recent NPDES monitoring (September by Cardno 2019).

**Other Considerations:** Beach seining is limited to areas with few underwater obstructions to snag a net, and with a shallow smooth shore to land the net. Densely vegetated areas or sites with steep banks can be difficult to sample, and algal mats or vegetation may clog the net and trap fish. The gear and sampling sites will be adjusted as necessary to minimize sampling impacts on fish. Dip nets may be used in areas where seining is infeasible. Any fish monitoring is contingent on obtaining appropriate federal authorization, such as scientific collection permits, applicable for tidewater goby and Southern California steelhead.

### 3.5 Birds

**Rationale:** Information on the location of breeding and nesting activity by western snowy plover and California least tern will be collected. If breaching occurs during breeding season it could

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affect nesting that occurs on the berm. Use of SCRE open water habitat for foraging by California least tern will be documented. Availability of open water influences the amount of foraging habitat available for California least tern.

**Methods:** Fixed radius point counts, area-transect counts, general visual surveys and limited nest monitoring western snowy plover and California least tern around the SCRE, including the adjacent foredune and foredune/beach areas extending up to 0.75 mile to the south, will be employed to capture the foraging range of local breeding populations. The point counts and area-transect censuses will provide data on the overall bird community, emphasizing comparisons between points within and between different areas and habitat types. Point counts, area-transect censuses and limited nest monitoring will be conducted weekly during nesting season (March–July) starting 15 minutes after sunrise and ending within five hours following sunrise, corresponding to peak activity of most birds. In addition, general visual surveys will be conducted weekly in August-October during the juvenile dispersal period to document foraging over the SCRE, wildlife ponds, and in the ocean adjacent to the SCRE. General visual surveys will consist of qualified biologists meandering the survey area using binoculars to view habitats suitable for nesting and foraging. All life stages of the bird species, nesting activities, and breeding behaviors will be documented. The focal point will be the any nesting activity directly on the berm, because that is the habitat feature most likely to be affected by changes in VRWF discharge. The fixed radius point counts and area-transect counts will also be conducted to determine abundance and distribution, including foraging over and near the SCRE by California least tern.

**Timing:** Surveys will occur weekly during the breeding season (March through July), and shortly after any summer breach events if occurring. Visual bird point-count surveys will be conducted during the breeding season surveys.

**Other Considerations:** The California Department of Parks and Recreation and the Ventura Audubon Society conduct monitoring of snowy plover and California least terns during the breeding season. Data from these other annual surveys may be used to support the PCAP objectives.

### 3.6 Habitat/Vegetation

**Rationale:** Vegetation provides key habitat structure. Surveys and mapping will document the vegetation communities within the SCRE, including areas of riparian vegetation, berm and lagoon edge habitat, and aquatic habitats. Vegetation along the perimeter could potentially provide cover for steelhead and tidewater goby to avoid predators.

**Methods:** Terrestrial surveys will be conducted by qualified biologists on the non-inundated portions of the SCRE. The terrestrial surveys may have limited accessibility, depending on vegetation density, the condition of lagoon water levels, and impacts from winter flood events. The terrestrial surveys will include accessing the VWRF discharge channel that cuts through the non-inundated northern portion of the SCRE to document vegetation density and overhang within the channel. Up to three transects will be conducted during each survey event to document cover. Vegetation will be characterized according to the *Manual of California Vegetation* (Sawyer et al.
Data collected along these three transects will include vegetation types, emerging vegetation observations, and structural observations including understory density and canopy cover visual estimates. The data will provide for habitat quality and functionality comparisons over time.

Edge vegetation around the perimeter of tidal channels and open water portions of the SCRE will be visually surveyed by qualified biologists using a flat bottom boat (e.g., kayak, canoe) to access areas with steeper banks and/or deep channels. Vegetation is usable for fish only if it is either submerged (e.g., branches hanging down into the water, or emergent vegetation such as cattails, or aquatic vegetation such as pondweed) or close above the water surface to discourage wading or diving birds from seeing or catching fish. At regular intervals, observers will document the conditions of the water’s edge (within 2 feet) to quantify occurrence and approximate elevation of vegetative cover, including submerged aquatic vegetation, emergent vegetation, and overhang vegetation. Documenting the elevation of vegetative cover will allow assessment of cover availability for fish under different lagoon water surface elevations. Bank and substrate conditions and lagoon water surface elevation at time of survey will also be noted.

In addition, aerial surveys will be conducted to document vegetation communities and changes from an aerial perspective. These surveys will be conducted either with a drone, operated by a licensed drone operator, or flyovers will be scheduled for fixed wing or helicopter photographic surveys to document the changing habitat conditions within the SCRE. This habitat and vegetation information will be used to inform an evaluation of habitat quality provided for the four listed species, and of primary biological features of southwestern willow flycatcher designated critical habitat.

**Timing:** Vegetation surveys within the SCRE will be conducted twice per year, in similar season as general fish surveys (April–May and September). Aerial surveys will be conducted once per year between the months of May and September.
CHAPTER 4
Implementation, Data Management, and Reporting

4.1 Pre-Construction Assessment Program Implementation Management

Implementation of the PCAP will be managed by Ventura Water in compliance with the mitigation monitoring and reporting plan (MMRP) prepared pursuant to the 2019 final environmental impact report (EIR) prepared for the Ventura Water Supply Projects, as well as the requirements of the City’s 2019 NPDES permit (CA0053651). The PCAP has been designed to comport with Mitigation Measure BIO-5 of the MMRP as well as Appendix E of the NPDES permit, to comply with the VWRPF NPDES Permit, and to support Porter Cologne Section 1211 process and ESA and CESA consultation, as well as permitting of the VenturaWaterPure project as determined appropriate by regulatory agencies.

4.2 Data Management and Reporting

4.2.1 Data Management Procedures

Effective data management will be integral to the success of the PCAP. The integration of protocols, standards, and practices will help ensure that data will be scientifically valid. Detailed monitoring protocols or standard operating procedures (SOPs) will be developed prior to initiating monitoring activities, based on logistical constraints and precise locations of sampling locations. The SOPs will include a description of the measures that will ensure the quality of the data collected and how to implement those measures. These quality assurance techniques may include, but are not limited to, procedures for calibrating devices, procedures for recording and transferring data, and methods for ensuring proper operation of field equipment.

The data management activities for the Project monitoring will be the responsibility of the Data Manager, assigned by the City. Data collection and information storage protocols will be standardized for such stages as data entry sheet design, data collection protocols, data entry, quality assurance/quality control, data processing, chart and graph generation, and metadata. Data collected will be housed in a centralized location in commonly used and acceptable digital formats (e.g., databases in Access or Excel, documents in Microsoft Word or PDF) so that the collected information may contribute to existing datasets.
All data collected as part of the PCAP will be stored electronically by Ventura Water. Data will be accessible to the Ventura Water Data Manager. Some data will be stored in tabular form and accessible for data analysis and reporting. Field notes and reports will be stored in pdf format. Data will be organized by metric type, using a filing system that identifies the metric and date in the file names.

4.2.2 Consistency and Incorporation of National Pollutant Discharge Elimination System Permit Monitoring Requirements

The PCAP has been prepared to be complimentary with the discharge and receiving water quality, benthic macroinvertebrate (BMI) and SCRE monitoring requirements mandated by the VWRF NPDES permit (CA0053651). Table 7 summarizes which of the SCRE monitoring metrics are also required by the NPDES Permit. The monitoring requirements provided in Appendix E of the NPDES Permit are reproduced in Attachment A.

### Table 7
**Monitoring Parameters and Methods**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Also Required in NPDES Permit?</th>
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</thead>
<tbody>
<tr>
<td>Bathymetry</td>
<td>NO</td>
</tr>
<tr>
<td>Ocean Berm Height</td>
<td>NO</td>
</tr>
<tr>
<td>Water Level (depth)</td>
<td>NO</td>
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<tr>
<td>Breach Morphology</td>
<td>YES</td>
</tr>
<tr>
<td>Depth to Groundwater</td>
<td>NO</td>
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<tr>
<td>Santa Clara River Flow Volume</td>
<td>NO</td>
</tr>
<tr>
<td>VWRF Discharge Flow Volume</td>
<td>YES</td>
</tr>
<tr>
<td>Temperature, DO, pH, conductivity, turbidity</td>
<td>YES</td>
</tr>
<tr>
<td>Nutrients (TN, TP)</td>
<td>YES</td>
</tr>
<tr>
<td>Chlorophyll-a</td>
<td>YES</td>
</tr>
<tr>
<td>Macroalgae</td>
<td>NO</td>
</tr>
<tr>
<td>Groundwater Quality</td>
<td>NO</td>
</tr>
<tr>
<td>General fish survey</td>
<td>YES</td>
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<tr>
<td>Western snowy plover and California least tern nesting</td>
<td>NO</td>
</tr>
<tr>
<td>Habitat Assessment surveys within SCRE (specifically for cover and aquatic vegetation)</td>
<td>YES</td>
</tr>
<tr>
<td>Habitat Mapping</td>
<td>NO</td>
</tr>
</tbody>
</table>
4.2.3 Pre-construction Assessment Program Reporting

At the completion of each sampling event (e.g., water quality, fish, birds), all field data will be summarized in a brief memo describing methods and observations and submitted to the City. Additionally, all data collected for each parameter will be compiled into an annual report. Access to data for review will be provided annually following QA/QC procedures.

4.2.4 Annual Report

Ventura Water will prepare an Annual Report compiling the data collected during the year. The report will be prepared in the fall of each year, summarizing data collected from October through September the following year. The Annual Report will include a brief executive summary that provides highlights of the year including a review of the data and any issues with data collection. The Annual Report will be submitted to CDFW, RWQCB, USFWS, and NMFS, with copies provided to Ventura Coastkeeper and Heal the Bay, for a period of three years.

4.3 Quality Assurance/Quality Control Procedures

The PCAP will be subject to QA/QC protocols covering 1) data collection standard operating procedures, 2) data storage procedures, 3) technical reviews of reporting, 4) management reviews.

4.3.1 Standard Operating Procedures

Each data collection method is subject to specific SOPs prepared by Ventura Water and kept on file. Monitoring personnel will be instructed in implementing the SOPs and will sign an acknowledgment form confirming understanding of the procedures. The forms will be kept on file. Monitoring personnel will not be allowed to perform monitoring prior to reading the SOPs and signing the form.

4.3.2 Data Storage Procedures

Each monitoring method will produce data that will be stored electronically and maintained by Ventura Water. Table 4 summarizes the data to be stored for each monitoring method. Some data will be continuous data downloaded from installed instruments and other data will be narrative field forms documenting observed conditions. PDF files of all field reports will be stored chronologically.

4.3.3 Technical Reviews

Each monitoring method will produce data stored electronically. If monitoring equipment malfunctions or data is uncollected at any time, City staff will confirm the discrepancy and provide a narrative for the annual report explaining the discrepancy and the actions taken to rectify the issue.
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CHAPTER 5
Monitoring, Assessment, and Adaptive Management Plan

5.1 Background

5.1.1 Purpose of the Monitoring, Assessment, and Adaptive Management Plan

The Ventura Water Supply Projects EIR included a mitigation measure (BIO-6) requiring implementation of a Monitoring Assessment and Adaptive Management Plan (MAAMP) to document and evaluate ecosystem conditions within the SCRE following the implementation of Phase 1a, which reduces VWRF discharges to an annual average CDL of 1.9 mgd. The MAAMP is mandated by the CEQA commitments in the MMRP as well as in NPDES requirements, and supports the City’s Section 7, CESA and Porter-Cologne Section 1211 consultations.

The purpose of the MAAMP is to provide a framework for evaluating the potential effects of further reduction of VWRF discharges proposed under Phase 1b of the VenturaWaterPure project. The data collection initiated in the PCAP will continue following implementation of Phase 1a discharge reductions associated with the VenturaWaterPure project under the guidance of the MAAMP. The MAAMP will evaluate the data collected to better understand the stressors exhibited in the SCRE and their sources. The MAAMP will identify action criteria and management measures as appropriate that will guide implementation of Phase 1b reductions in discharges (to an average annual of 0–0.5 mgd) if the data demonstrate that further discharge reductions would not result in the unauthorized “take” of sensitive species in the SCRE. The MAAMP does not impose any habitat management obligations onto the City. Rather the MAAMP provides a data collection and evaluation mechanism to ensure Phase 1b would not result in take of species. The premise of Phase 1b is that, as concluded by expert studies, returning to a more natural condition of reduced wastewater discharges into the SCRE would benefit habitat conditions. The City is not responsible for managing the SCRE as a natural resource, but is obligated to avoid and minimize adverse effects of wastewater discharges on the SCRE and its listed species.

The City will submit annual monitoring reports under the MAAMP to CDFW, USFWS and NMFS, with copies to Ventura Coaskeeper and Heal the Bay, for a period of five years. If, based on the information and analysis provided by the MAAMP, any of these agencies notify the RWQCB and the City that further reduction in VWRF discharges would result in an unauthorized “take” of one or more listed species, then further reductions proposed under Phase 1b would not
occur and the MAAMP and data collection activities associated with the MAAMP and PCAP would be terminated. The MAAMP is designed to facilitate the following actions:

- Continue the monitoring initiated in the PCAP (pre-Phase 1a) for a period of five years after Phase 1a discharge reductions are implemented to evaluate whether “take” would occur as a result of further reductions.
- Prepare annual data reports to assist in the evaluation of whether implementation of Phase 1b discharge reductions would result in “take.”
- Characterize the effects of reduced discharges, and the return to a more natural hydrology, on designated critical habitat.
- Provide data to support analyses and conclusions as to whether monitored changes in conditions within the SCRE likely result from reduced discharges or climate, changing hydrology, groundwater pumping, or other outside influences over which the City has no control.
- Provide for adaptations of the data collection methods to best serve the MAAMP objectives.
- Establish a scientific data-driven decision mechanism to support the wildlife agencies in determining whether Phase 1b would result in “take.”
- Outline management actions to avoid and minimize adverse impacts of any parameter if Phase 1b is implemented.

5.1.2 Monitoring and Adaptive Management Approach

Monitoring and adaptive management is an iterative approach that uses regular monitoring and assessments to evaluate progress towards project objectives. Adaptive management acknowledges that uncertainties exist in predicting how project implementation affects important resources, and provides a scientific and institutional framework for adjusting future management decisions as understanding of the ecosystem improves (Williams et al. 2009; Williams and Brown 2012).

The steps in the adaptive management process for the SCRE are as follows:

1. **Plan**: Define the problem, identify goals and objectives, identify expected outcomes (indicators), identify habitat parameters, and identify questions for assessment in Phase 1a, based on information from previous studies (Phase 3) and PCAP monitoring.

2. **Implement**: Implement the Phase 1a VWRF operations to reduce average annual discharge to 1.9 mgd, and conduct monitoring as per the MAAMP to determine if additional Phase 1b discharge reductions as recommended by the SRP should be implemented.

3. **Evaluate and Respond**: Analyze, synthesize, and manage data annually to document status and trends in the SCRE parameters and special-status species in response to Phase 1a discharges, relative to baseline conditions documented during PCAP monitoring. Communicate findings to decision-makers and managers annually to determine if and when to adjust management actions and/or monitoring to improve project performance and inform future actions. Following Phase 1a discharge reduction implementation, evaluate data and trends to determine whether reducing discharge below 1.9 mgd would avoid unauthorized take and significant adverse effects to listed species consistent with the EIR. If so, then move forward with Phase 1b to phase out discharges to the SCRE consistent with the SRP recommendations, the NPDES permit, and the *Water Quality*...
5.2 Indicators to be Considered in the Monitoring, Assessment, and Adaptive Management Plan

The reduction of VWRF discharge is expected to improve SCRE water quality and ecosystem health and maintain or enhance habitat for the four special-status species by reducing stressors and maintaining beneficial drivers (Revell et al. 2018). The underlying basis for this expectation assumes the SCRE would return to a more natural condition resulting from the discharge reductions. The objective of the MAAMP is to collect data that lead to a determination of whether Phase 1b would avoid unauthorized take of listed species and phase out closed-berm discharges to the SCRE in compliance with the SRP recommendations, the NPDES permit, and the Water Quality Control Plan for Enclosed Bays and Estuaries adopted by the State Water Resources Control Board, including the following:

1. Reduction of unseasonal breaching due to VWRF discharge
2. Enhancement of water quality for fish due to VWRF discharge
3. Maintenance of habitat suitability to support focal species
4. Reduction of non-native fish and amphibian assemblage

Table 8 provides a framework to evaluate these key indicators. The MAAMP data collection program supports this framework. Recommendations for future reductions in flow should be based on these indicators, focusing on the potential for “take.”

5.2.1 Reduction of Unseasonal Breaching

Unseasonal breaching (i.e., June through October) represents the greatest threat to the SCRE ecosystem, including listed species. Unseasonal breaching can strand tidewater goby (eggs in burrows as well as juveniles and adults) and steelhead, and can transport fish out of the estuary into the ocean. Furthermore, unseasonal breaching can rapidly increase salinity in the estuary when juvenile steelhead and tidewater goby are unable to tolerate rapid salinity change (Revell et al. 2018). Unseasonal breaching can also affect breeding success of western snowy plover and California least terns that may be nesting on the berm and may eliminate foraging during summer time open berm conditions. Annual reports provided under the PCAP and continued under the MAAMP will record the frequency and timing of sand berm breaches along with any known causes. These may be compared with historical data to determine whether the discharge reductions have decreased unseasonal breaching or what other causal relationships. The data regarding berm height and water elevation will assist in understanding the berm breaching dynamics and timing when returning to a more natural condition. The berm height data will assist in estimating the potential for unseasonal breaching if further reductions are enacted. The reduction in unseasonal breaching will also be evaluated with increasing stability of foraging habitat during breeding and fledging periods.
5.2.2 Enhancement of Water Quality for Fish

Nutrient loading contributed by VWRF discharges has been a primary concern due to the effect on stimulating algal growth (both phytoplankton and macroalgae), which contributes to low oxygen that is harmful to fishes. Phase 1a will substantially reduce the contribution of nutrients from the VWRF into the SCRE. Uncertainties exist regarding other nutrient inputs to the SCRE. Measuring nutrient levels in the discharge, estuary, groundwater and river will provide additional information on the relative impact of the VWRF discharges on nutrient loading in the SCRE compared to other factors in the watershed.

Water quality, particularly salinity and dissolved oxygen, is important to the distribution and abundance of many organisms in the SCRE. Salinity should increase in the fall, after juvenile steelhead and goby attain sufficient growth to withstand greater salinities, particularly in response to wave overwash to deter invasive species populations and to support various tidewater goby life stages (Revell et al. 2018). Avoiding unseasonal breaches will also minimize sudden increases in salinity during the spring and summer, which are not tolerated by juvenile goby and steelhead (Revell et al. 2018) and can result in population crash of invertebrate communities (Netto et al. 2012).

Low oxygen conditions in the SCRE are primarily associated with nutrient enrichment and algal blooms. Steelhead may be adversely affected by the low DO (<4 mg/L) that occurs at times in some places of the estuary, most notably in the reaches near the VWRF discharge during the warm summer months in pre-dawn hours where respiring algal biomass robs the water column of oxygen (Revell et al. 2018). Thus, reduction of nutrient loads is expected to enhance water quality, returning the SCRE to a more natural condition. However, low oxygen conditions could also occur in response to nutrients in other inflows to the SCRE, and if estuary waters are significantly stratified for extended periods of time. Monitoring will examine spatial, vertical, and diurnal patterns of DO.

The SRP Final Report described that increased nutrients may contribute to an increase in toxicity within the receiving water (Revell et al. 2018). Reducing discharge volumes would reduce this potential toxic effect of nutrient loading. As a result, nutrient concentration monitoring will be helpful in assessing the potential for reduced toxicity in the SCRE caused by nutrient load reduction in accordance with the species lifestage model developed by the SRP.
### TABLE 8  
**INDICATORS EVALUATED IN THE MONITORING, ASSESSMENT, AND ADAPTIVE MANAGEMENT PLAN**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Monitoring Category</th>
<th>Negative Stressor(s)</th>
<th>Positive Drivers(s)</th>
<th>Relevant Indicators</th>
</tr>
</thead>
</table>
| 1. Habitat for tidewater goby | Physical Processes and Hydrology, Water Quality, Habitat, Fish Presence | 1) Unseasonal breaching  
2) Low DO  
3) Toxics  
4) Rapid salinity change  
5) High velocity  
6) Predation/competition by nonnative species | 1) Stable estuary water surface elevation (WSE)  
2) Substrate suitable for burrows  
3) Water Quality:  
   - Low salinities (0–15 ppt)  
   - High DO  
   - Low nutrient related toxicity  
4) Low velocity  
5) Submerged and emergent vegetation  
6) Tolerant of high salinity | Reduction of Unseasonal Breaching  
Maintenance of Suitable Habitat  
Enhancement of Water Quality  
Reduction in Invasive Species |
| 2. Rearing habitat for out-migrating juvenile Southern California steelhead | Physical Processes and Hydrology, Water Quality, Habitat, Fish Presence | 1) Unseasonal breaching  
2) Shallow water <1 m/lack of deep water cover  
3) Water quality:  
   - Low DO (<4 mg/L)  
   - Unsuitable temperature conditions (<25°C)  
   - High salinity when not acclimated (>28 ppt)  
4) Toxics  
5) Closed mouth/berm during kelt downstream migration (kelts cannot return to the ocean)  
6) Lack of connected flow to spawning habitat | 1) Stable Estuary WSE  
2) Deep water/cover habitat >1 m  
3) Water quality:  
   - Non-lethal temperature (<25°C)  
   - High DO (>4 mg/L)  
   - Lower salinities (0–15 ppt)  
   - Low nutrient related toxicity  
4) Open mouth/berm during kelt downstream migration (kelts can return to the ocean)  
5) Connected flow to spawning habitat | Reduction of Unseasonal Breaching  
Maintenance of Suitable Habitat:  
Enhancement of Water Quality |
| 3. Foraging, breeding, and roosting habitats for snowy plover | Habitat, Bird Presence | 1) Unseasonal breaching can scour nests on the beach berm  
2) Extensive vegetation  
3) Lack of food resources | 1) Stable estuary WSE  
2) Seasonal breaching in winter can scour vegetation | Reduction of Unseasonal Breaching  
Maintenance of Suitable Habitat |
## TABLE 8
### Indicators Evaluated in the Monitoring, Assessment, and Adaptive Management Plan

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Monitoring Category</th>
<th>Negative Stressor&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Positive Drivers&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Relevant Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Foraging, breeding, and roosting habitats for California least tern</td>
<td>Habitat Bird Presence</td>
<td>1) Unseasonal breaching can scour nests on the beach berm 2) Toxics</td>
<td>1) Stable estuary WSE 2) Forage in top 1 m of water column, more forage area/higher water surface elevation 3) Water Quality  • High DO (to reduce algal blooms boost availability of food resources)  • Low nutrient related toxicity</td>
<td>Reduction of Unseasonal Breaching Maintenance of Suitable Habitat</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Monitoring Category</th>
<th>Negative Stressor&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Positive Drivers&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Relevant Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Maintenance or improvement of water quality in SCRE</td>
<td>Water Quality</td>
<td>1) Nutrient Loading 2) Low DO/Nutrient related toxicity 3) High water temperature</td>
<td>1) Seasonal breaching to reset nutrient load 2) Reduced Nutrient Loading 3) Salinity Variations that Favor Native Fish</td>
<td>Reduction of Unseasonal Breaching Enhancement of Water Quality</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Monitoring Category</th>
<th>Negative Stressor&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Positive Drivers&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Relevant Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Maintenance or improvement of SCRE habitats and designated critical habitats</td>
<td>Habitat/Vegetation Fish Presence Bird Presence</td>
<td>1) Unseasonal breaching 2) Low DO 3) Toxics 4) Rapid salinity change 5) High velocity 6) Predation/competition by nonnative species</td>
<td>1) Stable estuary water surface elevation (WSE) 2) Substrate suitable for burrows 3) Low nutrient related toxicity 4) Low salinities (0–15 ppt) 5) Low velocity 6) Submerged and emergent vegetation 7) Salinity Variations that Favor Native Fish</td>
<td>Reduction of Unseasonal Breaching Enhancement of Water Quality Maintenance of Suitable Habitat Reduction in Invasive Species</td>
</tr>
</tbody>
</table>

**NOTES:**

<sup>1</sup> Stressors and drivers from Revell et al. (2018).
5.2.3 Maintenance of Physical Habitat Suitability

Physical habitat suitability will be evaluated based on the requirements and stressors for tidewater goby, steelhead, snowy plover and California least tern as recommended by the SRP. Parameters for aquatic habitats types include:

- water depth,
- presence of submerged vegetation,
- presence of open water and aquatic habitat,
- water quality including DO, salinity, and temperature,
- presence of food sources for birds, and
- substrate.

Parameters for avian habitats include:

- presence of open water suitable for foraging,
- presence of physical and biological features within critical habitats, and
- reduction of unseasonal breaching that may result in nest inundation.

5.2.4 Non-native Fish and Amphibian Assemblage

Non-native fishes currently dominate the fish assemblage in the SCRE. Some invasive species (e.g., green sunfish) prey on tidewater goby and potentially steelhead juveniles. Other species may be competitors for invertebrate food resources. Common carp also degrade benthic habitat as they forage on the bottom, disturbing sediments and uprooting vegetation (Fofonoff et al. 2018). The fish assemblage composition is expected to change in response to VWRF reductions that alter the salinity regime in the estuary. It is unlikely, however, that non-native fishes will be eradicated in the SCRE since they are replenished from outside sources .

5.3 Modifications to the Pre-construction Assessment Program and Monitoring, Assessment, and Adaptive Management Plan

The objective of the MAAMP is to collect data that lead to a determination of whether Phase 1b would avoid “take” of listed species that rely on the SCRE. The City maintains the responsibility to determine what data are necessary to assess site conditions and the ecological response to management actions. It is anticipated that, through the data collection activities implemented under the PCAP and continued under the MAAMP, lessons will be learned regarding data collection methods, locations, and frequency of sampling. In addition, the value of certain data may be evaluated over time.
The MAAMP is meant to be adaptive to lessons learned and is not meant to impose a rigid, unchangeable data collection program. Rather, the MAAMP has been prepared to accommodate changes to future monitoring activities. Adjustments may include type of parameters, sampling frequencies, sampling locations, and/or methods. Any changes made to the data collection activities will be reported in the Annual Report with accompanying rationale for the adjustment. Any adjustment would be made in the interest of maintaining a sustainable, efficient and informative monitoring protocols serving the objective of ensuring that “take” of listed species will not occur. In this sense the term “Adaptive Management” applies to collecting and assessing data to determine the potential for Phase 1b discharge reductions to result in unauthorized “take” of listed species in light of uncertainty identified by CDFW surrounding the predicted effects of discharge reductions that result in a Continued Discharge Level that is less than an average annual level of less than 1.9 mgd during closed berm conditions. The action triggered by the evaluation of data would be to either approve Phase 1b reduced discharges or not.

5.4 Data Evaluation and Assessment of Phase 1a

The City will provide annual reports of MAAMP monitoring results to CDFW, USFWS, NMFS, and RWQCB, with copies to Ventura Coastkeeper and Heal the Bay. The City will meet with the agencies and other interested parties as needed to review the data and work toward a mutual understanding of the habitat conditions within the SCRE. Annual reports prepared by the City will include recommendations for further discussion or data collection modifications. The data will be presented to the wildlife agencies to answer following questions:

Q1. Have any of the stressor conditions listed below changed since implementation of Phase 1a, compared to pre-Phase 1a conditions?
   - Frequency of unseasonal breaches related to the discharge from VWRF
   - Frequency and duration of low dissolved oxygen conditions (less than 4 mg/L) associated with VWRF discharge
   - Frequency and duration of stressful temperature conditions (greater than 25°C)
   - Suitability of aquatic habitat (salinity, substrate, cover, depth) for focal fish species
   - Distribution and/or relative abundance of non-native fish and amphibian species that negatively impact focal fish species (i.e., predators or habitat disruptors such as green sunfish, carp, African clawed frog) which may be related to reduction in VWRF discharge
   - Suitability of foraging, breeding, and roosting habitat for focal avian species

Q2. If a stressor condition has changed, is it reasonable to infer that reduced VWRF discharges have contributed to the change?

Q3. If reduced discharges have maintained or improved conditions within the SCRE, is it reasonable to expect that further VWRF discharges reductions would maintain or further improve conditions?
Q4. If a stressor has not been reduced, what factors may have contributed to the conditions observed and are those related to Phase 1a reduction in discharge?

This question series is designed to create a decision tree to guide City and agency staff in effectuating the MAAMP. The MAAMP provides for the organized evaluation of water quality and habitat suitability data designed to answer a specific question of whether Phase 1b discharge reductions would avoid “take.” The question series may be modified as needed, but is designed to support a decision process made by regulators.

5.5 Decision-Making Process

Consistent with the Water Quality Control Plan for Enclosed Bays and Estuaries adopted by the State Water Resources Control Board, discharge of treated wastewater into an estuary is prohibited unless the discharge is proven to provide enhancement to the ecological conditions within the estuary. The NPDES permit for the Project (CA0053651) provides that the Phase 1b discharge reduction must not result in “take” of species occupying the SCRE that are listed for protection under the FESA or California Endangered Species Act. As a result, implementation of Phase 1b would be delayed only if the data indicate (and wildlife agencies concur) that the 1.9 mgd of discharge provided by Phase 1a enhances or maintains habitat values as compared to Phase 1b reduced discharges, and materially avoids “take” that would otherwise occur as a result of lower discharge volumes.

The City, the RWQCB, and wildlife agencies (NMFS, USFWS, and CDFW) will review the answers to the questions posed in Section 5.4 as appropriate. The City will request in writing that the regulatory agencies review the responses to the questions posed above, and the wildlife agencies would provide a response in writing concluding whether (after review of the data collected during the PCAP and MAAMP monitoring period) the proposed implementation of Phase 1b would result in “take” of a listed species. If the wildlife agencies conclude that “take” is likely to occur, then the City will, in consultation with the RWQCB, either implement measures to avoid “take,” or terminate the monitoring program and not implement Phase 1b.

If the wildlife agencies concur that Phase 1b is not likely to adversely affect listed species, then the City may submit to the RWQCB an updated Report of Waste Discharge reflecting modifications to the NPDES discharge permit providing for implementation of Phase 1b.
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CHAPTER 6
References


Reeves, G. H., F. H. Everest, J. R. Sedell, and J. D. Hall. 1987. Interactions between the Redside Shiner (Richardsonius balteatus) and the Steelhead Trout (Salmo gairdneri) in Western


Swift, C. C., J. Mulder, C. Dellith, and K. Kittleson. 2018. Mortality of Federally Endangered fishes Induced by Artificial Breaching of the Santa Clara River lagoon, Ventura County,


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Attachment A
The following tables (from Appendix E of the NPDES Permit) outline locations and metrics to be monitored at specific receiving water monitoring stations (Monitoring Stations RSW-001, RSW-002, RSW-003, RSW-004, and RSW-005).

<table>
<thead>
<tr>
<th>Monitoring Location Name</th>
<th>Monitoring Location Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSW-001</td>
<td>Receiving Water Monitoring Station: Located on the southeast shoreline of the Santa Clara River Estuary. Location may move as shoreline changes, within 200 feet from Latitude: 34.23211°, Longitude: -119.25766° with actual latitude and longitude to be reported with results. (Previously designated as R-001)</td>
</tr>
<tr>
<td>RSW-002</td>
<td>Receiving Water Monitoring Station: Located at the south shoreline of the Santa Clara River Estuary. Location may move as shoreline changes, within 200 feet from Latitude: 34.22982°, Longitude: -119.26199° with actual latitude and longitude to be reported with results. (Previously designated as R-002)</td>
</tr>
<tr>
<td>RSW-003</td>
<td>Receiving Water Monitoring Station: Located at the west shoreline of the Santa Clara River Estuary at the mouth of the outlet, where breaching has most recently occurred with the exact latitude and longitude to be reported with results. Approximately Latitude: 34.23081°, Longitude: -119.26443°. (Previously designated as R-003)</td>
</tr>
<tr>
<td>RSW-004</td>
<td>Receiving Water Monitoring Station: Located at the northwest shoreline of the Santa Clara River Estuary, immediately downstream of the discharge point to the Estuary, may move as shoreline changes, within 200 feet from Latitude: 34.23449°, Longitude: -119.26505° with actual latitude and longitude to be reported with results. (Previously designated as R-004)</td>
</tr>
<tr>
<td>RSW-005</td>
<td>Receiving Water Monitoring Station: Located at the Harbor Boulevard Bridge crossing of the Santa Clara River at the Estuary boundary. This sampling location is where the greatest volume of river water enters the Estuary, with the exact latitude and longitude to be reported with results. But when the Estuary is flooded the location is at Latitude: 34.23379°, Longitude: -119.25661°. (Previously designated as R-005)</td>
</tr>
</tbody>
</table>
### TABLE E-5
**RECEIVING WATER MONITORING REQUIREMENTS**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Sample Type</th>
<th>Minimum Sampling Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbidity</td>
<td>NTU</td>
<td>grab</td>
<td>quarterly</td>
</tr>
<tr>
<td>Total residual chlorine</td>
<td>mg/L</td>
<td>grab</td>
<td>monthly</td>
</tr>
<tr>
<td>Total Coliform</td>
<td>MPN/100mL or CFU/100mL</td>
<td>grab</td>
<td>monthly</td>
</tr>
<tr>
<td>Fecal coliform</td>
<td>MPN/100mL or CFU/100mL</td>
<td>grab</td>
<td>monthly</td>
</tr>
<tr>
<td>Enterococci</td>
<td>CFU/100mL</td>
<td>grab</td>
<td>weekly</td>
</tr>
<tr>
<td>Temperature</td>
<td>°F</td>
<td>grab</td>
<td>monthly</td>
</tr>
<tr>
<td>pH</td>
<td>pH units</td>
<td>grab</td>
<td>monthly</td>
</tr>
<tr>
<td>BOD5 20°C</td>
<td>mg/L</td>
<td>grab</td>
<td>quarterly</td>
</tr>
<tr>
<td>Total Organic Carbon</td>
<td>mg/L</td>
<td>grab</td>
<td>quarterly</td>
</tr>
<tr>
<td>Oil and grease</td>
<td>mg/L</td>
<td>grab</td>
<td>quarterly</td>
</tr>
<tr>
<td>Dissolved oxygen</td>
<td>mg/L</td>
<td>grab</td>
<td>monthly</td>
</tr>
<tr>
<td>Conductivity</td>
<td>µmhos/cm</td>
<td>grab</td>
<td>quarterly</td>
</tr>
<tr>
<td>Total Ammonia</td>
<td>mg/L</td>
<td>grab</td>
<td>monthly</td>
</tr>
<tr>
<td>Nitrate nitrogen</td>
<td>mg/L</td>
<td>grab</td>
<td>monthly</td>
</tr>
<tr>
<td>Nitrite nitrogen</td>
<td>mg/L</td>
<td>grab</td>
<td>monthly</td>
</tr>
<tr>
<td>Organic nitrogen</td>
<td>mg/L</td>
<td>calculation</td>
<td>monthly</td>
</tr>
<tr>
<td>Total Kjeldahl nitrogen (TKN)</td>
<td>mg/L</td>
<td>grab</td>
<td>monthly</td>
</tr>
<tr>
<td>Total nitrogen</td>
<td>mg/L</td>
<td>calculation/grab</td>
<td>monthly</td>
</tr>
<tr>
<td>Total phosphorus as P</td>
<td>mg/L</td>
<td>grab</td>
<td>monthly</td>
</tr>
<tr>
<td>Orthophosphate-P</td>
<td>mg/L</td>
<td>grab</td>
<td>monthly</td>
</tr>
<tr>
<td>Algal biomass (Chlorophyll a)</td>
<td>mg/L</td>
<td>grab</td>
<td>semiannually</td>
</tr>
<tr>
<td>Salinity</td>
<td>ppt</td>
<td>field</td>
<td>monthly</td>
</tr>
<tr>
<td>Surfactants (MBAS)</td>
<td>mg/L</td>
<td>grab</td>
<td>quarterly</td>
</tr>
<tr>
<td>Total hardness (CaCO3)</td>
<td>mg/L</td>
<td>grab</td>
<td>monthly</td>
</tr>
<tr>
<td>Chronic toxicity20</td>
<td>Pass or Fail, % Effect (TST)</td>
<td>grab</td>
<td>quarterly</td>
</tr>
<tr>
<td>Copper</td>
<td>µg/L</td>
<td>grab</td>
<td>monthly</td>
</tr>
<tr>
<td>Zinc</td>
<td>µg/L</td>
<td>grab</td>
<td>monthly</td>
</tr>
<tr>
<td>Nickel</td>
<td>µg/L</td>
<td>grab</td>
<td>monthly</td>
</tr>
<tr>
<td>Selenium</td>
<td>µg/L</td>
<td>grab</td>
<td>quarterly/semiannually</td>
</tr>
<tr>
<td>Perchlorate</td>
<td>µg/L</td>
<td>grab</td>
<td>annually</td>
</tr>
<tr>
<td>1,4 Dioxane</td>
<td>µg/L</td>
<td>grab</td>
<td>annually</td>
</tr>
<tr>
<td>1,2,3-Trichloropropane</td>
<td>µg/L</td>
<td>grab</td>
<td>annually</td>
</tr>
<tr>
<td>MTBE</td>
<td>µg/L</td>
<td>grab</td>
<td>annually</td>
</tr>
<tr>
<td>2,3,7,8-TCDD22</td>
<td>pg/L</td>
<td>grab</td>
<td>semiannually</td>
</tr>
<tr>
<td>PCBs as aroclors14</td>
<td>µg/L</td>
<td>grab</td>
<td>annually</td>
</tr>
<tr>
<td>PCBs as congeners15</td>
<td>µg/L</td>
<td>grab</td>
<td>annually</td>
</tr>
<tr>
<td>Remaining USEPA priority pollutants23 excluding asbestos and PCBs</td>
<td>µg/L</td>
<td>grab</td>
<td>semiannually</td>
</tr>
</tbody>
</table>
### TABLE E-6
**Surface Water Conditions Monitoring Requirements**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Minimum Sampling Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sludge banks or deposits</td>
<td>Volume, area, location description</td>
<td>weekly</td>
</tr>
<tr>
<td>Oil, grease, or slicks</td>
<td>Volume, area, location description</td>
<td>weekly</td>
</tr>
<tr>
<td>Foam</td>
<td>Volume, area, location description</td>
<td>weekly</td>
</tr>
<tr>
<td>Solids of waste origin</td>
<td>Volume, area, location description</td>
<td>weekly</td>
</tr>
<tr>
<td>Breaching (Flow from Estuary to Ocean)</td>
<td>Time, width and depth and latitude and longitude</td>
<td>weekly</td>
</tr>
<tr>
<td>Habitat</td>
<td>Number of species observed, diversity and refugio quality measure</td>
<td>quarterly</td>
</tr>
<tr>
<td>Siene Net Fish Species Count</td>
<td>Number of species, size, and diversity measure</td>
<td>annually</td>
</tr>
</tbody>
</table>

### TABLE E-7
**Sediment Monitoring Requirements**

<table>
<thead>
<tr>
<th>Location</th>
<th>Parameter</th>
<th>Minimum Sampling Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benthic Community</td>
<td>Where appropriate: identification of all organisms to lowest possible taxon; community structure analysis for each station; mean, range standard deviation, and 95 percent confidence limits, if appropriate, for value determined in the community analysis.</td>
<td>annually</td>
</tr>
<tr>
<td>Upper 5 cm of Sediment</td>
<td>Arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc, cyanide, phenolic compounds (chlorinated), phenolic compounds (non chlorinated), total halogenated organic compounds, aldrin and dieldrin, endrin, HCH, chlordane, total DDT, DDT derivatives, total PCB, PCB derivatives, toxaphene, total PAH, PAH derivatives, detected priority pollutants, compounds on the local 303(d) list, dissolved sulfides (pore water), TOC and grain size (sufficiently detailed to calculate percent weight in relation to phi size)</td>
<td>annually</td>
</tr>
</tbody>
</table>
Attachment B
### Summary of Modifications made to PCAP/MAAMP since September 28, 2020

<table>
<thead>
<tr>
<th>Modified Text</th>
<th>Page # and paragraph</th>
<th>Date comment incorporated</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> “Data collected along these three transects will include vegetation types, emerging vegetation observations, and structural observations including understory density and canopy cover visual estimates. The data will provide for habitat quality and functionality comparisons over time.”</td>
<td>Added to third paragraph of page 3-14</td>
<td>11/17/2020</td>
<td>Modification made in response to RWQCB comment</td>
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<td><strong>2</strong> “An assessment of algal species including the potential for harmful algal bloom (HAB) algal species will not be routinely conducted. However, if future algal blooms persist, the City may submit a sample to be analyzed for HAB by a qualified expert.”</td>
<td>Added to fourth paragraph of page 3-10</td>
<td>11/17/2020</td>
<td>Modification made in response to RWQCB comment</td>
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<td><strong>3</strong> “In addition to a vertical profile sample that mixes the water column, a grab sample will be collected at depth and a second sample collected at the surface in sample locations where stratification is possible.”</td>
<td>Paragraph 3 page 3-9</td>
<td>11/17/2020</td>
<td>Modification made in response to RWQCB comment</td>
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<td><strong>4</strong> 3.3.6 Algal Bloom Observations</td>
<td>Page 3-11</td>
<td>11/17/2020</td>
<td>Modification made in response to RWQCB comment</td>
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<td><strong>Rationale:</strong> The occurrence of algal blooms within the SCRE reflect water quality components including DO, temperature, and nutrient availability. Recording algal bloom events when they occur will assist in correlating the events with water quality conditions.</td>
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<td><strong>Method:</strong> During routine visual observations of the SCRE conducted by VWRF staff, evidence of algal blooms will be confirmed and recorded in the annual PCAP monitoring report.</td>
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<td><strong>Timing:</strong> Observations occur weekly.</td>
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<td><strong>5</strong> “The PCAP continuously measures the most ecologically significant outcome of eutrophication, i.e., low DO concentrations. The proposed program will monitor for the occurrence (if any) of eutrophication events through the combination of monitoring levels of phytoplankton biomass (in units of chlorophyll-a) and macroalgae, as well as phenomena related to eutrophication, such as subsequent hypoxia (by monitoring dissolved oxygen concentration). This information will supplement the information collected as part of its annual bioassessment monitoring conducted under the NPDES Permit Monitoring and Reporting Plan, which requires monitoring for algal assemblages and algal biomass.”</td>
<td>Page 3-8</td>
<td>5/28/2021</td>
<td>Modification made in response to RWQCB comment</td>
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<td><strong>6</strong> Edit to Row 3 of this table: “Paragraph 3 page 3-9.”</td>
<td>Page B-1</td>
<td>5/28/2021</td>
<td>Modification made in response to RWQCB comment</td>
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<td><strong>7</strong> <strong>Method:</strong> Water level data will be collected from existing groundwater monitoring wells, and from functioning piezometers used in the Phase 3 study. The existing piezometer wells and casings will be reused if feasible, and new water level sensors will be installed. Sensors will measure and log depth continuously at 30 minute intervals. The following five wells will be used if available access is granted by the State Parks: GW1 and GW2 south of the SCRE at the campground, and GW14 north of the SCRE next to the Polishing Ponds. Periodic groundwater level measurements will be collected at wells GW9 and GW10, when water quality grab samples are collected at these locations. If necessary, the elevation of the sensors and the corresponding water surface elevation will be surveyed using RTK GPS during installation, and well depth measurements will be taken during each download/service visit.</td>
<td>Page 3-7</td>
<td>6/17/2021</td>
<td>Modification made in response to VCK/HTB comment</td>
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<td><strong>8</strong> The station located in the deepest scour hole in the lagoon may shall be</td>
<td>Page 3-10, 6/17/2021</td>
<td></td>
<td>Modification made in response to RWQCB comment</td>
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equipped with two sondes, one near the surface and one near the bed.

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<th>Paragraph</th>
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<td>9</td>
<td><strong>Other Considerations:</strong> The construction of new monitoring wells and piezometers is not proposed to support the PCAP. The existing wells identified in Figure 7 will be used to the extent they are suitable to support periodic grab sampling and temperature probes.</td>
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<td>Page 3-12</td>
<td>6/17/2021</td>
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<td>10</td>
<td>The MAAMP will identify action criteria and management measures as appropriate that will guide implementation of Phase 1b reductions in discharges (to an average annual of 0–0.5 mgd closed berm condition) if the data demonstrate that further discharge reductions would not result in the unauthorized “take” of sensitive species in the SCRE.</td>
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<td>Page 5-1, second paragraph</td>
<td>6/17/2021</td>
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<td>11</td>
<td>Following Phase 1a discharge reduction implementation, evaluate data and trends to determine whether reducing discharge below 1.9 mgd would avoid unauthorized take and significant adverse effects to listed species consistent with the EIR. If so, then move forward with Phase 1b to phase out closed berm discharges to the SCRE consistent with the SRP recommendations, the NPDES permit, and the Water Quality Control Plan for Enclosed Bays and Estuaries adopted by the State Water Resources Control Board.</td>
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<td>Page 54-2, last paragraph</td>
<td>6/17/2021</td>
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