Final

# SSLOCSD WASTEWATER TREATMENT FACILITY REDUNDANCY PROJECT

## Coastal Hazards Monitoring Plan

**Prepared for**

**South San Luis Obispo County Sanitation District**

**December 2018**

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# 1 INTRODUCTION

This report presents a Coastal Hazards Monitoring Plan (Monitoring Plan) to be implemented by the South San Luis Obispo County Sanitation District (SSLOCSD; District) per the requirements of Special Condition 4 of the California Coastal Commission (CCC) Coastal Development Permit (CDP) 3-16-0233, issued for the SSLOCSD Wastewater Treatment Plant Redundancy and Improvements Project (Project). This Monitoring Plan is intended to provide a framework for conducting regular monitoring of the site's exposure to flooding hazards for existing and future conditions with sea-level rise.

## 1.1 Background

The CCC unanimously approved CDP 3-16-0233 for the SSLOCSD Wastewater Treatment Facility (WWTF) Redundancy and Improvements Project. The approved CDP includes an amendment to Special Condition 2 that extends the permit duration from 10 years to 30 years and establishes a series of deadlines for submittal of several technical studies described in Special Conditions 4, 5 and 6 within the 5- and 10-year period after issuance of the CDP.

To date, the project team has completed several planning and technical studies as part of the CEQA and permitting process, and the next phase of the project will focus on engineering design and preparation of construction documents. Prior to issuance of the CDP, the CCC needs to receive copies of the final engineering drawings (Special Condition 3) and a monitoring plan (Special Condition 4). This report is limited to development of the Monitoring Plan.

## 1.2 Study Goal and Objectives

The goal of this study is to prepare a Coastal Hazards Monitoring Plan that can be implemented by the District to track how the hazards change over time, and to document actions and responses for managing those hazards.

Special Condition 4 of the CDP describes the components and objectives of a monitoring plan that outlines future monitoring efforts to be conducted by the District, including how the monitoring program will be conducted and reported throughout the duration of the CDP. The following sections provide a summary of these study objectives.

### 1.2.1 Framework and Parameters of the Monitoring Plan

As described in the CCC staff report for CDP Application 3-16-0233, the Monitoring Plan will establish a framework and parameters for:

1. Regularly monitoring flood and other coastal hazards at the site and management responses to those hazards both on and off site, such as lagoon management and levee expansion.

2. Identifying how those hazards are impacting and affecting operations of the wastewater treatment plant.

3. Identifying changes necessary to allow continued appropriate and required functioning of the plant.

4. Identifying flood/hazard "triggers" to establish when actions (such as retrofits, upgrades, and including plant relocation) need to be pursued in response to specific flood/hazard events or flood management activities.

### 1.2.2 Metrics for Assessing Site Conditions and Potential Responses to Flooding

The CCC staff report for CDP Application 3-16-0233 requires that the Monitoring Plan shall include metrics for assessing site conditions and potential responses related to flooding of the site in relation to:

1. Emergency effluent discharge

2. Violation of effluent discharge limits

3. Emergency response measures, such as lagoon management and levee expansion

4. Use of redundancy equipment

5. Flood-required repairs

6. Incidents where prior flood proofing failed

7. Other appropriate evaluation metrics

### 1.2.3 Monitoring and Reporting

The District will implement this Monitoring Plan and submit annual monitoring reports that include and describe changes since the prior year's report, as well as cumulatively describing changes over time.

## 1.3 Report Organization

This Monitoring Plan is organized as follows:

**Section 1: Introduction** – Project background, permitting conditions and purpose of monitoring plan.

**Section 2: Site Description** – Description of the site and surrounding areas.

**Section 3: Hazards and Sea-Level Rise** – Description of flood and other coastal hazards at the site, and summary of updated guidance on sea-level rise.

**Section 4: Monitoring Program** – Description of the monitoring program data collection plan, including suggested methodology.

**Section 5: Monitoring Methods** – Description of methods for physical data collection, archiving relevant environmental data and documenting ongoing management actions.

**Section 6: Reporting** – Discussion of specific elements included in annual reports.

## 1.4 Report Preparers

This report was prepared by the following ESA staff:

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# 2 SITE DESCRIPTION

The SSLOCSD WWTF is located south of Pismo Beach and immediately west of Oceano, California, near the mouth of Arroyo Grande Creek (Figure 1). The wastewater plant treats sewage collected from the City of Arroyo Grande, City of Grover Beach, and the Oceano Community Services District. The treatment plant has design capacity of 5 million gallons per day (mgd) and a 9 mgd peak wet weather flow. Typical flows are approximately 3.5 mgd, but a flow of about 7.8 mgd was observed during a recent winter storm.[1]


SOURCE: ESRI 2016

**Figure 1**
Project Location and Vicinity Map

The plant sits approximately 2,000 feet from the Pacific Ocean shoreline and is bounded by the Arroyo Grande Creek to the south and Meadow Creek to the northwest, which convey the majority of runoff for the southern San Luis Obispo County region (Figure 2). The confluence of Arroyo Grande and Meadow Creeks forms a series of lagoons, the elevations of which are controlled by the beach berm. The Oceano Airport is located directly above the WWTF.

[1] Personal Communication, Gerhardt Hubner, Former District Administrator SSLOCSD, August 2017.


SOURCE: Aerial NAIP 012

**Figure 2**
Site Map (Zoomed In)

The WWTF is vulnerable to flooding via coastal, fluvial and estuarine sources. Section 3 describes each of these flooding hazards in greater detail. A sea-level rise vulnerability assessment was completed in 2016 that evaluated the potential impacts of higher sea-levels on the wastewater plant facilities and operations (ESA 2016). The primary findings of the study showed that although much of the plant is protected from temporary extreme fluvial flooding of Arroyo Grande Creek, access to the plant could be impacted at "nuisance" levels by 2050 and more widespread flooding similar to the December 2010 event could occur at "nuisance" levels by 2100. One of the important findings of the study is that the increased flood response at the plant is less than the change in sea-level rise. This is due to the hypsometry of the site, or the stage-storage relationship, which mutes the flood elevations of the lagoon for a given amount of sea-level rise. However, the site vicinity is low-lying, and extreme storm conditions and sea-level rise will increase the risk of flooding at the WWTF.

The WWTF is located on relatively low ground, which creates drainage issues that could potentially impact site operations. A levee along the north bank of Arroyo Grande Creek protects the southern edge of the WWTF from extreme rainfall-runoff events. Meadow Creek discharges to the Arroyo Grande Lagoon through a tide gate when the water levels in Arroyo Grande Lagoon are lower than the water surface elevation of Meadow Creek Lagoon. For many years, the County regularly managed water levels in Arroyo Grande Lagoon via periodic, mechanical breaching, which allowed water levels within Meadow Creek to lower before low-lying residential areas adjacent to the WWTF were impacted. These management actions have provided benefits to the wastewater plant, including maintaining regular access on County roads, and limiting flood levels from pooling in the site.

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# 3 HAZARDS AND SEA-LEVEL RISE

This section presents a brief summary of the hazards described in the prior Sea-Level Rise Analysis (ESA 2016) and compares the sea-level rise amounts used in prior work to the current sea-level rise guidance issued by the State of California (OPC 2018).

## 3.1 Summary of Flood Hazards

The WWTF is susceptible to flooding via three mechanisms: coastal flooding, fluvial flooding and estuarine flooding. Flooding associated with any of the three mechanisms is currently considered a low likelihood for existing conditions, as described in the Sea-Level Rise Analysis (ESA 2016). The majority of the WWTF site lies between 12 and 13 feet NAVD[2], with current Base Flood Elevations (BFE), as reported by FEMA maps, approximately 2.5 feet above existing ground elevations. According to District staff, plant operations would be completely overwhelmed by floodwaters at elevation 15 feet NAVD. A brief description of each flooding hazard is provided below:

1. **Existing and future coastal flooding.** Wave overtopping of the levee during extreme events results in flooding of Meadow Creek Lagoon. Erosion impacts from coastal flooding also present a potential hazard in that eroded conditions may exacerbate damage from subsequent storms.

2. **Fluvial flooding.** Extreme rainfall-runoff events result in overtopping of the levee along Arroyo Grande Creek, which straddles the southern border of the WWTF. This compromises plant operations and access.

3. **Estuarine flooding.** Elevated water levels in Arroyo Grande Lagoon result in increased water levels in Meadow Creek Lagoon and flooding in adjacent, low-lying residential areas at 10.4 feet NAVD and the WWTF at approximately 12 feet NAVD.

Based on the sea-level rise analysis conducted by ESA (2016), the primary flood mechanism affected by sea level rise will be estuarine flooding. Typical water levels will exceed the access threshold of 10.4 feet NAVD regularly by mid-century. Coastal flood and erosion impacts to the WWTF do not pose as significant of a hazard, unless the north levee at the Arroyo Grande Creek mouth is not maintained. Assuming high coastal erosion rates, the shore may migrate landwards towards the levee, which would compromise the safety of the residential areas and WWTF operations behind the structure.

[2] NAVD stands for North American Vertical Datum of 1989, a fixed reference for elevations determined by geodetic leveling.

## 3.2 Update to Sea-Level Rise Guidance

Recent updates to the State of California sea-level rise guidance were adopted by the Ocean Protection Council (OPC) in 2018, which supersede the projections from OPC (2013) that were used in the prior Sea-Level Rise Analysis (ESA 2016). Table 1 compares the values used in the prior study to the current sea-level rise guidance.

**TABLE 1**
**COMPARISON OF SEA-LEVEL RISE VALUES FROM OPC 2013 AND OPC 2018**

| Projection | 2050 | 2100 | Note |
|---|---|---|---|
| OPC (2013) used in Prior Sea-Level Rise Analysis | 1 to 2 feet | 3 to 5.5 feet | Range from the medium to high emissions scenarios |
| OPC (2018) – New Guidance | 1.8 to 2.6 feet | 6.7 to 9.9 feet | Range from the medium-high to extreme risk aversion projections |

As shown in Table 1, the sea-level rise projections presented by the new OPC 2018 guidance are higher than those presented in OPC 2013 and used in the prior Sea-Level Rise Analysis (ESA 2016). The implications of the new guidance are that the amounts used in the prior study are projected to occur at a slightly earlier timeframe, and the extreme risk aversion curve (also called H++) represents a new projection that has not been previously considered. The extreme risk aversion curve is associated with rapid melting of polar ice in Antarctica, and is not associated with a defined probability. The new guidance has minor implications for the mid-century scenario, but suggests that the impacts associated with 5.5 feet of sea-level rise could occur between 2074 and 2092 instead of at 2100 as previously assessed.

Table 2 presents the new sea-level rise projections for the Port of San Luis for the high emissions scenario. This table was presented in a recent 2018 draft update to the CCC 2015 Sea-Level Rise Policy Guidance Document, and is based on the projections of the OPC (2018) document. The three columns represent the sea-level rise projections for:

- Low risk aversion – to be used for temporary or low risk assets, such as trails
- Medium-high risk aversion – to be used for assets that have some ability to adapt, with low to moderate consequences if impacted
- Extreme risk aversion (H++) – to be used for critical infrastructure and assets that have high consequences if impacted.

ESA recommends that the District revisit the potential sea-level rise impacts to the project for late century as the design is finalized. The new projections have the greatest effect on adaptation decisions that are likely to occur in the 30- to 60-year timeframe. The values are presented here for completeness.

**TABLE 2**
**SEA-LEVEL RISE PROJECTIONS FOR PORT SAN LUIS PRESENTED BY CCC (2018) AND BASED ON OPC (2018)**

| Projected Sea Level Rise (in feet): *Port San Luis* | | | |
|---|---|---|---|
| | Probabilistic Projections (in feet) (based on Kopp et al. 2014) | | H++ Scenario (Sweet et al. 2017) |
| | **Low Risk Aversion** | **Medium-High Risk Aversion** | **Extreme Risk Aversion** |
| | *Upper limit of "likely range" (~17% probability SLR exceeds...)* | *1-in-200 chance (0.5% probability SLR exceeds...)* | *Single scenario (no associated probability)* |
| 2030 | 0.5 | 0.7 | 1.0 |
| 2040 | 0.7 | 1.2 | 1.6 |
| 2050 | 1.0 | 1.8 | 2.6 |
| 2060 | 1.3 | 2.5 | 3.7 |
| 2070 | 1.7 | 3.3 | 5.0 |
| 2080 | 2.1 | 4.3 | 6.4 |
| 2090 | 2.6 | 5.3 | 8.0 |
| 2100 | 3.1 | 6.7 | 9.9 |
| 2110* | 3.2 | 7.0 | 11.6 |
| 2120 | 3.7 | 8.2 | 13.8 |
| 2130 | 4.3 | 9.6 | 16.2 |
| 2140 | 4.8 | 11.1 | 18.7 |
| 2150 | 5.4 | 12.6 | 21.5 |

***Most of the available climate model experiments do not extend beyond 2100. The resulting reduction in model availability causes a small dip in projections between 2100 and 2110, as well as a shift in uncertainty estimates (see Kopp et al., 2014). Use of 2110 projections should be done with caution and acknowledgement of increased uncertainty around these projections.***

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# 4 MONITORING PROGRAM

This section outlines the Monitoring Program and establishes procedures and metrics for data collection. Monitoring will be performed to fit into the following framework, as outlined in the CDP:

**Step 1** –Flood hazards and management responses to those hazards will be monitored annually, as described in this report.

**Step 2** – As part of annual monitoring, the District will identify how flood hazards (fluvial, estuarine and/or coastal) are impacting and affecting operations of the WWTF.

**Step 3** – Monitoring results will be used to indicate when a flood hazard "trigger" (defined herein) has occurred that necessitates response actions by the District.

**Step 4** – If impacts or a triggering event occur in any given year, the District will evaluate how to best address flood hazards and recommend actions to reduce impacts.

Each step is described briefly below.

## 4.1 Monitoring

Monitoring activities include collecting physical data, archiving regional environmental data and documenting relevant management activities. Monitoring data collection and reporting will be according to the following schedule. More detail on monitoring methods and application of monitoring data is provided in Section 5.

A "Qualifying Rain Event" (as defined by the Regional Water Quality Control Board) is any event that produces 0.5 inches or more precipitation with a 48 hour or greater period between rain events. The additional visual assessment will occur within 48 hours of the conclusion of each "Qualifying Rain Event." Should the "Qualifying Rain Event" extend beyond 7 days, a visual assessment will also occur within 48 hours of the conclusion of each 7-day period within the "Qualifying Rain Event."

In addition to monitoring the hazards described above, the District will document various management actions that are directly or indirectly relevant to the operations of the WWTF. These management actions include activities conducted by the District on-site, such as maintenance of drainage assets and vegetation management, and activities conducted by others, such as levee improvements, vegetation management in Arroyo Grande Creek channel, and mechanical breaching of the Arroyo Grande Lagoon. The District will document each of these actions, including the location, who led the action, reference to permits that were obtained, and a summary of the action and the outcome.

**TABLE 3**
**SUMMARY OF MONITORING PLAN**

| Hazard Type | Monitoring Activity | Frequency |
|---|---|---|
| General | Obtain, assess and archive data collected by others:<br>• Tides<br>• Waves<br>• Evaporation & Precipitation<br>• Water Levels | Annually |
| Rainfall Event | • Photographs of Site<br>• Document areas of Ponding<br>• Record lagoon elevation using staff gage<br>• Document operational issues and damages to facilities | Each Qualifying Rainfall Event |
| Fluvial Flood on Arroyo Grande Creek | • Post-flood assessment of damages<br>• Identify location(s) of overtopping | Post-flood event |
| Arroyo Grande Channel Conditions | • Assess the conditions of channel visually for obstruction and vegetation<br>• Topographic survey of channel thalweg and lagoon footprint | • Every 3 years<br>• Every 3 years |
| Long-term Beach berm changes and Lagoon Flooding in Meadow Creek Lagoon and Arroyo Grande Lagoon | • Record lagoon stage and groundwater elevations from staff gages<br>• Assessment of vegetation encroachment in Meadow Creek Lagoon – visual / aerial<br>• Topographic survey of beach berm<br>• Analyze water level measurements by County and Compare Distribution of water levels to baseline (for Meadow Creek and Arroyo Grande Lagoons) | • Monthly<br>• Every 3 years<br>• Every 3 years<br>• Annually |
| Extreme Coastal Flood | • Assess effects of waves on tide gate and levee<br>• Record lagoon elevation using staff gage<br>• Review water level data from county for event | Post-extreme coastal storm event (greater than 10-year recurrence) |

## 4.2 Description of Flood Impacts

As part of annual monitoring, the District will identify how flood hazards (fluvial, estuarine and/or coastal) are impacting operations of the WWTF. This is envisioned to be a qualitative assessment of potential impacts to WWTF access, collection, treatment and discharge operations primarily based on input from operations personnel.

## 4.3 Identification of Flood Hazard "Triggers"

Monitoring data will be used to document episodic flood hazards (e.g. large storm events) as well as gradual increase in flood hazards due to sea-level rise. Based on prior analysis (ESA, 2016), the following flood conditions are considered "triggering" events or conditions that would necessitate further management action by the District.

**TABLE 4**
**FLOOD HAZARD TRIGGERS**

| Flood Threshold Event | Potential Flood Source |
|---|---|
| Levee Overtopping | Fluvial |
| Median Lagoon Elevation of 9.5 feet NAVD (2 foot increase over existing) | Estuarine |
| Event-based water levels exceeding 10.4 feet NAVD (County Threshold for Residences and WWTF Access) | Fluvial/Estuarine/Coastal |

Baseline conditions for median lagoon elevation, and methods for updating annually, are described under Section 5.2.4

## 4.4 Actions to Address Flood Hazards

If impacts or a triggering event occur in any given year, the District will evaluate how to best address flood hazards and recommend actions to reduce impacts. Because the nature of flood hazards can vary, the appropriate actions will be developed in response to the specific hazard. Short-term response actions may include items such as levee improvements, tide gate maintenance, WWTF retrofits etc. Longer-term response action could include WWTF upgrades and/or relocation.

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# 5 MONITORING METHODS

The following sections provide a series of monitoring activities, including physical monitoring, regional data archiving of hydrologic processes, and documentation of other management activities.

## 5.1 Physical Monitoring Activities

### 5.1.1 Land Surveys

Topographic and bathymetric monitoring of Arroyo Grande Creek and Oceano Lagoon shall be undertaken every three years. Surveys will be conducted at proposed locations shown on Figure 3, and should consist of the following components:

1. **Arroyo Grande Creek/Lagoon Thalweg Profile.** A thalweg elevation profile will be conducted along Arroyo Grande Creek, from the reach immediately adjacent to the WWTF through the lagoon and lagoon mouth down to roughly mean sea level (MSL) on the foredune face. In the event that the lagoon mouth is closed, the profile should extend up and over the closed mouth down the foredune face. All surveys should characterize any major breaks in slope or nick points/head cuts.

2. **Arroyo Grande Creek Lagoon Footprint Survey.** Additional to the thalweg profile, a footprint of the lagoon will be surveyed. The lagoon footprint shall be defined as the water surface elevation during the time of survey. The survey will be sufficient to characterize the shape and size of the lagoon, generally.

3. **Beach Berm Crest.** A beach berm crest will be surveyed north to south. The berm crest is defined as the top limit of the foredune slope.

4. **Survey Control.** A network of at least three (3) permanent survey control points shall be established within the site in order to maintain accurate vertical and horizontal accuracy between monitoring events. In order to maintain consistency for the monitoring period, all surveys should be conducted in a consistent coordinate system and datum, and should be surveyed relative to these three established control points.

The thalweg profile will be used to evaluate bed morphology changes, such as changes in bed elevation or slope, that could affect conveyance through Arroyo Grande Creek. The profile, lagoon footprint and beach berm will inform volumetric and geomorphic analysis of the lagoon. The elevation of the beach berm is also an important element of understanding opening/closing events, and provide insight about potential future breaching events.

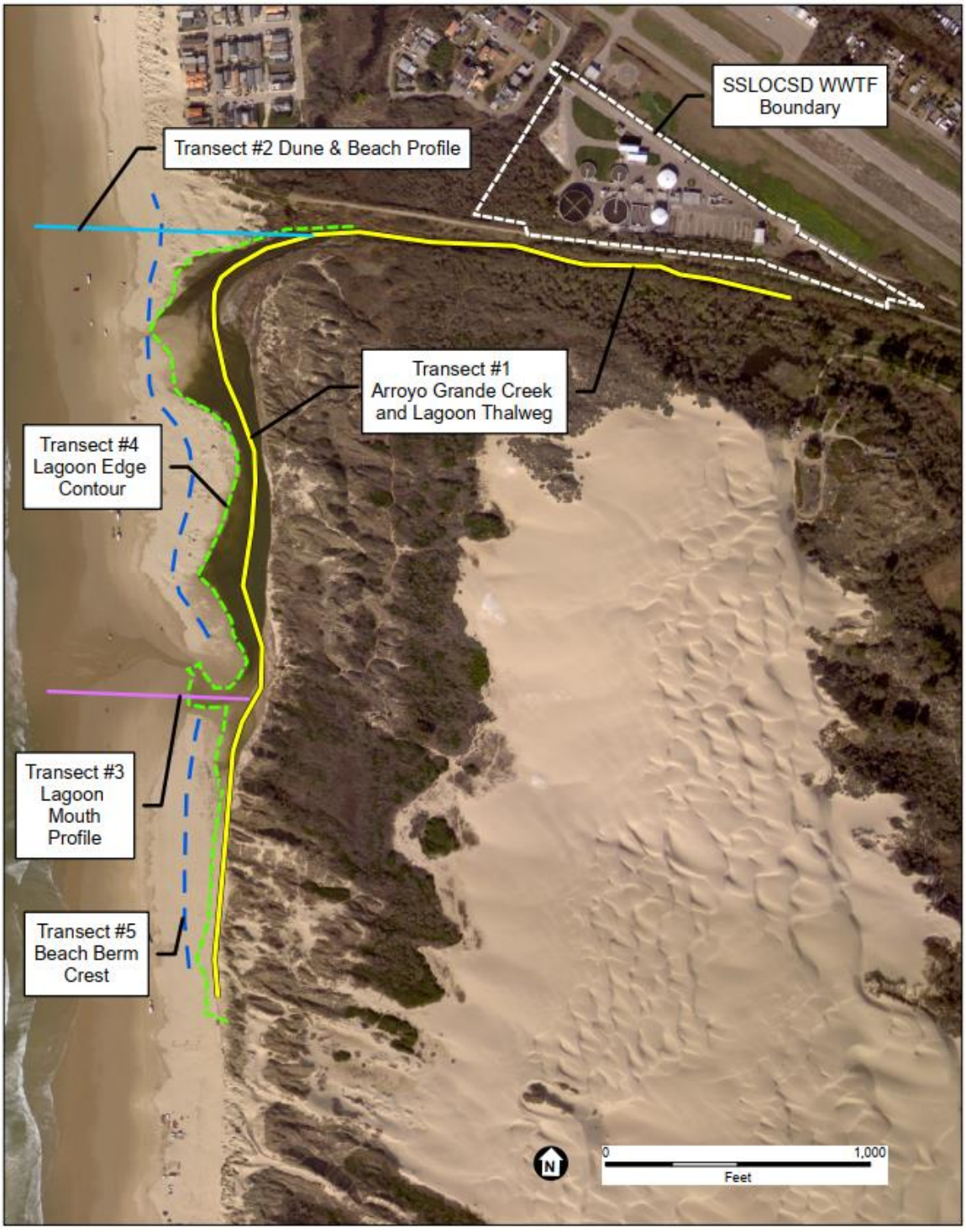



**Figure 3**
Survey Monitoring Layout

## 5.1.2 Repeat Photography

Photographic documentation will be undertaken \ during the same time as the survey effort. The photographic documentation techniques will be based on the principles of re-photography, also known as repeat photography. This is a technique of landscape study where scenes are repeatedly photographed at certain time intervals to determine the nature of long-term change. The compass bearing of the direction of view will be established and notated for every photo. Photographs shall be taken at the locations and in the directions shown in Figure 4. Locations and directions were chosen based on specific areas of interest as well as potential indicators for action. For example, the photo locations within Arroyo Grande Creek will not only help inform geomorphic analysis, but will also inform about vegetation encroachment within the creek which could affect channel conveyance.


**Figure 4**
Photo Monitoring Layout

## 5.1.3 Event-Based Observations

In addition to regularly scheduled land surveys, topographic and bathymetric monitoring of Arroyo Grande Creek and Ocean Lagoon shall be carried out after extreme events where flood hazards may be exacerbated. Event-based observations help quantify the impact of extreme events and provide benchmarks against which future storms can be compared. Qualitative observations of water levels around the WWTF should be taken. Where possible, high water marks should be logged and surveyed with water level elevation, date and time.

### 5.1.4 Groundwater Data

Groundwater elevations shall be recorded through the monitoring period. Groundwater elevations are assumed to rise at the same rate as sea level rise, which would impact water levels in Meadow Creek and Arroyo Grande Lagoons and render the entire system more susceptible to flooding (ESA, 2016). Establishing a continuous record of groundwater levels will help provide more nuanced understanding of environmental conditions around estuarine flood hazards (e.g. when Meadow Creek Lagoon water levels are elevated). A water level gage will be installed in the existing onsite well to collect continuous groundwater levels. Direct measurements will be made annually to calibrate water level gauge.

## 5.2 Regional Environmental Data Archiving

Regional environmental data archiving shall be carried out on a yearly basis as part of the Monitoring Program. Establishing a multi-year record of environmental conditions (e.g., tides, waves, precipitation, evaporation, water levels and groundwater measurements) at the WWTF will help inform short and long-term management decisions and will supplement survey data collected through the monitoring period. Additionally, these data also serve as the inputs to the quantified conceptual model (QCM) of Arroyo Grande Lagoon and water balance model used in the previous sea-level rise analysis conducted by ESA (2016).

Datasets included in the regional data archiving span information collected by the San Luis Obispo County and other government agencies, including the U.S. Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA) and the State of California.

The following sections describe the type of data that should be collected and analyzed as part of the monitoring program. Baseline conditions of tide, wave and meteorological data are also provided below for future comparisons.

### 5.2.1 Tides

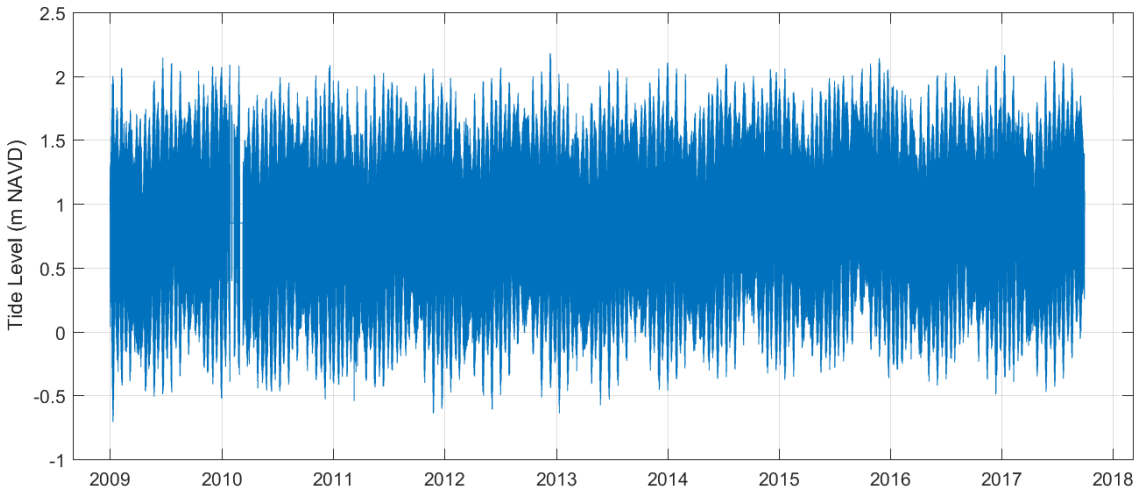
Observed and predicted tides will be compiled for each annual monitoring report. The tidal water elevations will be acquired from the Port San Luis tide gage, NOAA NOS Station 9412110, located about eight miles from the project site, but assumed to be representative of the actual conditions at the site.

Tides at the site are characterized by a mixed semi-diurnal tide signal, typical of the California coast, with two high tides and low tides occurring per day, each with unequal heights. The diurnal tide range, or the difference between mean higher high water (MHHW) and mean lower low water (MLLW), is approximately 5.3 feet. Table 5 presents the tidal datums at the Port San Luis tide gage. Figure 5 shows the observed tidal signal from 2009 through October 2017.

**TABLE 5**
**TIDAL DATUMS AT PORT SAN LUIS GAGE – NOAA #9412110**

| Datum | Value (ft NAVD) | Description |
|---|---|---|
| HOWL | 7.57 | Highest Observed Water Level (1/18/73, 9 AM) |
| HAT | 7.02 | Highest Astronomical Tide |
| MHHW | 5.25 | Mean Higher-High Water |
| MHW | 4.54 | Mean High Water |
| MTL | 2.75 | Mean Tide Level |
| MSL | 2.72 | Mean Sea Level |
| MLW | 0.96 | Mean Low Water |
| NAVD88 | 0 | North American Vertical Datum of 1988 |
| MLLW | -0.08 | Mean Lower-Low Water |
| LAT | -2.07 | Lowest Astronomical Tide |
| LOWL | -2.48 | Lowest Observed Water Level (1/7/51, 12 AM) |

Tidal Datum Analysis Period: 01/01/1983-12/31/2001



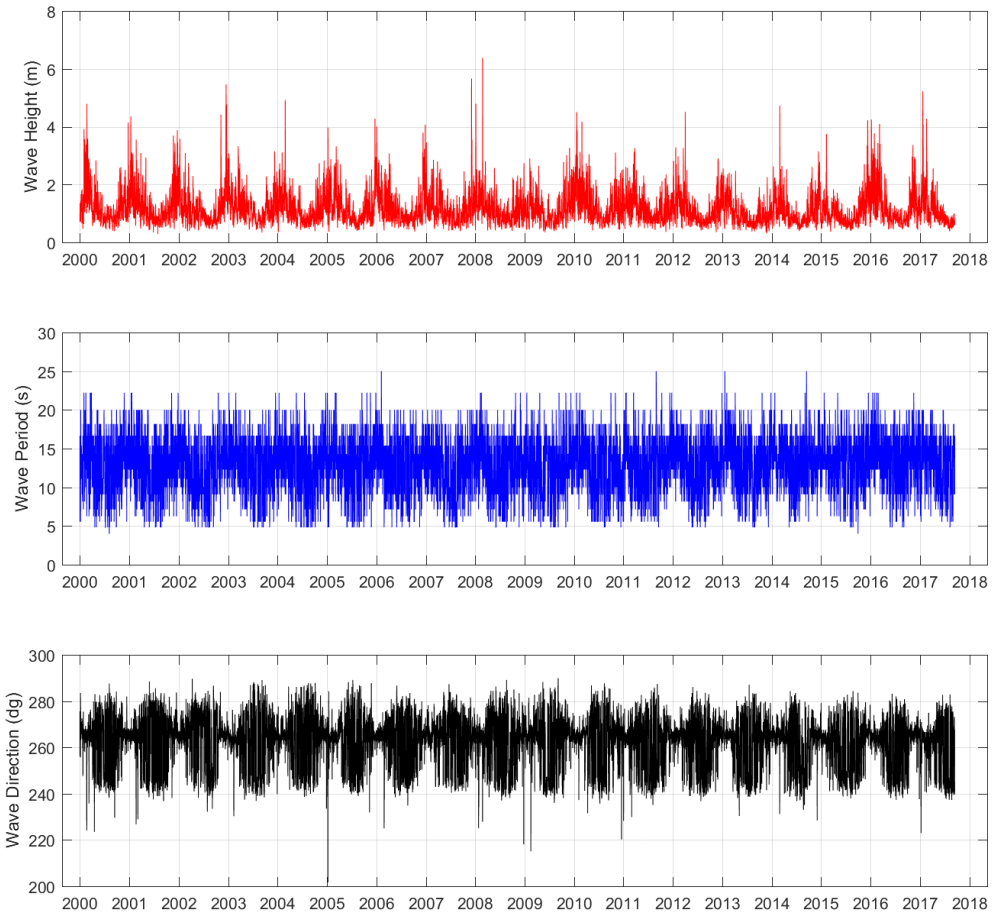

SOURCE: CDIP, NOAA

**Figure 5**
Observed Tides at Port San Luis Gage

## 5.2.2 Waves

Wave parameters, including the significant wave height, peak period and peak direction of wave approach, will be collected from the Coastal Data Information Program (CDIP) California Coastal Wave Monitoring and Prediction System (O'Reilly et al. 2016) at CDIP model output point (MOP) number SL068.[3] The data from the MOP are representative of nearshore conditions, and were transformed from deep water offshore using the CDIP transformation coefficients. Figure 6 presents nearshore values for significant wave height, wave period and wave direction.

Compiling a continuous wave record is necessary for identifying peak wave events which cause beach berm overtopping and characterizing the wintertime conditions relative to the historical baseline (e.g., extremely stormy, above average stormy, below average stormy, calm). Wave processes control the beach berm elevation, which influence the water levels in Arroyo Grande Lagoon and the state of the lagoon mouth (e.g. open, closed, perched overflow, etc.).




SOURCE: CDIP, NOAA

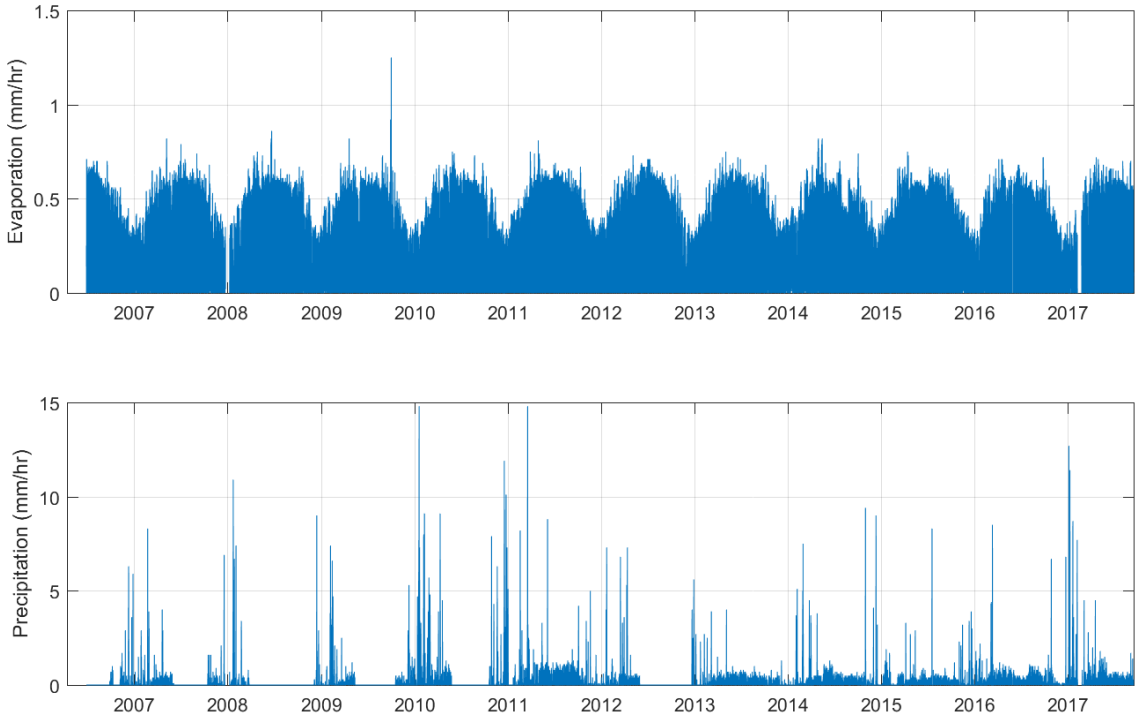
**Figure 6**
Wave parameters at MOP SL068

[3] Data were furnished by the Coastal Data Information Program (CDIP), Integrative Oceanography Division, operated by the Scripps Institution of Oceanography, under the sponsorship of the U.S. Army Corps of Engineers and the California Department of Parks and Recreation, http://cdip.ucsd.edu/

## 5.2.3 Meteorological Processes

Meteorological parameters, specifically evaporation and precipitation data, will be downloaded from the Nipomo CIMIS Station #202, which is located 6 miles from the WWTF. Precipitation data shall be obtained as daily rainfall totals and evaporation data as hourly measurements.

Extreme rainfall-runoff events heighten the risk of overtopping the levee along Arroyo Grande Creek. Moderate rainfall-runoff events in conjunction with elevated water levels in Arroyo Grande Lagoon are associated with estuarine flooding of the project site and surrounding areas. Correlating timing and extent of rainfall-runoff events to fluvial flooding events at the WWTF will help inform management of WWTF operations during wet weather. Figure 7 shows the baseline conditions at the meteorological station.




SOURCE: UC IPM[3]

**Figure 7**
Evaporation and Precipitation Data
Nipomo CIMIS Station #202

## 5.2.4 County Water Level Data

Water level data shall be obtained from San Luis Obispo (SLO) County Water Resources, which maintains a gage network throughout the Arroyo Grande-Meadow Creek system. Rating curve information has previously been acquired for Arroyo Grande Creek at 22nd Street and Highway 101 to convert water surface elevation at that gage location to streamflow (ESA PWA 2013; ESA 2016). The Monitoring Program should convert County water level data from the Arroyo Grande

Creek at 22nd Street location to streamflow using the rating curve to produce a continuous streamflow record for the monitoring period. The gage at Arroyo Grande Creek at 22nd Street is a radar gage and is prone to reporting incorrect values when water depths are very low or zero. Therefore, special care should be taken in examining the record and verifying data integrity. In the event that data returns seem questionable, contingency water surface elevation surveys shall be undertaken in order to verify readings. Table 6 lists the relevant gages for the project site and Figure 8 shows the locations of the installed gages.

**TABLE 6**
**SLO COUNTY WATER RESOURCES WATER LEVEL GAGES**

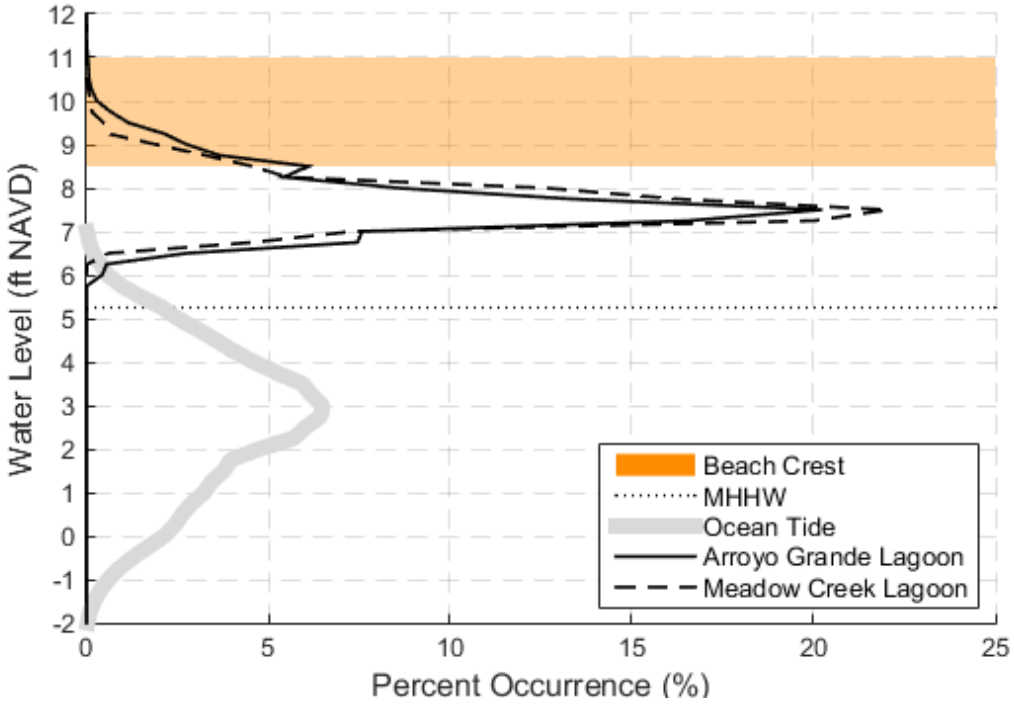
| Gage ID | Location | Established | Data |
|---|---|---|---|
| 4615 | Meadow Creek Lagoon at Pier Avenue | March 2011 | Water Level |
| 769 | Arroyo Grande Lagoon on downstream side of flap gates | January 2009 | Water Level |
| 770 | Meadow Creek Lagoon on upstream side of flap gates | February 2011 | Water Level |
| 734 | Arroyo Grande Creek at 22nd Street | January 2008 | Water Level |


SOURCE: ESRI

**Figure 8**
Location of SLO County Water Level Gages

Figure 9 presents the water level time series data processed to show the historical percent occurrence for a range of elevations. The figure includes water level time series of the ocean tides, Arroyo Grande Lagoon, and the Meadow Creek Lagoon. The yellow band illustrates the approximate vertical range of the beach berm crest, which is a primary control on the water levels in the lagoons upstream. This figure illustrates how the lagoon water levels are perched above the

ocean tides. The distributions of water levels in Arroyo Grande and Meadow Creek Lagoons are similar, but indicate that the water levels in Arroyo Grande Lagoon exceed those observed in the Meadow Creek Lagoon more often for elevations over 8 feet NAVD. The condition where the Arroyo Grande Lagoon water level exceeds Meadow Creek Lagoon prevent drainage from Meadow Creek Lagoon toward the ocean through the tide gates. As sea-level rises, this condition is expected to become more frequent. The baseline condition figure below can be used as a comparison to individual years of analyzed data collected in the future as part of the monitoring program. We recommend establishing a trigger for the condition when the median or peak lagoon water level for a given year exceeds 9.5 feet NAVD. Under these conditions we expect that impacts to the access and residential areas adjacent to the WWTF will become more frequent, toward nuisance conditions.




SSLOCSD WWTF Redundancy Project / 170619.00

SOURCE: Water level data from San Luis Obispo County

**Figure 9**
Percent occurrence of water levels for Ocean, Arroyo Grande, and Meadow Creek Lagoon

## 5.3 Ongoing Management Actions

Each year any relevant management activity in response to flooding, or that impacts potential flooding will be documented. Example ongoing management actions are summarized below.

### 5.3.1 Mechanical Breaching

The County historically managed water levels in Meadow Creek Lagoon via mechanical breaching of the sand bar located at Arroyo Grande Lagoon. Breaching allowed water to drain out of Meadow Creek Lagoon, thus preventing water levels from exceeding residential flood thresholds of approximately 10.4 feet NAVD (ESA PWA, 2013). However, due to adverse impacts on Central Coast steelhead habitats, artificial breaches now require permits. The most recent mechanical breach of Arroyo Grande Lagoon was carried out by the County on January 29, 2016, as an emergency measure to create additional storm water capacity within Meadow Creek Lagoon by lowering water levels in Arroyo Grande Lagoon by half a foot.

### 5.3.2 Arroyo Grande Creek Vegetation Management Program

The District administers annual vegetation maintenance for Arroyo Grande Creek, including willow trimming and grazing to remove unwanted vegetation[4]. Typically, the maintenance activities take place between July and October. Channel maintenance also includes repairing damages after extreme events and placement/removal of Temporary Levee Protection (sandbags and visquine) along the South Levee, which protects the WWTF.

### 5.3.3 Inflow/Infiltration Studies

A significant rainfall event on December 18-19, 2010 resulted in severe localized flooding of Oceano and temporary failure of the WWTF. A subsequent Inflow and Infiltration (I/I) analysis was conducted to review sewer locations with excessive ground and storm water entry into the WWTF system (Wallace Group, 2011). The WWTF has a design average flow capacity of 4.2 MGD and a design instantaneous wet-weather flow rate of 10.0 MGD. Any system improvements to reduce inflow and infiltration will be documented.

### 5.3.4 Airport Drainage

Elevations at the WWTF are relatively lower compared to surrounding sites and features. During extreme rainfall-runoff events, the access road located at the northwestern corner of the WWTF property boundary is flooded with runoff from the airport[5].

### 5.3.5 Levee Maintenance

Any improvements to the existing flood control levee, such as raising or erosion repair will be documented.

[4] Zone1/1A Advisory Committee, Public Works, June 9, 2017 Update

[5] Personal communication, Gerhardt Hubner, former SSLOCSD District Administrator, August 2017

# 6 REPORTING

Per requirements of Special Condition 4 of the CDP, annual monitoring reports will be submitted to the CCC each May, with the first monitoring report to be submitted by May 10, 2019. The reports shall describe survey and environmental data collected as part of the Monitoring Program, and any relevant management actions that have occurred. The Annual Coastal Hazards Monitoring Reports (ACHMR) will also include a description of how any flood hazards have impacted operations of the WWTF throughout the year, as described above. The ACHMR will describe the changes since the prior year's report, as well as cumulative changes over time. Specific report elements are described below.

## 6.1 Description of Data Collection

ACHMRs shall include descriptions of all data collected and provide information on methods used and accuracy of measurements taken. Parameters should be reported in a consistent datum and units to facilitate analysis and evaluation of data.

## 6.2 Summary of Annual Management Actions

Management actions that have been initiated, completed or are ongoing within the monitoring year shall be described in the ACHMR. The description should include location, timing, extent and general characteristics of actions taken. Additionally, the summary should relate the management action taken to any relevant flooding events that occurred during the year.

## 6.3 Photo Documentation

Photos collected as part of the photo documentation efforts will be included with annotations and summaries of changes observed. The photos will include a map that relates the photo to the location and the direction of the photo.

## 6.4 Environmental Processes Inventory

A summary of the data collected from the regional environmental archiving portion of the Monitoring Program, as described in Section 5.2, shall be provided in the ACHMR. Extreme events that are known or expected to have impacted flooding hazards (e.g., higher streamflow, increased wave heights) should be described.

## 6.5 Analysis & Evaluation

The report shall contain an analysis of all monitoring data collected with respect to its impacts on WWTF vulnerability. Lagoon and beach profiles will be compared to previous monitoring data and environmental data from extreme events. Changes in profiles will be presented in the form of cross-sections. Additionally, volume fluctuations and geomorphic changes shall be determined from the lagoon footprint data collected over the years. Any changes in vegetation noticeable from the photos taken along Arroyo Grande Creek and resultant impacts on surface roughness and overall conveyance should be noted.

## 6.6 Description of Flood Impacts

The District will identify any flooding that has occurred, likely source and how it has impacted operations of the WWTF. This qualitative assessment of potential impacts to collection, treatment and discharge operations primarily based on input from operations personnel.

## 6.7 Recommendations

Recommendations for managing project site conditions, including short-term and long-term actions, shall be included in each ACHMR. These recommendations will guide the management actions to be implemented the following monitoring year to improve resilience of the WWTF to flooding hazards. Each recommendation should outline the hazard, level of risk posed to the WWTF by the hazard, potential types of interventions as well as a description of the timing and extent of the interventions.

# 7 REFERENCES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