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ANCHOR QEA

Memorandum

May 6, 2020

To: George Johnson, Creeks Restoration Supervisor, City of Santa Barbara

From: Alyssa Cannon and Jack Malone, Anchor QEA, LLC

Re: Coastal Hazards Analysis for Andrée Clark Bird Refuge

The City of Santa Barbara (City) is proposing to perform habitat restoration and public access improvement activities at the Andrée Clark Bird Refuge (Bird Refuge) to improve water and wildlife habitat quality. At the request of the City, Anchor QEA, LLC, prepared this coastal hazards analysis to evaluate current coastal hazards associated with the proposed restoration design, as well as future coastal hazards due to sea level rise (SLR). The study was completed in accordance with the California Coastal Commission's (CCC's) *Sea Level Rise Policy Guidance* (2018).

This evaluation includes the following:

- Description of the Bird Refuge, proposed restoration work, and coastal setting
- Identification of current coastal hazards at the Bird Refuge, including high tides, storm waves, and shoreline erosion
- Identification of potential future coastal hazards at the Bird Refuge based on local predicted SLR estimates
- Discussion of the elements of the City's Coastal Land Use Plan Policy 5.1-64

This memorandum presents the analysis and results of the coastal hazards analysis that was conducted for the proposed restoration design.

Proposed Project Description

The Bird Refuge is located in Santa Barbara, California, on the Pacific coast (Figure 1). The site is bounded by the 101 Freeway on the north, East Cabrillo Boulevard on the south, and the Santa Barbara Zoo on the west (Attachment 1). The site contains approximately 30 acres of coastal wetlands and open water, including the brackish lake, which discharges water through an outlet control structure (weir) and five reinforced concrete pipe culverts under East Cabrillo Boulevard to a small saltwater lagoon at the back of the beach between East Cabrillo Boulevard and the Pacific Ocean.

Attachment 1 shows the proposed project elements, including habitat restoration, wetland creation, dune restoration, replacement of an existing concrete weir and gate, and construction of a bio-retention basin north of the municipal tennis courts on the north side of Highway 101.

The lake is connected to the ocean via a narrow channel, a concrete weir, five culverts that pass under East Cabrillo Boulevard, and a beach lagoon. For most of the year, the beach lagoon is

separated from the ocean by a naturally occurring beach berm. The existing weir is located on the north side of East Cabrillo Boulevard and was designed to control the elevation of the brackish lake. The weir is approximately 40 feet long and controls outflows from the Bird Refuge Lake to five 36-inch reinforced concrete pipe culverts that extend under East Cabrillo Boulevard to the small lagoon at the back of the beach. The structure included a 6-foot-wide sluice gate that could be manually raised and lowered to control the water level and outflows from the lake under normal operating conditions. The gate failed and was removed from the structure. The opening that was controlled by the gate has since been sealed off with a sheet of treated plywood. The remaining width of the structure includes an overflow weir. The overflow weir comprises a 12-inch deep opening at the top of the structure with steel bars spaced at 18 inches that screen debris as the water passes over the weir. The weir has a crest elevation of 4.9 feet National Geodetic Vertical Datum of 1929 (NGVD29) (7.6 feet North American Vertical Datum of 1988 [NAVD88]). The five culverts under East Cabrillo Boulevard are each 36 inches in diameter and have an average lake invert elevation of 1.38 feet NGVD29 (4.03 feet NAVD88) and an average exit elevation on the beach side of 0.6 foot NGVD29 (3.2 feet NAVD88). The design of the existing weir and culverts are shown in Attachment 2.

The City is proposing to replace the weir and gate on the north side of East Cabrillo Boulevard at the Bird Refuge to improve hydraulic control of flows between the lake and the beach lagoon. Improved hydraulic control will allow the City to increase tidal exchange between the ocean and the brackish lake (via the beach lagoon) to improve water and habitat quality. Attachment 3 shows the proposed replacement weir and water level control gate system. When closed, the crest elevation of the water level control gates will be the same as the weir crest at 4.9 feet NGVD29. When fully open, the gates have an elevation of 1.5 feet NGVD29. The existing culverts under East Cabrillo Boulevard and the roadway itself will not be changed. The design life of the proposed weir and gates is assumed to be 50 years from the proposed construction date of 2020 (until 2070).

Figure 1
Vicinity Map

Coastal Setting

The beach adjacent to the Bird Refuge (East Beach) is oriented south, with possible waves coming from directions ranging from the southeast to the southwest. Due to its coastal location, the beach and lagoon south of the Bird Refuge can be impacted by ocean swell as well as local storm waves. Storm, tide, and wave data are outlined in subsequent sections.

The existing hydraulic conditions at the Bird Refuge are controlled at the outlet of the lake by a weir, culverts, and a natural beach berm (Attachment 4). The natural beach berm elevation (approximately +8 feet NGVD29; 10.7 feet mean lower low water [MLLW]) is high enough to cut off the beach lagoon from tidal exchange except when the berm is breached during large rainfall events when flows from the Bird Refuge pass through the weir and culverts and raise the water elevation in the beach lagoon (Attachment 5). The proposed replacement weir and water level control gate system will allow for more control of water levels within the Bird Refuge and connectivity between the lake and beach lagoon.

Tidal Information (Water Levels)

Tidal information (water levels) at the Bird Refuge was taken from National Oceanic and Atmospheric Administration (NOAA) Station No. 9411340 in Santa Barbara (Figure 1) (NOAA 2019). Table 1 shows benchmark tidal elevations for the station.

Table 1
Tidal Datums and Water Level Elevations at the Bird Refuge (Santa Barbara Station 9411340)[1]

Tidal Datum	Elevation Relative to MLLW at Gauge Location (feet)	NGVD29 (feet)	NAVD88 (feet)
Highest observed water level (12/13/2012)	7.6	4.9	7.5
Highest astronomical tide[2]	7.2	4.5	7.1
Mean higher high water	5.4	2.6	5.3
Mean high water	4.6	1.9	4.5
Mean sea level	2.8	0.0	2.7
National Geodetic Vertical Datum of 1929 (NGVD29)	2.8	0.0	2.7
Mean low water	1.0	-1.8	0.9
North American Datum of 1988 (NAVD88)	0.1	-2.7	0.0
Mean lower low water (MLLW)	0.0	-2.8	-0.1
Lowest astronomical tide[3]	-2.0	-4.8	-2.1

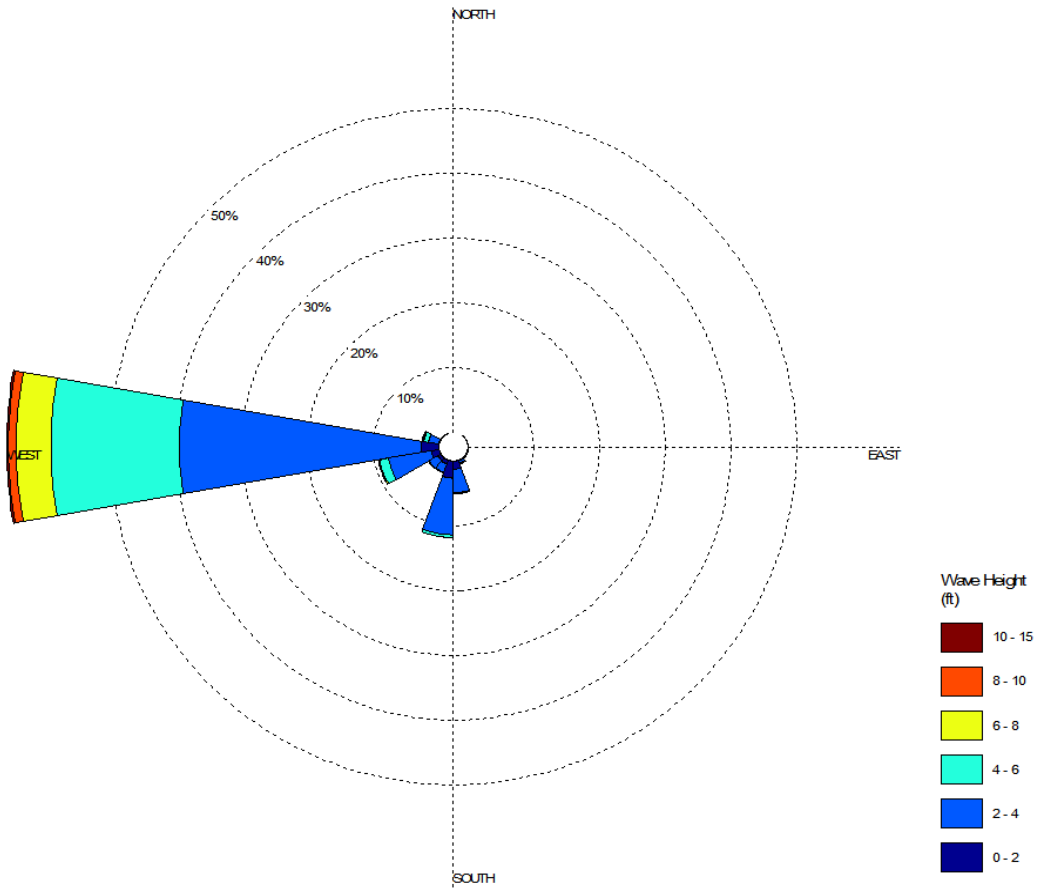
Notes:
1. The Santa Barbara station uses the Los Angeles Outer Harbor station (9410660) as a control station.
2. Highest astronomical tide is the elevation of the highest predicted astronomical tide expected to occur over the National Tidal Datum Epoch (1983 to 2001).
3. Lowest astronomical tide is the elevation of the lowest predicted astronomical tide expected to occur over the National Tidal Datum Epoch (1983 to 2001).

Wave Data

Ocean wave data were collected from two offshore buoy stations from NOAA's National Data Buoy Center: Anacapa Passage, California Buoy (Station 46217) and East Santa Barbara, California Buoy (Station 46053) (NOAA NDBC 2019). The Anacapa Passage buoy, located approximately 22 miles southeast of the Bird Refuge, provides data from 2008 through 2016. The longer-established East Santa Barbara buoy, located approximately 15 miles southwest of the Bird Refuge, provides data from 1994 through 2016. Wave roses of both sets of data are provided in Figures 2 and 3, respectively.

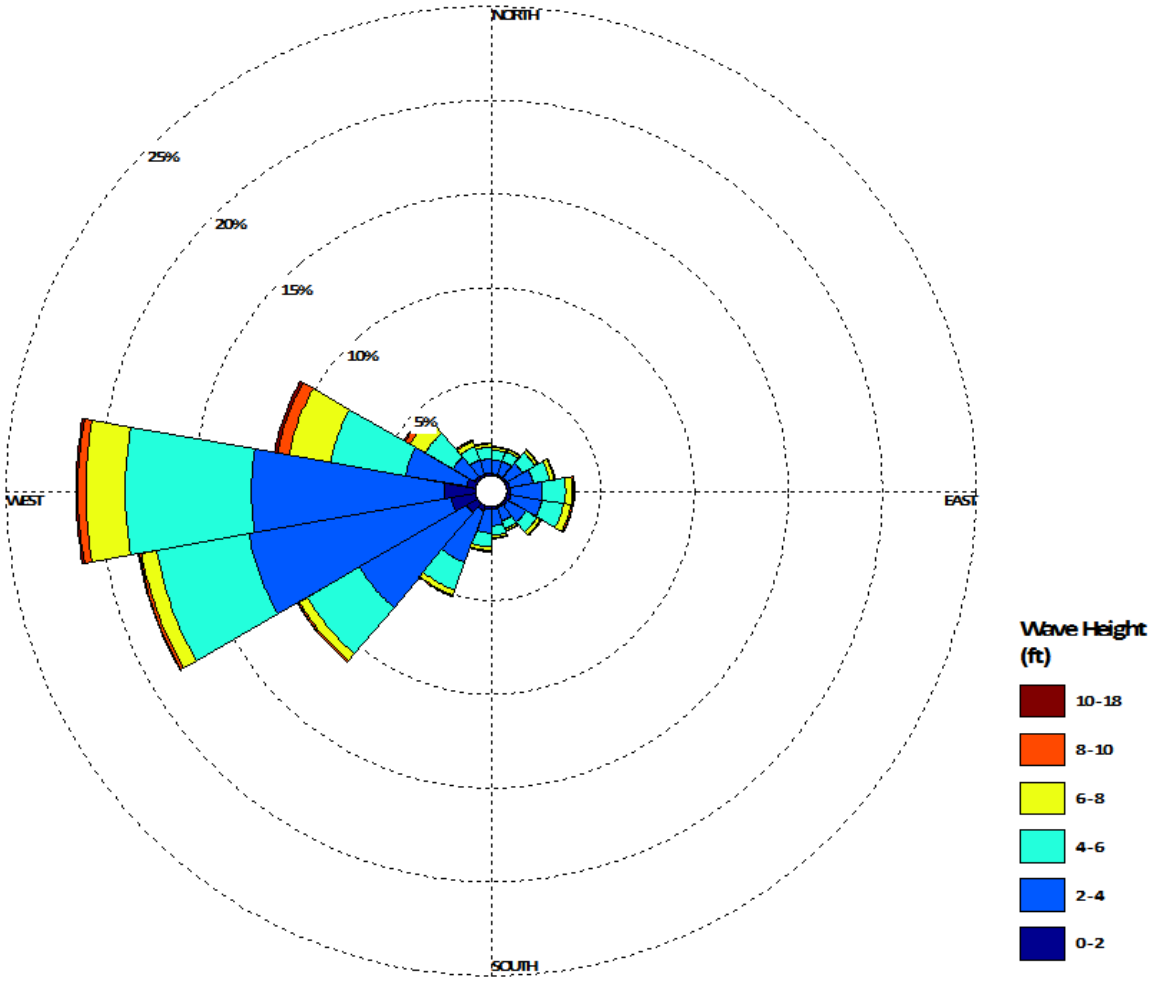
Waves from both buoys are predominately from the west, representing open ocean waves from the Pacific. Little to no waves are detected by the buoys from the northeast or east because of the orientation of the coastline and the fact that waves are primarily generated by storms in the Pacific Ocean or from typical coastal winds from the northwest to southwest (Figure 1).

Figure 2
Wave Height Distribution: Buoy Station 46217



Wave data from 2008 to 2016.

Figure 3
Wave Height Distribution: Buoy Station 46053



Wave data from 1994 to 2016.

Existing Coastal Hazards

Existing coastal hazards that can impact the Bird Refuge include extreme astronomical tides, storm surge (due to wind and wave setup during storms), and shoreline erosion (from waves and floods).

Extreme Tidal Levels

The highest astronomical tide at the Santa Barbara Station is 7.2 feet above MLLW (4.5 feet NGVD29), which is almost 2 feet above mean higher high water (MHHW). This tidal elevation can occur a few times per year. If the beach berm (approximately +8 feet NGVD29) is in place, the highest astronomical tides will not reach the beach lagoon or the lake. However, if the beach berm is breached, the highest astronomical tide elevation fully covers the culverts (invert of 1.4 feet NGVD29 with 3-foot diameters, putting the top of the culverts at 4.4 feet NGVD29) (Attachment 5). However, the highest astronomical tide elevation is below the existing weir crest elevation and proposed

closed water control gate crest elevation (4.9 feet NGVD29). With the water control gates open (elevation of 1.5 feet NGVD29), the highest astronomical tide would be 3 feet over the gate opening, assuming the beach berm elevation is low enough to allow the ocean tide to reach the beach lagoon

Extreme Waves

Wave data shown in Figures 2 and 3 for the directions of interest (east to southwest; clockwise) were used to estimate extreme deep-water ocean wave heights for return periods of 25, 50, 75, and 100 years. The results of the extreme value analysis are shown in Table 2. The wave heights in Table 2 represent open ocean waves at the East Santa Barbara buoy located approximately 15 miles offshore of East Beach in the Santa Barbara Channel. Nearshore wave heights experienced along the shoreline of East Beach during storms are much lower than these deep-water wave heights because the nearshore bathymetry causes the open ocean waves to refract, diffract, and break prior to reaching the shore.

Table 2
Extreme Deep-Water Waves at Santa Barbara Buoy (Station 46053)

Direction	Storm Return Year			
	25-Year Wave Height (feet)	50-Year Wave Height (feet)	75-Year Wave Height (feet)	100-Year Wave Height (feet)
91 to 120 degrees	14.6	14.9	15.1	15.2
121 to 150 degrees	14.0	14.4	14.5	14.6
151 to 180 degrees	16.7	17.5	18.0	18.2
181 to 210 degrees	15.5	16.1	16.3	16.4
211 to 240 degrees	16.6	17.2	17.5	17.7

Shoreline Erosion

The U.S. Geological Survey (USGS) Coastal Storm Modeling System (CoSMoS; Barnard et al. 2014) estimates the potential shoreline change resulting from erosion based on the following two storm events:

- January 2010 El Niño: A hindcast projection of the El Niño-fueled storm from January 18 to 25, 2010
- ARkStorm: A stitched-together storm based on two powerful West Coast storms that occurred in 1969 and 1986, representing a recurrence interval of at least 100 years

Based on the two storm events modeled with CoSMoS, the East Beach shoreline in the vicinity of the Bird Refuge could experience shoreline erosion ranging from 56 feet (ARkStorm) to 73 feet (January 2010 El Niño). The beach is approximately 375 feet wide from East Cabrillo Boulevard to the shoreline in the vicinity of the Bird Refuge. The existing natural beach berm at the mouth of the beach lagoon is approximately 250 feet wide from the MHHW line on the ocean side, to the same elevation on the lagoon side (Attachment 4). Therefore, the estimated 73 feet of erosion is not likely to breach the berm and allow the beach lagoon to connect to the ocean.

FEMA Storm Surge

The Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) for Santa Barbara includes offshore storm surge still water elevations for East Beach at the Bird Refuge (FEMA 2018). The FEMA offshore still water elevations represent the ocean surface elevation resulting from astronomical tides, storm surge, and freshwater inputs but excluding the effects of wave setup and wave runup.

The FEMA offshore still water elevations at the Bird Refuge are as follows[1]:

- 10% annual chance: 14.5 feet NAVD88 (14.6 feet MLLW; 11.9 feet NGVD29)
- 2% annual chance: 16 feet NAVD88 (16.1 feet MLLW; 13.4 feet NGVD29)
- 1% annual chance: 16.7 feet NAVD88 (16.8 feet MLLW; 14.1 feet NGVD29)
- 0.2% annual chance: 18.6 feet NAVD88 (18.7 feet MLLW; 15.3 feet NGVD29)

Summary

The design life of the proposed weir and water level control gates is approximately 50 years; therefore, existing (present-day) coastal hazards for the Bird Refuge are estimated using return period events similar in duration to the design life. The specific coastal hazards for this project are summarized in Table 3.

Table 3
Summary of Existing Coastal Hazards

Existing Coastal Hazard	Value
50-year significant deep-water wave height[1]	17.5 feet
Peak wave period	25 seconds[2]
Mean higher high water	5.4 feet MLLW (2.7 feet NGVD29)
Highest astronomical tide	7.2 feet MLLW (4.5 feet NGVD29)
FEMA 2% annual chance still water elevation (Pacific Ocean)	16.1 feet MLLW (13.3 feet NGVD29)
Storm shoreline erosion potential (January 2010 El Niño; CoSMoS)	73 feet of beach width

Notes:
1. Deep-water wave height from the Santa Barbara Channel Buoy (Station 46053).
2. The largest observed dominant wave period (period with the maximum wave energy) over the data period was used.

As shown in Table 3 and Attachment 5, the highest astronomical tide would not overtop the lake weir, but with the proposed gates open, the higher tides would be able to reach the lake, assuming that the natural beach berm is low enough to allow ocean water to reach the beach lagoon and the culverts beyond. The existing 50-year (2% annual chance) coastal still water elevation (13.3 feet NGVD29) is well above the elevation of the weir and gates and could also result in flooding of East Cabrillo Boulevard (approximately +9 feet NGVD29).

[1] Based on coastal transect 83 in the FIS

It should be noted that portions of the project area and East Cabrillo Boulevard experience temporary, localized flooding during large rain events under existing conditions.

Future Coastal Hazards

Future coastal hazards that may impact the Bird Refuge include the current coastal hazards identified in the previous section with the addition of increased ocean water elevations due to predicted SLR. SLR estimates for the Bird Refuge were taken from the CCC's *Sea Level Rise Policy Guidance* (2018) for Santa Barbara. The SLR guidance uses 2000 as the starting point and includes estimates from 2030 to 2150 for several risk levels; Table 4 presents estimates of SLR for years 2030 to 2100.

Uncertainties exist in estimates for SLR. One significant source of uncertainty is future greenhouse gas emissions. Researchers cannot know the amount or rate of greenhouse gas emissions that will be generated over the coming decades (CCC 2018); this affects climate change predictions. The CCC guidance uses a greenhouse gas concentration estimate of Representative Concentration Pathway (RCP) 8.5.

The CCC guidance also recommends which SLR risk aversion scenario to use in planning and permitting various types of projects. The scenarios are as follows:

- Low risk aversion: the upper value for the "likely range" of SLR, which has approximately a 17% chance of being exceeded; may be used for projects that would have limited consequences or a higher ability to adapt to SLR
- Medium-high risk aversion: the 1-in-200 chance (or 0.5% probability of exceedance); should be used for projects with greater consequences and/or a low ability to adapt to SLR
- Extreme risk aversion: accounts for the extreme ice loss scenario (which does not have an associated probability at this time); should be used for projects with little to no adaptive capacity that would be irreversibly destroyed or significantly costly to repair and/or would have considerable public health, public safety, or environmental impacts should that level of SLR occur

The proposed project entails native habitat restoration, dune restoration, wetland creation, public access improvements on the north side of the Bird Refuge, and replacement of an existing weir and non-functional water level control gate with larger gates. This project does not include a residence or habitable building or critical infrastructure that would affect public health and safety. The project has the ability to be adapted in the future if necessary to address SLR. Thus, a low risk aversion scenario is appropriate for this analysis. Due to the proximity of the project to East Cabrillo Boulevard, the City has elected to take a more conservative approach and use the medium-high risk aversion scenario for this analysis.

Table 4
Sea Level Rise Projections for the Santa Barbara Tide Gauge

Year	Low Risk Aversion	Medium-High Risk Aversion	Extreme Risk Aversion
2030	0.4	0.7	1.0
2040	0.7	1.1	1.6
2050	1.0	1.8	2.5
2060	1.3	2.5	3.6
2070	1.7	**3.3***	4.9
2080	2.1	4.3	6.3
2090	2.6	5.3	7.9
2100	3.1	6.6	9.8

Note:
* An SLR of 3.3 feet will be used for the future coastal hazards analysis to account for the 50-year design life and medium-high risk aversion the City has elected to use for this project.

The time frame used to evaluate impacts to the Bird Refuge due to predicted SLR is based on the design life of the proposed weir and gate structures (CCC 2018), which is estimated to be 50 years. If the restoration is completed in 2020, as planned, then sea level estimates for 2070 should be used for the future coastal hazards evaluation. SLR projections for 2100 are also included for reference, though there is a greater uncertainty associated with such long-term projections.

The SLR projection in Table 4 was added to the projected tidal elevations from Table 1 to estimate future conditions. The projected tidal elevations at the Bird Refuge based on low and medium-high risk aversion SLR estimates for 2070 and 2100 are summarized in Tables 5a and 5b.

Table 5a
Potential Future Tidal Datums at the Bird Refuge: Low Risk Aversion

	MLLW			NGVD29		
Tidal Datum	Current Conditions[1]	2070 Low Risk Aversion SLR Water Levels	2100 Low Risk Aversion SLR Water Levels	Current Conditions[1]	2070 Low Risk Aversion SLR Water Levels	2100 Low Risk Aversion SLR Water Levels
Highest astronomical tide	7.2	8.9	10.2	4.5	6.2	7.6
MHHW	5.4	7.1	8.5	2.6	4.3	5.7
Mean sea level	2.8	4.5	5.9	0	1.7	3.1
NAVD88	0.1	1.8	3.2	-2.7	-1.0	0.4
MLLW	0.0	1.7	3.1	-2.8	-1.1	0.3

Note:
1. Existing tidal datums are provided in Table 1.

Table 5b
Potential Future Tidal Datums at the Bird Refuge: Medium-High Risk Aversion

Tidal Datum	MLLW			NGVD29		
	Current Conditions[1]	2070 Medium-High Risk Aversion SLR Water Levels	2100 Medium-High Risk Aversion SLR Water Levels	Current Conditions[1]	2070 Medium-High Risk Aversion SLR Water Levels	2100 Medium-High Risk Aversion SLR Water Levels
Highest astronomical tide	7.2	10.5	13.8	4.5	7.8	11.1
MHHW	5.4	8.7	12.0	2.6	5.9	9.2
Mean sea level	2.8	6.1	9.4	0	3.3	6.6
NAVD88	0.1	3.4	6.7	-2.7	0.6	4.0
MLLW	0.0	3.3	6.6	-2.8	0.5	3.8

Note:
1. Existing tidal datums are provided in Table 1.

Future coastal hazards for the Bird Refuge combine current coastal hazards due to storm events (50-year return period) and increases in water level due to projected SLR. The 50-year wave height and period are considered to be the same for existing conditions and future conditions. Table 6 outlines the predicted future coastal hazards for the Bird Refuge.

Table 6
Summary of Future Coastal Hazards

Future Coastal Hazard	Value
50-year significant deep-water wave height[1]	17.5 feet
50-year peak wave period	25 seconds[2]
2070 mean higher high water	8.7 feet MLLW (6.0 feet NGVD29)
2070 highest astronomical tide	10.5 feet MLLW (7.8 feet NGVD29)
2070 FEMA 2% annual chance still water elevation (Pacific Ocean)	19.4 feet MLLW (16.6 feet NGVD29)
Storm shoreline erosion potential (January 2010 El Niño; CoSMoS)	73 feet

Notes:
1. Deep-water wave height from the Santa Barbara Channel Buoy (Station 46053).
2. The largest observed dominant wave period (period with the maximum wave energy) over the data period was used.

Coastal Storm Modeling System Predictions

Coastal Storm Modeling System (CoSMoS) makes predictions of potential coastal flooding resulting from coastal storms and SLR in coordination with long-term coastal changes over large geographic areas. The City requested that the CoSMoS-projected shoreline position and wave runup be presented for existing conditions as well as the years 2070 and 2100, assuming a projected SLR of 3.3 and 6.6 feet, respectively, under both storm and non-storm scenarios. Figure 4 illustrates the shoreline and wave runup from CoSMoS under these scenarios, including both 20- and 100-year storms.

LEGEND:

Wave Runup Scenarios

- No SLR, 20-Year Event
- No SLR, 100-Year Event
- 3.3 ft SLR, 20-Year Event
- 3.3 ft SLR, 100-Year Event
- 6.6 ft SLR, 20-Year Event
- 6.6 ft SLR, 100-Year Event

Shoreline Projections

- 3.3 ft SLR (No Nourishment)
- 6.6 ft SLR (No Nourishment)

NOTES:

1. Horizontal datum is CA State Plane III, NAD83, U.S. Feet.
2. Shoreline and wave runup data acquired from Coastal Storm Modeling System (CoSMos) for Southern California, v3.0, Phase 2 at https://www.sciencebase.gov.
3. Aerial image acquired from Google Earth Pro, v7.3.2.5776. Image date is April 12, 2018.

ABBREVIATIONS:

ft - Feet
SLR - Sea Level Rise

0 200
Feet

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Figure 4
CoSMos Shoreline and Wave Runup Projections
Coastal Hazards Analysis
Andrée Clark Bird Refuge

Data provided through CoSMoS are intended as a quick reference tool and may not accurately reflect site-specific conditions at a project level. CoSMoS predicts that the shoreline and wave runup will extend landward over time as the sea level rises. The extent of shoreline change and wave runup depicted in Figure 4 assume that no adaptive measures such as beach nourishment are implemented and do not reflect the detailed topography of the area, such as coastal bluffs.

Summary of Potential Impacts

Based on best available estimates for the region (CCC 2018), sea levels at the Bird Refuge are expected to increase 3.3 feet by 2070, for the medium-high risk aversion scenario.

For the SLR predictions for 2070 under the medium-high risk aversion scenario (increase of 3.3 feet), the predicted MHHW elevation will be 5.9 feet NGVD29, which is 1.1 feet above the proposed closed water level control gate crest (4.8 feet NGVD29), and 4.4 feet above the proposed open gate elevation (1.5 feet NGVD29). During the highest astronomical tides, which could occur a few times per year, the water elevation could reach 7.8 feet NGVD29, which is 3 feet above the proposed closed water level control gate crest, and 6.3 feet above the proposed open gate elevation. The FEMA 2% annual chance coastal still water elevation in 2070 (+16.6 feet NGVD29) is well above the control gate, and over East Cabrillo Boulevard (+9 feet NGVD29) and East Beach, similar to the existing conditions.

For the low-risk aversion SLR predictions for 2070 (increase of 1.7 feet), the predicted MHHW elevation will be 4.3 feet NGVD29, which is 0.5 foot below the proposed closed water level control gate crest (4.8 feet NGVD29), and 2.8 feet above the proposed open gate elevation (1.5 feet NGVD29). During the highest astronomical tides, which could occur a few times per year, the water elevation could reach 6.2 feet NGVD29, which is 1.4 feet above the proposed closed water level control gate crest, and 4.7 feet above the proposed open gate elevation. The FEMA 2% annual chance coastal still water elevation in 2070 (+15 feet NGVD29) is well above the control gate, and over East Cabrillo Boulevard (+9 feet NGVD29) and East Beach, similar to the existing conditions.

However, all the predicted 2070 water levels are below the current natural beach berm elevation (+8 feet NGVD29), and, therefore, would not reach the beach lagoon or into the culverts and beyond into the lake unless the berm is breached. Assuming the berm is breached, while the extreme tides will overtop the proposed gate and weir elevation, the connectivity between the lake and the ocean will be controllable below 4.8 feet NGVD29 in 2070 under the medium-high risk aversion scenario, and below MHHW in 2070 (4.3 feet NGVD29) under the low-risk aversion scenario, with the water level control gates and weir. Based on the FEMA FIS, extreme storm events (now and in the future) are expected to result in localized flooding of East Cabrillo Boulevard in the vicinity of the Bird Refuge. While the proposed restoration is not likely to eliminate this possibility, there is potential for localized flooding to be reduced. The proposed weir and water level control gates will provide greater conveyance of water flowing out of the Bird Refuge and increased and more reliable control of flows because there will be multiple adjustable water level control gates. The proposed debris rack

structure will be less prone to clogging compared to the existing structure and will be easier to maintain and clear of debris. The proposed weir also includes increased grating to allow high water levels within the lake that overtop the weir and control gates to flow into the culverts under the road rather than flowing over the road. The existing weir has a relatively small opening and a non-functional gate, which limit conveyance of water from the lake. In addition, the opening of the existing weir is prone to clogging with debris and vegetation during large rainstorms, which contributes to localized flooding of East Cabrillo Boulevard.

USGS's CoSMoS estimates the potential storm erosion for East Beach in the vicinity of the Bird Refuge to range from 56 to 73 feet. The beach is approximately 375 feet wide at the project location. As mentioned previously, the beach berm at the Bird Refuge is approximately 250 feet wide, so a loss of 73 feet of shoreline would not breach the berm or allow the beach lagoon to connect with the ocean. The potential shoreline loss due to medium-high risk SLR is shown in Figure 4: 1 meter (3.3 feet) for 2070 and 2 meters (6.6 feet) for 2100. Storm erosion (56 to 73 feet) in addition to the SLR shoreline retreat is likely to connect the ocean to the beach lagoon. The proposed restoration of vegetated dunes on both sides of the beach lagoon will create valuable native habitat and provide increased protection of the beach and existing infrastructure during storm events and increase resilience to SLR compared to the existing beach.

Similar potential future coastal impacts would apply to adjacent shorelines (outside the project area) and are independent of the proposed project at the Bird Refuge. The proposed project would not increase the risk of coastal hazards to the project site or adjacent areas.

Under existing conditions, portions of the project area and East Cabrillo Boulevard experience temporary, localized flooding during large rain events. In the near term, this flooding presents a greater and more frequent hazard to East Cabrillo Boulevard than projected SLR over the next 50 years. The proposed weir and water level control gates will improve the conveyance of water through the Bird Refuge under East Cabrillo Boulevard compared to the existing structure. The improved conveyance combined with operational measures implemented by the City, such as lowering the beach berm and opening the gates prior to large rainfall events, will help the City reduce localized flooding of East Cabrillo Boulevard in the project area.

Coastal Land Use Plan Policy 5.1-64 Shoreline Hazard Evaluation

The project site is located within Potential Shoreline Hazards Screening Area 1 (City-owned low-lying beach and backshore areas). New development and substantial redevelopment in this area are subject to evaluation of shoreline hazards by the City. The shoreline hazard evaluation is as follows.

A. *The profile of the beach*

   The proposed project includes restoration of sand dunes vegetated with native plant species. The dunes will provide native habitat and the vegetation will help to stabilize the sand on the upper portion of the beach.

B. *Mean high tide line, including a mean high tide line survey (unless data shows the mean high tide line will not be affected by the project)*

The mean high tide line will not be affected by the proposed project. The proposed project activities on the beach include dune restoration on the upper portion of the beach.

C. *The area of the project site subject to beach erosion, coastal flooding, and wave impact hazards*

The majority of the project site is north of East Cabrillo Boulevard and not subject to beach erosion. The project area is typically not subject to coastal flooding and wave impacts because it is separated from the ocean by a wide beach and East Cabrillo Boulevard. The majority of the project elements are restoration of native vegetation, so this coastal hazards analysis focuses on replacement of the existing weir and gate, which affect flow of water from the Bird Refuge Lake. The portion of the weir and gate to be replaced are north of East Cabrillo Boulevard and are not expected to be affected by beach erosion, coastal flooding, or wave impact for the expected design life of the structures. In addition, dunes are being restored with native vegetation on East Beach. While portions of the dunes may be impacted by coastal hazards, the dunes overall will serve as a "soft" approach to limit shoreline erosion; they also may help to make the beach more resilient and protect the beach and East Cabrillo Boulevard from erosion, coastal flooding, and wave impact hazards.

D. *The FEMA Base Flood Elevation and mapped areas*

The FEMA 2% annual chance coastal still water elevation in 2070 (+15 feet NGVD29) is well above the control gate, and over East Cabrillo Boulevard (+9 feet NGVD29) and East Beach, similar to the existing conditions.

E. *Future projections in SLR, associated beach erosion, coastal flooding, and wave impacts, and any additional SLR-related impacts that could be expected to occur over the life of the project in both storm (100-year storm) and non-storm scenarios. The analysis will utilize best available science and include, at a minimum, evaluation of projected SLR at a high emission scenario based on state guidance.*

Tables 4 through 6 summarize project SLR and beach erosion, and Figure 4 shows project shorelines and wave runup under both storm and non-storm conditions in the years 2070 and 2100 using the CCC's medium-high SLR projections.

F. *Design requirements to assure stability and structural integrity*

The replacement weir and gate structures are designed to provide stability and structural integrity in accordance with standard structural engineering standards. The replacement structures are on the north side of East Cabrillo Boulevard. The structural integrity of the replacement weir and gates will not be threatened by beach erosion, coastal flooding, or wave impacts during their estimated 50-year design life. The existing culverts under the

roadway will not be replaced and the roadway itself will not be affected by the proposed project.

G. *The need for a shoreline protection device over the life of the project*

It is anticipated that shoreline protective devices will not be required for the replacement weir and gates or native habitat restored as part of the project over the design life of the weir and gates.

H. *The long-term impacts of proposed development on sand supply*

The proposed project will not affect sand supply.

I. *The impacts of the proposed development during construction and operation on beach erosion, coastal flooding, wave impacts, and any other hazards on or near the site*

Construction of the proposed project will not affect beach erosion, coastal flooding, wave impacts, or other coastal hazards. The duration of construction will be short, and the City proposes to construct the project during the dry season to the extent feasible. Operation of the proposed weir and gates will reduce coastal flooding by providing greater capacity to drain water from the Bird Refuge and reducing the likelihood of the weir becoming clogged with debris during rain events.

J. *The impacts of proposed development on public access to and along the shoreline;*

The proposed project will not affect public access to and along the shoreline. The proposed replacement weir and gate structures are located north of East Cabrillo Boulevard and are currently not accessible to the public, and will not be accessible in the future.

K. *Any necessary mitigation measures, alternatives, or monitoring protocols to be completed over the life of the development and that are needed to avoid or minimize any potential beach erosion, coastal flooding, wave impacts hazards, and any potential impacts to public access to and along the shoreline*

The proposed project will not result in increased beach erosion, coastal flooding, wave impact hazards, or public access to and along the shoreline so mitigation measures, alternatives, and monitoring are not required. The proposed project is intended to restore native habitat and improve the overall quality of the Bird Refuge.

L. *A statement verifying whether the development will minimize risks to life and property; assure stability and structural integrity; and neither create nor contribute significantly to erosion,*

geologic instability, or destruction of the site or surrounding area over its expected life, factoring in the effects of sea level rise

The proposed project is being designed to minimize risks to life and property; assure stability and structural integrity; and neither create nor contribute significantly to erosion, geologic instability, or destruction of the site or surrounding area over its expected life, factoring in the effects of SLR.

References

Barnard, P.L., M. van Ormondt, L.H. Erikson, J. Eshleman, C. Hapke, P. Ruggiero, P.N., Adams, and A. Foxgrover, 2014. Coastal Storm Modeling System: CoSMoS. Southern California 1.0, Projected Flooding Hazards. DOI: 10.5066/F74B2ZB4. Available at: http://walrus.wr.usgs.gov/coastal_processes/cosmos/socal1.0/.

CCC (California Coastal Commission), 2018. *Sea Level Rise Policy Guidance. Interpretive Guidelines for Addressing Sea Level Rise in Local Coastal Programs and Coastal Development Permits*. Science Update adopted November 2018.

FEMA (Federal Emergency Management Agency), 2018. FEMA Flood Insurance Rate Map Panel 1391 to 1835. Map Number 06083C1391J. September 28, 2018.

NOAA (National Oceanic and Atmospheric Administration), 2019. Tides and Currents. Accessed May 2019. Available at: https://tidesandcurrents.noaa.gov/datums.html?id=9411340.

NOAA NDBC (National Data Buoy Center), 2019. National Data Buoy Center. Available at: http://www.ndbc.noaa.gov.

Attachment 1
Site Plan

EXISTING STORM DRAIN CHANNEL
PROPOSED VEGETATED BIO-RETENTION BASIN (SEE DRAWING C-2.4)
OLD COAST HWY
MUNICIPAL TENNIS COURTS
STATE HIGHWAY 101
RAILROAD
EXISTING PLATFORM/DOCK
017-010-079
PROPOSED WOODEN POST AND ROPE BARRIER ALONG EXISTING PATHWAY
017-391-001
017-391-002
EXISTING PARKING AREA
017-391-003
LOS PATOS WAY
017-391-008
EXISTING FOOTBRIDGE
EXISTING LAKE INLET FROM HWY 101 CULVERT
PROPOSED EXCLUSION FENCE
NORTH SHORELINE AREA
PROPOSED INTERPRETIVE SIGN LOCATION
EXISTING PLATFORM/DOCK
PROPOSED HABITAT BOULDER (TYPICAL)
017-382-001
EXISTING PLATFORM/DOCK
ISLAND
ISLAND
ISLAND
SOUTH SHORELINE AREA
PROPOSED COIR LOG (TYP.)
HIGH WATER ELEVATION (4.88' NGVD29)
E CABRILLO BLVD
017-392-001
009-270-001
SANTA BARBARA ZOO
017-382-002
017-383-002
WEST SHORELINE AREA
OUTLET STRUCTURE (SEE DRAWING C-2.3)
E CABRILLO BLVD
BACKDUNE
BEACH DUNE OUTLET CHANNEL FROM LAGOON
MHHW
BEACH LAGOON AREA
FOREDUNE
VOLLEYBALL COURTS

1. HORIZONTAL DATUM: CALIFORNIA STATE PLANE ZONE V, NORTH AMERICAN DATUM (NAD83), U.S. SURVEY FEET
2. VERTICAL DATUM: NATIONAL GEODETIC VERTICAL DATUM OF 1929, FEET.
3. REFER TO EXISTING CONDITIONS PLANS (SHEETS V-1.1 THROUGH V 1.9) FOR EXISTING CONDITION PLANS.
4. THIS PLAN (CS-1) PROVIDES A SITEWIDE OVERVIEW OF PROPOSED CONDITIONS. REFER TO GRADING AND CONSTRUCTION MATERIALS PLANS AND PLANTING PLANS FOR PROPOSED PLAN DETAILS.

LEGEND

- HIGH WATER ELEVATION (+4.88' NGVD29)
- MHHW
- LIMIT OF GRADING
- PARCEL BOUNDARY
- PROPOSED COIR LOG
- PROPOSED WOODEN POSTS AND ROPE BARRIER
- PROPOSED WOOD LATH SAND FENCE
- PROPOSED EXCLUSIONARY FENCE
- FRESHWATER MARSH
- SALT MARSH
- WILLOW SCRUB
- WOODLAND
- COASTAL SAGE SCRUB
- DUNE
- WILDFLOWER
- EXISTING TURF TO REMAIN
- PROPOSED HABITAT BOULDERS
- PROPOSED PERVIOUS PAVERS
- PROPOSED TREES
- EXISTING TREES TO BE RETAINED

0 0.5 1
SCALE: 1"=100'

811 Know what's below. Call before you dig.

PROJECT ENGINEER _____ DATE _____

PUBLIC WORKS DEPARTMENT
ENGINEERING DIVISION
APPROVED: _____ DATE _____
CITY ENGINEER _____ ORIGINAL SIGNED DATE _____

DESIGN EBP
DRAWN EBP
CHECKED MW
65 % DRAFT

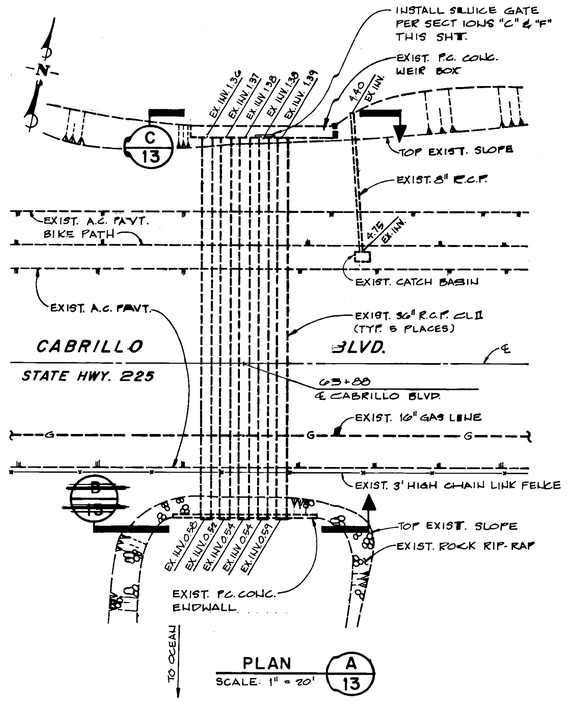
NO.	REVISIONS	DATE	APPROVED

ANDRÉE CLARK BIRD REFUGE
COASTAL RESTORATION
COMPOSITE SITE PLAN

PBW. NO. -
BID NO. - SHT. DES. -
DWG. NO. CS-1.0
SHT. 5 OF 53

K:\Projects\1214-City of Santa Barbara\Coastal Design\Construction Plans\G03_CS01 ACBR.dwg; 12/20/2019 3:18 PM; Erik Pipkin

Attachment 2
Existing Weir Design Drawings



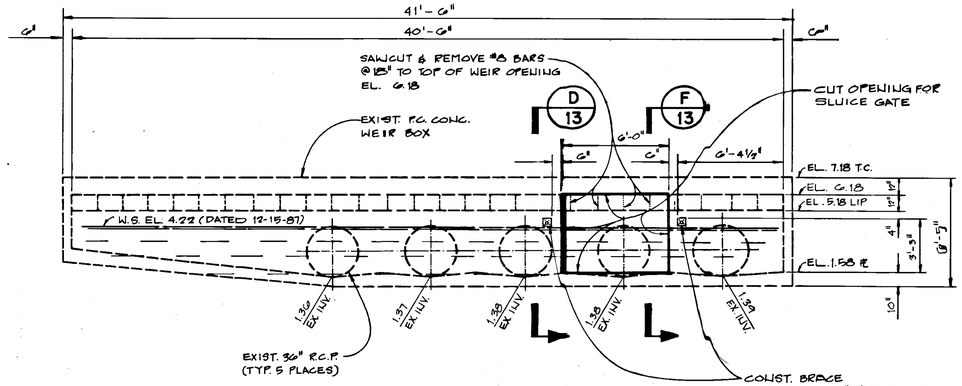
PLAN (A 13)
SCALE: 1" = 20'

TOPOGRAPHY BY:

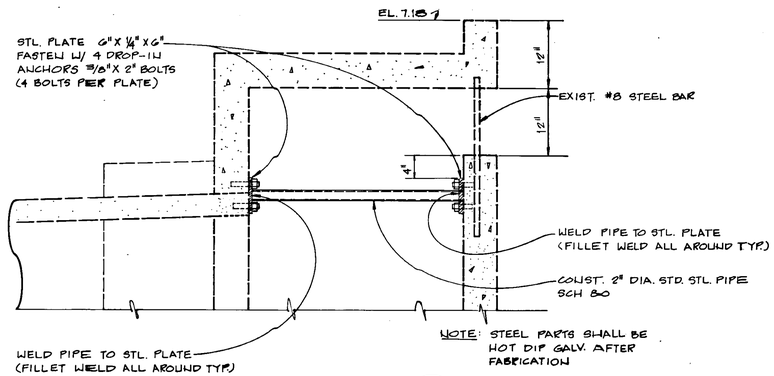
PENFIELD & SMITH FIELD SURVEY
DATED 1-13-87.

BENCHMARK:

3½" BC IN R.R. BRIDGE "A-609 1942"
LOS PATOS WAY EL. 27.37
U.S.C & G.S. MEAN SEA LEVEL DATUM
ADJUSTMENT OF 1929.

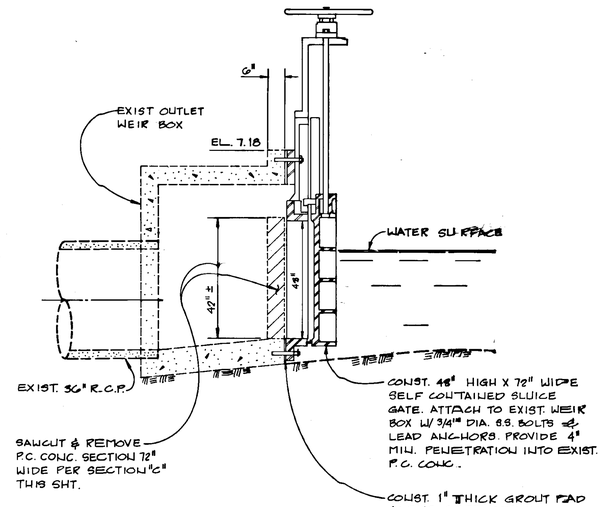


SECTION (C 13)
WEIR FACE
SCALE: ¼" = 1'-0"

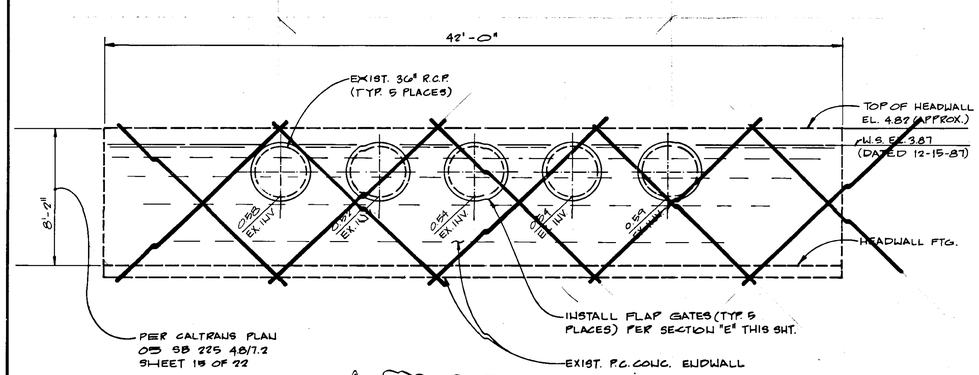


NOTE: STEEL PARTS SHALL BE HOT DIP GALV. AFTER FABRICATION

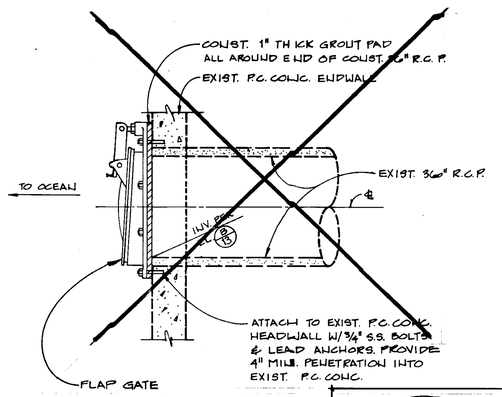
SECTION (D 13)
SCALE: 1" = 1'-0"



SECTION (F 13)
SLUICE GATE
SCALE: ½" = 1'-0"



1 DELETE
~~ELEVATION~~ (B 13)
~~AT OUTLET~~
~~SCALE: ¼" = 1'-0"~~



1 DELETE
~~SECTION~~ (E 13)
~~FLAP GATE~~
~~SCALE: ½" = 1'-0~~

NOTES

1. CONTRACTOR SHALL DRAIN PONDED WATER AT ENDWALL BY GRADING OUTLET CHANNEL TO OCEAN.
2. ALL BOLTS SHALL BE STAINLESS STEEL TYPE 316.
3. BOLTS SHALL BE SECURED TO EXIST. R.C. CONC. WITH DROP-IN LEAD ANCHOR SHIELDS.
4. CONTRACTOR SHALL FIELD VERIFY ALL DIMENSIONS PRIOR TO CONSTRUCTION & FABRICATION.
5. FLAP GATES AND SLUICE GATE SHALL BE APPROVED BY THE CITY.

REGISTERED LANDSCAPE ARCHITECT — BILLY GOODNICK — 2853 — 3/31/89 — STATE OF CALIFORNIA

FOR REVISIONS ONLY

ANDREE CLARK BIRD REFUGE
ENHANCEMENT PROGRAM
IMPROVEMENTS TO OUTLET WEIR • PLAN & SECTIONS
CONSTRUCTION and GRADING PLAN

NORTH

MAY 1988

NO.	DESCRIPTION	DATE	APPROVED
1	Deleted flap gates	5/31/89	JWD

REVISIONS

DESIGN C. A. S.
DRAWN W. S. K.
CHECK ED
FLD. BK. NO.
PAGE
ATLAS

URS CORPORATION
1421 CHAPALA
SANTA BARBARA, CALIFORNIA 93101
TEL: (805) 966 0811

Craig A. Steward R.C.E. 37285 DATE 12-22-88
REGISTERED PROFESSIONAL ENGINEER — CRAIG A. STEWARD — No. 37285 — CIVIL — STATE OF CALIFORNIA
Penfield & Smith
ENGINEERS INC.
111 EAST VICTORIA STREET
POST OFFICE BOX 789 • SANTA BARBARA, CA 93102
TEL. 805-963-9532
W.O. 8519 (28-00)

GEORGE W. GIRVIN ASSOCIATES
LANDSCAPE ARCHITECTURE
Park Planning • Urban Design • Land Planning • CA Lic. #1620
1629 Fifth Avenue, San Rafael, California 94901-1828
Telephone (415) 459-3 443

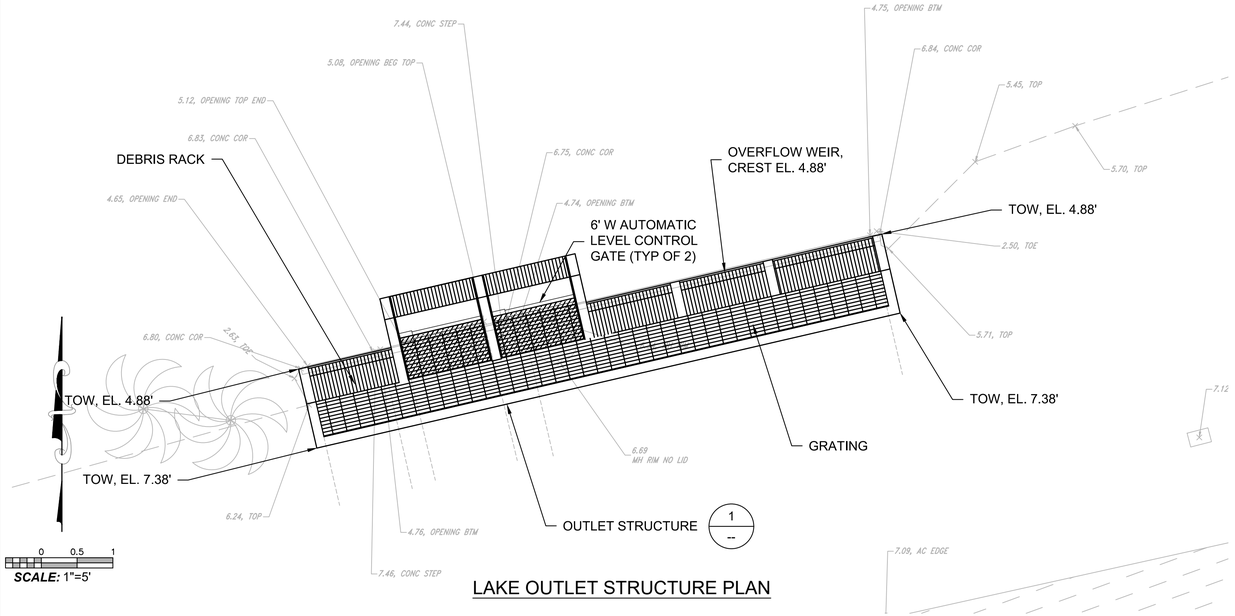
CITY OF SANTA BARBARA
PUBLIC WORKS DEPARTMENT - ENGINEERING DIVISION
REVIEWED
JWD — CITY ENGINEER — DATE 12-22, 19 88

SCALE AS NOTED

PROJ. NO. 6901
SHT. 13 OF 19 SHTS.
DWG. NO. L-10

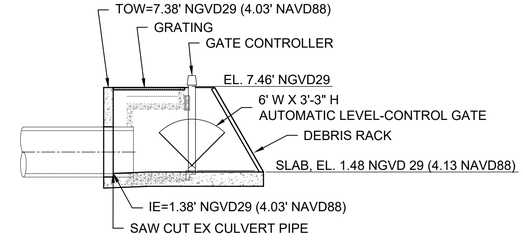
CITY DWG. No. C-3-609

Attachment 3
Proposed Weir and Water Level Control Gate Design

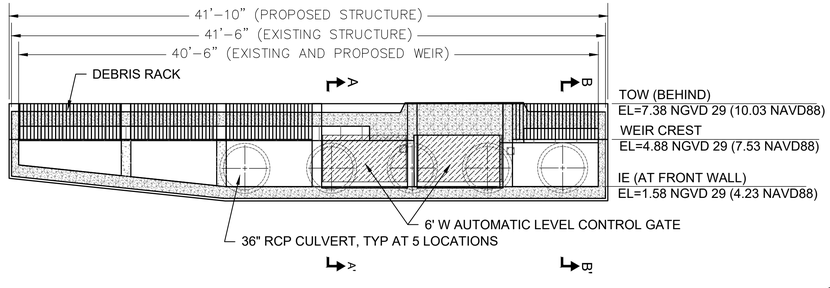


LAKE OUTLET STRUCTURE PLAN

DETAIL 1: LAKE OUTLET STRUCTURE PLAN
SCALE: 1"=5'



B
--
CROSS-SECTION: LAKE OUTLET STRUCTURE
SCALE: 1" = 5'



A
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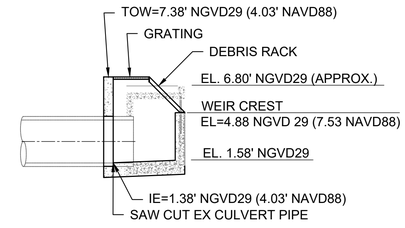
CROSS-SECTION: LAKE OUTLET STRUCTURE
SCALE: 1" = 5'



C
--
CROSS-SECTION: LAKE OUTLET STRUCTURE
SCALE: 1" = 5'

Know what's **below.**
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PROPERTY LINES
ARE APPROXIMATE

PROJECT ENGINEER DATE

CITY OF SANTA BARBARA
CALIFORNIA

ANCHOR QEA

PUBLIC WORKS
DEPARTMENT
ENGINEERING DIVISION

APPROVED: CITY ENGINEER DATE
ORIGINAL SIGNED DATE

DESIGN EBP
DRAWN TPG
CHECKED PCH

35 % DRAFT

NO.	REVISIONS	DATE	APPROVED

ANDRÉE CLARK BIRD REFUGE

COASTAL RESTORATION
OUTLET STRUCT. PLAN AND SECTIONS

PBW. NO. -
BID NO. - SHT. DES. -
DWG. NO. S-1
SHT. 27 OF 38

K:\Projects\1214-City of Santa Barbara\Coastal Design\Construction Plans\S01-S02 ACBR.dwg; 6/28/2019 12:43 PM; Erik Pipkin

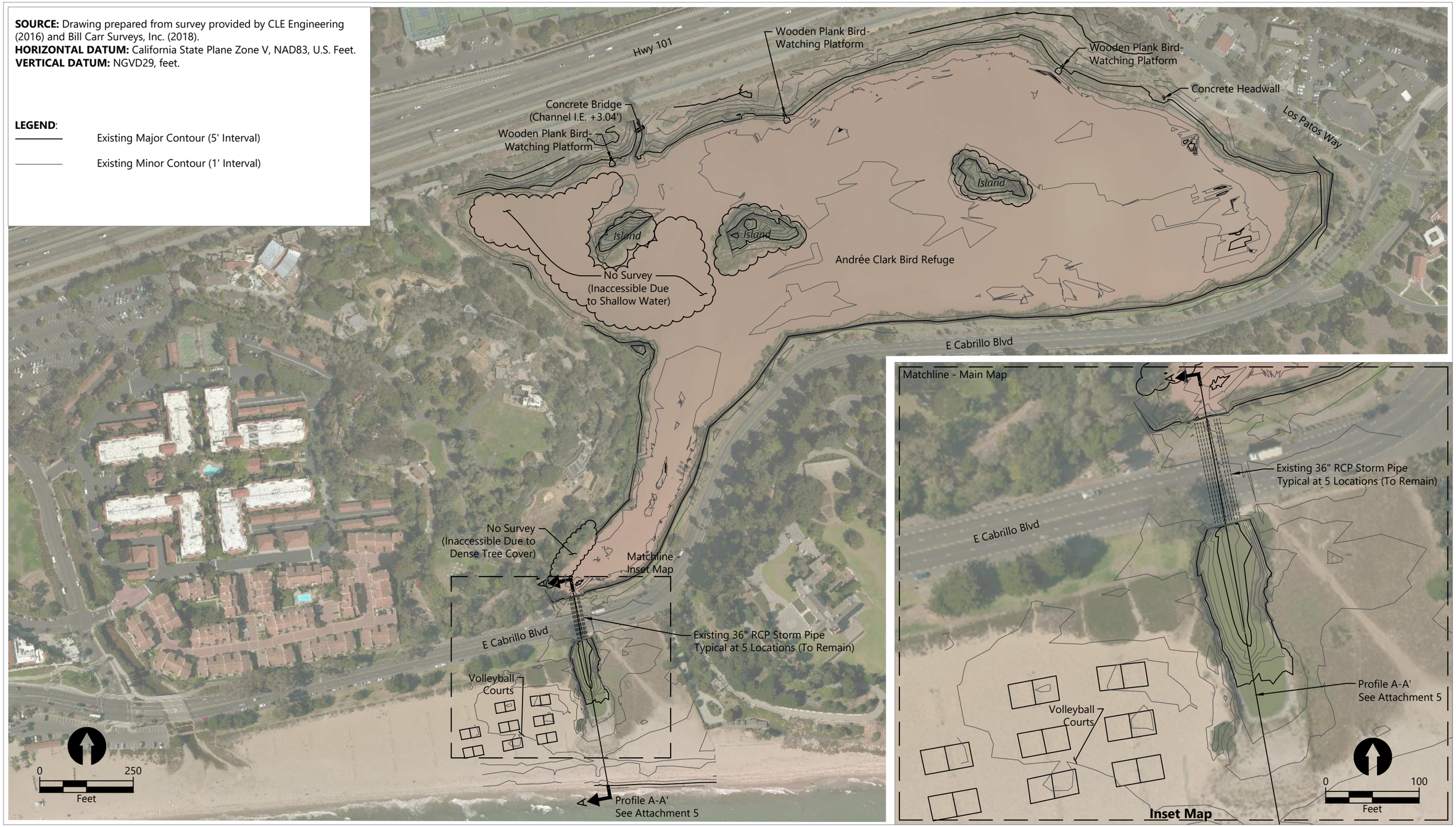
Attachment 4
Existing Conditions Plan

SOURCE: Drawing prepared from survey provided by CLE Engineering (2016) and Bill Carr Surveys, Inc. (2018).
HORIZONTAL DATUM: California State Plane Zone V, NAD83, U.S. Feet.
VERTICAL DATUM: NGVD29, feet.

LEGEND:

——— Existing Major Contour (5' Interval)

——— Existing Minor Contour (1' Interval)



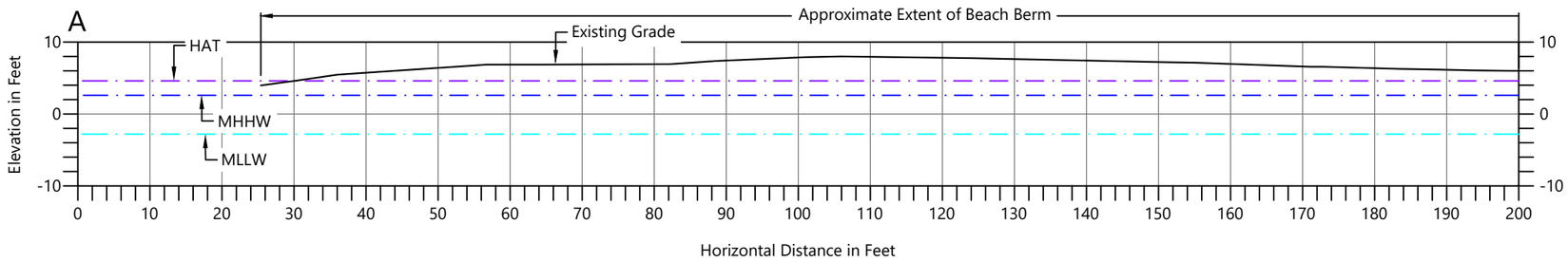
Publish Date: 2019/09/26 1:40 PM | User: epipkin
Filepath: K:\Projects\1214-City of Santa Barbara\Coastal Design\1214-PL-01-Coastal Existing Base.dwg Existing Conditions Plan

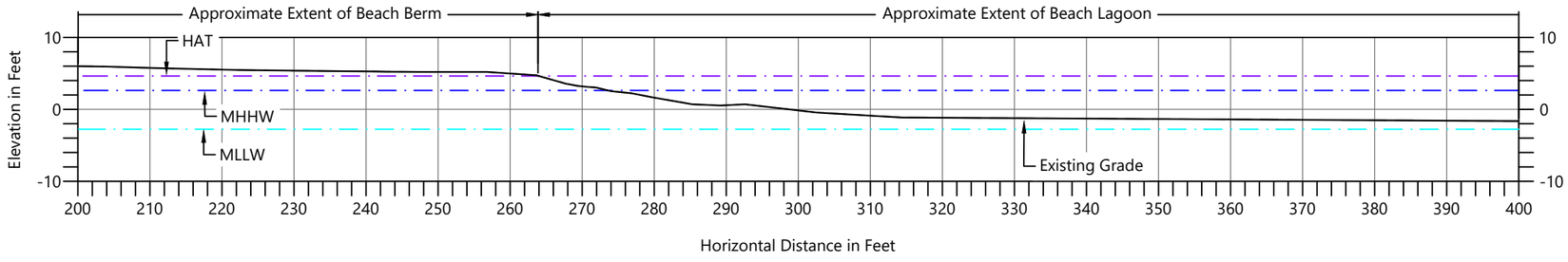
ANCHOR QEA

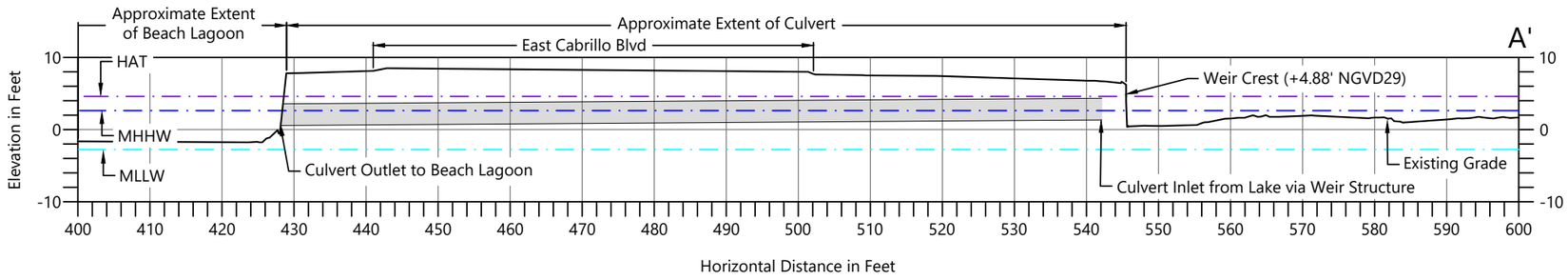
Attachment 4
Existing Conditions Plan

Andrée Clark Water Quality and Habitat Improvement Project

Attachment 5
Existing Conditions Profile A-A′







SOURCE: Drawing prepared from survey provided by CLE Engineering (2016) and Bill Carr Surveys, Inc. (2018).
HORIZONTAL DATUM: California State Plane Zone V, NAD83, U.S. Feet.
VERTICAL DATUM: NGVD29, Feet.

NOTE: Culvert drawn based on City of Santa Barbara Drawing C-3-609.

LEGEND:

- Existing Grade
- Highest Astronomical Tide (+4.5' NGVD29/+7.2' MLLW)
- Mean Higher High Water (+2.6' NGVD29/+5.4' MLLW)
- Mean Lower Low Water (-2.8' NGVD/0' MLLW)
- Culvert

0 20
Feet

Publish Date: 2019/09/26 9:26 AM | User: epipkin
Filepath: K:\Projects\1214-City of Santa Barbara\Coastal Design\1214-PL-01-Coastal Channel Profiles.dwg Existing Conditions Profile A-A'

ANCHOR QEA

Attachment 5
Existing Conditions Profile A-A'

Andrée Clark Water Quality and Habitat Improvement Project