Final

SURFER'S BEACH PILOT RESTORATION PROJECT

Preliminary Design Report

Prepared for
San Mateo County Harbor District

June 2021

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1 INTRODUCTION

This report describes the preliminary engineering design of the Surfer's Beach Pilot Restoration Project (project), including 30%-complete plans and a preliminary estimate of probable construction costs. Through this work, ESA is supporting the San Mateo County Harbor District (District) as part of a long-term effort to address sediment management challenges at Pillar Point Harbor and erosion at Surfer's Beach. ESA is the Project Engineer for the project, leading the preparation of concept design through final construction plans, specifications and cost estimates, working closely with the Project Manager Brad Damitz, who is leading permitting and environmental review for the project. This report provides information on the project completed to a level of detail that is sufficient to inform the regulatory agency permitting processes, develop a project description for environmental review, and as a basis for initiating the final design process.

1.1 Background

Surfer's Beach is a popular beach and recreation area located on the San Mateo County coast, just south of Pillar Point Harbor (PPH), immediately north of the City of Half Moon Bay, and west of the unincorporated community of El Granada (Figure 1).

SOURCE: USGS

Surfer's Beach Pilot Restoration Project

Figure 1
Project location and vicinity

Since construction of the PPH breakwater in 1961 by the U.S. Army Corps of Engineers (USACE), Surfer's Beach has experienced a significant amount of beach and bluff erosion, leading to a recent permanent loss of sandy intertidal beach area and bluff-top coastal scrub and grassland, as well as an increased exposure of California State Route 1 (Highway 1 or SR 1) to erosion and flood hazards during coastal storms (Figure 2). While the shore at Surfer's Beach eroded, significant accretion and deposition of sediment inside PPH has resulted in impacts on navigation and use of the boat launch ramp (Figure 3). Historically, sediment was managed in the PPH East Basin by dredging and disposal of dredge spoils offshore. However, this practice became unfavorable from environmental and economic perspectives after designation of the Monterey Bay National Marine Sanctuary (MBNMS) in 1992. The MBNMS regulations do not allow disposal of dredge material outside of permitted designated disposal areas. These changes contributed to the District conducting less frequent maintenance dredging in the harbor and disposal of dredged material (predominantly sand) at feasible upland locations. As subtidal areas in PPH filled in, eelgrass beds established and spread to areas where the depths were conducive to their growth. Growth and expansion of the eelgrass beds has added another constraint to harbor maintenance dredging, as eelgrass habitat is protected by federal and state law, and impacts would require mitigation.

Surfer's Beach Pilot Restoration Project

Figure 2
Photograph of Surfer's Beach on January 13, 2021 at low tide, showing Highway 1 at left with rock revetment, eroded beach and exposed rocks

Surfer's Beach Pilot Restoration Project

Figure 3
Photograph showing significant accumulation of sand adjacent to boat launch ramp in foreground and along the East Breakwater in background (1/13/21)

The erosion at Surfer's Beach and the impacts of sand shoaling (i.e., accretion) inside the harbor generated significant interest and concern of local community members. In addition to general beach recreation, Surfer's Beach is a very popular surf spot for surfers of all levels of experience, and in particular beginners because of its sheltered location (Figure 4). The surf break at Surfer's Beach is characterized by wave "peaks" that are formed by incident waves crossing waves reflected off the East Breakwater. However, the increased extents of exposed rock revetment along the shore and loss of beach has also increased the amount of "backwash" or wave reflections directed seaward, which tends to degrade the surf quality. The loss of the sandy beach has exposed a greater amount of imported quarry stone, which poses a hazard to surfers and water users.

While the Surfer's Beach area has eroded, areas immediately inside the harbor have significantly shoaled, which often results in the temporary closure of one or more of the boat launch ramps until the material is dredged and moved elsewhere. The loss of active boat launch ramps significantly reduces the ability of recreational boats to be launched, which in turn reduces fees collected by the District. Community members have voiced concerns at this situation and support the ideas of implementing a sensible solution where the sand that has accumulated in the harbor is used to nourish the beach at Surfer's Beach.

Surfer's Beach Pilot Restoration Project

Figure 4
Photograph showing a surfer going "left" at Surfer's Beach in October 2018

Upon request of the District in 2009, the USACE conducted a series of studies and evaluations to assess the cause of the erosion and whether there was a federal interest in mitigating for damages that occurred after construction of the harbor. Specifically, the USACE conducted coastal engineering and economic studies for a range of project alternatives where sand was dredged from the harbor and placed as a berm along the shore of Surfer's Beach (USACE 2015a, USACE 2015b). The USACE efforts culminated in a *Continuing Authorities Program (CAP) Section 111 Detailed Project Report and Draft Environmental Assessment*, which concluded that while the project alternatives considered would be feasible and have less than significant environmental impacts, there was no economic justification for a federal interest in the project (USACE 2016).

With no federal partner on the project, the San Mateo County Harbor District Board of Commissioners unanimously approved a pilot project to design and implement a scaled-down version of the USACE project in 2015. The Surfer's Beach Pilot Restoration Project (project) was proposed as an opportunity to demonstrate that the beneficial reuse of dredged harbor sediments as beach nourishment at Surfer's Beach can be implemented with no significant impacts to marine resources in the Monterey Bay National Marine Sanctuary (MBNMS or Sanctuary; GFNMS 2017). The District received grant funding from the California Division of Boating and Waterways (DBW) and the California Ocean Protection Council (OPC) to help fund the project planning, design and implementation.

1.2 Project Purpose and Scope of Study

The purpose of the project is to address erosion at Surfer's Beach by restoring sandy beach area using dredged material from navigable areas of Pillar Point Harbor, including the boat launch ramp. The project seeks to demonstrate the feasibility of successfully implementing a beach nourishment project at Surfer's Beach in the MBNMS without having significant impacts to the coastal resources. This demonstration would consist of a pilot restoration project that dredges approximately 75,000 to 100,000 cubic yards of sand from the harbor and places it at Surfer's Beach. The project would use physical and ecological monitoring to assess the project's effects on the environment, which would help to establish metrics that could be used to evaluate the performance of the project and to calibrate expectations for a larger or repeated future effort.

The scope of this study is to develop the engineering design of the pilot project, which would be used to inform potential future, larger efforts. This report presents a project design that is intended to comply with regulatory requirements, and will be used as a basis for discussions with and review by permitting agencies. Based on surveys and observations, we expect that the project will impact existing eelgrass habitat, and therefore will require mitigation. The District has initiated an eelgrass mitigation project to meet these requirements, including a harbor-wide eelgrass management and mitigation plan (MTS 2020) and the engineering design of an eelgrass mitigation project at the PPH West Basin (see Appendix C).

1.3 Structure of Report

This report is structured as follows:

- **Section 2 – Project Setting:** Describes the site, its history, its current physical and ecological conditions that relate to the design and performance of the proposed project.
- **Section 3 – Project Goal and Objectives:** Lists the overarching goal of the project and some of the key operational objectives that are used to guide the development of the design.
- **Section 4 – Project Alternatives:** Briefly describes the alternatives considered by the USACE, selection of the preferred project alternative, and a discussion of construction alternatives that were used to determine the preferred design and construction approach.
- **Section 5 – Preliminary Engineering Design:** Presents a description of the project, the major design elements, construction access and staging, dredge operations, coastal resources, and cost estimate.
- **Section 6 – Conclusions and Recommendations:** Summarizes the findings of the report.
- **Appendix A – Historical Aerial Imagery of Surfer's Beach and Pillar Point Harbor Vicinity:** Collection of readily available aerial and oblique aerial imagery of the project site and vicinity from 1928 to present, from a variety of sources.
- **Appendix B – 30%-Complete Construction Plans for Surfer's Beach Pilot Restoration Project:** Half-size (11"x17") preliminary construction plans for the Surfer's Beach Pilot Restoration Project.
- **Appendix C – 30%-Complete Construction Plans for Pillar Point Harbor Eelgrass Mitigation Project Preliminary Design:** Half-size (11"x17") preliminary construction plans for the Pillar Point Harbor Eelgrass Mitigation Project.

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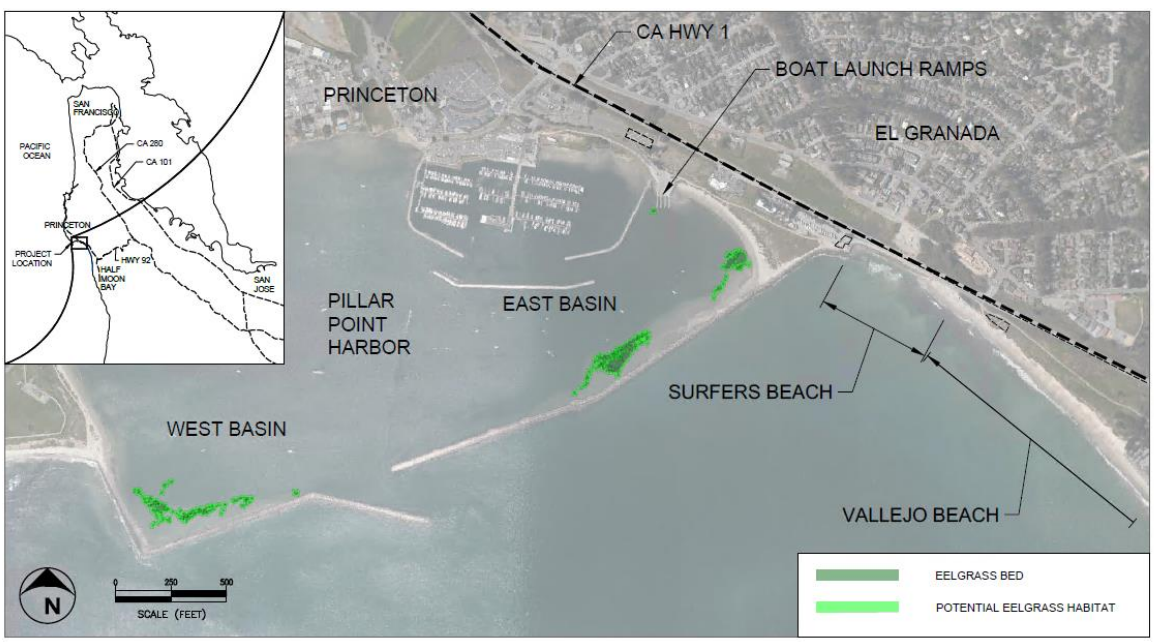
2 PROJECT SETTING

This section describes the primary site features of the project area, its history, key elevations and sediment characteristics, the coastal hydrology and morphology, including the water levels, tides, wave climate, and morphology change over time, existing biological resources at the site, and implications of climate change and sea-level rise.

2.1 Existing Project Site Features

Figure 5 identifies the locations of several key landmarks and project site features. The project is primarily located in the PPH East Basin, where accumulated sand is proposed to be dredged, and at Surfer's Beach, where the sand will be placed. Surfer's Beach and the East Basin are separated by the PPH East Breakwater. Much of Surfer's Beach is backed by an approximately 1,000-foot-long rock revetment that protects Highway 1 from erosion, and transitions to natural, unarmored bluffs along Vallejo Beach immediately south of the site. Figure 5 also identifies the locations of existing eelgrass beds that were mapped by MTS in 2019. A heavily-used, paved coastal trail is located in the project site, running through the bluffs at Vallejo Beach, on the shoulder of Highway 1 at Surfer's Beach, and at the back of dune-wetland complex in the backshore of the PPH East Basin toward the PPH boat launch ramps.



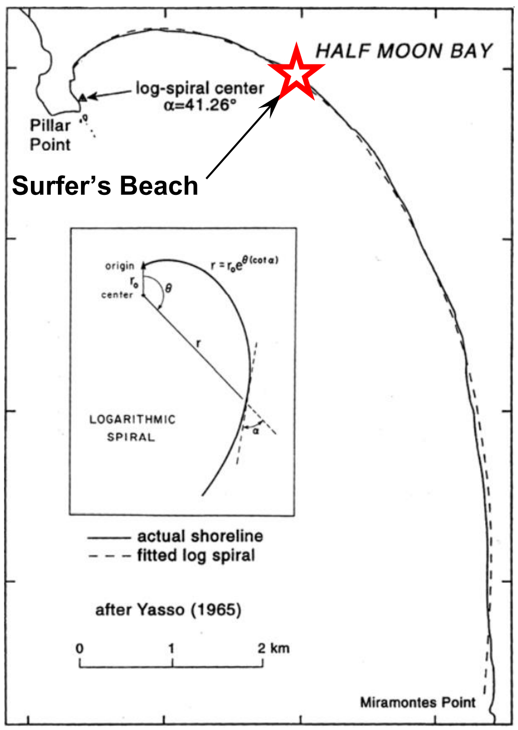
SOURCE: ESA, Maxar, MTS (2020)

Surfer's Beach Pilot Restoration Project

Figure 5
Project site, including existing site features and proposed dredge and placement areas

2.2 Site History and Shore Morphology

The project site is located at the northern portion of Half Moon Bay, a hook-shaped bay that provides natural sheltering within the hooked portion at the north with progressively increasing wave exposure, beach sand grain size and beach slope moving away from the hooked portion to the south (Wiegel 1964). The hook shape of the bay was formed by the containment of littoral material between Pillar Point in the north and Miramontes Point in the south, and the prevailing wave direction from the northwest that eroded the shore into a simple log-spiral shape (Lajoie and Mathieson 1985). Figure 6 presents a schematic that shows the approximate project location on the log-spiral shape of Half Moon Bay. This general log-spiral shape of the bay represented an approximate equilibrium shore that was formed over thousands of years with a low, but finite, rate of cliff retreat, limiting most shore erosion to periods of storms (Griggs et al. 2005). Appendix A includes several aerial and oblique photographs of the Surfer's Beach and Pillar Point vicinity from 1928 to present day.



SOURCE: USACE 2009

Surfer's Beach Pilot Restoration Project

Figure 6
Schematic of the natural log-spiral shape of Half Moon Bay and location of Surfer's Beach

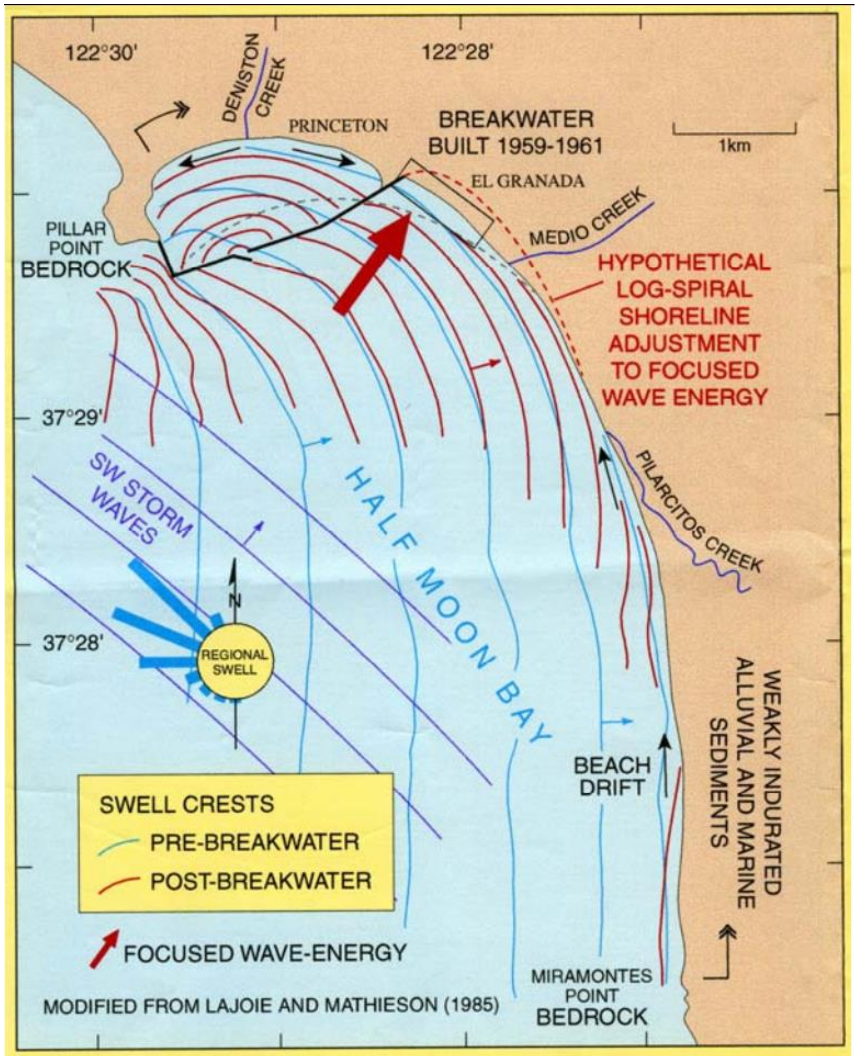
Construction of the Pillar Point Harbor East and West Breakwaters commenced in 1959 and was completed in 1961. The breakwaters were constructed by hauling and placing large rock on the existing substrate, including sandy and rocky areas (Figure 7). A 1,000-foot-long spur "dogleg" was added to the West Breakwater in 1967 to reduce penetration of storm waves into the harbor entrance. To provide calmer conditions in the harbor for the fishing fleet, an inner breakwater system was constructed in 1982.

SOURCE: VanderWerf 1997

Surfer's Beach Pilot Restoration Project

Figure 7
Construction of the Pillar Point Harbor West Breakwater, circa 1960

Figure 8 shows how the wave patterns in Half Moon Bay and Pillar Point Harbor changed due to construction of the Outer Breakwater in the early 1960s. The construction of the breakwaters disrupted the equilibrium wave pattern and focused wave energy at the low cliffs south of the East Breakwater, causing rapid erosion along the shore (Lajoie and Mathieson 1985). The most likely causes of the increased erosion are shifting the center of the log-spiral to the south and cutting off the sand supply from the north (USACE 2009). Shifting the center of the spiral changes the wave-energy dynamic along the length of Half Moon Bay as the shore tries to return to an equilibrium configuration, with the greatest changes at areas closest to the log-spiral center (USACE 2009). The dashed red line in Figure 8 represents the hypothetical log-spiral shape for post-breakwater construction, indicating a large erosion potential in the area from Surfer's Beach to Miramar. The blockage of littoral sand from the north to the south also contributes to the erosion. Sediment sourced from local creeks is deposited in the harbor and trapped (e.g., Deer Creek, see PWA 1999). A second source of sediment is sand that is pushed through the porous breakwater from the south by waves, which is then trapped (USACE 2015a). The accumulated sand in the harbor has become an operational nuisance and navigational hazard.



SOURCE: Lajoie and Mathieson USGS Poster

Surfer's Beach Pilot Restoration Project

Figure 8
Hypothetical log-spiral shoreline adjustment to focused wave energy after construction of the Pillar Point Breakwaters

Figure 9 shows a photograph of the erosion along the shore of Surfer's Beach in 1971. After construction of the East Breakwater was completed in 1961, the shore responded immediately with erosion rates increasing from approximately 3 inches per year to over 7 feet per year (Lajoie and Mathieson 1985). The erosion damaged a County road and threatened Highway 1, which triggered the construction of rock revetments to protect the highway over the last several decades. More recently, bluff erosion to the south of the existing highway revetments was estimated between 1.64 and 2.3 feet per year (USACE 2015a).

SOURCE: Photo by Ken Lajoie

Surfer's Beach Pilot Restoration Project

Figure 9
Photograph showing erosion of the Surfer's Beach shore looking north toward Pillar Point Harbor in 1971

2.3 Coastal Hydrology and Meteorology

This section presents relevant information related to the coastal hydrology, including the water levels, tides and waves, and meteorology. Note that the below provides a general summary, and a thorough discussion of these physical conditions are located in the *North Half Moon Bay Shoreline Improvement Project CAP 111 Coastal Engineering Appendix* (USACE 2015a). The sections below provide a summary of information, as well as supplemental data for consideration.

2.3.1 Water Levels, Tides, and Datums

Table 1 presents the tidal datums for the project site, which include both published datum from NOAA for Pillar Point Harbor, NOAA tidal datum adjusted to account for 0.17 feet of sea-level rise from the midpoint of the current tidal epoch, and a prorated datum based on ESA field measurements in summer 2019. Additional information on the tide datum analysis and the field measurements is included in a *Geomorphic Basis of Design of the Pillar Point Harbor West Trail Living Shoreline Project*, prepared for the District (ESA 2020). We recommend using the published datums for design and construction purposes, but note that additional observations may be warranted to assess whether higher tides should include an adjustment for sea-level rise since the 1983-2001 tidal epoch and other factors.

TABLE 1
COMPARISON OF PUBLISHED AND ADJUSTED TIDAL DATUMS AT PILLAR POINT

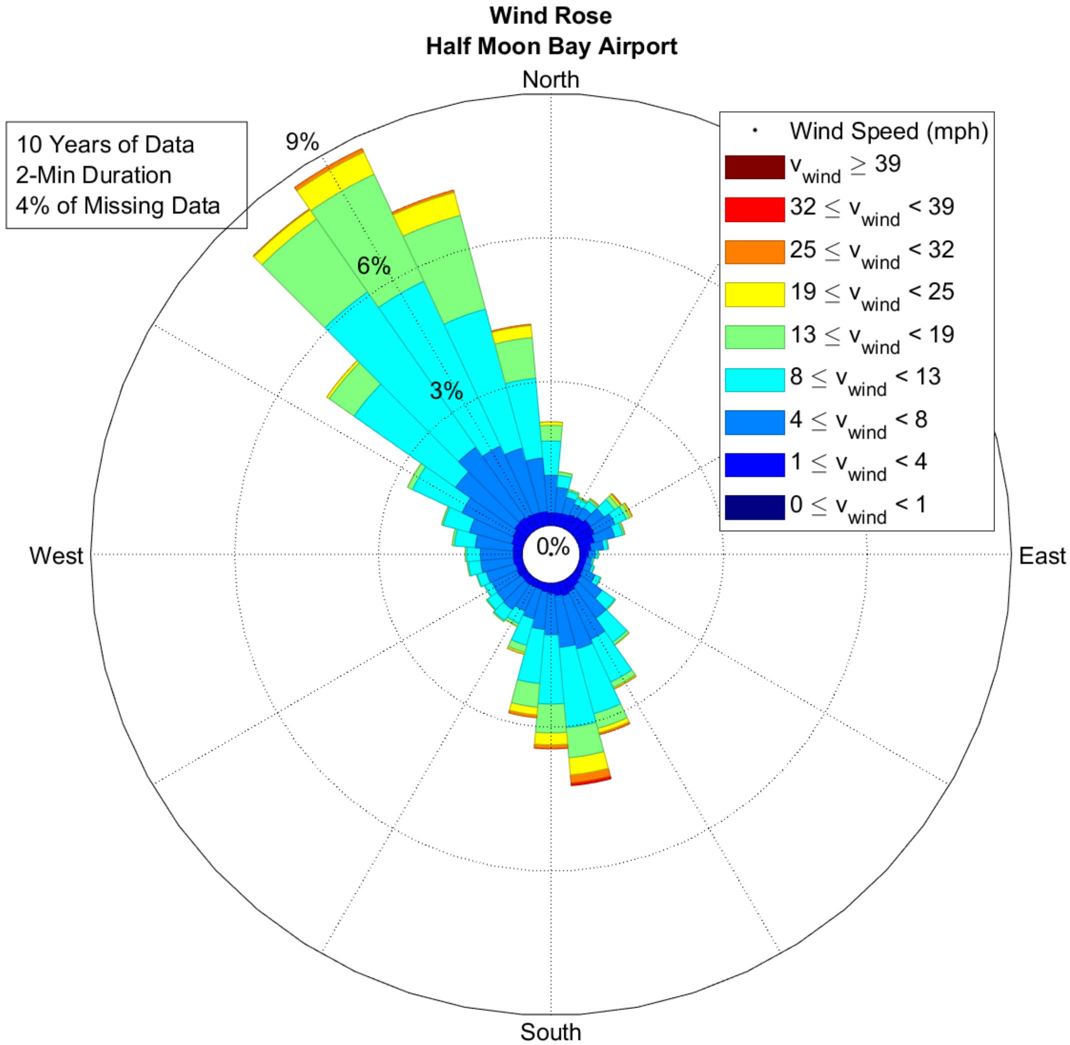
Datum	Description	NOAA Published[a] (feet NAVD)	NOAA Published +0.17 feet SLR[b] (feet NAVD)	ESA Prorated[c] (feet NAVD)
HAT	Highest Astronomical Tide (12/31/1986 5:42:00 PM)	7.32		
MHHW	Mean Higher-High Water	5.64	5.81	5.9
MHW	Mean High Water	4.99	5.16	5.2
MTL	Mean Tide Level	3.07	3.24	3.1
MSL	Mean Sea Level	3.03	3.20	3.1
DTL	Mean Diurnal Tide Level	2.84	3.01	3.0
MLW	Mean Low Water	1.15	1.32	1.1
MLLW	Mean Lower-Low Water	0.04	0.21	0.0
NAVD	North American Vertical Datum of 1988	0.00	0.00	0.0
LAT	Lowest Astronomical Tide (5/25/1990 1:12:00 PM)	-2.07		

NOTES:
a NOAA NOS Station 9414131, current epoch 1983-2001
b Published NOAA datums adjusted by 0.17 feet to account for sea-level rise from midpoint of current tidal epoch to August 2019 (1.96 mm/yr, based on San Francisco Tide Gauge)
c Value adjusted by difference of the computed NOAA Predicted MSL and the published value

SOURCE: NOAA; ESA

2.3.2 Offshore and Local Wind Climate

Winds near the project site have a strong seasonal dependence, with greatest wind speeds in the late winter and early spring and weakest in the summer and fall. Analysis of measured wind speed at the Half Moon Bay Buoy (NDBC 46012) indicate mean monthly wind speeds between 11 and 18 miles per hour (mph) in the winter/spring and between 5 and 11 mph in the summer and fall (USACE 2015a). Wind direction is predominantly from the northwest, but strong, winter storm winds are typically from the southwest to southeast. Figure 10 presents a wind rose of wind measurements at Half Moon Bay airport, which graphically displays the distribution wind speeds as a function of direction and percent occurrence.



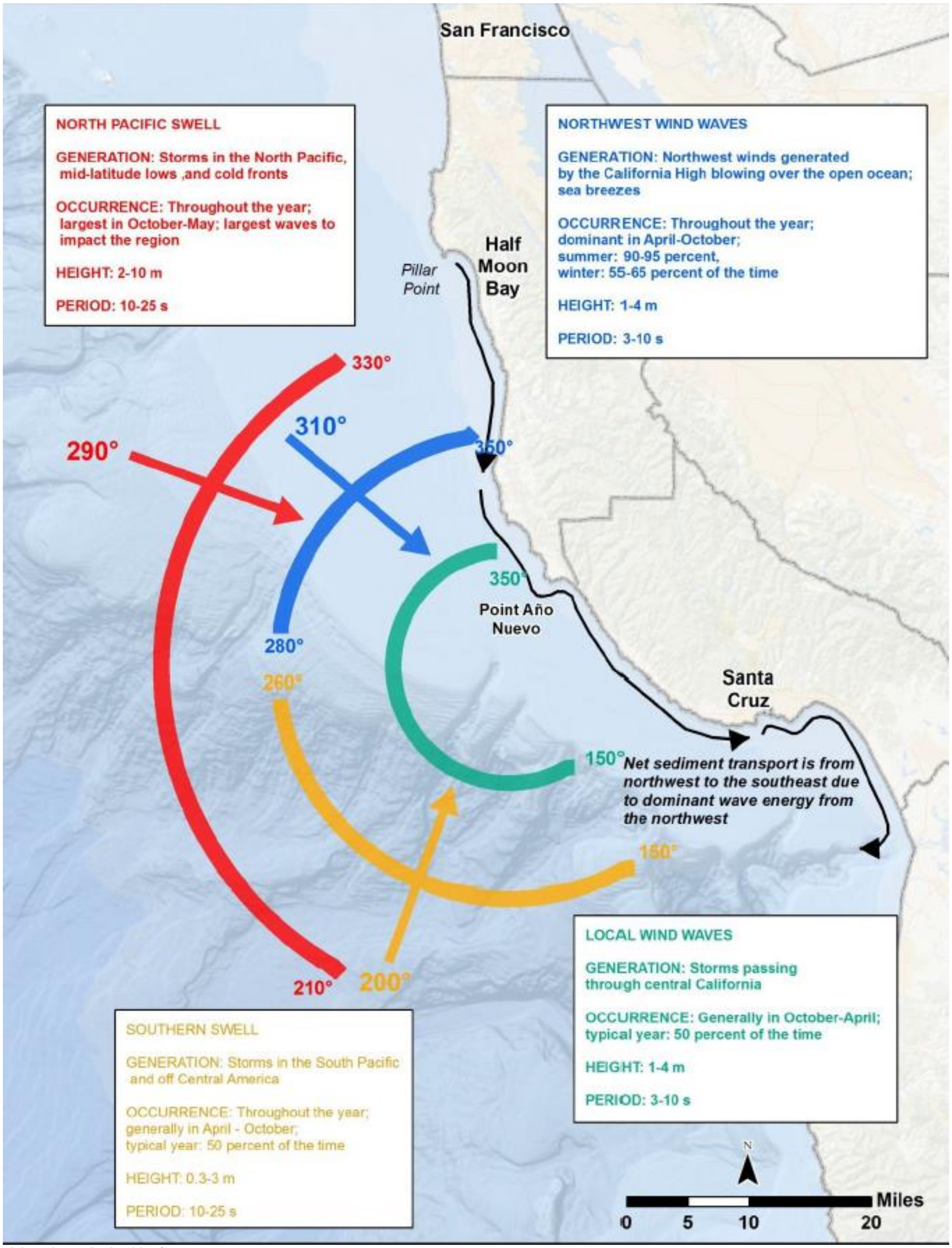
SOURCE: NOAA ASOS

Surfer's Beach Pilot Restoration Project

Figure 10
Wind rose near project site at Half Moon Bay Airport

2.3.3 Wave Climate

Detailed descriptions of the wave climate in the vicinity of the project are described in USACE (2015a) and ESA (2020). The wave climate primarily comprises locally generated wind waves, storm seas and swell, and long-wave "surge" and tsunami events (ESA,2020). Figure 11 presents a schematic of the regional wave climate (USACE 2015b). The schematic illustrates the directional bands and the likely range in wave height and period for local wind waves, northwest wind waves, North Pacific swell, and South Pacific swell. The strongest events are primarily attributed to large winter swells and storm waves, although the summer south swells also exhibit long periods and hence more power albeit intermittent.



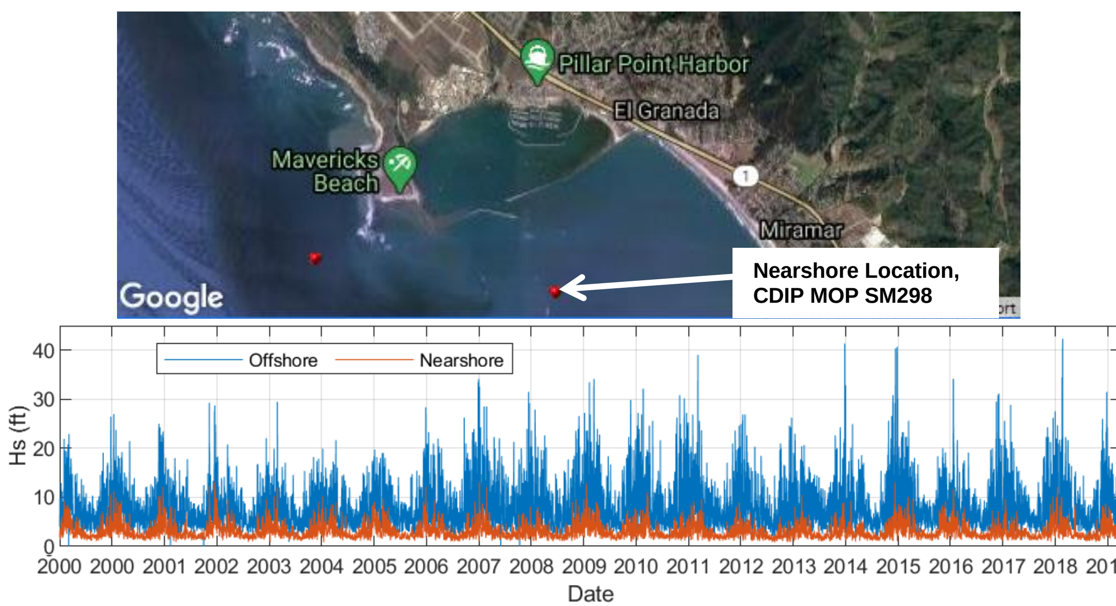
SOURCE: USACE 2015b

Surfer's Beach Pilot Restoration Project

Figure 11
Regional wave climate in the Santa Cruz littoral cell

As waves approach the project site, ground and wind swell refract around Pillar Point and the reefs offshore. Refracted waves initially approaching from the northwest will turn and approach the shore from the southwest, while southwest swells tend to focus more directly to the Surfer's Beach area. Waves also interact with the East Breakwater, such that the waves approaching Surfer's Beach from the southwest will reflect off the breakwater and propagate toward the southeast, crossing the incident waves from the southwest. These wave crossings form "peaks," which produce the high-quality surfing waves at Surfer's Beach.

Detailed wave modeling of the site has been completed by USACE (2015a), Caltrans (2014), and CHE (2012). USACE (2015a) developed a coupled wave and sediment transport model using the Coastal Modeling System (CMS) as a tool to evaluate alternatives for the *North Half Moon Bay Shoreline Improvement Project*, which led to this current pilot study. The wave model was calibrated to measurements at offshore and nearshore locations in the project vicinity, and generally showed wave heights decreasing by approximately half as they transformed from offshore to nearshore (USACE 2015a). This is consistent with ESA analysis comparing offshore wave measurements (represented by the Monterey Bay buoy) to modeled wave height at a nearshore location in northern Half Moon Bay immediately south of the PPH entrance (Figure 12). Figure 12 (bottom panel) presents a 20-year time series of the measured offshore wave height at Monterey (CDIP buoy 185) and the nearshore modeled wave height (CDIP MOP SM298), which shows a significant reduction in wave height from offshore to nearshore. Figure 12 (top panel) also identifies the approximate location of the nearshore wave height reported by CDIP MOP SM298. The reduction in wave height is attributed to refraction and diffraction as waves bend toward shore and into the lee of Pillar Point and adjacent reefs.



SOURCE: CDIP

Surfer's Beach Pilot Restoration Project

Figure 12
Time series of wave height at Monterey buoy CDIP 185 (Offshore) and CDIP MOP SM298 (Nearshore); top panel shows nearshore location

Modeling completed by Caltrans in 2014 included a SWAN model that was used to verify general wave trends, but was not calibrated to data. CHE (2012) conducted detailed wave modeling for a project inside of the harbor, and computed wave heights in the open ocean for the 50- and 100-year return periods to be 31.5 feet and 35 feet, respectively.

2.4 Site Topography and Bathymetry

Figure 13 shows the topographic and bathymetric elevations inside of Pillar Point Harbor and Surfer's Beach. The data are compiled from bathymetric survey data collected by eTrac Inc. in 2019, under contract to ESA, bathymetric survey data from the USGS, and publicly available LiDAR for the uplands. The East Basin of PPH includes subtidal and intertidal areas, with elevations that range from approximately -15 feet NAVD to over 3 feet NAVD.

Deposits of sand along the breakwater and the East Beach within Pillar Point Harbor have grown since construction of the breakwaters. Sand accumulates regularly around the PPH boat launch ramp. In 2019, The area at and immediately adjacent to the boat launch ramp was dredged due to sand accumulations that interfered with normal boat launch operations. Sand accumulation in previously subtidal areas pose a hazard to navigation, with intertidal sand bars growing in locations that used to be used for anchorage. This is particularly evident at the shallow, sand filled area inside the East Basin along the breakwater.

Outside of the harbor at Surfer's Beach, elevations extend from subtidal offshore conditions to intertidal beach that fluctuates between 0 to 3 feet NAVD. Farther south, the beach is wider and has dry beach elevations above 10 feet NAVD in areas where sand seasonally builds. In winter conditions, when sand is seasonally stripped from the beach, "hardpan" – a stiff clay beneath the sand beach – is exposed in much of the intertidal areas. Remnants of a failed, shore-parallel rock revetment can be seen in the surf zone, where erosion flanked around the end and behind the structure. The shore is currently backed by a rock revetment along the highway that is constructed to approximately 20 feet NAVD.

SOURCE: ESA, eTrac, USGS

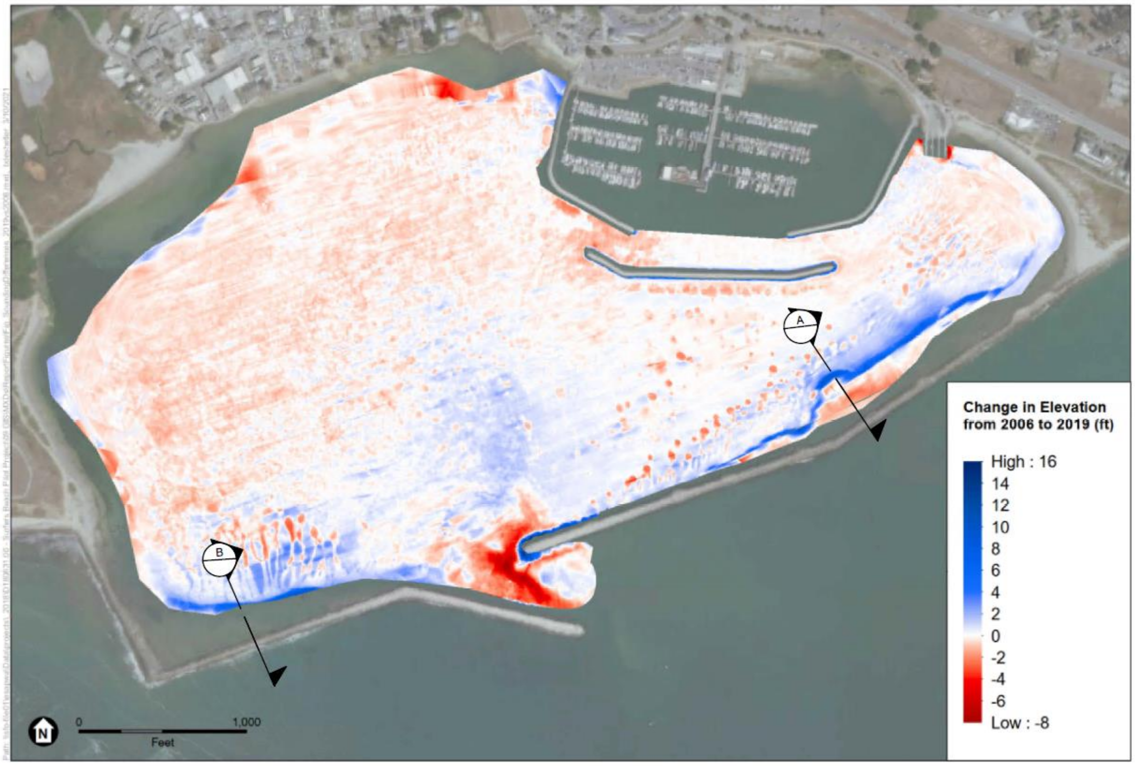
Surfer's Beach Pilot Restoration Project

Figure 13
Composite site topography and bathymetry of Pillar Point Harbor and Surfer's Beach area

2.5 Recent Morphology Change in Pillar Point Harbor

Per request of the permitting agencies, we evaluated the recent morphology change inside of Pillar Point Harbor. Figure 14 presents a map of morphology change from 2005 to 2019 based on bathymetric surveying of the harbor. In the figure, areas of red indicate erosion or deepening from 2006 to 2019, and areas of blue indicate accretion or shoaling from 2006 to 2019. The horizontal extents of the map of morphology change is limited by the extents of the 2006 survey. However, the map indicates the following:

- Significant shoaling along both the East and West Breakwaters on the order of ten feet vertically, and shifting laterally into the harbor
- Erosion and deepening of the entrance channel on the order of eight to ten feet
- Widespread areas of erosion and shoaling across the West and East Basins on the order of one to two feet; it is not clear how these changes occurred or if they are significant without additional analysis

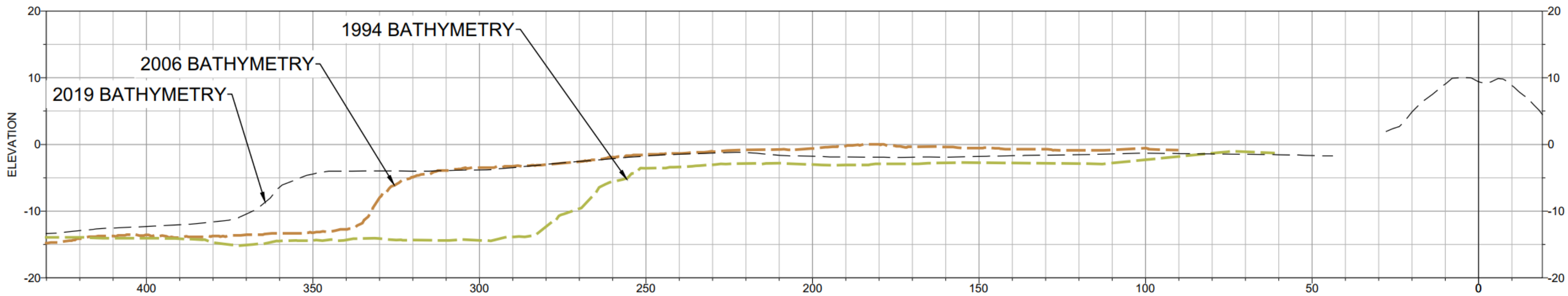


SOURCE: ESA, MTS (2020), GBA

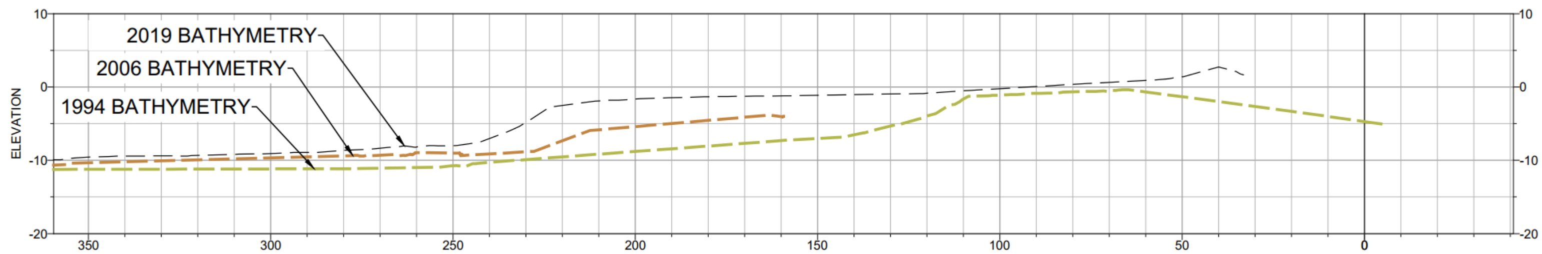
Surfer's Beach Pilot Restoration Project

Figure 14
Bed elevation change in Pillar Point Harbor from 2006 to 2019

Figure 15 presents bed profiles of sections A and B cut from Figure 14 at the East and West Basins, respectively. The profiles include surveys from 1994, 2006, and 2019, showing the vertical and lateral growth of sand deposits in sheltered areas of the harbor. Rough calculations of these figures suggest that the East Breakwater shoal has grown by over 6,000 cubic yards per year between 1994 and 2019, with a growth of almost 9,000 cubic yards per year between 1994 and 2006.



SECTION A – Sand Shoal at East Breakwater PPH



SECTION B – Sand Shoal at West Breakwater PPH

SOURCE: ESA, MTS (2020), GBA (1994,2006)

Surfer's Beach Pilot Restoration Project

Figure 15
Pillar Point Harbor bed profiles showing lateral growth of depositional areas adjacent to breakwaters; Profile A at top is located at the East Breakwater, and Profile B at bottom is located at West Breakwater

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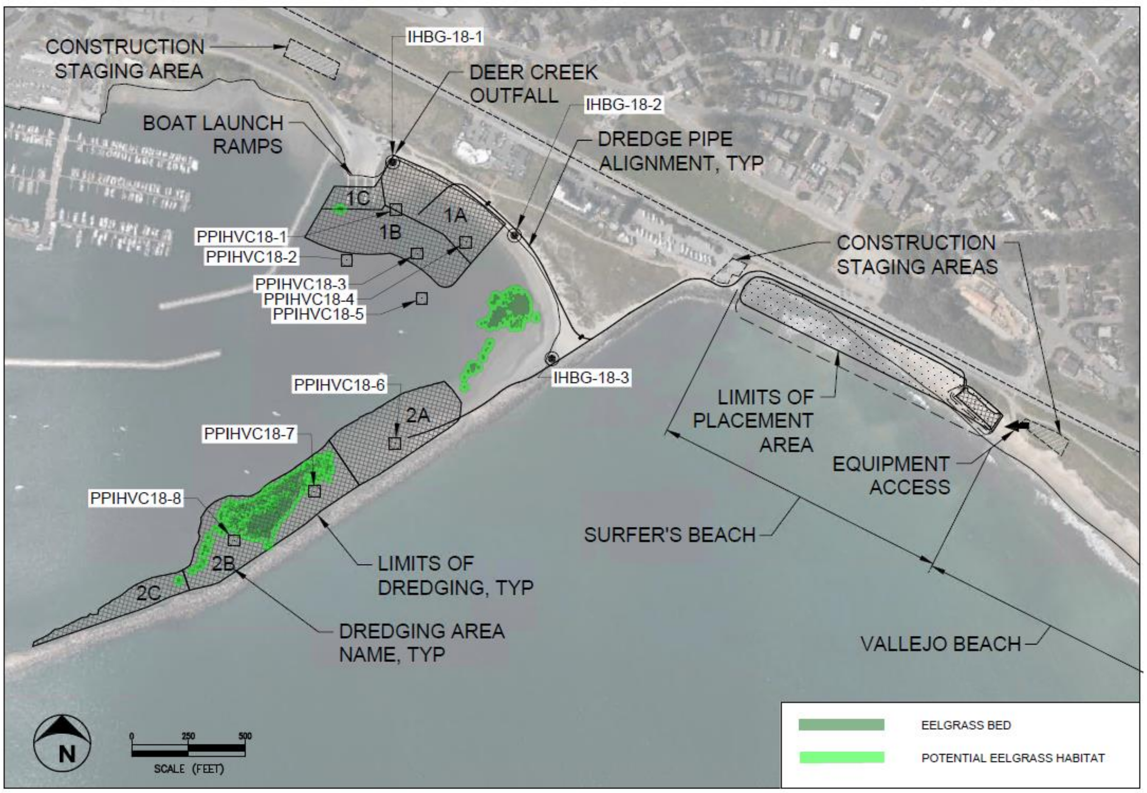
2.6 Sediment Sampling

A sediment sampling and analysis plan was prepared and implemented by Kinetics Laboratories Inc., with results described in a draft report (Kinetics 2019). Figure 16 shows the locations of sediment sampling locations relative to proposed dredge locations (see Section 5). Sampling included three beach grab samples along the beach between the boat launch ramps and the East Breakwater and eight sediment cores throughout the East Basin. Three beach grab samples at Surfer's Beach were also collected for reference and to assess the degree of compatibility of nourished material, but are not shown on the map. The dredge areas allocate different sources of sand for the Surfer's Beach Pilot Restoration Project and the Pillar Point Harbor Eelgrass Mitigation Project. Because the Surfer's Beach project will require mitigation to eelgrass impacts, we have identified sand source locations and volumes for both of the projects, which will rely on dredging of material in the East Basin. The dredge areas may be refined during final design.



SOURCE: ESA, MTS

Surfer's Beach Pilot Restoration Project

Figure 16
Locations of sediment sampling, proposed dredge and placement areas, and eelgrass beds in project area

Table 2 tabulates the results of the sediment analysis for all grab samples and cores. The table identifies the sediment sample, the dredge area, the percent of gravel, sand and fines, the estimated median grain size (D50), the sample depth below grade, and the expected use destination. Overall, sediments tend to be coarser in dredge areas 1A, 1C, 2A, and 2B, with finer materials at dredge areas 1B, 2C, and portions of 1A along the border with 1B. Material destined for Surfer's Beach has approximate D50 ranging from 0.14 to 0.32 millimeters.

TABLE 2
SUMMARY OF SEDIMENT CHARACTERISTICS FROM SEDIMENT SAMPLING COMPLETED IN 2019

Sample ID	Location (Dredge Area)	Gravel (%)	Sand (%)	Fines (%)	D50 (mm)	Sample Depth (feet below grade)	Use Destination
East Basin Beach Samples							
IHBG18-1	1A and adjacent beach	0	99	1	0.15	0.0 – 0.5	Surfer's Beach
IHBG18-2		0	98	2	0.14	0.0 – 0.5	
IHBG18-3		0	98	2	0.14	0.0 – 0.5	
Surfers Beach Reference Samples							
SBREF18-1	Surfer's Beach	0	99	1	0.21	0.0 – 0.5	
SBREF18-2		0	99	1	0.2	0.0 – 0.5	
SBREF18-3		0	99	1	0.23	0.0 – 0.5	
Sample 1							
PIHVC18-1Top	1A/1C	1	85	14	0.21	0.0 – 3.0	Surfer's Beach
PIHVC18-1Mid		3	83	13	0.23	3.0 – 4.7	
Sample 2							
PIHVC18-2Top	Near 1B	0	52	48	0.08	0.0 – 2.0	Eelgrass Mitigation
PIHVC18-2Mid		1	57	42	0.14	2.0 – 3.7	
Sample 3							
PIHVC18-1Top	1B	0	68	32	0.11	0.0 – 3.0	Eelgrass Mitigation
PIHVC18-3Mid		3	73	24	0.18	3.0 – 6.0	
PIHVC18-3Bot		1	62	37	0.15	6.0 – 6.7	
Sample 4							
PIHVC18-4Top	1A	1	95	4	0.23	0.0 – 3.0	Surfer's Beach
PIHVC18-4Mid		0	75	25	0.23	3.0 – 4.1	
PIHVC18-4B1		0	98	2	0.32	4.1 – 5.8	
PIHVC18-4B2		0	57	43	0.11	4.1 – 5.8	
Sample 5							
PIHVC18-5Top	Near 1B	0	57	43	0.09	0.0 – 3.0	Eelgrass Mitigation
PIHVC18-5Mid		0	63	37	0.13	3.0 – 6.0	
PIHVC18-5Bot		0	58	42	0.12	6.0 – 6.5	
Sample 6							
PIHVC18-6Top	2A	0	97	3	0.15	0.0 – 3.0	Surfer's Beach
PIHVC18-6Mid		0	96	4	0.18	3.0 – 6.0	
PIHVC18-6Bot		0	94	6	0.18	6.0 – 8.5	
Sample 7							
PIHVC18-7Top	2B	0	97	3	0.16	0.0 – 3.0	Surfer's Beach
PIHVC18-7Mid		0	96	4	0.14	3.0 – 6.0	
PIHVC18-7Bot		0	95	5	0.17	6.0 – 8.5	
Sample 8							
PIHVC18-8Top	2B/2C	0	97	3	0.15	0.0 – 3.0	Surfer's Beach
PIHVC18-8Mid		0	95	5	0.14	3.0 – 6.0	
PIHVC18-8Bot		0	92	8	0.14	6.0 – 7.3	
Sample 1-5 Composite							
PIHVC18-Top		0	79	21	0.16	0.0 – 3.0	
PIHVC18-Mid		2	71	27	0.17	3.0 – 6.0	
PPIHVC18-Bot		0	61	39	0.14	6.0 +	

SOURCE: Kinetic Laboratories, Inc., 2020

2.7 Biological Resources

This section generally identifies that the project area includes valuable biological resources that need to be considered in the planning and design of the project. Evaluation of these biological resources is beyond the scope of this report, and is being led by others involved in the project. ESA understands that project documentation in preparation by others will identify and quantify the existing biological resources in the project area.

Of greatest relevance to the project design are existing eelgrass (*Zostera marina*) beds in the East and West Basins of PPH. Figure 17 presents a photograph of an eelgrass bed in the East Basin during a low tide in January 2021. A number of field studies have mapped the eelgrass extents (e.g., MTS 2020). Eelgrass is aquatic plant native to marine environments on the coastline of North America, is identified as a Habitat of Particular Concern for Pacific Coast groundfish by the Pacific Fishery Management Council, and has its own specific California Eelgrass Mitigation Policy (CEMP) through NOAA NMFS.[1] The distribution of eelgrass in Pillar Point Harbor is shown in Figures 5 and 14 above. Eelgrass "meadows" (or beds) were observed and mapped in the East and West Basins of PPH, with the extent of these meadows changing based on seasonal, yearly, and decadal conditions (MTS 2020). Based on field surveys conducted in November 2019, Eelgrass was found predominantly between elevations -4 and 0 feet NAVD and -3 and 1 feet NAVD in the East and West Basin, respectively (MTS 2020). Because the project is expected to impact existing eelgrass beds, MTS prepared a *Pillar Point Harbor-Wide Eelgrass Management and Mitigation Plan* for PPH, and ESA is currently preparing the engineering design for a project that will mitigate impacts and expand and enhance eelgrass beds in the West Basin (see Appendix C).

SOURCE: ESA — Surfer's Beach Pilot Restoration Project

Figure 17
Eelgrass bed in East Basin of Pillar Point Harbor

[1] National Oceanographic and Atmospheric Administration (NOAA), 2020, Seagrass on the West Coast, https://www.fisheries.noaa.gov/west-coast/habitat-conservation/seagrass-west-coast.

2.8 Climate Change and Sea-Level Rise

Projections of global sea-level rise are well-documented and investigated, with recent research projecting sea-level rise on the order of 2 to 10 feet by 2100 in California (e.g., Cayan et al. 2009, NRC 2012, Griggs et al. 2017). This research has been used to develop a series of policy guidance documents by the State of California that have recommended including specific amounts of sea-level rise in project planning and design, including the Ocean Protection Council's (OPC) *State of California Sea-Level Rise Guidance* (OPC 2018) and the CCC's *Sea-Level Rise Policy Guidance* with guidelines for addressing sea-level rise in Coastal Development Permits (CDPs) (CCC 2018). Recently, the OPC adopted a new target to "ensure California's coast is resilient to at least 3.5 feet of sea level rise by 2050, as consistent with the State's *Sea-Level Rise Guidance Document* as appropriate for a given location or project" (OPC 2018).

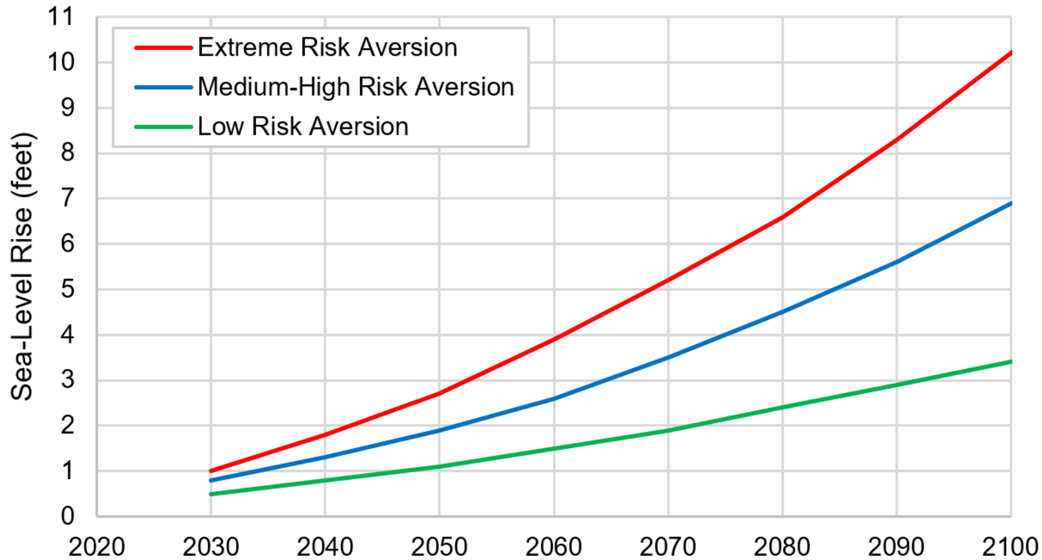
The current sea-level rise guidance for the California coast presents future projections over time for three risk aversion categories: low, medium-high, and extreme (Table 3). These risk aversion categories are intended to be selected based on a project's apparent level of tolerable risk and its ability to adapt to future sea-level rise. The low and medium-high risk aversion scenarios are probabilistic projections where "low" represents the upper bound of the "likely range" (~17% probability of exceedance for a given year) and "medium-high" represents a 1-in-200 chance (0.5% probability of exceedance for a given year). The extreme risk aversion (or H++) is a single scenario that does not have an associated likelihood of occurrence (OPC 2018).

TABLE 3
SEA-LEVEL RISE PROJECTIONS FOR A RANGE OF RISK AVERSIONS AT SAN FRANCISCO, CALIFORNIA

Year	Low Risk Aversion[a]	Medium-High Risk Aversion[b]	Extreme Risk Aversion[c]
2030	0.5	0.8	1.0
2040	0.8	1.3	1.8
2050	1.1	1.9	2.7
2060	1.5	2.6	3.9
2070	1.9	3.5	5.2
2080	2.4	4.5	6.6
2090	2.9	5.6	8.3
2100	3.4	6.9	10.2
2110	3.5	7.3	11.9
2120	4.1	8.6	14.2
2130	4.6	10.0	16.6
2140	5.2	11.4	19.1
2150	5.8	13.0	21.9

NOTES:
[a] Likely range, with approximately 17% probability that sea-level rise meets or exceeds this amount; only the projections for upper end of the likely range for the high emissions scenario are shown
[b] 1-in-200 chance, with a 0.05% probability that sea-level rise meets or exceeds this amount; only the projections for a high emissions scenario are shown
[c] H++ scenario, not associated a probability, and represents a single extreme but possible scenario
SOURCE: OPC 2018

Figure 18 presents a graphical plot of the sea-level rise projections tabulated in Table 3 through year 2100. Note that the curves accelerate over time, and that these trends are expected to increase well beyond the end of the century. Table 3 includes projections of sea-level rise out to year 2150, although the uncertainty increases for projections beyond year 2100 due to a limited number of models that project sea-level rise beyond the end of the 21st century.



SOURCE: OPC 2018

Surfer's Beach Pilot Restoration Project

Figure 18
Sea-level rise projections for San Francisco from year 2030 to 2100 for low, medium-high, and extreme risk aversion projections

Because the nature of the project is to test and experiment a short-term action as a pilot, and the expected project life is short, we do not recommend including an allowance for sea-level rise in the design. Potential larger placements after the pilot project should consider the implications of an appropriately selected amount of sea-level rise to evaluate how it could affect the project's performance, maintenance, and need for additional future placements. The current project is intended improve the existing condition, and due to the adverse coastal access, flood and erosion implications to Highway 1, and limited operational capacity in PPH, we think this project is urgent to inform adaptation to sea-level rise, which will exacerbate many of these issues. The project is a one-time action, and its life is expected to be relatively short (i.e., less than 10 years), and so it does not warrant a detailed examination of its performance with sea-level rise.

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3 PROJECT GOAL AND OBJECTIVES

Through the planning efforts that have taken place to-date on the project, a series of goals and objectives have been loosely defined and stated (GFNMS 2017). We have developed the following project goal and objectives based on information in the GFNMS (2017) *White Paper on the Potential for Beneficial Reuse of Dredged Sediment for Restoration at Surfer's Beach, in San Mateo County, in the Monterey Bay National Marine Sanctuary*, as well as input provided by the Technical Advisory Group and by the District. The following goal and objectives need to be reviewed and agreed upon by the District and others for consistency.

3.1 Project Goal

The goal of the project is to study the potential benefits and impacts of implementing a pilot project that beneficially reuses approximately 75,000 to 100,000 cubic yards of sand dredged from Pillar Point Harbor and placed at Surfer's Beach.

3.2 Project Objectives

The pilot project is a multi-objective project that will have several benefits and constraints. Therefore, we expect that several objectives will be "competing," in the sense that increasing the benefits of one objective could reduce the benefits or increase the impacts of other objectives.

The objectives identified in the GFNMS (2017) *White Paper* are the following:

1. Prevent or mitigate beach erosion and sea cliff retreat
2. Improve protection of Highway 1 and other structures
3. Increase quality and quantity of public access and recreation
4. Reduce the need for coastal armoring
5. Improve biological habitat

Further, from the GFNMS (2017) *White Paper*:

> GFNMS believes that the beneficial reuse of the sand from inside Pillar Point Harbor for beach nourishment appears to be the best option to restore sandy beach habitat and reduce the erosion at Surfer's Beach. The sanctuary would, therefore, support a beneficial reuse project at the site provided that the proposed action is consistent with all relevant federal, state, and local regulatory programs and requirements and provided that the project is designed and implemented in a manner that prevents, mitigates, or reduces adverse effects to the environment and results in net beneficial environmental impacts and other positive benefits,

such as improved public access and shoreline protection. Any beneficial reuse project would need to comply with the appropriate required sediment testing and screening, project design considerations to minimize biological impacts, and monitoring requirements to ensure that the dual goals of resource protection and a successful beach restoration are achieved.

Therefore, we have identified the following additional objectives to comply with regulatory oversight:

6. Comply with all relevant federal, state, and local regulatory programs and requirements

7. Design and implement project in a manner that prevents, mitigates, or reduces adverse effects to the environment, resulting in net-beneficial environmental impacts and other positive benefits

8. Develop and implement a monitoring program, which includes a detailed monitoring plan, that will be used to measure the project benefits and impacts relative to success criteria, including for physical and ecological considerations

We have also identified the following objectives based on our understanding of the District's needs:

9. Improve operations of the boat launch ramp in PPH by removing sediments that interfere with the boat launch activities

10. Improve navigation and anchorage in the East Basin by deepening areas of significant shoaling

11. Minimize construction cost relative to project objectives and constraints

4 PROJECT ALTERNATIVES

This section presents information on alternatives, including a summary of the project alternatives considered by the USACE in their CAP 111 study (USACE 2015a, USACE 2016), an assessment of construction alternatives focused on construction methods, a discussion of placement design alternatives, and finally a summary of the selected preferred alternative.

4.1 Project Alternatives Considered

As part of the CAP 111 study (USACE 2015a, USACE 2016), the USACE evaluated eight alternatives, including the “No Action” alternative and a “Medium Beach Fill” alternative. Six of the eight alternatives were considered but eliminated and can be reviewed in the USACE (2016) report. In addition, a smaller sand placement was identified as a potential pilot study during the development of the *Coastal Regional Sediment Management Plan for the Santa Cruz Littoral Cell, Pillar Point to Moss Landing* (USACE 2015c). Below are summaries of the “No Action” and “Medium Beach Fill” alternatives as presented by the USACE (2016) and the subsequently developed Surfer’s Beach Pilot Restoration Project (this project). The alternatives previously developed were reviewed, along with variations of the pilot project, with review by a Technical Advisory Group (TAG) that advised the District.

4.1.1 No Action Alternative

The “No Action” alternative represents a condition in which no project is implemented, and conditions continue to evolve without any actions that would mitigate for erosion of Surfer’s Beach and accretion of sediment in PPH. The “No Action” alternative is required as part of environmental review by the National Environmental Policy Act (NEPA), and characterizes current and anticipated future conditions at the project site in the absence of the proposed actions (USACE 2016). This is similar to the evaluation of “No Project,” which is required under the California Environmental Quality Act (CEQA). The key findings of the USACE (2016) evaluation of the “No Action” alternative are as follows:

- Inside the harbor, sand would continue to accumulate along the inside of the East Breakwater and in the vicinity of the boat launch ramp.
- Outside the harbor, there would be continued loss of viable beach in front of the revetment, and the bluffs along Vallejo Beach would continue to erode. As sea-levels rise, the increased exposure of the bluffs to waves would result in much greater erosion rates.
- The accretion and erosion would result in the loss of recreational opportunities and threats to public safety along Highway 1 and navigational safety in PPH.

- Extrapolating the current estimated bluff erosion rates into the future, an approximately 80-foot-long section of the southbound shoulder of Highway 1 would be undermined within 10 years, and approximately 250 feet would be at risk in 50 years.

- Beach erosion would result in the loss of recreational beach area at Surfer’s and Vallejo Beaches, and sections of the pedestrian Coastal Trail would likely be lost.

- Continued accretion of the sediment in PPH would increase the size of the existing shoal, posing an increasingly significant navigational risk of ship damage or stranding.

4.1.2 Medium Beach Fill Alternative (USACE 2016)

The USACE (2016) study selected the “Medium Beach Fill” alternative as the proposed action, which involved a one-time dredging of approximately 140,000 to 150,000 cubic yards of sand accumulated along the East Breakwater and placement of that sand to form a 125-foot-wide elevated berm along for an approximately 3,100-foot-long section of shore that included Surfer’s and Vallejo Beaches (USACE 2016). This alternative was found to satisfy the project purpose of mitigating near-term beach and bluff erosion, and would reduce the navigation hazard posed to vessels using the boat launch ramp. This alternative was selected by the USACE over a “Maximum Beach Fill” alternative that would have beneficially reused a greater amount of sand – approximately 200,000 to 250,000 cubic yards – and constructed a 180-foot-wide berm along the same stretch of shore due to perceived environmental impacts.

The main findings of the USACE (2016) evaluation of the “Medium Beach Fill” alternative include the following:

- The sand source for this alternative would be the extensive sand shoal that has formed on the north side of the East Breakwater, which would be dredged to a depth of -10 feet NAVD, or approximately matching the surrounding bathymetry, and then pumped onto the adjacent back beach south of the breakwater.

- No future additional sand placement was assumed.

- Sand placement would be most effective in reducing erosion of the unprotected bluffs and in creating a beach in the immediate vicinity of the East Breakwater. Over time, the sand would be transported by natural coastal processes to the south, potentially widening the beach in front of Miramar.

- Approximately 10 to 15% of the sand would erode within one year of placement, with the majority of this sand moving seaward to the adjacent nearshore zone. After initial adjustment of the placed sand to ambient hydrodynamic conditions, the expected lifespan of the visible placement would likely be greater than six years, with an estimated residence time of sand placed in the project area on the order of 30 to 40 years.

- To minimize impacts to nearshore zone and recreation, such as surfing, the sand would be placed on the beach above the tides, and constructed as a linear berm with elevation 9 to 10 feet NAVD, top width of 125 feet, and beach face sloping at approximately 12:1 (horizontal to vertical).

4.1.3 Surfer's Beach Pilot Restoration Project

After the USACE determined that there would be no federal interest in pursuing the alternative described above (Section 4.1.2), the Beach Replenishment Committee, formed by San Mateo County Harbor District Board of Commissioners, advanced the idea of designing and implementing a pilot study as a scaled-down version of the USACE (2016) preferred alternative. The pilot study was also recommended as a potential approach in the *Coastal Regional Sediment Management Plan for the Santa Cruz Littoral Cell, Pillar Point to Moss Landing* (USACE 2015c), which identified several policies of the Monterey Bay National Marine Sanctuary that would allow authorization of a pilot project.

Ultimately, the pilot project alternative was determined to be an approximately 75,000 to 100,000 cubic yard placement of sand at Surfer's Beach, and sourced from the shoal along the East Breakwater and from near the boat launch ramp. The alternative would be implemented as described in the USACE (2016) "Medium Beach Fill" alternative, but would comprise a smaller volume and therefore a smaller footprint. The smaller footprint would be achieved either by reducing the elevation, the berm width, or the length of placement. Based on review of subsequent modeling by the USACE, and discussion of alternatives at a TAG meeting for the project, a reduction in the length of shore that the material would be placed was selected. This resulted in an alternative where up to 100,000 cubic yards of sand would be placed as an approximately 1,000-foot-long berm along Surfer's Beach from the East Breakwater to Vallejo Beach.

The District and other project proponents have indicated that this alternative is suitable to provide short-term benefits to maintaining a beach that slows erosion, improves recreation and habitat, and improves navigation in the East Basin, as well as providing a template that can be used for ongoing monitoring that will inform potential future, larger placements of sand.

4.2 Construction Alternatives Assessment

This section summarizes an assessment of potential construction alternatives with a focus on construction methods. This information was developed and presented for review by the TAG. The selected approach incorporates the TAG recommendations.

Each alternative needs to achieve the primary goals and associated co-benefits stated above. Three alternative methods of construction were analyzed at a conceptual level considering four performance criteria: project efficacy, cost effectiveness, environmental suitability and public access/overall acceptability. These construction alternatives include pumping sand as a slurry via suction dredge, transporting the sand along a conveyor, or transporting the sand in trucks, which are described in the sections below. Alternatives were rated for each criterion as positive (+), neutral (0) or negative (-) as shown in Table 4. Each of the performance criteria are explained below.

TABLE 4
RELATIVE RANKING OF POTENTIAL CONSTRUCTION METHODS

Alternative	Description	Project Efficacy	Cost Effectiveness	Environmental Suitability	Public Access / Overall Acceptability
1	Slurry - Suction Dredge	+	+	+	+
2	Conveyor with bucket	-	-	0	-
3	Trucks	0	-	-	-

4.2.1 Performance Criteria

The following describe the criteria used to evaluate the alternatives in Table 4, above.

Project Efficacy

The project success is based on the following sub-criteria:

- Boat Launch – Does the alternative clear the boat launch area of excess sand, and facilitate improved use of the facility?
- Navigation – Does the alternative improve vessel navigation conditions within the Harbor?
- Beach – Does the alternative improve beach conditions (surfing and public access)?
- Protection – Does the alternative reduce wave run-up on the road and will it last longer?
- Scalable – Is the alternative scalable to a potential larger scale project in the future?

Cost Effectiveness

Is the alternative relatively low in cost compared to other feasible alternatives?

Environmental Suitability

Does the alternative limit turbidity, GHG emissions and other environmental impacts?

Public Access and Overall Acceptability

Does the alternative limit disruption to local activities such as vehicular and pedestrian traffic?

4.2.2 Construction Alternatives

The following subsections provide technical descriptions for each potential alternative construction method for sand placement at Surfer's Beach.

Construction Alternative 1 – Sand Slurry Placement

This alternative is preferable for a number of reasons. A dredge pipeline is the least intrusive transport device in that it contains the slurry and cannot be tampered with along its route (closed pipe), and could be located along the top of the revetment to minimize impacts to the pedestrian trail. This alternative is easily scalable to larger projects as well. Discharging sand slurry at the placement location can be controlled using multiple manifolds at different flowrates as needed. This allows for flexibility under changing conditions so that construction is optimized.

This alternative includes two options of sand extraction. One option is to use a suction dredge with cutter-head and transport the slurry through a dredge pipeline to the placement area (Figure 19). Another option is to use a clamshell bucket to dredge the sand and place it in a hopper that is fed into a slurry pump (Figure 20). Based on review of the project site and the anticipated volume, a small dredge would likely be sufficient to excavate and transport the materials to the placement location. To maximize the potential number of bids received for the project, we do not anticipate requiring specific equipment to be used for excavation.

D180631.00 - Surfers Beach Pilot Project

Figure 19
Suction dredge with cutter-head

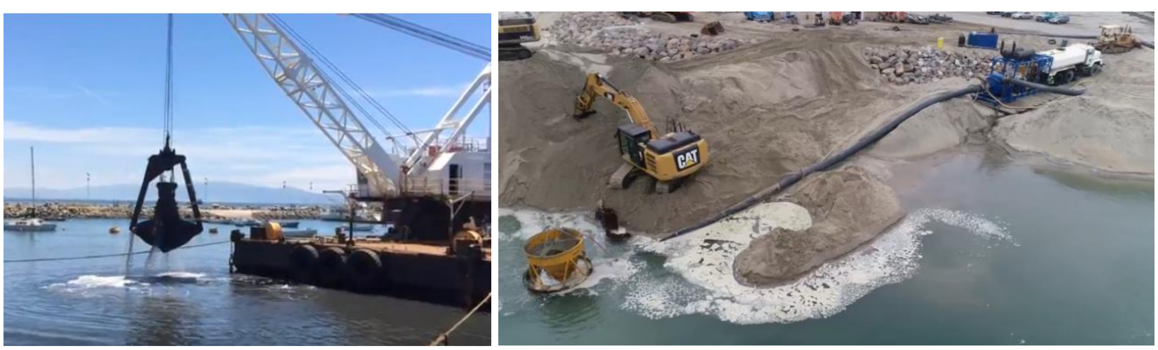

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Figure 20
Clamshell bucket dredge using a crane (left) and bucket excavation and transport via hopper to slurry pump (right)

Construction Alternative 2 – Conveyor with Bucket

Under this alternative, sand would be extracted with a bucket and placed on to a conveyor system (Figure 21). The bucket and conveyor alternative requires the sand to be excavated from land or dredged and dewatered before it can be moved on the conveyor. A conveyor is more complicated than a dredge pipe; it is more complicated to set up, may take up more space and is more susceptible to tampering. Transport via conveyor has the potential for spillage along the conveyor route. This option was being considered by the District as an alternative if a suction dredge/slurry was ruled out (e.g. due to MBNMS regulations not allowing for use of a dredge). However, it has been determined that the project is possible under current MBNMS regulation using a suction dredge. Therefore, this option is not being recommended for further analysis as it is costlier to set up and control.

SOURCE: Access Construction Equipment

D180631.00 - Surfers Beach Pilot Project

Figure 21
Portable conveyor system transporting sand

Construction Alternative 3 – Trucks

This alternative involves the excavation of sand with land-based equipment, loading onto trucks, and hauling sand to the receiver location. A typical truck used for this alternative could hold approximately 10 cubic yards of sand (Figure 22). Dredged sands would need to be dewatered before it could be loaded onto trucks, which requires a temporary dewatering area or equipment. There are limited access points for trucks at the site, so traffic permits and planning would be necessary to minimize disruptions in the area. This alternative would also require defining a haul route, which would greatly increase existing congestion along Highway 1 between Capistrano Road and Surfer's Beach, as well as a turnaround location or circular route back to the Harbor along Obispo Road and Avenue Alhambra. Delivering sand to the placement area by trucks limits the rate of placement and is more expensive due to the multiple handling steps required to extract and dewater the sand, load the sand onto trucks, haul and dump the sand at the placement area and the spread the sand. Of the three alternatives, hauling sand by trucks also results in more greenhouse gas emissions and causes the greatest disruptions to local traffic.

SOURCE: ESA

D180631.00 - Surfers Beach Pilot Project

Figure 22
Truck dumping sand at South Ocean Beach

Similar to the conveyor belt option above, this option was being considered by the District as an alternative if a suction dredge/slurry was ruled out. Since dredging is possible, this alternative was ruled out due to environmental impacts (GHG emissions), traffic impacts and the fact that using trucks is more complicated and would take more time than the dredge slurry alternative.

4.3 Placement Design Alternatives

The following sections describe the project concept, followed by a series of design alternatives focused on different containment methods, as well as a matrix that summarizes the implications, effort required, and ability to retain sand at the placement area.

4.3.1 Beach Nourishment & Project Concept

Beach nourishment is a common solution for mitigating erosion in coastal areas (e.g., SPUR et al. 2015, USACE 2015b). One type of beach nourishment involves constructing a sacrificial berm along the backshore that erodes during storm events and replenishes the beach profile seaward of the berm while protecting the backshore from erosion and wave run-up. One such use of a sacrificial sand berm at Ocean Beach is shown in Figure 22 above; this interim adaptation measure is constructed each year where sand is excavated from the north where beaches are wide and trucked and placed at two areas where bluff erosion threatens backshore infrastructure.

The sand placement design alternatives are based on the above-mentioned technical studies performed by the USACE. The USACE considered placement design alternatives for a larger 150,000 cubic yard project that consist of a wide sand berm sloping from 10 to 9 feet NAVD at varying widths depending on the extents of placement. The current pilot project under design proposes to excavating and transport up to 100,000 cubic yards of sand, as a demonstration for a potentially larger project in the future.

Figures 23 and 24 show a detailed conceptual plan and typical design section, respectively, that would accommodate 100,000 cubic yards of placed sand over the length of the Highway 1 revetment (approx. 1,080 feet). This concept shows the design sand placement section and the likely equilibrated profile after construction is completed. The sand would be contained by a sand berm (note that other options are available and described in sections below) constructed on the existing beach at the east end of the project site. Sand slurry would be discharged landward of the containment berm and allowed to decant. Once sufficient sand is built up, it can be mechanically spread using excavators or dozers. The constructed geometry of the sand embankment would be slightly higher than the target geometry for the near-term equilibrium conditions. In other words, the sand embankment is built up such that after construction, the top-most, seaward edge sloughs and moves the toe seaward, similar to the concepts described by the USACE (2015a).

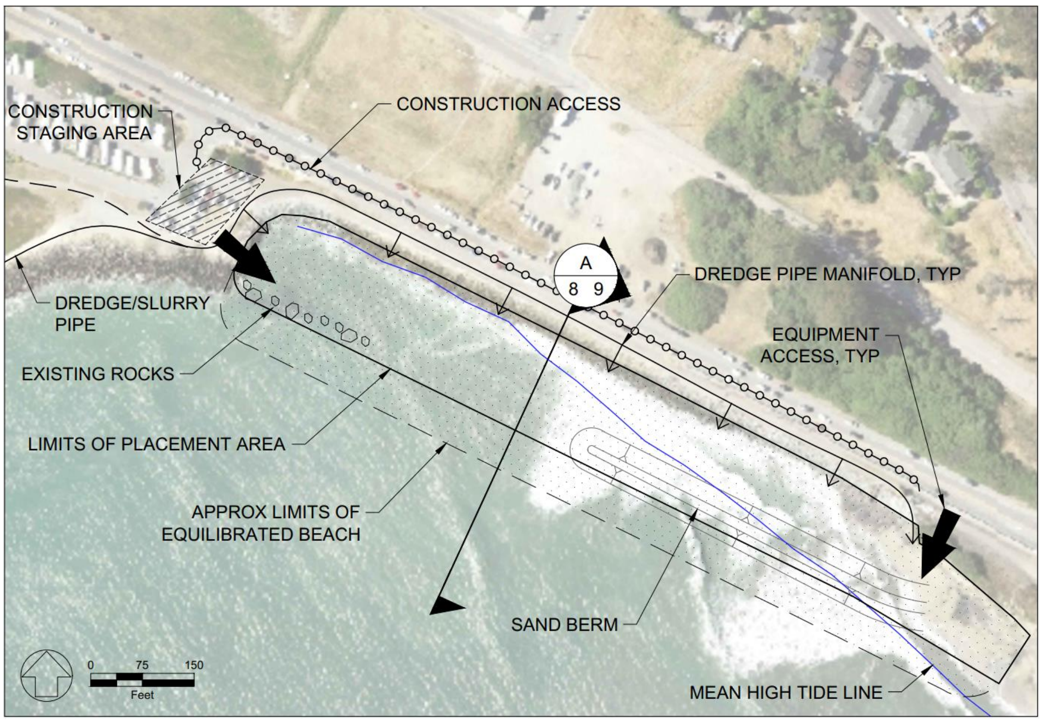

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Figure 23
Placement area along Highway 1 revetment

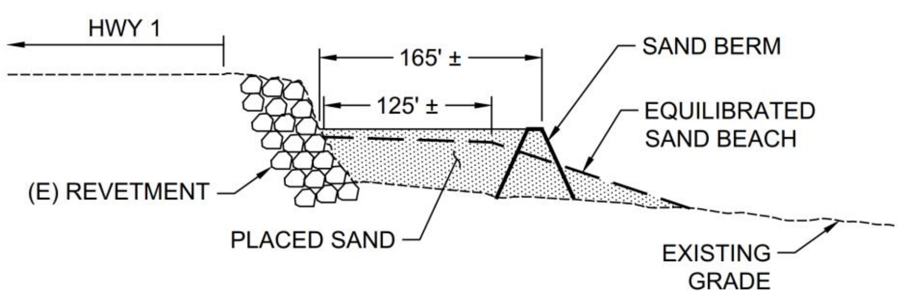

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Figure 24
Typical design profiles for sand placement along Highway 1 revetment

4.3.2 Slurry Placement Containment

Dredged sand can be contained during placement with a variety of methods. A range of methods are possible with varying degrees of effort to construct, maintain and remove after construction is complete. Table 5 presents the range of methods for sand containment that are feasible at the placement area.

TABLE 5
CHARACTERISTICS OF SAND CONTAINMENT METHODS AND POTENTIAL IMPLICATIONS

Method	Can be removed	Implications	Effort to maintain during construction	Comment	Sand retention in placement area
No Containment	N/A	Greater sand transport away from placement, difficulty building elevation.	Low	May not have access for land based equipment.	Low
Sand Berm	N/A	Requires adequate dry sand (beach) for working area.	Medium	Need dry sand and land-based equipment.	Medium
Geotextile Bladder	Yes	Expensive, potentially challenging to deploy and hold in place.	High	Need water pump and land based equipment or crane to position.	Medium
Steel Sheet Piles	Yes	Requires crane access for installation and removal, obstructions (rocks) could impede installation.	Low	Limited	High
Gabion Cages	Yes	Some risk that full removal not possible.	Low	Limited	Medium
Small Rock	No	May mobilize and persist.	Medium	May need to regrade to maintain section.	Medium
Large Rock	No	May be objectionable.	Low	Limited	Medium

No Containment

Without any containment device, dredged slurry is pumped through a pipe along the top of the Highway 1 revetment and discharged from a series of manifolds and allowed to flow over the revetment and onto the shoreline. Sand slowly settles out of the slurry and through the water column to build up the beach in the placement area. This method results in a diffused placement of sand and would not build up the beach as effectively. No containment likely results in more sand drifting away from the revetment before settling to the ocean floor and makes it more difficult to build elevation of the beach. Placing sand without containment reduces the construction contractor’s ability to provide a particular grade and design geometry, especially since there may be limited access for land-based equipment to manage the constructed sand beach.

Sand Berm

Sand is pushed into a berm along an offset from the toe of the revetment. Due to the lack of beach area to work on near the East Breakwater and Highway 1 revetment, the berm is constructed starting at the south end of the placement area where the beach is more easily accessed with existing beach to start the berm. As dredged slurry is decanted behind the initial berm a dozer could push the newly placed sands to build up and extend the sand berm moving north. Figure 25 shows a small sand berm constructed along the shoreline (left) to create a slurry dewatering basin that is filled from a dredge pipe with multiple manifolds (locations where sand can be discharged from the pipeline, right) while a dozer spreads the sand.

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Figure 25
Sand berm construction for slurry dewatering; line shows dredge pipe alignment and arrows indicate discharge manifolds

Geotextile Bladder

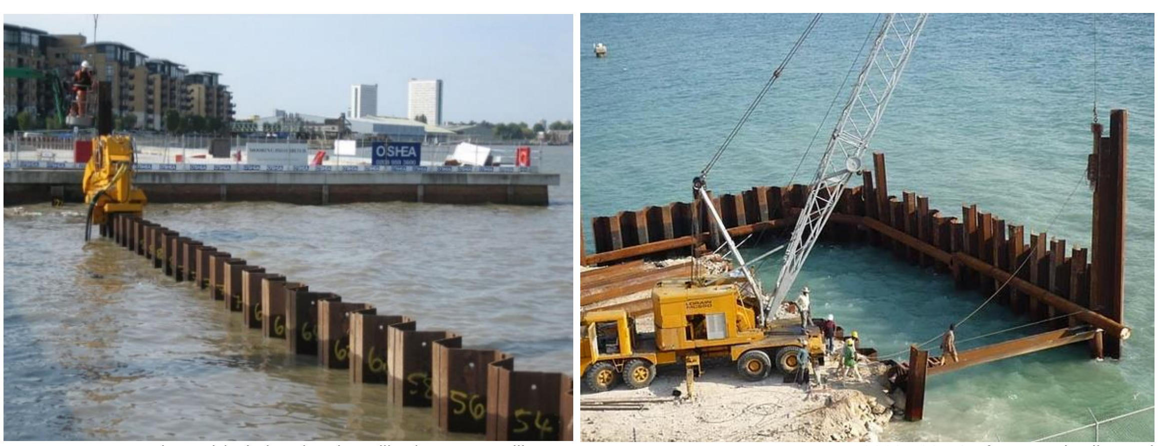
A large flexible tube bladder is placed in the water along an offshore alignment and filled with sand slurry to stabilize in place to provide containment. Dredged slurry is then pumped behind the geo-tubes to dewater. Once the sands are placed, the tubes are emptied and removed. Figure 26 presents a photograph of a geotextile bladder being used for containment in a dredging and placement operation.

SOURCE: www.geologicnow.com D180631.00 - Surfers Beach Pilot Project

Figure 26
Example of Geo-tube bladders as dredge placement containment

Steel Sheet Piles

Sheet piles are driven into the sandy bottom along an offshore alignment to construct a dewatering basin for slurry placement. Once the sand is placed, the sheet piles are removed. This method requires limited maintenance and has the highest sand retention in the placement area during construction. The method requires a crane for placement of individual sheet piles. Rocks and other buried material would likely impede driving of piles. Figure 27 presents photographs of steel sheet piles being used as a containment barrier for fill placement.



SOURCE: www.w-h.co.uk/solutions/marine-piling/, www.escpiling.com D180631.00 - Surfers Beach Pilot Project

Figure 27
Example of steel sheet piles used for dredge placement containment

Gabion Cages

Gabion cages are made of steel wire and filled with stone, and are commonly used in slope stabilization. The cages are placed in an offshore alignment to form a perimeter for sand containment. This option is similar to the sheet piles in that a crane and maybe a barge is needed to place the pre-assembled gabions. Figure 28 presents a photograph showing a series of gabion cages forming a breakwater.

SOURCE: www.gabion-cage.com

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Figure 28
Gabion cages forming a breakwater

Small Rock

Small rock is placed as a berm along an offshore alignment to contain the placed sand. Small rock would be very difficult to remove completely and would require some effort to maintain during construction of the sand placement. Most likely, the small rock would not be removed and would be allowed to disperse into the existing sediment and would be buried in sand as the embankment equilibrates.

Large Rock

Large rock would be placed into a containment berm and would likely be partially buried in sand as the embankment equilibrates. Although the large rock may be slightly easier to remove than the small rock, it may be objectionable from a recreational and environmental perspective. However, adding large rocks to the existing rocks (former revetment along the shore) and building up an extension from the breakwater could facilitate repeated sand placement efforts by providing a sheltered location for discharge of slurry.

4.3.3 Preferred Sand Placement

The preferred sand placement consists of the following elements, subject to further engineering and decisions to be made during design, environmental review, and permitting:

- Place sand at the most eroded portion of shore near the breakwater and along armored portion of Highway.
- Anticipate some "losses" of sand owing to transport away from the site during construction, and therefore facilitate containment to limit losses and place additional sand to counter losses
- Excavate sand using a hydraulic dredge (with cutter-head and/or hopper fed by clamshell, per decision of construction contractor)
- Dredge limits were informed by sediment sampling results, with the objective of obtaining coarser sand
- Transport sand from excavation area to the placement by pumping a sand slurry through a pipeline located along the beach inside the harbor, turning along the breakwater toward Highway 1, and then located above the rock revetment along Highway 1
- Containment using a temporary sand berm barrier is considered the most feasible, and should be included in the project description and design
- The Construction Contractor will determine whether the sand slurry discharge has one discharge point or has multiple (e.g., a manifold)
- Manage construction risk by separating the construction contract into two primary work items for acceptance, measurement and payment:
  - Excavation: well-defined and low risk
  - Placement: less-defined and higher risk; allow Construction Contractor to test a limited number of different options for placement

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5 PRELIMINARY ENGINEERING DESIGN

This section describes the preliminary engineering design of the preferred alternative (see Section 4) and presents a summary of the project description, a discussion on design of the dredging plan and sections, a discussion on the design of the placement area and sections, preliminary information on construction access and staging, discussion of coastal resources that could be potentially affected by the project, and a preliminary opinion of probable construction costs. The 30%-complete construction plans, which reflect this information, are located in Appendix B.

5.1 Project Description Summary

As described in the sections above, the Surfer's Beach Pilot Restoration Project (project) is a multi-objective, beneficial reuse beach nourishment project. The project will include dredging and placement of up to 100,000 cubic yards of sand from within Pillar Point Harbor (PPH) that will be pumped to Surfer's Beach, immediately south of the East Breakwater. The project is being designed to address coastal erosion and reduce the threat of structural damage and recreation loss along Surfer's Beach. Specific benefits include: preventing or mitigating beach erosion and sea cliff retreat; improving protection of Highway 1 and other structures; increasing quality and quantity of public access and recreation; reducing the need for hard structures (e.g. seawalls and revetments) and improving beach habitat. This project will also address the issues associated with the shoaling that has occurred inside of the Harbor since the outer breakwater was constructed. The project is considered a pilot project, in the sense that it will be monitored to evaluate its benefits and impacts, which will be used to inform potential larger placements of sand in the future. Because the project is expected to impact existing eelgrass beds in the East Basin of PPH, the District has contracted with ESA to develop the engineering design and construction documents for an eelgrass mitigation project (eelgrass project) that is based on a recently completed Eelgrass Mitigation Plan for PPH (MTS 2020).

5.2 Dredging Plan and Sections

Material for the project will be sourced from dredging in the PPH East Basin (Figure 29). We identified six distinct dredge zones that will be used to sequence dredge activities and to allocate material for the project and the eelgrass mitigation project, which is expected to be constructed first or possibly concurrently. Note that the eelgrass bed located at the landward end of the East Breakwater is a reference eelgrass bed that is to be left undisturbed in its existing state, and which will be used as a baseline for evaluating the performance of the eelgrass project in the West Basin. The excavation footprints and geometry of dredging were designed to meet both material volume and sequencing needs for the Surfer's Beach and eelgrass projects. We sequenced the dredging of each zone based on its likely destination (e.g., Surfer's Beach or eelgrass project), as well as its sediment characteristics, presence of eelgrass, impact on commercial fishing, and recreational use within PPH and at the project site (see Table 6). We have sequenced the dredging for the eelgrass mitigation project to proceed first and target the finer sands compatible with eelgrass but less desirable for Surfer's Beach. Note that completion of dredging in zone 1B (flagged for the eelgrass project) will be required to access the zone 1A and 1C material, which will be used at Surfer's Beach (sand sizes and dredge areas are described in Section 2.6). A significant amount of very coarse sand is located in the vicinity of the Deer Creek outfall adjacent to the boat launch ramp. This material is located from near the boat launch docks, up the beach to the outfall, and could be used as a surface material that could mitigate the potential of wind-blown sand issues, but could also be used for other portions of the placement design, including the construction of the temporary containment berms.

The typical dredge pipe alignment is also shown on Figure 29, and will be installed, maintained and manipulated by the contractor. We expect that the final design will include requirements for maintaining pedestrian access with the dredge pipeline in place, and in general the alignments of the pipeline will be limited to the beach, adjacent to the East Breakwater, and along the pedestrian Coastal Trail above Surfer's Beach.

Figure 30 shows typical cross-sections for Sections A and D of the excavation area (see Figure 29 for locations), which identify the design dredge depth, the over-dredge limit, as well as horizontal stationing information and approximate limits of dredge zones. The dredge zones in the East Basin will be excavated to elevation -8 feet NAVD, with an allowed 2-feet over-dredge limit to elevation -10 feet NAVD. Note that in some areas eelgrass will be removed by others prior to dredging, and used as "seed" material for the eelgrass project in the West Basin. Note that the over-dredge increases available sand by 25,000 cubic yards to a total of 100,000 cubic yards.

Eelgrass source material for the eelgrass project is located in zone 2B, and will require physical removal and transplant of eelgrass shoots, consistent with the methods described in the Eelgrass Mitigation Plan for PPH (MTS 2020). Dredging of zone 2B will not commence until after the eelgrass project is complete and all eelgrass has been transplanted to the mitigation site from the source location. Additional details on the eelgrass project are located in the *Pillar Point Harbor Eelgrass Mitigation Project Preliminary Design* (Appendix C).

TABLE 6
PILLAR POINT HARBOR DREDGE ZONE DESCRIPTIONS

Dredge Zone	Area (Acres)	Dredge Invert (feet NAVD)	Dredge Volume (cy)	Sequencing	Material Fate
Dredge Zone 1 – Near Boat Launch Ramp					
1A	2.7	-8.0	15,800	After 1B	Surfer's Beach
1B	2.9	-8.0	45,300	-	Eelgrass Mitigation
1C	0.6	-8.0	760	After 1A,1B	Surfer's Beach
Dredge Zone 2 – Along East Breakwater					
2A	3.1	-8.0	27,000	-	Surfer's Beach
2B	4.6	-8.0	45,300	After Eelgrass Project	Surfer's Beach
2C	1.1	-8.0	5,900	-	Eelgrass Mitigation

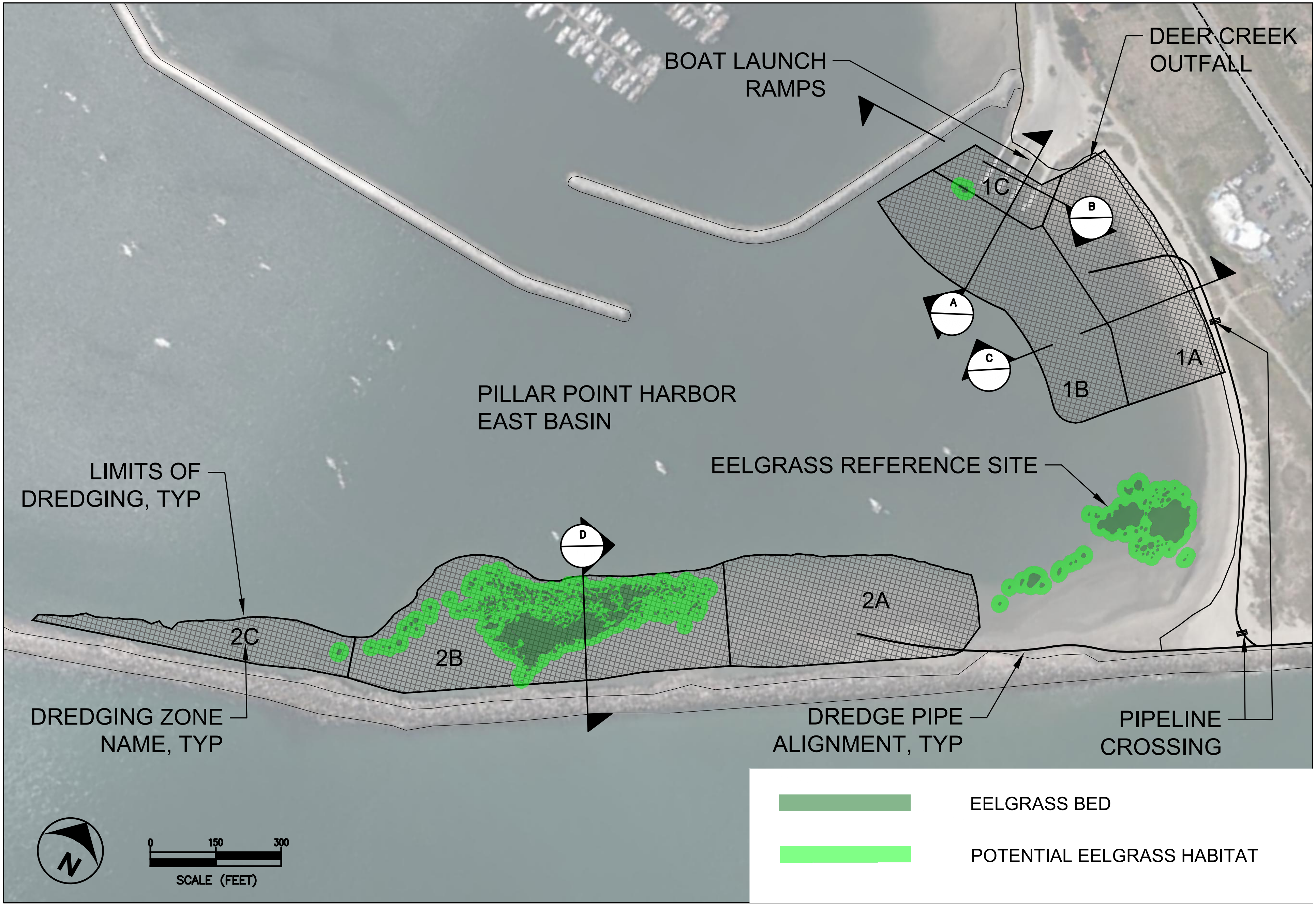

Figure 29
Map of dredge zones and existing eelgrass beds

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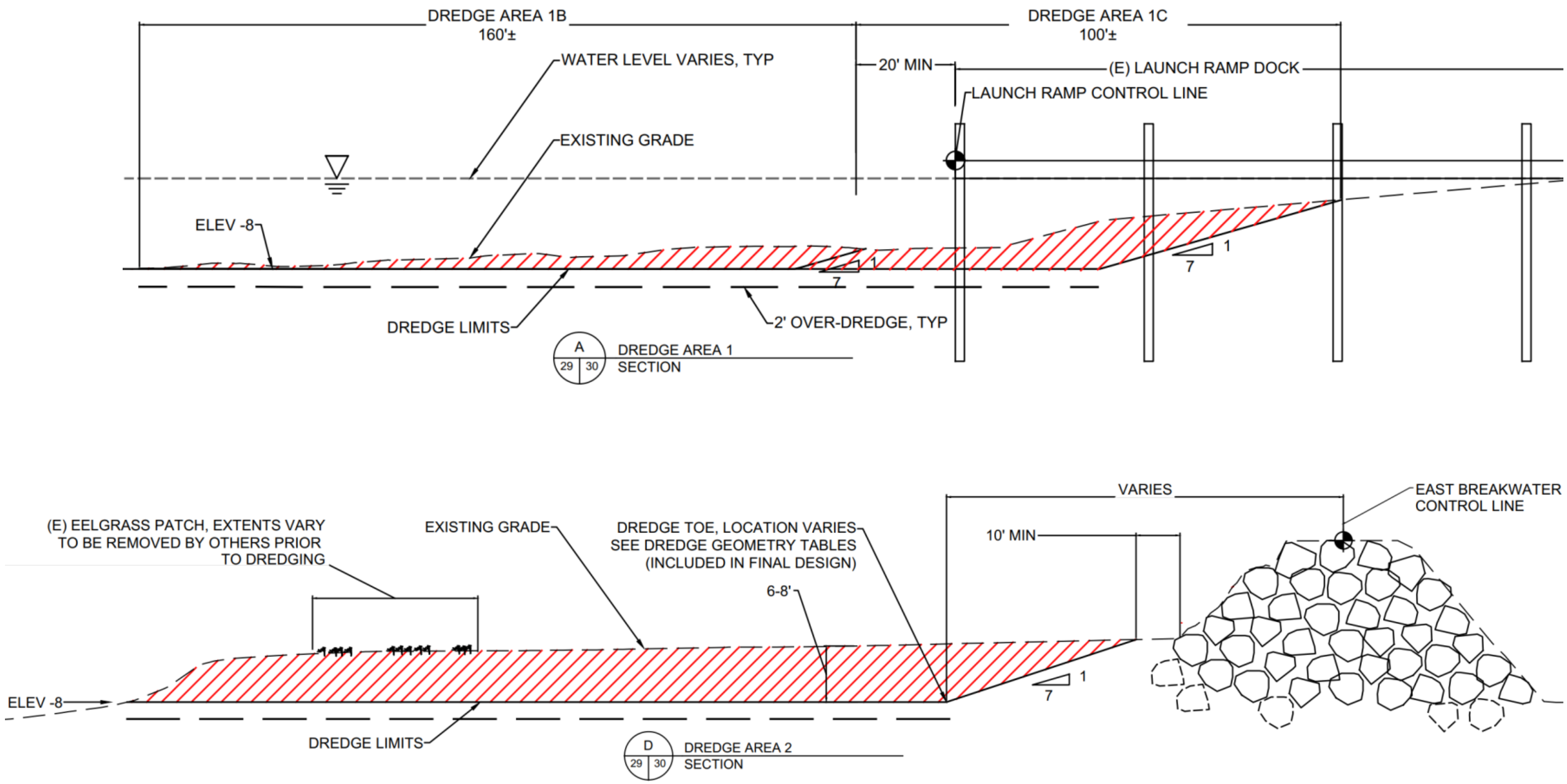

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Figure 30
Typical dredge sections at Sections A and D (see plan view Figure 29, additional sections in Appendix B)

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5.3 Placement Plan and Section

Dredge materials will be discharged at Surfer's Beach to nourish the eroded beach by constructing a linear sand fill "embankment" along approximately 1,000 feet of shore fronting Highway 1. Following construction, the sand is expected be transported from the placement location by waves and currents to the offshore and to the south, resulting in a sand beach that will diminish over time. Figure 31 presents a plan view of the placement area. The figure shows the dredge pipe alignment extending to the placement area from the PPH East Basin, which will discharge sand slurry from a single discharge point or a series of manifolds, which is still under consideration for final design. Also shown on the figure are construction access routes, construction staging areas, beach access location for construction equipment, limits of sand placement, and the mean high water line (or mean high tide line).

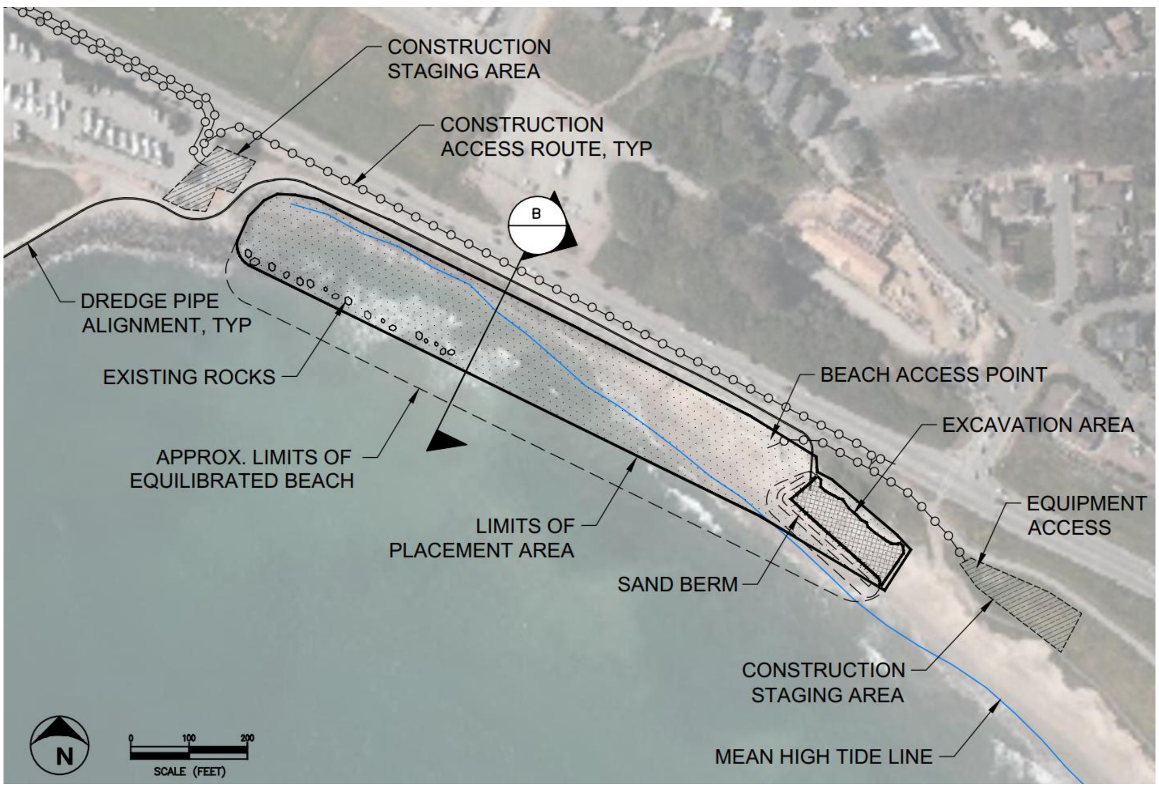

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Figure 31
Plan view of the sand placement area at Surfer's Beach

Sand placement is expected to start at the south end of the placement area and work north toward the East Breakwater. Prior to discharging sand slurry, the contractor will grade a small area of existing beach to build a containment berm on the order of 4 to 6 feet tall with the native sand. This berm will form a cell into which the slurry sand will be discharged and allowed to decant, after which it can be shaped by heavy equipment into the beach's design geometry. Some of the sand will be used to extend the containment berm, which will form additional cells that will receive sand slurry. We expect that the contractor will test methods and, with approval of the engineer, proceed with slurry discharging and berm construction. Because the placed sand is expected to be subject to waves and tides, ongoing management of the containment berm will be required. In the event that a significant swell and tide combination is forecast that could affect the construction in the placement area, the engineer will notify the contractor to protect the work and remove equipment from the beach.

MBNMS regulations currently do not allow discharge of dredge material within the boundaries of the Sanctuary (below MHW). The initial construction of the containment berm will be located above MHW, and once material is formed into a sand beach "embankment," the material will be moved by equipment and shifting the MHW line as the berm is constructed. To comply with the requirements of the Sanctuary, discharge of the material will occur on the landward side of each containment cell.

Figure 32 presents a typical cross-section of the constructed beach, including the sand berm used for temporary containment during construction. The hatched area of the cross section represents the approximate placement limits. The solid black line represents the approximate shape of the beach face of the berm at the end of the construction period as the sand berm equilibrates to the ambient hydraulics of waves and tides. Note that the beach design elevation and geometry is based on the "Medium Beach Fill" alternative from USACE (2015a), which describes the beach being constructed to elevation 10 feet NAVD with an "embankment" width of approximately 150 feet. Although the project is not expected to protect Highway 1 and the revetment from extreme storm events, we recognize that the presence of a sandy beach will improve performance and decrease exposure of the highway and shore protection structure to waves.

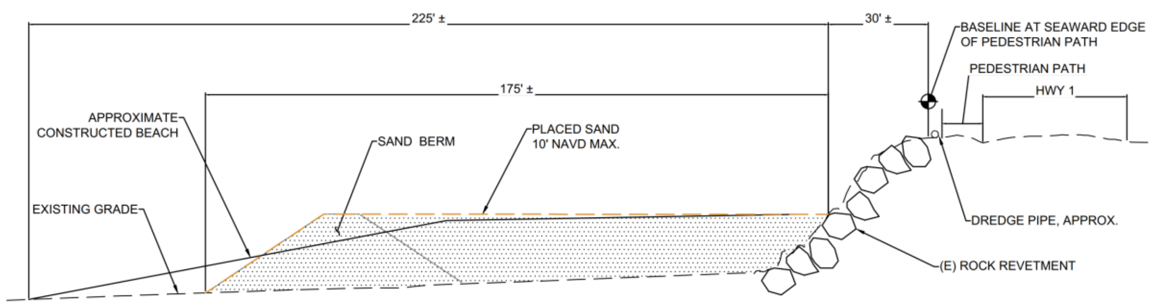

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Figure 32
Typical cross-section of the constructed sand berm, including the confinement berm

Table 7 summarizes quantities and parameters of the sand placement and grading. Construction of the initial temporary containment berm is expected to require grading of approximately 1,000 cubic yards of existing beach sand to form the first containment cell at the south end of the placement area. The overall footprint of the sand placement is approximately 5 acres along an approximately 1,000-foot reach of shore.

TABLE 7
QUANTITIES AND PARAMETERS OF SAND PLACEMENT AND GRADING

Sub Area	Area (Acres)	Placement Elevation/Cut Invert (feet NAVD)	Volume (CY)	Order (Rank)	Material Source
Beach Placement Area	4.7	10.0	100,000 (FILL)	2	East Basin
Temporary Berm Cut	0.3	2ft below beach	1,000 (CUT)	1	Surfers Beach

5.4 Construction Staging and Access

This section describes potential construction staging and access areas identified by ESA, which will require additional coordination with various agencies and property owners.

5.4.1 Construction Staging Areas

We have identified three potential construction staging areas:

1. Inside the harbor in the vicinity of the boat launch ramp, which would be used for dredge operations

2. At the existing parking lot at the north end of the placement area, to be used as an intermediate location for access to the dredge pipe and placement area

3. On the bluff top south of the placement area, on the east side of the pedestrian Coastal Trail

Construction Staging Area 1 is located on District property, and we expect can be coordinated relatively easy with the District staff. Consideration of maintaining boat launch activity will be needed in determining the final location of the staging area. This area would include a trailer in the upper boat trailer parking lot (parking lot C-3), near the boat launch, and parking spaces for trucks. Crew would be picked up at the boat launch ramp. Additional area near the boat launch ramp would be used as temporary mob/demob, with an attempt to minimize conflicts with harbor operations.

Construction Staging Area 2 will be located in a heavily-used parking lot adjacent to the RV lot (see Figure 31). It is not known whether special approval is needed to utilize this existing parking lot as a construction staging area. ESA identified this location as a location for staging of small trucks and equipment needed to access and maintain the dredge pipeline.

Construction Staging Area 3 will be located on the bluff top at the south end of the placement area (see Figure 31). Figure 33 presents photographs of the ingress/egress to Construction Staging Area 3 on the left, and a picture of the staging area on the right. Equipment would exit the highway, cross over the curb, and cross the pedestrian Coastal Trail to enter the staging area. This would require temporary and limited public access to facilitate the entrance or exit of equipment and vehicles. This would be an intermittent activity, as there are no major imports of material required for the project via truck. The staging area itself would include an equipment laydown area in the grass area on the east and/or west side of the Coastal Trail and above the bluffs, which would likely have a layer of crushed rock placed for subgrade. The area would be restored at the end of construction. Use of this site as a staging will require approval by San Mateo County.

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Figure 33
Photos of construction ingress/egress (left) and Construction Staging Area 3 (right)

5.4.2 Construction Access to Beach

Construction equipment would access the beach on the south side of the existing pedestrian access stairs. Figure 34 shows photographs of the rock revetment adjacent to the stairs where equipment would access the beach (left) and the equipment route along the Coastal Trail from the Construction Staging Area 3 to the beach access point (right). Preparation of the beach access point for heavy equipment would require moving existing rocks so that a ramp could be constructed from the Coastal Trail to the beach. At the end of construction, the ramp would be removed and the rocks would be replaced. This activity will likely require coordination and approval from San Mateo County, the City of Half Moon Bay, and Caltrans.

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Figure 34
Location of construction access to beach on south side of stairs (left)
and route to beach access from Construction Staging Area 3 (right)

5.5 Coastal Resources Potentially Affected

The project has the potential to affect several high-value coastal resources, including Highway 1, coastal access, and local ecology. The following sections identify these potential issues, but evaluation of potential impacts of the project will be completed by others. Pre- and post-construction monitoring of the project will be conducted to evaluate the benefits and impacts to these resources.

5.5.1 Highway 1

Highway 1 is immediately adjacent to the Surfers Beach placement site and is an important transportation corridor for local residents, as well as commercial and recreational users (Figure 35). Currently, during high tides coinciding with large swell events, the rock revetment is overtopped with water reaching the southbound lane of Highway 1, leaving behind small deposits of sand and gravel along both the coastal access trail and the highway. Construction activities may require temporary and short-lived disruptions to traffic during equipment transport into and out of the staging area, or across the beach access point. No long-term impacts are anticipated.

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Figure 35
Pedestrian Coastal Trail and Highway 1

5.5.2 Coastal Access

The project has the potential to affect important coastal access assets in the project area, including the existing parking area at the north end of the placement site, the Coastal Trail that traverses the project site from the boat launch ramps and south past the placement site and Construction Staging Area 3, pedestrian beach access, lateral access of the beach during construction, and to some extent, surfing. We have identified the following potential effects to coastal access during project construction:

- The small parking lot at the north end of the site might be used for construction staging, and therefore its existing uses would be impacted during construction. No long-term impacts are anticipated.
- Access along the Coastal Trail would likely be interrupted periodically to facilitate movement of construction equipment and vehicles into and out of the staging area and to and from the beach access ramp. During these periods, a flagging crew would control the flow of pedestrians to allow for the movement of vehicles and equipment, and then re-open the trail to use. These disturbances are expected to be relatively short and intermittent.
- A significant amount of signage would be helpful to inform the public of the nature of the construction, and what kinds of impacts or disruptions to their typical use may be expected.
- Access to the beach from the Coastal Trail via the existing stair case is likely to be impacted during the beginning period of sand placement activities, until the primary slurry discharge is moved north of the stairs, and during movement of construction equipment to and from the beach via the construction access ramp. Similarly, lateral access along the beach is expected to be limited to areas south of active sand placement and construction activity.
- The dredge pipeline will likely be a relatively small pipe on the order of 2 feet in diameter, and so would not pose a great obstacle to most pedestrians. It will be located in an alignment so as to limit disturbances that would require somebody to step over or cross the pipe. However, we do expect that some configurations of dredge pipe alignment will pose a crossing obstacle when the pipe crosses an existing pathway, primarily on the beach in the East Basin of PPH. In these locations, a small sand pipe crossing would be constructed. Figure 36 shows an example of a constructed beach crossing for public access over a slurry dredge pipe in Florida.

SOURCE: Amelia Island Living (2021)

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Figure 36
Example of beach crossing for public access over a dredge slurry pipe in Florida

- We do not expect the project to impact surfing negatively, as surfers can enter the water outside of the construction area and paddle to where they want to surf. Signage should be used to inform surfers of the project, and to attempt avoiding entering the construction area from the water side.

5.5.3 Site Ecology

The project is intended to benefit ecology overall, and is beyond the scope of this document. Biological resources will be assessed separately by others in environmental review and permitting for the project. The design of the project endeavors to limit disturbance to existing ecosystems and wildlife, and final design will incorporate additional information as needed and provided.

5.6 Engineer's Estimate of Probable Construction Costs

Table 8 presents an estimate of the probable construction cost for the project, totaling approximately \$2.9 million for a 75,000 cubic yard project. The total increases to about \$3.6 million for a larger project of 100,000 cubic yards. This estimate represents the probable construction costs for a preliminary level of design, and will be refined as the design progresses. Note that the engineer's estimate is targeted to be higher than the lowest bid(s) in a competitive climate. This project is unique, as it hasn't been done before, and most dredge contractors are remote and hence a "premium" is included in the form of a relatively large contingency in the engineer's estimate of construction costs. For the Pillar Point Harbor Eelgrass Mitigation Project, we estimated a probable construction cost of approximately \$1.8 million, assuming it is a separate construction contract. If the Surfer's Beach and Pillar Point Harbor Eelgrass Mitigation Projects are combined, a potential savings on the order of the mobilization (about \$0.5 million) could be realized.

TABLE 8
ENGINEER'S ESTIMATE OF PROBABLE CONSTRUCTION COSTS – 30%-COMPLETE DESIGN

Item	Description	Quantity	Unit	Unit Price	Extended Cost
1	Mob/Demob	1	LS	$ 400,000	$ 400,000
2	Dredge/Placement	75,000	CY	$ 24	$ 1,800,000
	Subtotal Items 1 and 2				*$ 2,200,000*
	Contingency (30%)				*$ 660,000*
	Total w/ Contingencies (Items 1 and 2, Rounded)				**$ 2,860,000**
	Unit Cost with Contingencies				$ 38.13
3	Additional Dredge/Placement	25,000	CY	$ 24	$ 600,000
	Subtotal Items 1, 2, and 3				*$ 2,800,000*
	Contingency (30%)				*$ 840,000*
	Total w/ Contingencies (Items 1, 2, and 3, Rounded)				**$ 3,640,000**
	Unit Cost with Contingencies				$ 36.40

These cost estimates are intended to provide an approximation of total project costs appropriate for the preliminary level of design. These cost estimates are considered to be approximately -15% to +30% accurate, and include a 30% contingency to account for project uncertainties (such as final design, permitting restrictions and bidding climate). This 30% contingency includes a 10% market contingency to account for uncertainty in bidding and contractor availability. These estimates are subject to refinement and revisions as the design is developed in future stages of the project. This table does not include estimated project costs for permitting, design, construction monitoring and/or ongoing maintenance. Estimated costs are presented in 2021 dollars, and would need to be adjusted to account for price escalation for implementation in future years. This opinion of probable construction cost is based on: ESA's previous experience, bid prices from similar projects, consultation with contractors/suppliers, R.S Means (2020) cost database. Please note that in providing opinions of probable construction costs, ESA has no control over the actual costs at the time of construction. The actual cost of construction may be impacted by the availability of construction equipment and crews and fluctuation of supply prices at the time the work is bid. ESA makes no warranty, expressed or implied, as to the accuracy of such opinions as compared to bids or actual costs.

6 CONCLUSIONS AND RECOMMENDATIONS

Based on the above information in this report, we have identified the following conclusions:

- This preliminary design provides documentation of the project's background, relevant information on the erosion, water levels, waves, and sediment dynamics, as well as limited understanding of existing ecology of the site.
- The preferred project alternative was selected based on an alternatives analysis completed by the USACE as part of the CAP 111 study (USACE 2015a, USACE 2016), information in the Regional Sediment Management Plan (USACE 2015c), and based on review of information and discussions with the project TAG, including additional modeling by the USACE in 2019.
- The engineering design defines the dredging of approximately 75,000 to 100,000 cubic yards of sand from the East Basin of Pillar Point Harbor and placed at Surfer's Beach as a beneficial reuse of sediment. The dredging limits identified in the preliminary plans accommodate up to approximately 100,000 cubic yards of sediment.
- This project is a multi-objective project that is expected to have several co-benefits, including mitigation to or reducing beach and bluff erosion, reduction of hazards to Highway 1 and the revetment structure, improved coastal access and recreation, and improved ecological use of the site.
- The project is expected to impact an existing eelgrass bed in the East Basin of Pillar Point Harbor, which will be mitigated by implementing an eelgrass mitigation project currently in design.
- The project would be constructed using suction or clamshell dredge and pumping a sand slurry from the dredge areas to Surfer's Beach, where it will be discharged in a series of cells formed on the beach by temporary containment berms.
- Potential impacts to coastal resources should be evaluated by others for the project, which would inform changes to the design during development of final design.
- The engineer's estimate of probable construction costs for the Surfer's Beach Pilot Restoration Project is approximately $2.9 million for a 75,000 cubic yard project, increasing to approximately $3.6 million for a 100,000 cubic yard project.
- The engineer's estimate of probable construction costs for the eelgrass mitigation project is approximately $1.8 million (see plans in Appendix C).

- If the Surfer's Beach and eelgrass mitigation projects are combined in one construction contract, a potential savings on the order of the mobilization (approximately $0.5 million) could be realized.

- The dredging for Surfer's Beach and eelgrass mitigation projects will also include a full dredging of the boat launch ramps, which is normally required every six to eight years at a significant expense to the District. The last full dredging of the ramps occurred in 2013, with a partial dredging episode completed in 2019.

Based on the work completed to date, and looking toward next steps, we recommend the following:

- Consider implementing a 100,000 cubic yard project; we expect a minor economy of scale for a larger project, and we suggest placing as much material as possible.

- Consider combining the construction contract for the Surfer's Beach and eelgrass mitigation projects, which could provide a costs savings on the order of $0.5 million.

- Include additive bid item, as an option, for additional dredging to maximize the amount of high-quality beach sand for the project.

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Wiegel, R.L., 1964, *Oceanographical Engineering*, Prentice-Hall, Inc., Englewood Cliffs, NJ, 532 pp.

8 ACKNOWLEDGEMENTS

We graciously thank and acknowledge the contributions of the San Mateo County District staff John Moren and the Project Manager Brad Damitz.

The following ESA staff contributed to the development of the engineering design and this report:

Louis White, PE (ESA Project Manager/Engineer)

Bob Battalio, PE (Project Director)

BK Cooper

Scott Smith, EIT

Becca Deshetler, EIT

James Jackson, PE

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Appendix A
Historical Aerial Imagery of Surfer's Beach and Pillar Point Harbor Vicinity

APPENDIX A
Historical Aerial Imagery of Surfer’s Beach and Pillar Point Harbor Vicinity

This appendix presents several historical aerial images of the project site at Surfer’s Beach, Pillar Point Harbor, and its vicinity over time. The imagery was sourced from the digital libraries of the University of California at Santa Cruz (UCSC) and Santa Barbara (UCSB), as well as the California Coastal Records Project, copyright of Kenneth and Gabrielle Adelman 2002-2015, and the U.S. Naval Photographic Center.

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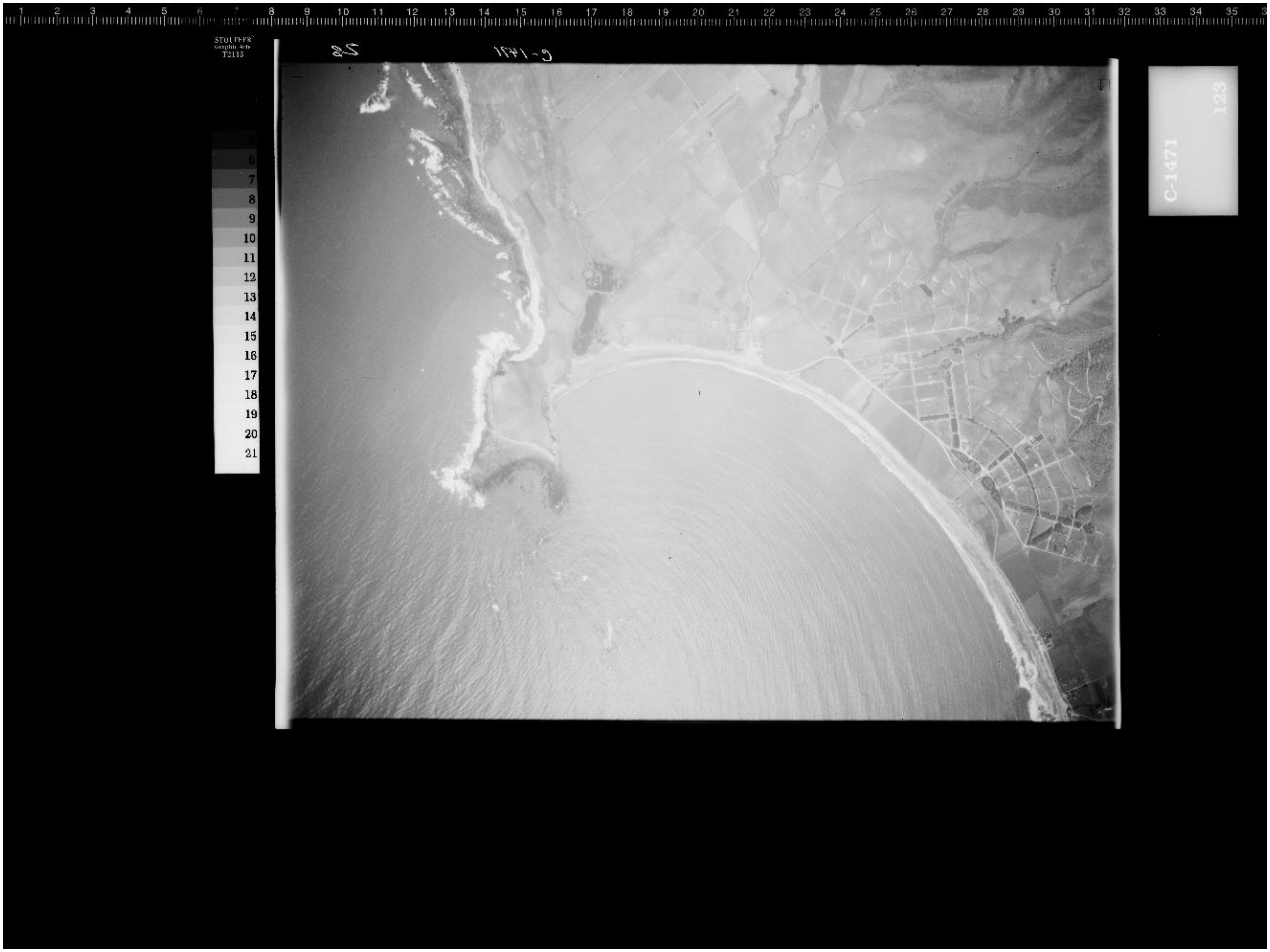
SOURCE: UCSC

Surfer's Beach Pilot Restoration Project

Figure A-1
Aerial Image of Pillar Point and Vicinity: 1928



SOURCE: UCSB

Surfer's Beach Pilot Restoration Project

Figure A-2
Aerial Image of Pillar Point and Vicinity: 1931

SOURCE: UCSB

Surfer's Beach Pilot Restoration Project

Figure A-3
Aerial Image of Pillar Point and Vicinity: 1941

SOURCE: UCSB

Surfer's Beach Pilot Restoration Project

Figure A-4
Aerial Image of Pillar Point and Vicinity: 1943

060824 60824 NEG

NUMBER

DATE 15 March 1943

TAKEN BY: NAS Alameda

LOCATION:

SUBJECT:

Aerial of Army landing strip and the Anti-Aircraft Training Center at Point Montara, Calif. Alt. 7000'; F. L. 8.25". Looking southwest. Filter Aero #1.

RELEASED FOR PUBLICATION: ~~CONFIDENTIAL~~

DATE: DEC 15 1959

ISSUED TO: U.S. NAVAL PHOTOGRAPHIC CENTER

DOWNGRADED TO: UNCLASSIFIED
AUTHORITY: CHINFO LTR 01-250
SER 63 OF 8 JAN 1957

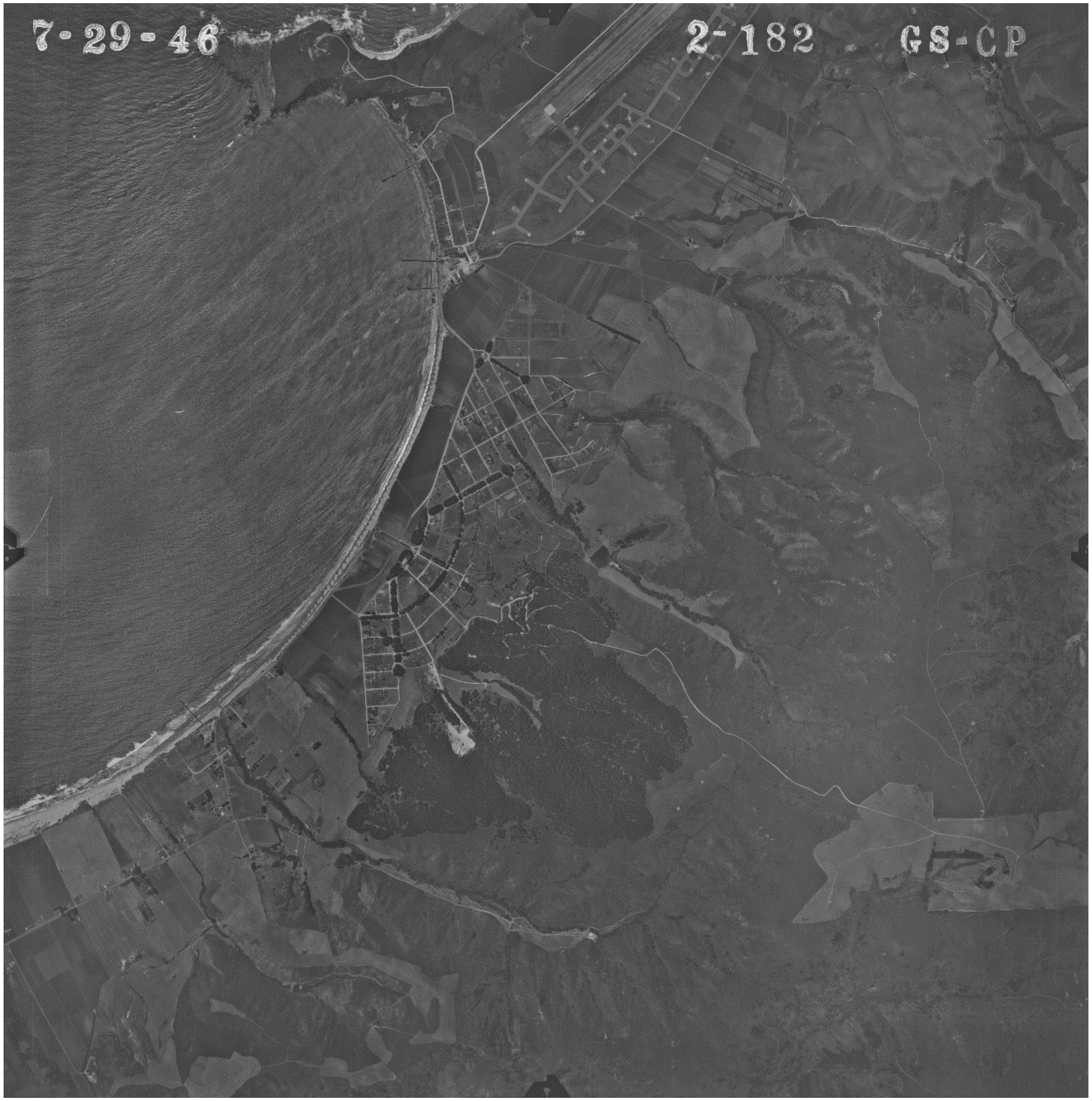
USN
COMMANDING OFFICER

NOTES:

SOURCE: U.S. Naval Photographic Center

Surfer's Beach Pilot Restoration Project

Figure A-5
Oblique Aerial Image of Pillar Point and Vicinity, 1943



SOURCE: UCSB

Surfer's Beach Pilot Restoration Project

Figure A-6
Aerial Image of Pillar Point and Vicinity: 1946

SOURCE: UCSB

Surfer's Beach Pilot Restoration Project

Figure A-7
Aerial Image of Pillar Point and Vicinity: 1956

SOURCE: UCSB

Surfer's Beach Pilot Restoration Project

Figure A-8
Aerial Image of Pillar Point and Vicinity: 1965 – A

SOURCE: UCSB

Surfer's Beach Pilot Restoration Project

Figure A-9
Aerial Image of Pillar Point and Vicinity: 1965 – B

SOURCE: UCSC

Figure A-10
Aerial Image of Pillar Point and Vicinity: 1970 – A

SOURCE: UCSB

Figure A-11
Aerial Image of Surfer's Beach and Vicinity: 1970 – B

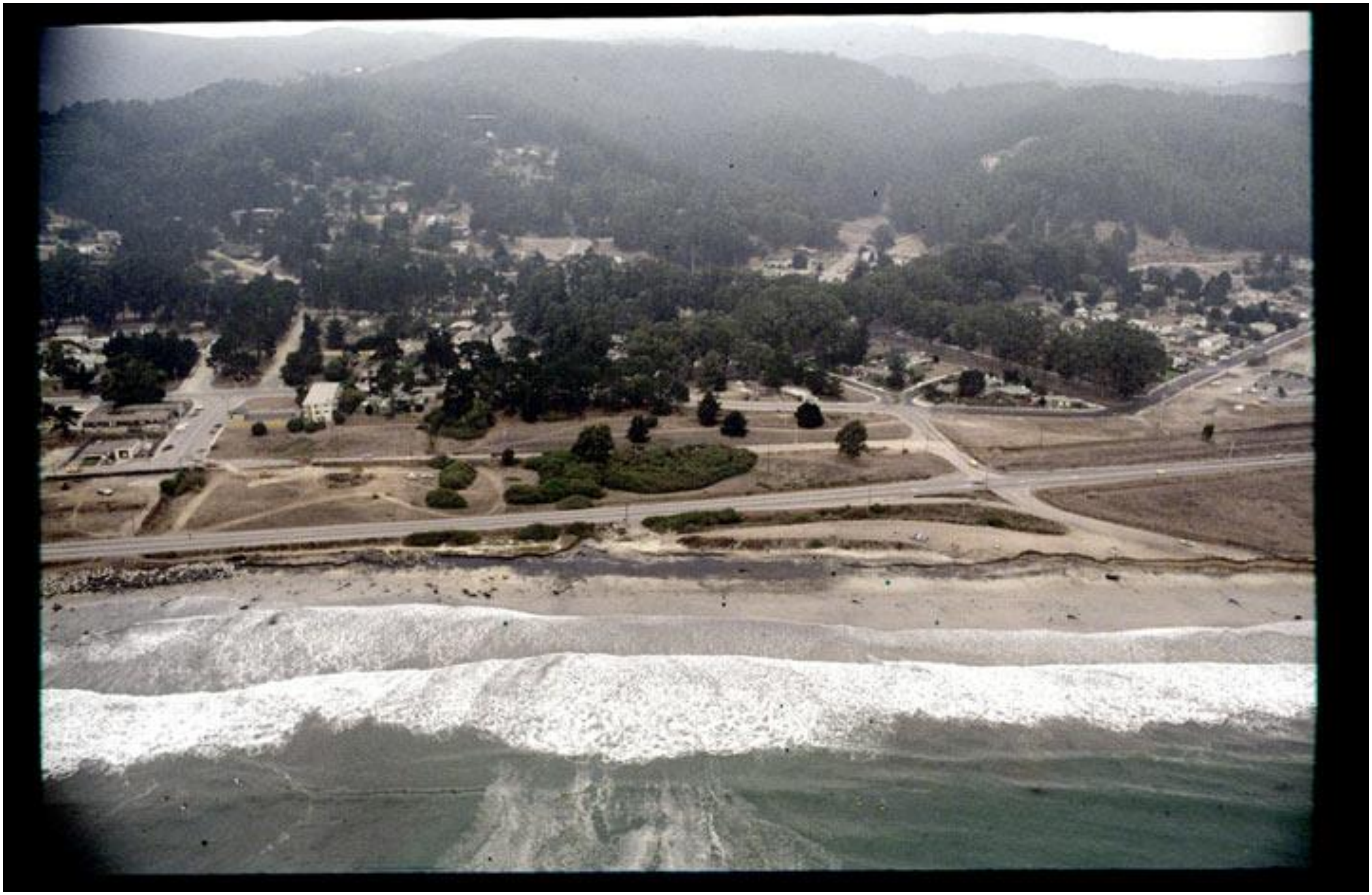
SOURCE: UCSB

Surfer's Beach Pilot Restoration Project

Figure A-12
Aerial Image of Surfer's Beach and Vicinity: 1970 – C

SOURCE: Kenneth & Gabrielle Adelman 2002-2015

Figure A-13
Oblique Aerial of Surfer's Beach Project Site: 1972



SOURCE: Kenneth & Gabrielle Adelman 2002-2015

Figure A-14
Oblique Aerial of Surfer's Beach Project Site: 1979

SOURCE: Kenneth & Gabrielle Adelman 2002-2015

Figure A-15
Aerial of Pillar Point and Vicinity: 1986

SOURCE: UCSB

Surfer's Beach Pilot Restoration Project

Figure A-16
Aerial Image of Pillar Point and Vicinity: 1987

SOURCE: Kenneth & Gabrielle Adelman 2002-2015

Surfer's Beach Pilot Restoration Project

Figure A-17
Oblique Aerial of Surfer's Beach Project Site: 1987

SOURCE: Kenneth & Gabrielle Adelman 2002-2015

Surfer's Beach Pilot Restoration Project

Figure A-18
Aerial of Pillar Point and Vicinity: 1993

SOURCE: UCSB

Surfer's Beach Pilot Restoration Project

Figure A-19
Aerial Image of Pillar Point and Vicinity: 2001 – A

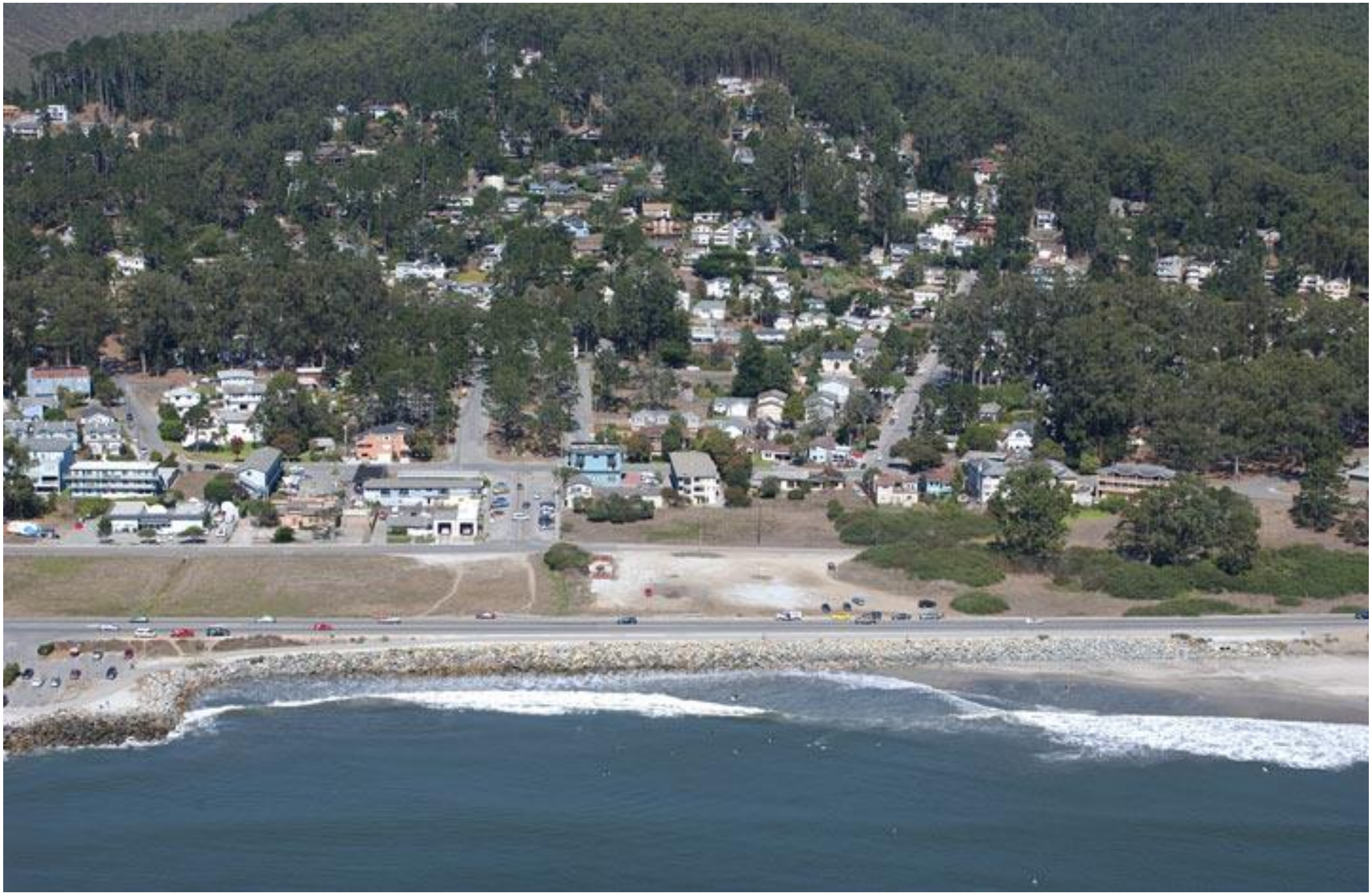
SOURCE: UCSB

Surfer's Beach Pilot Restoration Project

Figure A-20
Aerial Image of Pillar Point and Vicinity: 2001 – B

SOURCE: Kenneth & Gabrielle Adelman 2002-2015

Figure A-21
Oblique Aerial of Surfer's Beach Project Site: 2002



SOURCE: Kenneth & Gabrielle Adelman 2002-2015

Figure A-22
Oblique Aerial of Surfer's Beach Project Site: 2004

SOURCE: Kenneth & Gabrielle Adelman 2002-2015

Figure A-23
Oblique Aerial of Surfer's Beach Project Site: 2005

SOURCE: Kenneth & Gabrielle Adelman 2002-2015

Figure A-24
Oblique Aerial of Surfer's Beach Project Site: 2008

SOURCE: Kenneth & Gabrielle Adelman 2002-2015

Surfer's Beach Pilot Restoration Project

Figure A-25
Oblique Aerial of Surfer's Beach Project Site: 2009

SOURCE: Kenneth & Gabrielle Adelman 2002-2015

Surfer's Beach Pilot Restoration Project

Figure A-26
Oblique Aerial of Surfer's Beach Project Site: 2010

SOURCE: Kenneth & Gabrielle Adelman 2002-2015

Surfer's Beach Pilot Restoration Project

Figure A-27
Oblique Aerial of Surfer's Beach Project Site: 2013

SOURCE: Kenneth & Gabrielle Adelman 2002-2015

Surfer’s Beach Pilot Restoration Project

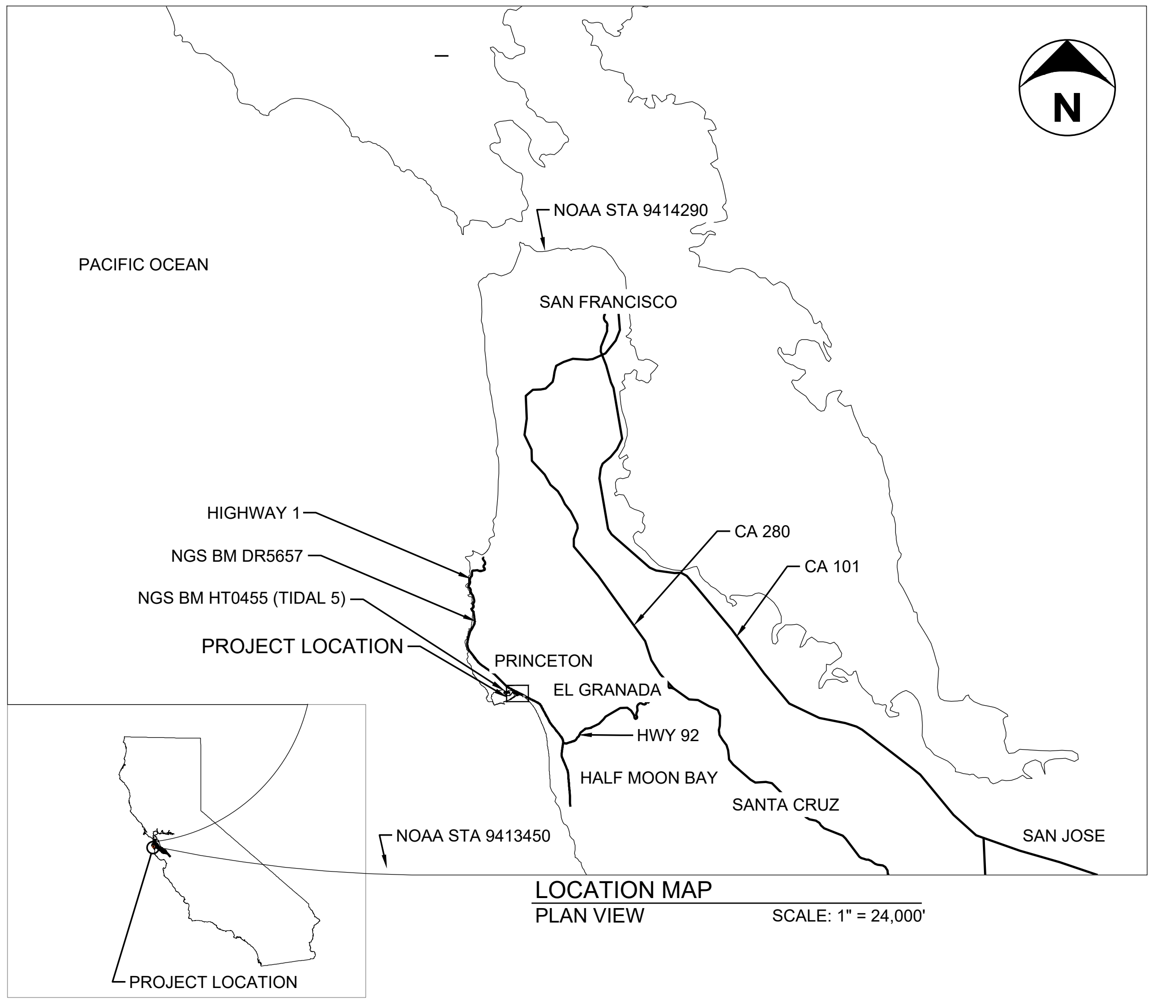
Figure A-28
Oblique Aerial of Surfer’s Beach Project Site: 2019

Appendix B

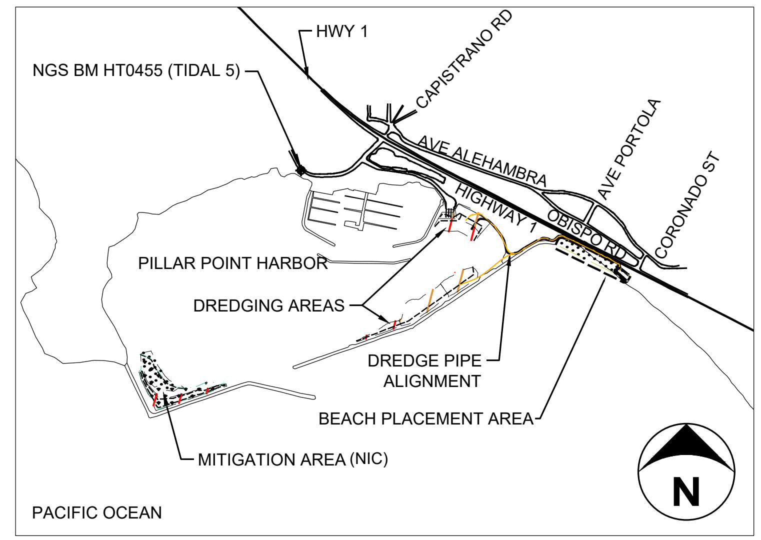
30%-Complete Construction Plans for Surfer’s Beach Pilot Restoration Project

SURFERS BEACH PILOT PROJECT

PRELIMINARY DESIGN
JUNE 9, 2021

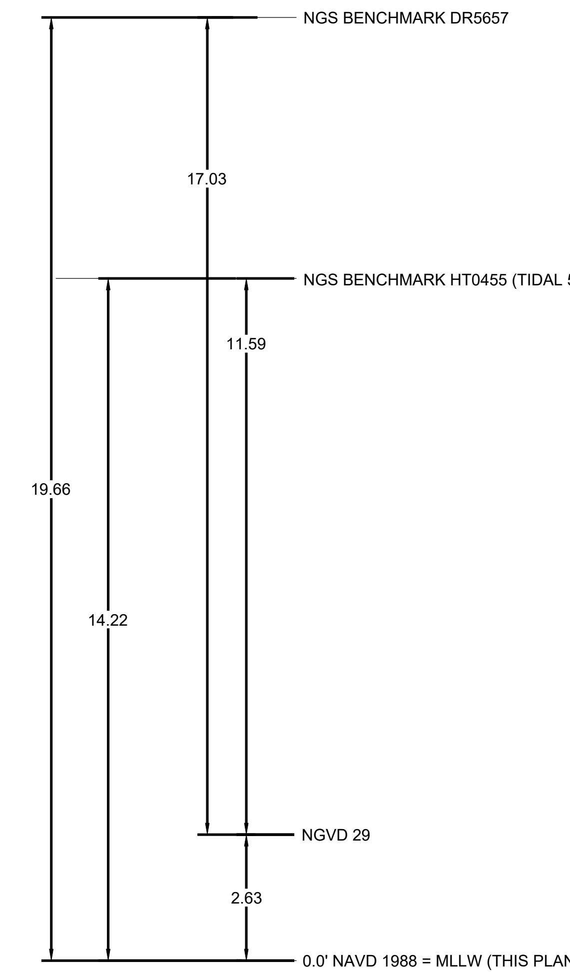


LOCATION MAP
PLAN VIEW SCALE: 1" = 24,000'



VICINITY MAP
PLAN VIEW SCALE: 1" = 1,500'

DATUMS (GENERAL NOTE 4)



INDEX OF SHEETS

SHEET NO.	Sheet Description	Sheet Title
01	C-01	TITLE SHEET
02	C-02	SITE ACCESS & KEY PLAN AND GENERAL NOTES
03	C-03	EXISTING CONDITIONS - PLACEMENT AREA
04	C-04	EXISTING CONDITIONS - DREDGING AREA
05	C-05	DREDGING PLAN
06	C-06	DREDGING SECTIONS
07	C-07	PLACEMENT PLAN
08	C-08	BEACH PLACEMENT DETAIL PLAN
09	C-09	PLACEMENT SECTIONS

DEFINITIONS

PROJECT OWNER: SAN MATEO COUNTY HARBOR DISTRICT
504 AVENUE ALEHAMBRA, STE 200
P.O. BOX 1449, EL GRANADA, CA 94018

CONTACT: JOHN MOREN
PH: (650) 741-9163

PROJECT ENGINEER: ENVIRONMENTAL SCIENCE ASSOCIATES
550 KEARNY STREET, SUITE 800
SAN FRANCISCO, CA, 94116

CONTACT: LOUIS WHITE, PE
PH: (415) 896-5900

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SAN MATEO COUNTY HARBOR DISTRICT
504 AVENUE ALHAMBRA, STE 200,
P.O. BOX 1449, EL GRANADA, CA 94018

REVISIONS

#	DATE	DESCRIPTION

DESIGNED	L. WHITE
DRAWN	S. SMITH
CHECKED	L. WHITE
IN CHARGE	L. WHITE C76509
PROJECT NUMBER	180631.00
ISSUE DATE	6/9/2021

SCALE IS AS SHOWN WHEN PLOTTED TO FULL SIZE (22"x34")
1"

PHASE
PRELIMINARY DESIGN

SHEET TITLE
TITLE SHEET

SHEET NUMBER
C-01

SHEET 01 OF 9

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LEGEND

(symbol)	DREDGING AREA (SBPP, GENERAL NOTE 2)
(symbol)	DREDGING AREA (PPHEMP(NIC) & SBPP, GENERAL NOTE 2)
(symbol)	DREDGING PIPELINE
(symbol)	PLACEMENT AREA
(symbol)	EELGRASS BED
(symbol)	POTENTIAL EELGRASS HABITAT
(symbol)	CONSTRUCTION ACCESS ROUTE

GENERAL NOTES

1) THE SURFERS BEACH PILOT PROJECT AND THE PILLAR POINT HARBOR EELGRASS MITIGATION PROJECT ARE PARALLEL AND INTEGRATED PROJECTS.
2) A. DREDGED MATERIAL SHALL BE ALLOCATED FOR THE PILLAR POINT HARBOR EELGRASS MITIGATION PROJECT (PPHEMP) (NOT IN CONTRACT) FROM DREDGE AREAS 1B, 1C, AND 2B AS PART OF THE PHASING SEQUENCE OUTLINED IN THE SPECIFICATIONS AND UNDER DIRECTION OF THE OWNERS REPRESENTATIVE.
B. ONCE DREDGED MATERIAL FROM AREAS 1B, 1C, AND 2C HAS MET THE VOLUME REQUIREMENTS OF THE PPHEMP, REMAINING DREDGED MATERIAL SHALL BE ALLOCATED TO THE SBPP
3) PLACEHOLDER NOTE
4)

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SHEET TITLE
SITE ACCESS & KEY PLAN AND GENERAL NOTES

SHEET NUMBER
C-02

SHEET 02 OF 9

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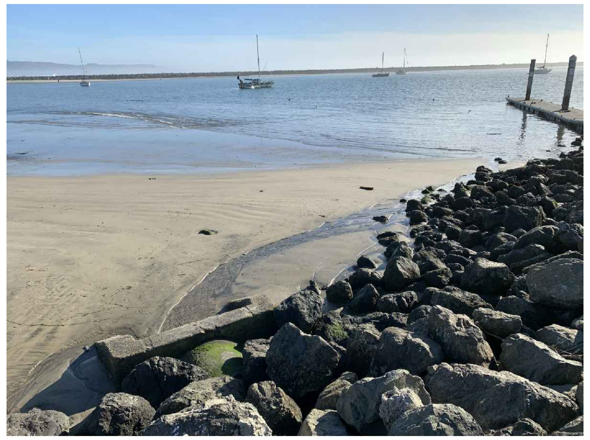

A DEER CREEK OUTFALL - LOOKING SOUTH
PHOTO

B EAST BREAKWATER - LOOKING WEST
PHOTO

C EAST BEACH - LOOKING NORTHWEST
PHOTO

D EAST BEACH - LOOKING NORTHEAST
PHOTO

NOTES

LEGEND

- EELGRASS BED
- POTENTIAL EELGRASS HABITAT
- CONSTRUCTION ACCESS ROUTE

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PHASE
PRELIMINARY DESIGN

SHEET TITLE
EXISTING CONDITIONS - DREDGING AREA

SHEET NUMBER
C-03

SHEET 03 OF 9

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NOTES

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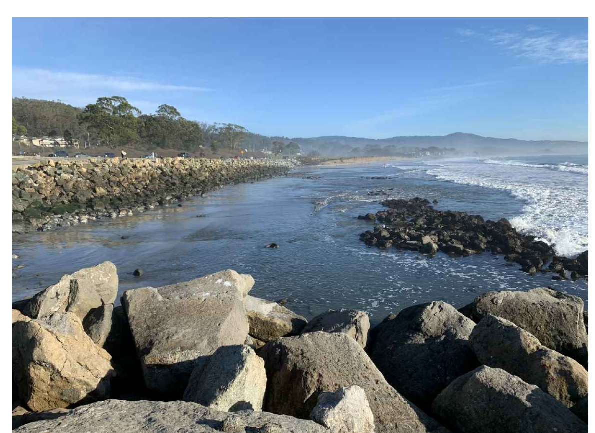
LEGEND

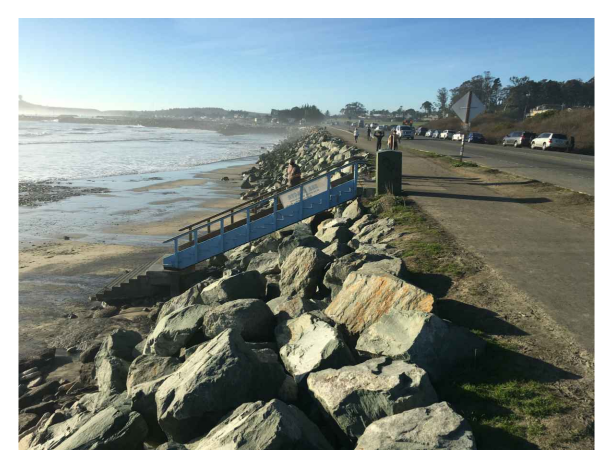
CONSTRUCTION ACCESS ROUTE

CONSTRUCTION STAGING AREA



A SURFERS BEACH - LOOKING SOUTH

PHOTO



B SURFERS BEACH - LOOKING NORTH WEST

PHOTO

C SURFERS BEACH - LOOKING SOUTH

PHOTO

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SHEET TITLE

EXISTING CONDITIONS - PLACEMENT AREA

SHEET NUMBER

C-04

SHEET 04 OF 9

NOTES

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LEGEND

- DREDGING AREA (SBPP, GENERAL NOTE 1)
- DREDGING AREA (PPHEMP(NIC) & SBPP, GENERAL NOTE 1)
- DREDGING PIPELINE
- PLACEMENT AREA
- EELGRASS BED
- POTENTIAL EELGRASS HABITAT
- CONSTRUCTION ACCESS ROUTE

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SHEET TITLE
DREDGING PLAN

SHEET NUMBER
C-05

SHEET 05 OF 9

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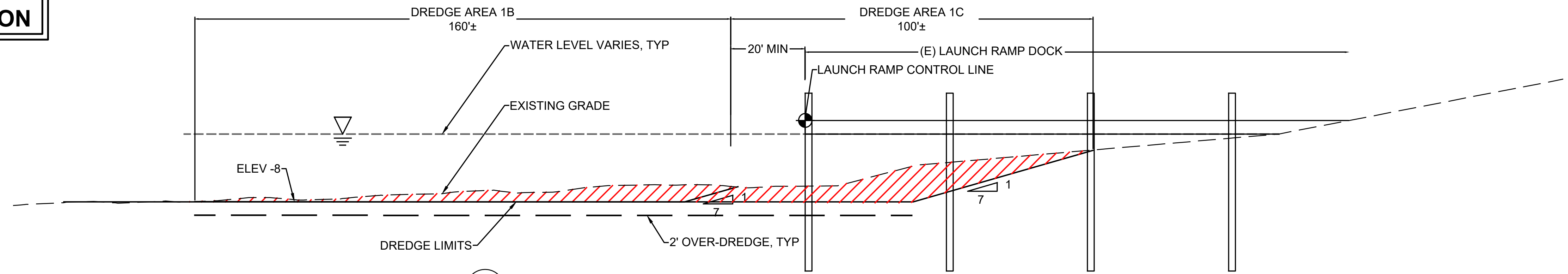

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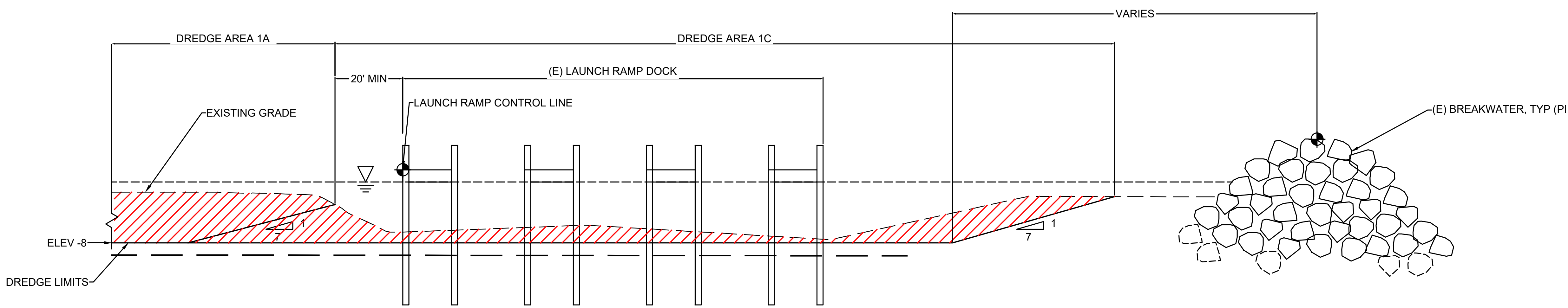

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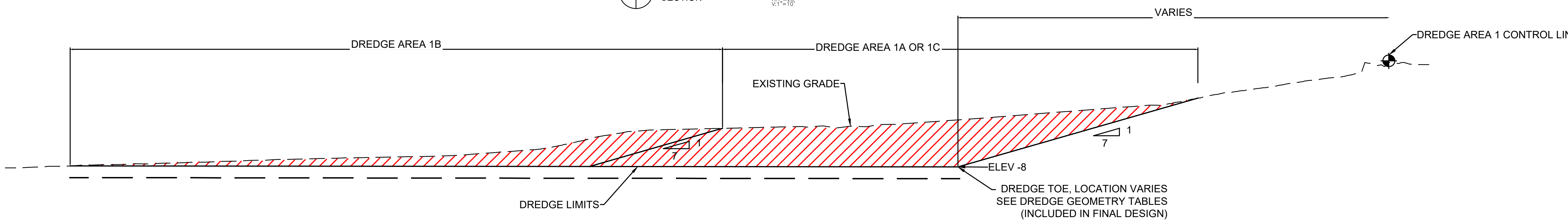

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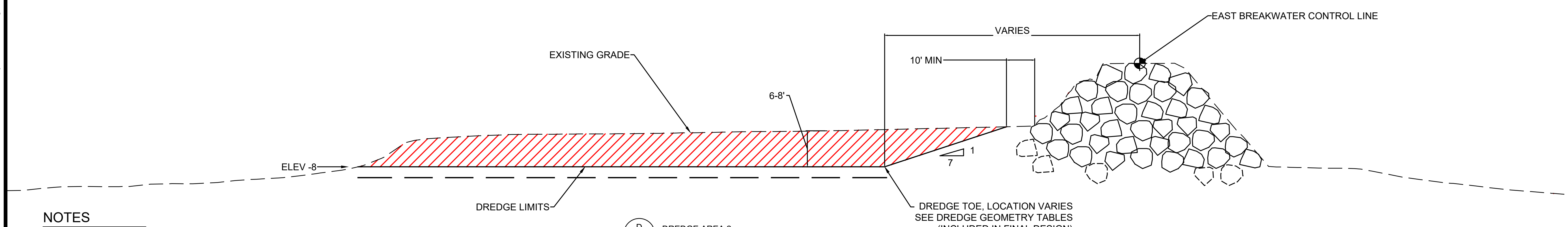

D C-06 C-06 DREDGE AREA 2 SECTION H:1"=20' V:1"=10'

NOTES

1"=20' 20 10 0 20 40
Scale Feet

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SHEET TITLE
DREDGING SECTIONS

SHEET NUMBER
C-06

SHEET 06 OF 9

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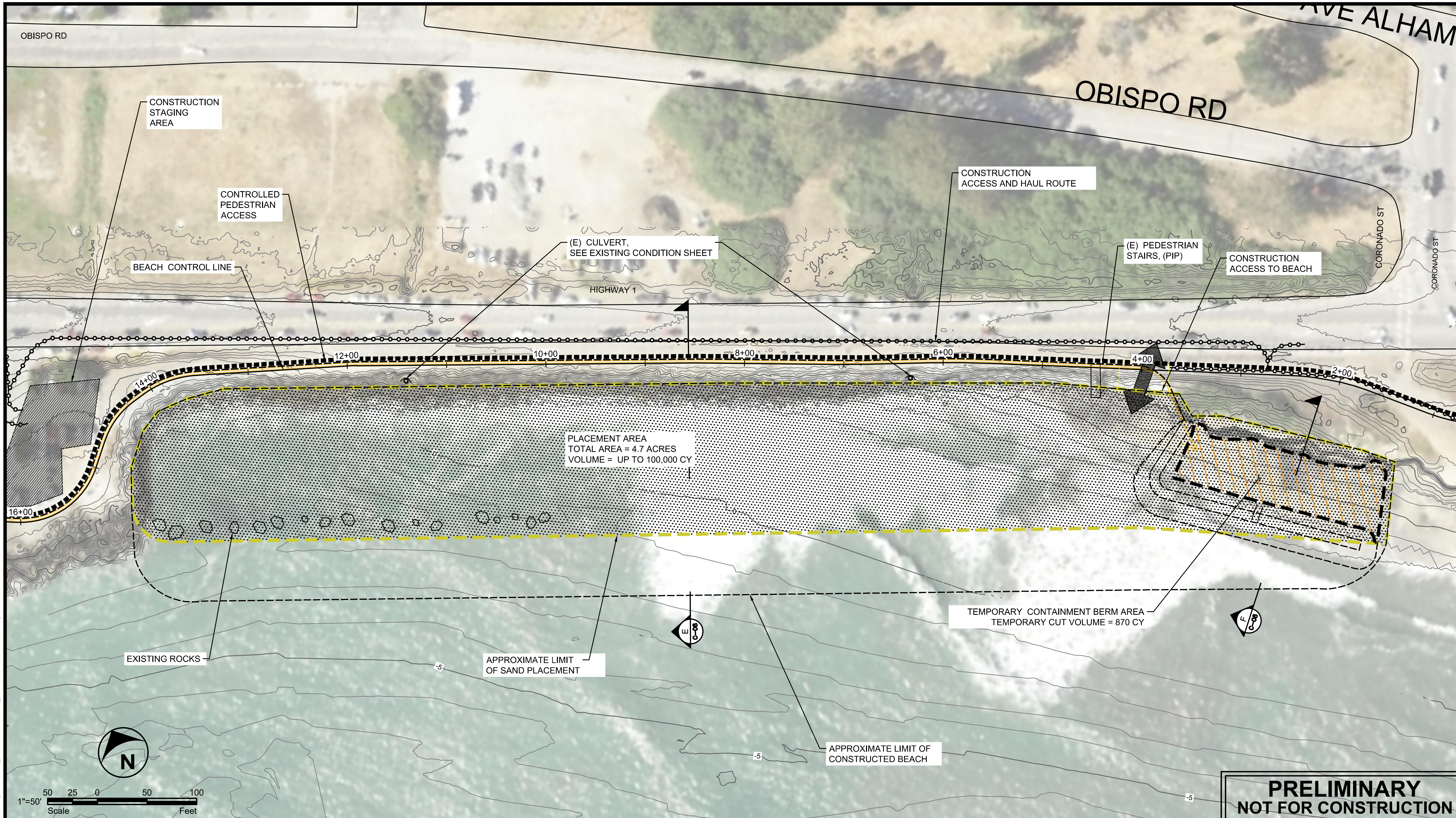

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DREDGING AREA
DREDGING PIPELINE
PLACEMENT AREA
TEMPORARY EXCAVATION
CONSTRUCTION ACCESS ROUTE
PEDESTRIAN ACCESS ROUTE

NOTES

NOTES NOTES NOTES.

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PRELIMINARY DESIGN

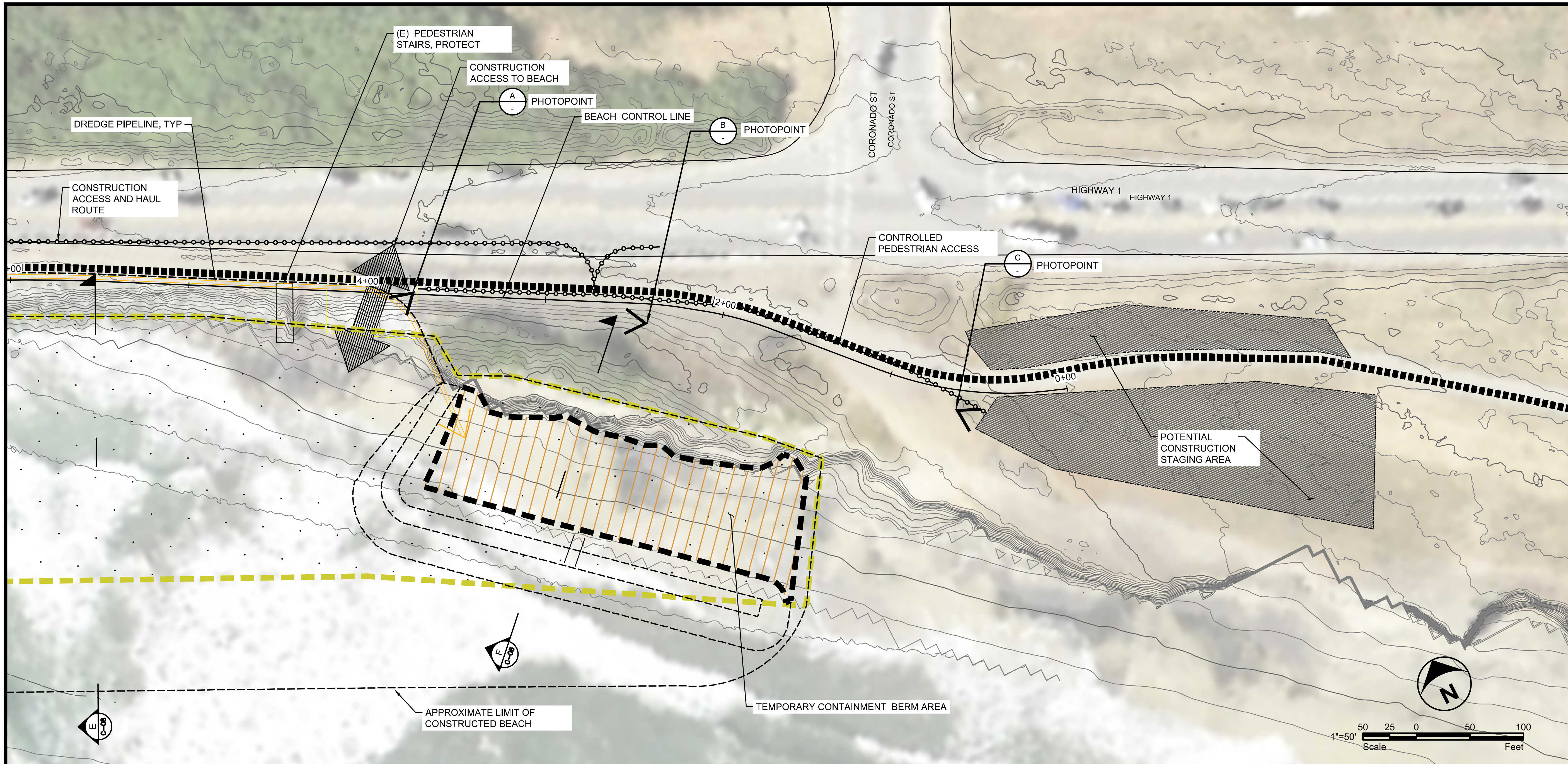
SHEET TITLE

PLACEMENT PLAN

SHEET NUMBER

C-07

SHEET 07 OF 9



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LEGEND

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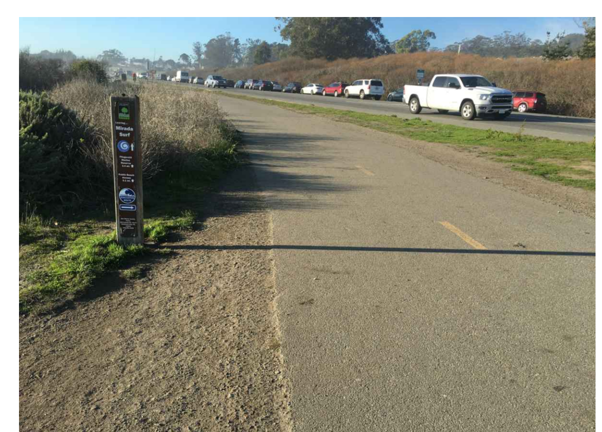
	DREDGING PIPELINE
	PLACEMENT AREA
	EELGRASS BED
	POTENTIAL EELGRASS HABITAT
	CONSTRUCTION ACCESS ROUTE
	CONSTRUCTION STAGING AREA
	PEDESTRIAN ACCESS ROUTE

A SURFERS BEACH - LOOKING NW
PHOTO



B PEDESTRIAN TRAIL - LOOKING NORTH
PHOTO

C PEDESTRIAN TRAIL - LOOKING SOUTH
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SHEET TITLE
BEACH PLACEMENT DETAIL PLAN

SHEET NUMBER
C-08

SHEET 08 OF 9

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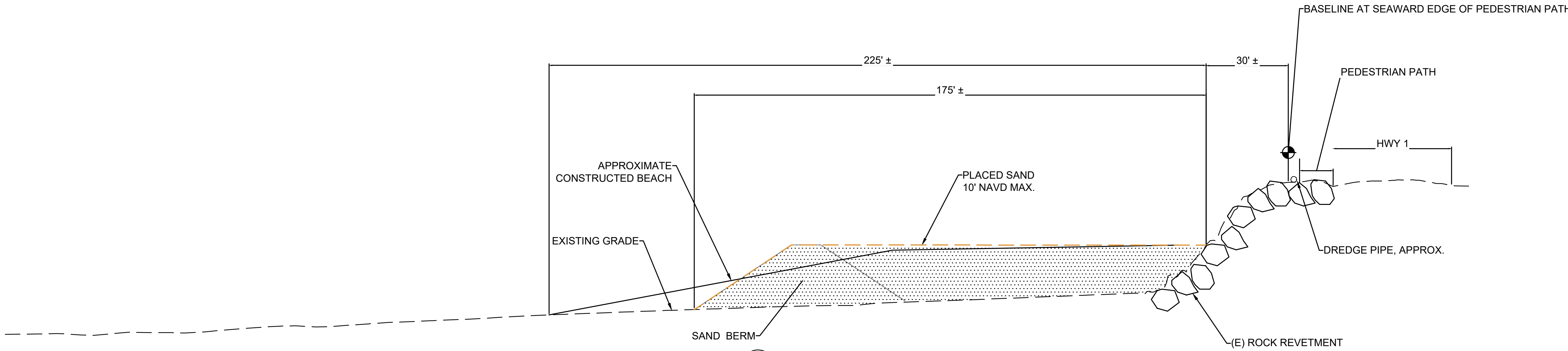
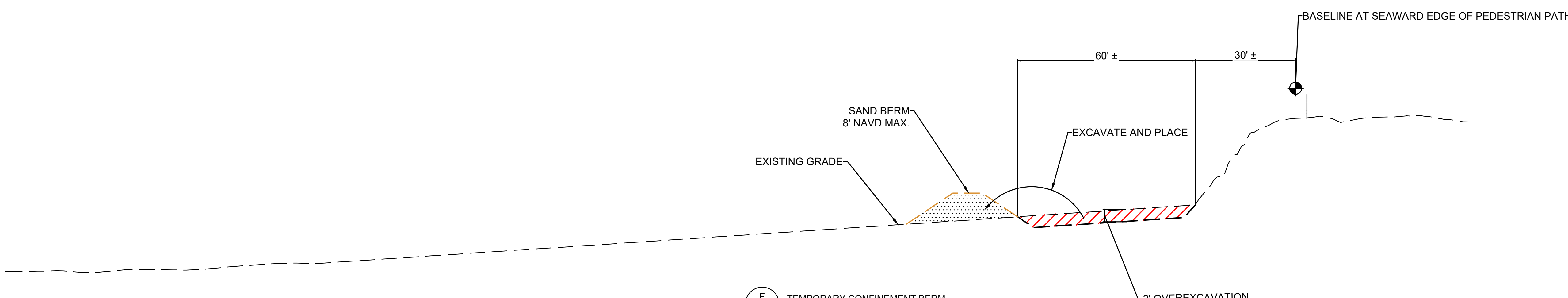


E C-07 C-08 DREDGE PLACEMENT (BEACH) SECTION



F C-07 C-08 TEMPORARY CONFINEMENT BERM SECTION

NOTES

1"=20' Scale 20 10 0 20 40 Feet

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SAN MATEO COUNTY HARBOR DISTRICT CALIFORNIA

PROJECT NAME

SURFER'S BEACH RESTORATION PROJECT PILOT

SAN MATEO COUNTY HARBOR DISTRICT
504 AVENUE ALHAMBRA, STE 200,
P.O. BOX 1449, EL GRANADA, CA 94018

REVISIONS

#	DATE	DESCRIPTION

DESIGNED	L. WHITE
DRAWN	S. SMITH
CHECKED	L. WHITE
IN CHARGE	L. WHITE C76509
PROJECT NUMBER	180631.00
ISSUE DATE	6/9/2021

SCALE IS AS SHOWN WHEN PLOTTED TO FULL SIZE (22"x34")
1"

PHASE
PRELIMINARY DESIGN

SHEET TITLE
PLACEMENT SECTIONS

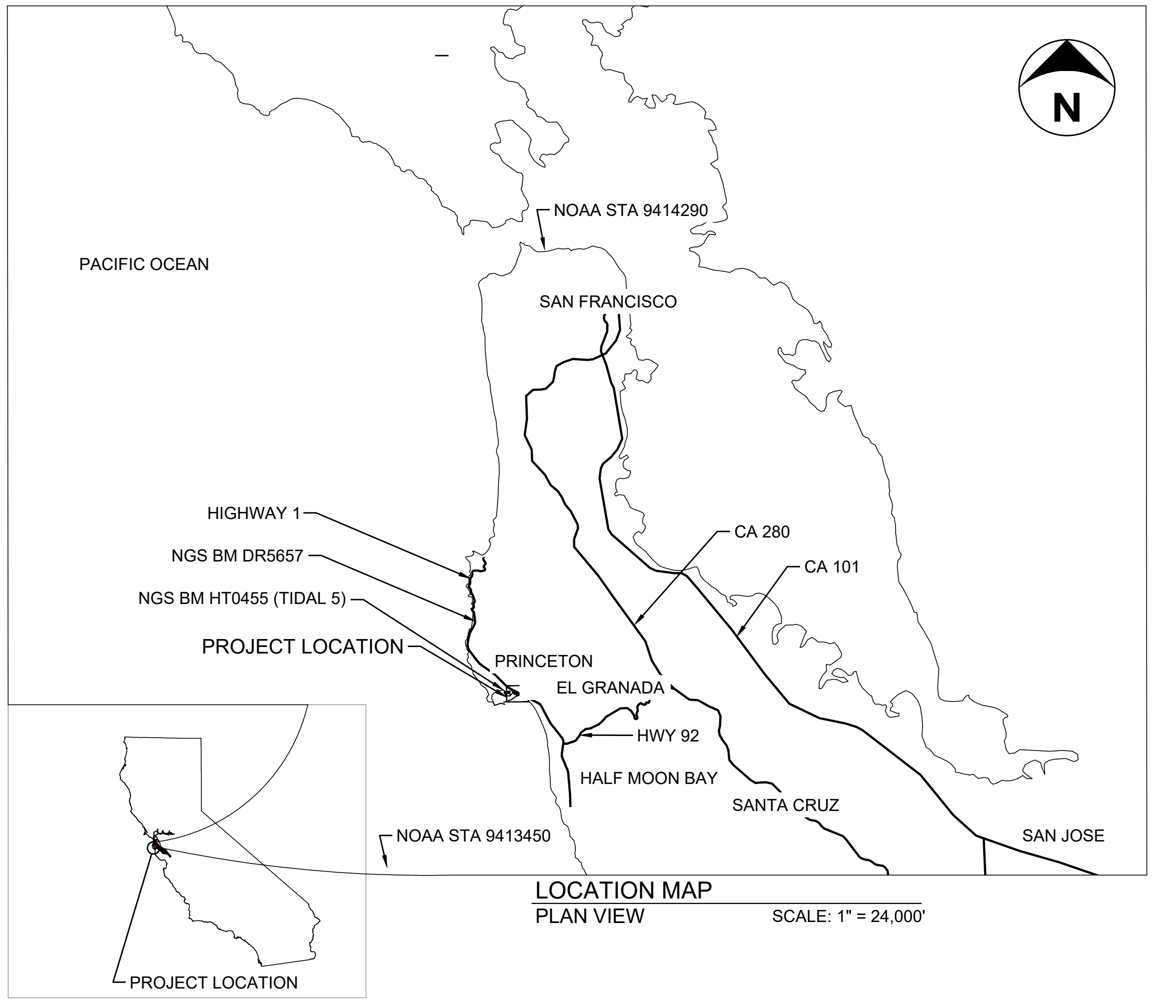
SHEET NUMBER
C-09

Appendix C

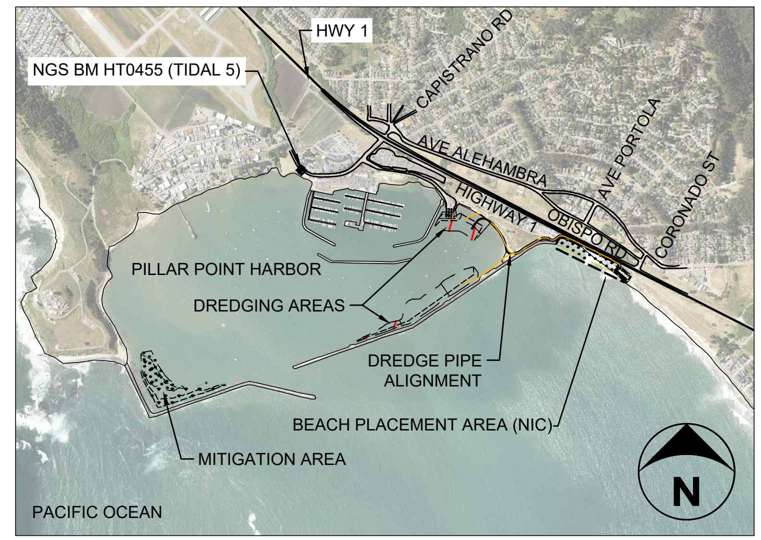
30%-Complete Construction Plans for Pillar Point Harbor Eelgrass Mitigation Project

PILLAR POINT HARBOR
EELGRASS MITIGATION PROJECT

PRELIMINARY DESIGN
MARCH 12, 2021

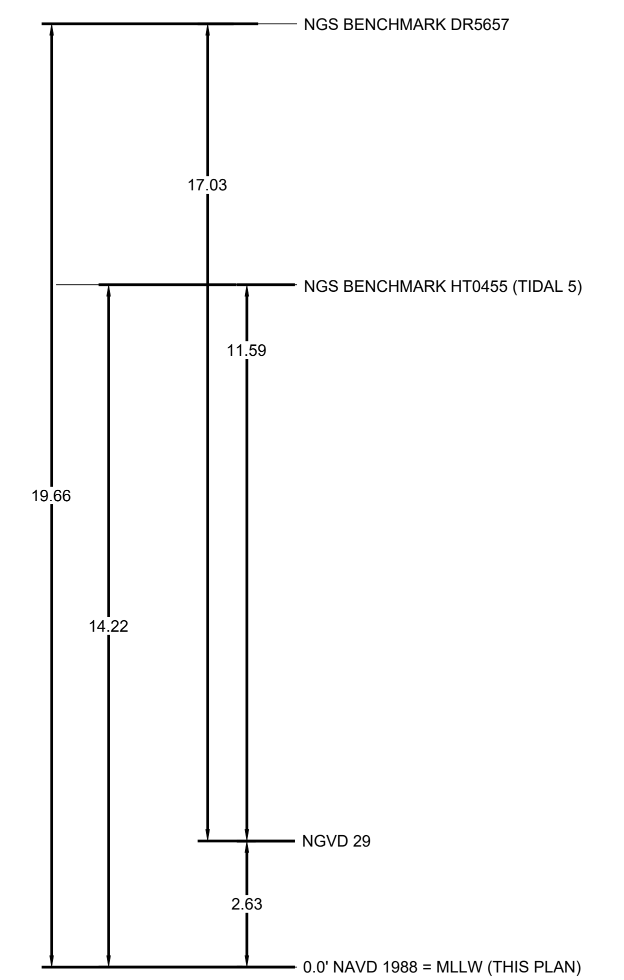


LOCATION MAP
PLAN VIEW SCALE: 1" = 24,000'



VICINITY MAP
PLAN VIEW SCALE: 1" = 1,500'

DATUMS (GENERAL NOTE 4)



DEFINITIONS

PROJECT OWNER: SAN MATEO COUNTY HARBOR DISTRICT
504 AVENUE ALEHAMBRA, STE 200
P.O. BOX 1449, EL GRANADA, CA 94018

CONTACT: JOHN MOREN
PH: (650) 741-9163

PROJECT ENGINEER: ENVIRONMENTAL SCIENCE ASSOCIATES
550 KEARNY STREET, SUITE 800
SAN FRANCISCO, CA, 94116

CONTACT: LOUIS WHITE, PE
PH: (415) 896-5900

INDEX OF SHEETS		
SHEET NO.	Sheet Description	Sheet Title
01	C-01	TITLE SHEET
02	C-02	SITE ACCESS & KEY PLAN AND GENERAL NOTES
03	C-03	EXISTING CONDITIONS - DREDGING AREA
04	C-04	EXISTING CONDITIONS - MITIGATION AREA
05	C-05	DREDGING PLAN
06	C-06	DREDGING SECTIONS
07	C-07	MITIGATION AREA PLAN
08	C-08	MITIGATION AREA SECTIONS

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SAN MATEO COUNTY HARBOR DISTRICT CALIFORNIA

PROJECT NAME
PILLAR POINT HARBOR
EELGRASS MITIGATION
PROJECT

SAN MATEO COUNTY HARBOR DISTRICT
504 AVENUE ALHAMBRA, STE 200,
P.O. BOX 1449, EL GRANADA, CA 94018

REVISIONS

#	DATE	DESCRIPTION

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PROJECT NUMBER	180631.00
ISSUE DATE	3/12/2021

SCALE IS AS SHOWN WHEN PLOTTED TO FULL SIZE (22"x34")
1"

PHASE
PRELIMINARY DESIGN

SHEET TITLE
TITLE SHEET

SHEET NUMBER
C-01

SHEET 01 OF 7

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LEGEND

	DREDGING AREA (SBPP (NIC) (GEN. NOTE 2))
	DREDGING AREA (PPHEMP & SBPP (NIC) (GEN. NOTE 2))
	DREDGING PIPELINE
	PLACEMENT AREA
	EELGRASS BED
	POTENTIAL EELGRASS HABITAT
	CONSTRUCTION ACCESS ROUTE

GENERAL NOTES

1) THE PILLAR POINT HARBOR EELGRASS MITIGATION PROJECT AND THE SURFERS BEACH PILOT PROJECT (NOT IN CONTRACT) ARE PARALLEL AND INTEGRATED PROJECTS.
2) A. DREDGED MATERIAL SHALL BE ALLOCATED FOR THE PILLAR POINT HARBOR EELGRASS MITIGATION PROJECT (PPHEMP) FROM DREDGE AREAS 1B, 1C, AND 2B AS PART OF THE PHASING SEQUENCE OUTLINED IN THE SPECIFICATIONS AND UNDER DIRECTION OF THE OWNERS REPRESENTATIVE.
B. ONCE DREDGED MATERIAL FROM AREAS 1B, 1C, AND 2C HAS MET THE VOLUME REQUIREMENTS OF THE PPPHEMP, REMAINING DREDGED MATERIAL SHALL BE ALLOCATED TO THE SBPP
3) PLACEHOLDER NOTE
4) MATERIAL AND DREDGE QUANTITIES ARE SHOWN IN TABLE, BELOW:

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FILE: K:\projects_2018\D180631.00 - Surfers Beach Pilot Project\10 CAD\Dwgs\PERMIT_FIGS\02 SITE PLAN.dwg PLOT DATE: 3/12/2021 2:23:08 PM PLOTTED BY: SCOTT SMITH

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PROJECT NAME

PILLAR POINT HARBOR EELGRASS MITIGATION PROJECT

SAN MATEO COUNTY HARBOR DISTRICT
504 AVENUE ALHAMBRA, STE 200,
P.O. BOX 1449, EL GRANADA, CA 94018

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PHASE

PRELIMINARY DESIGN

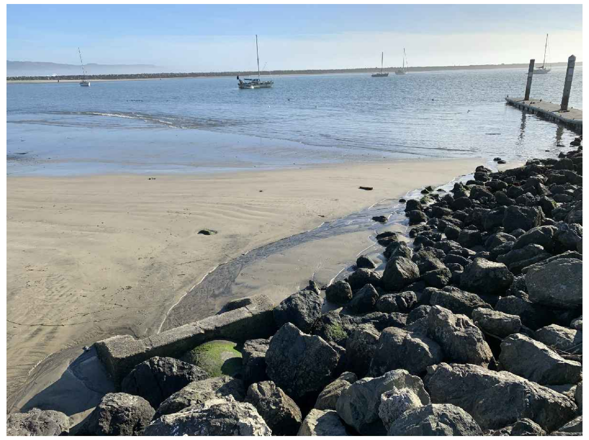
SHEET TITLE

SITE ACCESS, STAGING & SURVEY CONTROL

SHEET NUMBER

G03

SHEET 03 OF 7

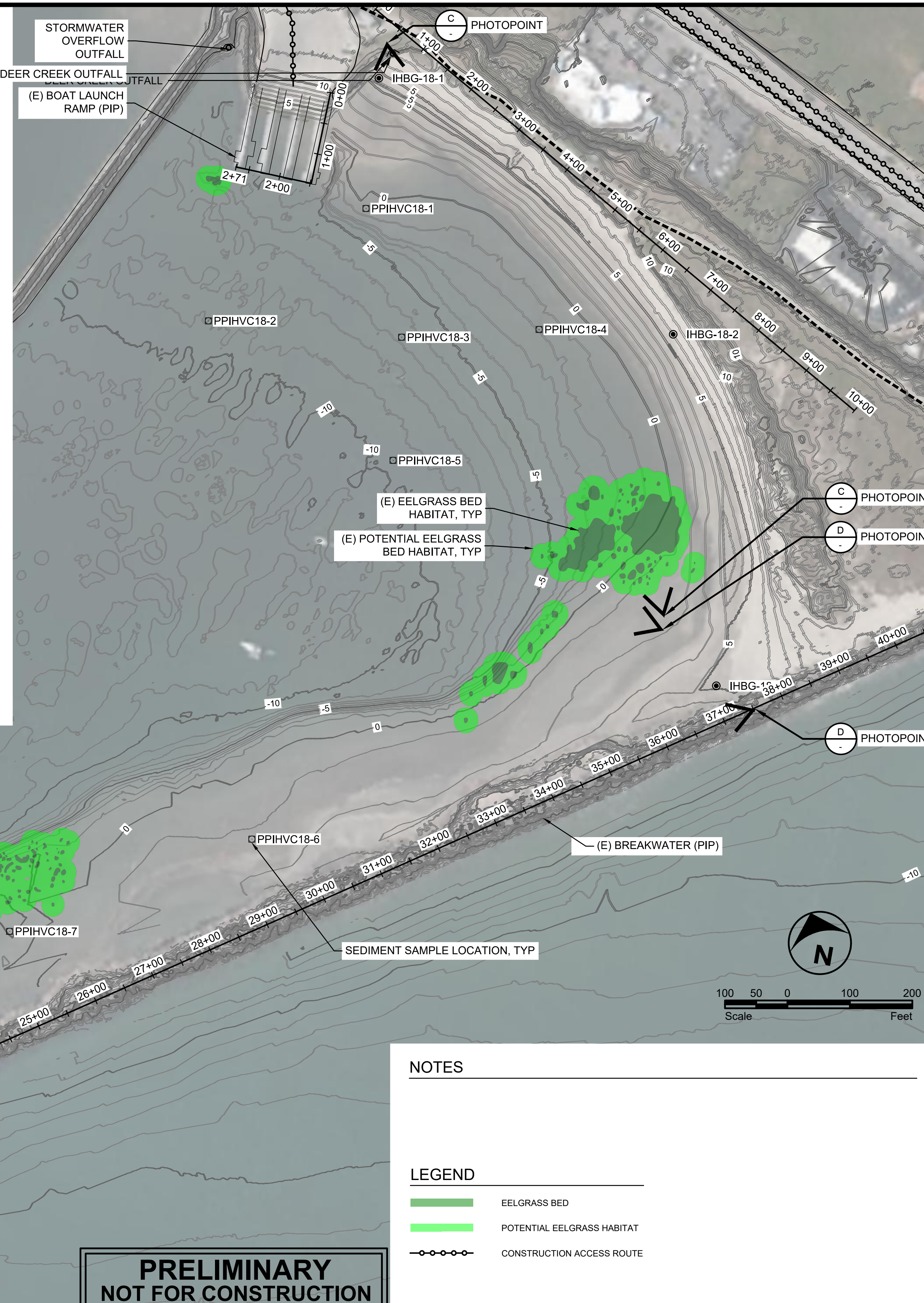
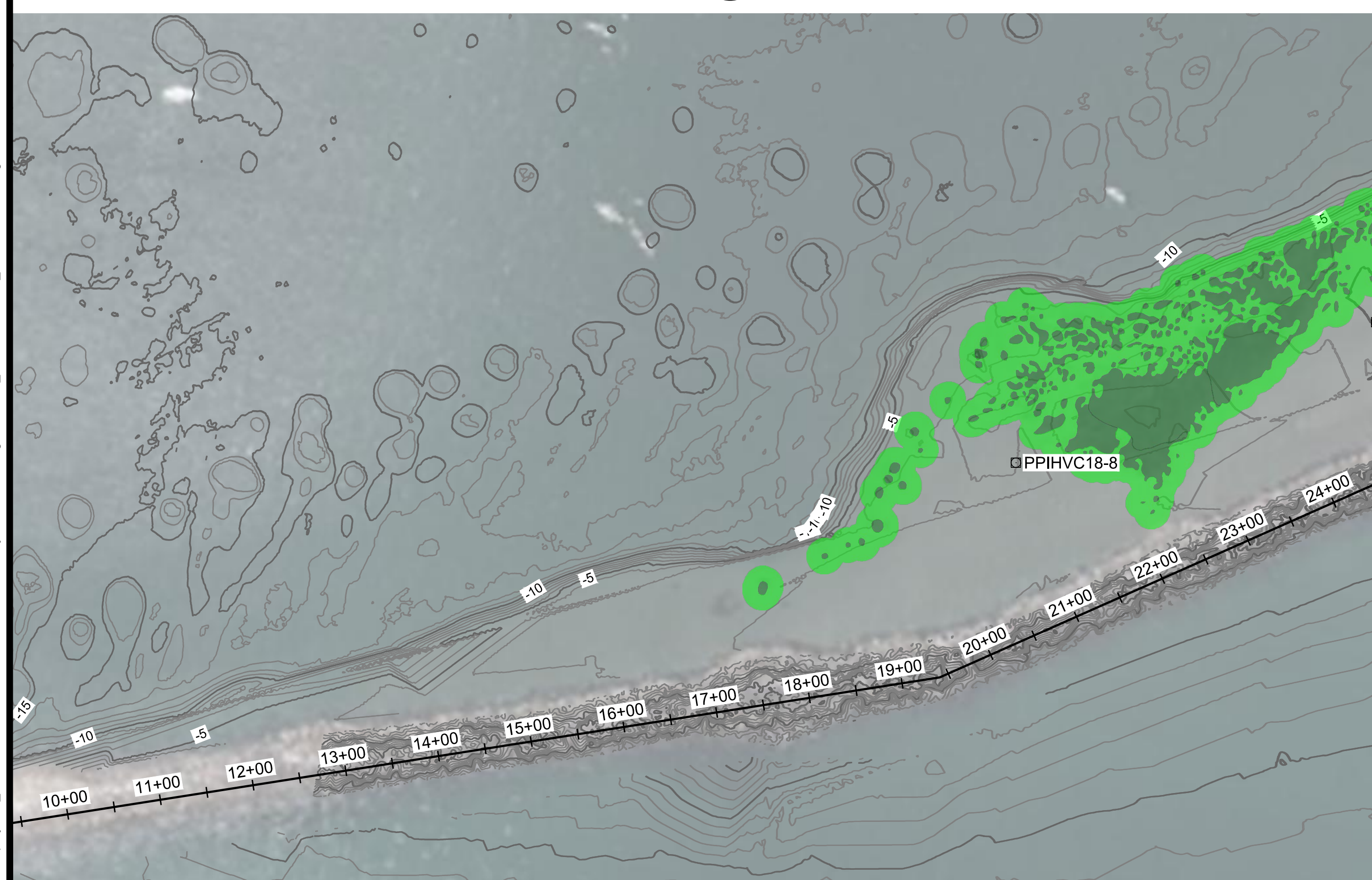


A DEER CREEK OUTFALL - LOOKING SOUTH
PHOTO

B EAST BREAKWATER - LOOKING WEST
PHOTO

C EAST BEACH - LOOKING NORTHWEST
PHOTO

D EAST BEACH - LOOKING NORTHEAST
PHOTO

NOTES

LEGEND

EELGRASS BED
POTENTIAL EELGRASS HABITAT
CONSTRUCTION ACCESS ROUTE

PRELIMINARY
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PRELIMINARY
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PROJECT NAME
PILLAR POINT HARBOR EELGRASS MITIGATION PROJECT
SAN MATEO COUNTY HARBOR DISTRICT
504 AVENUE ALHAMBRA, STE 200,
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REVISIONS

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PROJECT NUMBER	180631.00
ISSUE DATE	3/12/2021

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1"

PHASE
PRELIMINARY DESIGN

SHEET TITLE
EXISTING CONDITIONS - DREDGING AREA

SHEET NUMBER
C-03

SHEET 03 OF 7

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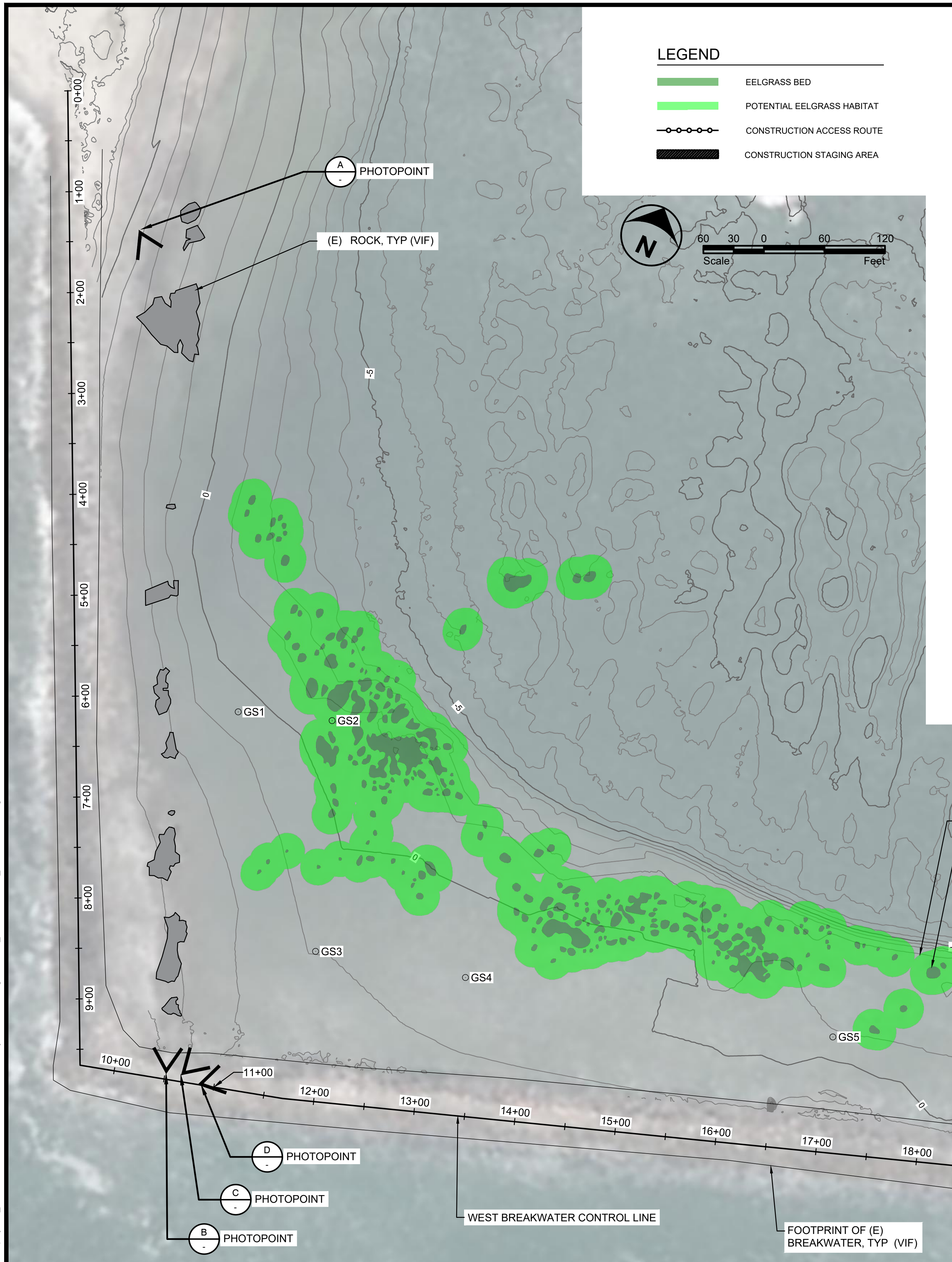
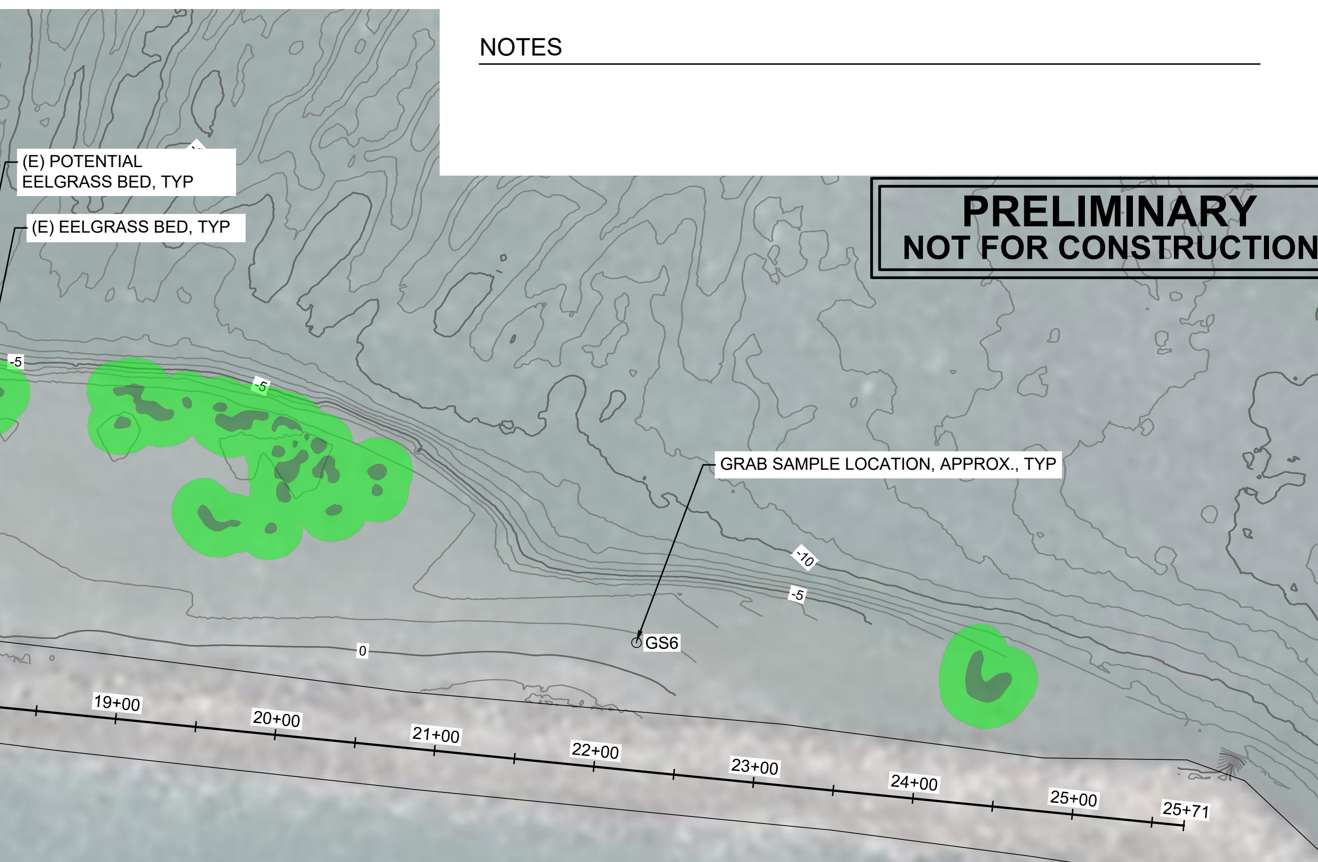
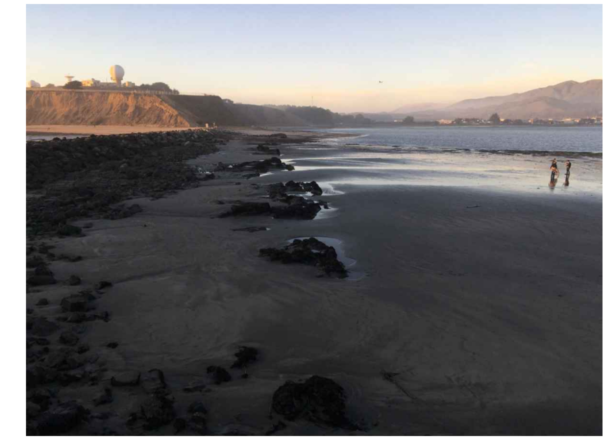
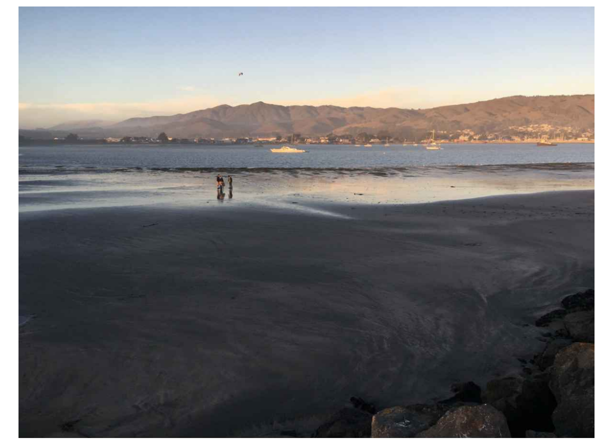




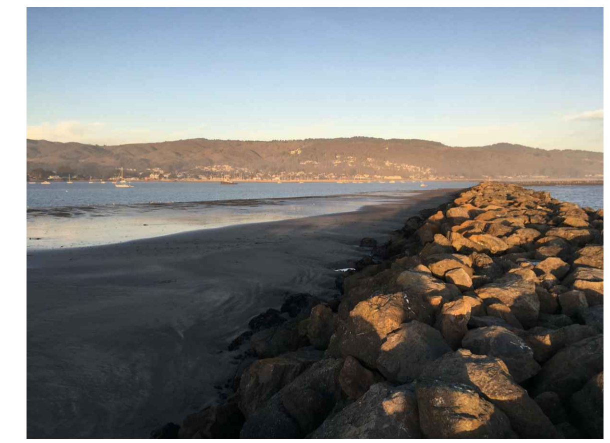
A PPH WEST BASIN - LOOKING SOUTH
PHOTO



B WEST BREAKWATER - LOOKING NORTH
PHOTO



C WEST BREAKWATER - LOOKING NORTH EAST
PHOTO



D WEST BREAKWATER - LOOKING EAST
PHOTO

NOTES

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SAN MATEO COUNTY HARBOR DISTRICT CALIFORNIA

PROJECT NAME
PILLAR POINT HARBOR EELGRASS MITIGATION PROJECT

SAN MATEO COUNTY HARBOR DISTRICT
504 AVENUE ALHAMBRA, STE 200,
P.O. BOX 1449, EL GRANADA, CA 94018

REVISIONS

#	DATE	DESCRIPTION

DESIGNED	L. WHITE
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IN CHARGE	L. WHITE C76509
PROJECT NUMBER	180631.00
ISSUE DATE	3/12/2021

SCALE IS AS SHOWN WHEN PLOTTED TO FULL SIZE (22"x34")
1"

PHASE
PRELIMINARY DESIGN

SHEET TITLE
EXISTING CONDITIONS - MITIGATION AREA

SHEET NUMBER
C-04

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NOTES

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LEGEND

- DREDGING AREA (SBPP, GENERAL NOTE 1)
- DREDGING AREA (PPHEMP(NIC) & SBPP, GENERAL NOTE 1)
- DREDGING PIPELINE
- PLACEMENT AREA
- EELGRASS BED
- POTENTIAL EELGRASS HABITAT
- CONSTRUCTION ACCESS ROUTE

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PILLAR POINT HARBOR EELGRASS MITIGATION PROJECT

SAN MATEO COUNTY HARBOR DISTRICT
504 AVENUE ALHAMBRA, STE 200,
P.O. BOX 1449, EL GRANADA, CA 94018

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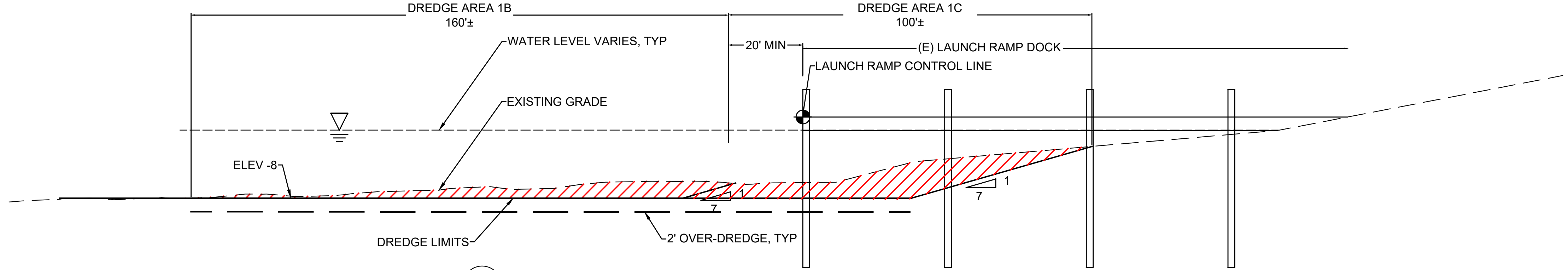
1"

PHASE
PRELIMINARY DESIGN

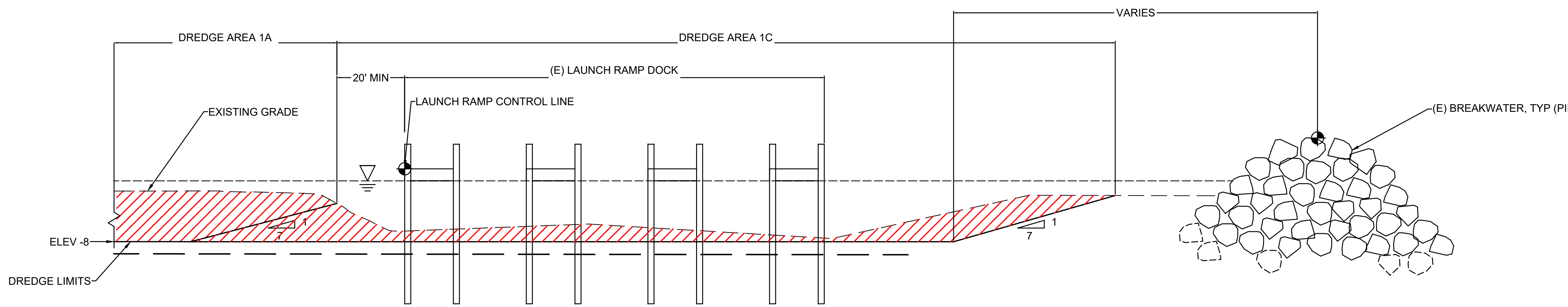
SHEET TITLE
DREDGING PLAN

SHEET NUMBER
C-05

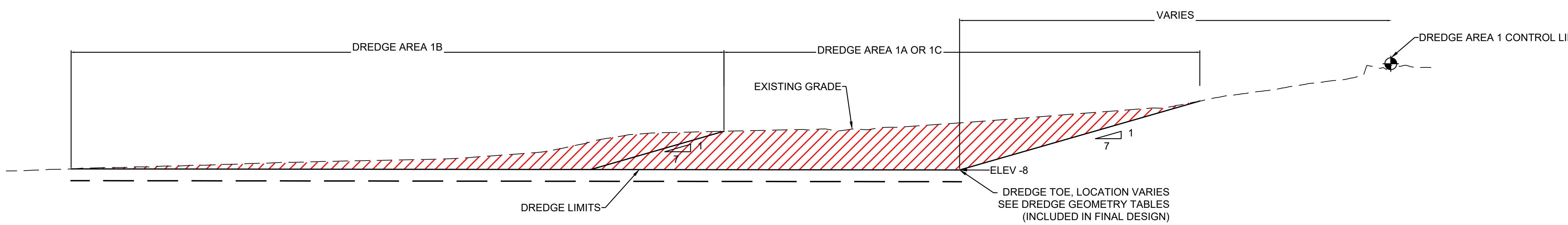
SHEET 05 OF 7



A
C-06 C-06
DREDGE AREA 1
SECTION



B
C-06 C-06
DREDGE AREA 1
SECTION



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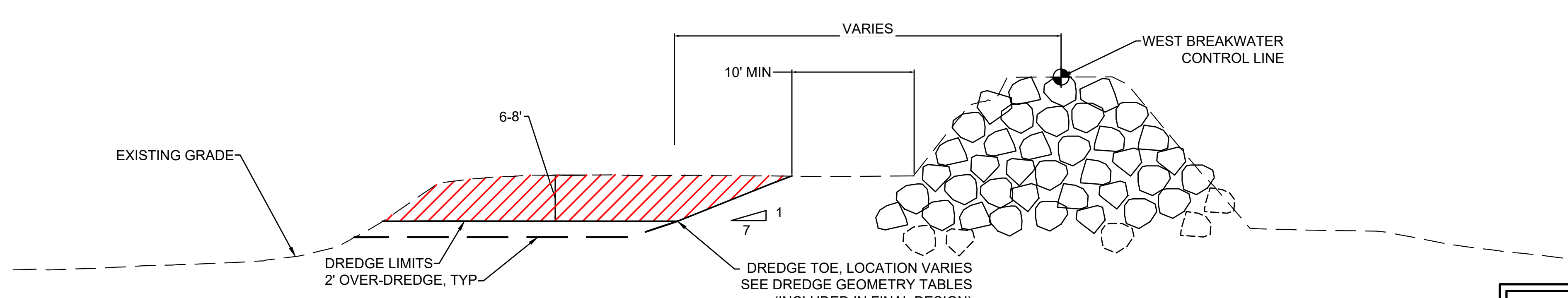
C-06 C-06
DREDGE AREA 1
SECTION



D
C-06 C-06
DREDGE AREA 2
SECTION

20 10 0 20 40
1"=20'
Scale
Feet

NOTES

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PILLAR POINT HARBOR
EELGRASS MITIGATION
PROJECT

SAN MATEO COUNTY HARBOR DISTRICT
504 AVENUE ALHAMBRA, STE 200,
P.O. BOX 1449, EL GRANADA, CA 94018

REVISIONS

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DRAWN	S. SMITH
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IN CHARGE	L. WHITE C76509
PROJECT NUMBER	180631.00
ISSUE DATE	2/18/2021

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1"

PHASE
PRELIMINARY
DESIGN

SHEET TITLE
DREDGING
SECTIONS

SHEET NUMBER
C-06

SHEET 06 OF 7

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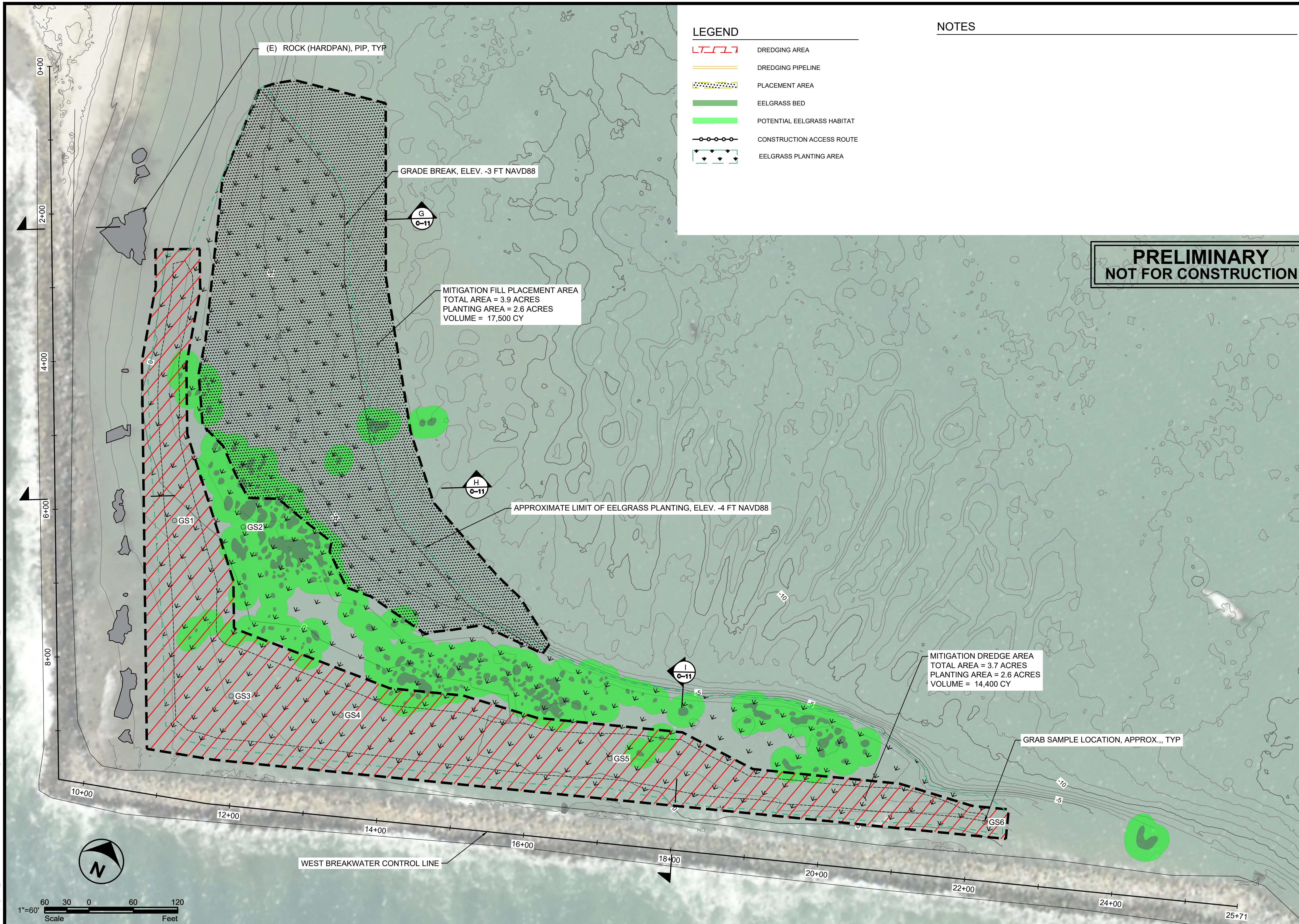

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PROJECT NAME

PILLAR POINT HARBOR EELGRASS MITIGATION PROJECT

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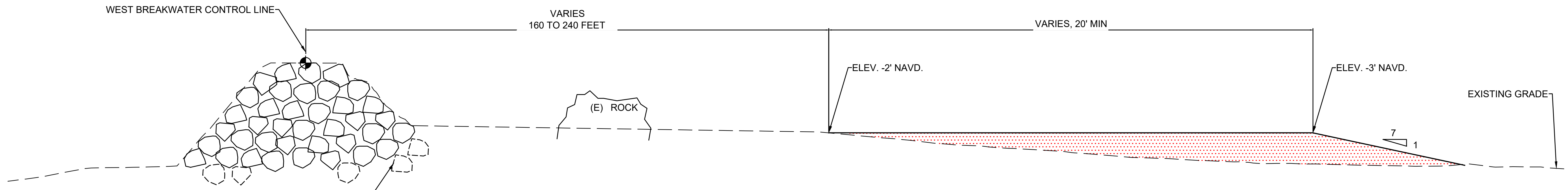
PHASE
PRELIMINARY DESIGN

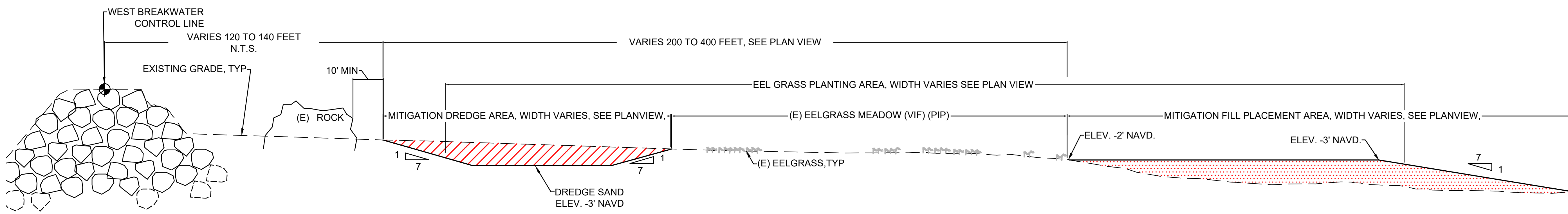
SHEET TITLE
MITIGATION AREA PLAN

SHEET NUMBER
C-07

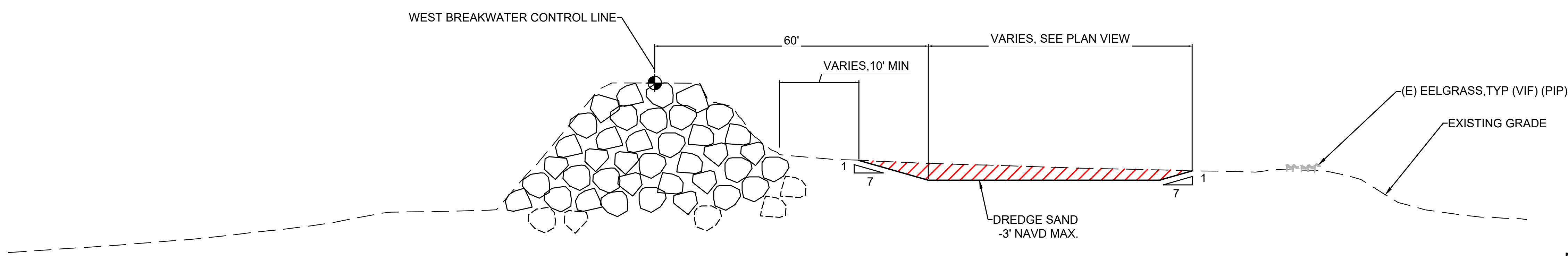
SHEET 07 OF 7



G C-06 MITIGATION PLACEMENT AREA SECTION H:1"=20' V:1"=10'



H C-06 MITIGATION DREDGE AND PLACEMENT AREA SECTION H:1"=20' V:1"=10'



I C-06 MITIGATION DREDGE AREA SECTION H:1"=20' V:1"=10'

NOTES

1"=20' 20 10 0 20 40 Scale Feet

PRELIMINARY
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FILE: K:\projects_2018\D180631.00 - Surfers Beach Pilot Project\10 CAD\Dwgs\PERMIT_FIGS\05 DREDGE_PLACEMENT SECTIONS.dwg PLOT DATE: 3/12/2021 2:24:49 PM PLOTTED BY: SCOTT SMITH

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PILLAR POINT HARBOR
EELGRASS MITIGATION
PROJECT

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ISSUE DATE	2/18/2021

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1"

PHASE
PRELIMINARY DESIGN

SHEET TITLE
MITIGATION AREA SECTIONS

SHEET NUMBER
C-08

SHEET 08 OF 7