Attachment 1

Shoreline at Mountain View Lake Habitat Island

Alternatives Analysis Report

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Prepared for:

City of Mountain View

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Delivering a better world

Prepared for:

City of Mountain View

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List of Acronyms and Abbreviations

ASOS	Automated Surface Observing System
CEM	Coastal Engineering Manual
CEQA	California Environmental Quality Act
DSOD	Division of Safety of Dams
E	East
ENE	East-Northeast
ENW	East-Northwest
ESE	East-Southeast
ESW	East-Southwest
EVA	Extreme Value Analysis
ft	feet
GIS	Geographic Information System
H	Horizontal
N	North
NAVD	North American Vertical Datum
NNE	North-Northeast
NNW	North-Northwest
NWP	Nationwide Permit
NWS	National Weather Service
RTK	Real Time Kinematic
S	South
SSE	South-Southeast
SSW	South-Southwest
USACE	United States Army Corps of Engineers
US	United States
USFWS	United States Fish and Wildlife Service
V	Vertical
W	West
WNE	West-Northeast
WNW	West-Northwest
WSE	West-Southeast
WSW	West-Southwest
WSEL	Water Surface Elevation

1. Introduction

The City of Mountain View (the City) owns and operates Shoreline Sailing Lake (Sailing Lake) at Mountain View Regional Park (Shoreline Park), located in the northern part of the City bounded by Garcia Avenue and Amphitheater Parkway to the south, City of Palo Alto boundary at San Antonio Road to the west, Stevens Creek to the east, and the City shoreline border with the United States Fish and Wildlife Service (USFWS)-owned former salt evaporation ponds to the north. Sailing Lake Dam (the Dam) was constructed on the north-east side of the lake separating Sailing Lake and the Coast Casey Forebay. The Dam is jurisdictional under the California Department of Water Division of Safety of Dams (DSOD).

Shoreline Park includes several structures and features that require various repairs or improvements. The resulting Shoreline Park Water Control Structures Improvements Project (23-44) is an umbrella project created to address various deficiencies around the site.

This Alternatives Analysis Report explores solutions to the erosion and associated habitat degradation that has occurred at the Sailing Lake habitat Island. The island has been eroding for decades due to wave action, reducing suitable bird nesting habitat and resulting in steep cliffs that can lead to chick mortality. Nesting success has also been negatively impacted by frequent disturbance from recreational users on the lake during the breeding season.

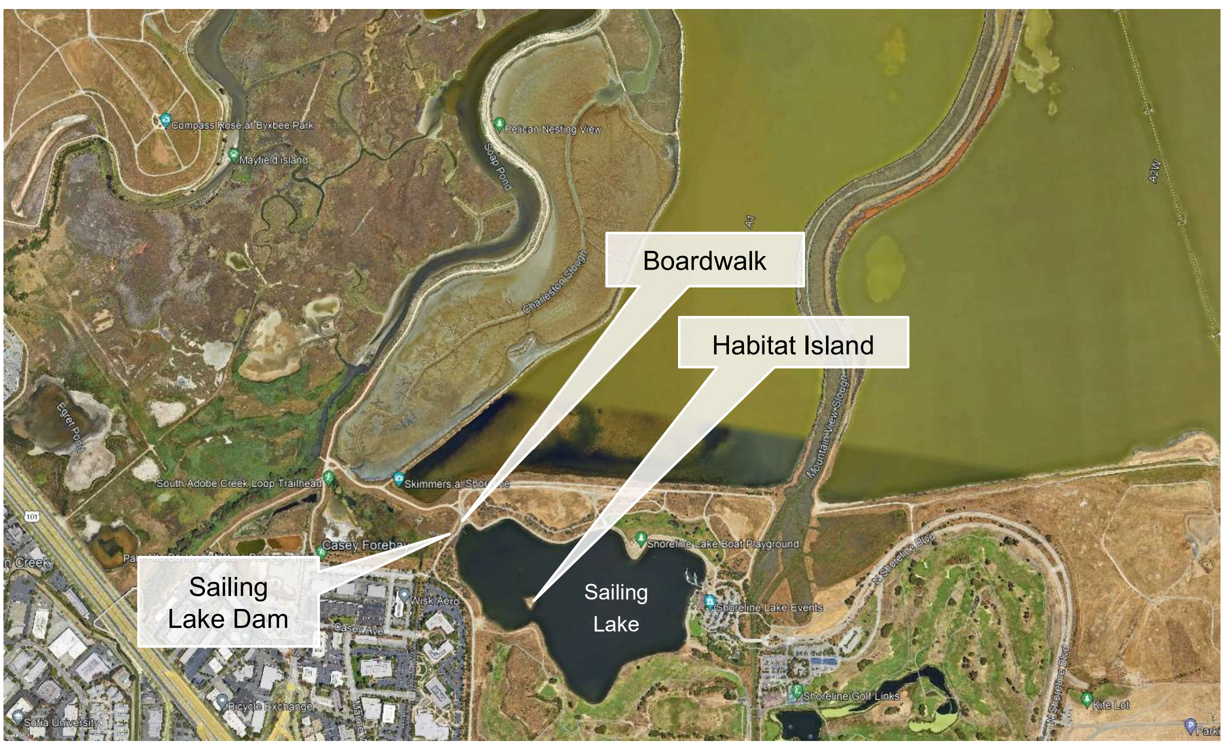


Figure 1-1 Project Site Overview

1.1 Purpose and Scope

This report summarizes proposed alternatives to restore the habitat island to match or exceed historic island size, maximize benefit for relevant nesting bird species, prevent future erosion, and provide a more robust protection barrier around the island to prevent island access by recreational users. A more refined description of project objectives is provided in Section 1.3 below.

A multi-criteria evaluation was completed to understand the extent to which each alternative addresses project objectives, and give the City information to select an alternative to move forward into detailed design. A detailed description of the evaluation approach, criteria, and results are provided in Section 6.

1.2 Document Organization

This report is organized into the following sections:

- **Section 1: Introduction** provides the purpose and scope of the study, project objectives, regulatory setting, organization of the report, and limitations.
- **Section 2: Existing Conditions** provides a summary of existing conditions associated with structures, physical, and biological conditions on the island that are pertinent to the development of the alternatives presented herein.
- **Section 3: Technical Analyses** provides a description of technical analyses relied upon during development and evaluation of the alternatives herein.
- **Section 4: Alternative Descriptions** provides an overview of each alternative, describing key components, construction considerations, and uncertainties.
- **Section 5: Cost Opinions for Alternatives** provides a description of the basis for cost development and a summary of estimated costs for island alternatives and floating barriers.
- **Section 6: Alternatives Evaluation** provides a description of the framework used to evaluate alternatives and a comparison of key evaluation factors across the alternatives proposed for further consideration.
- **Section 7: References** provides a list of references from the main body of this report.

This report includes the following appendices:

- Appendix A Drawings
- Appendix B Conceptual Design Estimates
- Appendix C Soil Sample Lab Results

1.3 Project Objectives

The term “restoration” has multiple goals for the Sailing Lake Habitat Island Restoration, as described in more detail below.

First, there is an over-arching goal for this project to “restore” the island to its original acreage or greater, and to do so in a way that will minimize future erosion.

Second, there is a more specific restoration goal to enhance bird nesting habitat within both the existing island area and any proposed expansion areas to maximize benefit for bird species including black skimmers, Forster’s terns, American avocets, and black-necked stilts.

Tabel 1-1 below lists key objectives that will drive the proposed alternative development, breaking them up per the two definitions above related to restoration.

Table 1-1 Objectives Summary

Objective	Description
Restore Habitat Island	
1. Expand island acreage	Expand acreage to equal or greater than original as-built condition
2. Minimize future erosion	Regrade island banks to milder slopes to dissipate wave energy; incorporate coarse substrate and large wood, as appropriate
3. Provide maintenance access	Provide boat access to the island to facilitate maintenance by Shoreline staff
Restore or Enhance Nesting Habitat	
4. Improve shoreline access and nesting ground slope for birds	Regrade to a mosaic of slopes ranging from flat up to 21 degrees(1) for suitable nesting habitat and increase shoreline linear length
5. Provide suitable nesting substrate	Add oyster shells, sand, or gravel to maximize benefit for nesting
6. Remove Non-native invasive vegetation	Remove all non-native invasive vegetation on island to enable creation of suitable nesting habitat, which consists primarily of areas with no cover and small pockets of low-growing native vegetation (alkali heath and pickleweed) that provide cover and serve as wind breaks
7. Minimize human disturbance	Build a new and more effective barrier with 100-foot buffer around island with limited maintenance

(1) Ackerman, et al. (2014)

1.4 Regulatory Setting

Any habitat island improvements may qualify for Nationwide Permit #27 (NWP 27) from the United States Army Corps of Engineers (USACE) pursuant to Clean Water Act Section 404.

NWP 27 allows for: Activities in waters of the United States associated with the restoration, enhancement, and establishment of tidal and non-tidal wetlands and riparian areas, the restoration and enhancement of non-tidal streams and other non-tidal open waters, and the rehabilitation or enhancement of tidal streams, tidal wetlands, and tidal open waters, provided those activities result in net increases in aquatic resource functions and services.

- Activities authorized by NWP 27 may include the construction of small nesting islands.
- NWP 27 does not have any limit on the amount of cut and fill in order to qualify for the NWP.
- Submittal of a pre-construction notification to the USACE would be required (this is essentially an application for coverage under the NWP).

Ultimately it would be up to the USACE to determine, but consultation could be avoided if the project can demonstrate that there would be no impacts to federally-listed species. There are two federally listed species, California least tern and western snowy plover, that have potential to occur in the greater area of the park. However, the island does not provide suitable breeding habitat for these species and they are not among the species identified by park staff as occupying the island. None of the species that have been known to occupy the island are federally-listed; however, all of the species are protected under the Migratory Bird Treaty Act, so it may be determined that consultation is needed with the United States Fish and Wildlife Service (USFWS) relative to complying with the NWP general conditions regarding migratory birds. The USACE would initiate consultation with the USFWS and the owner would provide a Biological Assessment. After consultation, the USFWS would issue a Biological Opinion for the project, which would be required to finalize the USACE permitting process.

The State Water Board pre-certified a number of the NWPs, which streamlines the Clean Water Act Section 401 Water Quality Certification permitting for the pre-certified NWPs, but NWP 27 is not pre-certified. However, the State Water Board did issue a Statewide General Order for restoration projects in 2022, which has a similar effect in streamlining the 401 Water Quality Certification permitting for restoration projects. Note there is also a previously authorized programmatic authorization for restoration projects less than 5 acres and a cumulative total of 500 linear feet of stream bank or coastline, and that qualify under the California Environmental Quality Act (CEQA) categorical exemption under California Code of Regulations title 14, section 15333, “Small Habitat Restoration Projects”. Discussion with the Water Board would be needed because this project is not an exact match for the categories of restoration projects addressed in the newer order (https://www.waterboards.ca.gov/water_issues/programs/cwa401/generalorders/2022/srgo-final-order-attachment-a.pdf) but would potentially be considered bioengineered bank stabilization.

Provided the project qualifies for coverage under either one of these general orders, it should be considered self-mitigating and compensatory mitigation would not be required.

All of the above is subject to confirmation with the agencies. For this reason, a mitigation contingency cost was added to each island alternative in Section 5.

1.5 Limitations

This work was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of the engineering profession practicing in the same locality, under similar conditions and at the date the services are provided. The conclusions, opinions, and recommendations in this report are based on a limited number of observations and data. It is possible that conditions could vary between or beyond the data evaluated. AECOM makes no other representation, guarantee, or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

Some background information and other data used by AECOM in preparing this report have been furnished by third parties. AECOM has relied on this information as furnished and is neither responsible for, nor has confirmed, the accuracy of this information.

Conceptual or planning-level alternatives are uncertain by nature, given the typical lack of sufficient design parameters and analysis available during the planning phase. Although this report strives to address key uncertainties typically developed during the project design phase and related to feasibility and cost, additional investigation, analysis, and design are needed to adequately address the uncertainties. Analyses and results presented in this report are for the current study only and should not be extended or used for any other purposes.

2. Existing Conditions

The sections below give an overview of existing conditions associated with the Sailing Lake habitat island.

2.1 Coordinate System and Datum

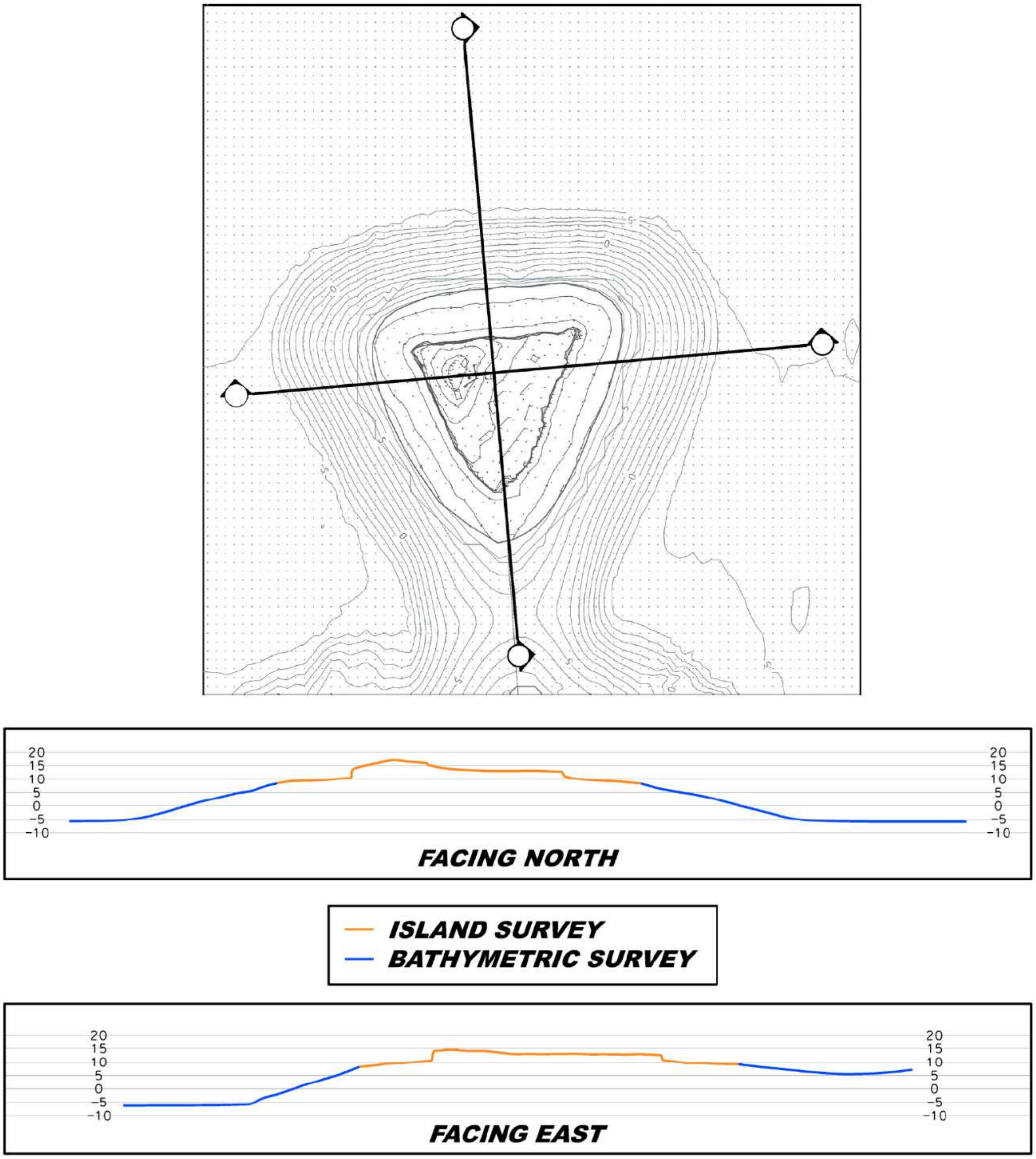
All elevations referenced in this report are given in feet, North American Vertical Datum of 1988 (NAVD88), unless otherwise noted. The horizontal coordinate systems used for geographic information system and computer-aided design data, figures, and drawings are referenced to California State Plan, Zone 3, North American Datum of 1983 (U.S. feet) Epoch 2023.25.

2.2 Sailing Lake

Sailing Lake, also known as Shoreline Sailing Lake, is an artificial nontidal saltwater lake in Shoreline Park, with an approximate area of 45 acres and an average depth of 18 feet. The lake has multiple recreational uses including kayaking, sailing, and windsurfing.

Sailing Lake is a closed water body, with the salt water supply from the San Francisco Bay provided by the Sailing Lake pump station at Charleston Slough. The lake level is maintained at a constant level around 10.5 feet NAVD88 (Moffatt & Nichol 2020), and controlled by a concrete outlet structure that discharges to Permanente Creek and a backflash valve to Charleston Slough. A drain line was constructed in 2000 (Schaaf & Wheeler 2000) that allows the City to drain the lake close to elevation 5.3 feet (NAVD88), although the process is slow and is currently done infrequently.

At the western limit of Sailing Lake, adjacent to Coast-Casey Forebay, the Sailing Lake Access Road was improved in 2021 to enhance its stability and reduce breaching risk to the Coast-Casey Forebay. This access road is a DSOD jurisdictional dam, and provides an access route for construction and maintenance projects along the shoreline.



REY 2023

Figure 2-1 Combined topographic and bathymetric surface data

2.3 Topography and Bathymetry

New ground and bathymetric surveys were completed to support the project. The bathymetric survey was completed by REY (REY 2023) using multibeam sonar techniques. Field survey data was acquired on October 18, 2023 between the hours of 0800 and 1600 PDT.

The bathymetric survey vessel employed was a 21' Bennington pontoon boat, powered by a 75hp Honda 4-stroke outboard motor. Sonar data was acquired with a Teledyne-Reson T50P multibeam sonar, with 1024 beams (512 standard) and multi-detect (up to 5 returns per beam per ping) options enabled. The sonar was operated at 420kHz. Sound velocity at the sonar head was acquired with a Valeport miniSVS sound velocity probe. Sound velocity in the water column was acquired with an AML Minos-X sound velocity profiler. Positioning and vessel dynamics were acquired using an Applanix POS-MV Wavemaster

II, operated in Real Time Kinematic (RTK) mode. RTK correction data was received by a PacificCrest ADL telemetry radio. Survey data was acquired using Hypack 2022. The survey was performed in accordance with US Army Corps of Engineers standards for hard bottom hydrographic surveys and provided for 200% bottom coverage.

To supplement the bathymetry data, AECOM conducted an above surface topographic survey of the habitat island. Data from both surveys were combined to produce a digital terrain model of the lake in its entirety. Figure 2-1 shows the combined topographic and bathymetric surface data.

2.4 Habitat Island

Since no as-built drawings exist for the Sailing Lake habitat island, its exact date of construction is unknown, although it was likely constructed as part of the overall Sailing Lake development in the early 1980s. It is unknown if the island was originally intended to support bird habitat, and historic data suggests that the area may not have originally been an island, but connected on the south side to the lake shoreline.

The island has experienced significant erosion over the years, decreasing the overall size of the island and reducing the habitat value provided. Figures 2-2 and 2-3 show the existing near-vertical side slopes that have resulted from decades of wind-wave erosion. These steep slopes have reduced nesting success for waterbirds breeding on the island as chicks that fall into the water are unable to climb back on the island.

Figure 2-2 Habitat Island

Figure 2-3 Island Vertical Side Slopes

While the original habitat island size is not known, a 1991 aerial photograph (see Figure 2-4) shows the historic island size (7,990 square feet, or 0.18 acre) larger than the current footprint of approximately 4,925 square feet (0.11 acre). An older aerial photo from 1982 appears to show the island during construction (still connected to the southern shore – see rough outline on Figure 2-4) but the water level in this earlier aerial photo may be lower than current conditions to facilitate construction, thus making it difficult to estimate the actual island extents. Therefore, the 1991 aerial photograph is used to document historic baseline conditions related to size.

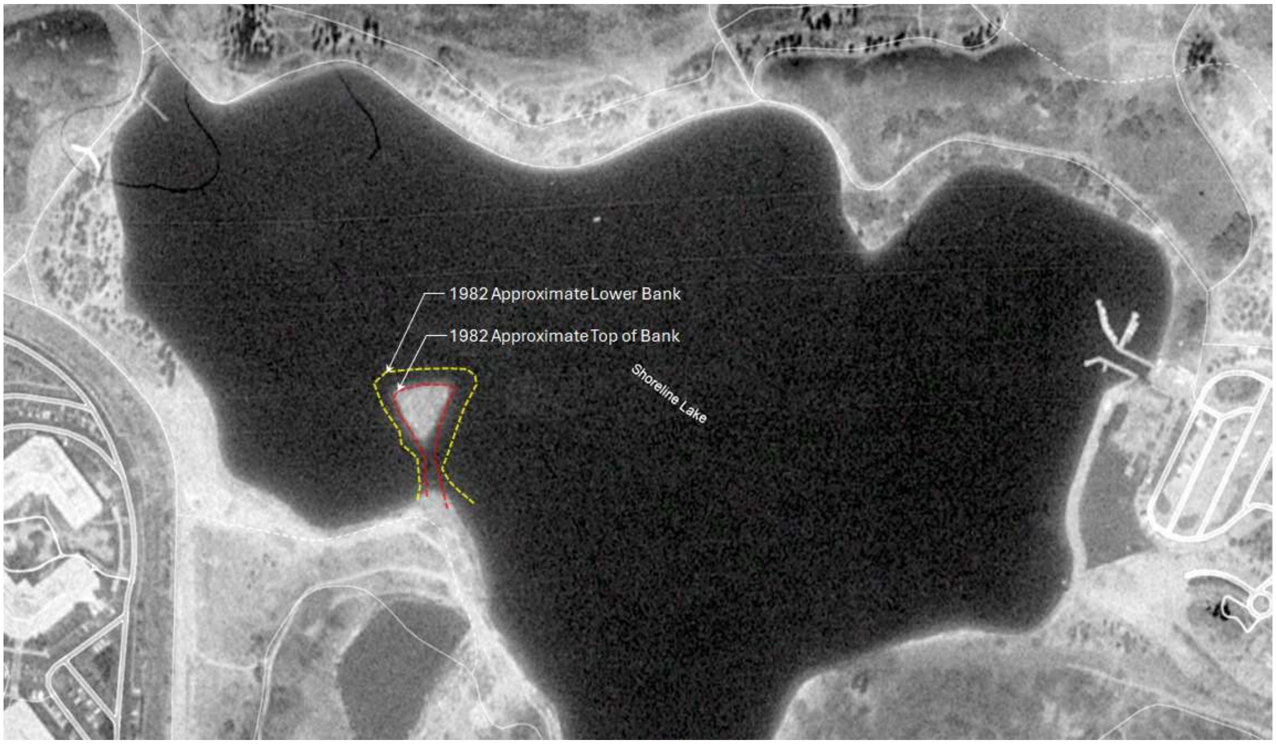


Figure 2-4 1991 Aerial Photography with 1982 Approximate Island Extents

Figure 2-5 shows an overlay of the 1991 island size (in red) compared to a 2023 aerial photograph of the existing island.

Figure 2-5 1991 Versus 2023 Island Size

Over half of the existing island surface is relatively flat, ranging in elevation from 11 feet to 13 feet. The surface ramps up to a higher “knob” area in the northwest corner at a peak elevation of approximately 16 feet.

The lower relatively flat terrace includes several wooden frames used to hold bird nesting substrate, such as sand and pea gravel, in place, which is replenished by City personnel (see Figure 2-6) (H.T. Harvey & Associate 2023).

The island surface is predominately vegetated, with a few pockets of native species including alkali heath and pickleweed (see Figures 2-6 and 2-7), and larger areas of non-native species including mallow, mustard, thistles, poison hemlock and non-native grasses. Exposed island surfaces are generally a combination of earth and gravel.

A floating barrier surrounds the island to block access to recreational lake users. Currently the barrier ropes and buoys are prone to biofouling, which causes them to sink which can lead to safety issues for boaters.

(Photo credit: Philip Higgins, City of Mountain View)

Figure 2-6 Habitat Island Surface Features

2.4.1 Maintenance

Every year prior to breeding season, City personnel remove invasive vegetation using weed trimmers to maintain the low-statured, sparsely vegetated areas suitable for nesting black skimmers and other waterbirds. As mentioned above, the City also maintains wooden frames and provides nesting substrate such as sand and pea gravel. City personnel access the island via boat for habitat maintenance in the fall and winter, and for monitoring during the breeding season.

(Photo credit: Philip Higgins, City of Mountain View)

Figure 2-7 Habitat Island Pickleweed

2.4.2 Geologic Considerations

A geologic field investigation was completed on the habitat island on October 10, 2023. Hand augers were drilled at three locations (B1, B2 and B3) on the island at the approximate locations shown on Figure 2-8. Also shown are two locations on the sides (S1 and S2) of the island from where partially eroded material was collected. Two samples were collected at location B-3.

The characteristics of the soils observed were as follows:

- B1 – LEAN CLAY (CL) with Sand, Dry, Light Brown, Fine to Medium Coarse. Ground was drilled for up to 1.5 feet after which the soil was too hard for the hand auger to drill further.
- B2 – FAT CLAY (CH), Moist, Dark Brown, Fine. The sample was collected between the depths of 1.5 feet to 2 feet and 3 inches. The material in the top 1.5 feet was similar to that collected at B-1.
- B3-A – LEAN CLAY (CL) with Sand and Gravel, Dry, Light Brown, Fine to Coarse. The sample was collected between the depths of 0-1 foot 6 inches below ground surface.
- B3-B – LEAN CLAY with Sand & Gravel. Moist, Dark Brown with red, Fine. The sample was collected between depths of 1 foot 6 inches to 2 feet and 3 inches.
- S-1 – Sample collected was similar to the soil collected in B-1.
- S-2 – Sample collected was similar to the soil collected in B-2.

Figure 2-8 Boring and Soil Sample Locations

Additional investigation may be required for final design to address uncertainties related to dewatering operations. The majority of proposed island area will be constructed using imported fill material.

2.4.3 Bird Observations

Bird use is monitored by City staff, who typically see birds arrive for courtship in mid-March, quickly followed by observations of first eggs, and final bird observations in late September. In any given breeding season, up to 200 nests are observed by the City (see Figure 2-9). The first nesting pair of black skimmers were seen in 2013, numbers have increased to approximately 50 nesting pairs in 2021 and 2022 (H.T. Harvey & Associates, 2023).

Species documented by the City using the habitat island for various activities include the following:

- Nesting bird use: black skimmer (*Rynchops niger*), Forster's tern (*Sterna forsteri*), American avocet (*Recurvirostra americana)*, black-necked stilt (*Himantopus mexicanus*), killdeer (*Charadrius vociferus*), Canada goose (*Branta canadensis*), and mallard (*Anas platyrhynchos*)
- Roosting bird use: cormorants (*Phalacrocoracidae*) and white pelican (*Pelecanus erythrorhynchos*)
- Foraging and/or using the lake in large numbers: black skimmer, Forster's tern, white pelican, cormorant, great egret (*Ardea alba*), snowy egret (*Egretta thula*), American coot (*Fulica americana*), Canadian goose (*Branta canadensis*), ruddy ducks (*Oxyura jamaicensis*), great blue heron (*Ardea Herodias*), and California gulls (*Larus californicus*)

Figure 2-9 Habitat Island Bird Observations

3. Technical Analyses

The primary technical analysis completed to support alternatives development are the following:

- Wind wave analysis, which informs proposed island geometry and erosion protection extent and size
- Nesting bird habitat preferences

3.1 Wind Wave Analysis

A coastal engineering analysis was completed to establish the design wave conditions for the lake and habitat island. This analysis followed the guidelines and procedures in Part II of the United States Army Corps of Engineers (USACE) Coastal Engineering Manual (CEM), which are widely used in coastal engineering design projects throughout the world (USACE 2006).

Even over small lakes like the Shoreline Park Sailing Lake, winds generate waves when they occur over water. Wind-driven waves are characterized by their height and period, both of which are important to the design of shoreline features. There are three critical variables that determine wind-driven wave heights and periods. They include wind speed, wind duration (the length of time that the wind blows), and wind fetch length (the distance over the water that the wind blows).

Often, the wave conditions for a particular return period (e.g., the 50- or 100-year return period) are used as design wave conditions. As an example, the 100-year wind speed is the wind speed that has a 1-percent annual chance of occurrence. There are no universal guidelines on which return period should be used for the design of natural shoreline features. Often, the selection is based considering a combination of factors including constructability, construction costs, the expected lifetime of the feature, construction and maintenance costs in case of failure, and the variability in wave conditions. The 50- or 100-year wave conditions are often used in the design of hard shoreline protection structures. For this project, AECOM selected the 100-year wave conditions considering several aspects. One is the likely high cost of repair if the island were to be damaged. The other is that wind-driven waves are generally small on Sailing Lake, and there is likely little difference between the 50- and 100-year conditions. Finally, the 100-year wind-driven wave conditions were used by Moffat & Nichol to design shoreline protection alternatives for eroding sections of the Shoreline Lake shoreline in 2020 (Moffat and Nichol 2020). Therefore, using the 100-year conditions is consistent with previous work on the lake. The AECOM riprap slope protection design associated with the Sailing Lake access road project (AECOM 2021) was also reviewed and considered, even though that project was under the jurisdiction of the Division of Safety of Dams, which typically require more conservative design criteria than may be necessary for this project (AECOM 2021).

The analysis included two general steps. The first step consisted of a wind analysis, which included processing and analyzing historical wind observations from a wind station close to the lake. A statistical extreme value analysis (EVA) was applied to determine the wind conditions for the increasing return periods (2-, 5-, 10-, 20-, 25-, 50-, 100-, and 500-year). In the next step, the 100-year wind speeds from multiple directions were used in a wind fetch analysis to determine the 100-year significant wave height (Hs) and peak spectral wave period (Tp) at the current bird habitat island. Both of these analysis steps are described in detail in the following sections.

3.1.1 Wind Analysis

The National Weather Service (NWS) Automated Surface Observing System (ASOS) maintains a national network of wind stations that record wind speeds and directions. These stations record standardized hourly measurements at 10 meters (33 feet) elevation and averaged over 2 minutes. ASOS has operated a wind station at the Moffett Airfield since 1945. Moffet Airfield is approximately 2.7 miles from Sailing Lake and along the same shoreline of San Francisco Bay, so the wind conditions observed at the airfield are likely representative of the conditions at the lake. A wind rose histogram shows the distributions of historical wind speeds and directions at Moffett Airfield (Figure 3-1).

Winds are typically described based on where they are blowing from, and the wind rose plot shows that the majority of winds blow from the northwest followed by the southeast.

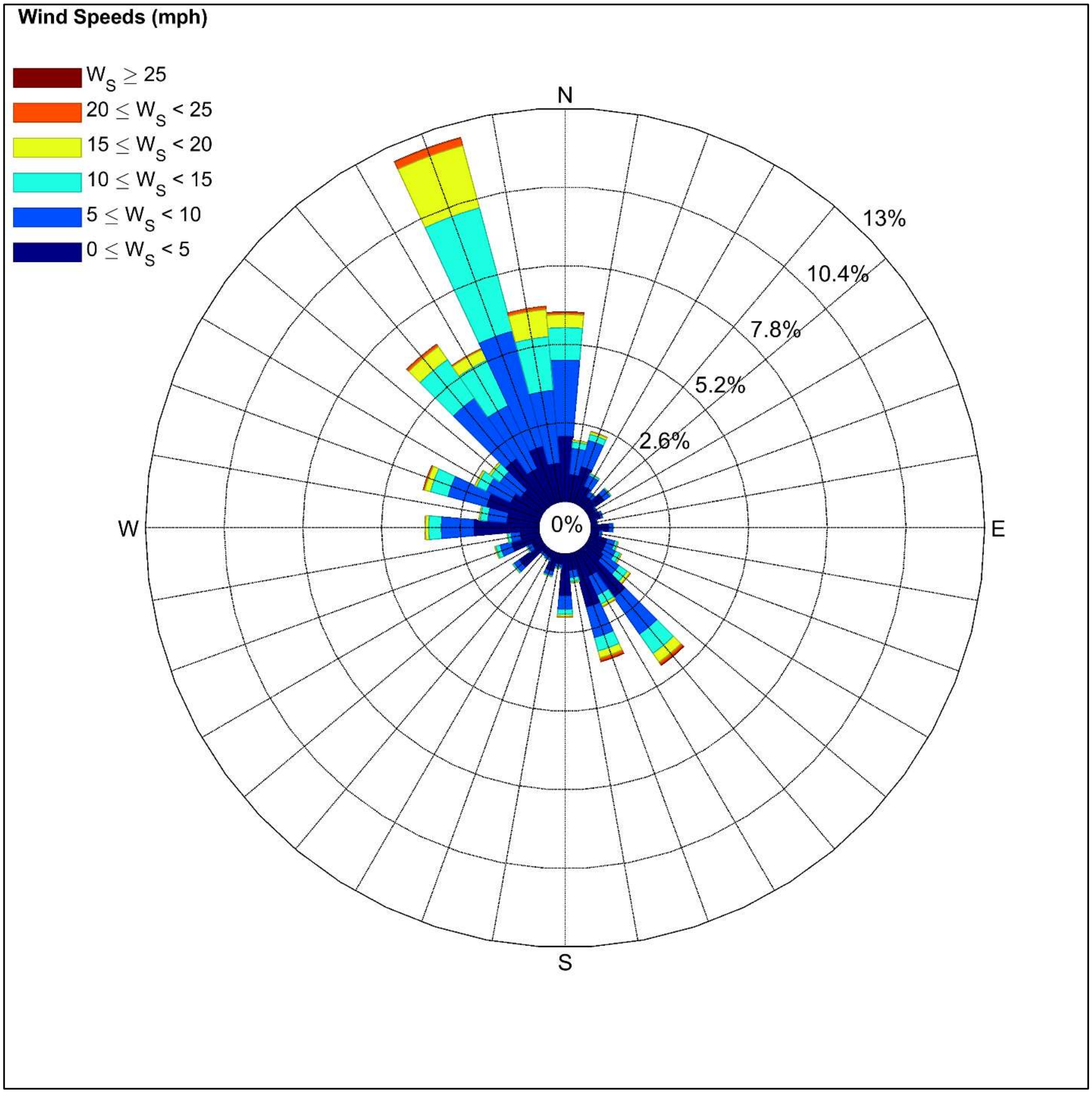


Figure 3-1 Moffett Airfield Wind Rose Plot

An initial review of the data showed a limited number of localized, short duration, high wind speed measurements. While most high wind events are characterized by a gradual increase and decrease in wind speed over longer durations, these short duration spikes are likely inaccurate measurements in the wind observation record, where the wind speed increased as much as 50 miles per hour (mph) in one hour. AECOM applied a filter to remove any records where the hourly increase in wind speed exceeded 30 mph.

AECOM applied statistical EVAs to wind speeds from distinct directional bins. We used the same directional bins used by Moffat and Nichol (2020) such that an EVA was applied every 22.5 degrees moving clockwise from 0 degrees (north). Each directional bin was 22.5 degrees wide. Using the 45-degree directional bin as example, the EVA was applied to winds between 33.75 and 56.25 degrees. Each EVA was applied to maximum annual wind events based on water year, July to June. Each EVA estimated the 2-, 5-, 10-, 20-, 25-, 50-, 100-, and 500-year wind speeds by direction (Table 3-1 and Figure 3-2). The maximum observed wind speeds are also shown for comparison. The results indicate that the highest wind speeds are predicted from the southeast and northwest directions.

Table 3-1 Estimated Wind Speeds for Various Return Periods and Directions for Shoreline Lake

	Direction															
Return Period (Years)	N 0	NNE 22.5	NE 45	ENE 67.5	E 90	ESE 112.5	SE 135	SSE 157.5	S 180	SSW 202.5	SW 225	WSW 247.5	W 270	WNW 292.5	NW 315	NNW 337.5
2	25.1	20.3	16.5	10.6	13.1	20.6	24.7	23.6	22.0	16.6	14.2	17.3	20.6	21.4	21.4	23.4
5	29.1	23.7	20.3	13.6	16.5	25.3	29.5	28.7	26.4	20.7	18.1	20.7	23.1	25.6	25.1	26.8
10	32.0	25.6	22.4	15.6	18.7	28.8	32.9	32.0	29.5	23.2	20.9	23.2	24.6	28.2	27.6	29.7
20	34.9	27.2	24.2	17.7	20.8	32.4	36.4	35.0	32.6	25.5	23.8	25.7	25.9	30.6	29.8	32.9
25	35.8	27.7	24.8	18.4	21.4	33.6	37.6	35.9	33.6	26.2	24.8	26.5	26.2	31.3	30.5	34.0
50	38.9	29.0	26.2	20.5	23.4	37.5	41.4	38.6	36.8	28.2	28.0	29.1	27.3	33.5	32.7	37.9
100	42.1	30.1	27.5	22.7	25.4	41.7	45.4	41.2	40.1	30.1	31.4	31.9	28.2	35.7	34.8	42.4
500	50.4	32.2	29.9	28.0	29.8	52.7	55.9	46.9	48.2	34.0	40.4	39.1	30.1	40.3	39.6	56.0
Maximum Observed	49.5	32.3	30.0	20.8	23.1	52.0	46.1	39.2	42.8	34.7	30.0	32.3	30.0	34.7	34.7	38.1

NOTE: Wind speeds are color coded such that low speeds are blue, medium speeds are clear, and high speeds are red.

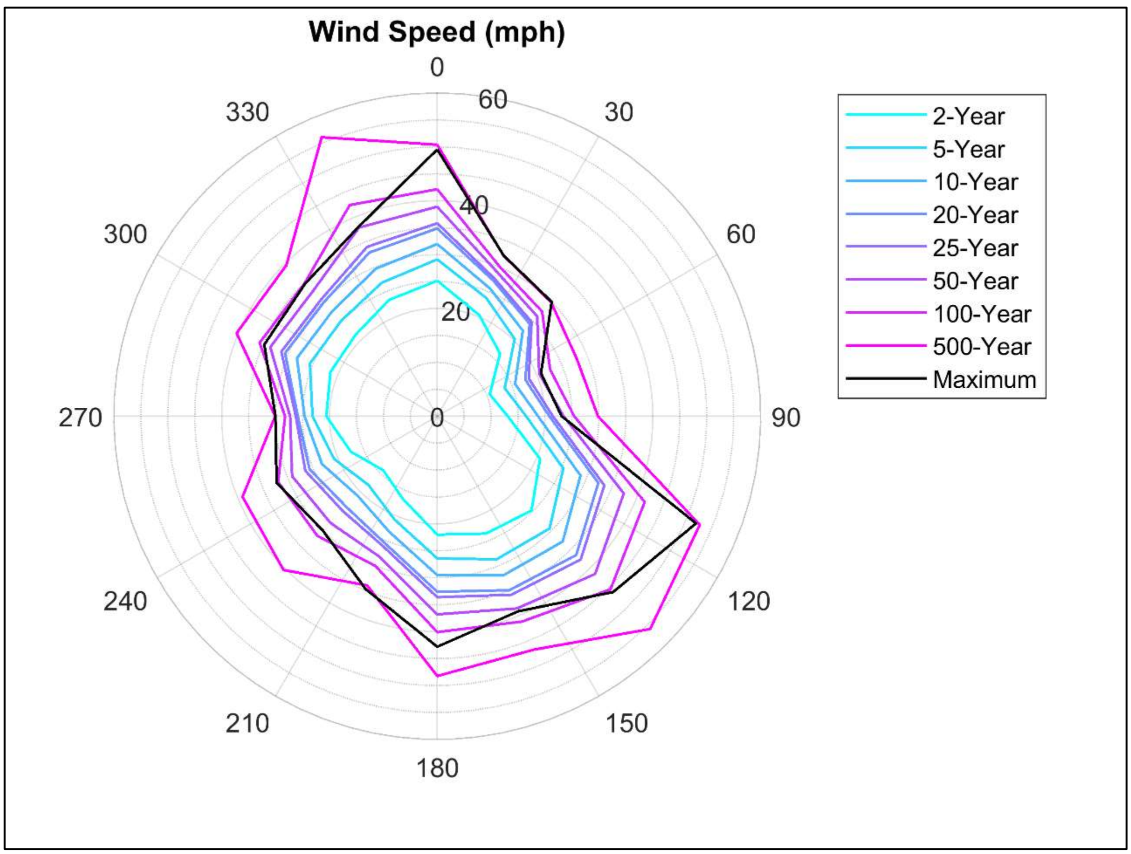


Figure 3-2 Estimated Wind Speeds by Direction

3.1.2 Wind-Driven Wave Analysis

AECOM conducted a wind-fetch analysis to calculate the significant wave heights and peak spectral wave periods associated with the 100-Year wind speeds. The wind fetches were measured using ArcMAP Geographic Information System (GIS) software from the lake shoreline to the existing habitat island for each wind direction (Figure 3-3).

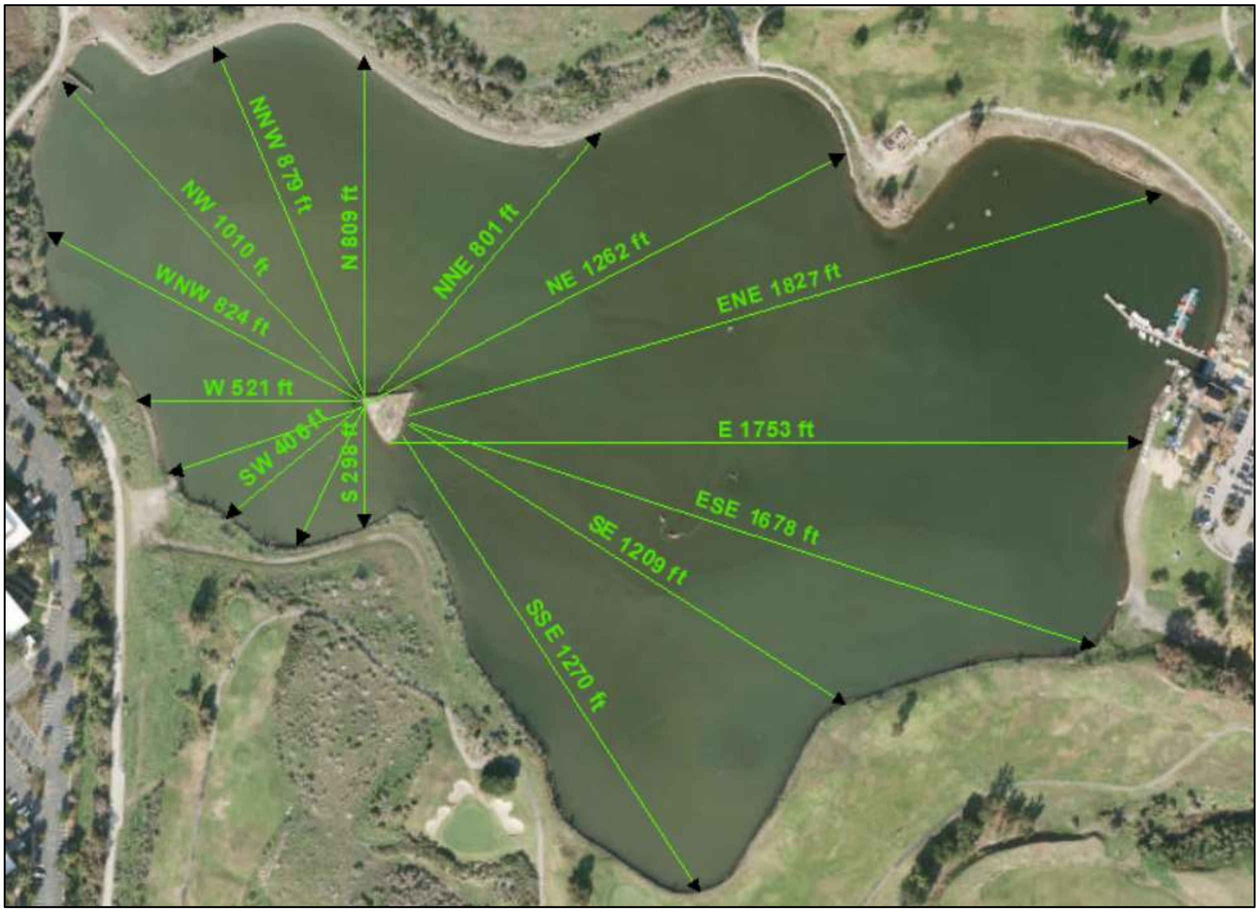


Figure 3-3 Wind Fetch Lengths in Sailing Lake

Table 3-2 Predicted 100-Year Wind-Driven Wave Conditions at Sailing Lake

	Direction															
Wave Characteristic	**N 0**	**NNE 22.5**	**NE 45**	**ENE 67.5**	**E 90**	**ESE 112.5**	**SE 135**	**SSE 157.5**	**S 180**	**SSW 202.5**	**SW 225**	**WSW 247.5**	**W 270**	**WNW 292.5**	**NW 315**	**NNW 337.5**
Observed Wind Speed, mph	42.1	30.1	27.5	22.7	25.4	41.7	45.4	41.2	40.1	30.1	31.4	31.9	28.2	35.7	34.8	42.4
Fetch Length, ft	809	801	1262	1827	1753	1678	1209	1270	298	351	406	476	521	824	1010	879
Significant Wave Height, ft	0.6	0.4	0.4	0.4	0.5	0.8	0.8	0.7	0.3	0.3	0.3	0.3	0.3	0.5	0.5	0.6
Peak Spectral Wave Period, sec	0.8	0.7	0.8	0.9	0.9	1.1	1.0	1.0	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.9
33-Percentile Wave Height, ft	0.6	0.4	0.4	0.4	0.5	0.8	0.8	0.7	0.3	0.3	0.3	0.3	0.3	0.5	0.5	0.6
10-Percentile Wave Height, ft	0.7	0.5	0.6	0.5	0.6	1.0	1.0	0.9	0.4	0.3	0.4	0.4	0.4	0.6	0.7	0.8
1-Percentile Wave Height, ft	1.0	0.7	0.7	0.7	0.8	1.4	1.3	1.2	0.6	0.4	0.5	0.5	0.5	0.8	0.9	1.0
Maximum Wave Height, ft	1.1	0.7	0.8	0.8	0.9	1.5	1.4	1.3	0.6	0.5	0.6	0.6	0.6	0.9	1.0	1.1

NOTE: Significant wave heights and peak spectral wave periods are color coded such that low speeds are blue, medium speeds are clear, and high speeds are red.

Although the majority of winds approach the lake from the northwest, followed by the southeast, the analysis shows that the largest and longest 100-year waves approach the island from the southeast. This section of the lake combines higher wind speeds with longer fetches to produce the largest waves. The maximum significant wave height of 0.8 feet and maximum peak spectral wave period of 1.1 seconds approach from the east-southeast direction. Slightly smaller and shorter waves approach the island from the northwest. The maximum significant wave height of 0.6 feet and maximum peak spectral wave period of 0.9 seconds approach from the north-northwest direction. High winds do approach the lake from this direction, but the wind fetch is more restricted to produce slightly smaller and shorter waves. The significant wave heights and peak spectral wave periods are plotted by direction in Figure 3-4 and Figure 3-5 respectively.

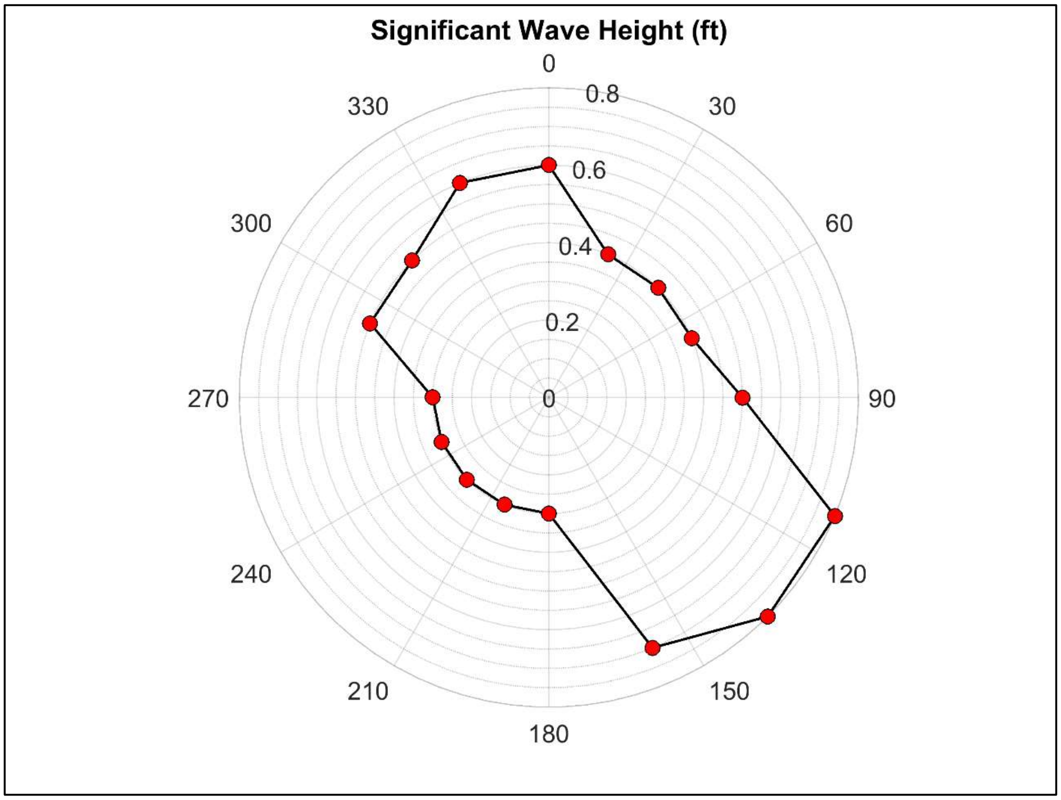


Figure 3-4 Significant Wave Heights by Direction

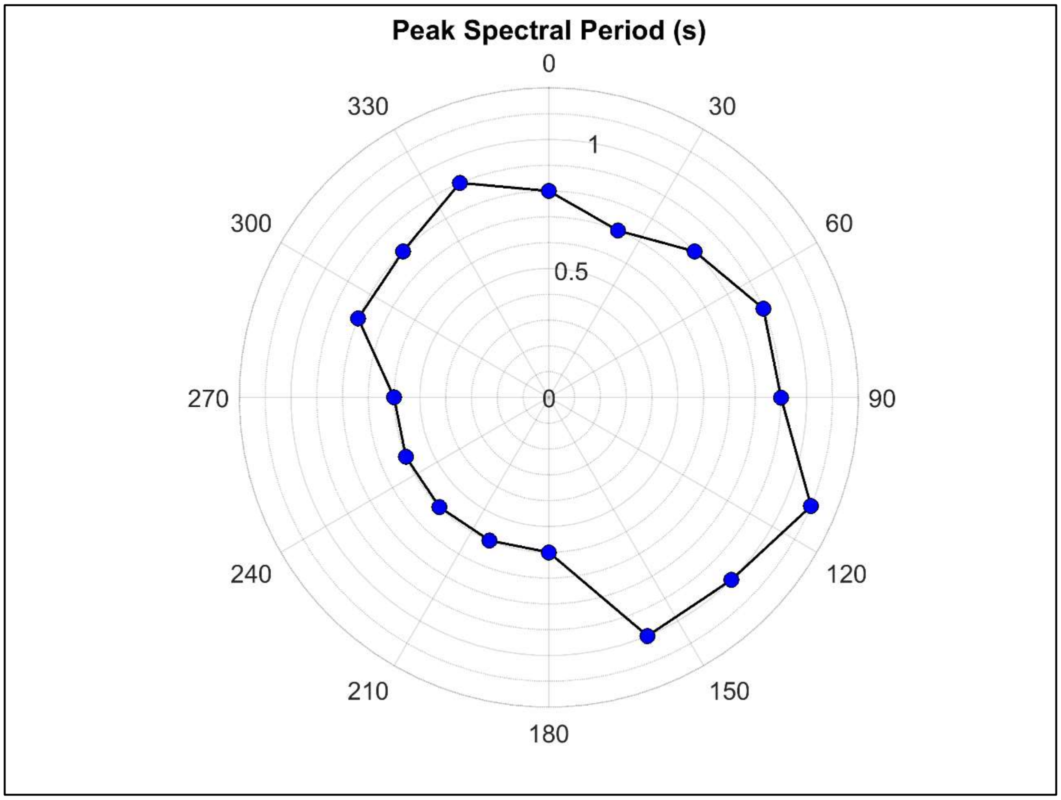


Figure 3-5 Peak Spectral Wave Periods by Direction

3.1.3 Summary and Recommendations

This section summarizes the coastal engineering analysis to develop design wave conditions for the proposed bird habitat island alternatives at Sailing Lake. Winds generally approach the lake from the northwest, and then from the southeast. The 100-year wind-wave conditions were estimated following design guidance in the USACE CEM (USACE 2006). The highest wave conditions are generally small (maximum significant wave height of 0.8 feet, and maximum peak spectral wave period of 1.1 seconds). Slightly smaller waves approach from the northwest.

Because the majority of winds approach the lake from the northwest, and the 100-year wave conditions form the northwest are only slightly smaller than those from the southeast, it is recommended that the wave conditions from both directions be factored into the design. As these waves are not particularly large, it is hoped that natural features such as gravel, cobble, woody debris, and slope control can be used to prevent flooding and erosion. Those aspects should be refined in further design stages.

3.2 Bird Habitat

The San Francisco Bay is a designated site of hemispheric importance to shorebirds and annually supports more than 1 million waterbirds (Page and others, 1999; Morrison, 2001; Stenzel and others, 2002). The bay supports more than 325,000 shorebirds in autumn, 225,000 in winter, and as many as 932,000 during spring migration (Stenzel and others, 2002).

The San Francisco Bay estuary is the largest breeding area for avocets along the Pacific Coast (Stenzel and others, 2002; Rintoul and others, 2003), and 75 percent of breeding avocets in the South Bay nest on islands within ponds (Ackerman and others, 2013).

The Sailing Lake habitat island is an annual nesting site for black skimmers, Forster’s terns, American avocets, black-necked stilts, and some resident waterfowl such as mallards and Canada geese. The island is used as a roosting site during the nonbreeding season by a variety of resident and migratory waterbirds and gull species.

3.2.1 Target Species

Based on research completed and input from City personnel familiar with the island habitat and historic and current bird use, nesting bird habitat was selected as the target use for the four identified target species: black skimmers, Forster's terns, American Avocet, and black-necked stilts. Black skimmer nesting habitat criteria is given priority due to its status as a California Bird Species of Special Concern (breeding).

3.2.2 Island Characteristics

Anecdotal information and preliminary data provided by City staff indicate that the existing island provides suitable habitat for species listed in Section 2.4.3 of this report, and that bird populations have grown over time. Based on site experience and observations by City staff, the following information will be considered in the proposed design:

- Nesting birds prefer an island surface consisting of varying areas of sand, pebbles and oyster shells.
- Wooden frames help prevent erosion of substrate and provide shelter for young birds.
- Nesting black skimmers prefer sparse or non-existent vegetation.
- Steep slopes have resulted in eggs rolling away from nests into the water. Wooden frames have been installed to help prevent this, resulting in an increase in nesting success, especially for black skimmers.

Other relevant research and studies to inform the proposed island geometry, substrate, vegetation and elevation are summarized below.

Geometry

The list below summarizes information related to **island geometry** that is relevant to the proposed Sailing Lake habitat island alternatives and subsequent design:

- Ackerman and others (2014) noted from studies at the Don Edwards Wildlife Refuge that, although there was no difference in nest success between linear and rounded islands, linear islands exhibited as much as eight times more nests than rounded islands after accounting for all other island variables including size.
- Hartman and others (2016) found the following:
  - Linear islands are more conducive to bird nesting than are rounded islands because, for a given island size, a linear shape allows for more area within 23 feet of the water's edge.
  - Both avocets and terns selected island plots close to the water's edge, with nesting probability peaking at 23 feet and 6.6 feet from the water's edge for avocets and terns, respectively. This suggests that construction of long and narrow islands 23 to 50 feet wide would maximize habitat within the preferred proximity to water, whereas large, rounded islands would contain more of less preferred habitat farther from the water's edge.
  - Orienting linear islands in an east-to-west direction would maximize the amount of area with south-facing slopes preferred by nesting avocets and terns, and that islands with a mix of areas with moderately steep terrain and flatter surfaces would accommodate preferred slopes of both avocets and terns.

Substrate/Vegetation

The list below summarizes information about island **surface features** relevant to the proposed Sailing Lake habitat island alternatives and subsequent design:

- Hartman and others (2016) found that it is preferrable to ensure nesting islands contain patches of short vegetation, ranging from 10 to 100 percent cover, as well as areas with little (<10 percent cover) or no cover; tall vegetation is not ideal. Avocets and terns were more likely to nest in microhabitats with vegetation (65 percent of avocet nests, 76 percent of tern nests) than without it, and the most common species of vegetation were pickleweed (*Sarcocornia pacifica*) and alkali-heath

(*Frankenia salina*). Yet, many avocet nests were in sparsely vegetated areas, suggesting that islands with complete vegetation cover would not be conducive to nesting by avocets.

- Maslo and others (2016) found the following:
  - Black skimmers nest in several habitat types, including sand/shell beaches, salt marshes and dredge spoil islands.
  - All species used non-vegetated beach and dunes for nesting. Black skimmers also nested frequently on mud flats and salt marshes.
  - Although the sandy beach area was not as important to black skimmer nest-site selection, probability of occurrence increased with increasing sandy beach area. More important to skimmer occupancy was the total marsh area within 100 meters.

Elevation

The list below summarizes information about island **elevation** relevant to the proposed Sailing Lake habitat island alternatives and subsequent design:

- Hartman and others (2016) found the following:
  - To increase nesting probability, islands should have abundant area between 1.6 feet and 5 feet above the water surface because this range encompasses the preferred elevations of both avocets and terns.
  - Avoidance of low-lying, near-water areas by avocets and terns may reduce the likelihood of avocet nest flooding.
  - American avocets nesting on island plots in South San Francisco Bay, California, peaked at an elevation of 2.6 feet, peaked at a distance of 23 feet from the water's edge, and increased as slope increased up to a peak of approximately 15 degrees.
  - Both avocets and terns prefer microhabitats with some vegetation; a higher degree of vegetation cover (>50%) was more important to nesting terns than avocets.
  - Avocet and tern nest microhabitat selection also was affected by aspect; both species' nests were more likely to have south-facing than north-facing slopes relative to random sites.
- Maslo and others (2016) found that all species were predicted to nest ≥13 feet from the high tide line.

3.2.3 Summary

Based on the literature review documented above, preferred island attributes for nesting waterbirds in the South San Francisco Bay include the following:

- Islands that are more linear in shape.
- Preference for south-facing slopes.
- Mosaic of slopes ranging from flat to moderately steep (21 degrees).
- Abundant area within 23 feet of the water's edge.
- Abundant area in the elevation range of 1.6 feet to 5 feet above the water surface.
- Patches of short vegetation (10-100% cover) and areas with less than 10% cover or no cover
- Shells preferred substrate for skimmers and terns, while black necked stilts prefer a sand/silt mixture or mudflat.

More species-specific information is provided in Table 3-3.

Table 3-3 Target Species Overview

Common Name	Scientific Name	Nesting Location	Nesting Substrate	Nesting Vegetation	Nesting Vegetation Cover (%)	Distance from Water (feet)	Nesting Elevation (feet above WSEL)	Slope Degree	Facing Slope	Roosting Location
Black Skimmer	*Rynchops niger*	sandy beaches, low small island, gravel bars, dikes	shell, sand-silt	-	Un-vegetated to 30	-	Prefer higher	-	-	Sand bars, beaches
Forster's Tern	*Sterna forsteri*	low islands, open levees, barren islands	shell, sandy gravel	*Pickleweed, Alkali-heath*	55	6.6	2.4	6	South	Pilings, floating objects, exposed beaches
American Avocet	*Recurvirostra americana*	barren islands, salt flats, levees and dikes	-	-	40	23	1.6 to 3.3	15	South	Mudflat
Black-necked Stilt	*Himantopus mexicanus*	islands in shallow water, levees, dikes	friable soil, mudflats	*Pickleweed*	75	On edge	-	-	-	Islands in shallow water, levees, alkali flats

Notes:
1. Dash (-) indicates no data available
2. Ackerman et al. (2014)
3. Hartman et al. (2016)
4. Maslo et al. (2016)

4. Alternative Descriptions

This section summarizes the alternatives development process and the current alternatives under consideration for detailed design.

Alternatives presented in this section include:

- Alternative 1 – Repair Eroded Slopes
- Alternative 2 – Repair Eroded Slopes and Expand Island Size

An overview is provided for each alternative describing key aspects of the alternative, associated habitat benefits, general maintenance considerations, and uncertainties.

4.1 Alternatives Development

An initial set of conceptual alternative grading plans were developed and presented to the City on September 1, 2023. Target species and habitat preferences were summarized, and a variety of alternatives were presented that varied in size and shape. Alternatives were then refined to incorporate comments received and additional analyses completed. Alternatives were generally developed to meet or exceed the objectives defined in Section 1.3, which included consideration for City staff access to the island for maintenance and monitoring and minimization of potential impacts on recreational use. All alternatives will minimize impact to existing nests to the extent feasible, and construction will occur outside of the bird nesting season.

In addition to island geometry alternatives, options for an island barrier system were presented to the City, including floating barriers, floating habitat islands and engineered log structures/piles. Three specific types of floating barriers were identified for further consideration, and are described in more detail in Section 4.6.

4.2 Alternative 0 – Maintain Existing Condition

Alternative 0 includes no improvements to the existing island, leaving the existing near vertical eroded banks and associated risk to wildlife. In addition, no improvements would be made to the existing surface features on the island surface. A new barrier system will be constructed to reduce human interaction with the island and wildlife. The objective of this alternative is to maintain the current level of City operation and maintenance and limit near-term capital costs.

This alternative does not meet the primary goals of the project to return the island to its previous size and minimize future erosion. In addition, it is anticipated that this alternative will result in continued erosion and further reduction of the island size over time, further limiting available bird nesting areas and opportunities. For these reasons, Alternative 0 is not further evaluated in this study

4.3 Alternative 1 – Repair Eroded Slopes

Alternative 1 preserves the existing habitat island shape and size (of the top of the island) while repairing the eroded slopes around the perimeter (see Figure 4-1). While the existing topography on the island surface would primarily remain intact, the proposed island side slopes would be constructed at 3H:1V (see Figure 4-2 for cross section). The top of the island area remains at 0.11 acre, while the acreage of the proposed island at the current Water Surface Elevation (WSEL) of 10.5 feet is 0.16 acre. Gravel erosion protection would be provided on the slopes from several feet below the WSEL to 2.5 feet vertically above the WSEL.

In order to construct the slope, the lake would likely be drawn down below the lowest elevation of the proposed slope improvements using existing infrastructure. In some areas, the proposed slopes extend down to approximate elevation 9.0 feet NAVD88 where they daylight into the existing island side slopes, which range from 3.2H:1V to 4.6H:1V. The Contractor would likely drain the lake level enough, and potentially provide cofferdams, to create a dry work area that would accommodate their construction approach. The Contractor could choose to either work from the island surface, from a floating barge, or create a work bench adjacent to the island. See Section 4.7 for additional construction method options the Contractor may consider, and Section 5 for dewatering and cofferdam assumptions associated with preliminary cost opinions presented in this report.

The surface of the island would be improved to maximize the quality of habitat provided by removing invasive vegetation and providing a mixture of new substrate and pockets of native vegetation preferred by the target bird species. The existing wooden frames and guiderails would be removed and re-purposed onsite, and all existing non-native vegetation would be cleared and removed from the site. Existing nests will be protected where feasible and associated material may be reused onsite

Based on research summarized in Section 3.2, and with the intent of providing ideal nesting habitat for the maximum number of target species, it is proposed to use oyster shells in some higher areas of the island, sand in some mid-elevation areas, and exposed earth or a sand/silt mixture closer to the water surface and just above the gravel erosion protection on the slopes. Existing native vegetation would be preserved to the extent feasible, and additional pockets of pickleweed and alkali heath would be added. Wooden frames and guiderails would be used in certain areas to prevent movement of the substrate and large wood would be added to provide additional habitat complexity. Figure 4-3 shows the various surface treatments proposed in Alternative 1.

Benefits associated with Alternative 1 include improved nesting habitat over existing conditions for a wider range of bird species, and a long-term solution to reduce the risk of future erosion and minimize maintenance.

Maintenance of the island should be reduced from current activities, but monitoring and maintenance of the erosion protection and nesting substrate would be required to some extent throughout the year, particularly prior to the nesting season (for substrate augmentation).

A construction duration of two months would likely be required for this alternative, with mobilization starting in early October, after confirmation of the end of the nesting season.

Key uncertainties associated with Alternative 1 include the following:

1. Geotechnical characteristics associated with existing habitat island slopes beneath the WSEL and overall stability of the slopes is unknown. Additional information may be required to assess construction equipment access and long-term slope stability.
2. Dewatering effort may vary as a function of lake bottom material characteristics and effectiveness of pumps and cofferdams.

The extent and density of invasive vegetation species is not fully understood at this time, and could impact the activities required to rid the surface of all invasive plants and seed banks

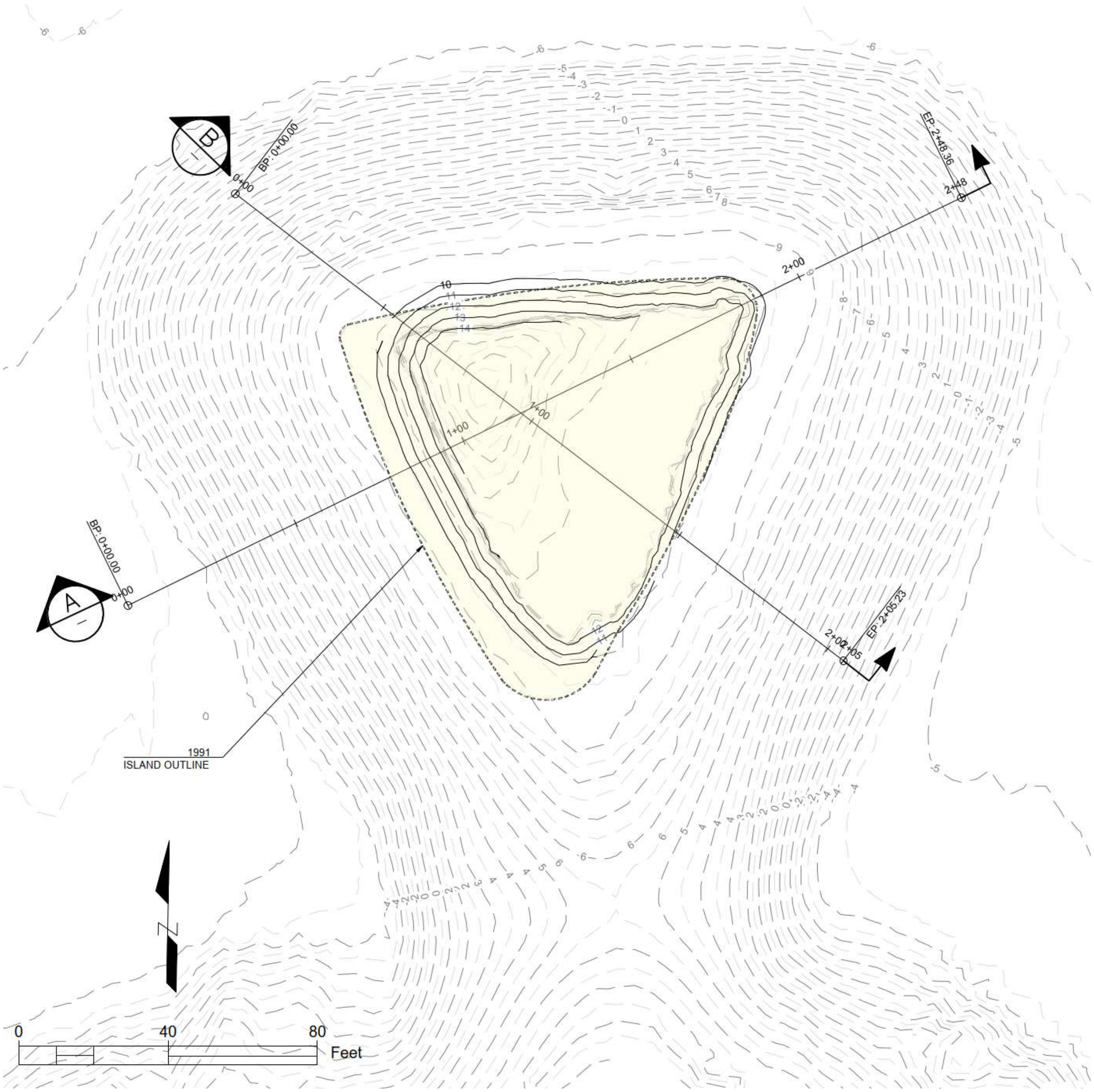


Figure 4-1 Alternative 1 Grading Plan

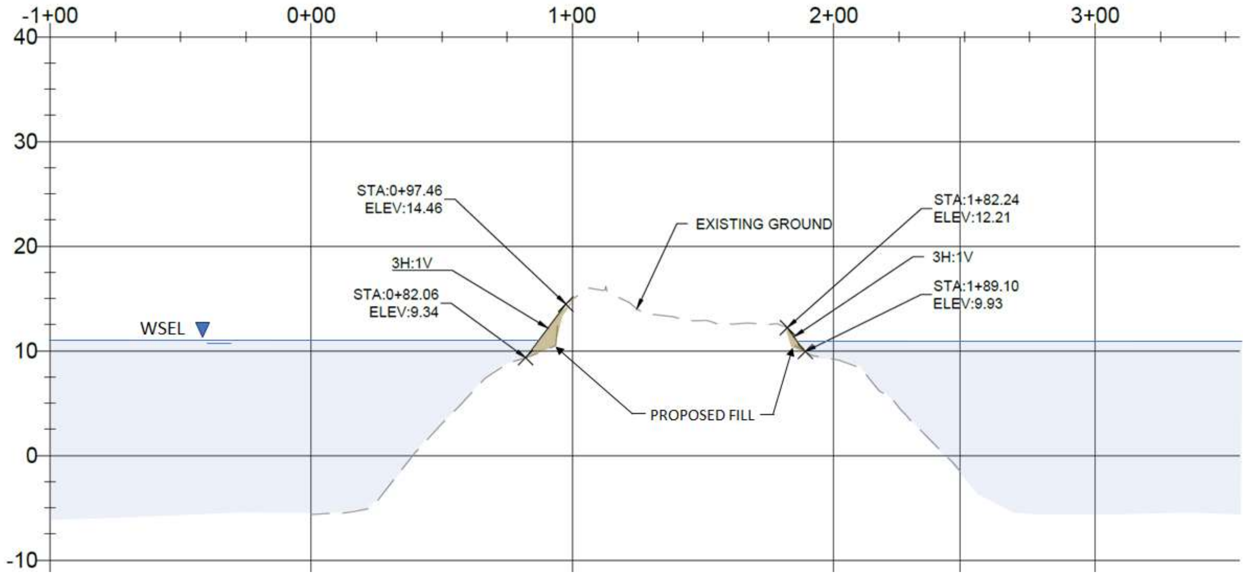


Figure 4-2 Alternative 1 Cross Section A

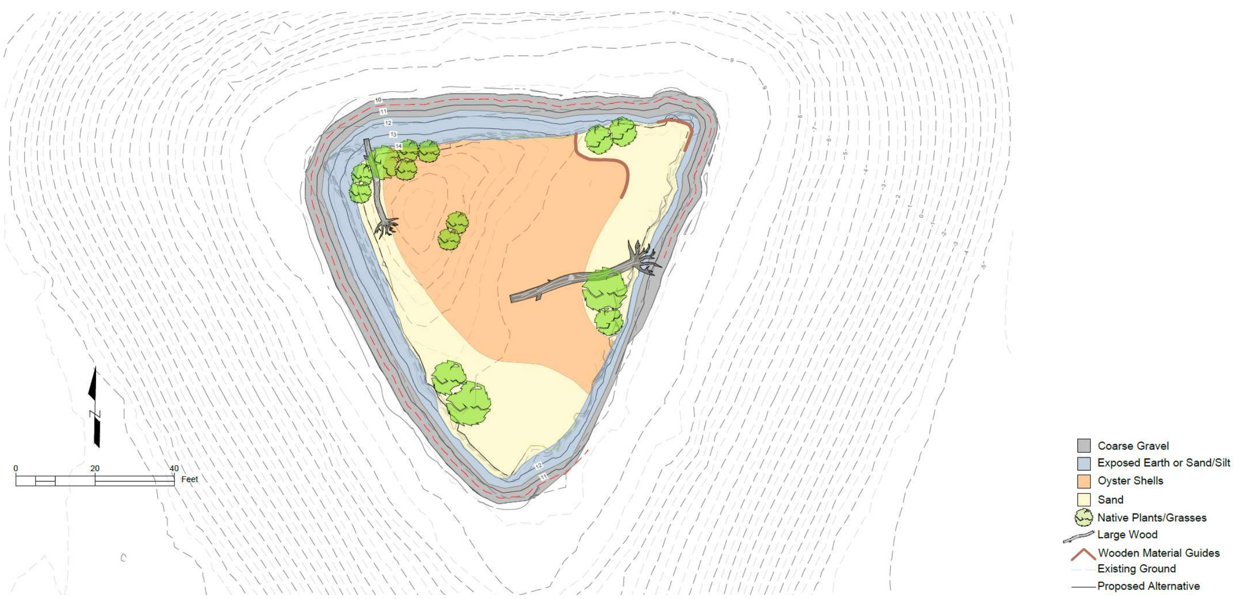


Figure 4-3 Alternative 1 Surface Treatments

4.4 Alternative 2 – Repair Eroded Slopes and Expand Island Size

Alternative 2 preserves the existing habitat island shape, repairs the eroded slopes around the perimeter, and increases the top of island area to match the approximate historic size. While the existing topography on the island surface would primarily remain intact, the proposed island side slopes would be constructed at 4H:1V above the water surface elevation (WSEL) and 2H:1V below the WSEL (see Figure 4-5 for cross section). The top of the island area increases to 0.18 acre (matching historic), while the associated acreage of the proposed island at the current WSEL of 10.5 feet is 0.28 acre. Gravel erosion protection would be provided on the slopes from several feet below the WSEL to 2.5 feet vertically above the WSEL.

In order to construct the slope, the lake would likely be drawn down to the lowest level possible using the existing infrastructure . Based on input from the City, the lowest feasible lake level allowed for construction is 8 feet NAVD88. In some areas, the proposed slopes extend down to approximate elevation 5.0 feet NAVD88 where they daylight into the existing island side slopes, which range from 3.2H:1V to 4.6H:1V. The Contractor would likely drain the lake level as much as possible, and potentially provide cofferdams, to create a dry work area inside the cofferdams that would accommodate their construction approach. The Contractor could choose to either work from the island surface, from a floating barge, or create a work bench adjacent to the island. See Section 4.7 for additional construction method options the Contractor may consider, and Section 5 for dewatering and cofferdam assumptions associated with preliminary cost opinions presented in this report.

The surface of the island would be improved to maximize the quality of habitat provided by removing invasive vegetation and providing a mixture of new substrate and pockets of native vegetation preferred by the target bird species. The existing wooden frames and guiderails would be removed and re-purposed onsite, and all existing non-native vegetation would be cleared and removed from the site. Existing nests will be protected where feasible and associated material may be reused onsite

Based on research summarized in Section 3.2, and with the intent of providing ideal nesting habitat for the maximum number of target species, it is proposed to use oyster shells in some higher areas of the island, sand in some mid-elevation areas, and exposed earth or a sand/silt mixture closer to the water surface and just above the gravel erosion protection on the slopes. Existing native vegetation would be preserved to the extent feasible, and additional pockets of pickleweed and alkali heath would be added. Wooden frames and guiderails would be used in certain areas to prevent movement of the substrate and large wood would be added to provide additional habitat complexity. Figure 4-6 shows the various surface treatments proposed in Alternative 2.

Benefits associated with Alternative 2 include a return in size to slightly beyond the historic island acreage, improved nesting habitat over existing conditions for a wider range of bird species, and a long-term solution to reduce the risk of future erosion and minimize maintenance.

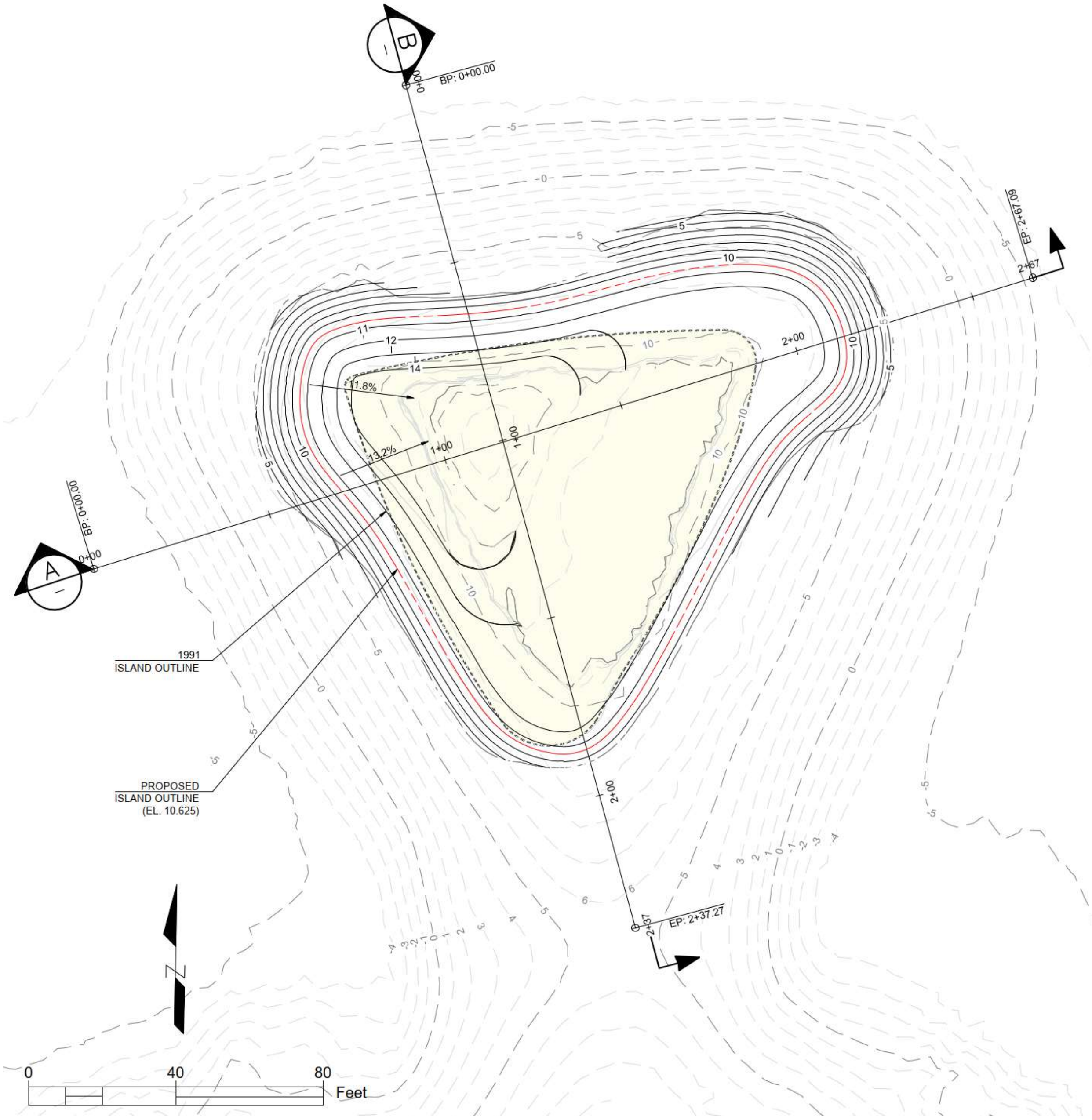


Figure 4-4 Alternative 2 Grading Plan

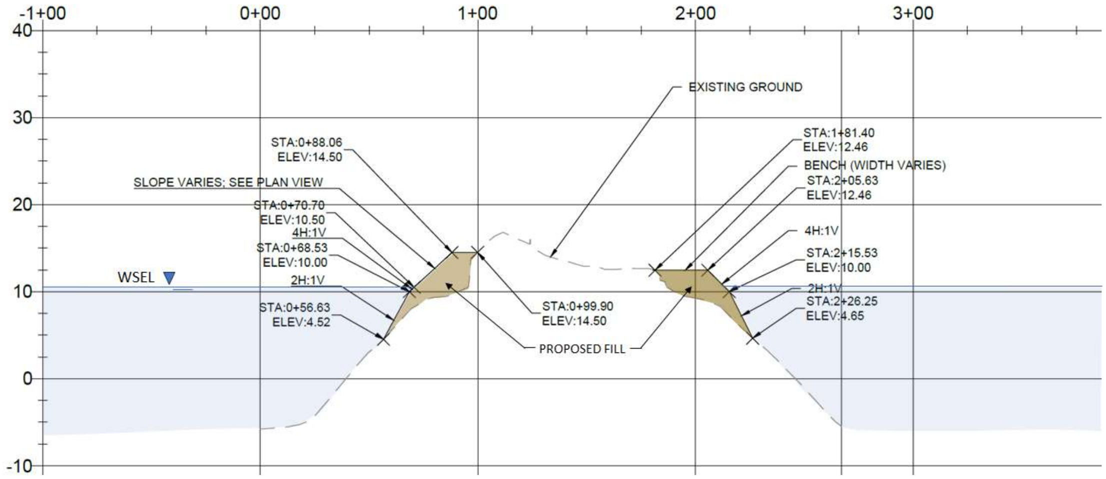


Figure 4-5 Alternative 2 Cross Section A

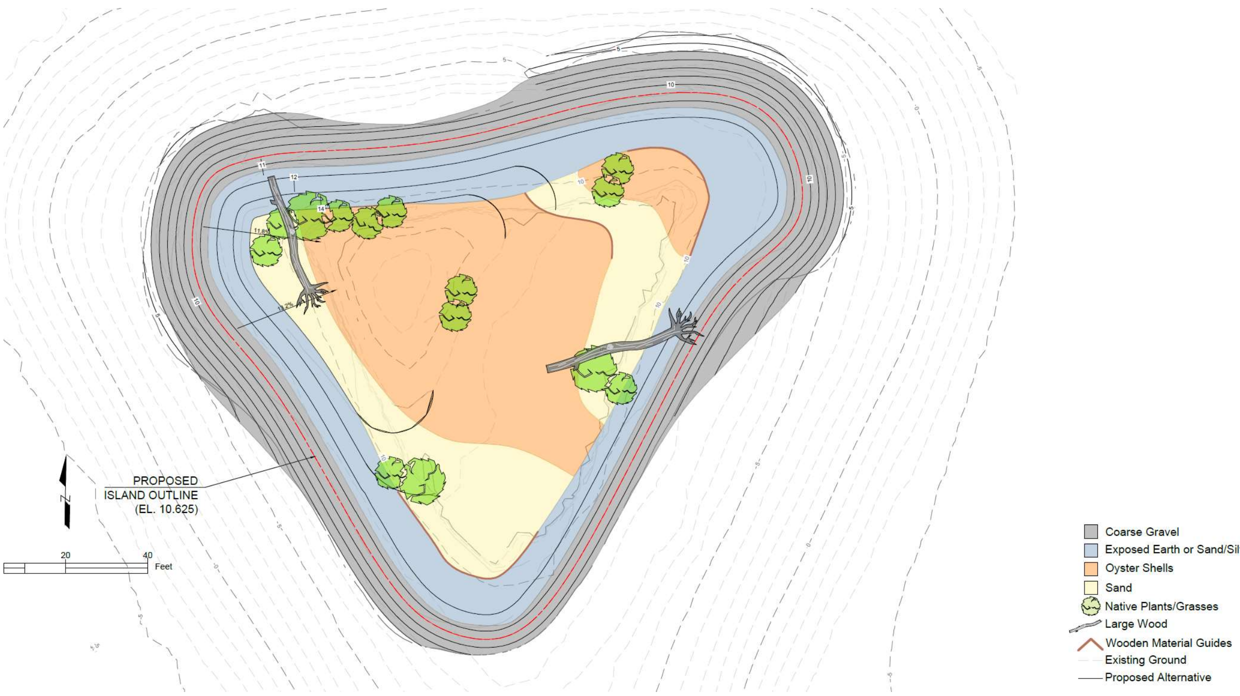


Figure 4-6 Alternative 2 Surface Treatments

Maintenance of the island should be reduced from current activities, but monitoring and maintenance of the erosion protection and nesting substrate would be required to some extent throughout the year, particularly prior to the nesting season (for substrate augmentation). The maintenance effort would be slightly greater than Alternative 1, given the increased shoreline length.

A construction duration of three to four months would likely be required for this alternative, with mobilization starting in early October, after confirmation of the end of the nesting season.

Key uncertainties associated with Alternative 2 include the following:

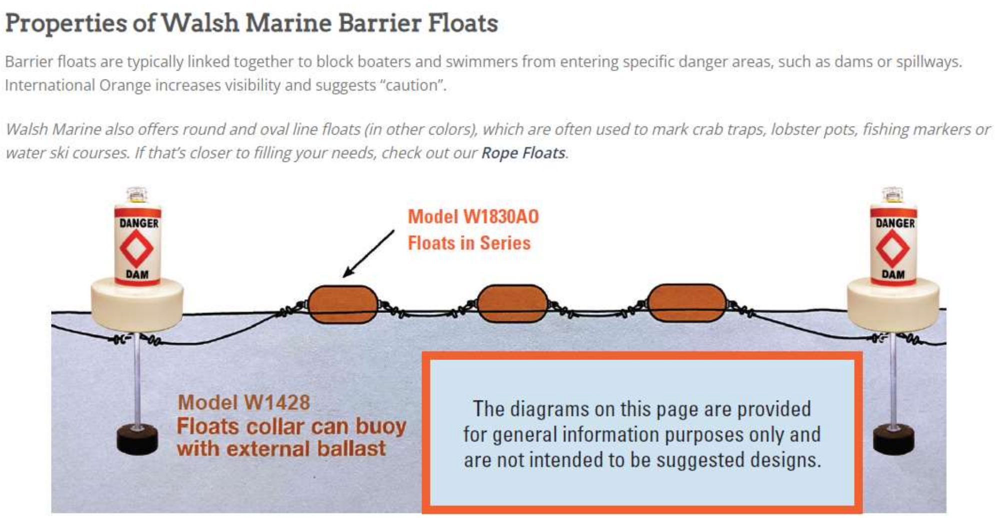
1. Geotechnical characteristics associated with existing habitat island slopes beneath the WSEL and overall stability of the slopes down to elevation -5.0 feet is unknown. Additional information may be required to assess construction equipment access and long-term slope stability.

2. Dewatering effort may vary as a function of lake bottom material characteristics and effectiveness of pumps and cofferdams.
3. The extent and density of invasive vegetation species is not fully understood at this time, and could impact the activities required to rid the surface of all invasive plants and seed banks.

4.5 Barrier Options

There are three barrier options under consideration, and they include the following:

1. **Walsh marine buoy system** with barrier floats, float collar buoys and chain connectors (see Figure 4-7): Barrier floats are linked together to block boaters from entering the vicinity of the island. The international orange color increases visibility and suggests “caution”. The float collar buoys provided additional visibility and instruction to recreation lake users. Anchors to the lake bottom will be provided at key locations to prevent the buoy system from moving significantly. Initial data from the supplier suggest that this product is robust enough to not sink with mussel and algae accumulation, but additional discussion and research will be completed during detailed design. https://walshmarineproducts.com/shop/
2. **Musthane floating security barrier system** with large floats and chain connectors (see Figure 4-8): Floating security barriers are larger in size than the Walsh Marine system for better protection against boater entry, with easy installation and maintenance. Anchors to the lake bottom will be provided at key locations to prevent the buoy system from moving significantly. Initial data from the supplier suggest that this product is robust enough to not sink with mussel and algae accumulation, but additional discussion and research will be completed during detailed design. https://www.musthane.com/our-solutions/floating-security-barriers/
3. **Drilled wooden piles with rope/buoy system** would include either single wooden piles, or groups of piles, connected with heavy duty marine rope and a buoy system at the water surface (see Figure 4-9). Wooden piles would be spaced at an appropriate distance to anchor the rope and buoy system in place, as well as impede boater access.



https://walshmarineproducts.com/shop/

Figure 4-7 Walsh Marine Buoy System

https://www.musthane.com/our-solutions/floating-security-barriers/

Figure 4-8 Musthane Floating Barrier

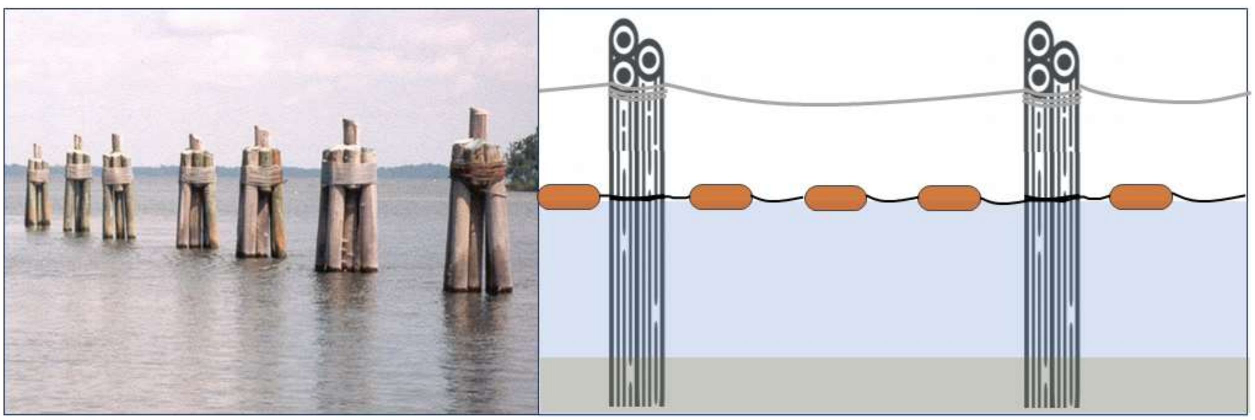


Figure 4-9 Wooden Piles with Rope/Buoy System

4.6 Construction Methods

There are several construction methods that could be considered by the Contractor to construct the various island improvements discussed above. Regardless of the alternative selected, the Contractor may prefer to draw down the lake level to the maximum feasible extent (8 feet NAVD88, determined by the City to limit impacts to lake recreation) to limit the cost of any cofferdam system and associated pumping. Due to the timing of construction outside the bird nesting window, there is little to no risk of habit or nests being established on exposed lakebed sediments during drawdown.

Three construction methods that are reasonable to consider for this project are described in more detail below: water inflated cofferdam, sheetpile cofferdam, and rockfill placement in the wet.

- Water inflated cofferdams are often used for temporary water diversion in water construction and flood protection projects. They are produced from flexible reinforced PVC membrane material and characterized by being light-weight, easily deployed and removed, compact in storage, repairable and reusable. They typically have a maximum height of approximately 8 feet, depending on the manufacturer. See Figure 4-10 below for a schematic and photograph.

- Sheetpile cofferdams are commonly used in many different types of construction to retain either soil or water. Sheetpiles materials are typically steel, have interlocking edges and are vibrated or driven into the underlying soils via drilling equipment placed on a barge. They can provide water diversion for heights of 20 feet and above. See Figure 4-11 for a schematic and photograph.
- Rockfill placement in the wet involves the dumping of rockfill material from a barge to build up a stable workpad for construction equipment and subsequent earth fill placement. The size and anticipated volume of rockfill could be refined during detailed design. See Figure 4-12 for a schematic.

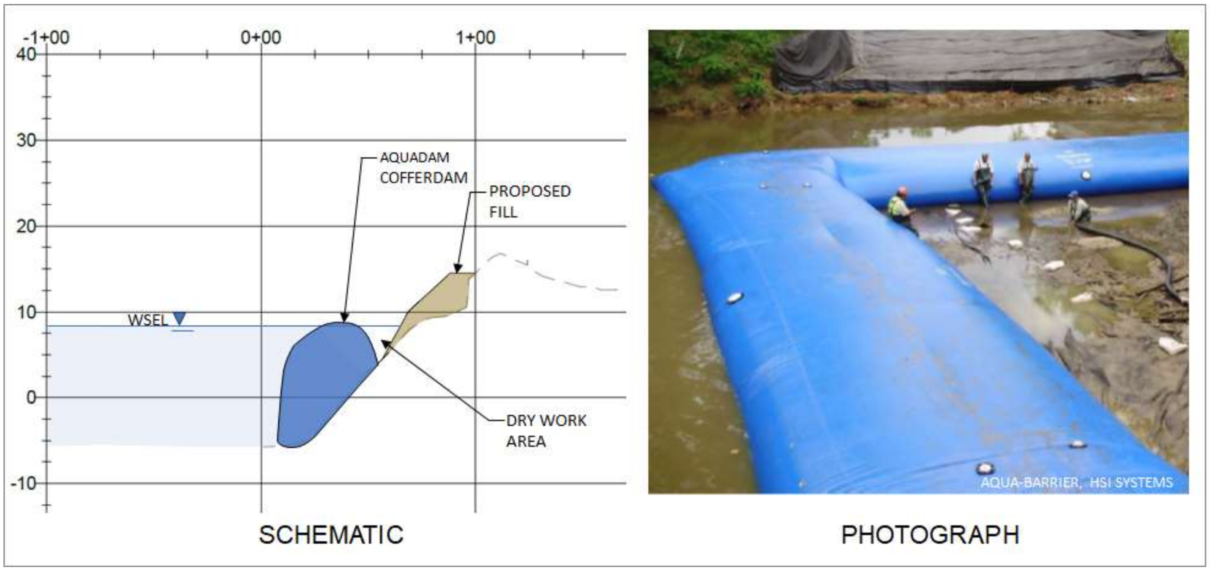


Figure 4-10 Water Inflatable Cofferdam

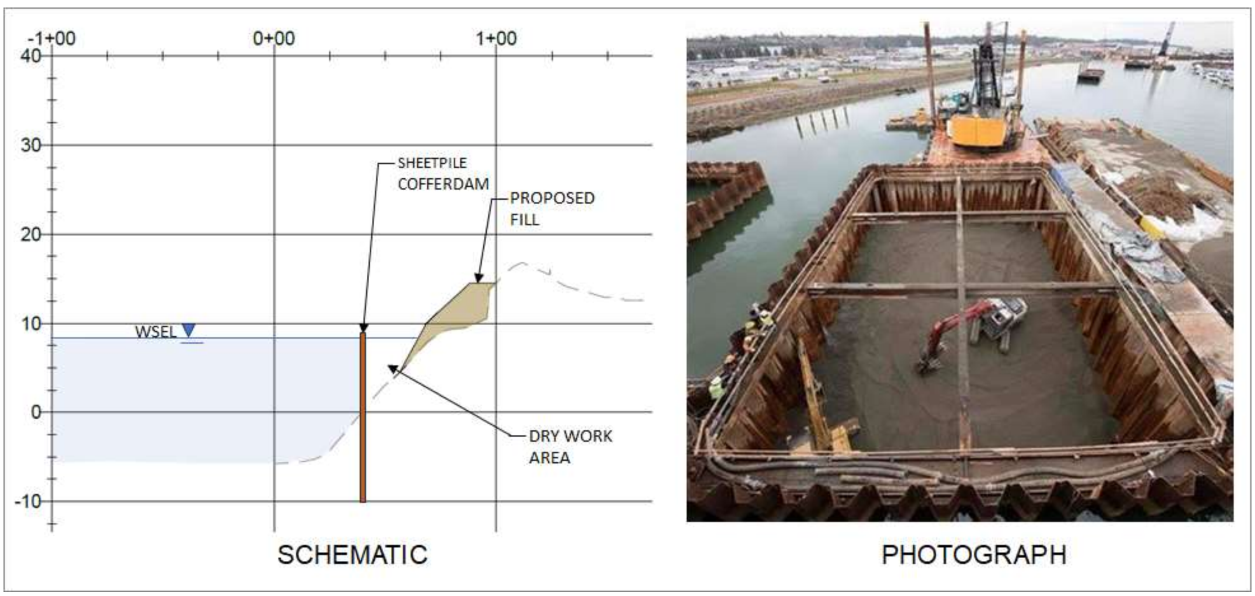


Figure 4-11 Sheetpile Cofferdam

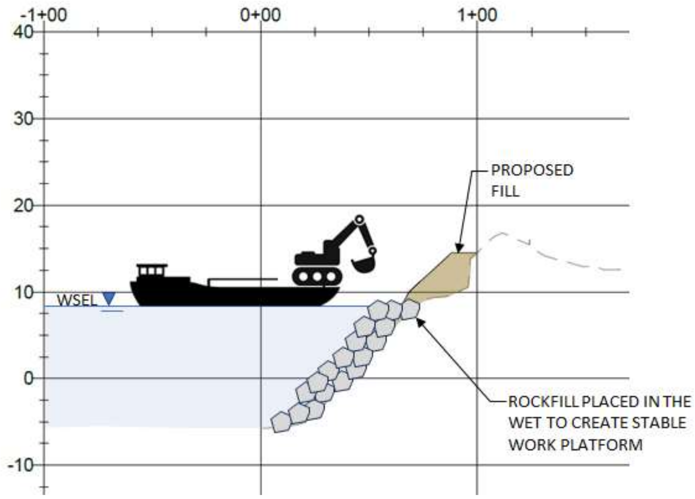


Figure 4-12 Rockfill Placement in the Wet

5. Cost Opinions for Alternatives

This section describes the anticipated construction costs for each alternative summarized in Section 4. Detailed cost information is provided in Appendix B.

5.1 Basis for Cost Development

The methods used to develop the opinions of probable construction costs (OPCC) are described below. The resulting opinions of cost are provided in Section 5.2.

The engineer's opinion of costs associated with construction includes assessment of the procurement of materials and the time, labor, and equipment required to install, erect, and construct each of the alternatives to the intended initial operational condition. The anticipated construction costs are included herein as OPCCs; OPCCs express an opinion of costs, generated by the study engineers and based on information available at the time this report was prepared.

OPCC are based on the measurement and pricing of quantities wherever information is provided and/or reasonable assumptions for other work not covered in the drawings or descriptions herein. Unit rates have been obtained from historical records and/or discussion with Contractors. The unit rates reflect current bid costs in the area. All unit rates relevant to subcontractor work include the subcontractors' overhead and profit unless otherwise stated. The mark-ups cover the costs of field overhead, home office overhead and profit and range from 15% to 25% of the cost for a particular item of work.

Quantities were developed in AutoCAD or measured off the drawings provided in Appendix A. Earthwork fill volumes are summarized below in Table 5-1. See Section 4.7 for construction methods the Contractor may consider when proposing on the project. For estimating purposes, it was assumed that water inflatable cofferdams would be utilized in locations that could accommodate their maximum feasible height, and when additional height was required, the Contractor would utilize sheetpile cofferdams instead.

Table 5-1 Offsite Fill Volume Summary

Alt. No.	Earth Fill Volume (cubic yards)
1	480
2	920

Pricing reflects probable construction costs obtainable in the project locality on the date of this statement of probable costs. This estimate is a determination of fair market value for the construction of this project. It is not a prediction of low bid. Pricing assumes competitive bidding for every portion of the construction work for all subcontractors and general contractors.

Since AECOM has no control over the cost of labor, material, equipment, or over the contractor's method of determining prices, or over the competitive bidding or market conditions at the time of bid, the statement of probable construction cost is based on industry practice, professional experience and qualifications, and represents AECOM's best judgment as professional construction consultant familiar with the construction industry. However, AECOM cannot and does not guarantee that the proposals, bids, or the construction cost will not vary from opinions of probable cost prepared by them.

The following assumptions were used as a common framework during OPCC development for each alternative:

- OPCCs are developed in conformance with AACE International Recommended Practice No. 18R-97, Class 5 Cost Opinions, with a range of accuracy based on 0 to 10 percent project definition and a +50 percent to -25 percent range of accuracy.
- The basis of pricing has been derived from rates prevailing in Mountain View, California during the 1st Quarter 2025.

- There will not be a strict material specification associated with the offsite fill required to construct the expanded island areas (not including surface substrate and gravel erosion protection), so it is assumed that there will be no difficulties sourcing this material.
- The allowances for the General Contractor's Indirect Markups are summarized below:
  - General Conditions @ 8%
  - General Requirements @ 7%
  - Insurance and Bonds @ 3%
  - General Contractor Overhead and Profit @ 7%
  - A Design Reserve Contingency has been included @ 30%
- The Contractor will be required to pay prevailing wages.
- Escalation added for 2 years @ 5% annual escalation.
- A mitigation contingency of 10% has been included based on discussion with the City.

5.2 Cost Summary

This section summarizes the results of the various costs analyses described in Section 5.1.

Table 5-2 summarizes the OPCC for Alternative 1 (Repair Eroded Slopes). The majority of the cost associated with Alternative 1 involves mobilization of equipment to the site (barge, temporary dock, etc.) and the surface treatments proposed to maximize ecological benefit.

Table 5-2 Alternative 1 OPCC Summary

Line Item #	Line Item	Description	Estimate
1	General Conditions	Mobilization, temporary facilities, staging, etc.	$223,500
2	Demolition	Removal of existing barrier and wooden features	$24,240
3	Earthwork	Clearing & grubbing, dewatering, cut and fill	$68,943
4	Exterior Improvements	Surface materials and planting	$295,986
		Subtotal	**$612,669**
		General Conditions (8%)	$49,014
		General Requirements (7%)	$46,318
		Insurance and Bonds (3%)	$21,240
		General Contractor OH and Profit (7%)	$51,047
		Escalation – 2 years	$79,979
		Total Construction Cost	**$860,266**
		Design/Construction Contingency (30%)	$258,080
		Mitigation Contingency (10%)	$86,027
		Total Construction Cost with Contingency	**$1,204,373**

Table 5-3 summarizes the OPCC for Alternative 2 (Repair Eroded Slopes and Expand Island Size). Approximately 54 percent of the cost for this alternative involves the dewatering and earthwork activities to construct the proposed island slopes, with approximately 80 percent of this activity reserved for cofferdams and dewatering.

Table 5-3 Alternative 2 OPCC Summary

Line Item #	Line Item	Description	Estimate
1	General Conditions	Mobilization, temporary facilities, staging, etc.	$223,500
2	Demolition	Removal of existing barrier and wooden features	$24,240
3	Earthwork	Clearing & grubbing, dewatering, cut and fill	$849,493
4	Exterior Improvements	Surface materials and planting	$470,135
		Subtotal	**$1,567,368**
		General Conditions (8%)	$125,389
		General Requirements (7%)	$118,493
		Insurance and Bonds (3%)	$54,338
		General Contractor OH and Profit (7%)	$130,591
		Escalation – 2 years	$204,608
		Total Construction Cost	**$2,200,787**
		Design/Construction Contingency (30%)	$660,236
		Mitigation Contingency (10%)	$220,079
		Total Construction Cost with Contingency	**$3,081,102**

Vendor estimates for the two proprietary buoy barrier systems are a function of the barrier system length. The barrier length is the same for Alternatives 1 and 2 at approximately 850 linear feet.

Table 5-4 summarizes the OPCC for Barrier System Option 1 (Walsh).

Table 5-4 Barrier Option 1 (Walsh) OPCC Summary

Line Item #	Description	Qty	Unit	Unit Rate	Estimate
1	New Floating Barriers & Anchors (material only)	850	LF	$ 33	$28,050
2	Installation Cost	1	LS	$16,830	$16,830
3	Land Barrier Anchors	2	EA	$ 7,500	$15,000
				Subtotal	**$59,880**
				General Conditions (8%)	$4,790
				General Requirements (7%)	$4,527
				Insurance and Bonds (3%)	$2,076
				General Contractor OH and Profit (7%)	$4,989
				Escalation – 2 years	$7,817
				Total Construction Cost	**$84,079**
				Design/Construction Contingency (30%)	$25,224
				Total Construction Cost with Contingency	**$109,303**

Table 5-5 summarizes the OPCC for Barrier System Option 2 (Musthane).

Table 5-5 Barrier Option 2 (Musthane) OPCC Summary

Line Item #	Description	Qty	Unit	Unit Rate	Estimate
1	New Floating Barriers (material only)	850	LF	$ 256	$217,600
2	Installation Cost	1	LS	$87,040	$87,040
3	Land Barrier Anchors	2	EA	$ 7,500	$15,000
				Subtotal	**$319,640**
				General Conditions (8%)	$25,571
				General Requirements (7%)	$24,165
				Insurance and Bonds (3%)	$11,081
				General Contractor OH and Profit (7%)	$26,632
				Escalation – 2 years	$41,727
				Total Construction Cost	**$448,816**
				Design/Construction Contingency (30%)	$134,645
				Total Construction Cost with Contingency	**$583,461**

For the third wooden pile option, the cost for driving the wooden piles from a barge can vary significantly depending on the exact length of pile needed below the lake bottom and the number of driven piles needed at each location. Assuming one driven pile per anchor location (with other logs bolted to the stable driven pile), and pile anchor locations every 50 linear feet along the barrier alignment, Table 5-6 summarize the OPCC for Barrier Option 3.

Table 5-6 Barrier Option 3 (Wooden Piles) OPCC Summary

Line Item #	Description	Qty	Unit	Unit Rate	Estimate
1	New Floating Barriers (material only)	850	LF	$ 33	$28,050
2	Floating Barrier Installation Cost	1	LS	$16,830	$16,830
3	Land Barrier Anchors	2	EA	$ 7,500	$15,000
4	Drilled Wooden Pile Groups	17	EA	$ 4,000	$68,000
5	Marine Rope (material & installation)	1190	LF	$ 8	$9,520
				Subtotal	**$137,400**
				General Conditions (8%)	$10,992
				General Requirements (7%)	$10,387
				Insurance and Bonds (3%)	$4,763
				General Contractor OH and Profit (7%)	$11,448
				Escalation – 2 years	$17,937
				Total Construction Cost	**$192,927**
				Design/Construction Contingency (30%)	$57,878
				Total Construction Cost with Contingency	**$250,806**

Table 5-7 summaries OPCC totals for all island alternatives and barrier options, in addition to providing key metrics requested by the City.

Table 5-7 OPCC Summary

Item No.	Alternative/Option Name	OPCC	Island Area (acre)*	Cost per acre ($/0.05ac)	Fill Volume (cy)	% Cost for Barge	% Cost for Dewatering	% Cost for Fill
Island Alternatives								
1	Repair Eroded Slopes	$ 1,204,373	0.16	$ 380,000	480	23%	0%	9%
2	Repair Eroded Slopes & Expand Island Size	$ 3,081,102	0.28	$ 558,000	920	9%	47%	7%
Barrier Options								
1	Walsh Marine Buoy System	$ 109,303	-	-	-	-	-	-
2	Musthane Security Barrier System	$ 583,461	-	-	-	-	-	-
3	Drilled Wooden Piles with Rope/ Buoy System	$ 250,806	-	-	-	-	-	-

* Island acreage measured at elevation 10.5 feet

6. Alternative Evaluation

This section describes the multi-criteria evaluation completed to compare alternative performance against key evaluation criteria. The evaluation criteria are in line with project objectives described in Section 1.3 and were broken into the following categories:

1. Engineering: engineering and technical considerations including maintenance, construction duration and construction cost
2. Environmental: environmental considerations including benefits for target species
3. Regulatory: regulatory constraints or challenges
4. Recreation: benefits and impacts associated with public use and recreation

6.1 Evaluation Framework

A simple evaluation framework was developed to score the island alternatives based on the selected evaluation criteria. The framework consists of an excel spreadsheet that allows for scoring of alternatives for each criteria using a range of scores between 1 and 10. Scores are developed based on qualitative or quantitative methods, depending on the information and data available (see Section 6.2).

Total scores are provided for consideration of the City in selection of the island alternative to move forward into detailed design.

6.2 Island Alternatives Comparison

This section summarizes how the island alternatives compare for the various criteria selected under each evaluation category described above. Quantitative data are provided where appropriate, and the basis for scores are discussed in the subsections below.

6.2.1 Engineering

Engineering evaluation criteria were broken down as follows:

- Historic size: ability to return to the previous size, thereby repairing the damage caused by erosion
- Long-term maintenance: relative effort required to maintain proposed improvements; also considers ease of access for maintenance
- Construction duration: length of likely construction duration; consideration of whether duration fits within non-breeding season
- Construction cost: estimated cost of construction

Table 6-1 summarizes key data and scores for each alternative for engineering criteria. Note that higher scores represent lower maintenance effort, construction durations and construction costs.

Table 6-1 Engineering Criteria Scores

Criteria	Data		Scores	
	Alt. 1	Alt. 2	Alt 1	Alt. 2
Equal or Greater than Historic Size	No	Yes	0	8
Long-term maintenance	Low	Medium	7	6
Construction Duration	2 months	3-4 months	8	7
Construction Cost(1)	$1.2M	$3.1M	8	6
Total Score	**-**	**-**	**23**	**27**

(2) Construction cost rounded to nearest $100,000

Alternative 2 scores higher due to its ability to restore the historic island size and relatively low construction cost, duration and future maintenance effort.

6.2.2 Environmental

Environmental evaluation criteria were broken down as follows:

- Acreage: size of proposed habitat island, which has a direct correlation to nesting use if thoughtfully designed
- Shoreline length: length of proposed habitat island shoreline, which has a direct correlation to nesting use if thoughtfully designed
- Slope variability: extent of surface with lower, variable slopes, which has a direct correlation to nesting use if thoughtfully designed
- Benefits to multiple species: ability to accommodate elevations, substrate and vegetation preferences of multiple species

Table 6-2 summarizes key data and scores for each alternative for environmental criteria. Note that higher scores represent greater benefit associated with each criterion.

Table 6-2 Environmental Criteria Scores

Criteria	Data		Scores	
	Alt. 1	Alt. 2	Alt. 1	Alt. 2
Acreage	0.16 acre	0.28 acre	2	8
Shoreline length	358 feet	440 feet	2	5
Slope variability	Low	Medium	2	4
Benefits to multiple species	Low	Medium	3	6
Total Score	**-**	**-**	**9**	**23**

Alternative 2 scores higher since it provides a larger area, longer shoreline length, and accommodates the most benefits for multiple species. Alternative 1 scores lower due to its relatively small size, length of shoreline and limited slope variability.

6.2.3 Regulatory

Regulatory evaluation criteria were broken down as follows:

- Fill volume in Waters of the U.S.: volume of material in jurisdictional waters of the U.S, which could trigger mitigation requirements from the USACE if project does not qualify for NWP 27
- Potential for temporary impacts: qualitative assessment of potential impacts to water quality, recreation, and existing biological resources

Table 6-3 summarizes key data and scores for each alternative for regulatory criteria. Note that lower scores represent greater potential impact associated with each criterion.

Table 6-3 Regulatory Criteria Scores

Criteria	Data		Scores	
	Alt. 1	Alt. 2	Alt. 1	Alt. 2
Fill in Waters	480 CY	920 CY	10	8
Potential for temporary impacts	Low	Low	8	8
Total Score	**-**	**-**	**18**	**16**

CY = cubic yards

Alternative 1 scores slightly higher due to its smaller overall footprint and fill volume.

6.2.4 Recreation

Recreation-related evaluation criteria were broken down as follows:

- Aesthetic value: value of proposed island footprint and surface treatments from an aesthetic perspective
- Impact to view corridor: potential impact to view corridors for lake recreation users and the birding community
- Impact to navigation/recreation: negative impact on the ability of boaters to use the lake safely
- Ability to restrict public access to habitat island: does the alternative design create issues in restricting public access, relative to other alternatives?

Table 6-4 summarizes key data and scores for each alternative for recreation-related criteria. Note that lower scores represent greater potential negative impact to recreation.

Table 6-4 Recreation Criteria Scores

Criteria	Data		Scores	
	Alt. 1	Alt. 2	Alt. 1	Alt. 2
Aesthetic value	Low	Medium	4	5
Impact to view corridor	Low	Low	8	8
Impact to navigation/ recreation	Minor	Minor	6	6
Ability to restrict public access	High	High	8	8
Total Score	**-**	**-**	**26**	**27**

Alternative 2 scores slightly higher due to the increased aesthetic value that a larger island with more habitat features provides.

6.3 Barrier Evaluation

Since the barrier system design will not affect the decision of which island alternative is selected, and the barrier design will continue to evolve as new product research is completed, a more simplistic approach was taken to evaluate the three options for the barrier protection system. The evaluation considered cost, aesthetics, maintenance, and effectiveness as selection criteria. Each option was scored for each criterion with scores ranging from 0 to 5, with 5 being the most positive or beneficial.

The lowest cost option was Option 1, and the highest cost option was Option 2. For aesthetics, Option 3 with the traditional drilled wooden pile design was deemed most pleasing, while the large black buoys associated with Option 2 were deemed the least pleasing. The maintenance effort for Option 2 will likely be the least, due to the robust buoy design that would limit biofouling and the potential for sinking. Maintenance effort for Options 1 and 3 were similar, with Option 1 likely requiring the most effort due to the potential for biofouling and damage from boats. Option 2 would be the most effective at keeping boaters away from the habitat island, while Option 1 would be the least effective due to the potential for certain size boats to float over the smaller buoys.

Table 6-5 shows the scores for each barrier option across the various criteria, and then summarizes the total score and associated ranking.

Table 6-5 Barrier Evaluation Scoring

		Scoring (0 to 5, with 5 the most positive)					
No.	**Option Name**	**Cost**	**Aesthetics**	**Maintenance**	**Effectiveness**	**Total**	**Rank**
1	Walsh Marine Buoy System	5	3	2	2	12	2
2	Musthan Floating Securing Barrier System	1	1	4	5	11	3
3	Drilled Wooden Piles w/ Buoy System	4	4	3	4	15	1

6.4 Conclusions and Recommendations

Figure 6-6 shows a summary of the full evaluation framework for the island alternatives, with raw scores from Section 6.2 inserted into the spreadsheet. The evaluation tool summarizes total scores and associated ranking. These results indicate that Alternative 2 ranks higher based on the evaluation criteria selected and calculated scores.

In general, island Alternative 2 meets one of the primary objectives of the project in meeting or exceeding the historic size of the habitat island, while maintaining a high level of benefits for wildlife, minimizing regulatory risks and potential impacts to recreation, and limiting construction costs and duration. Based on these results, it is recommended that Alternative 2 move forward to detailed design and implementation.

Table 6-6 Habitat Island Evaluation Results

Category/Criteria	Alternative 1 Score 0-10	Alternative 2 Score 0-10
Engineering		
Equal to or Greater than Historic Size	0.0	10.0
Long-term maintenance	7.0	6.0
Construction duration	8.0	7.0
Construction cost	8.0	6.0
Environmental		
Acreage	2.0	8.0
Shoreline length	2.0	5.0
Slope variability	2.0	4.0
Benefits to multiple species	3.0	6.0
Regulatory		
Fill volume in Waters	10.0	8.0
Temporary impacts	8.0	8.0
Recreation		
Aesthetic value	4.0	5.0
Impact to view corridor	8.0	8.0
Impact to navigation	6.0	6.0
Ability to restrict public access	8.0	8.0
Total Score - Overall	**76**	**95**
Total Score - Rank	**2**	**1**

The highest ranking barrier option from Table 6-5 is Option 3, which includes drilled wooden piles with a rope and buoy system connecting the piles.

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Appendix A
Drawings

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SAILING LAKE HABITAT ISLAND RESTORATION EXISTING GROUND

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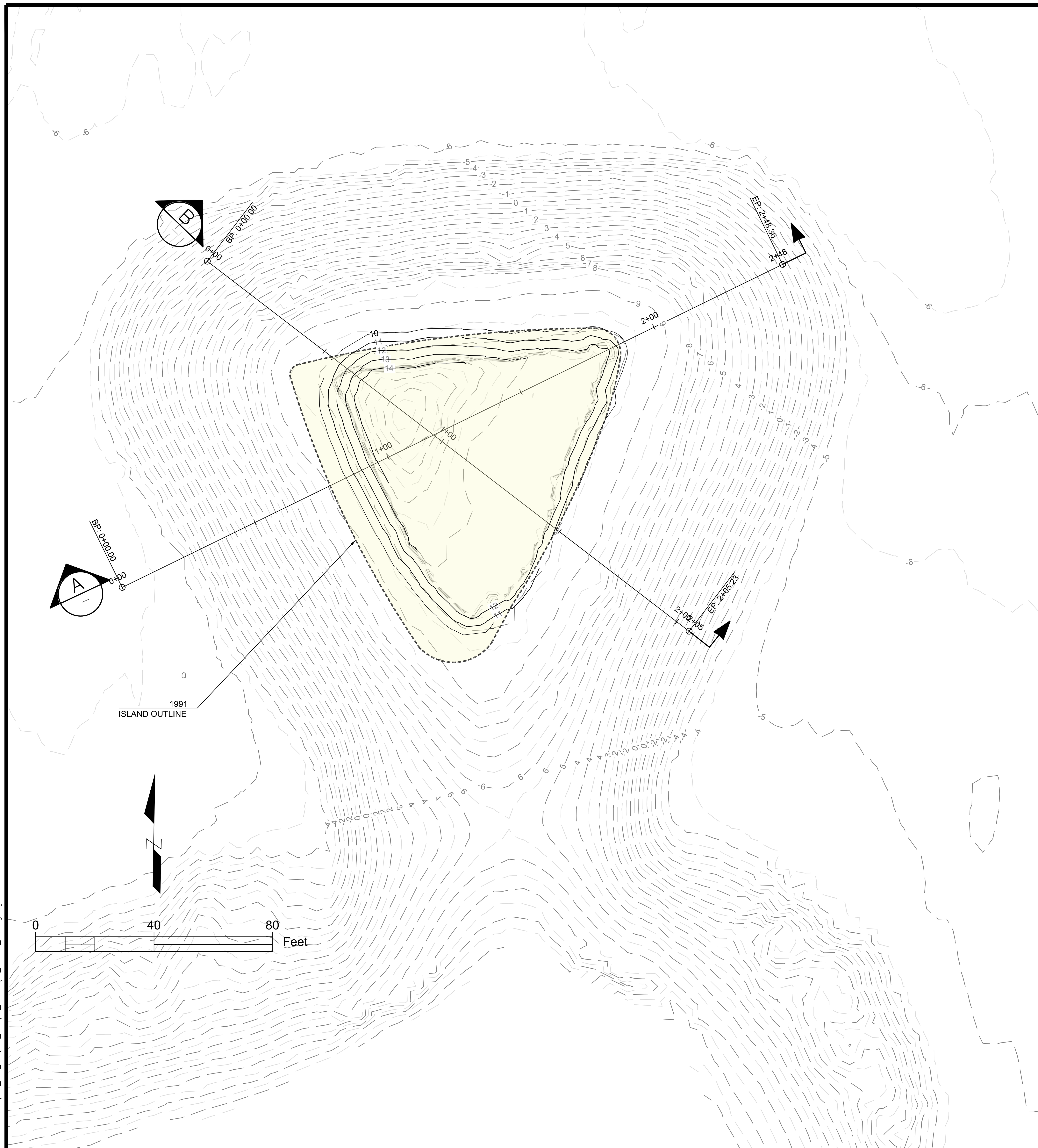

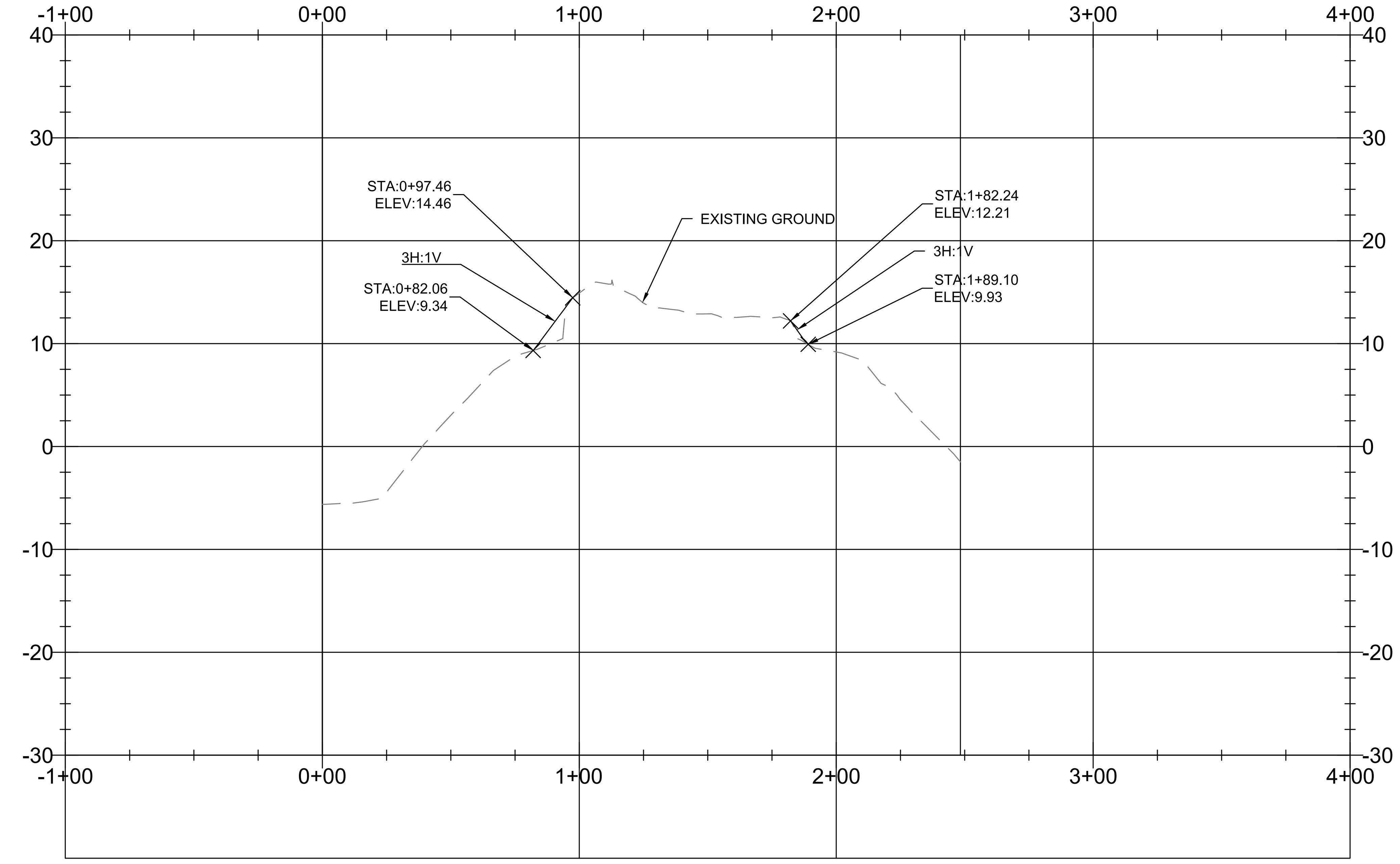

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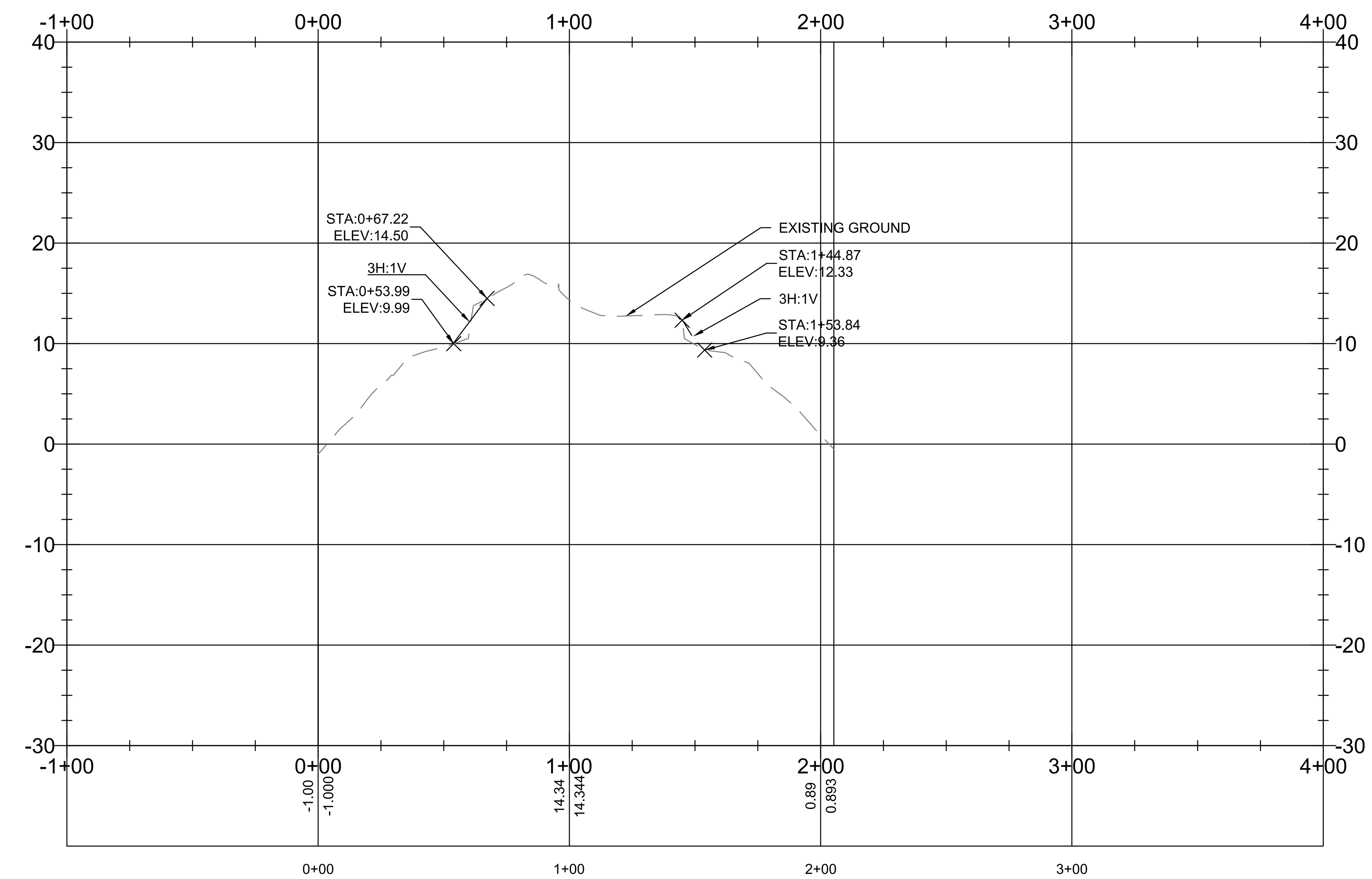

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SAILING LAKE HABITAT ISLAND
RESTORATION
ALTERNATIVE 1 GRADING PLAN

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SAILING LAKE HABITAT
ISLAND RESTORATION
ALTERNATIVE 1 SURFACE TREATMENTS

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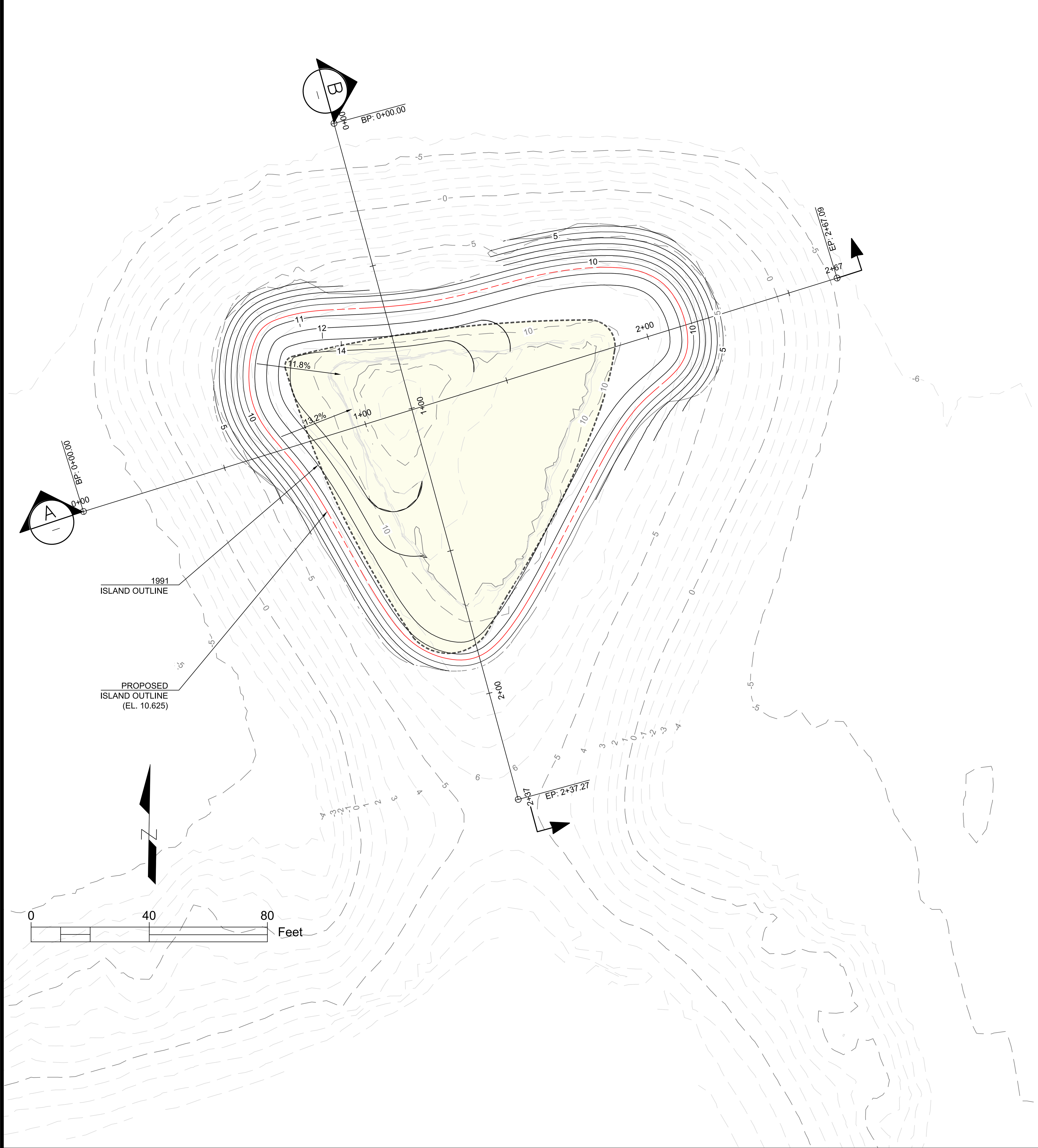

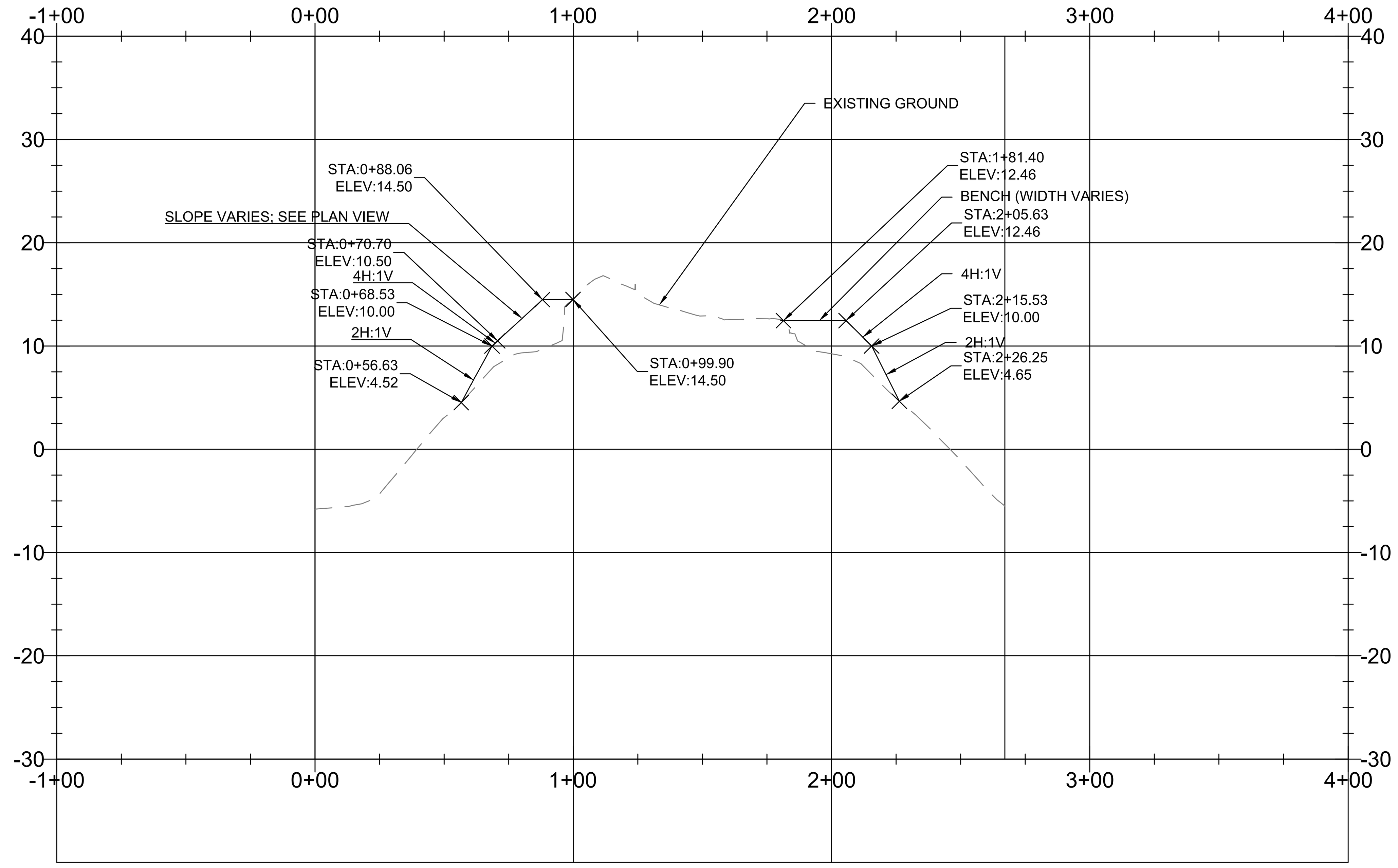

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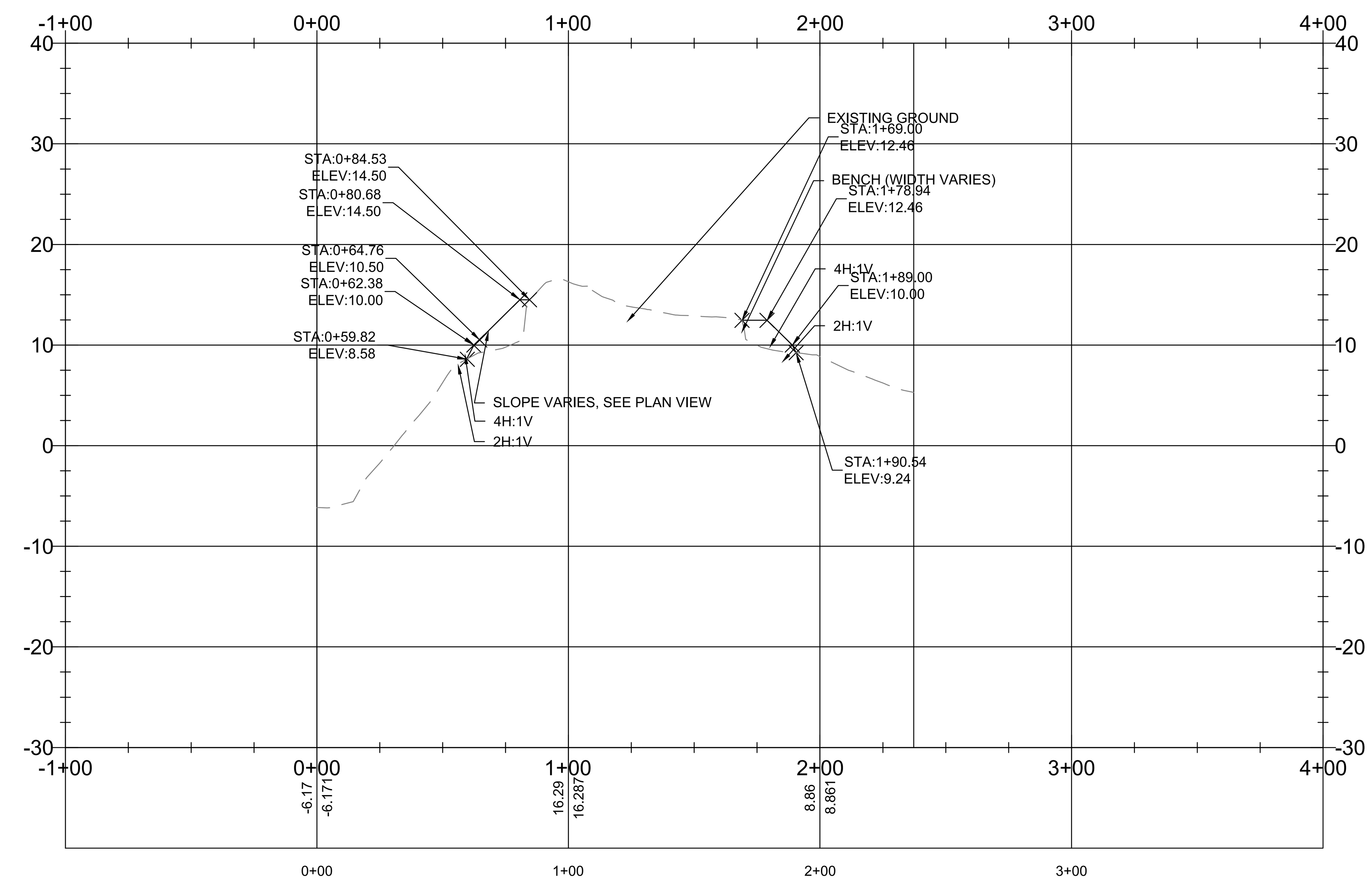

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SAILING LAKE HABITAT
ISLAND RESTORATION
ALTERNATIVE 2 GRADING PLAN

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SAILING LAKE HABITAT
ISLAND RESTORATION
ALTERNATIVE 2 SURFACE TREAMENTS

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Appendix B
Conceptual Design Estimates

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CITY OF MOUNTAIN VIEW CA PUBLIC WORKS DEPARTMENT

Sailing Lake Habitat Island Restoration Project

Conceptual Design Estimate Rev 1

July 15, 2025

Document Issue Sheet

Issue Nr.	Document	Issue Date	Parties Sent To	Prepared By	Checked By	Reviewed By
1.0	Sailing Lake Habitat Island Restoration Project Conceptual Design Estimate	4/2/2024		Karen Medina	Peter Morris	Peter Morris
2.0	Sailing Lake Habitat Island Restoration Project Conceptual Design Estimate	8/2/2024		Karen Medina	Peter Morris	Peter Morris
3.0	Sailing Lake Habitat Island Restoration Project Conceptual Design Estimate	7/15/2025		Jenny Ta	Seth Gentzler	Seth Gentzler

Contents

1.0 | Executive Summary

1.1 This cost summary represents the Conceptual Design Estimate. This estimate report has been based upon the information listed in Section 3.0. The cost is a current day fixed price at 3rd Quarter 2025 price levels and excludes other items listed in section 3.0.

1.2 The high level breakdown of the estimated construction costs are summarized below:

Item	GFA	$/SF	Total
Alternative 1 - Sitework	7,990	$129	$1,032,319
Alternative 2 - Sitework	12,019	$220	$2,640,945
Floating Barrier Options*			
Option 1 - Walsh Marine Buoy System			$100,895
Option 2 - Musthane Floating Security Barrier System			$538,579

*Note - * The Option cost is to be added to the total cost for each Alternative.*

1.3 This estimate is based on the General Contract being competitively bid with a minimum of Three (3 EA) qualified general and main subcontractors.

1.4 A number of assumptions have had to be made in compiling this estimate with regards to specification / quality and scope. We would strongly recommend that all assumptions and exclusions made are thoroughly reviewed to re-confirm our base assumptions. These are outlined in section 3.0.

1.5 There has been no allowance for "Demand Pull" escalation, which is driven by numerous factors including; market conditions, demand of labor, demand of materials, Contractor appetite.

1.6 This estimate has been prepared solely for the use of the Client and should not be relied upon by any third party.

2.0 | Basis, Assumptions and Exclusions

Basis and Assumptions

2.1 The basis of pricing has been derived from rates prevailing in Mountain View CA during 1st Quarter 2024

2.2 The allowances for the General Contractor's Indirect Markups are summarized below:
General Conditions @ 8%
General Requirements @ 7%
Insurance and Bonds @ 3%
General Contractor Overhead and Profit @ 7%

2.3 A Design Reserve Contingency has been included @ 20%

2.4 The contractor will be required to pay prevailing wages.

2.5 This document is based on the measurement and pricing of quantities wherever information is provided and/or reasonable assumptions for other work not covered in the drawings or specifications, as stated within this document. Unit rates have been obtained from historical records and/or discussion with contractors. The unit rates reflect current bid costs in the area. All unit rates relevant to subcontractor work include the subcontractors overhead and profit unless otherwise stated. The mark-ups cover the costs of field overhead, home office overhead and profit and range from 15% to 25% of the cost for a particular item of work. Pricing reflects probable construction costs obtainable in the project locality on the date of this statement of probable costs. This estimate is a determination of fair market value for the construction of this project. It is not a prediction of low bid. Pricing assumes competitive bidding for every portion of the construction work for all subcontractors and general contractors. Since AECOM has no control over the cost of labor, material, equipment, or over the contractor's method of determining prices, or over the competitive bidding or market conditions at the time of bid, the statement of probable construction cost is based on industry practice, professional experience and qualifications, and represents AECOM's best judgment as professional construction consultant familiar with the construction industry. However, AECOM cannot and does not guarantee that the proposals, bids, or the construction cost will not vary from opinions of probable cost prepared by them.

2.6 Sales Tax included

2.7 Work to be performed during normal working hours

2.8 Escalation added for 2 years @ 5% annual escalation

2.9 All other assumptions as noted in the detailed cost estimate

2.0 | Basis, Assumptions and Exclusions

Exclusions

2.11 Non-standard material sizes

2.12 Effects of working conditions / efficiency

2.13 Assessments, taxes, finance, legal charges

2.14 Environmental impact mitigation

2.15 Land and easement acquisition

2.16 Off Site Utility Upgrades and / or Off Site Infrastructure improvements except as specified

2.17 LEED Certification

2.18 Exterior signages

2.19 Mock-ups

2.20 Builder's risk, project wrap-up and other owner provided insurance program

2.21 Disconnections and diversions of existing services, if any

2.22 Developers risk allowance / overall project contingency

2.23 Finance charges, developers costs and profit

2.24 Phasing requirements

2.25 No requirement for a pause on construction activities

2.26 Soft costs

2.27 Hazardous tests, abatement and demolition

3.0 | Alternative 1 - Sitework

Div	Description	Qty	Unit	Unit rate	Total
				GFA	4,881
1	General Conditions	Qty	Unit	Unit rate	Total
	Marine equipment				
	Mobilize barge and crane rig: truck to site, launch at boathouse	1	LS	15,000.00	$15,000
	Set anchor posts & springs	5	EA	2,000.00	$10,000
	Barge rental, material barge, excavator barge & tender	10	WK	10,850.00	$108,500
	Demobilize	1	LS	8,000.00	$8,000
	Establish temporary dock for material transfer				
	Place temporary dock	600	SF	15.00	$9,000
	Floating dock rental	10	WK	3,500.00	$35,000
	Landside staging, and fence	1,500	SF	20.00	$30,000
	Remove dock and staging, restore site	1	LS	8,000.00	$8,000
	General Conditions				
	Included below after the sections				
				Sub-Total | General Conditions:	$223,500
2	Existing Conditions	Qty	Unit	Unit rate	Total
	Site Demolition				
	Removal of existing floating barrier	890	LF	16.00	$14,240
	Disposal of existing floating barrier	1	LS	5,000.00	$5,000
	Remove existing wooden boxes / guides	1	LS	5,000.00	$5,000
				Sub-Total | Existing Conditions:	$24,240
31	Earthwork	Qty	Unit	Unit rate	Total
	Clearing and grubbing	4,881	SF	2.00	$9,762
	Grading	4,881	SF	1.00	$4,881
	Water filled cofferdams including mobilization, using Aqua Barrier at 8' high				*Not Required*
	Earth fill from off site	480	CY	110.00	$52,800
	Cut	10	CY	150.00	$1,500
				Sub-Total | Earthwork:	$68,943
32	Exterior Improvements / Site Work	Qty	Unit	Unit rate	Total
	Place coarse gravel, assumed 2' layer thickness	114	CY	265.00	$30,210
	Place silt/sand, assumed 2' layer thickness	109	CY	419.00	$45,671
	Place sand, assumed 2' layer thickness	188	CY	419.00	$78,772
	Place oyster shells, assumed 2' layer thickness	239	CY	447.00	$106,833
	Planting				
	Pickleweed	22	EA	90.00	$1,980
	Alkali heath	22	EA	80.00	$1,760
	Planting irrigation	1	LS	16,000.00	$16,000
	Site Furnishing				
	Large wood, 15-20' long, 18" diameter ABH	2	EA	6,000.00	$12,000
	Wooden guiderails, 4"x4" wood	120	LF	23.00	$2,760
				Sub-Total | Exterior Improvements / Site Work:	$295,986

3.0 | Alternative 1 - Sitework

SUBTOTAL | Hard Construction Cost Excl Markups			**$612,669**
Indirect Markups			Total
General Conditions @ 8%	8.00%	$	*49,014*
General Requirements @ 7%	7.00%	$	*46,318*
Insurance and Bonds @ 3%	3.00%	$	*21,240*
General Contractor Overhead and Profit @ 7%	7.00%	$	*51,047*
Escalation - 2 years	5.00%	$	*79,979*
TOTAL | Hard Construction Costs Incl Markups			**$860,266**
Design Reserve / Contingency Allowance	30.00%	$	*258,080*
TOTAL | Hard Construction Cost Incl Markups & Contingency			**$1,118,346**

* Note this estimate breakdown does not include the mitigation contingency.

4.0 | Alternative 2 - Sitework

Div	Description	Qty	Unit	Unit rate	Total
				GFA	4,881
1	General Conditions	Qty	Unit	Unit rate	Total
	Marine equipment				
	Mobilize barge and crane rig: truck to site, launch at boathouse	1	LS	15,000.00	$15,000
	Set anchor posts & springs	5	EA	2,000.00	$10,000
	Barge rental, material barge, excavator barge & tender	10	WK	10,850.00	$108,500
	Demobilize	1	LS	8,000.00	$8,000
	Establish temporary dock for material transfer				
	Place temporary dock	600	SF	15.00	$9,000
	Floating dock rental	10	WK	3,500.00	$35,000
	Landside staging, and fence	1,500	SF	20.00	$30,000
	Remove dock and staging, restore site	1	LS	8,000.00	$8,000
	General Conditions				
	Included below after the sections				
			Sub-Total | General Conditions:		$223,500
2	Existing Conditions	Qty	Unit	Unit rate	Total
	Site Demolition				
	Removal of existing floating barrier	890	LF	16.00	$14,240
	Disposal of existing floating barrier	1	LS	5,000.00	$5,000
	Remove existing wooden boxes / guides	1	LS	5,000.00	$5,000
			Sub-Total | Existing Conditions:		$24,240
31	Earthwork	Qty	Unit	Unit rate	Total
	Clearing and grubbing	4,881	SF	2.00	$9,762
	Grading	4,881	SF	1.00	$4,881
	Cofferdams including mobilization and temporary sheeting	4,881	SF	150.00	$732,150
	Earth fill from off site	920	CY	110.00	$101,200
	Cut	10	CY	150.00	$1,500
			Sub-Total | Earthwork:		$849,493
32	Exterior Improvements / Site Work	Qty	Unit	Unit rate	Total
	Place coarse gravel, assumed 2' layer thickness	405	CY	265.00	$107,325
	Place silt/sand, assumed 2' layer thickness	274	CY	419.00	$114,806
	Place sand, assumed 2' layer thickness	222	CY	419.00	$93,018
	Place oyster shells, assumed 2' layer thickness	268	CY	447.00	$119,796
	Planting				
	Pickleweed	22	EA	90.00	$1,980
	Alkali heath	22	EA	80.00	$1,760
	Planting irrigation	1	LS	16,000.00	$16,000
	Site Furnishing				
	Large wood, 15-20' long, 18" diameter ABH	2	EA	6,000.00	$12,000
	Wooden guiderails, 4"x4" wood	150	LF	23.00	$3,450
			Sub-Total | Exterior Improvements / Site Work:		$470,135

4.0 | Alternative 2 - Sitework

SUBTOTAL | Hard Construction Cost Excl Markups			**$1,567,368**
Indirect Markups			Total
General Conditions @ 8%	8.00%	$	*125,389*
General Requirements @ 7%	7.00%	$	*118,493*
Insurance and Bonds @ 3%	3.00%	$	*54,338*
General Contractor Overhead and Profit @ 7%	7.00%	$	*130,591*
Escalation-2 years	5.00%	$	*204,608*
TOTAL | Hard Construction Costs Incl Markups			**$2,200,787**
Design Reserve / Contingency Allowance	30.00%	$	*660,236*
TOTAL | Hard Construction Cost Incl Markups & Contingency			**$2,861,023**

* Note this estimate breakdown does not include the mitigation contingency

7.0 | Floating Barrier

Div Description

OPTION 1 - Walsh Marine Buoy System

Div	Description	Qty	Unit	Unit rate	Total
35	Waterway and Marine Construction				
	New Floating barriers, walsh marine bouy system supply only	850	LF	33.00	$28,050
	Installation cost	1	LS	16,830.00	$16,830
	Land barrier anchors	2	EA	7,500.00	$15,000
	Sub-Total | Waterway and Marine Construction:				$59,880
	SUBTOTAL | Hard Construction Cost Excl Markups				**$59,880**

	Indirect Markups			Total
	General Conditions @ 8%	8.00%	$	*4,790*
	General Requirements @ 7%	7.00%	$	*4,527*
	Insurance and Bonds @ 3%	3.00%	$	*2,076*
	General Contractor Overhead and Profit @ 7%	7.00%	$	*4,989*
	Escalation-2 years	5.00%	$	*7,817*
	TOTAL | Hard Construction Costs Incl Markups			**$84,079**
	Design Reserve / Contingency Allowance	30.00%	$	*25,224*
	TOTAL | Hard Construction Cost Incl Markups & Contingency			**$109,303**

7.0 | Floating Barrier

OPTION 2 - Musthane Floating Security Barrier System

35	Waterway and Marine Construction	Qty	Unit	Unit rate	Total
	New Floating barriers, Musthane Floating Security Barrier System, supply only	850	LF	256.00	$217,600
	Installation cost	1	LS	87,040.00	$87,040
	Land barrier anchors	2	EA	7,500.00	$15,000
				Sub-Total | Waterway and Marine Construction:	$319,640
	SUBTOTAL | Hard Construction Cost Excl Markups				**$319,640**

Indirect Markups			Total
General Conditions @ 8%	8.00%	$	*25,571*
General Requirements @ 7%	7.00%	$	*24,165*
Insurance and Bonds @ 3%	3.00%	$	*11,081*
General Contractor Overhead and Profit @ 7%	7.00%	$	*26,632*
Escalation-2 years	5.00%	$	*41,727*
TOTAL | Hard Construction Costs Incl Markups			**$448,816**
Design Reserve / Contingency Allowance	30.00%	$	*134,645*
TOTAL | Hard Construction Cost Incl Markups & Contingency			**$583,461**

About AECOM

AECOM is the world's trusted infrastructure consulting firm, delivering professional services throughout the project lifecycle — from planning, design and engineering to program and construction management. On projects spanning transportation, buildings, water, new energy and the environment, our public- and private-sector clients trust us to solve their most complex challenges. Our teams are driven by a common purpose to deliver a better world through our unrivaled technical expertise and innovation, a culture of equity, diversity and inclusion, and a commitment to environmental, social and governance priorities. AECOM is a *Fortune 500* firm and its Professional Services business had revenue of $13.2 billion in fiscal year 2020. See how we are delivering sustainable legacies for generations to come at aecom.com and @AECOM.

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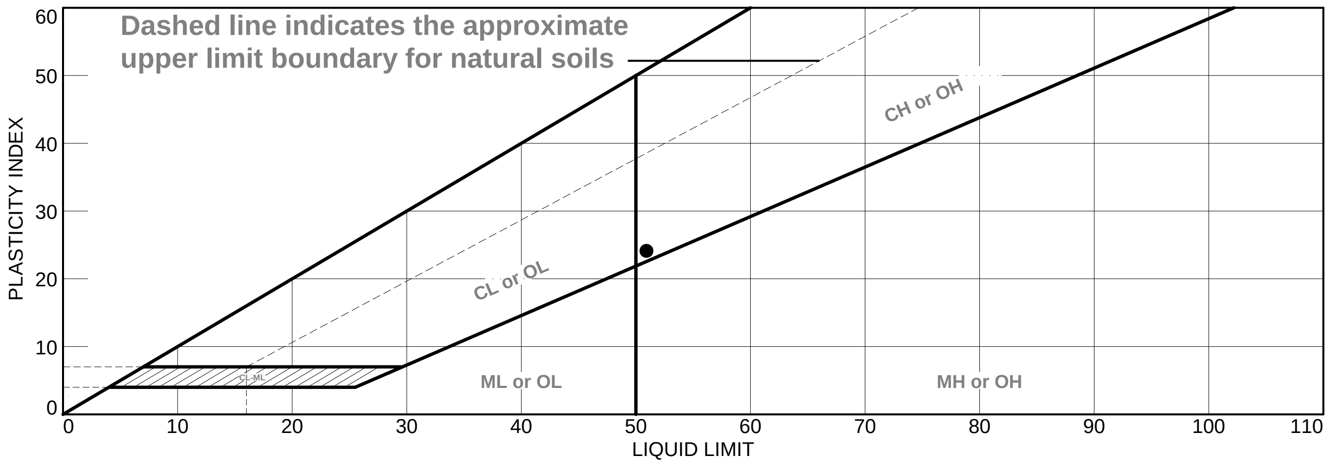
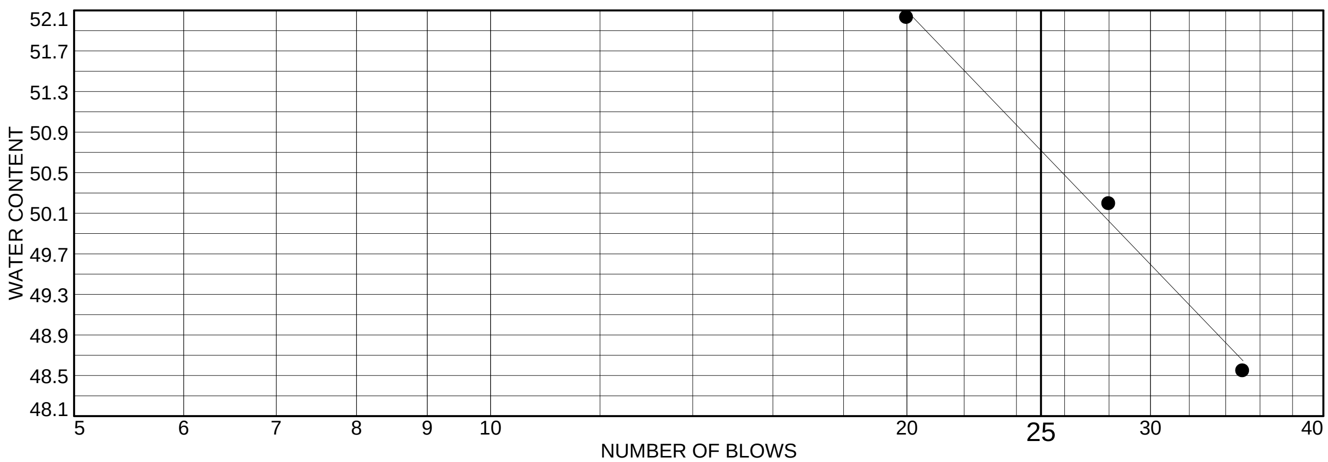
Appendix C
Soil Sample Lab Results

LIQUID AND PLASTIC LIMITS TEST REPORT ASTM D-4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Grayish brown clayey sand	51	27	24	68	49	SC

Project No. 2301-115.0 **Client:** AECOM

Project: Shoreline Park Improvements

60712869

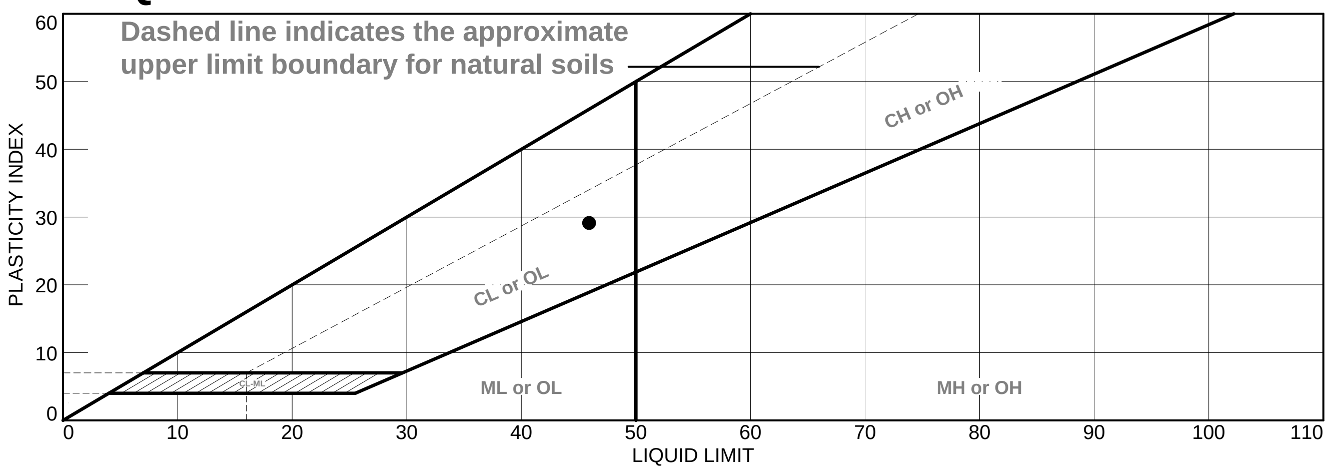
● **Source of Sample:** B-1 **Depth:** Bulk **Sample Number:** 1

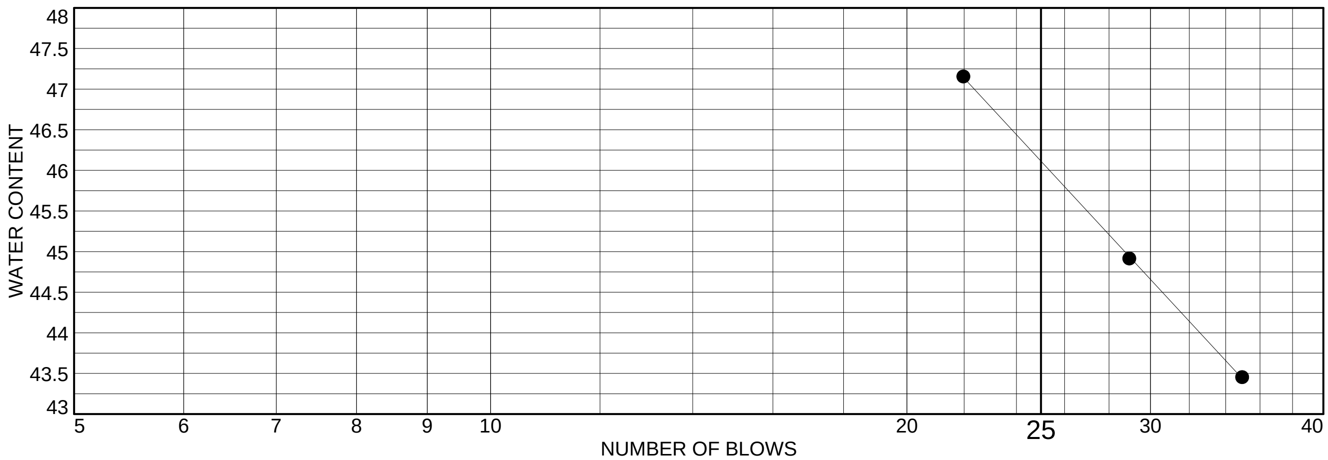
Remarks:

Figure

Tested By: JH **Checked By:** JH

LIQUID AND PLASTIC LIMITS TEST REPORT ASTM D-4318





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Grayish brown clay with sand	46	17	29	83	69	CL

Project No. 2301-115.0 **Client:** AECOM

Project: Shoreline Park Improvements

60712869

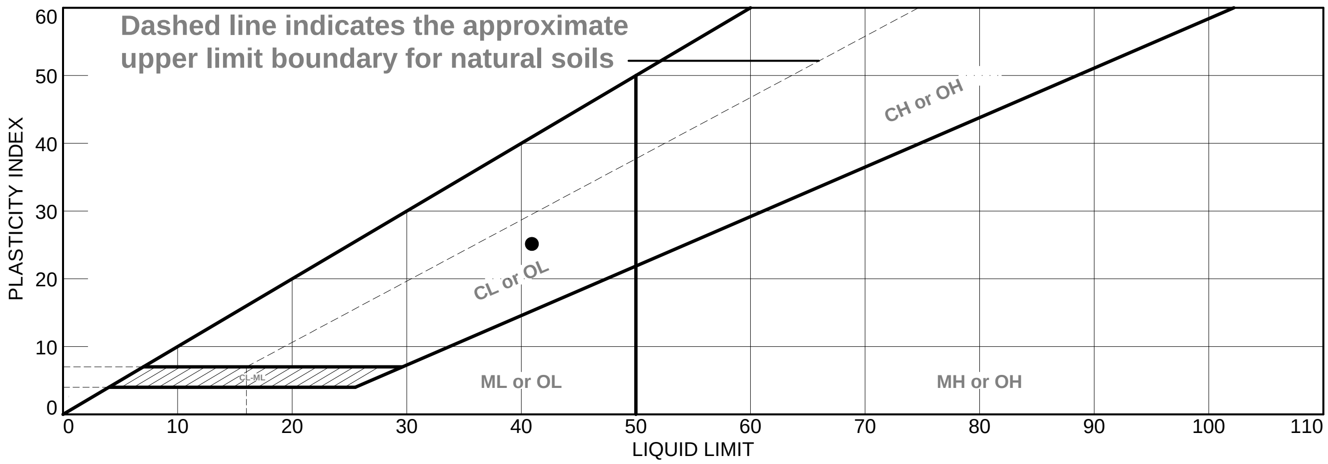
● **Source of Sample:** B-2 **Depth:** Bulk **Sample Number:** 1

Remarks:

Figure

Tested By: JH **Checked By:** JH

LIQUID AND PLASTIC LIMITS TEST REPORT ASTM D-4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Grayish brown sandy clay	41	16	25	77	60	CL

Project No. 2301-115.0 **Client:** AECOM

Project: Shoreline Park Improvements

60712869

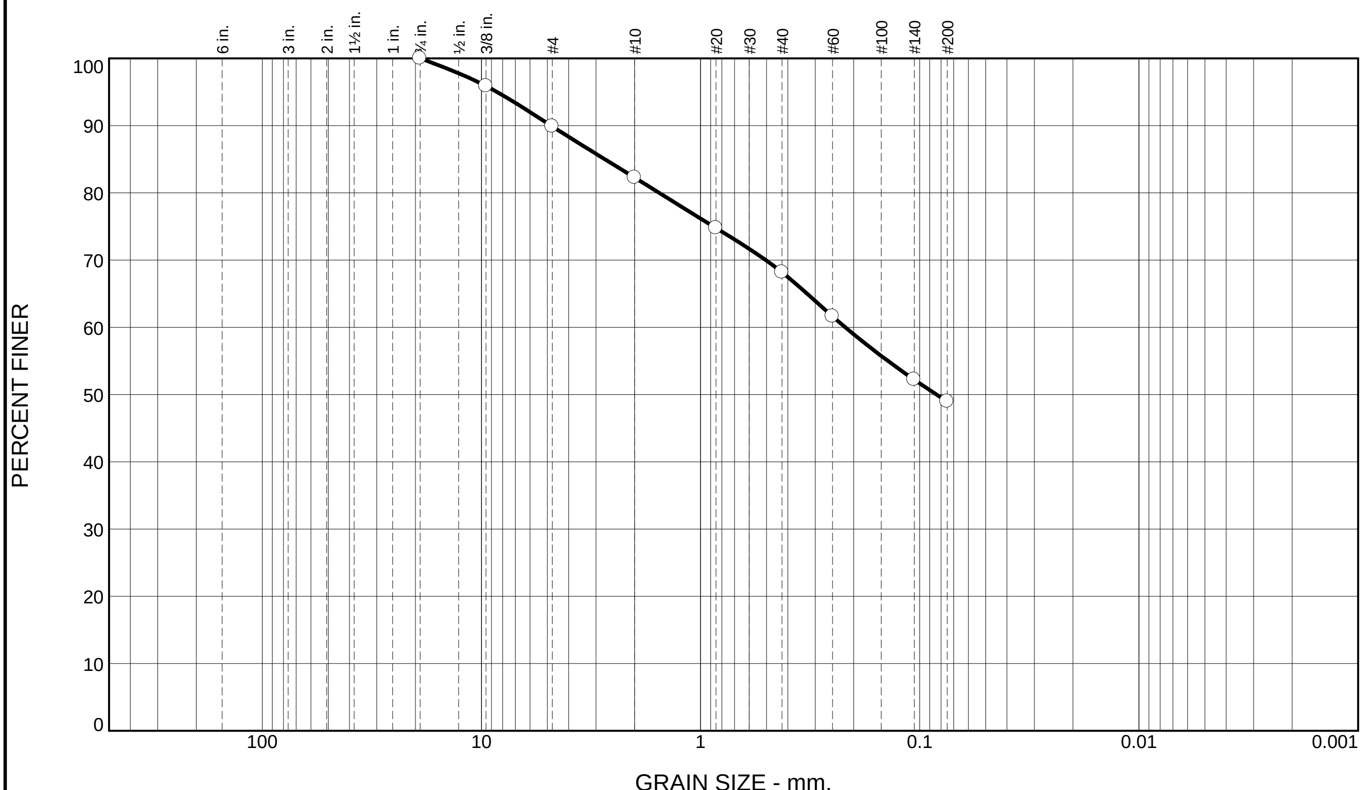
● **Source of Sample:** B-3B **Depth:** Bulk **Sample Number:** 1

Remarks:

Figure

Tested By: JH **Checked By:** JH

Particle Size Distribution Report ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	10	8	14	19	49	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100		
3/8	96		
#4	90		
#10	82		
#20	75		
#40	68		
#60	62		
#140	52		
#200	49		

* (no specification provided)

Soil Description

Grayish brown clayey sand

Atterberg Limits

PL= 27 LL= 51 PI= 24

Coefficients

D_{90}= 4.8154 D_{85}= 2.7379 D_{60}= 0.2186
D_{50}= 0.0839 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= SC AASHTO= A-7-6(8)

Remarks

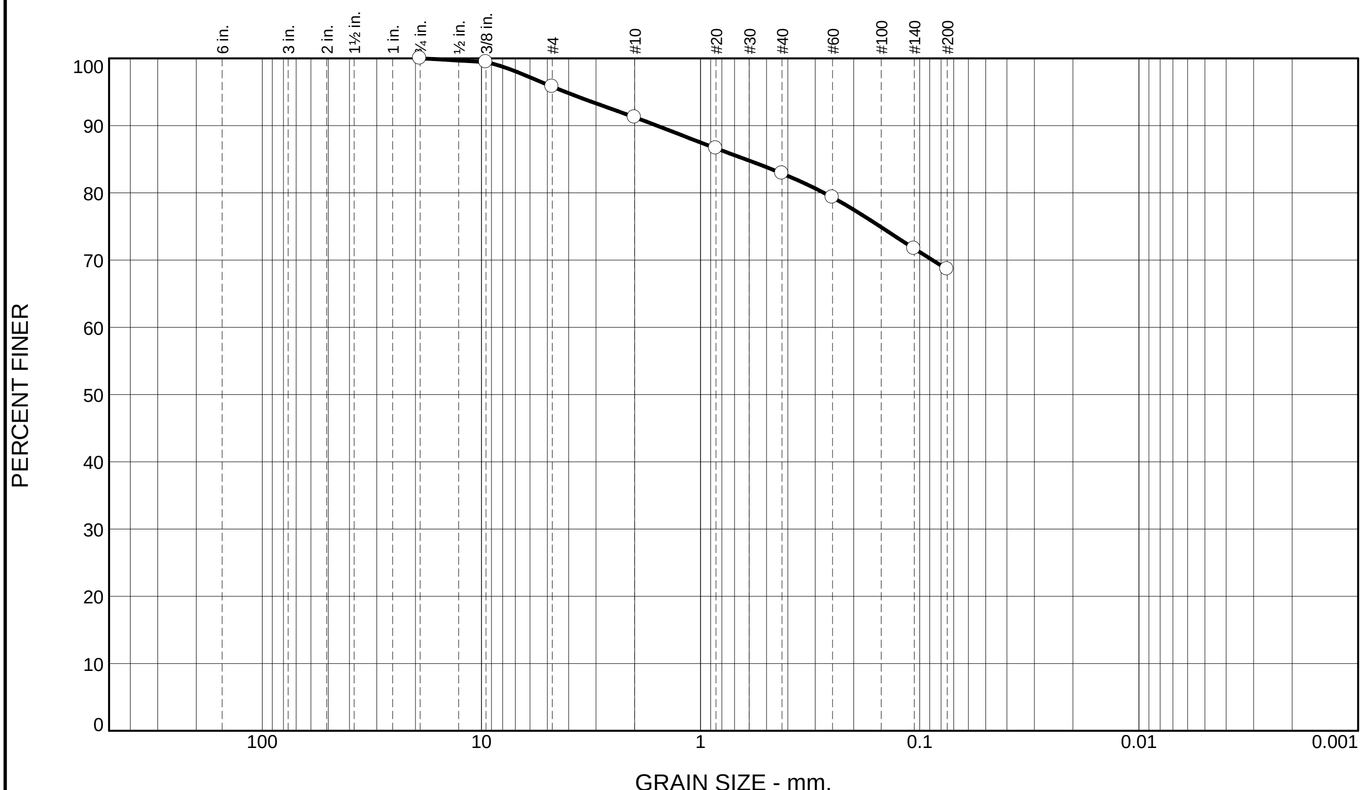
Source of Sample: B-1 **Depth:** Bulk
Sample Number: 1

Date: 12-29-23

Client: AECOM
Project: Shoreline Park Improvements
60712869
Project No: 2301-115.0 **Figure**

Tested By: SK **Checked By:** JH

Particle Size Distribution Report ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	4	5	8	14	69	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/4	100		
3/8	99		
#4	96		
#10	91		
#20	87		
#40	83		
#60	79		
#140	72		
#200	69		

* (no specification provided)

Soil Description

Grayish brown clay with sand

Atterberg Limits

PL= 17 LL= 46 PI= 29

Coefficients

D_{90}= 1.5852 D_{85}= 0.6252 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-7-6(18)

Remarks

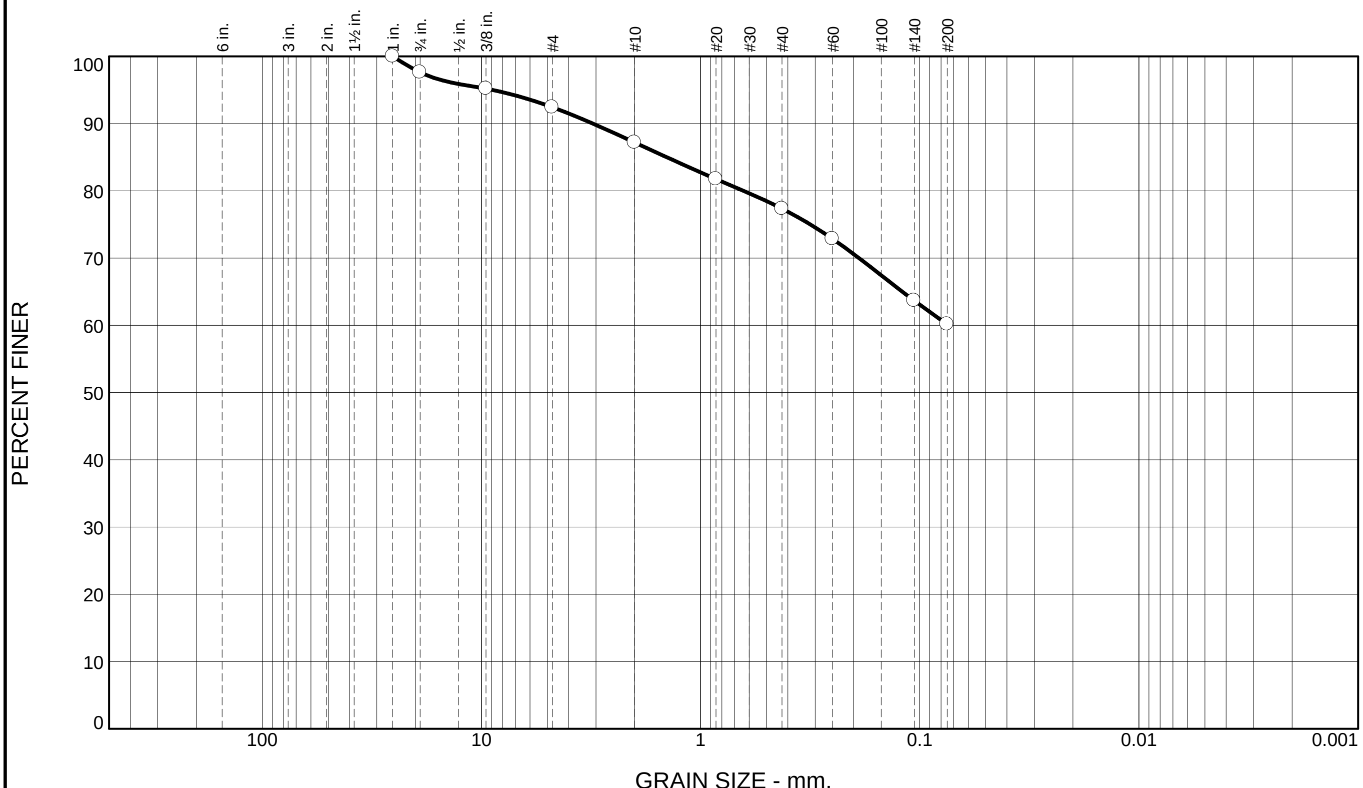
Source of Sample: B-2 **Depth:** Bulk
Sample Number: 1

Date: 12-29-23

Client: AECOM
Project: Shoreline Park Improvements
60712869
Project No: 2301-115.0 **Figure**

Tested By: SK **Checked By:** JH

Particle Size Distribution Report ASTM D422



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	2	6	5	10	17	60	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1	100		
3/4	98		
3/8	95		
#4	92		
#10	87		
#20	82		
#40	77		
#60	73		
#140	64		
#200	60		

* (no specification provided)

Soil Description

Grayish brown sandy clay

Atterberg Limits

PL= 16 LL= 41 PI= 25

Coefficients

D_{90}= 3.1047 D_{85}= 1.4274 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-7-6(12)

Remarks

Source of Sample: B-3B **Depth:** Bulk
Sample Number: 1 **Date:** 12-29-23

Client: AECOM
Project: Shoreline Park Improvements
60712869
Project No: 2301-115.0 **Figure**

Tested By: SK **Checked By:** JH