



550 Kearny Street
Suite 800
San Francisco, CA 94108
415.896.5900 **phone**
415.896.0332 **fax**

esassoc.com

ATTACHMENT A

Technical Advisory Committee (TAC) Roster

Below is a roster of technical advisory committee (TAC) for the study. The Project Team would like to acknowledge the group for their input, expertise and involvement in the process.

Name	Affiliation
Marilyn Latta	California State Coastal Conservancy
Evyan Sloane	California State Coastal Conservancy
Kathy Boyer	Estuary & Ocean Science Center – San Francisco State University
Mike Vasey	Estuary & Ocean Science Center – San Francisco State University
Stuart Siegel	Estuary & Ocean Science Center – San Francisco State University
Peter Baye	Independent Consultant
Lindy Lowe	Port of San Francisco
Carol Bach	Port of San Francisco
Barbara Maloney	Romberg Tiburon Center Master Planning Working Group, PAGE
Christine Thompson	Romberg Tiburon Center Master Planning Working Group, PAGE
Steve Dangermond	Romberg Tiburon Center Master Planning Working Group, Dangermond Keane Architecture
Jill Anthes	Romberg Tiburon Center Master Planning Working Group, San Francisco State University Planning
Brandon Kline	Romberg Tiburon Center Master Planning Working Group, San Francisco State University Planning
Jeremy Lowe	San Francisco Estuary Institute
Julie Beagle	San Francisco Estuary Institute
Rich Ambrose	University of California, Los Angeles
Jason Toft	University of Washington
Jeff Cordell	University of Washington

The Project Team would like to thank the following San Francisco State University staff and student helpers who assisted with the project workshops:

- Daniela Barcelo
- Carl Hendrickson
- Ryan Hartnett
- Elizabeth Max
- Byron Riggins



550 Kearny Street
Suite 800
San Francisco, CA 94108
415.896.5900 [phone](#)
415.896.0332 [fax](#)

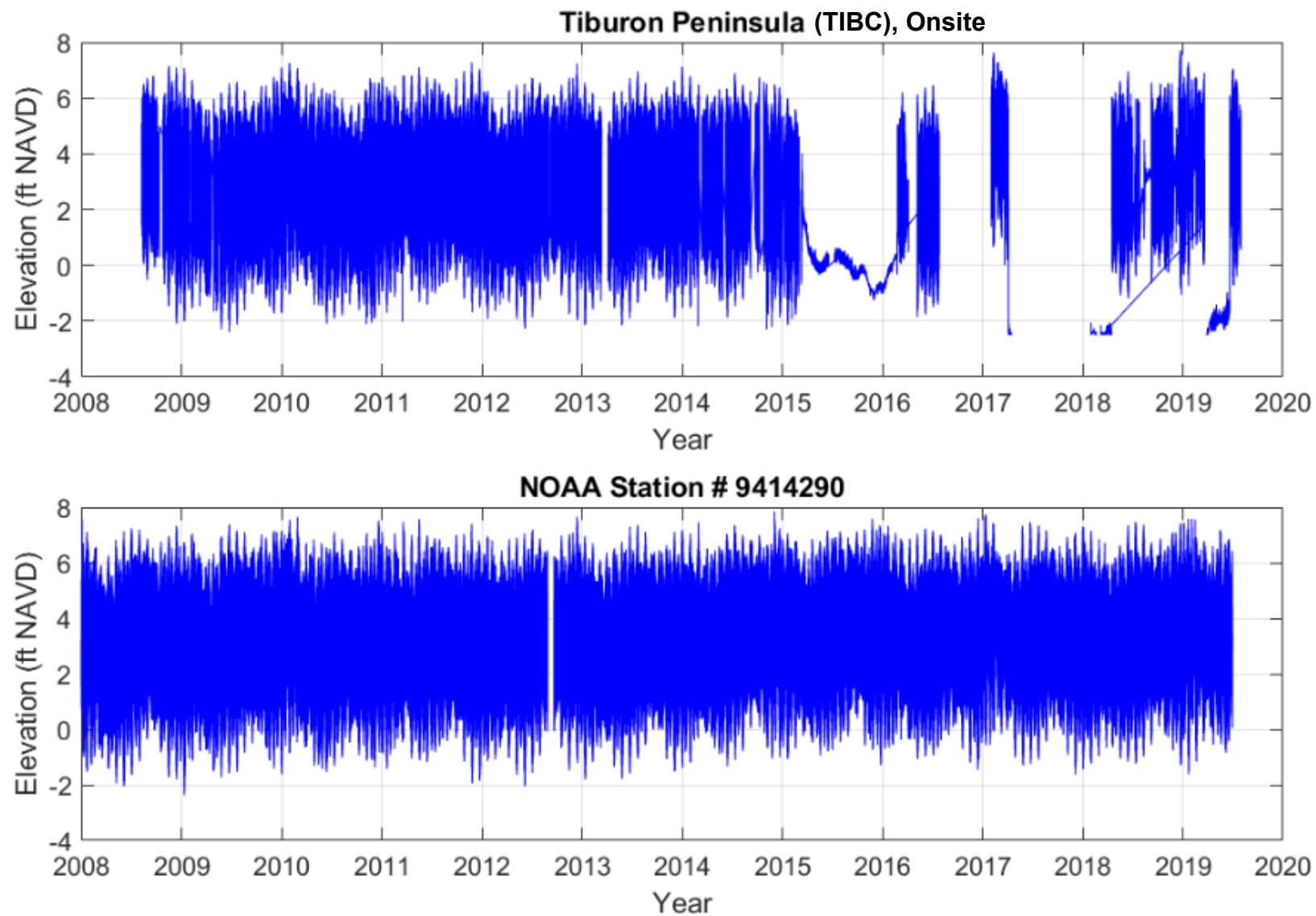
esassoc.com

ATTACHMENT B

Physical Processes Supplemental Information

Figures

- Figure B-1. Tidal Record from NOAA Station TIBC and #941420
- Figure B-2. Still Water Level Extreme Value Analysis – NOAA Station #9414290 Record
- Figure B-3. Wind Speed Probability and Cumulative Distribution
- Figure B-4. Time Series of Significant Wave Height (Top) and Peak Wave Period (Bottom)
- Figure B-5. Significant Wave Height Extreme Value Analysis – TIBC Record
- Figure B-6. Wind Speed Extreme Value Analysis – Oakland Airport Record

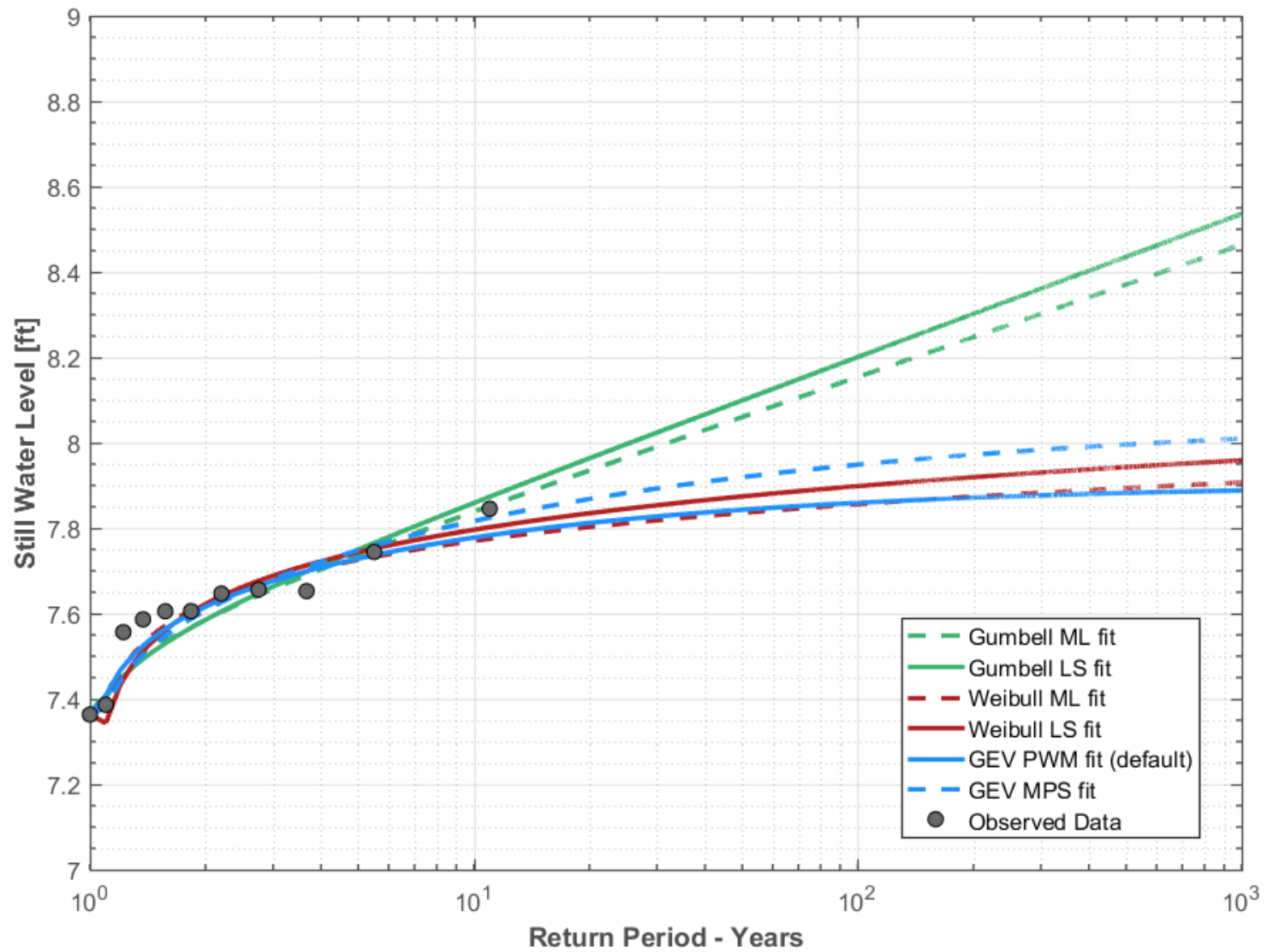


SOURCE: NOAA Tide and Currents (2019)

SFSU Nature-Based Restoration of an Armored Shoreline. D160876.00

Figure B-1

Tidal Record from NOAA Station TIBC and #941420



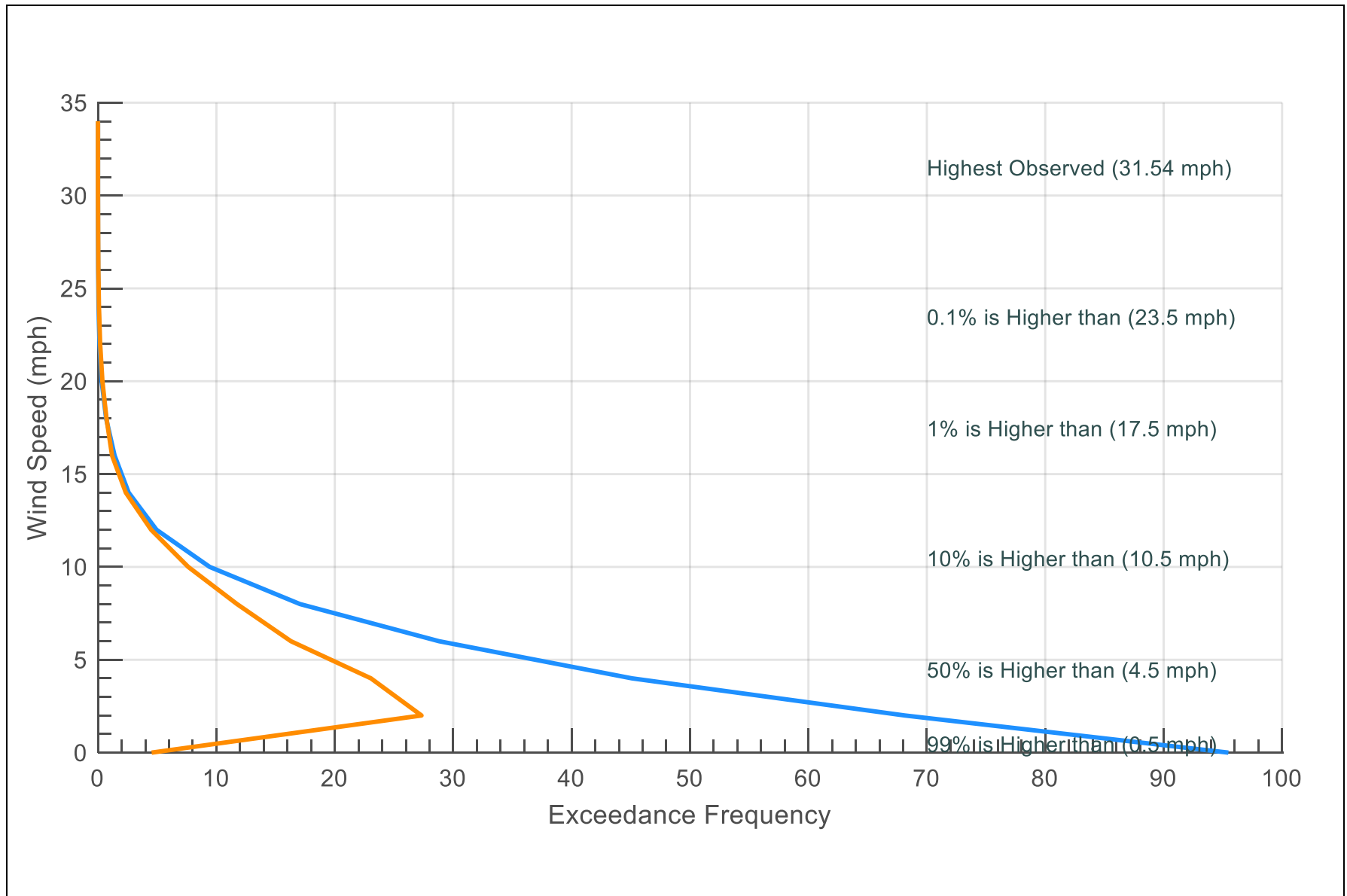
SOURCE: ESA (2019)

SFSU Nature-Based Restoration of an Armored Shoreline. D160876.00

Figure B-2

Still Water Level

Extreme Value Analysis – NOAA Station #9414290 Record

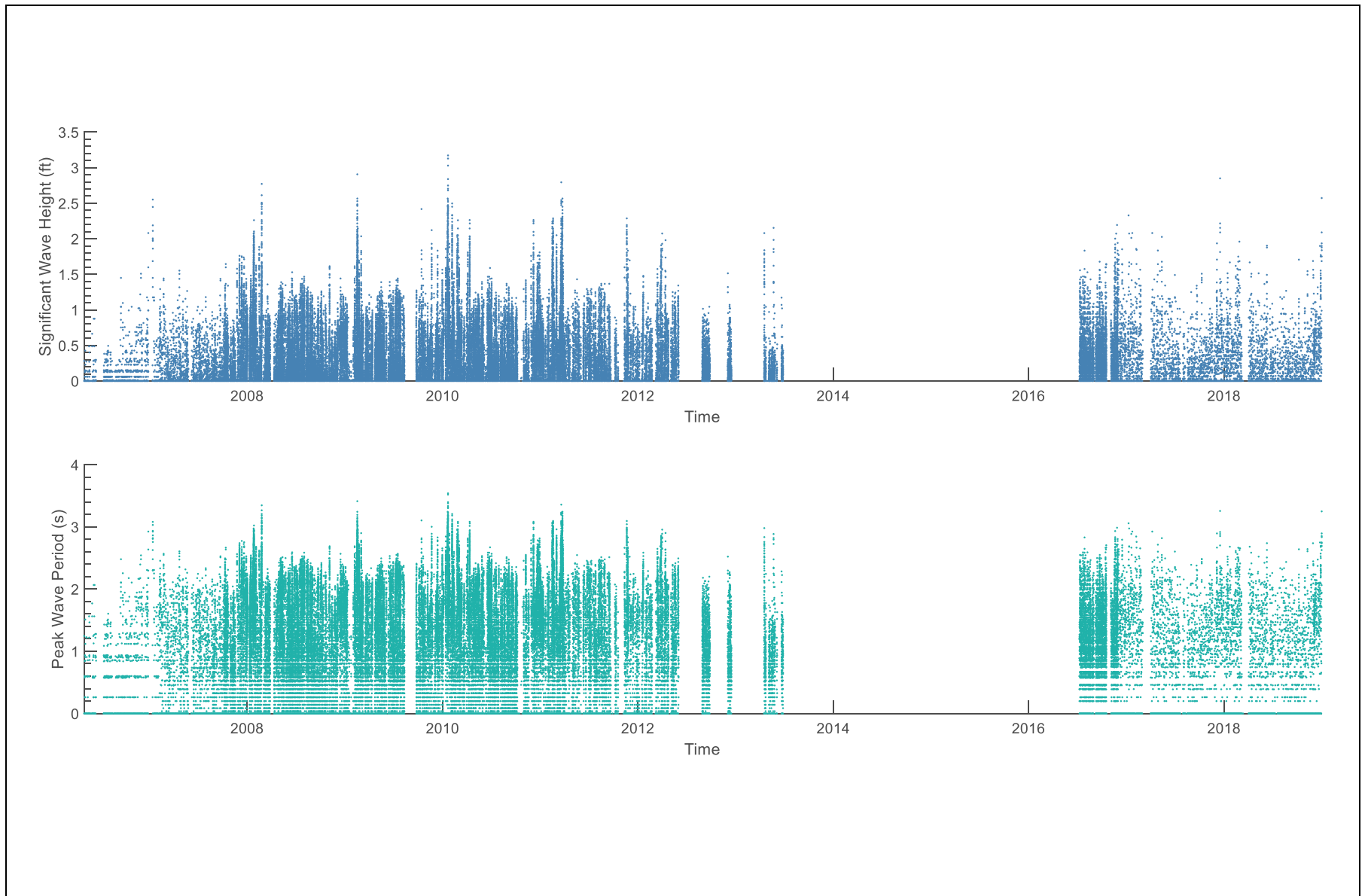


SOURCE: ESA (2019)

SFSU Nature-Based Restoration of an Armored Shoreline. D160876.00

Figure B-3

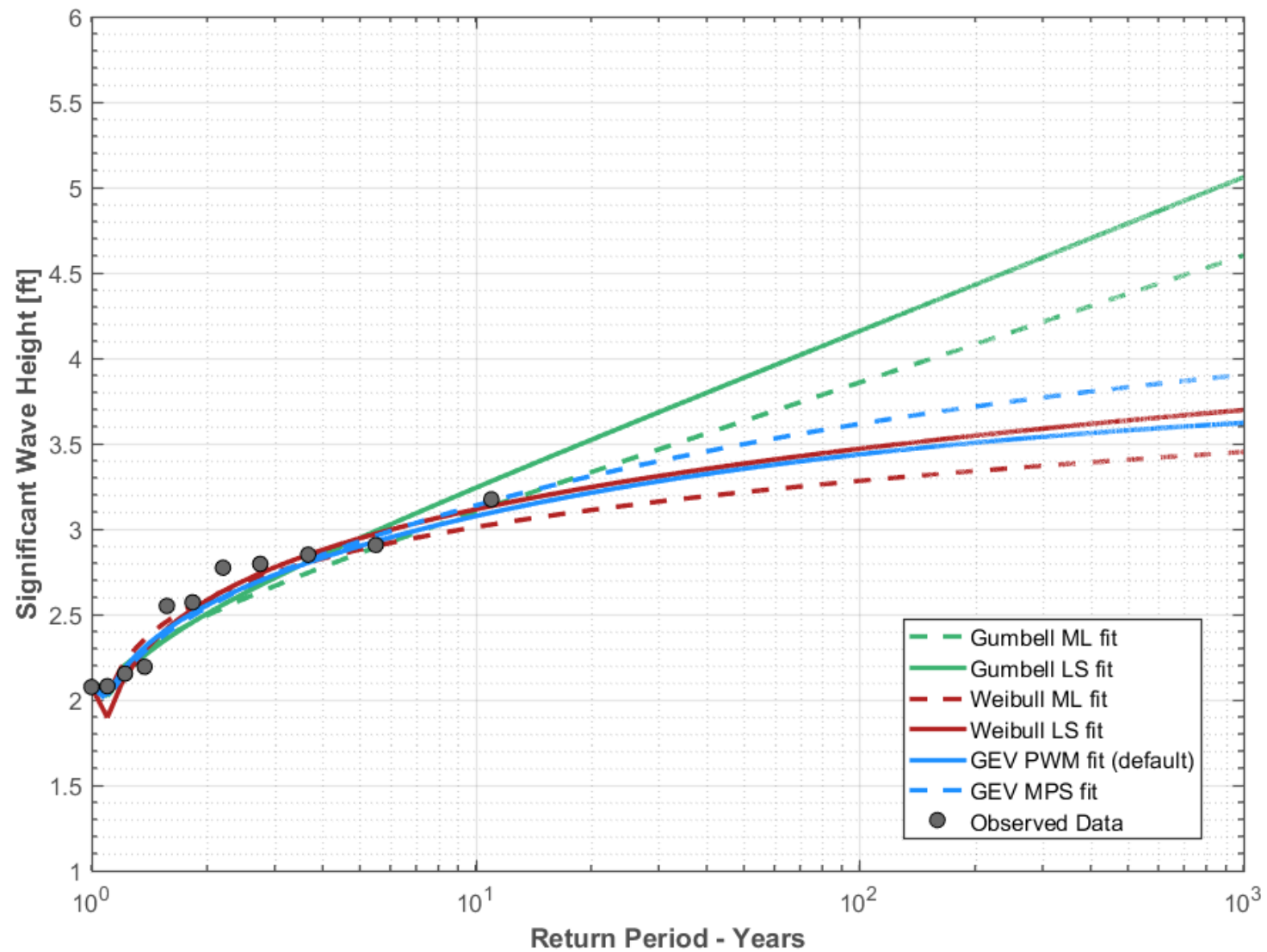
Wind Speed Probability and Cumulative Distribution

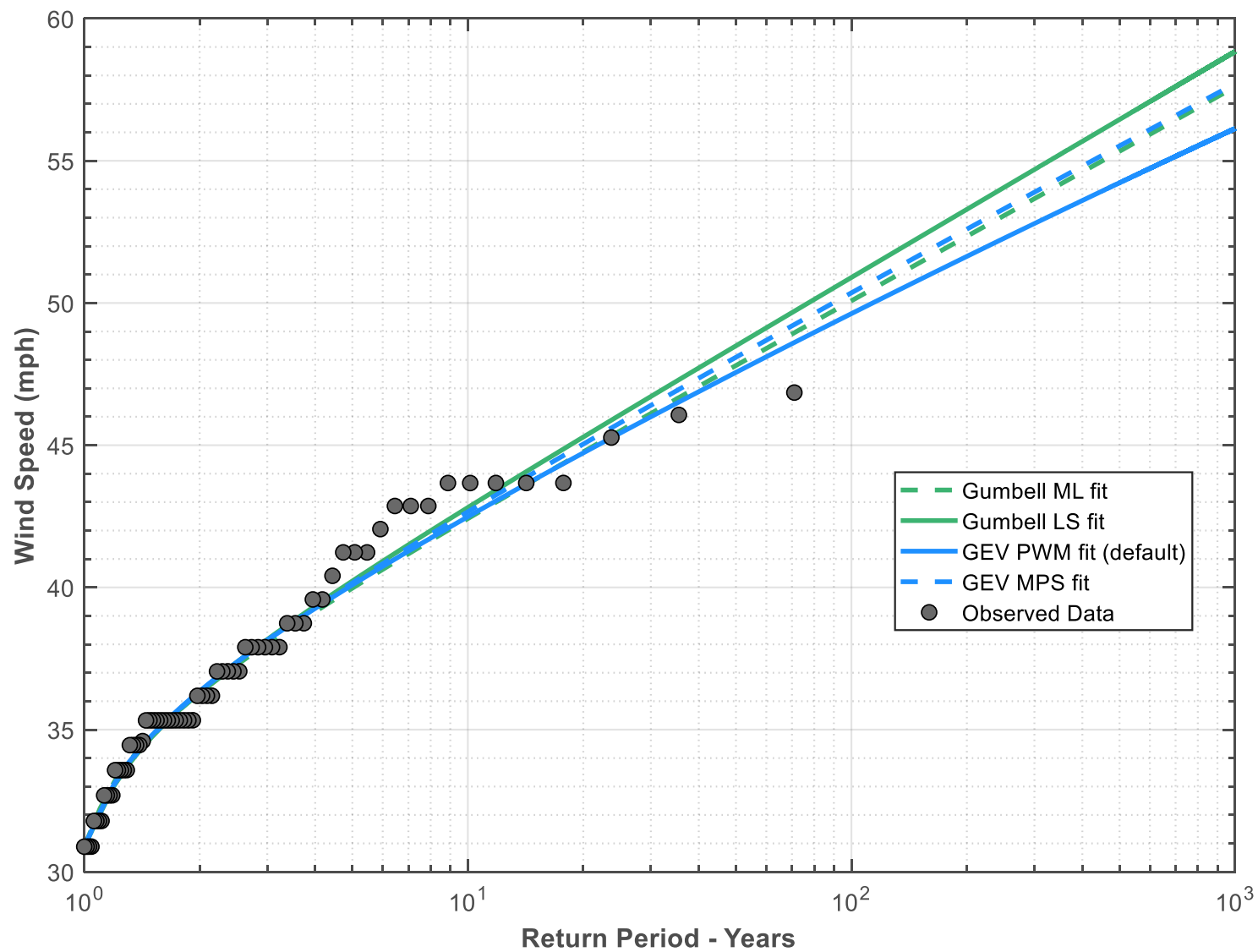


SOURCE: ESA (2019)

SFSU Nature-Based Restoration of an Armored Shoreline. D160876.00

Figure B-4
Time Series of Significant Wave Height (Top) and
Peak Wave Period (Bottom)





SOURCE: ESA (2019)

SFSU Nature-Based Restoration of an Armored Shoreline. D160876.00

Figure B-6

Wind Speed

Extreme Value Analysis – Oakland Airport Record



550 Kearny Street
Suite 800
San Francisco, CA 94108
415.896.5900 [phone](#)
415.896.0332 [fax](#)

esassoc.com

ATTACHMENT C

Charrette Materials

- **Shoreline Planning Charrette, July 11, 2019**
- **Conceptual design Charrette – December 12, 2019**

Charrette Agenda

Nature-Based Restoration of Armored Shoreline

Estuary & Ocean Science Center, SF State Romberg Tiburon Campus

Shoreline Planning Charrette

July 11, 2019 10 am – 3 pm + project site tour 9 – 10 am

Meeting Objectives:

1. Generate a range of nature-based restoration and adaptation concepts for the campus shoreline
2. Collect feedback and ideas for refining emerging concepts from the concurrent SF State led physical master planning process for the campus.

Outcomes from this charrette will inform basic shoreline edge treatment for inclusion in the physical master plan for the SF State Romberg Tiburon Campus being prepared by Page Southerland Page, Inc. (San Francisco) and collaborators.

Agenda:

Time	What	Where
9 – 10 am	Project Site Walk (Karina)	Romberg-Tiburon Campus - meet in front of Delta Hall
10 – 10:15 am	Introductions (All)	Bay Conference Center
10:15 – 11:45 am	Project background • Background on project, master plan process, objectives (Karina) – 15 min • Site conditions, sea level rise conditions for the campus shoreline (Tiffany) – 15 min • Ecology of SF Bay rocky shores (Karina and Chela) – 15 min • Guest speakers • Julie Beagle - Remote sensing work of Bay beaches, implications for beach design • Jason Toft – Restoration of intertidal/subtidal cobble beaches • Jeff Cordell– Habitat enhancements to seawalls • Opportunities and constraints, initial concepts (Karina and Tiffany) • Brief discussion (All)	
11:45 am – 12:00 pm	Brief on post-lunch activities (Tiffany)	
12:00 – 12:30 pm	Lunch break	
12:30 – 1:45 pm	Concept brainstorming session (All)	
1:45 – 2:45 pm	Report out and discussion (All)	
2:45 – 3:00 pm	Next steps, project schedule, adjourn (Karina)	

Designing a Nature-based Restoration of an Armored Shore

Read Ahead Materials

Opportunities and constraints for public university field station and marine laboratory

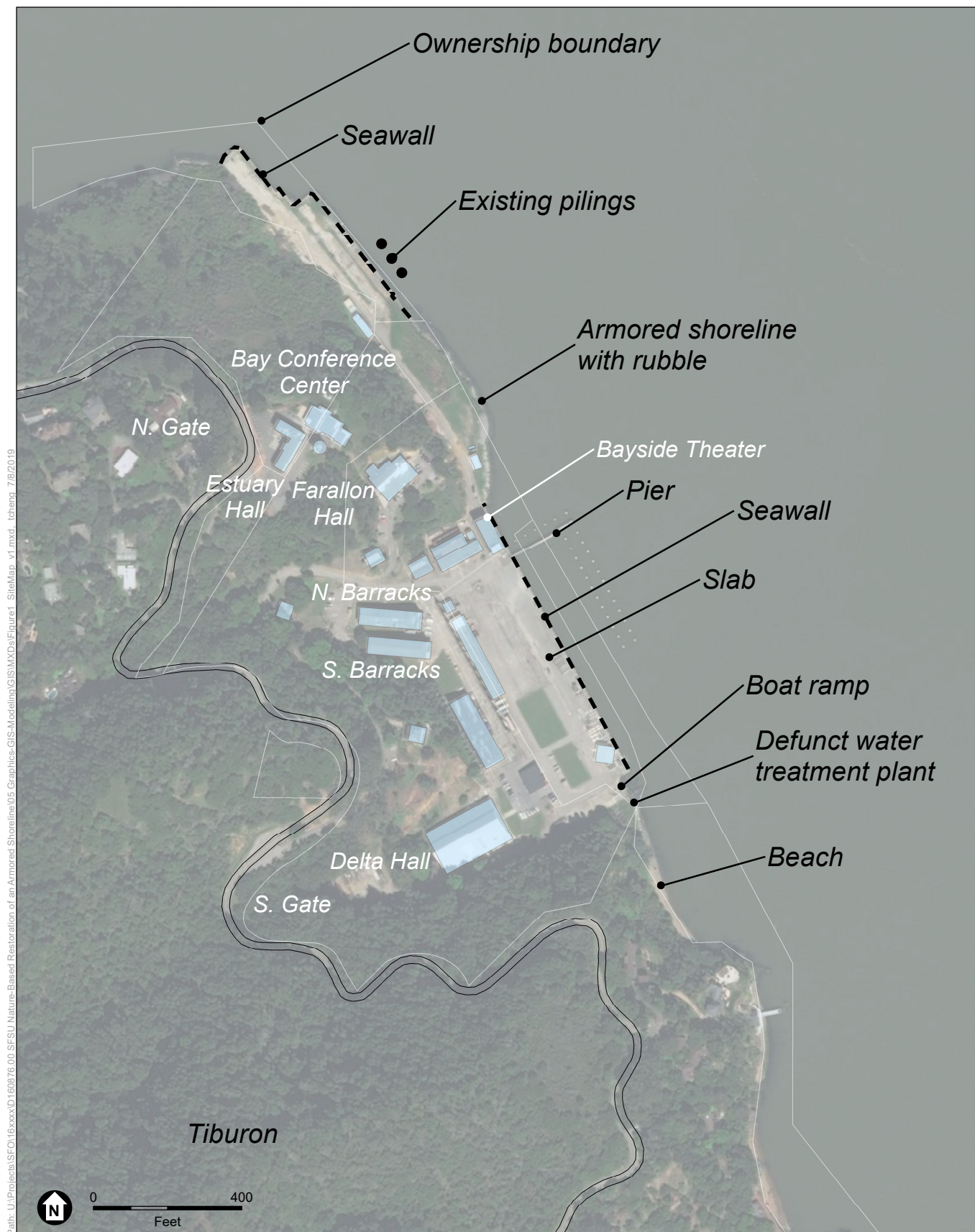
San Francisco State University's Estuary & Ocean Science (EOS) Center is located on the shore of San Francisco Bay, on the Romberg Tiburon Campus (RTC). Formal ownership of the property by SF State was achieved in 2008. Currently, the university is developing its first physical master plan for the campus. As a California agency, it is charged by EO B-30-50 (2015) with taking climate change into account as part of its infrastructure planning. Furthermore, natural infrastructure has been identified as a priority.

RTC has been ecologically and physically transformed from decades of industrial and naval uses between 1904 and 1958. The entire shore of the campus is armored. Flooding, overtopping and erosion are regular occurrences during winter storms and high tides where the armoring is in poor condition and seasonal watersheds connect with the bay. Sea level rise and climate change will make these problems worse over the coming decades.

Our goal for this design charrette is to generate **a portfolio of potential nature-based adaptation and restoration approaches** for possible inclusion into the physical master plan for RTC. We have identified **three very different areas of the campus shore** with different opportunities, risks and constraints. We seek your scientific and technical input to **advance a subset of conceptual design solutions** for these three areas, from the initial portfolio of ideas, **to be further developed and refined** in a follow-on Design Workshop this fall.



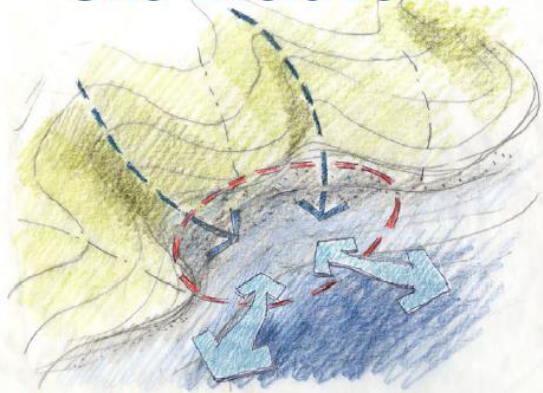
SF State University Romberg Tiburon Campus



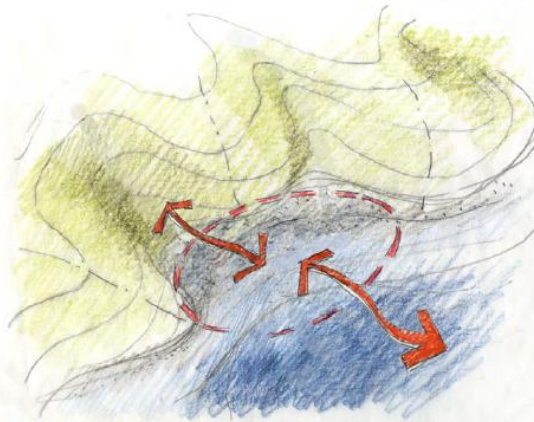
Source: ESRI Aerial (2019), SFSU Parcel Boundaries (2019)

San Francisco State University Nature-Based Restoration of Armored Shoreline

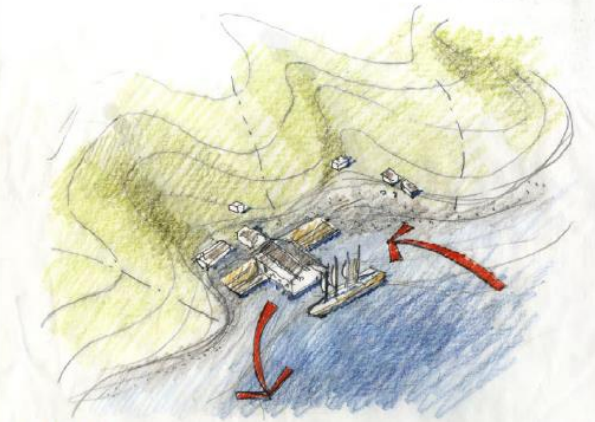
Site Evolution



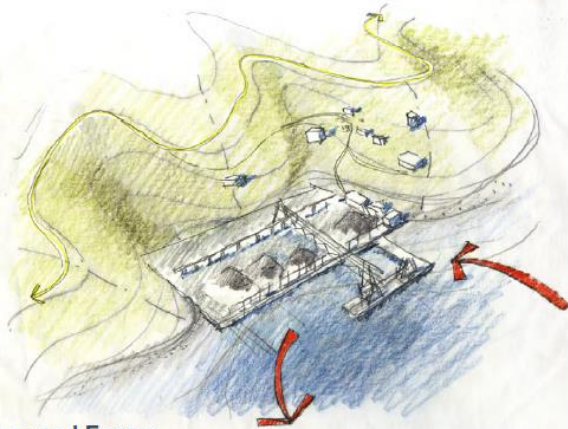
The Original Cove Coast Miwok < 1700s



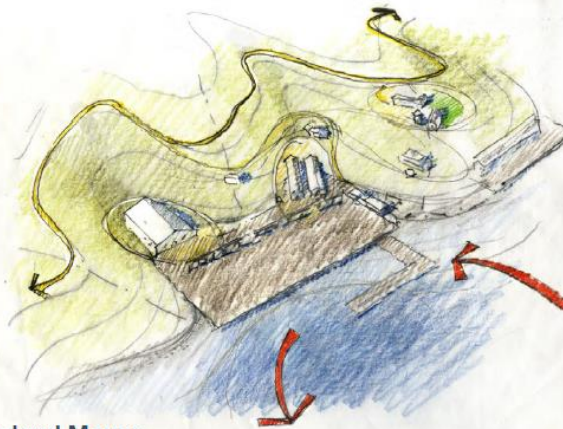
Exchange 1831-1880s Ranchlands



Extraction 1877-1903 Cod Fish Processing



Imposed Forms
1904-1931 US Navy Fuel
(Coal) Depot



Upland Moves
1933-1942 John Roebling's Sons Co
1940-1958 US Navy Net Depot



New Orientation

The EOS Center has a vested interest in place-based research and education with its mission to connect science, society and the sea for a healthy planet. Many of our faculty and students are involved in innovative research and planning related to climate adaptation and resilience in the region and for the State. We are keenly aware of the risks of sea level rise and climate change for SF Bay and coastal zones around the world. We intend to share our scientific knowledge on the challenges and solutions to inform our physical master plan for the future.

We are championing inclusion of innovative nature-based restoration and climate adaptation planning for our campus bay shore as it is extraordinary opportunity to use our unique campus as model of evidence-based planning and application of different kinds of nature-based climate adaptation design solutions. The university and the public will benefit by making smart infrastructure investments for the future, and our students and faculty and the broader community will have a place where they can study and learn about nature-based climate adaptation approaches.

Also relevant, the master plan is being developed within the [Living Community Challenge](#) framework from the [International Living Future Institute](#). It calls for restoring a healthy interrelationship with nature, celebrating transformative change, net positive energy and water use, and other sustainability and human-health related design and planning imperatives. The framework aligns well with adopting nature-based climate adaptation approaches.

The master plan team (Page - San Francisco) recently developed a summary analysis of existing site conditions. Our design charrette work will benefit from a basic understanding of upland conditions and future program plans for the campus. The following figures illustrate these.

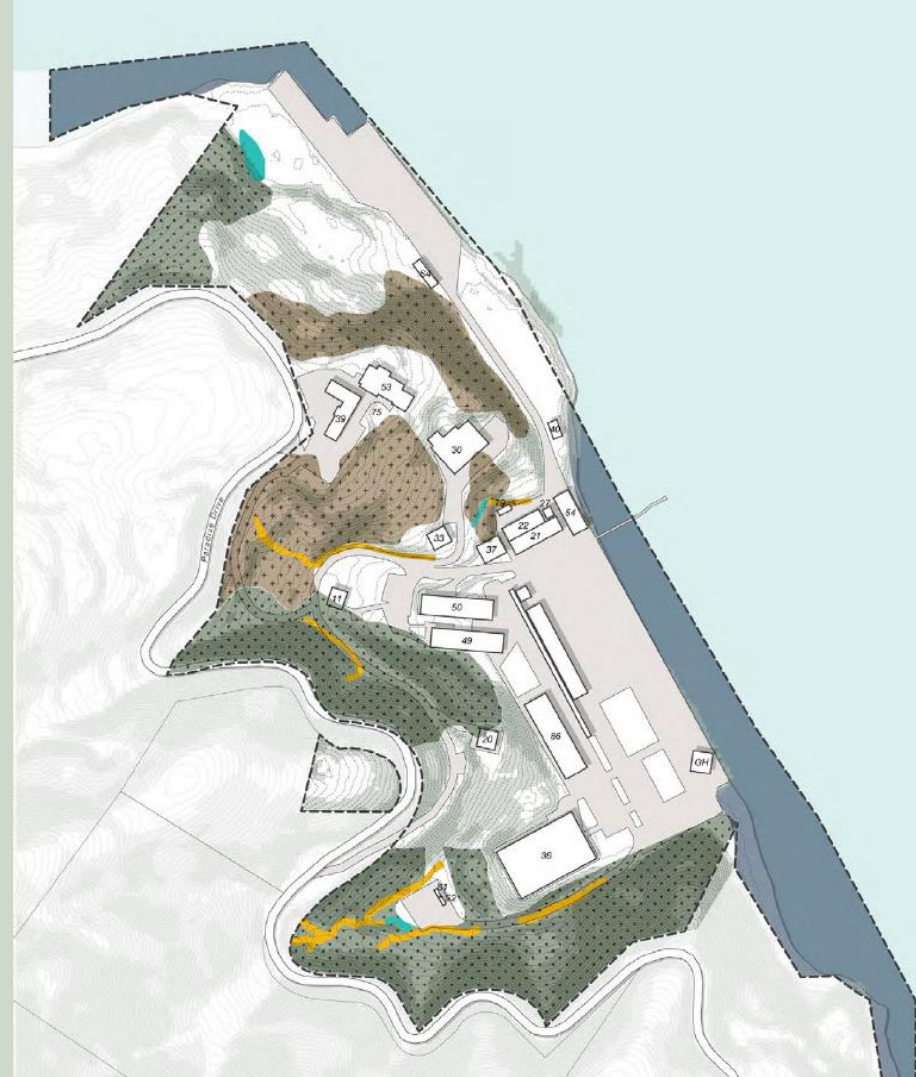
Sensitive Biological Communities

Both sensitive and non-sensitive biological communities have potential for restoration.

Concrete drainages also offer opportunities for restoration.



-  Coast Live Oak
-  California Bay Forest
-  Ephemeral Drainage
-  Potential Seasonal Wetland
-  San Francisco Bay



Sensitive Biological Communities

Combination of both sensitive and non-sensitive biological communities.

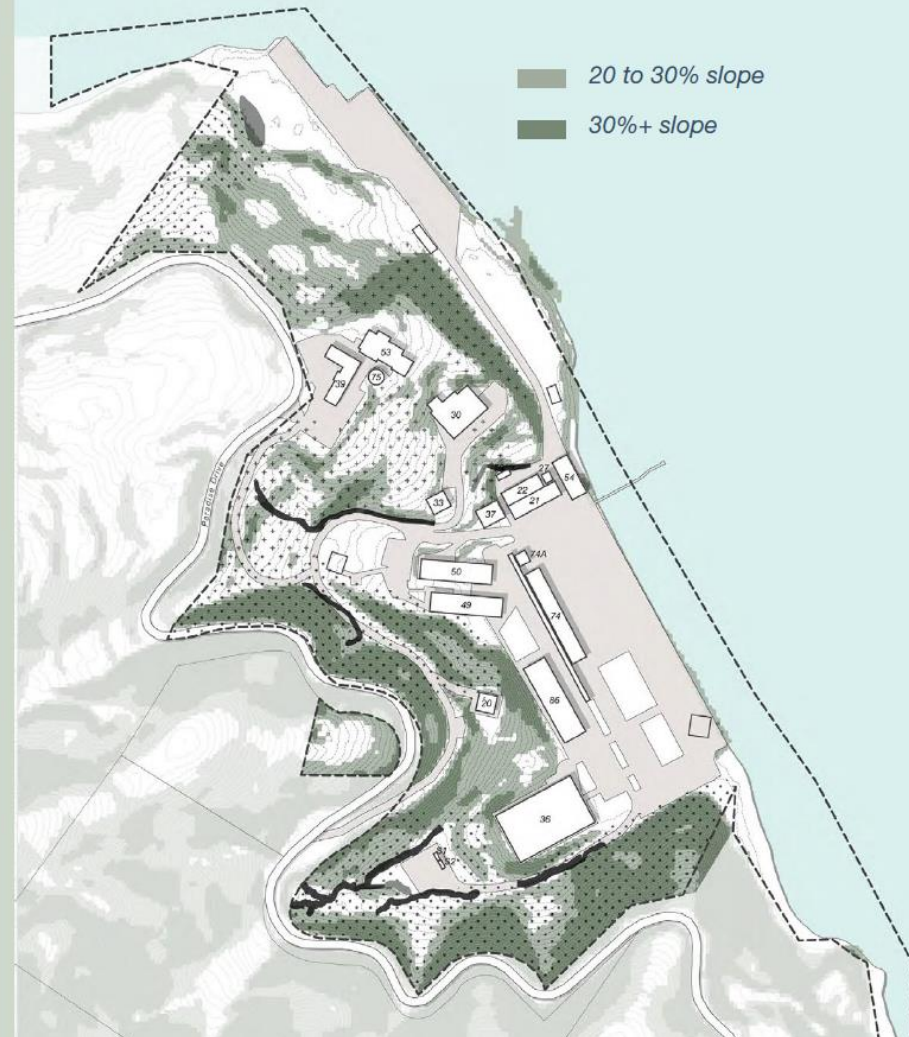
Will require further review through the CEQA process, and may limit the location of future development types.



Significant Slopes

Steep slopes (20% and greater) inform biological and hydrological conditions on the site.

These slopes dictate both water and human movement throughout the site.



Major Stormwater Flows

The site features three watersheds and two primary drainages.

There are existing buildings located in both natural drainage paths.

Water flowing from the uplands down the campus ravines has limited locations to recharge.

Larger offsite watersheds contribute to significant stormwater movement.

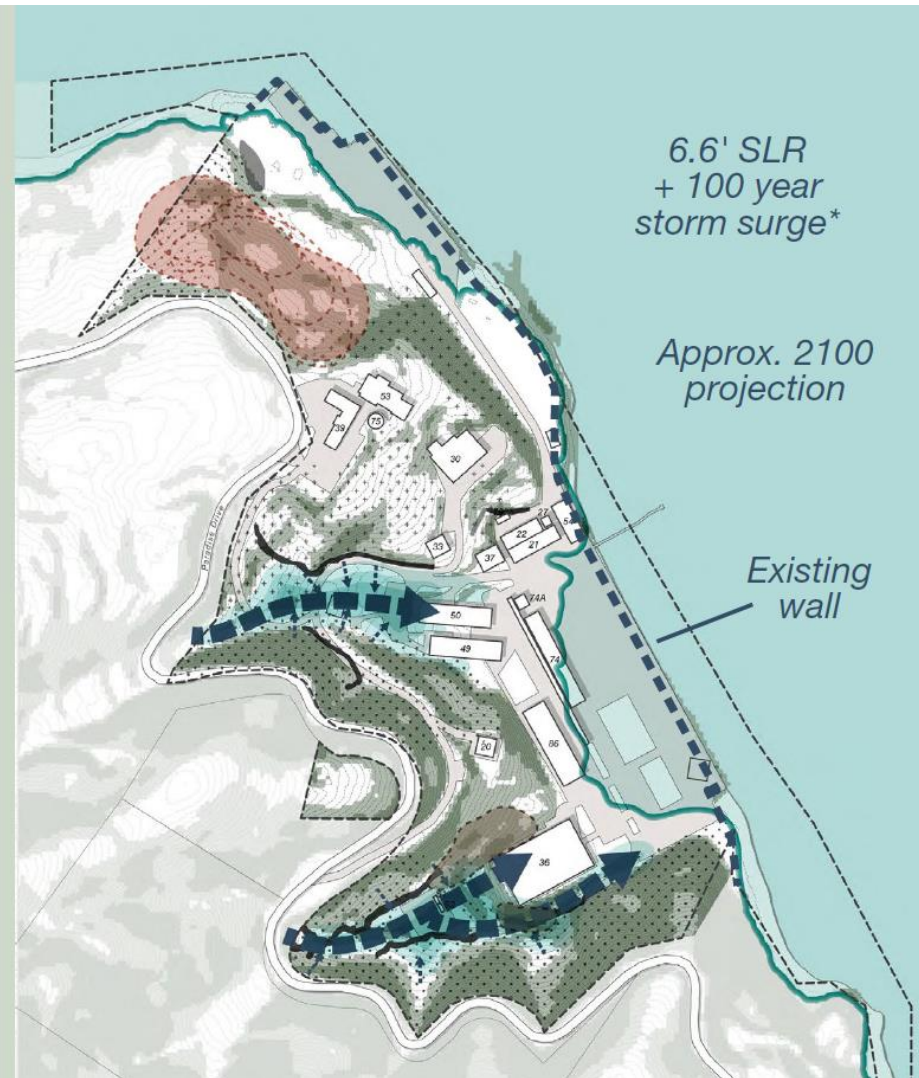
The historic cove would have featured marshland to disperse and treat stormwater runoff.



Future Shoreline Considerations

Future sea level rise projections mimic the historic shoreline that existed prior to the campus's development.

State of California recommends planning for a 7- to 10-foot rise



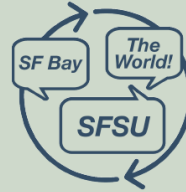
Plan Vision Statements



**Leadership
in Research
and Climate
Science**



**Education
for a Diverse
Student Body**



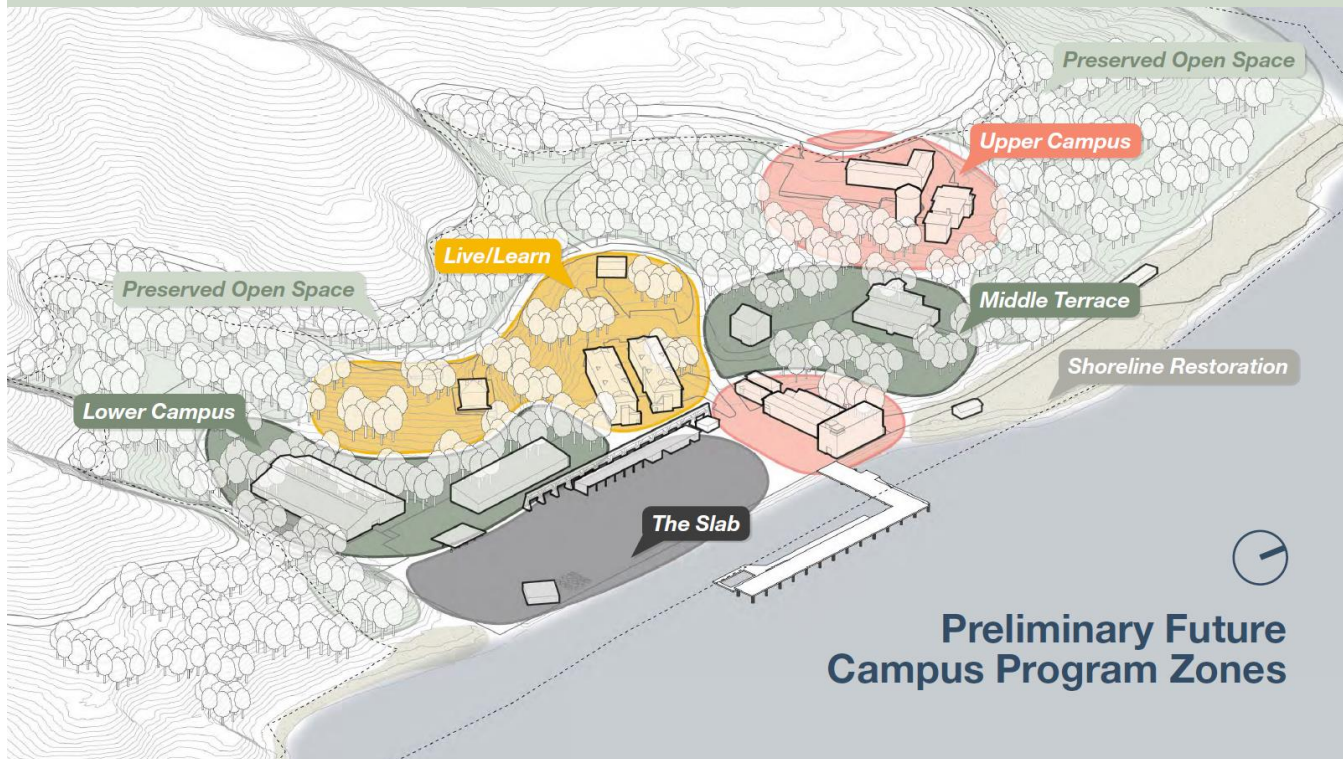
**Community
Resource and
Partner**



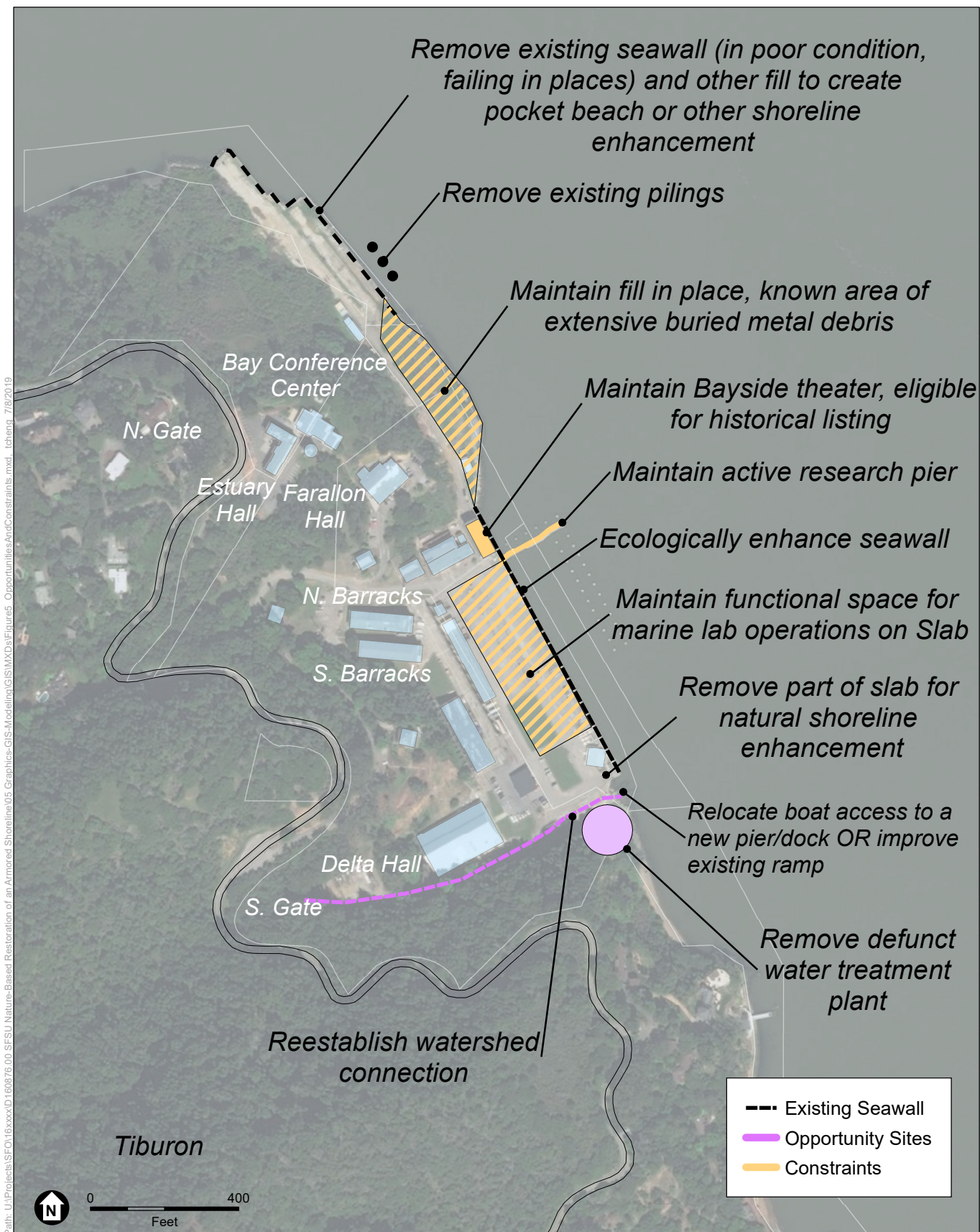
**Distinct and
Sustainable
Campus
Character and
Environment**



**Self-
Sufficiency
and Resiliency**



**Preliminary Future
Campus Program Zones**



SOURCE: ESRI Aerial (2019)

San Francisco State University Nature-Based Restoration of Armored Shoreline . D160876.00

Initial Opportunity Area Concepts

•***Opportunity Area 1: South Pocket Beach and Enhanced Creek***

The concept restores a more natural shoreline and watershed connection for the southern part of the site. Existing infrastructure in this area would be removed. The defunct water treatment plant, existing boat ramp, and part of the concrete slab would be removed (with boat access relocated elsewhere onsite). Coarse sediment (gravel and cobble) would be placed to form a pocket beach along the shore, extending the existing (reference) beach located south of the EOS Center. The creek channel would be realigned into a more natural earthen channel and the existing concrete creek channel removed. The creek would drain through the beach berm, intermittently overtopping the beach berm during high runoff events. Depending on final site elevations, the transition from creek to beach would be primarily fresh water habitat (above bay water levels) or experience periodic saline input from wave overtopping events. The corner of the existing seawall would be used as a hard point to retain beach sediment.

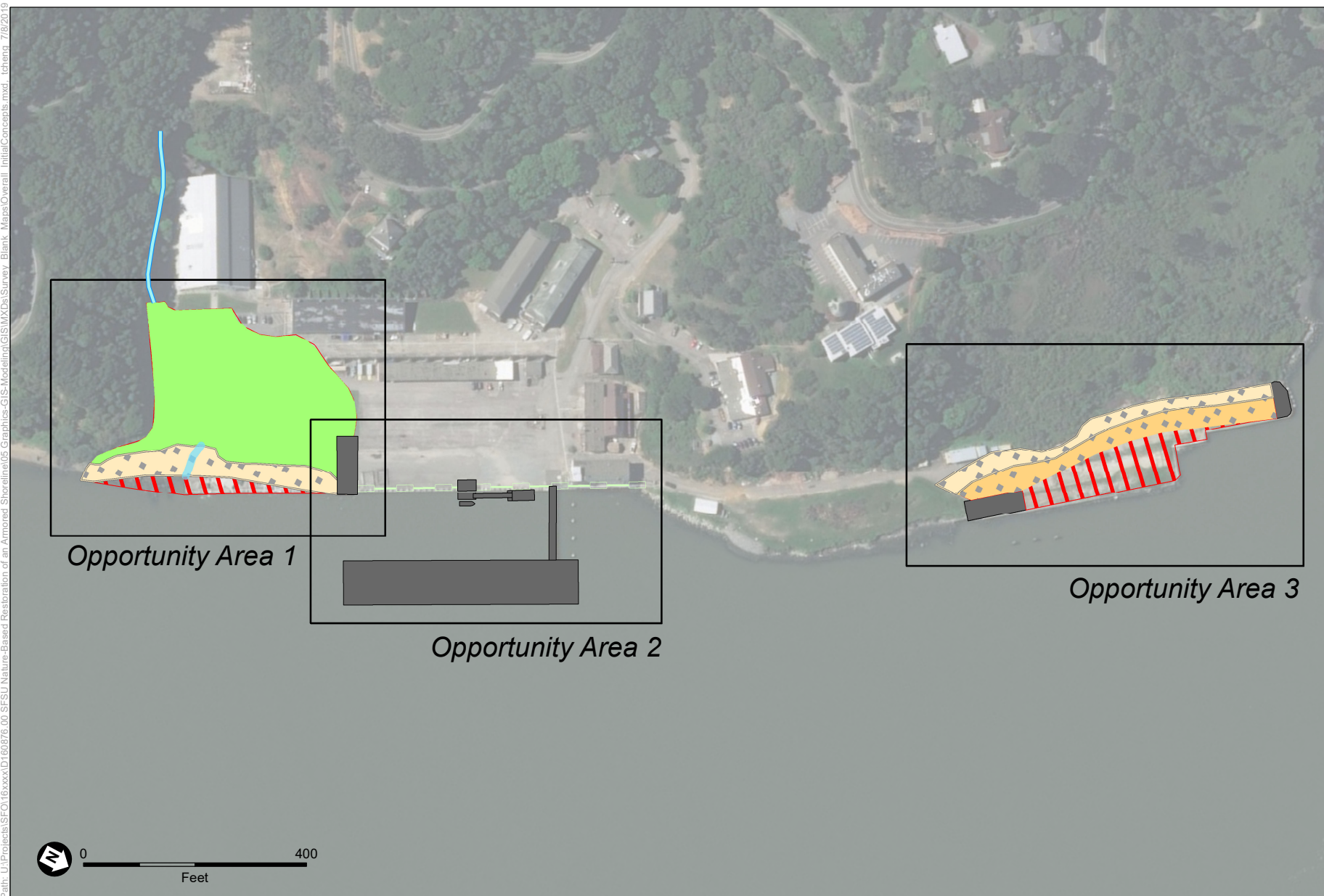
•***Opportunity Area 2: Living Seawall Enhancement***

The concept-introduces living seawall enhancements along the existing “slab” and creates habitat for intertidal and subtidal species for the central part of the site. The concept would involve designing texture into the seawall to create more surface area to support native species that use rocky habitats. The texture could be created in the form of steps, shelves, or cobble protrusions (example: Elliott Bay Seawall, Seattle, WA) or tiles (example: Volvo Living Seawall, Sydney, Australia). Depending on future boat access design, there may be potential to install similar living seawall enhancements on those hard structures as well for increased habitat area.

•***Opportunity Area 3: North Pocket Beach***

The concept creates a pocket beach, or series of pocket beaches, along the northern part of the site. The northern part of the site contains earth fill surrounded by rock protection and a failing bulkhead. The concept is to remove the armor and fill, construct artificial headlands (labeled “hard points” in the sketches) and place coarse sediment to form a pocket or cove beach, or beaches. Beach sediments are likely gravel and cobble with some sand and will reuse existing coarse sediments as appropriate. The headlands, shown only as rectangles, will likely be a combination of existing structures to remain and renovation with boulders, to be determined. The initial concept layout was developed using judgment and consideration of geomorphology and tidal and wave conditions and informed by a reference site south of the EOS Center.

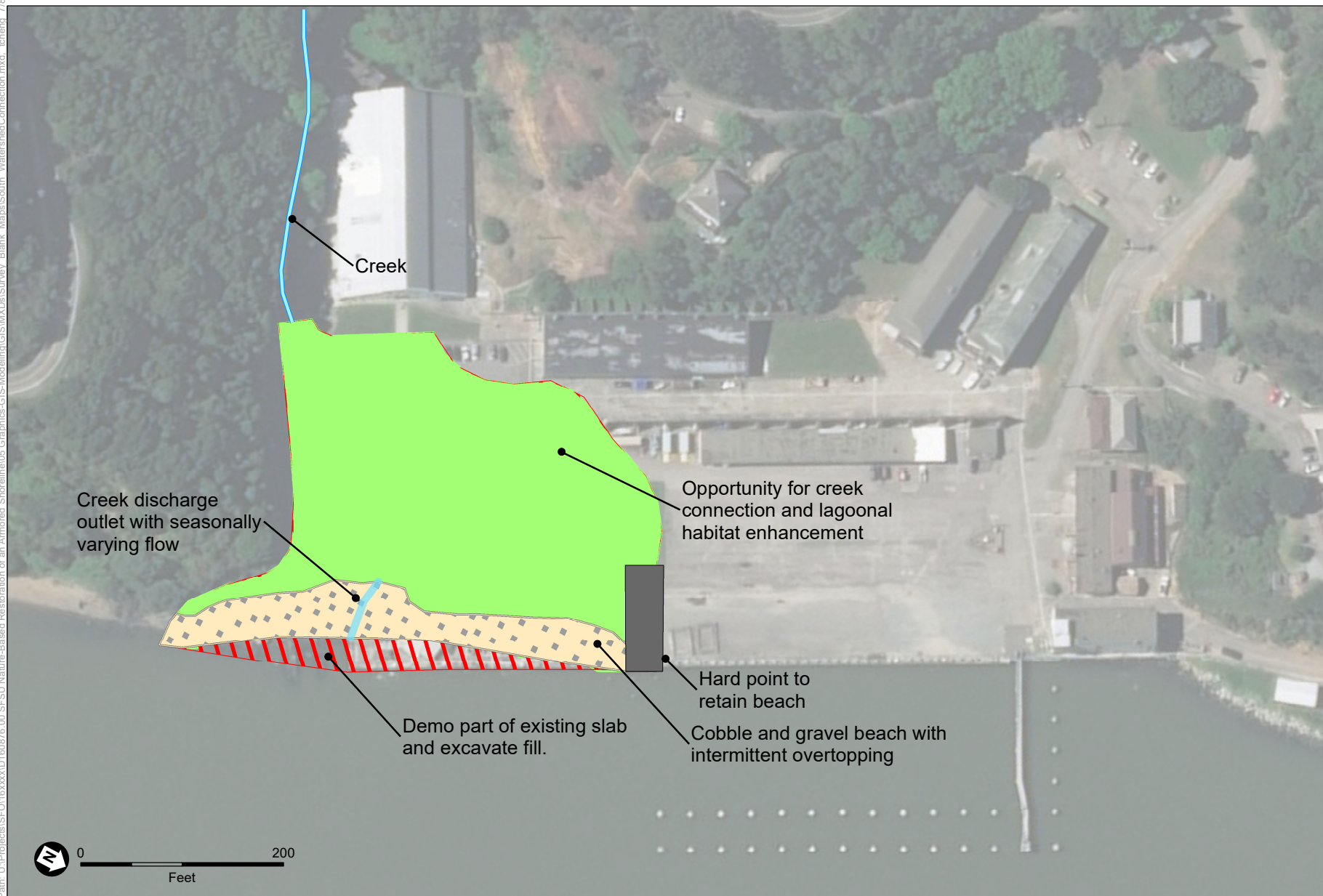
Path: U:\Projects\SFO\16xxxx\Dr160876_00 SFSU Nature-Based Restoration of an Armored Shoreline\05 Graphics-GIS-Modeling\GIS\MXDs\Survey Blank Maps\Overall InitialConcepts.mxd, tcheng, 7/9/2019



SOURCE: ESRI Aerial (2019)

San Francisco State University Nature-Based Restoration of Armored Shoreline D160876.00

Path: U:\Projects\SFO\16xxxx\Dr160876_00 SFSU Nature-Based Restoration of an Armored Shoreline\05 Graphics-GIS-Modeling\GIS\MXDs\Survey Blank Maps\South WatershedConnection.mxd, tcheng, 7/8/2019

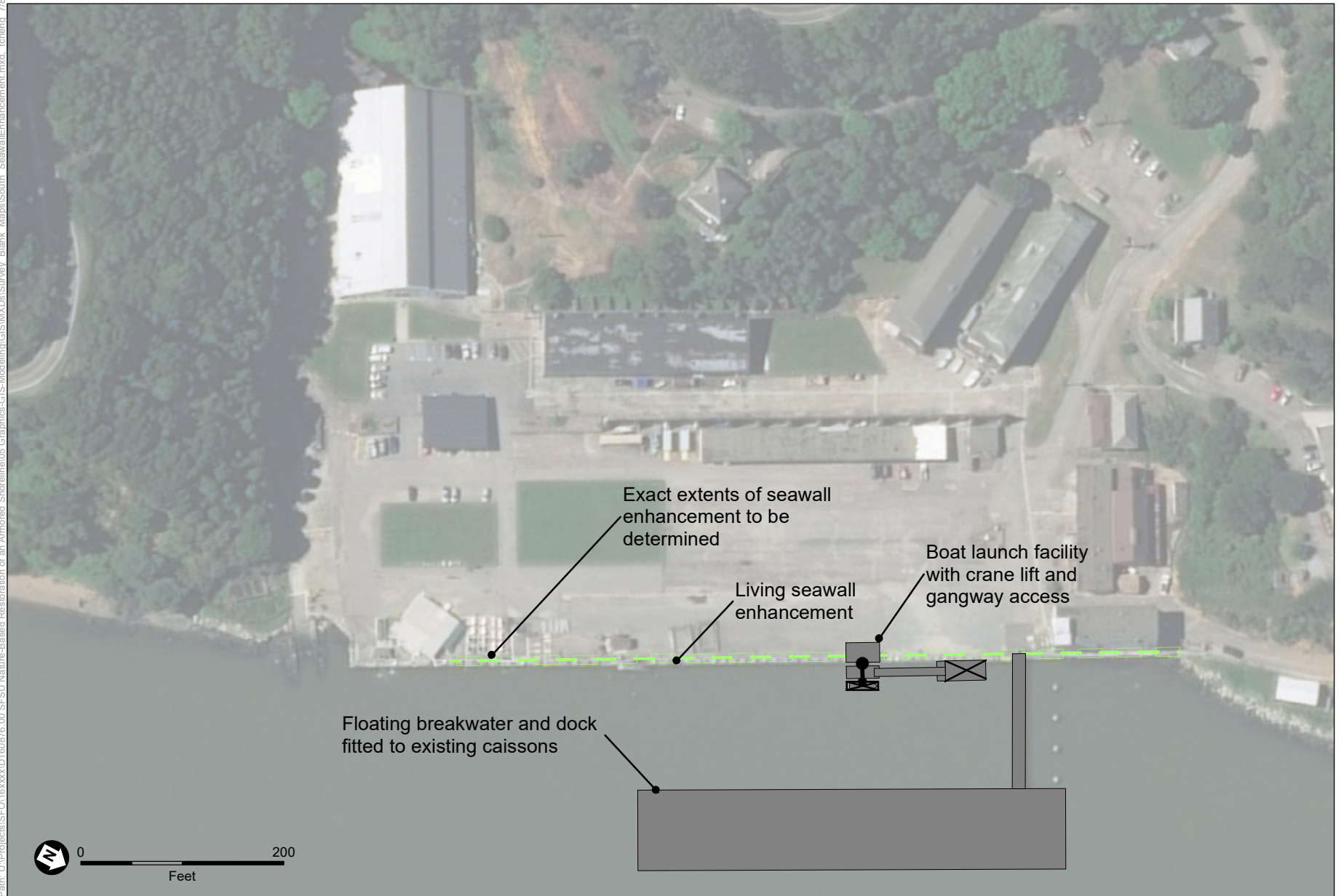


SOURCE: ESRI Aerial (2019)

San Francisco State University Nature-Based Restoration of Armored Shoreline D160876.00

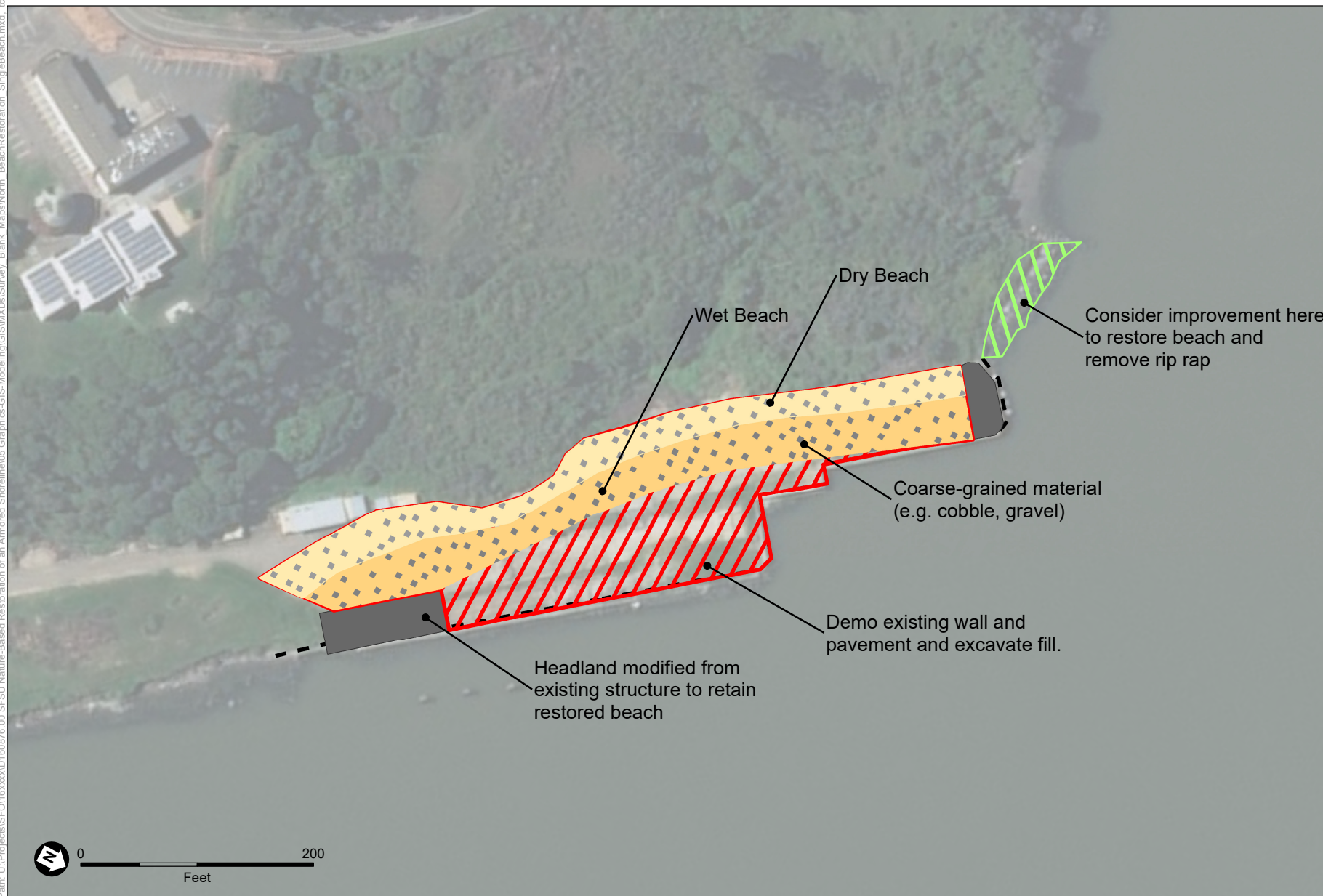


Initial Concept
Opportunity Area 1: Southern Watershed Connection



SOURCE: ESRI Aerial (2019)

San Francisco State University Nature-Based Restoration of Armored Shoreline D160876.00



SOURCE: ESRI Aerial (2019)

San Francisco State University Nature-Based Restoration of Armored Shoreline D160876.00

San Francisco State University

Nature-Based Restoration of Armored Shoreline

Shoreline Charrette, Concept Brainstorming Session- 7/11/2019, 12:30 – 1:45 PM

Instructions to participants:

There are three stations in this exercise: North, Central and South. You have 25 minutes total at each station to brainstorm new concepts and provide comments on initial concepts. Each group will be asked to give a debrief of their session afterwards for each area. Feel free to ask questions of the Project Team (Karina, Tiffany, Michelle, Louis)

- Mark up blank maps (provided) with ideas, suggestions and comments for new opportunities. Use post-its to provide further detail.
- Mark up initial concepts maps (provided) with feedback / initial impressions.

Guiding questions:

- What modifications or refinements are suggested for the initial concepts?
- What additional nature-based adaptation concepts should be considered? Assume unconstrained by cost.
- What are the ecological benefits of each concept? Include initial concepts and any new concepts. What are access, recreation, educational or other benefits?
- What are the drawbacks of each concept?
- Are there examples of reference sites and case studies appropriate to the concepts?
- How resilient are the concepts to climate change and what measures might increase resilience?
- Any additional comments?

Background on site modifications, timeline

Today:

- **SF State University Romberg Tiburon Campus ~ 50 acres**
 - Estuary & Ocean Science Center (with SF Bay National Estuarine Research Reserve and Smithsonian Environmental Research Center)
 - Eligible to be listed as *Historic Landscape*, 4 historically significant buildings

Formerly:

- **Coast Miwok Land and Waters**
 - Campus shore (~ 750 m) consisted of steep coastal bluffs to the north and a small shallow cove to the south on the Tiburon Peninsula, adjacent to the deep waters of a sunken river channel.
 - Abundant water ran off the Tiburon ridge forming two seasonal watershed drainages connecting to the bay at the northern and southern ends of the cove.
 - Shell mounds common on the Tiburon Peninsula. Likely encampment/inhabitation. Small indigenous artifacts (spearheads) have been found.
- **1831-1880s John Reed Cattle and Dairy Ranchlands – Rancho Corte Madera Del Presidio**
 - Houses and a brick kiln present at the north end of the cove.
- **1877-1903 Lynde & Hough's Pioneer Fish Warehouse**
 - Established the US Pacific Cod Fishery.
 - Constructed pile wharf 140 x 100 ft with a 2-story warehouse, platforms for receiving and discharging cargos in the cove.
 - Capacity for storing 1200 tons of salted codfish in redwood barrels. 75 employees most of whom lived on site were provisioned by on site agriculture and dairy cattle, chickens, abundant local water, etc.

Background on site modifications, timeline (con't.)

- **1904-1931 US Navy Fuel Depot – first Pacific Coast coaling station**
 - A coaling dock, large gantry crane, underwater coal bunkers and overhead coal derricks, an L-shaped wharf trestle, coal hoisting tower, cable railway and power plant were constructed inside and around the cove.
 - Coal storage capacity was reported to be 140,000 tons piled 23 feet high at the peak of operations. These piles filled the cove up to bulkhead seawall supporting the gantry coal loading system for the ships.
 - Extant pier pilings - steel encased concrete assumed to be from this period.
- **1933-1942 John Roebling's Sons Co - reeled suspension cables for Golden Gate Bridge**
 - A seawall with a wharf and a large warehouse was constructed along the northern portion of the property, beyond the cove.
 - Seawall is approximately 3' thick and 9' tall. It was poured without footings and secured back to the shore by redwood timber "tiebacks".
 - In poor condition and failing in areas, some "informal" fill and rip-rap repairs made
- **1940-1958 US Navy Net Depot and Net Training School – charged with construction of anti-submarine and anti-torpedo nets**
 - In 1940 the cove area behind the seawall was filled creating the concrete slab present today. Thought to be in good condition but more information needed.
 - Concrete blocks of about 14 tons were produced here during this period for holding the submarine nets in place across the Golden Gate. Many remain on site today and were used in places as improvised shoreline armoring.



Coast Miwok Land and Waters



1831-1880s John Reed Cattle and Dairy Ranchlands – Rancho Corte Madera Del Presidio





1904-1931 US Navy Fuel Depot - coaling station



1933-1942 John Roebling's Sons Co - reeled suspension cables for Golden Gate Bridge



1940-1958 US Navy Net Depot and Net Training School



South Pocket Beach



Photo Source: ESA, 2019

Water Treatment Plant



Photo Source: ESA, 2019

Boat Ramp



Photo Source: ESA, 2019

Wrack line by boat ramp



Photo Source: ESA, 2019



Photo Source: ESA, 2019

Armored shoreline north of pier

Existing Seawall in NE Portion of Campus



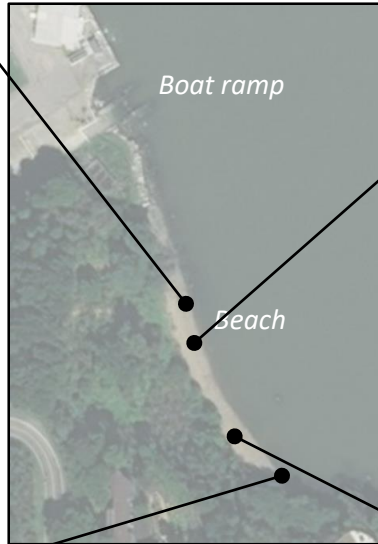
Reference Site



North end of beach populated by coarse grain sand and pebbles



Middle of beach intermediate in sediment size



Rocky substrate providing habitat area for aquatic species



South end of beach populated by cobble

Conceptual Design Workshop

Nature-Based Restoration of an Armored Shoreline

Estuary & Ocean Science Center, SF State Romberg Tiburon Campus

December 12, 2019, 9 am – 2 pm

Meeting Objectives:

1. Present progress on conceptual nature-based restoration design, based on input from the July 2019 charrette and continued planning and design activities over Summer/Fall 2019
2. Solicit input on refined conceptual designs for each reach, including ecology, climate resilience, constructability and costs

Outcomes from this planning process will inform shoreline treatment for inclusion in the master plan for the SF State Romberg Tiburon Campus being prepared by Page Southerland Page, Inc. (San Francisco) and collaborators.

Draft Agenda

Time	What
9 – 9:15 am	Introductions (All)
9:15 – 9:30 am	Study Update (Karina) • Summary of July 2019 charrette input • Update on Campus Master Plan • Work-to-date on conceptual designs over Summer/Fall 2019
9:30 am – 9:45 am	Master Plan Context for the Conceptual Design (ESA)
9:45 am – 10:45 am	Adaptation Pathways and Conceptual Designs for the Campus Shoreline (ESA)
10:45 am – 11:00 am	<i>Break</i>
11:00 am – 12:00 pm	Group Discussion and Q&A - South and Central Reaches (All)
12:00 – 12:30 pm	Lunch break
12:30 – 1:30 pm	Group Discussion and Q&A - North Reach (All)
1:30 – 1:45 pm	Recap of Group Discussion (All)
1:45 – 2:00 pm	Next steps, adjourn (Karina)

Conceptual Design Workshop

Nature-Based Restoration of an Armored Shoreline

Read Ahead Materials

Estuary & Ocean Science Center, SF State Romberg Tiburon Campus

December 12, 2019, 9 am – 2 pm

Summary of July 2019 Charrette Feedback

In July 2019, a group of experts in coastal ecology and processes was convened to participate in a planning charrette for the nature-based restoration of an armored shoreline at the San Francisco State University (SFSU) Romberg Tiburon Campus (RTC). Charrette participants were asked to provide input on initial restoration concepts for three opportunity areas identified along the campus shore. Over Summer/Fall 2019, the Project Team revised the restoration concepts (more below), developed preliminary quantities and cost estimates, and is now inviting the group of experts to a follow-on design workshop.

The revised concepts incorporate the following suggested refinements from the initial charrette:

Opportunity Area 1: South Pocket Beach, Back-barrier Wetland and Creek Restoration

- Reduce the size of the beach and back-barrier wetland to the area facing Delta Hall due to continuing use of slab for campus activities and proximity to restored creek
- Locate the pocket beach further inland for feasibility
- Reuse large concrete blocks distributed around campus for artificial headlands
- Consider enhancements at the edge of the removed slab that would enhance ecological, access, and educational value. This could include terracing the seawall or enhancing rugosity.

Opportunity Area 2: Living Seawall Enhancement and Boat Access Improvements

- Anticipate retreat from the slab edge and full or partial slab removal with sea level rise
- Develop phased plan balancing current boat access needs with future adaptive retreat and improved access and functionality:
 - For near-term, improve the existing boat ramp in the South Reach, add seawall habitat
 - In the medium term, create a new small boat launch facility within an expanded pier complex (including wave dissipation) in the Central Reach that also supports public and emergency access.

Opportunity Area 3: North Pocket Beach Restoration and Recreational Field Shoreline Protection

- Consider restoring the historic hillside and bluff. Bluffs will erode and provide a source of sediment for beaches and other shoreline habitats.
- Extend concept to shoreline along recreational field for continuous shoreline treatment between the slab and proposed north pocket beach.
- Reuse large concrete blocks for use as hard points.
- Consider connecting the north watershed in the longer term, if cultural resource considerations change over time.

Conceptual Design Descriptions

The revised concepts are presented below by location along the shoreline. The timeframes referenced are further described in the shoreline adaptation pathways diagrams for the South, Central and North Reaches (Figures 1 and 2). The adaptation pathways were developed to capture consideration of different possible futures for the campus shoreline in response to sea level rise. They also support analysis and exploration of how these different options might be implemented and articulated with assumptions informed by the campus master planning process. Both planning efforts are anticipating future sea level rise impacts to the campus shoreline.

Opportunity Area 1: South Pocket Beach, Back Barrier Wetland and Creek Restoration

The concept restores a more natural shoreline and watershed connection for the southern part of the site (Figure 3). In the near-term, the existing defunct water treatment plant would be removed. Improvements to the existing boat ramp (e.g. widening and setting back the slope) would be made in order to maintain boat access onsite while the University pursues funding for the pier improvements (see Opportunity Area 2). In the medium-term, the existing boat ramp and slab in front of Delta Hall would be removed. The pavement and fill underneath would be excavated and stockpiled on campus to allow for reuse elsewhere, where feasible. Coarse sediment (gravel and cobble) would be placed to create a pocket beach of approximately 200 feet length. The area behind the beach would be graded to form a back-barrier wetland. Large boulders (onsite) or concrete blocks along the existing shoreline would be relocated to act as a hard point to retain beach sediment. The creek channel would be realigned into a more natural earthen channel and the existing concrete creek channel removed. The creek would flow into a restored wetland and drain through the beach berm, intermittently overtopping the beach berm during high runoff events. Depending on final site elevations, the transition from creek to beach would be primarily fresh water habitat (above bay water levels) or more saline. The area closest to shore would experience periodic saline input from wave overtopping events. The concept layout was developed using professional judgment and consideration of geomorphology and tidal and wave conditions and informed by reference sites around San Francisco Bay and Tomales Bay.

Opportunity Area 2: Living Seawall Enhancement and Pier Improvements

The concept introduces 1) living seawall enhancements along the existing “slab” wall and creates habitat for intertidal and subtidal species for the central part of the site from the edge of the boat ramp to the existing Bayside Theater (approx. 4800 linear feet) and 2) future pier improvements (Figure 4). The concept would design texture into the seawall in the near-term to create more surface area to support native species that use rocky habitats. The texture could be created in the form of steps, shelves, or cobble protrusions (example: Elliott Bay Seawall, Seattle, WA) or tiles (example: Volvo Living Seawall, Sydney, Australia). In the medium-term, assuming the University secures funding for pier improvements, a boat winch and crane system installed on a pile-supported deck would be used to lift and lower boats into the water. Users would access boats via a gangway and boarding float. The existing caissons would be retrofitted with lateral bracing, in order to support a new floating breakwater and dock. This configuration would allow for sheltering of research vessels in the water from ferry wakes.

Opportunity Area 3: North Pocket Beach Restoration and Recreational Field Shoreline Protection

The concept proposes stabilizing the eroding shoreline along the flat filled “Field” area (between the Bayside Theater and northern seawall) with a rock revetment and creating a pocket gravel beach (approx. 300 ft extent) and natural hillslope to the north (Figure 5). The northern Opportunity Area

contains earth fill surrounded by rock protection and a failing bulkhead. Due to the planned future recreational usage of the Field and poor-quality fill soils, stabilization of the shore edge would occur in the near-term. Removal of the creosote pilings offshore of the seawall is also recommended in the near-term. For the medium-term, the gravel beach restoration would entail removing the existing bulkhead and seawall, removing earthen fill, constructing artificial headlands and placing coarse sediment to form a pocket or cove beach. Beach sediments are likely gravel and cobble and will reuse onsite coarse sediments as appropriate. The headlands will likely be a combination of existing structures to remain and renovation with (onsite) boulders or large concrete blocks. The hillside to the north of the pocket beach may opportunistically accrete coarse sediment due to the location of the artificial headlands. The concept layout was developed using professional judgment and consideration of geomorphology and tidal and wave conditions and informed by a reference site south of the EOS Center.

Conceptual Design Workshop

Nature-Based Restoration of an Armored Shoreline

Estuary & Ocean Science Center, SF State Romberg Tiburon Campus

December 12, 2019, 9 am – 2 pm

General Questions:

- What modifications would you suggest to increase the ecological (recreation, education, or other) benefits provided by the concepts?
- What measures could increase resilience of these concepts to climate change?
- How can we use the site to learn and pilot approaches that will have application elsewhere?
- Do the proposed concepts for the medium-term and long-term future of the campus seem consistent with your understanding of the site and overall campus master plan?

South & Central Reaches:

- What ecology is desired in the habitat behind the gravel beach? What mix of open water, wetlands and riparian is desired? Any target plant communities?
- What ecological uses can the fill sourced from the excavation/demo of the slab be used for?
- The concrete weights appear to be comprised of locally-sourced coarse materials. The conceptual design recommends reusing these elsewhere (headland hard points). Are there any other potential for reuse (e.g. grinding up for material)? Do you know any examples where this has been done? (Question also applies to North Reach)

North Reach:

- Do you have recommendations for ecologically enhancing or modifying rip rap for the recreational field shoreline? For example:
 - Maintaining or filling void spaces
 - Enhancing rugosity
 - Incorporating rocky shoreline elements, such as: macroalgae transplants, small pool areas, boulder islands for roosting, oyster elements
- Should we consider alternatives to rip rap?
- If the fill behind the seawall is clean earth (e.g. from the adjacent hillslope) what ecological uses can this fill be used for?

Nature-Based Restoration of an Armored Shoreline



December 12, 2019

Overview

- Study Update
 - Summary of July 2019 Charrette Input
 - Campus Master Plan Update
 - Work-To-Date
- Master Plan Context for Conceptual Design
- Adaptation Pathways and Conceptual Designs for the Campus Shoreline
- Group Discussion and Q&A

Study Update (9:15 – 9:30 am)

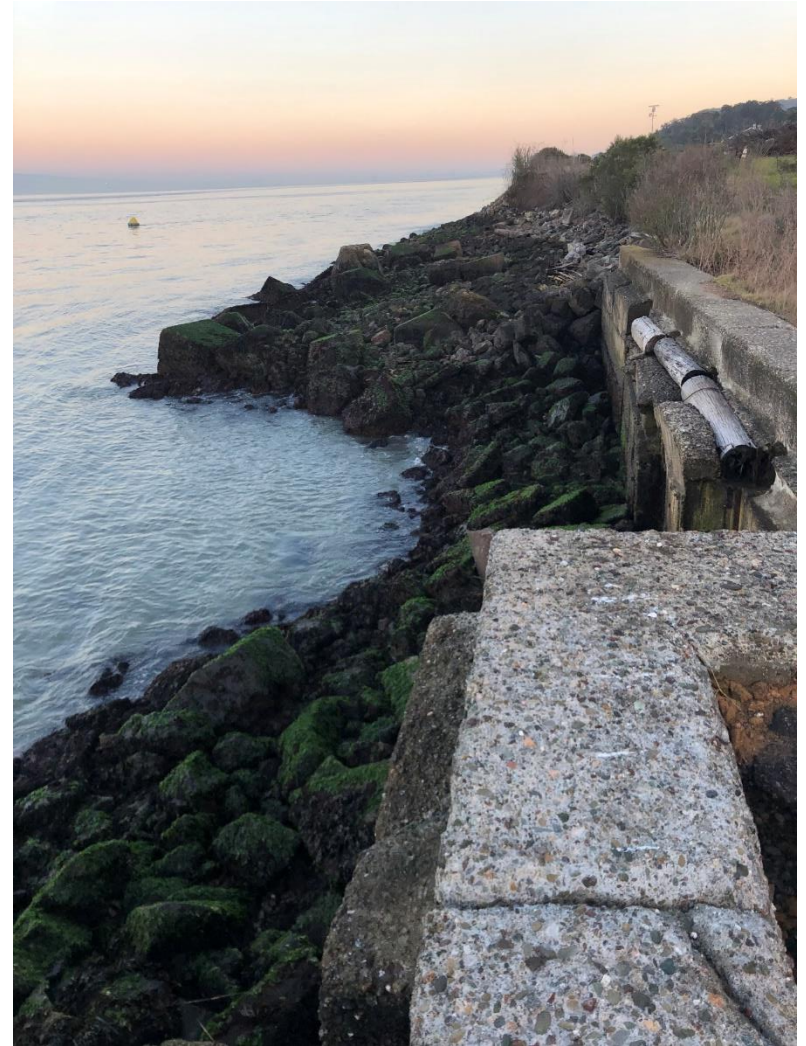
July 2019 – Shoreline Planning Charrette

Feedback for Initial Concepts

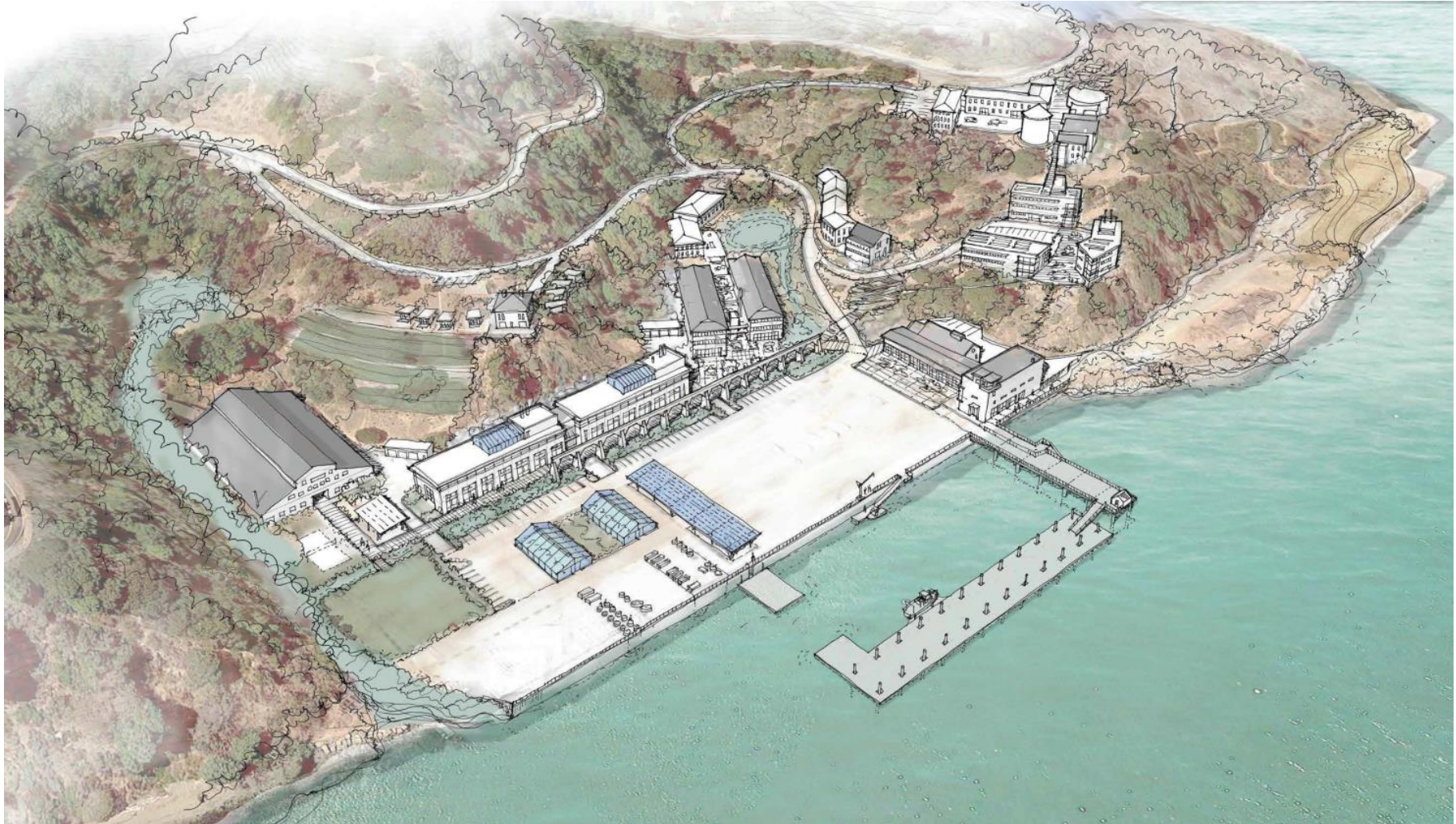
- **South Reach**
 - Naturalize creek
 - Create range of habitats: fresh, brackish and saline habitat. Potential habitat benefits for bivalves, eelgrass and birds.
 - Locate coarse-grained pocket beach further inland
- **Central Reach**
 - Living Seawall enhancements on existing seawall could benefit oysters, *Fucus*, herring breeding and salmonid feeding
 - Potential to apply seawall enhancements on pilings, while they are being retrofitted for floating dock
- **North Reach**
 - Coarse-grained beach restoration extent could be smaller, using existing seawall as hard points to anchor beach
 - Restore historic bluffs, which would provide source of sediment for existing and proposed beach
 - Consider shoreline enhancements for the field area for continuously enhanced shoreline

Conceptual Design Workshop Goals

- Present progress on conceptual nature-based restoration design, based on input from the July 2019 charrette and continued planning and design activities over Summer/Fall 2019
- Solicit input on refined conceptual designs for each reach, including ecology, climate resilience, constructability and costs

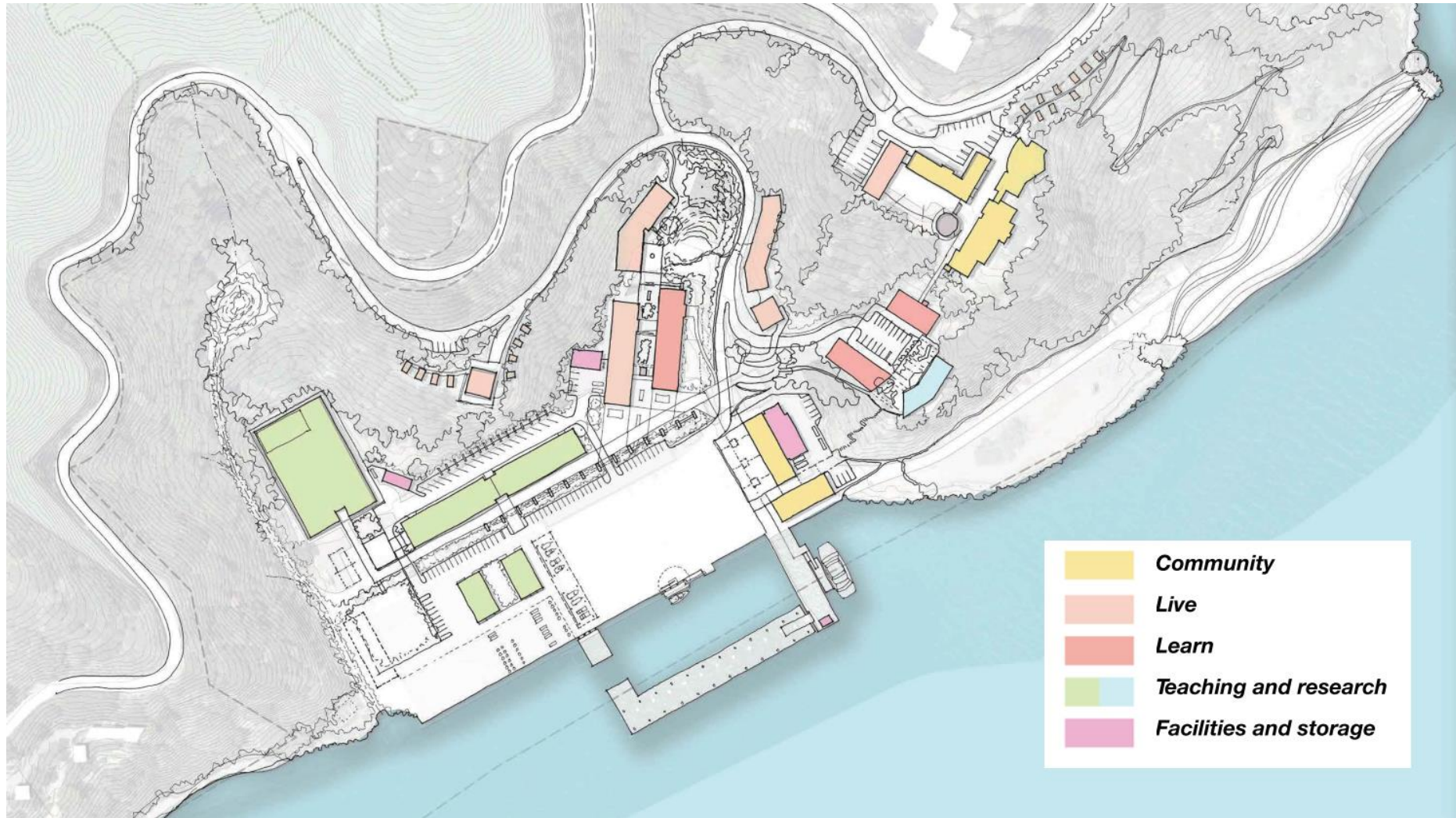


Preferred Scheme – Campus Master Plan



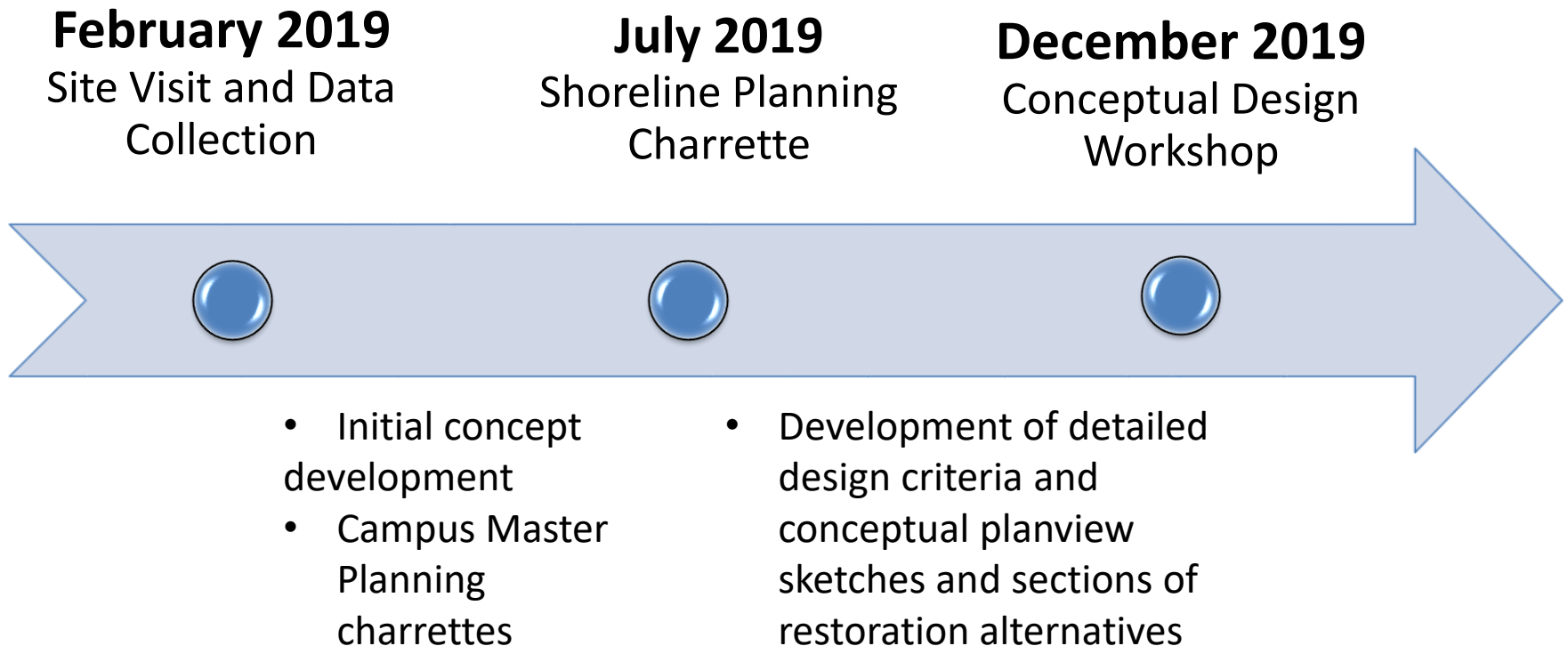
Source: San Francisco State University

Preferred Scheme – Campus Master Plan



Source: San Francisco State University

Project Work-to-Date



Conceptual Design Workshop Goals

- Present progress on conceptual nature-based restoration design, based on input from the July 2019 charrette and continued planning and design activities over Summer/Fall 2019
- Solicit input on refined conceptual designs for each reach, including ecology, climate resilience, constructability and costs



Master Plan Context for Conceptual Designs (9:30 – 9:45 am)



Delta Hall to remain until 2050 or until the end of its useful life, then decommissioned

- Retreat and “hold the line” at existing gantry structure when bay ward edge of slab is overtopped



Maintain options to preserve historic theater building indefinitely for now.



- Ability to launch boats will continue indefinitely
- Potential for campus to serve as disaster relief / evacuation site. To be revisited prior to construction of new launch site on slab and any significant slab size reduction.





- Area north of Bayside Theater – field and northern seawall to be used as recreational / open space area for campus community, as appropriate with SLR
- Assume materials (small metal debris) buried under the field would be expensive to remove.

Sea Level Rise

- Under existing conditions, seawall is overtopped around boat launch area during winter storm events
- Combination of sea level rise and storm surge predicted to overtop edge of seawall regularly by 2050
 - 3 ft of SLR by 2050 (Extreme Risk Aversion)
 - 5-year storm surge = ~2 ft

Estimated SLR (ft) for San Francisco Bay

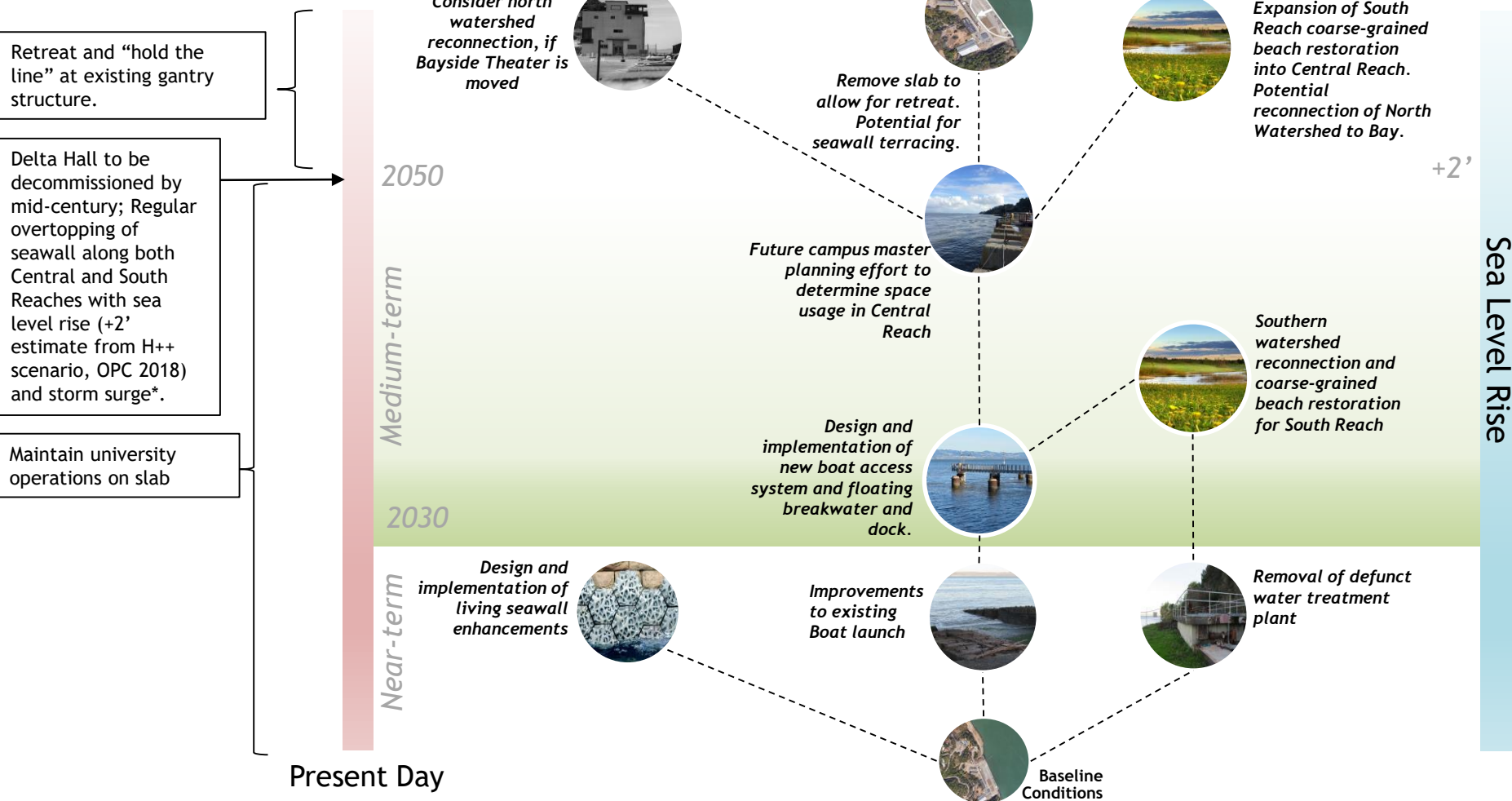
	Medium-High Risk Aversion	Extreme Risk Aversion
2040	1.3	1.8
2050	1.9	2.7
2070	3.5	5.2
2100	6.9	10.2

Source: Ocean Protection Council – 2018 SLR Guidance. Values assume high emissions.

Adaptation Pathways for the Campus Shoreline (9:45 – 10:45 am)

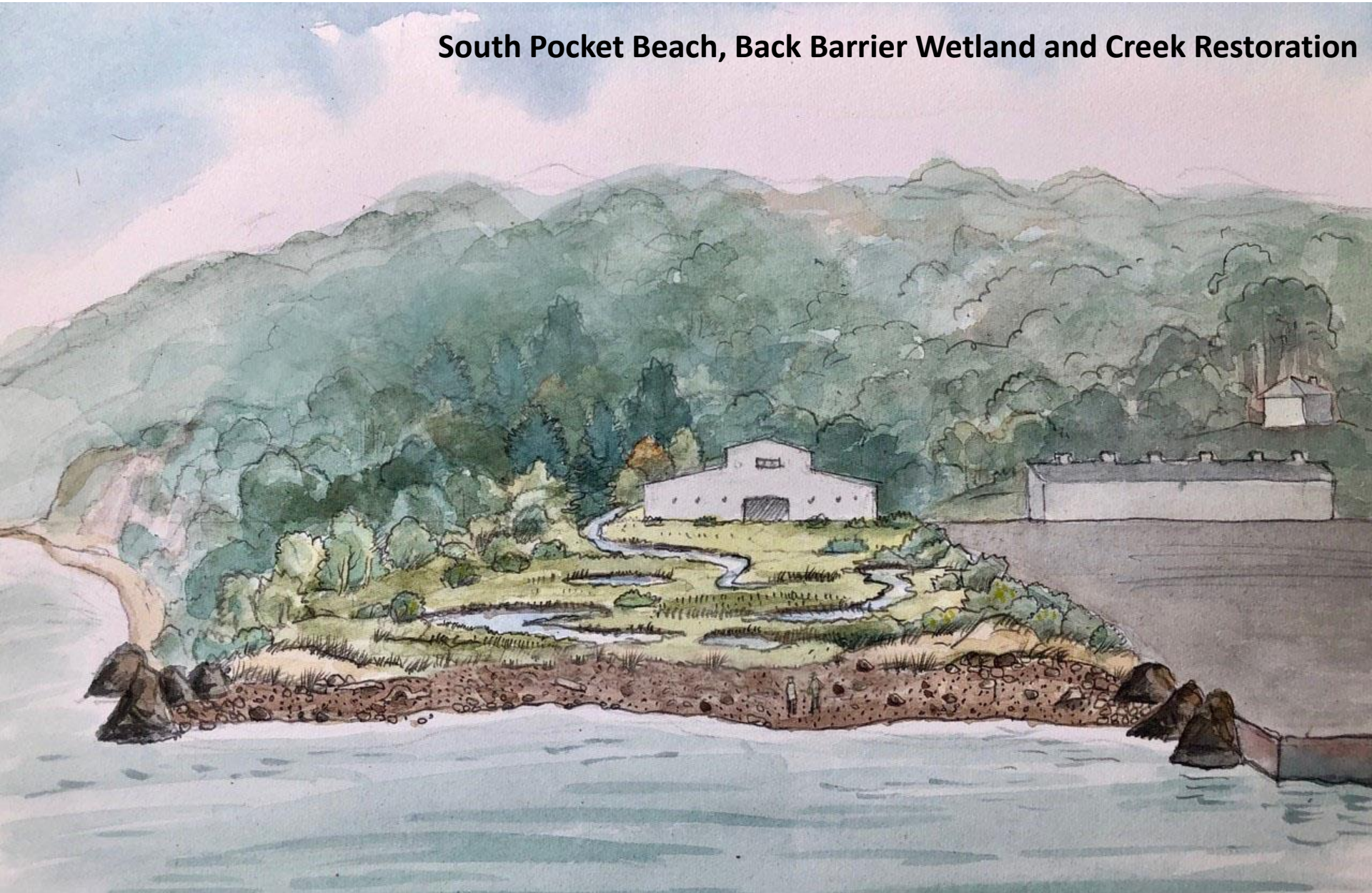
Figure 1. Shoreline Adaptation Pathways South and Central Reaches

Campus Master Plan



*Based off of flood extents provided by Adapting to Rising Tides (ART) and Our Coast Our Future (OCOF) for site

South Pocket Beach, Back Barrier Wetland and Creek Restoration



Opportunity Site 1: South Reach

Concept Description

- Reconnection of southern creek to Bay
- **Coarse-grained beach restoration** using cobble and gravel
- Range of saline to freshwater wetland habitat immediately behind beach berm
- Additional considerations
 - Delta Hall and access road to remain for another 30 years
 - Future flow path of creek may be realigned



Opportunity Site 1: South Reach

Streamflow

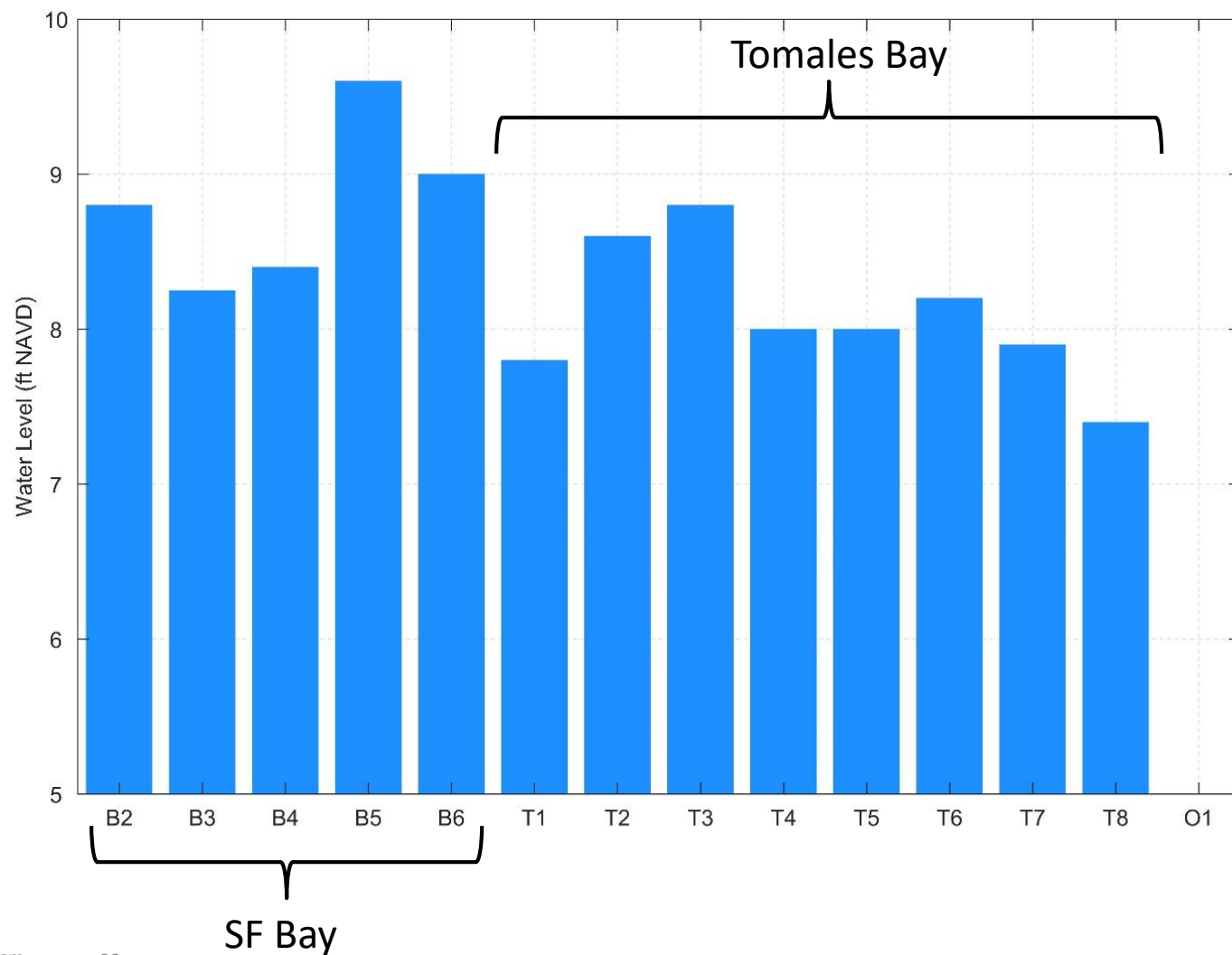
- Approx. watershed size: 44.2 ac
- Peak flows for south creek
 - 2-year: 6 cfs
 - 10-year: 18.8 cfs
 - 100-year: 40.4 cfs
- Sherwood confirmed that StreamStat estimates were similar to HydroCAD model results.



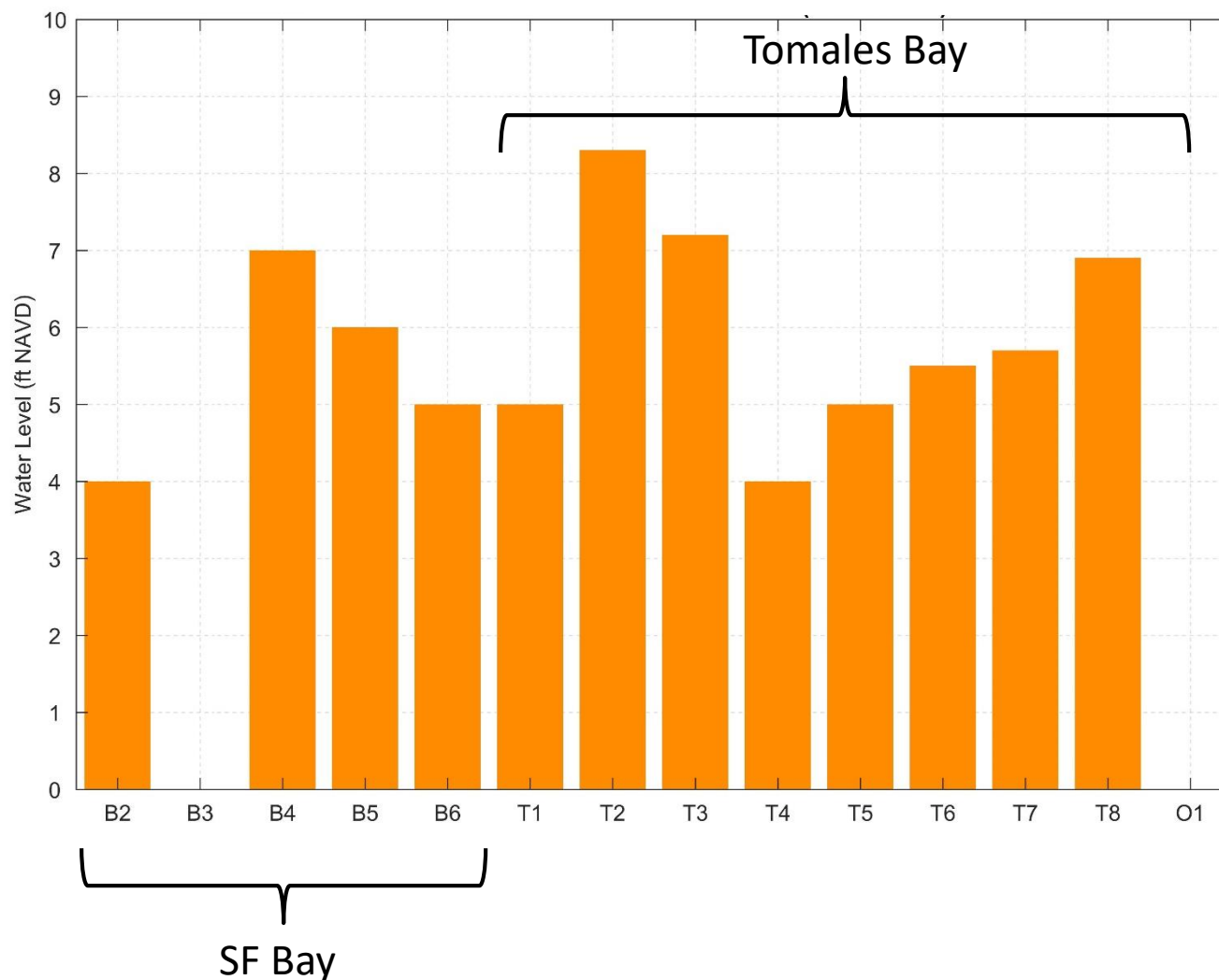
Comparison to Reference Sites

Site #	Site Name	Watershed Size (Acres)	10 yr creek flow (cfs)	Longest Wind Fetch (mi)	FEMA BFE (ft NAVD)	Beach Crest Elev (ft NAVD)	Backbarrier Pond Elev (ft NAVD)
SF Bay Sites							
B1	Project Site	40	19	4	10	--	--
B2	Keil Cove	64	19	8	10	8.8	<6
B3	EOS-Adjacent Beach	--	--	16	12	Bluff toe at 8.25	--
B4	Rat Rock Cove	12	--	10	10	8.4	7
B5	Peacock Gap	256	67	20	12	9.6	<6
B6	Richmond Harbor	--	--	8	--	9	--
Tomales Bay Sites							
T1	Pita Beach	105	23	2	--	7.8	5
T2	Pelican North Beach	128	43	2	10	8.6	8
T3	Duck Cove	68	22	2	--	8.8	7
T4	Indian Beach 1	20	--	4	--	8.0	4
T5	Indian Beach 2	213	75	4	--	8.0	5
T6	Shallow Beach	215	75	2	--	8.2	5
T7	Shell Beach 1	116	41	8	13	7.9	6
T8	Shell Beach 2	18	--	8	13	7.4	7

Reference Sites – Beach Crest Elevation



Reference Sites – Back Barrier Wetland Elevation



Opportunity Site 1: South Reach

Ecology

- Potential species appropriate for brackish marsh fringe behind the cobble and gravel beach berm
 - *Carex praegracilis*
 - *Bolboschoenus maritimus*
 - *Jaumea*
 - *Distichlis spicata*
 - *Juncus arcticus*
- Examples of vegetation that may occupy the highest/driest portion of the marsh gradient
 - *Sarcocornia*
 - *Distichlis spicata*



*Carex praegracilis**
Clustered Field Sedge



*Bolboschoenus maritimus***
Saltmarsh tuber-bulrush



Jaumea carnosa
Marsh Jaumea



Distichlis spicata
Saltgrass



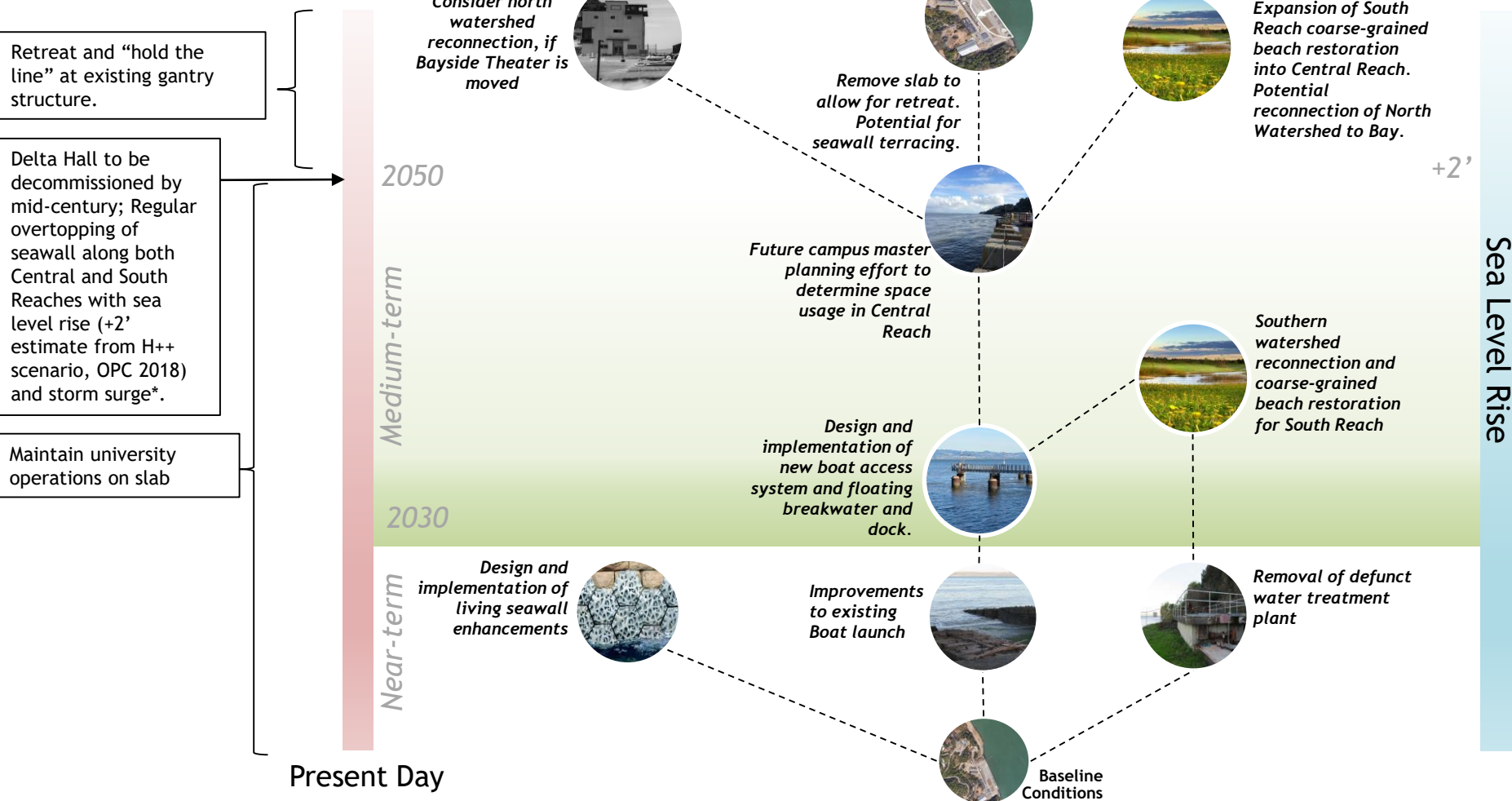
Juncus arcticus
Baltic rush



Sarcocornia
Samphires/saltworts

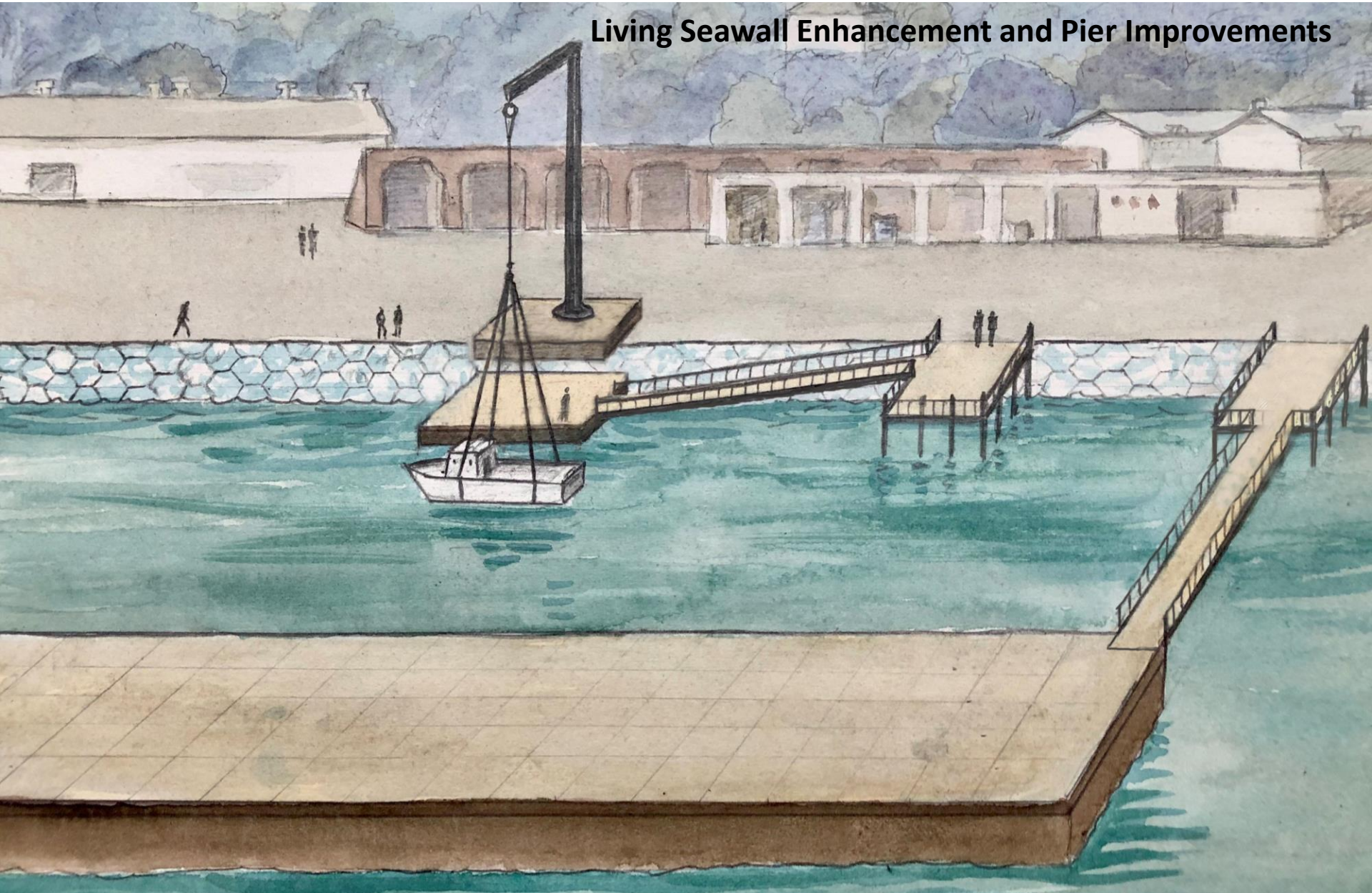
Figure 1. Shoreline Adaptation Pathways South and Central Reaches

Campus Master Plan



*Based off of flood extents provided by Adapting to Rising Tides (ART) and Our Coast Our Future (OCOF) for site

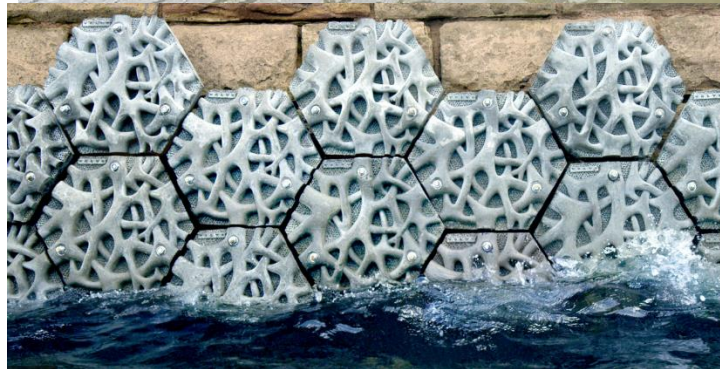
Living Seawall Enhancement and Pier Improvements



Opportunity Site 2: Central Reach

Living Seawall Enhancements

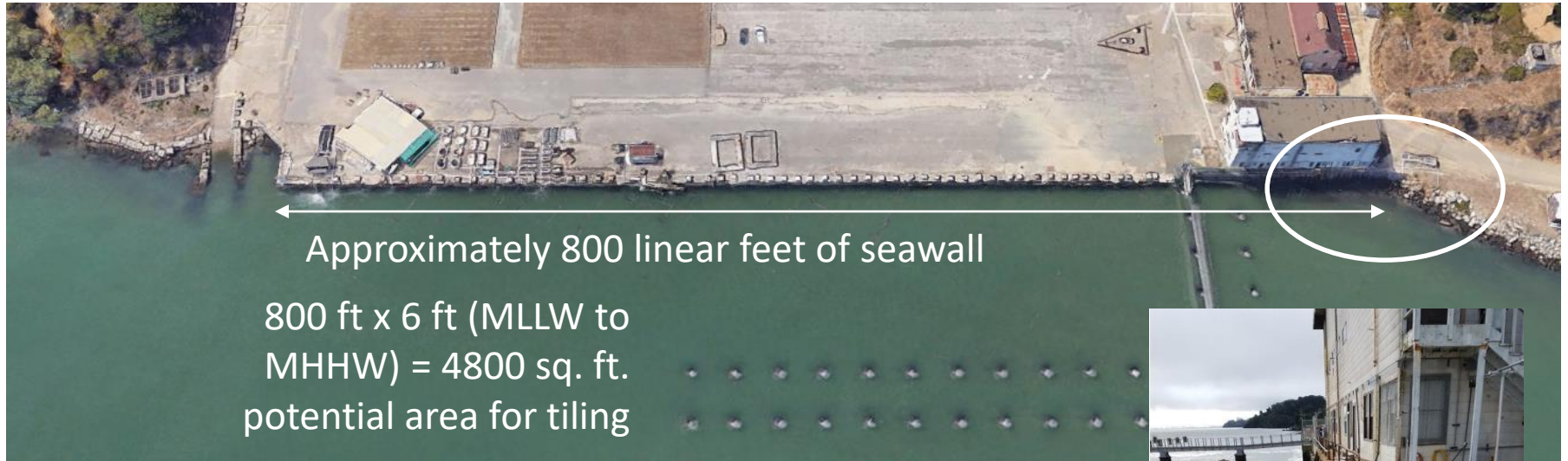
- Living Seawall enhancements in subtidal and intertidal range (between MLLW and MHHW)
- Target species: oysters, *Fucus*, herring breeding, salmonid feeding
- Base of seawall estimated to be lower than MLLW
- Living seawall enhancements from Seattle Seawall project were about 2% of total construction cost, approx. \$125/s.f.



Source: Volvo Living Seawall

Opportunity Site 2: Central Reach

Living Seawall Enhancements



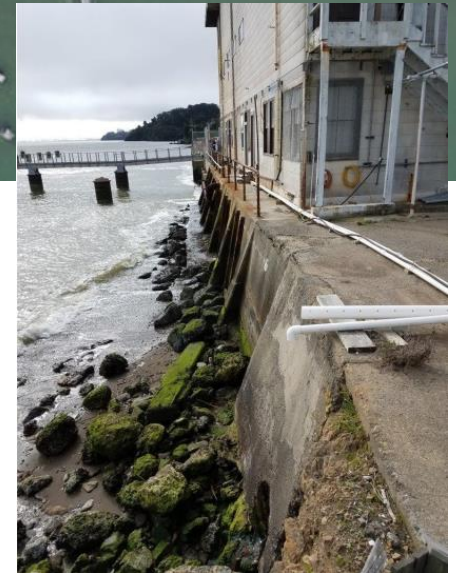
MHHW

Intertidal range –
salmonid feeding
(MLLW → MHHW)

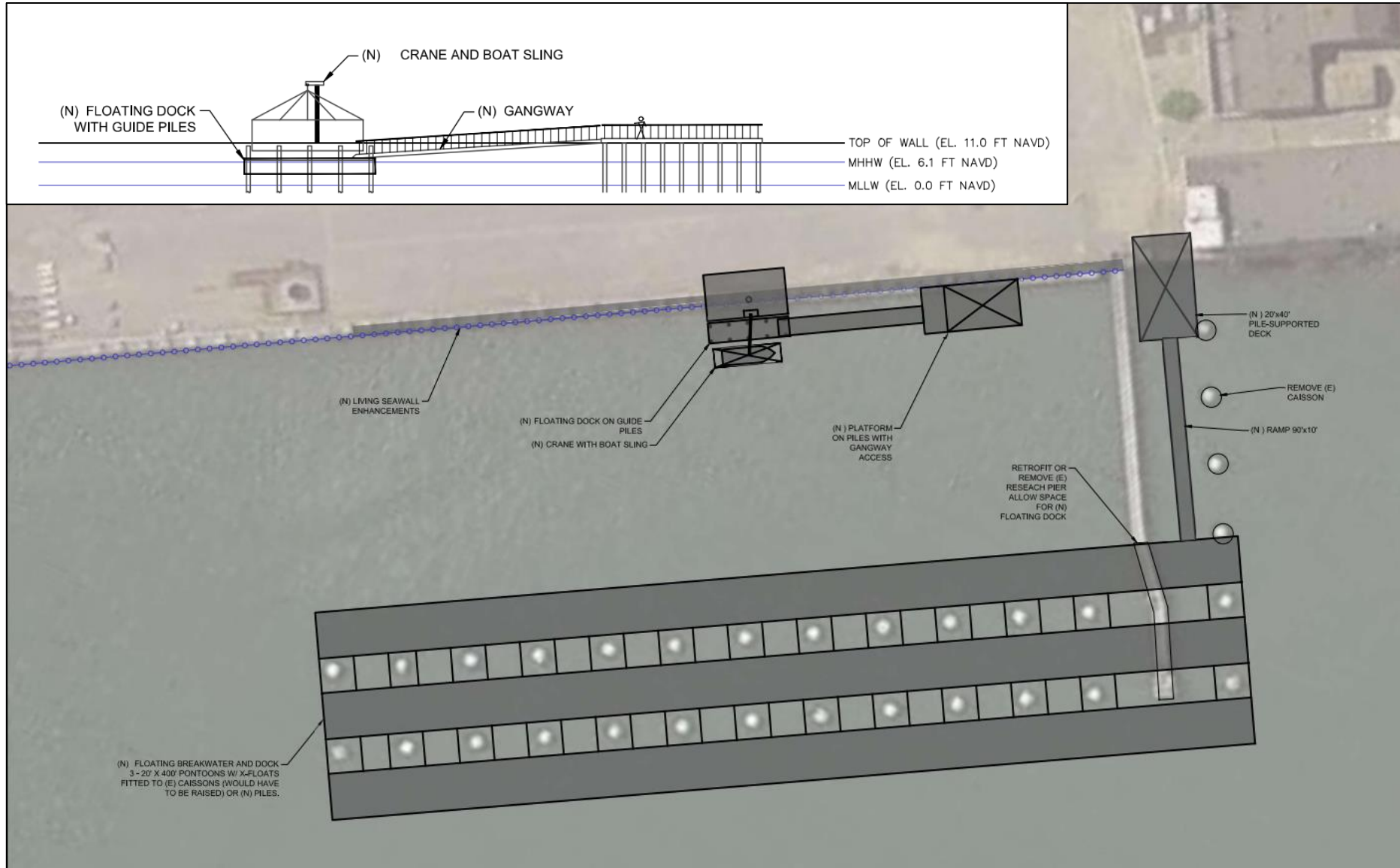
MLLW

Oyster recruitment (-1'
to +1' MLLW)

Area of seawall by
historic theater
favorable for initial pilot
test– access from field
area onto beach/rubble



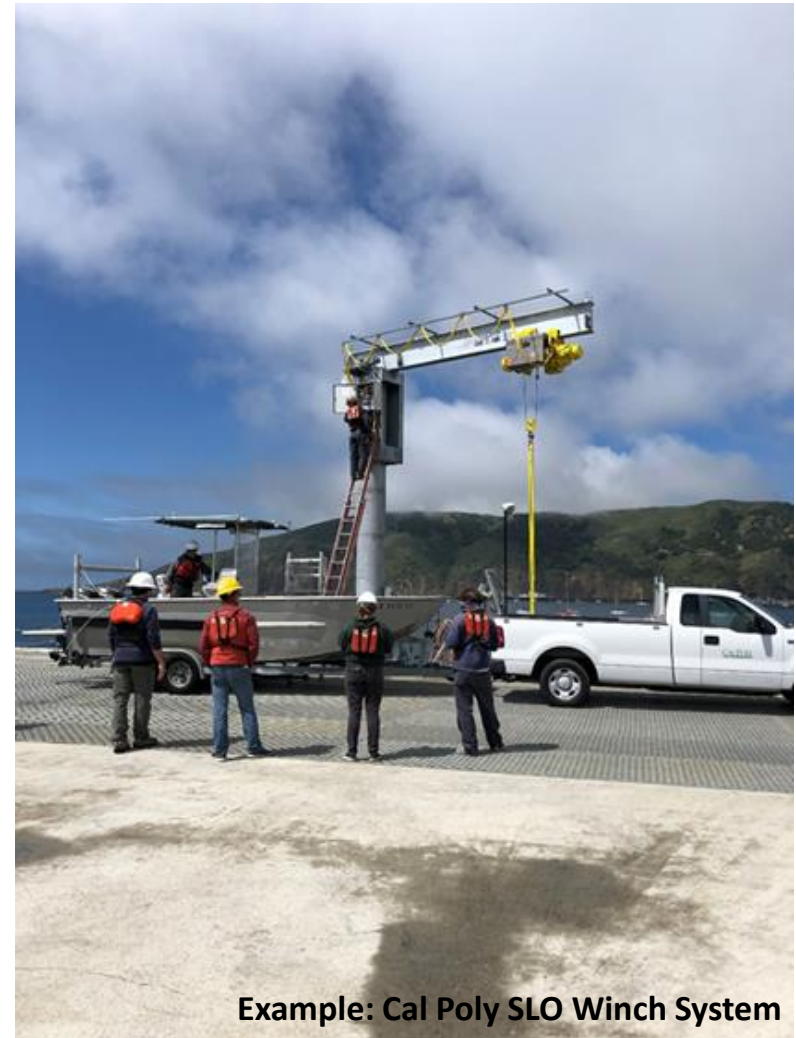
Opportunity Site 2: Living Seawall Enhancements and Pier Improvements



Opportunity Site 2: Central Reach

New Boat Access System

- Winch System with Floating Docks
 - Expected usage during Spring/Summer (research)
 - Safe harbor for small vessels via pier/wharf enclosure
 - Improvements to existing caissons (lateral bracing)
- Near-term Boating Improvements
 - Improve existing boat ramp by widening and setting back slope
 - Interim solution (~10 yrs) while SFSU procures funding for new boat system



Example: Cal Poly SLO Winch System

Long-Term Vision for the South + Central Reaches

Beyond 2050

- Future sea level rise conditions may warrant further retreat of the slab edge to central gantry structure
- Southern creek flow path can be naturalized after removal of Delta Hall.
- Potential to expand footprint of coarse-grained beach restoration.
 - Recreate historic cove



North Pocket Beach Restoration and Recreational Field Shoreline Protection

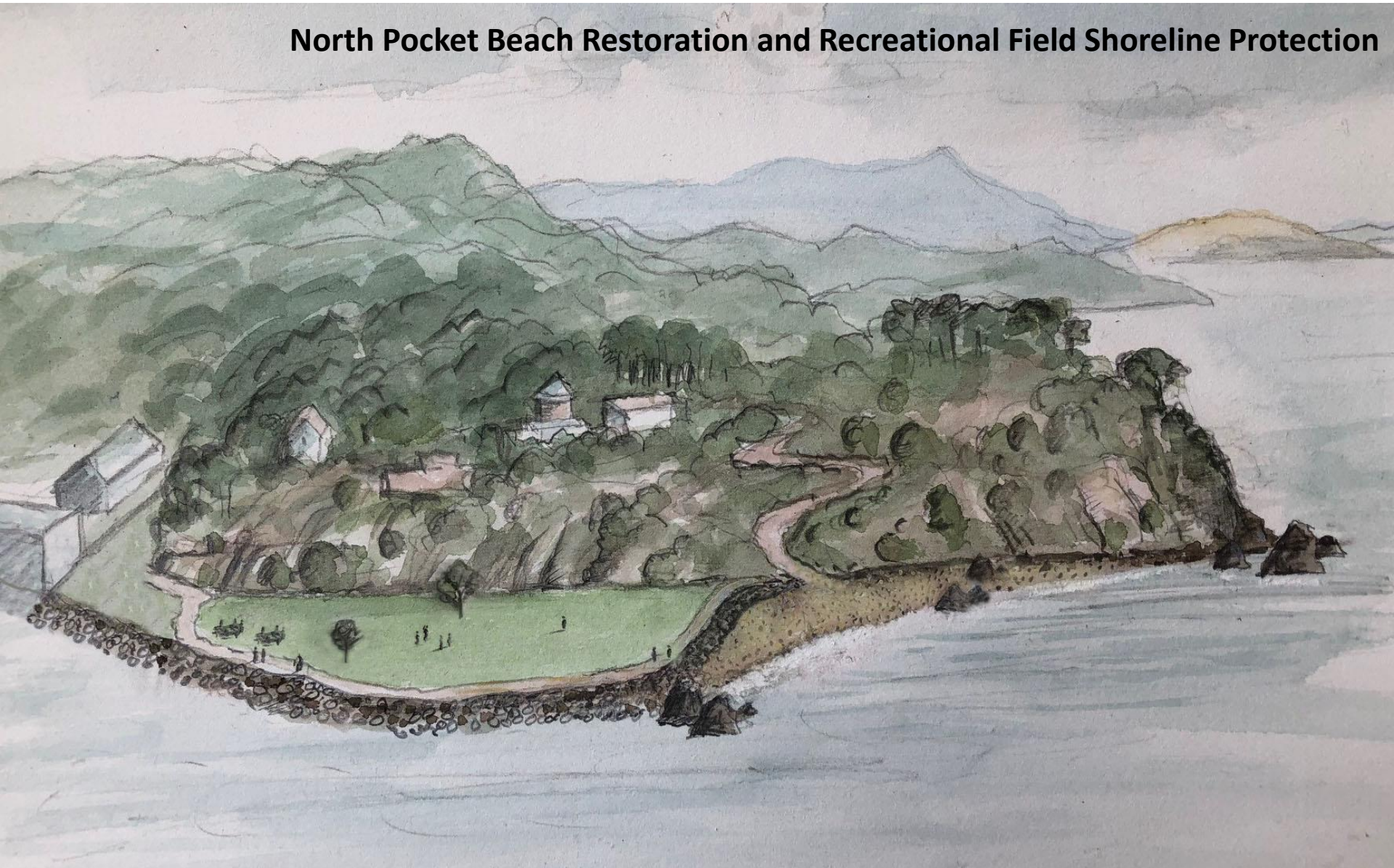
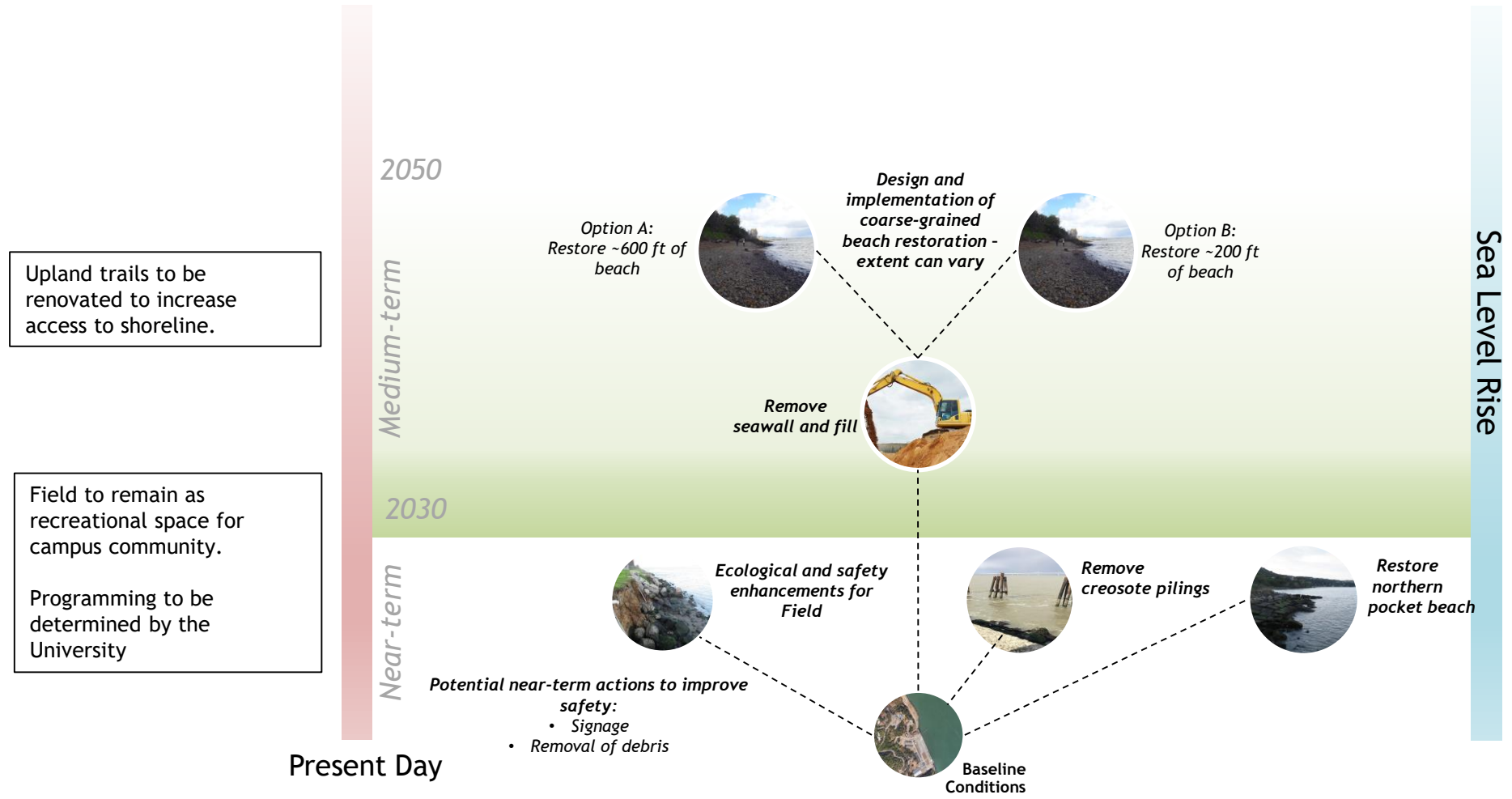


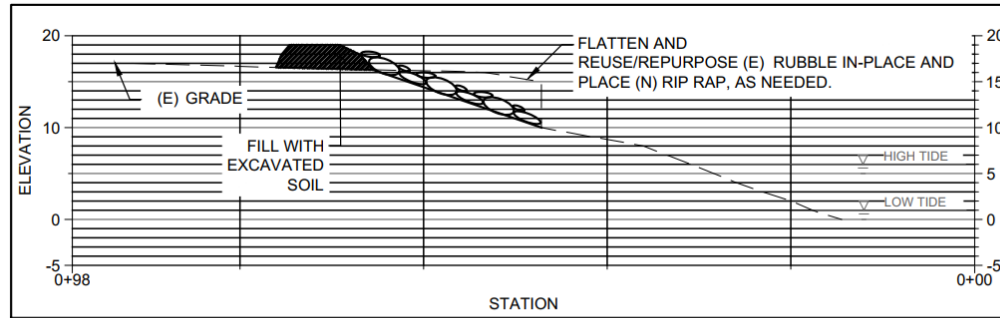
Figure 2. Shoreline Adaptation Pathways North Reach

Campus Master Plan



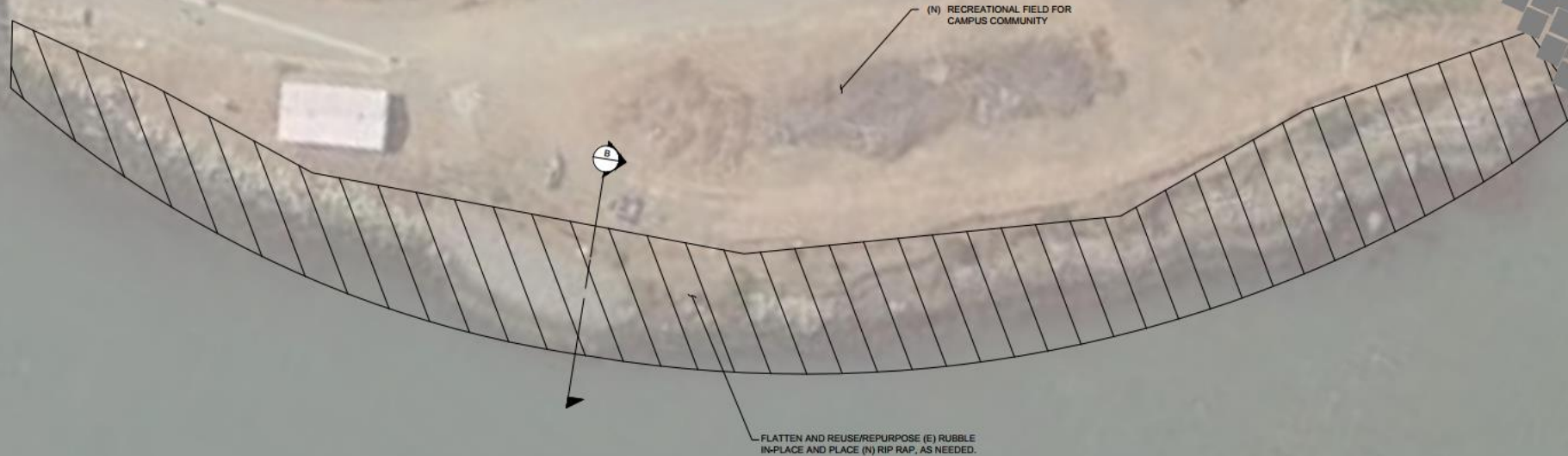
Opportunity Site 3: North Reach

Recreational Field Shoreline Stabilization



B ROCK REVETMENT SHORELINE SECTION
SECTION
SCALE: 1"=10'

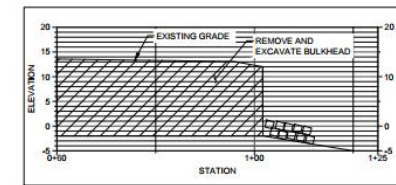
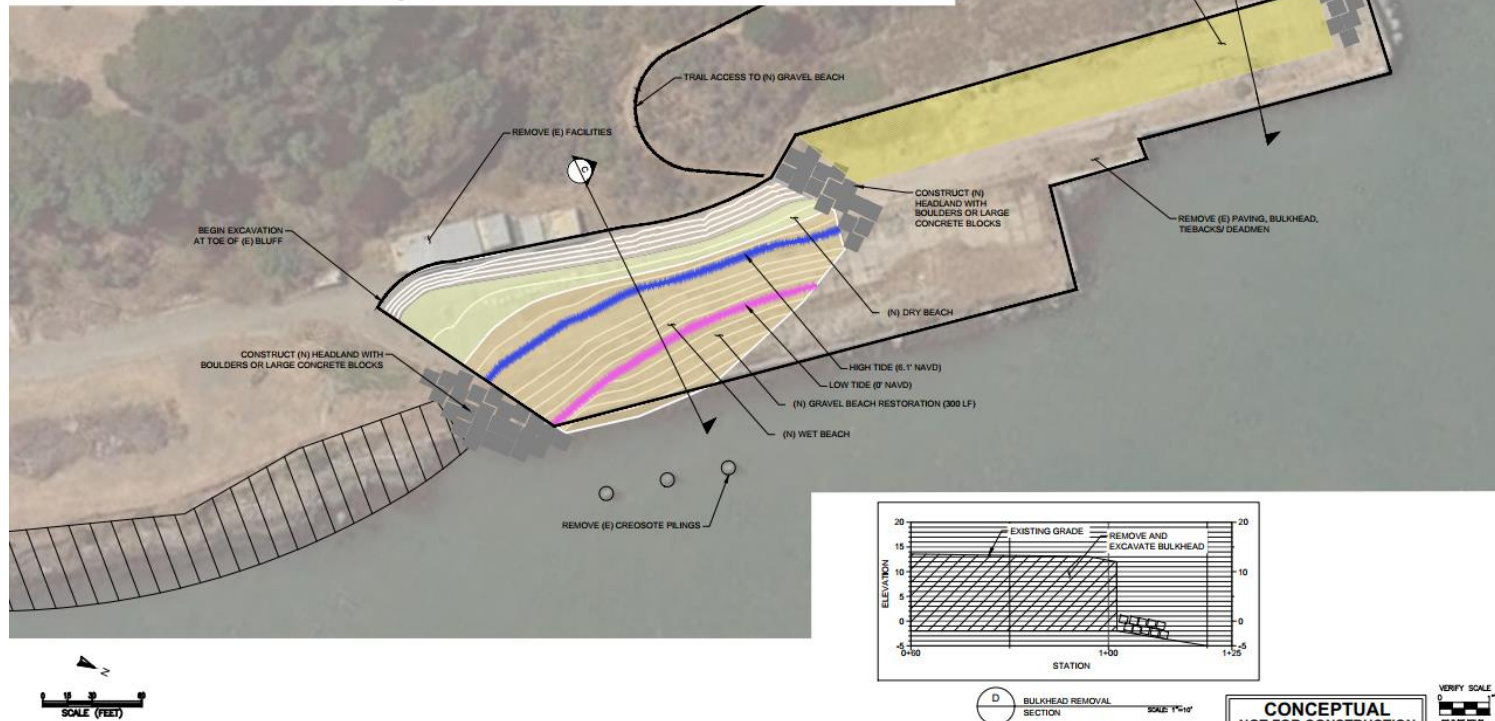
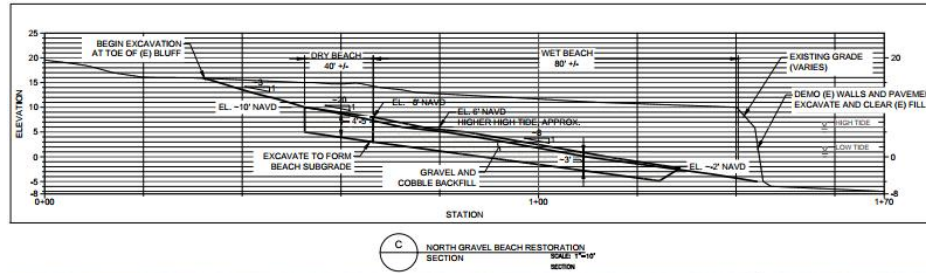
Lay back shoreline edge (existing scarp) to create gentler slope and stabilize shoreline using existing rubble, boulders and concrete weights.



Opportunity Site 3: North Reach

Coarse-Grained Beach Restoration

- Removal of seawall structure and excavate fill – approx. 35,000 cy
- Cobble and gravel beach restoration (300 ft) along southern edge of existing seawall and historic bluff edge
- Opportunity for passive accretion beyond headland
- Allow for retreat and future sea level rise



D BULKHEAD REMOVAL SECTION SCALE 1"=10'

CONCEPTUAL
NOT FOR CONSTRUCTION

Recommended Near-Term Actions (Next 10 Years)

- Central & South Reach
 - Improvements to existing boat launch
 - Conduct bathymetry survey between existing piles and Central seawall
 - Removal of defunct water treatment plant
 - Installation of living seawall enhancements to seawall
- North Reach
 - Geotechnical analysis for seawall and coring recommended for fill in field and behind seawall
 - Ecological and safety enhancements to the Field area
 - Removal of remnant creosote pilings

Conceptual Cost Estimates

- ROM estimates developed based off of preliminary quantities, presented in 2020 USD
- Assumed to be approximately -30% to 50% accurate and include a 35% design contingency.

Item #	Description	Extended Price
1	South Pocket Beach, Back Barrier Wetland Creation and Enhanced Creek	\$2,200,900
2	Living Seawall Enhancements	\$625,000
3	Pier Improvements	\$4,680,000
4	Recreational Field Shoreline Enhancements	\$889,500
5	Gravel Beach and Shore Restoration	\$2,433,800
6	Mobilization	\$1,082,920
7	Environmental Protection	\$541,460

Rounded Total: \$16,820,000

Note: This opinion of probable construction costs is based on: ESA project experience, bid prices from similar projects, consultation with contractors/supplies, R.S.Means online and the ENR Cost Index Tables. Please note that in providing opinions of probable construction costs, ESA has no control over the actual costs at the time of construction.

Break (10:45 – 11:00 am)

Group Discussion & Q&A – General Questions

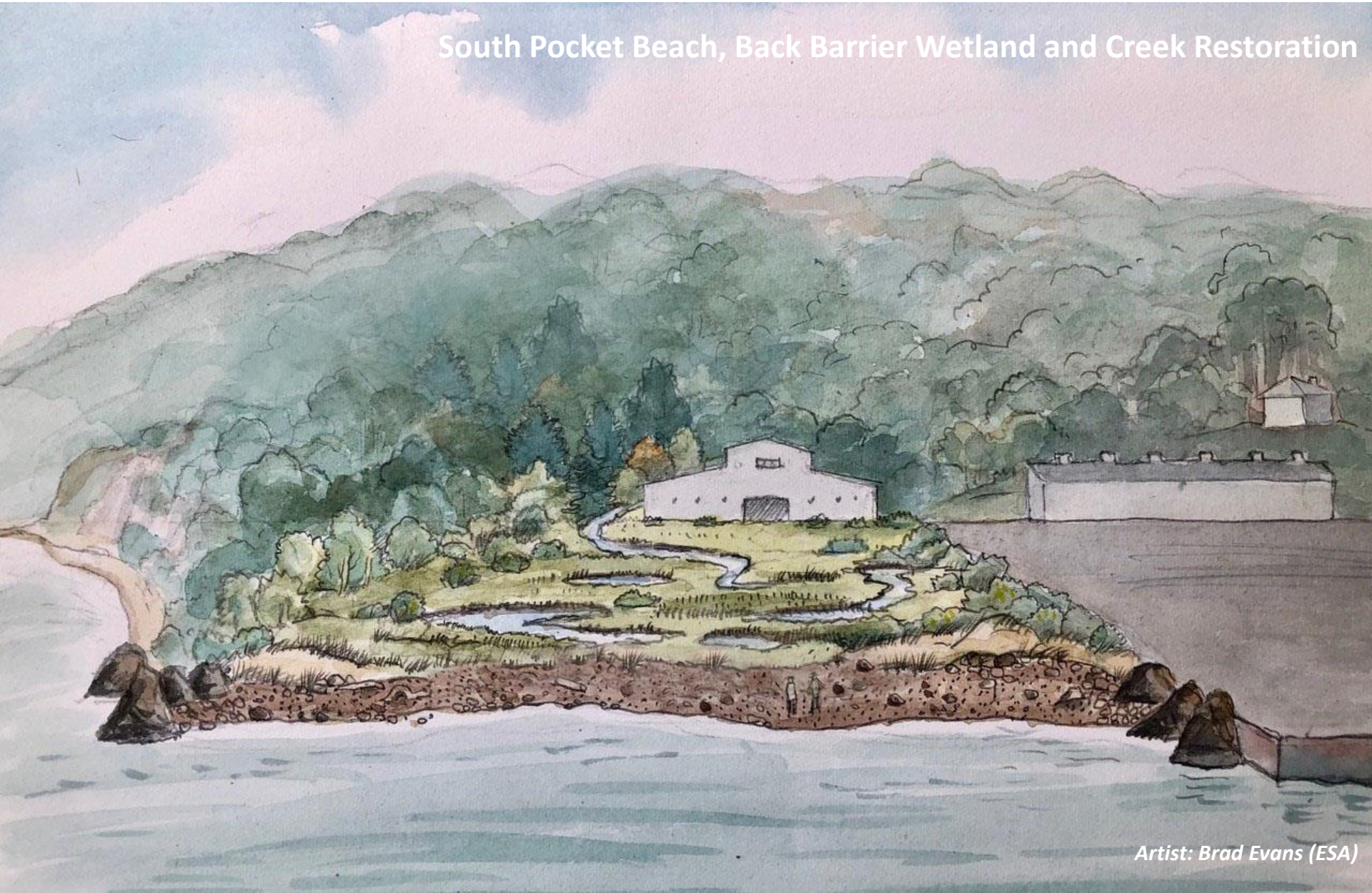
- What modifications would you suggest to increase the ecological (recreation, education, or other) benefits provided by the concepts?
- What measures could increase resilience of these concepts to climate change?
- How can we use the site to learn and pilot approaches that will have application elsewhere?
- Do the proposed concepts for the medium-term and long-term future of the campus seem consistent with your understanding of the site and overall campus master plan?

Group Discussion & Q&A – South and Central Reaches

(11:00 – Noon)

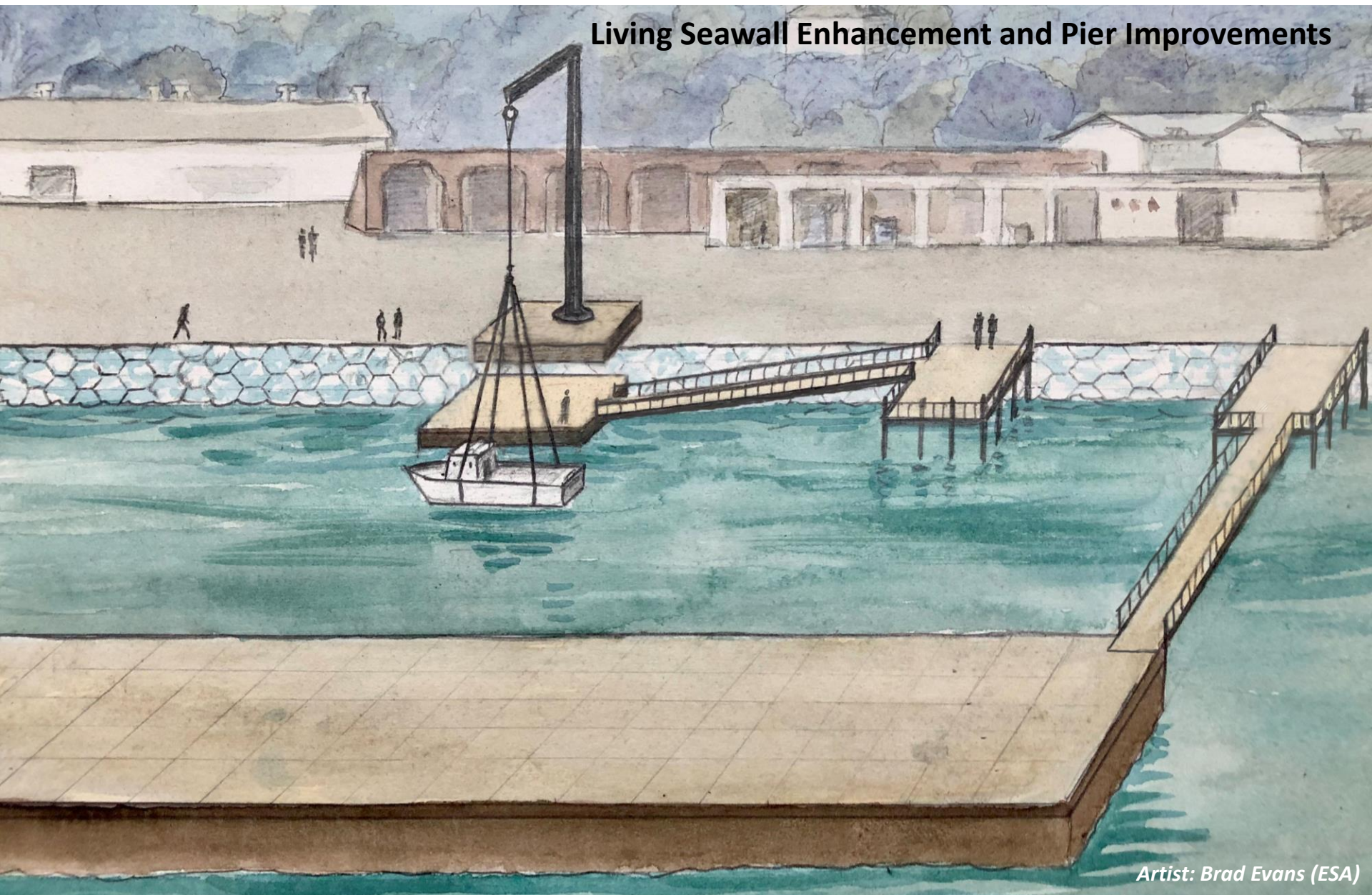
- What ecological uses can the fill sourced from the excavation/demo of the slab be used for?
- What ecology is desired in the habitat behind the gravel beach? What mix of open water, wetlands and riparian. Any target plant communities?
- Are there any other potential for reuse of the concrete weights? E.g. examples of projects where this has been done

South Pocket Beach, Back Barrier Wetland and Creek Restoration



Artist: Brad Evans (ESA)

Living Seawall Enhancement and Pier Improvements



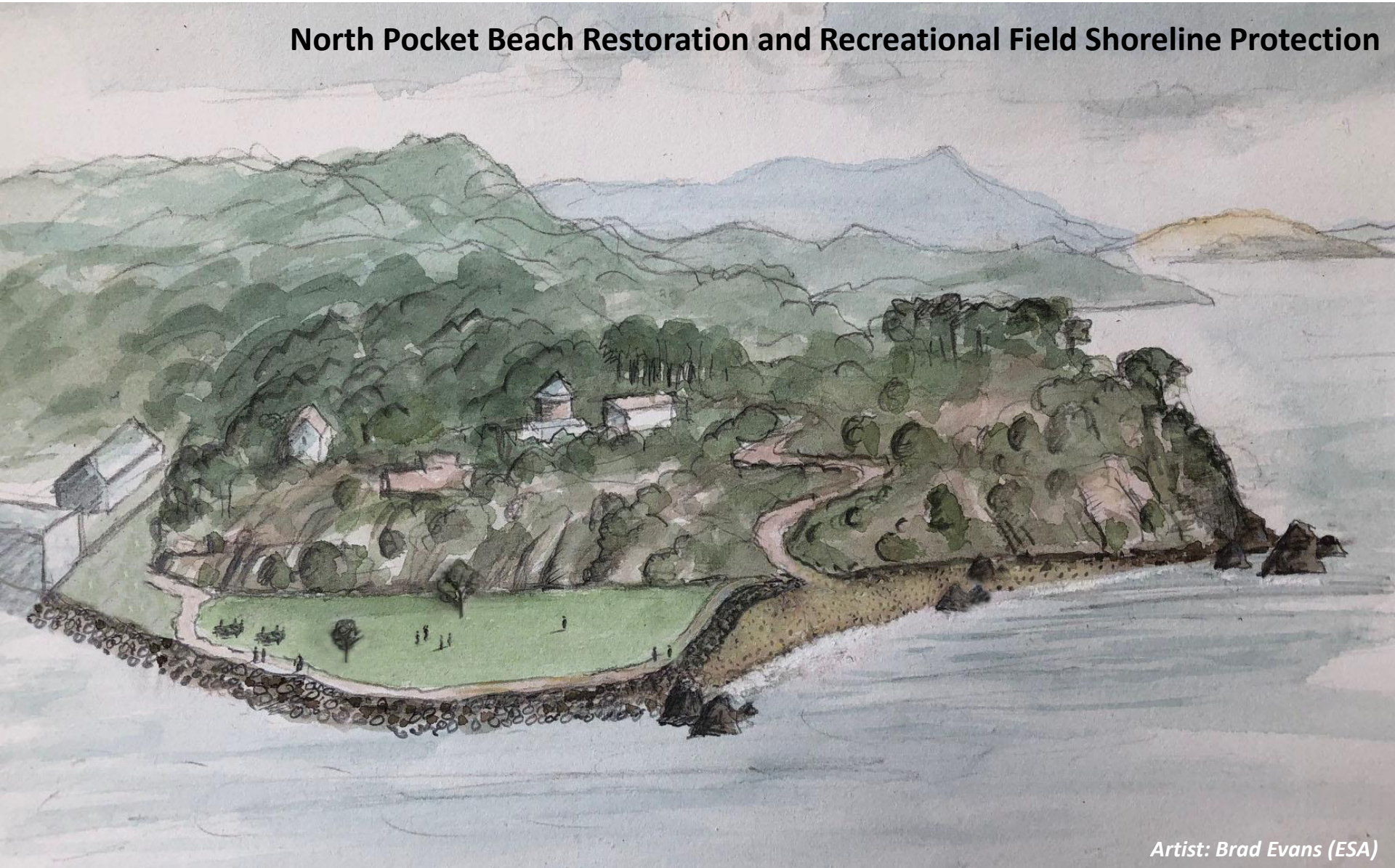
Artist: Brad Evans (ESA)

1989-2019

Group Discussion & Q&A – North Reach (11:00 – Noon)

- If the fill behind the seawall is clean earth (e.g. from the adjacent hillslope) what ecological uses can this fill be used for?
- Do you have recommendations for ecologically enhancing or modifying rip rap for the field area shoreline?
- Should we consider alternatives to rip rap?

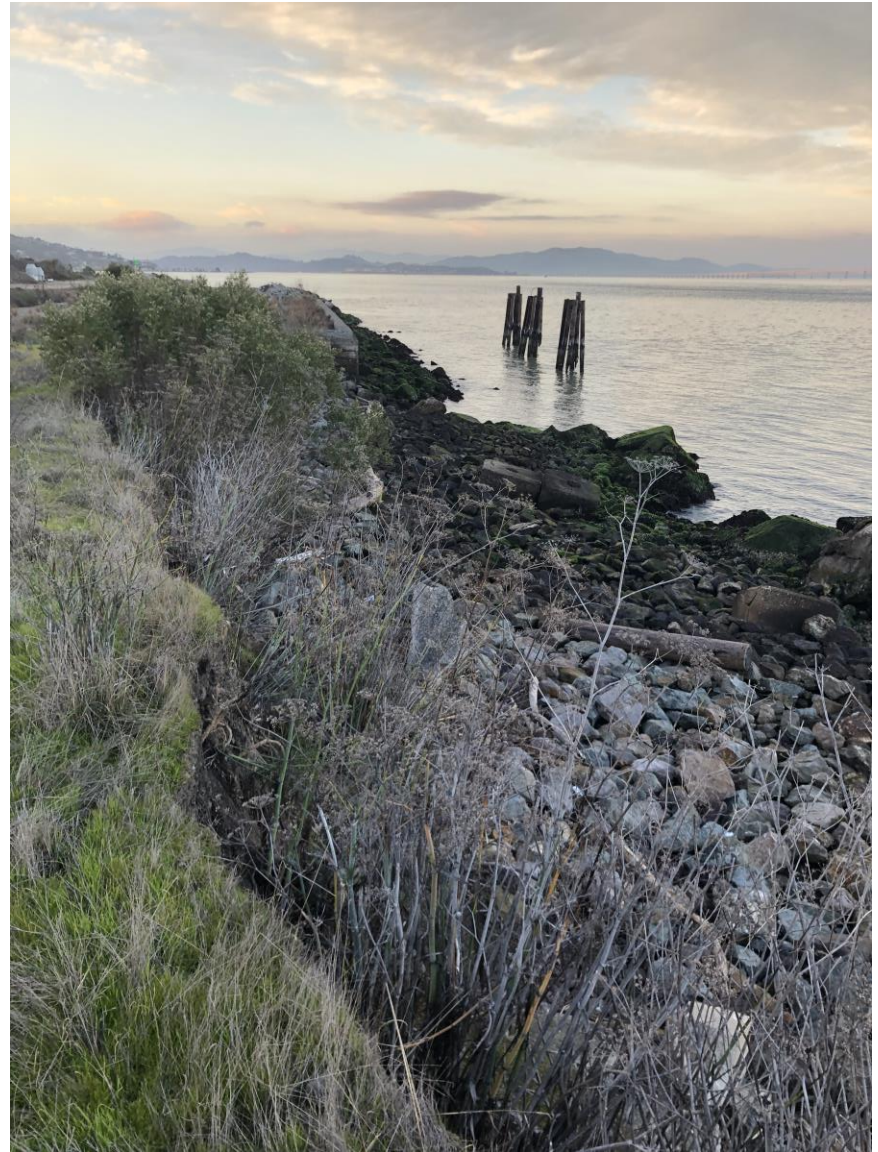
North Pocket Beach Restoration and Recreational Field Shoreline Protection



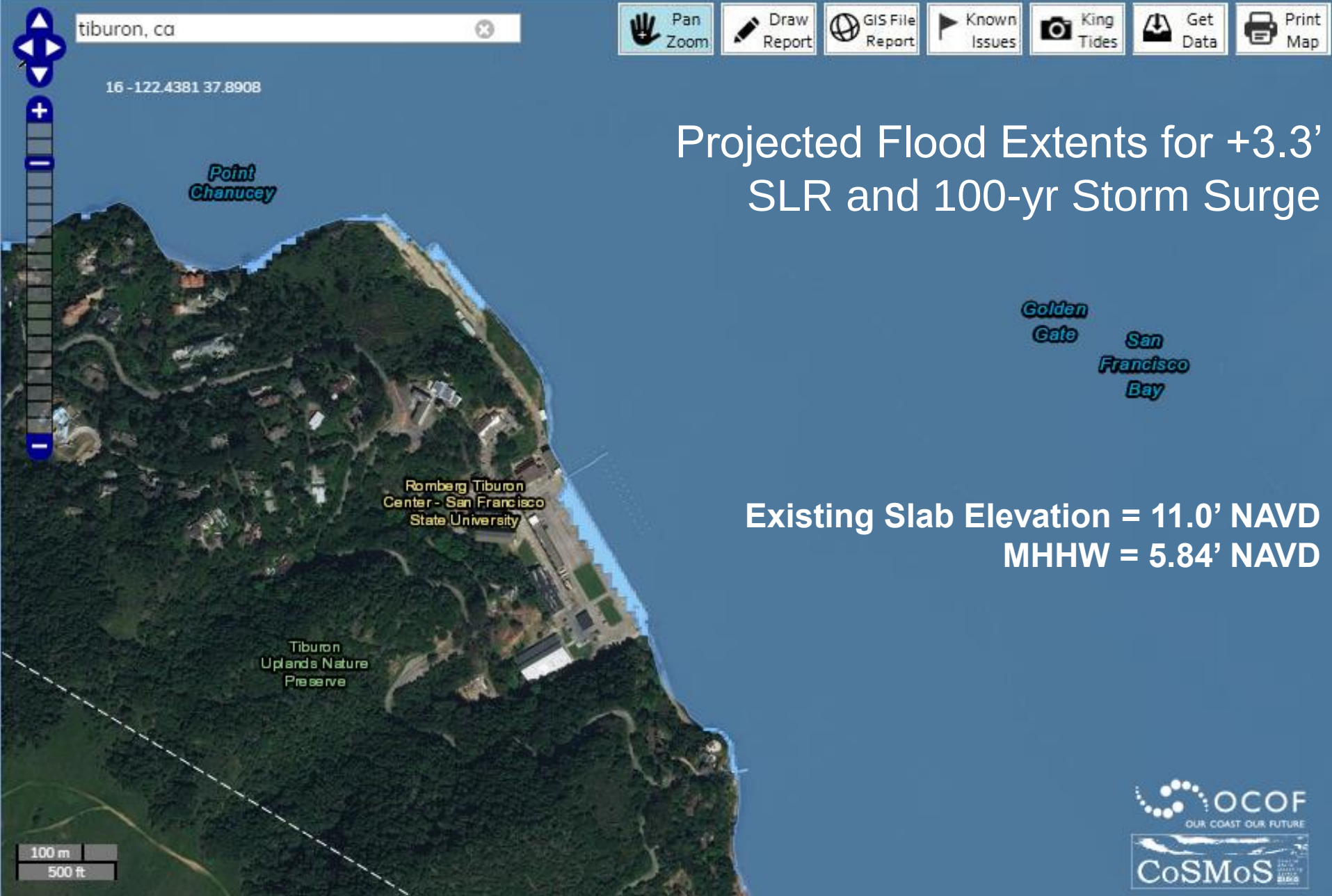
Artist: Brad Evans (ESA)

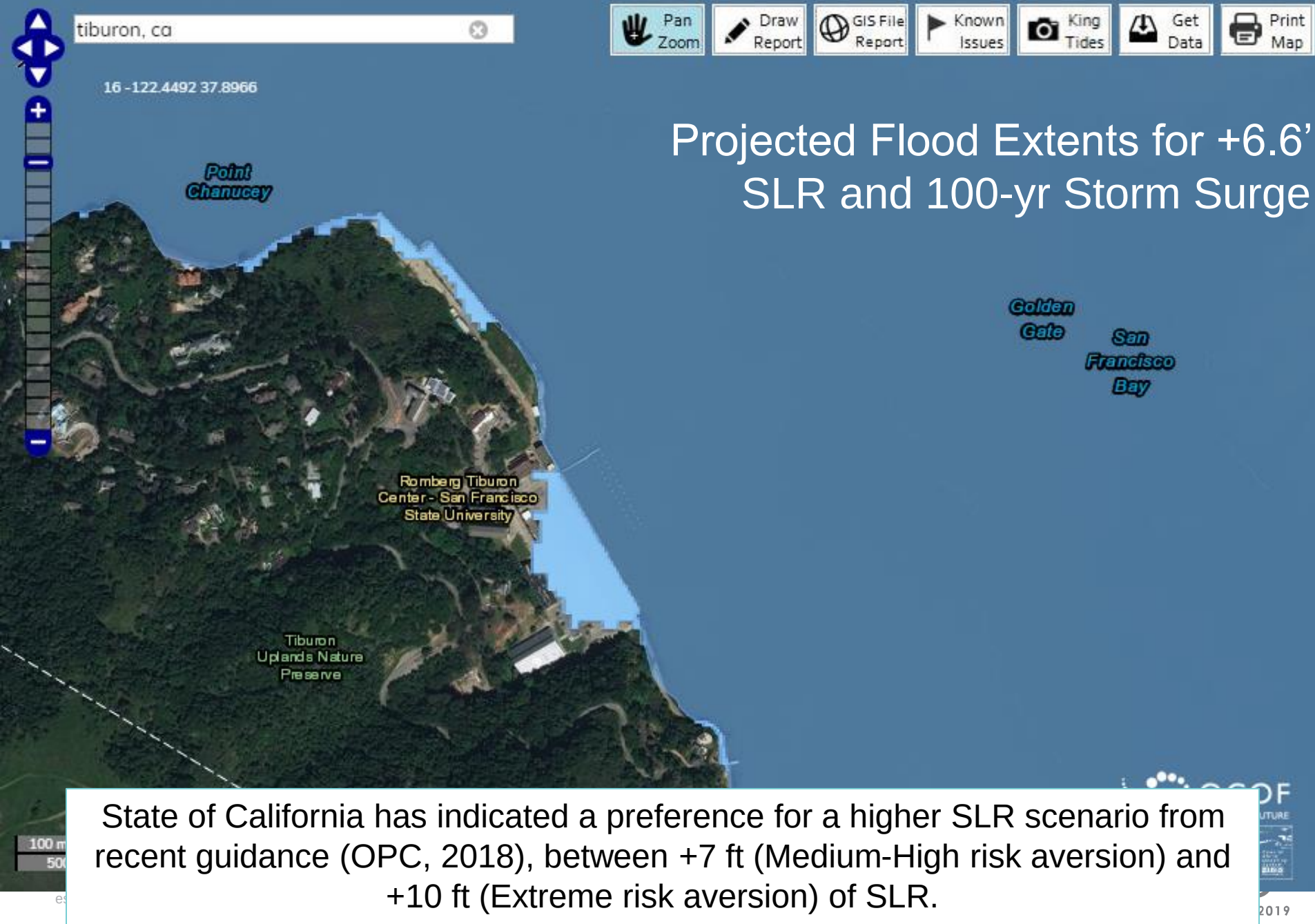
Next Steps

- Refinements to conceptual design for South, Central and North Reaches based on input collected at today's workshop
- Conceptual Design Report – Spring 2020
 - Draft to be distributed for comment before final report

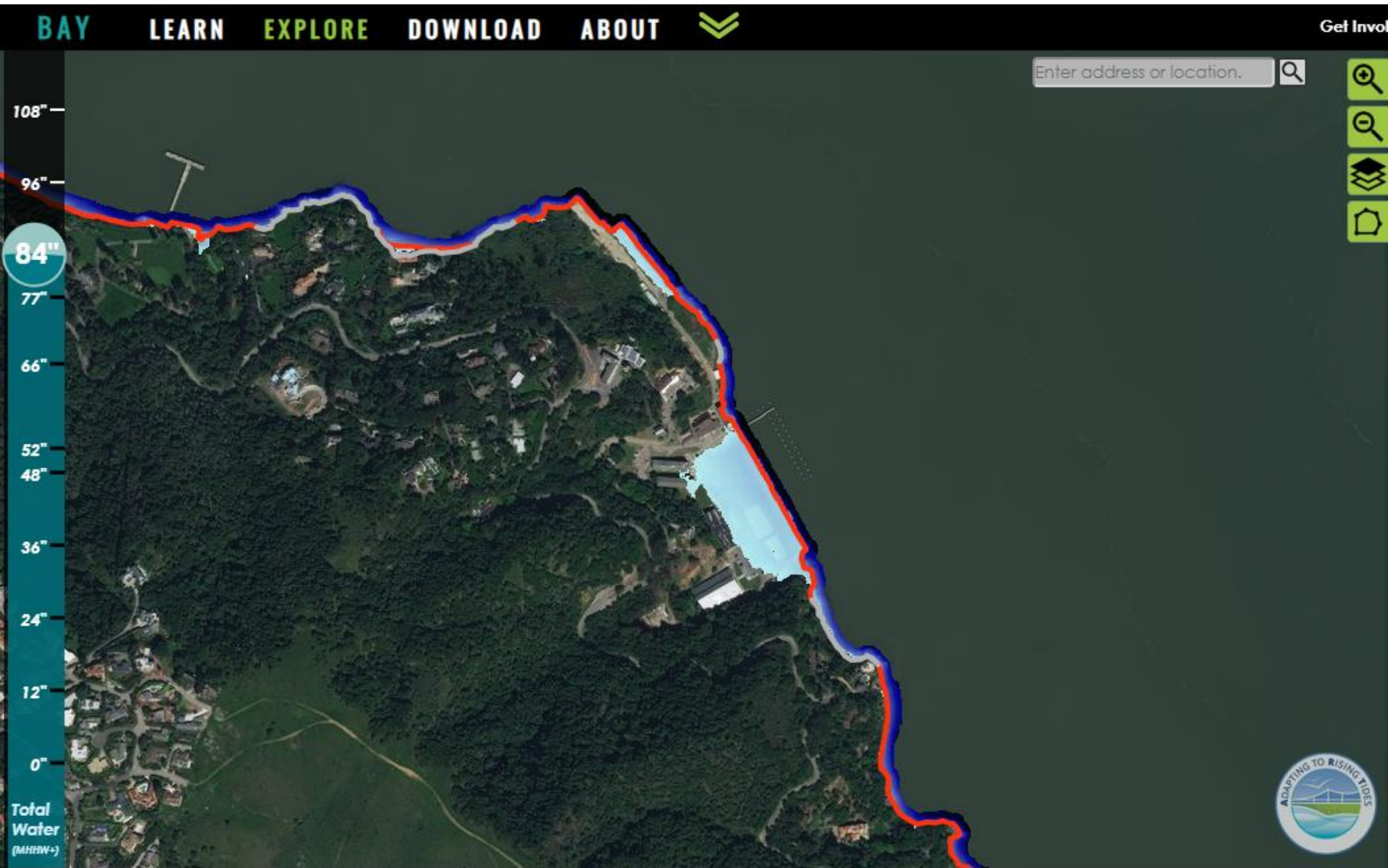


Additional Slides





Projected MHHW Flood Extent for +7' of Sea Level Rise



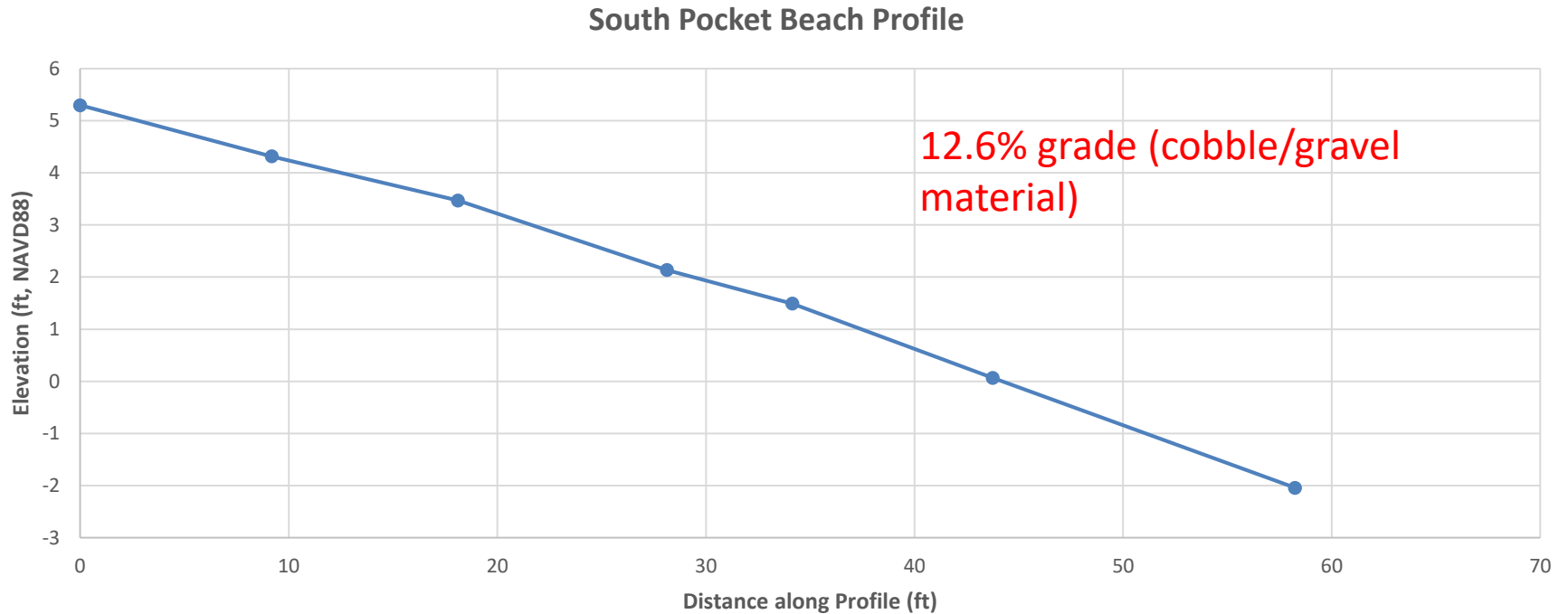
Reference Sites – South Pocket Beach



Photo: ESA (2019)

Reference Site

South Pocket Beach Profile



Reference Sites – North Pocket Beach



Photo: Karina Nielsen (2019)

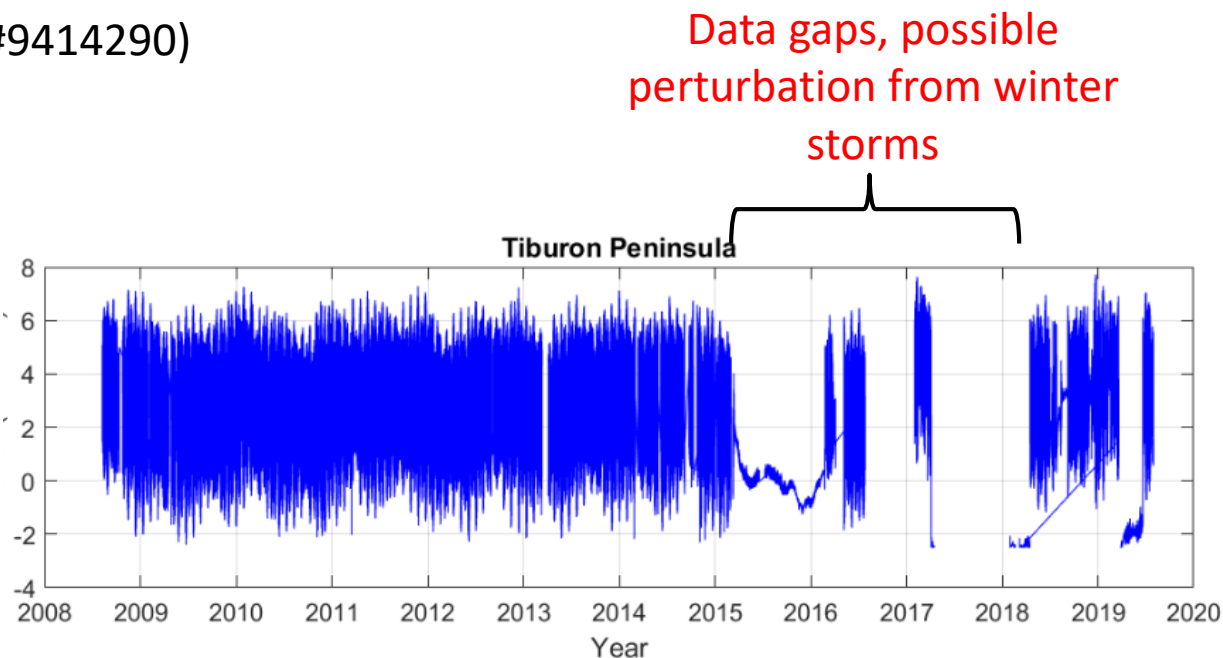
Tides

- Tide data available at SFSU's research pier (TIBC) – sonde installed approx. 1 m below MLLW
- Longer record available from NOAA Richmond (Station # 9414290) from 2008-present
 - Closest station with tidal benchmarks at NOAA Golden Gate (Station #9414290)

Table 1. Tidal Datums for NOAA Station #9414290

Datum	Value	Description
MHHW	5.84	Mean Higher-High Water
MHW	5.23	Mean High Water
MSL	3.12	Mean Sea Level
MLW	1.13	Mean Low Water
MLLW	0.00	Mean Lower-Low Water
NAVD88	-0.06	North American Vertical Datum

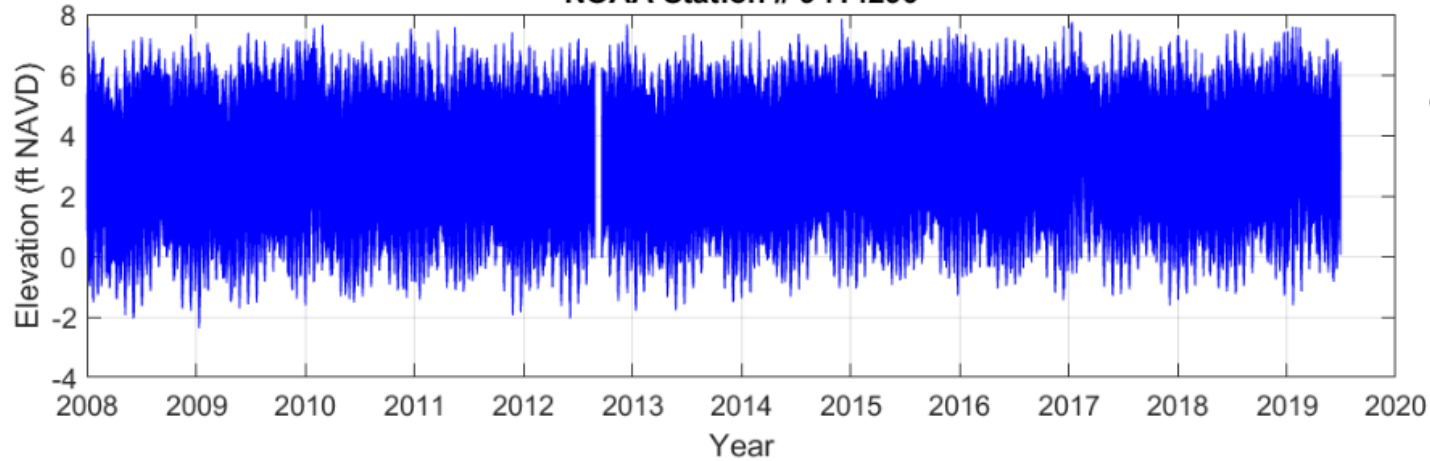
Unit (ft)



Tides

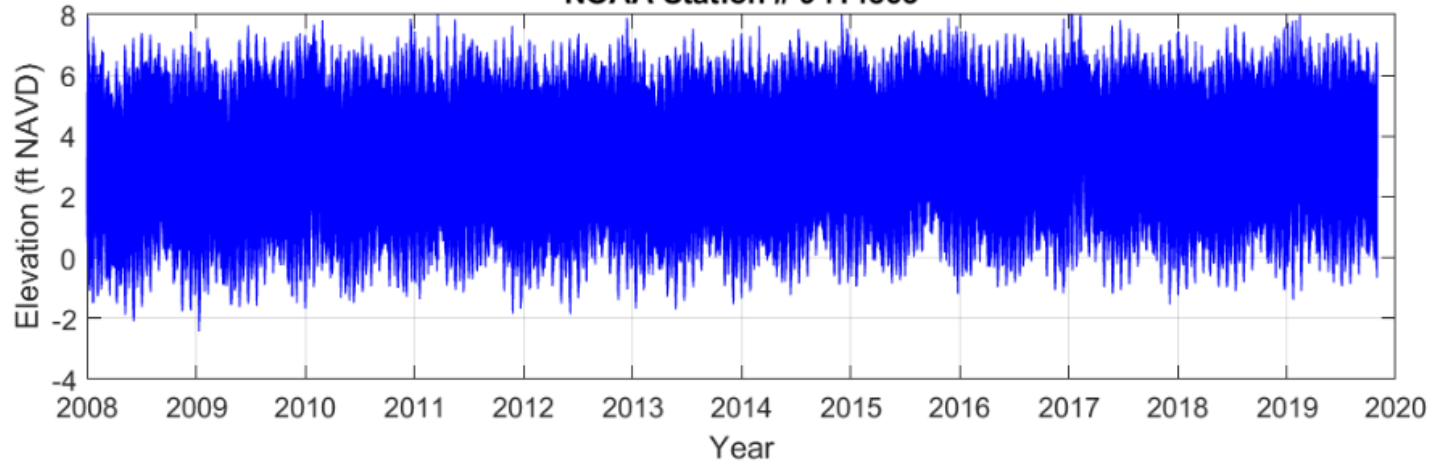
Comparison with NOAA Golden Gate and Richmond Stations

NOAA Station # 9414290



Golden Gate

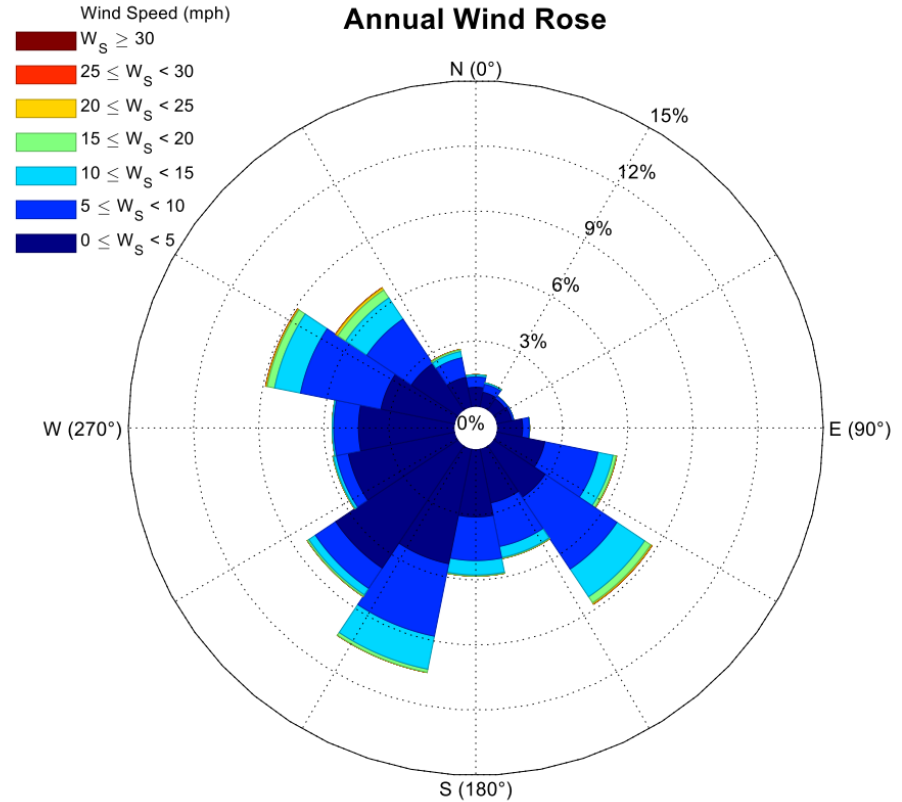
NOAA Station # 9414863



Richmond

Wind Climate

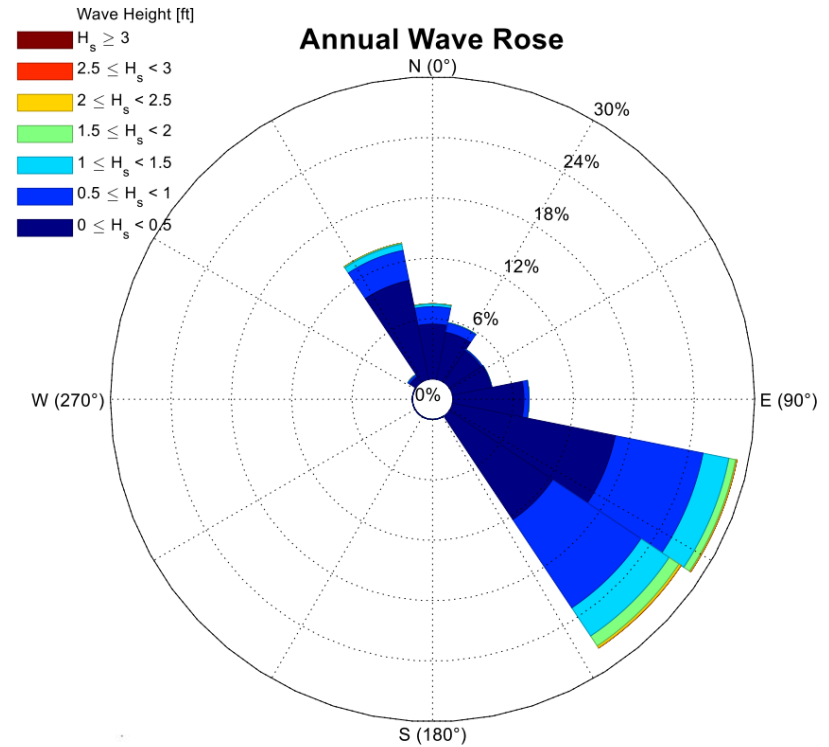
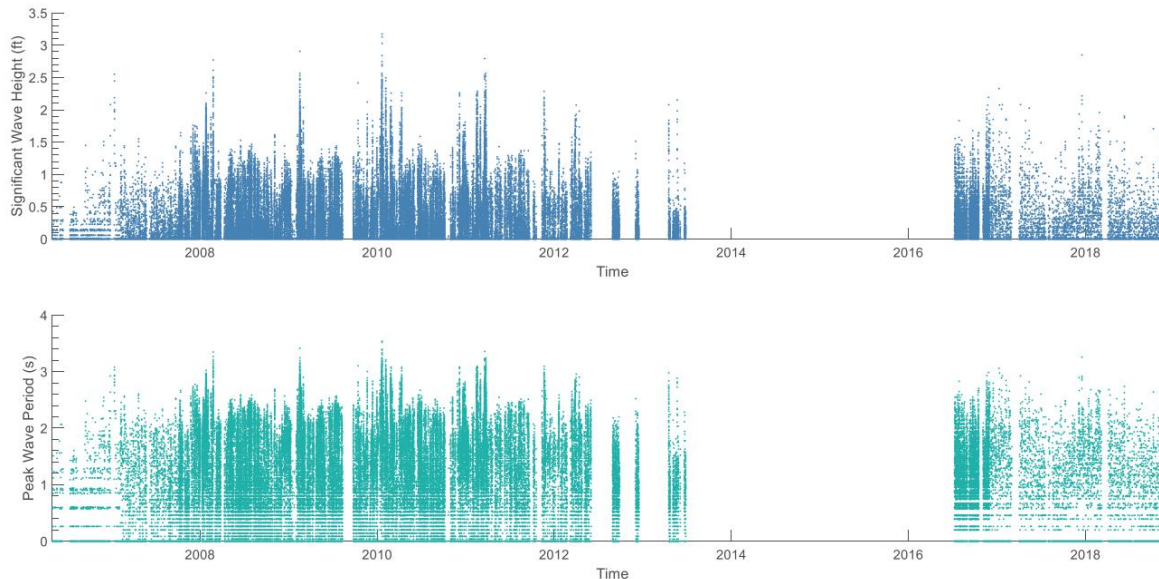
- Annual wind rose evaluated from data collected at SFSU's research pier (NOAA TIBC1)
 - 2006-2018 record
- Three primary directions for winds at the Tiburon site – SW, SE and NW
 - 1/3 of winds arrive from SW
- Maximum wind speeds observed arrive from the SE (corresponds with winter storms)



Wave Climate

Wind-Generated Waves

- Wind-wave generation to estimate wave height and wave period, based on wind record available at NOAA TIBC
 - USACE Coastal Engineering Manual
- Waves > 2 ft height arrive predominantly from the SE (storm events)



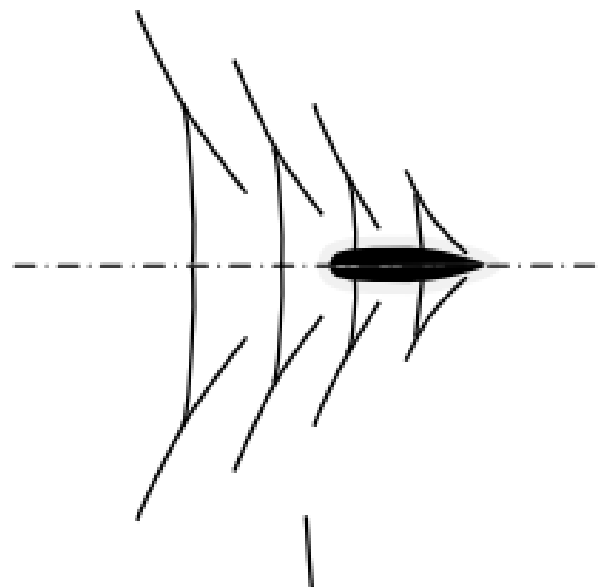
50-year design wave height of 4.3 ft, period of 5.2 sec

(Based off of extreme wind analysis from OAK Airport record)

Wave Climate

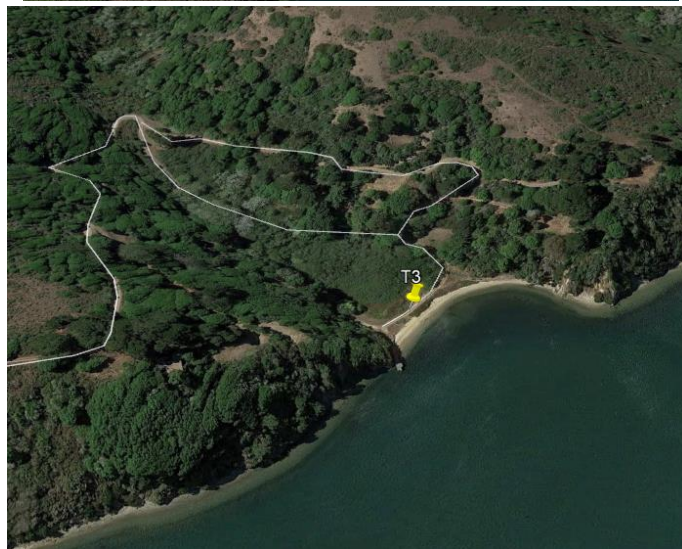
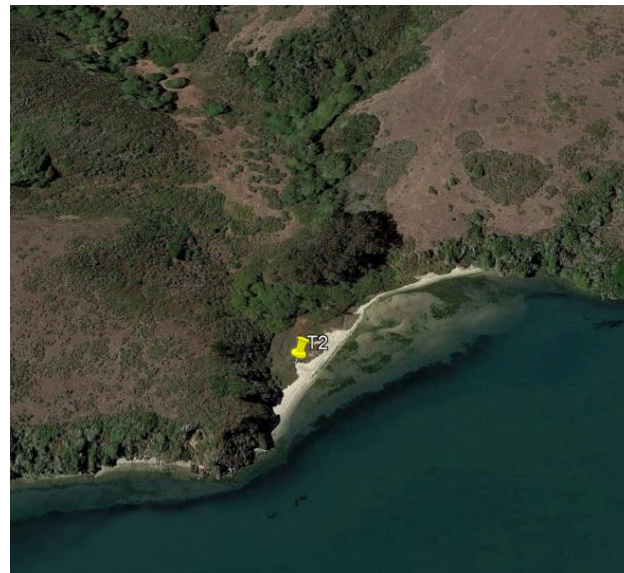
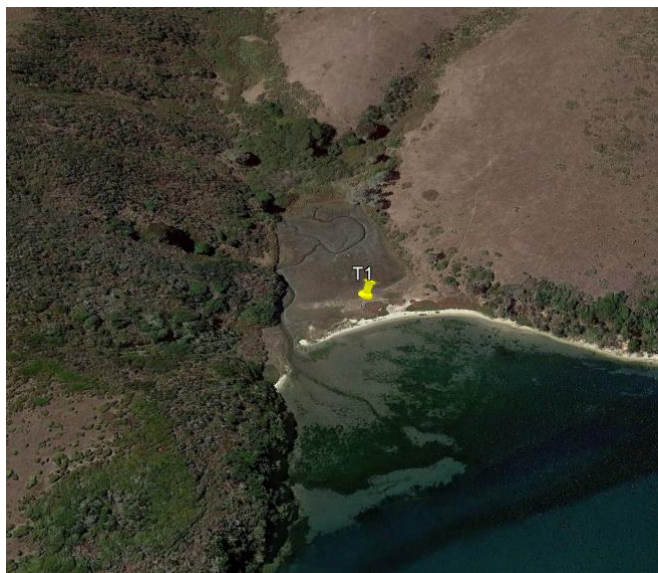
Ferry Wakes

- Corte Madera channel located approx. 2000 feet offshore of campus
 - R/T ferry service every 30 min from SF to Larkspur
 - 38 one-way trips daily
- Boat wakes understood to have larger erosive potential for shoreline, compared to typical wind-generated waves
 - Estimated* wake heights of ~1.6 ft with wave period of 3 s

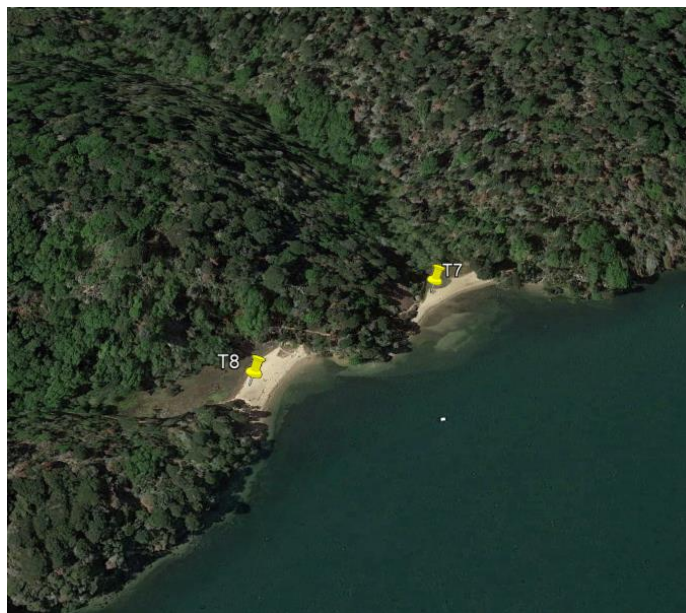


Reference for Ferry Wake Characteristics: Macfarlane, G.J., Bose, N. and Duffy, J.T., 2012, "Wave Wake: Focus on vessel operations within sheltered waterways", To be presented at the SNAME Annual Meeting, Providence,, Rhode Island, 24-26th October 2012.

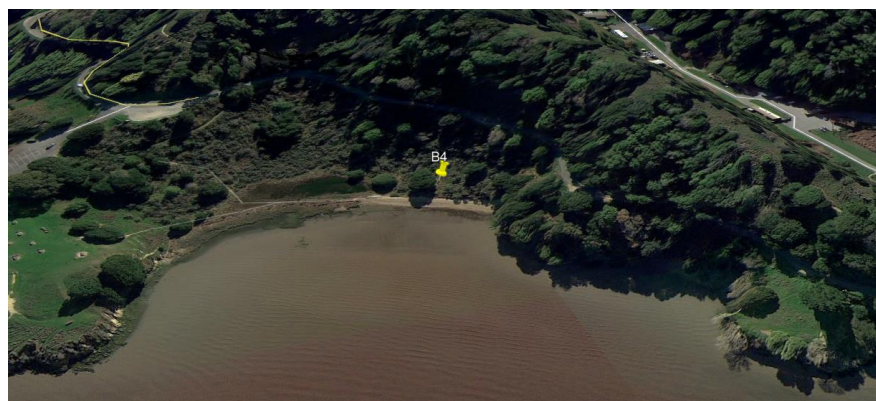
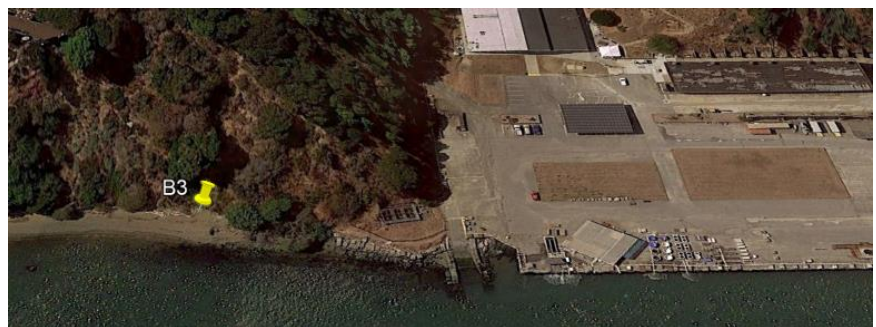
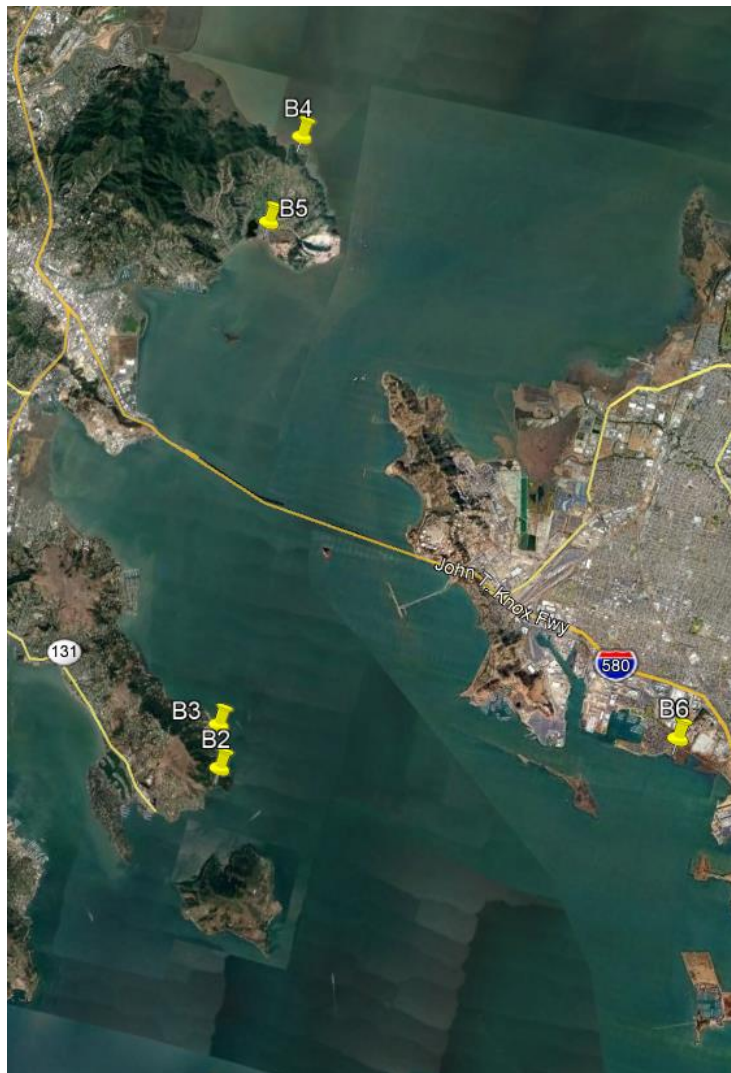
Comparison to Reference Sites – Tomales Bay



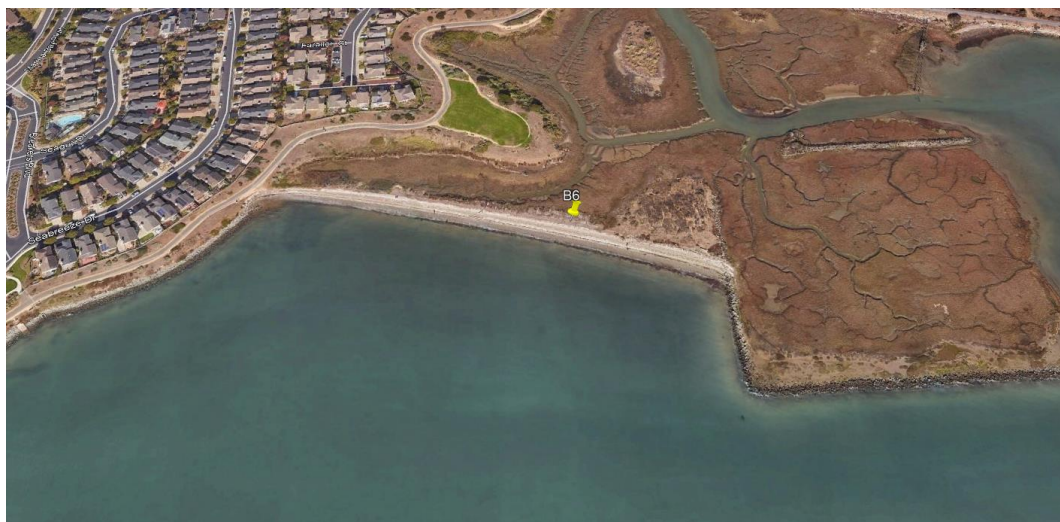
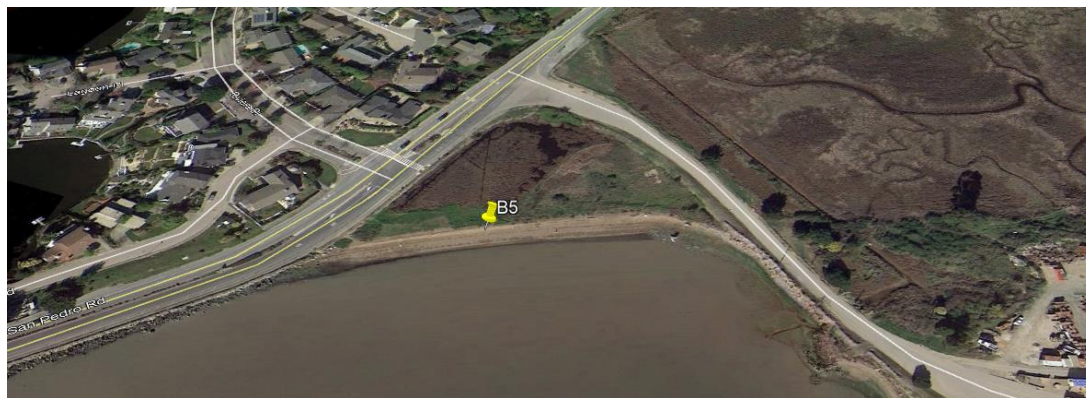
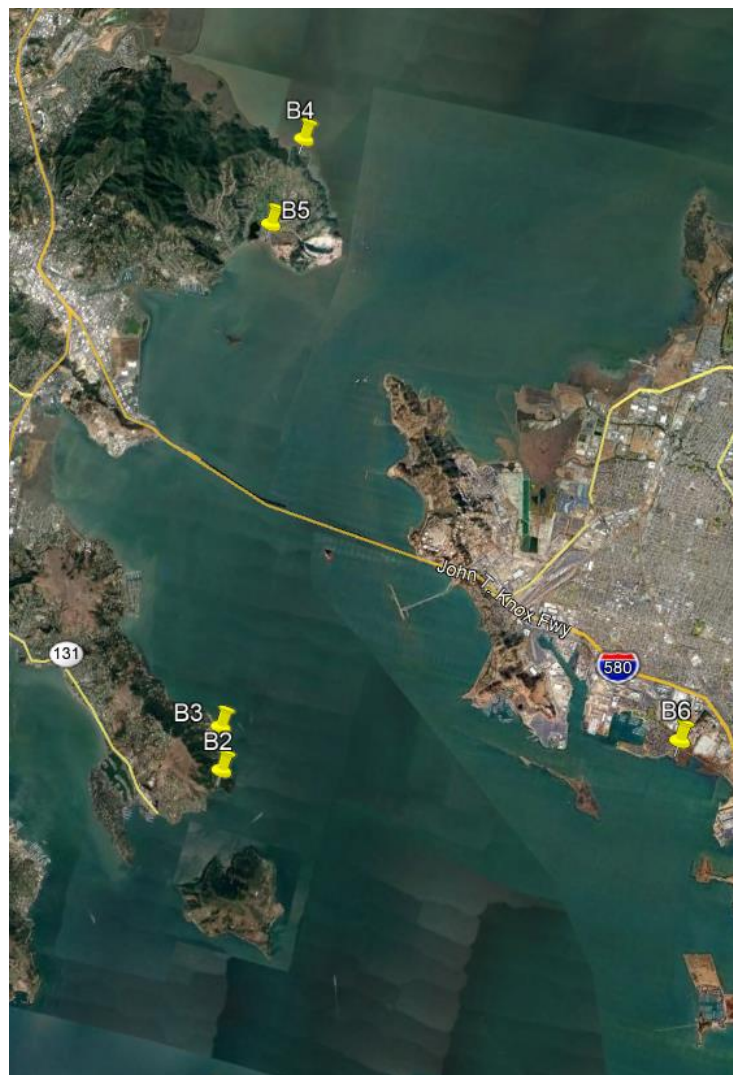
Comparison to Reference Sites



Comparison to Reference Sites



Comparison to Reference Sites





550 Kearny Street
Suite 800
San Francisco, CA 94108
415.896.5900 [phone](tel:415.896.5900)
415.896.0332 [fax](tel:415.896.0332)

esassoc.com

ATTACHMENT D

Pier Improvements and Boating Access



550 Kearny Street
Suite 800
San Francisco, CA 94108
415.896.5900 [phone](#)
415.896.0332 [fax](#)

esassoc.com

memorandum

date June 27, 2022

to Karina Nielsen, EOS Center, San Francisco State University

cc Bob Battalio PE, ESA

from Tiffany Cheng PE, ESA; Michelle Orr PE, ESA

subject Appendix D: Boating Improvements for San Francisco State University's Romberg Tiburon Campus (RTC)

Environmental Science Associates (ESA) is supporting the San Francisco State University (SFSU) Romberg Tiburon Campus (RTC) with campus master planning and conceptual nature-based restoration design along the campus shoreline. As part of this effort, ESA provided conceptual-level consideration of boat launch facility improvements. An operational boat launch is considered critical for campus research. The existing boat launch is in need of improvements and is located in an area with strong restoration potential. ESA explored relocating the boat launch slightly further north, to the pier area, so the existing boat launch location could be integrated into a larger shoreline restoration. ESA conducted a limited effort to visually assess the condition of existing boating and pier facilities at the RTC and identified potential short-term and long-term boat launch improvements. This memo documents planning related to boating facilities on campus and is included as an appendix to the broader nature-based restoration study. Additional engineering assessment of existing boat access features and design will be required should RTC pursue any of the recommended boating improvements.

Existing Boat Launch and Pier Facilities

ESA conducted a site visit in January 2019 to assess existing shoreline conditions, including boating facilities. The existing boat launch facility is located in the South Reach, immediately adjacent to the southern edge of the large concrete slab area. (**Figure 1**). Small sandy pocket beaches have formed on either side of the launch. The sides of the boat launch are comprised of heavy concrete weights, which remain on campus after its prior use as a naval base.

An active research pier and remnant caisson piles¹ are located outboard of the slab (**Figure 2**). The slab is behind a vertical bulkhead. The pier extends approximately 190 ft into the Bay and is supported by piles. Additional remnant piles surround the pier. RTC operates a sonde that measures water levels, temperatures and other characteristics beneath the pier. The caisson piles were observed to have some wear and corrosion. Overall, the

¹ Caisson piles (*caisson* is French for 'large box') are watertight retaining structures, typically made of wood, steel or reinforced concrete, used as a foundation in water environments.

piles were assessed to be in adequate condition for supporting vertical gravity loads, such as for a pier, but would likely require bracing for lateral loading, such as for docking boats (Tipping 2017).



Figure 1. Existing boat launch at RTC (Source: ESA, 2019)



Figure 2. Existing research pier and caisson piles (Source: ESA, 2019)

Site Exposure to Waves and Currents

The research pier and boat launch are exposed to swell and wave action from the Bay. ESA conducted a limited wind-wave generation model for the RTC shoreline for a range of wind speed events. The significant wave height corresponding to the 1-yr and 10-yr wind events are approximately 2.0 ft and 3.1 ft, respectively.

Nearby commuter ferries pass by EOS frequently (half-hour to hour intervals during the day), generating waves which reflect from the bulkhead wall, creating a quartering sea surface not ideal for boat launching (**Figure 3**). Deep water depths immediately offshore from the bulkhead contribute to tidal currents close to the structure. Generally, the site's exposure to waves and currents is too high to maintain a vessel or small float structure in the water all the time.



Figure 3. Quartered sea surface due to wave reflection off existing bulkhead
(Source: ESA, 2019)

RTC Boating Facility Needs

ESA gathered qualitative input from users of the boating facilities (RTC faculty and researchers) on issues related to the existing facilities and planned/desired future uses. Users offered the following feedback on the existing facility:

- Vessels launched from the existing boat ramp are subject to fast currents; it was noted that users of the facility experience difficulties landing the boat due to the orientation of the structure to Bay currents and the narrow width of the structure.

- Boats must be stored on land, which takes up space on the slab and requires additional manpower and logistics to move/handle prior to boarding or after disembarking.
- The slope of the launch is steep and often wet from high tides, which was also noted as a potential safety hazard to users.

Users expressed a need for improvements to the existing facility.

Users expressed the following input on planned/desired future boat launch uses:

- Boat ramp functionality should be maintained at some level in the future, either by improving the existing structure or finding a new location along the campus shoreline. Launching boats off the existing pier is not possible because the pier structure does not have the capacity to accommodate boat loads, and was not designed for boat launching.
- RTC staff and researchers desire the ability to keep boats in the water for short periods of time (e.g. 5-10 days), assuming non-inclement weather.
- Research teams need to be able to depart/return in sync with research objectives/logistics that are often outside of business hours.

Planning for boat access improvements is considered to be high-level at this stage. Several parameters which affect frequency and character of boat access operations are yet to be decided (e.g. will the boat hoist be operated by trained staff only or a wider group of students and researchers?). For this level of planning and the limited scope, ESA assumed that vessels and other marine equipment would be brought onto land periodically during inclement weather and that programming around boat operations (e.g. types of boats, types of users, rules and usage guidelines) will be determined and refined by the University in the future.

Potential Boating Improvements

Based on input gathered from the site visits and RTC faculty and researchers, ESA worked with RTC staff to identify potential short-term and long-term improvements to the existing water access facilities. Further refinement in boat programming at the University should be factored into the installation of new systems/equipment. Short-term improvements to boat access include reducing the steepness of the existing boat launch, widening the slot and perhaps re-orienting the entrance to lessen exposure to fast currents.

ESA explored two scenarios for long-term improvements to boat access:

- Relocate boat launch to the pier area, with the following components:
 - a. Winch and crane system to lower boats into the water
 - b. A new floating dock and ramp for boarding people and equipment onto the boats
 - c. Small protected harbor, enclosed by a new floating breakwater and dock system
- Relocating boat launch elsewhere along campus shoreline, potentially in the North Parcel

Staff feedback on the long-term scenarios for boat access revealed a preference for relocation to the research pier, with ability to lower/raise vessels into the water and short-term storage. Relocating the boat launch to the North

Reach would mean greater logistics to transport staff, equipment and vessels, as well as working with space constraints with transport between existing campus buildings and other buildings that may remain. Since the Campus Master Plan and future RTC shoreline is still being developed, constraints related to relocating the boat launch may change in the future. For this effort, only the pier area launch scenario was progressed.

Pier Area Boat Launch Scenario

The pier area scenario boating improvements are shown in **Figure 4**. This concept includes a new winch and crane system located on a pile-supported platform for lowering/raising boats into the water, with a new, adjacent floating dock and ramp for boarding people and equipment. A new floating breakwater and dock system would be co-located on the existing piles, allowing access to the water and boats to be tied up within the small, protected harbor. The piles would be braced and raised vertically as needed to support the floating breakwater and dock system.

The concept responds to site-specific considerations, in particular high wave energy at the site. Based on inspection and professional judgement, wave exposure at the site is too extensive to utilize typical marina floats designed for protected basins for boat access. Given the site exposure, a concept specifies a hoist boat launch, which would be used when conditions were within operation parameters only (**Figure 5**). The concept includes a jib-boom hoist similar to those used at ocean piers (e.g. Point Arena, Gaviota). Similar to Point Arena, a gangway and float would be lashed to the deck but lowered by the crane during operational conditions, allowing a place to access the boat during launching. A key question is whether the depth at the bulkhead wall is sufficient for launching at low tide and if not, the facilities would be extended bayward. Since the bulkhead is old and its integrity has not been fully investigated or confirmed, the concept includes new pile-supported platforms for both the hoist and the top of the gangway, and a third pile-supported structure to house an operations building controlling access and launching, again, modeled after Point Arena pier. It is possible that the existing bulkhead can accommodate the crane loads in which case a new pile-supported pier may not be needed for the crane. An assessment would require consideration of the crane capacity, type and all this would relate to the boat programming.

A floating breakwater is included in order to improve the operational range. It could be co-located with the existing piles. However, these piles were previously cross-braced (observations of corroded prior tie-bar connections) and hence may not have been embedded sufficiently to resist lateral loads. Also, it is not clear that the elevation of the existing piles is high enough to accommodate high waters and float motions. A floating breakwater was sketched without detailing the pile bracing and extensions: bracing, additional piles and or moorings would likely be required. The dimensions of the floating breakwater were selected to significantly dissipate typical and extreme wind waves. The location and geometry would not fully shelter the launching location, but would rather “clarify” the sea forms by reducing the wave reflection pattern, while also allowing currents to pass relatively unimpeded. Note that the floating breakwater could also be used for temporary boat berthing and staging near the launch.



Figure 5. Example of jib boom crane / boat hoist setup (Source: Pelloby Cranes)

Estimated Costs

For planning purposes, ESA developed reasonable order of magnitude (ROM) cost estimates for the proposed boating improvements (see **Table 1**). These cost estimates are assumed to be approximately -30% to 50% accurate and include a 35% design contingency to account for project uncertainties. These estimates are subject to revisions as boat programming at the RTC is further refined. Estimated costs are presented in 2020 dollars and would need to be adjusted to account for price escalation for future implementation. This opinion of probable construction costs is based on: ESA project experience, bid prices from similar projects, consultation with contractors/supplies, R.S.Means online and the Engineering-News Record (ENR) Cost Index Tables.

Table 1. ROM Estimates for Boating Improvements

Item #	Description	Extended Price
Near-term: Existing Boat Ramp Improvements		
1	Existing Boat Ramp Improvements	\$400,000
Medium-term Pier Improvements		
2	Winch and Crane System	\$100,000
3	Pile supported deck for crane and ramp support	\$580,000
4	Gangway and boarding float	\$100,000
5	Floating Breakwater and Dock	\$3,600,000
	Mobilization*	\$468,000
	Environmental Protection**	\$234,000

*Estimated as 10% of total

**Estimated as 5% of total

References

- Coast and Harbor Engineering (CHE). 2007. "North Reach Coastal Engineering Analysis and Conceptual Shore Protection Design, Romberg Tiburon Center, Tiburon, CA". *Technical Memorandum*.
- Engineering News-Record. 2022. *Engineering News-Record Construction Cost Index History Tables*. Accessed at: <https://www.enr.com/economics>
- RS Means Online. 2022. Accessed at: <https://www.rsmeansonline.com/>
- Tipping Structural Engineers. 2017. "Appendix B: Maritime Elements - Structural". *Prepared for San Francisco State University*.