

# **SAN FRANCISCO WATERFRONT COASTAL FLOOD STUDY, CALIFORNIA**

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## **APPENDIX K – COMPENSATORY MITIGATION PLAN**

JULY 2026

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USACE TULSA DISTRICT | THE PORT OF SAN FRANCISCO



**US Army Corps  
of Engineers** 



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## Acronyms and Abbreviations

| Acronym     | Definition                                                            |
|-------------|-----------------------------------------------------------------------|
| BCDC        | San Francisco Bay Conservation and Development Commission             |
| CE/ICA      | Cost-Effective, Incremental Cost Analysis                             |
| EWNG        | Engineering with Nature Working Group                                 |
| HEA         | Habitat Equivalency Analysis                                          |
| NFS         | Non-federal sponsor (Port of San Francisco and City of San Francisco) |
| NMFS        | National Marine Fisheries                                             |
| RAWG        | Resource Agency Working Group                                         |
| SFWCFS      | San Francisco Waterfront Coastal Flood Study, CA                      |
| TNBP        | Total Net Benefit Plan                                                |
| USACE       | U.S. Army Corps of Engineers                                          |
| USFWS       | U.S. Fish and Wildlife Service                                        |
| Water Board | San Francisco Bay Regional Water Quality Control Board                |
| WRDA        | Water Resources Development Act                                       |

## 1.0 Introduction

This appendix presents the compensatory mitigation plan for unavoidable habitat impacts associated with the San Francisco Waterfront Coastal Flood Study, CA (SFWCFS) project. This plan is only intended to address compensatory mitigation work and not the sequence of other activities performed during project planning to avoid, minimize, rectify, or reduce habitat impacts from each project alternative (see Engineer Regulation (ER) 1105-2-100, Section C-3e. A detailed discussion of the sequence actions are included in Appendix D-1-5 (Habitat Modeling), while more details can be found in the plan formulation appendix (Appendix A), the environmental supporting documents (Appendix D-1 and associated sub-appendices), and the 404(b)(1) analysis (Appendix D-4-1). These actions are incorporated into the mitigation objectives of this plan. The planning work performed to document those sequencing actions is complete and led the team to the need to develop a compensatory habitat mitigation plan for unavoidable impacts to fish and wildlife resources. This document details the work performed, including coordination, plan formulation, and environmental compliance, to develop the compensatory habitat mitigation plan.

It is important to note that this recommended mitigation plan will be further refined during the design phase, and it is fully anticipated that the mitigation site size, cost, and potentially even site location could be modified during subsequent planning phases, especially if these sites are unavailable in 10 years when construction would begin. Therefore, the level of detail here is at a higher level than might be typically seen in other U.S. Army Corps of Engineers (USACE) mitigation plans. The intent of this plan is to provide a worst-case scenario cost-estimate to confirm that sufficient mitigation exists in the area to offset the worst-case scenario losses, and document the most likely avenues for mitigation, monitoring and adaptive management.

### 1.1 Requirements

The authority and requirements for compensatory mitigation are founded in Federal laws and regulations. The legal foundation for mitigation for ecological resources includes the Clean Water Act, various Water Resources Development Acts (WRDAs), and other environmental laws. These laws are implemented and administered through rules, guidance, regulations, and policies issued by Executive Branch agencies.

The relevant laws and regulations specific to compensatory mitigation planning for USACE civil works projects are listed in the References section of this document. The specific procedures followed to develop this compensatory habitat mitigation plan are found in ER 1105-2-100, Appendix C. Other forms of mitigation, such as plans for cultural resources conservation or induced flood damage, may also be required for a project. Those types of mitigation requirements are not directly related to fish and wildlife habitat impacts and are not covered in this plan.

Compensatory mitigation is the “restoration (re-establishment or rehabilitation), establishment, enhancement, and/or in certain circumstances preservation of aquatic resources for the purposes of offsetting unavoidable adverse impacts which remain

after all appropriate and practicable avoidance and minimization has been achieved” (see 40 CFR 230.92). It is the policy of the USACE civil works program, and in accordance with Section 906 of WRDA 1986, as amended, to demonstrate that impacts to all significant ecological resources, both terrestrial and aquatic, have been avoided and minimized to the extent practicable, and that any remaining unavoidable impacts have been compensated to the extent possible. Section 906(d) of WRDA 1986, as amended, requires functional assessments to be performed to define ecological impacts and to set mitigation requirements for impacted habitats. USACE policy in ER 1105-2-100, paragraph C-3(d)(5), requires the use of a habitat-based methodology, supplemented with other appropriate information, to describe and evaluate the impacts of the alternative plans, and to identify the mitigation needs.

## 1.2 Coordination and Collaboration

Two interagency teams (Resource Agency Working Group [RAWG] and Engineering with Nature Working Group [EWNG]) met throughout the study and resource agencies contributed expertise and information to support the identification of significant resources, impacts, and avoidance, minimization and potential compensation (mitigation) measures. The RAWG includes more than 50 members from agencies including: San Francisco Bay Conservation and Development Commission (BCDC), California Department of Fish and Wildlife, City of San Francisco Planning Department, Environmental Protection Agency, National Park Service, National Marine Fisheries, Regional Water Quality Control Board, California State Lands Commission, USACE, US Fish and Wildlife, and Port of San Francisco. The EWNG was set up to identify where and which natural and nature-based features (NNBFs) should be considered within the study area and to help describe how NNBFs contribute to regional habitat goals and project benefits. The EWNG included 15 individuals from Federal, state, and local agencies, universities, non-governmental organizations, and private industry who have been identified as experts in the field of Engineering with Nature and ecological restoration.

The cooperating and participating agencies are listed below. An early interagency coordination meeting was held to comply with the provisions of the Water Resources Reform and Development Act of 2014 Section 1001. The meeting afforded agencies an opportunity to learn about the project and to provide initial input into the study.

- **Cooperating Agencies:** Environmental Protection Agency Region 9 (Formally Accepted), Federal Emergency Management Agency Region IX (Planning and Implementation Branch), National Marine Fisheries Service (Formally Accepted), National Park Service, US Fish and Wildlife Service
- **Participating Agency:** California Department of Fish and Wildlife, California Regional Water Quality Control Board, California State Lands Commission, San Francisco Bay Conservation and Development Commission, and San Francisco Planning Department

The views of each of the resource agencies were considered in the development of the Recommended Plan and this compensatory mitigation plan. The RAWG and EWNG

were provided an opportunity to review the draft compensatory mitigation plan during the 45-day agency and public review period that began January 26, 2024. The Water Board, BCDC, and EPA each provided written comments on the mitigation plan during the public review period.

The Water Board noted that for Water Certification purposes, the mitigation plan will need to account for and consider the mitigation type in relation to the impact type (i.e., in-kind or out-of-kind mitigation) as well as the temporal loss of functions, values, and acreages that will occur from the time the project impacts occur to when any mitigation is fully established. Response to each part of the comment is below:

- The mitigation plan has been updated since public release to clearly differentiate between in-kind and out-of-kind mitigation measures.
- Regarding the temporal and functional value of the lost and compensated habitat, the Habitat Equivalency Analysis (HEA) model used accounts for both with input parameters that assume a habitat value of 1.0 (best possible) over a 100-year period of analysis for the existing condition and has varying habitat values over the period of analysis for the different types of compensatory mitigation over the identified recovery period.
- The acreage requirement does not align with USACE compensatory mitigation policy. However, there are many other factors of the Recommended Plan that would likely address this need but is too speculative at this phase of planning to quantify for inclusion now. For example, as each wharf is rebuilt, the number of piles is likely to be minimized, resulting in a decrease in bay fill compared to the existing condition.

The Water Board and BCDC both note that the Engineering with Nature® (EWN®) features should be incorporated into the Recommended Plan and should be considered as a way to minimize adverse impacts. Both agencies suggest that the EWN features reduce the total net loss of aquatic habitats thus decreasing the amount of compensatory mitigation required. While USACE agrees with this assessment, this mitigation plan is taking a conservative approach to the mitigation need (i.e., worst case scenario) and accounting for the unavoidable losses to aquatic habitats without consideration of EWN® benefits in case the EWN® features change during the design phase. During the design phase, the EWN® features can be modeled and an appropriate methodology determined to demonstrate no net loss of aquatic habitats.

Each of these organizations will be offered an opportunity to continue to play a role in the refinement of the mitigation plan during the design phase when the project is authorized and funded.

## 2.0 Ecological Resources

The SFWCFS is in the San Francisco Bay watershed. From a habitat standpoint the area is characterized as the largest estuary on the west coast. The Bay Area is home to over 7 million people and is one of the densest urban areas in the nation.

Historically, San Francisco Bay had about 300 square miles of tidal marsh with 6,000 miles of channels and 12 square miles of shallow pan. Until the 1850's, the Bay was navigable as far south as San Jose. Following the 1850's Gold Rush, large amounts of sediment from upstream erosion and hydraulic mining flowed into the Bay, and surrounding tidal wetlands were diked for salt production, hay-fields, or filled in, reducing the Bay's size by as much as one-third.

The Bay is home to over 500 species of fish and wildlife, 20 of which are threatened or endangered with extinction. The Bay and its surrounding water systems play host to millions of migratory birds every year as they cross the Pacific flyway.

### 2.1 Sources of Information

The PDT, RAWG, and EWNG investigated the habitat resources found in the project area. The teams collected information from existing data sources and conducted site visits, when possible. No site-specific surveys were completed during the feasibility phase but will be completed during the design phase to confirm the presence/absence, quantity, and quality of existing habitat at the adversely impacted and restoration sites when the designs are more fully developed. Sources of habitat data include information from resource agencies, published reports, agency records, and site visits. **Table K-1** describes the data sources used to develop the mitigation plan.

**Table K-1: Data Sources**

| Year             | Source of Information                  | Information                                                                                               | Use in Mitigation Planning                                                     |
|------------------|----------------------------------------|-----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| 2023             | San Francisco Estuary Institute (SFEI) | California Aquatic Resources Inventory (CARI)                                                             | Habitat Mapping                                                                |
| 2023             | Google                                 | Google Earth Imagery                                                                                      | Habitat Mapping, Identification of Potential Mitigation Sites                  |
| 2023             | EPA                                    | Compensatory Mitigation in Estuarine and Marine Habitats                                                  | Mitigation Measure Identification                                              |
| 2021, 2022, 2023 | PDT                                    | Site Visits                                                                                               | Inventory site conditions                                                      |
| 2022             | San Francisco Estuary Partnership      | San Francisco Estuary Blueprint                                                                           | Mitigation Measure Identification                                              |
| 2015             | Goals Project                          | Bayland Ecosystem Goals Project                                                                           | Mitigation Measure Identification                                              |
| 2010             | Werme et al. (SFEI)                    | Removal of Creosote-Treated Pilings and Structures from San Francisco Bay                                 | Mitigation Measure Identification, Designs, Considerations, and Cost Estimates |
| 2010             | Werme et al. (SFEI)                    | SF Bay Creosote Pilings GIS Data                                                                          | Mitigation Measure Identification                                              |
| 2010             |                                        | San Francisco Bay Subtidal Habitat Goals Report, Conservation Planning for the Submerged Areas of the Bay |                                                                                |
| Various          | Port of San Francisco                  | Cost Estimates for Pier and Pile Removal Projects                                                         | Cost Estimates                                                                 |

## 2.2 Identification of Habitats and Impacts

The project area includes several aquatic habitat types including intertidal, subtidal, open water, wetlands, and associated vegetation. Only subtidal habitat is expected to have unavoidable adverse impacts as a result of implementing the Recommended Plan.

Implementation of the Recommended Plan would result in a total net loss of 9.0 acres of subtidal habitat (see Appendix D-1-5). The impact is the result of fill material being placed within the open water column to allow for construction of a new seawall at the Ferry Plaza (Pier 0), Rincon Park, and Pier 96. Subtidal habitats are submerged areas beneath the San Francisco Bay water surface to the Bay bottom and include mud, shell,

sand, rocks, artificial structures, shellfish beds, macroalgal beds, and the water column above the bay bottom (Cosentino-Manning et al. 2010). Soft substrate comprises the majority of the bay's bottom (approximately 90%) and ranges between soft mud with high silt and clay content and areas of coarser sand.

Subtidal habitat in the San Francisco Bay is recognized as significant across institutional, public, and technical perspectives. Significance assessments assist teams in understanding the ecosystem impacts of the project and the linkages of the resources to other parts of the system or watershed. The following supports that subtidal habitat is considered significant in the study area:

- **Institutional, Technical and Public Criteria:** As mentioned in Section 2.0, up to one-third of the historic bay has been filled in, so resource agencies and the public recognize the value in maintaining what open water is present and discourages bay fill unless for the purpose of restoring habitat.
- **Institutional Criteria:** Subtidal habitat is regulated under the Coastal Zone Management Act and Clean Water Act and has been identified as a critical resource for Endangered Species Act and Magnuson-Stevens Fishery Management Act protected and managed species.
- **Technical Criteria:** Subtidal habitats provide diverse structure and function as an important habitat in the bay for various wildlife including fish (protected and managed herring and salmon), shellfish, invertebrates, marine mammals, and birds (diving ducks, shorebirds) that forage, rest, refuge, migrate through, and reproduce in the subtidal areas (Cosentino-Manning et al. 2010). The most common large mobile benthic invertebrate organisms in the Bay include blackspotted shrimp (*Crangon nigromaculata*), the bay shrimp (*C. franciscorum*), Dungeness crab (*Metacarcinus magister*), and the slender rock crab (*Cancer gracilis*). All these mobile invertebrates provide an important food source for carnivorous fishes, marine mammals, and birds in San Francisco Bay's food web.

## 2.3 Significant Net Losses

Based upon the type of habitat in the project area it was determined that the Habitat Equivalency Analysis (HEA) would be an appropriate tool to assess the project's impacts on fish and wildlife habitat and other ecological resources. Other models were considered such as Habitat Evaluation Procedures and THERM; however, none of these were sensitive to the potential changes at the impact or restoration site that would demonstrate a mitigation need or the value of the potential mitigation measures. HEA is a method developed by the National Oceanographic and Atmospheric Administration (NOAA) to scale compensation for habitat damage resulting from oil spills and other damage-related impacts (NOAA 1997). HEA is currently only approved on a project-by-project basis. The study has received single-use model certification from the Ecosystem Restoration Center of Expertise (Eco-PCX).

HEA focuses on complete, in-kind replacement of services lost between the time of impact and when the restored or created habitat becomes fully functional. HEA accomplishes this by incorporating the concept of discounting from economic theory (i.e. services for future years have a lower value on benefits because they take longer to accrue). Model outputs are in a discounted-service-acre-year (DSAY). A complete description along with the model parameters and assumptions have been documented in Appendix D-1-5 (Habitat Modeling).

For purposes of the feasibility study, the worst-case scenario of implementation was assumed and included construction and long-term operation of the Recommended Plan measures. Because this is a worst-case scenario mitigation plan, there is no consideration of the net benefits from implementation of EWN® features or the likely decrease in fill from wharf rebuilding. Additional coordination with the resource agencies will occur during the design phase to better understand what an appropriate assumption for the quantity of tidal marsh and intertidal habitat that would be restored/created and how that could contribute to project benefits that would offset the impacts of bay fill as part of the total project design. As a result, only the bay fill impacts to subtidal habitats were modeled.

The HEA results indicate that for 1.0 acre of bay fill, a total of 500,000 DSAY are lost, which totals 4,500,000 DSAY lost for the 9.0 acres of bay fill associated with implementing the Recommended Plan.

### **3.0 Mitigation Planning**

The project includes mitigation sequencing actions employed during the development and refinement of details for each alternative plan. These sequencing actions include steps to avoid, minimize, rectify, and reduce/eliminate habitat impacts for each alternative. These actions are part of the overall mitigation plan for the project. The need for compensatory mitigation is driven by the remaining unavoidable impacts to significant ecological resources.

#### **3.1 Mitigation Planning Objective**

The goal of this mitigation plan is to fully compensate for the unavoidable impacts to subtidal habitats that would occur with project implementation. The objectives of the mitigation plan are defined by the results of the HEA. HEA was also used to estimate potential project impacts and potential outputs of mitigation measures. The objective of this mitigation plan is:

- Compensate for the loss of 9.0 acres of subtidal habitat (4,500,000 DSAY) along the San Francisco Waterfront in San Francisco Bay.

Other factors may influence planning objectives and the development of strategies, measures, and alternative plans. These may even play a role in plan selection depending on specific project circumstances and opportunities. Some of these factors are based on legal requirements and policies and others are derived from scientific or technical standards. For example, acquisition of lands or interests in lands for mitigation

must be acquired before construction of the project commences or concurrently with acquisition of lands and interests in lands for other project purposes; and the physical construction of the mitigation work is required to be carried out before or concurrently with project construction (see Section 906(a) of WRDA 1986, as amended). This introduces an implementation time factor to consider later in plan evaluation and selection. Another example, from a scientific perspective, larger contiguous land tracts may offer better habitat value for fish and wildlife compared to dispersed smaller areas. This may influence site selection and land considerations for a mitigation project.

### 3.2 Land Considerations

Most of the subtidal habitats along the waterfront are publicly owned by the Port of San Francisco (Port) and/or the City of San Francisco (City) as granted under the Burton Act. Most of the piers and adjacent lands are also owned by the Port and/or City, with a few exceptions of private parcels along the 7.5-mile waterfront. Since the Port and City are the primary landowners and the NFS, finding mitigation options without real estate challenges should not be an issue. Additionally, focusing on mitigation on their lands will reduce the overall costs and provide long-term protection to the site.

### 3.3 Mitigation Strategies

Planning strategies are different means employed to develop an alternative plan or plans to achieve a project goal. The use of one or more strategies helps teams focus on an approach to developing a plan. For mitigation planning work, strategies may range from the purchase of mitigation bank credits to the construction of a project or projects to achieve the objectives and compensate for unavoidable habitat impacts. Strategies may also involve different approaches to site selection such as the use of public lands or identifying contiguous sites to enhance wildlife corridors or expand wildlife populations. In addition, Section 2036(c) of WRDA 2007, as amended, requires USACE to consider mitigation banks and in-lieu fee programs where appropriate. Consideration of these options as mitigation strategies may be helpful when available. The strategies considered for planning this mitigation project are described below.

- **Purchase of mitigation bank credits.** Mitigation banks sell credits for mitigation work performed at an approved site. The banks are approved and legally bound through banking instruments that hold the operators to certain standards of performance and reporting. The use of mitigation banks for a project may offer advantages to the government and non-federal sponsor (NFS) by reducing performance risk and eliminating project specific requirements for operations and maintenance work and the development of monitoring and adaptive management plans.
- **Purchase of in-lieu fee program credits.** In-lieu fee programs are established by state or local natural resource management agencies and approved by USACE and U.S. Environmental Protection Agency to accept funds for future mitigation work. The programs are approved to implement either specific or general wetland or other aquatic resource development projects. Programs must

meet the requirements that apply to an offsite mitigation effort and provide adequate assurances of success and timely implementation. A formal agreement between the program sponsor and the agencies, like a banking instrument, defines the conditions under which the use of the program is considered appropriate. Using an in-lieu-fee program for a project's mitigation needs may offer advantages to the government and NFS by reducing performance risk and eliminating project specific requirements for operations and maintenance work and the development of monitoring and adaptive management plans.

- **Construction of a mitigation project.** The government and NFS may choose to construct a mitigation project. This construction strategy offers some potential advantages in tailoring a project to specific needs or locations. In addition, the partners may bring special expertise to the project gained from previous work on similar projects in the area.
- **Non-structural mitigation methods.** Various non-structural approaches may be available for accomplishing mitigation objectives. These approaches generally do not involve major construction work and therefore potentially reduce some associated environmental impacts. These actions may include land preservation, invasive species control, environmental flows, or other management actions that produce ecosystem benefits. As a strategy reducing environmental impacts may be more appropriate and complimentary in sensitive or protected areas. Non-structural mitigation may be combined with all other mitigation strategies to guide formulation of alternative plans.
- **Partnership opportunities.** Many organizations have goals that align with USACE mitigation planning needs, the Environmental Operating Principles, or other missions. Opportunities may exist to collaborate to plan a project that meets the goals of the mitigation plan and the watershed goals of one or more partners. This strategy offers an opportunity to benefit from the strengths of organizations outside of government and may leverage existing information or offer unique local insight. There may be opportunities to perform habitat mitigation work on lands managed by partners.

### 3.4 Identify Measures

Management measures are actions or activities that work towards accomplishing planning objectives. Each measure is linked to one or more stressors or drivers in the conceptual ecological model. A measure may stand alone as a single activity that serves as an alternative plan. Two or more individual measures may be combined to form an alternative plan.

Measures were identified based on resource agency feedback and were further developed and guided by the goals established in several conservation and management plans developed by various partnerships and coordination efforts in San Francisco Bay (see Table 1). Within these plans, the common restoration goals

applicable to habitats along the waterfront and that align with the mitigation objective include:

- Improve biodiversity, resilience, and water quality
- Limit disturbances to soft substrates and discourage the use of bay fill
- Remove artificial structures that have negative impacts on soft bottom habitat function, contribute to water quality degradation and that provide minimal habitat benefit
- Remove marine debris from intertidal or subtidal areas
- Minimize the impacts of aquatic invasive species on native subtidal habitats

Most of these plans focus on restoration actions in habitats that would not meet the mitigation objective, such as tidal marsh restoration. Other restoration actions include measures that may be considered out-of-kind mitigation such as: preserving remaining natural habitats (e.g. eelgrass and oyster beds and soft bottoms); protecting areas for future expansion, restoration or creation of natural habitats; restoration of natural habitats; or improving water quality for discharges directly into the Bay. While each of these would provide an overall benefit to subtidal habitat, other measures are available that would meet the restoration goals stated above. If for some reason sufficient in-kind measures cannot be found during the design phase, consideration of these out-of-kind mitigation measures, and refinements to the mitigation plan, should be considered in coordination with the resource agencies.

A total of 10 measures were identified as meeting the planning objective; however, of these only two were carried forward as potential mitigation measures that could be implemented to offset the impacts to subtidal habitat. The measures and the rationale for carrying forward or eliminating from further consideration is documented in **Table K-2**.

**Table K-2: Potential Mitigation Measures**

| Measure                               | Description                                                                                                                                                                   | Carried Forward | Rationale                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mitigation Bank Credits               | (In-kind) Purchase mitigation credits from an approved mitigation bank.                                                                                                       | No              | No approved mitigation banks currently exist in the primary, secondary, or tertiary service area that provide open water or subtidal habitat credits.                                                                                                                                                                                                                                                                                               |
| In-Lieu Fee Credits                   | (In-Kind) Purchase ILF credits from an approved bank.                                                                                                                         | No              | No approved ILF credits are available in the primary, secondary, or tertiary service area that provide open water or subtidal habitat credits.                                                                                                                                                                                                                                                                                                      |
| Restoration- Pile Removal             | (In-Kind) Remove abandoned and derelict piles from the waterfront, with a primary focus on known locations with creosote piles.                                               | Yes             | <p>These measures meet the objective of restoring subtidal habitat by:</p> <ul style="list-style-type: none"> <li>Reducing shading of the bottom and water column</li> <li>Reducing restrictions to flow and sediment movement</li> <li>Restoring, re-creating, or realigning intertidal mudflats, sand flats, rock, shellfish, and macroalgal beds, and soft bottoms</li> <li>Reducing toxic effects of creosote and other contaminants</li> </ul> |
| Restoration- Pier Removal             | (In-Kind) Remove abandoned, derelict, or unused piers and overwater structures to include removal of all decking, pilings, and other materials associated with the structure. | Yes             |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Restoration- Restore Shoreline        | (In-Kind) Remove shoreline fill in abandoned or unused areas.                                                                                                                 | No              | As of now, there does not appear to be any areas that would be suitable to restore the shoreline along the 7.5-mile waterfront or in other adjacent areas. However, as conditions changes over the next decade, this measure should be reconsidered during the design phase.                                                                                                                                                                        |
| Restoration- Trash and debris removal | (Out-of-Kind) Remove trash and debris (e.g. abandoned boats, fishing gear) from the open water areas along the waterfront.                                                    | No              | This would require a reoccurring program to be set up in perpetuity and would not be a permanent improvement to water quality due to the recurring nature of trash input. There would be uncertainty whether the measure would fully compensate for the loss in perpetuity.                                                                                                                                                                         |

## San Francisco Waterfront Coastal Flood Study

| Measure                                  | Description                                                                                                                                                              | Carried Forward | Rationale                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Restoration-<br>Increase diversity       | (Out-of-kind) Addition of living seawalls or texture to existing artificial structures and incorporating troughs into deepwater habitats                                 | No              | Small-scale efforts have been completed and shown success; however, the long-term benefits are still assumed. Additionally, there are significant challenges in quantifying how much each of these measures could offset one acre of subtidal habitat loss. These are acknowledged as extremely valuable tools for increasing diversity; however, for purposes of mitigation there is risk and uncertainty in knowing that the impact has been sufficiently offset and will provide benefits in perpetuity. This measure should be reconsidered in the design phase when many of the pilot projects have been completed. |
| Restoration-<br>Invasive Species Removal | (Out-of-Kind) Remove at least two invasive species from the waterfront                                                                                                   | No              | The potential for eradication or reduction to acceptable levels may or may not occur within a reasonable time frame (for example, no longer than 10 years). There is also no guarantee whether the proposed methods for treatment are going to work or whether there is reasonable assurance that no identifiable vector will re-introduce the species proposed for control or eradication, making this an extremely difficult task and introduces significant uncertainty whether the measure would fully compensate for the loss in perpetuity.                                                                        |
| Preservation –<br>Open Water             | (Out-of-Kind) Permanently protect areas of open water in or near ecologically important habitat through the implementation of appropriate legal and physical mechanisms. | No              | Areas that could meet this purpose are found on publicly owned lands and actions which could affect habitat is regulated under various Federal and State laws. The State, City, and Port have implemented several actions to minimize impacts that is also contributing to existing habitat protection.                                                                                                                                                                                                                                                                                                                  |
| Preservation –<br>Future Uses            | (Out-of-Kind) Protect submerged land as it may become available to incorporate transition zones into restoration designs.                                                | No              | This measure would be dependent on other activities that would not be associated with the mitigation action. Additionally, the considerations for Open Water preservation are also applicable here.                                                                                                                                                                                                                                                                                                                                                                                                                      |

The two measures carried forward (Pile and Pier Removal) were further assessed to determine the potential to combine it with other measures to form alternative plans. Both measures can stand alone as a plan or be combined to form another plan. Neither of these measures have any restrictions that would prevent its combination with another measure.

HEA was used to calculate the benefit of pile and pier removal to determine the DSAY of units gained and determine the total acreage needed for compensatory mitigation. One acre of pile removal results in 299,999 DSAY of subtidal habitat, while one acre of pier removal results in a gain of 499,999 DSAY of subtidal habitat (**Table K-3**).

**Table K-3: HEA Results for Mitigation Measures**

| Injury/Restoration | DSAY/ac | Injured Units: Replacement Habitat Size |
|--------------------|---------|-----------------------------------------|
| Bay Fill           | 500,000 | --                                      |
| Pier Removal       | 499,999 | 1:1                                     |
| Pile Removal       | 299,999 | 1:1.67                                  |

The measures were then combined into an array of alternative plans aligned with the mitigation planning strategies. A no action alternative is included as a basis for comparison as well as meeting the requirements of the National Environmental Policy Act.

- **No Action Alternative.** Under this scenario no mitigation work would be performed, and the structure, functions and values of project impacted habitats would be permanently lost. The alternative is retained for purposes of a baseline comparison against other action alternatives.
- **Alternative 1.** Remove 15.1 acres of abandoned and derelict piles from the San Francisco waterfront between Aquatic Park and Heron's Head. The Warne et al. Creosote Piling Geodatabase identifies at least 8.5 acres (2,549,992 DSAY). Approximately 1.8 acres of additional pile removal (524,999 DSAY) can be conducted at the Concrete Plant at Pier 90 where the new seawall would be constructed landward of the existing dilapidated wharf that will not be rebuilt. These known and available locations provide a total of 10.3 acres (3,089,990 DSAY), which would require an additional 4.8 acres (1,439,995 DSAY) of pier removal options to be investigated during the design phase to implement this alternative.
- **Alternative 2.** Remove 9.1 acres of abandoned, derelict, or unnecessary piers from the San Francisco waterfront between Aquatic Park and Heron's Head. The Waterfront Plan and Design & Access Element includes policies for removal of a portion of the Pier 23 shed and Pier 64. These options equate to about 3.5 acres

of pier removal (1,749,997 DSAY). Other piers identified in the Waterfront Plan have already been completed. One additional pier not identified in the Waterfront Plan but that the Port has expressed interest in removing is just west of the 4<sup>th</sup> Street Bridge in Mission Creek. This location would result in 2.0 acres (999,998 DSAY) of pier removal benefits. These known and available locations provide a total of 5.5 acres (2,749,995 DSAY), which would require an additional 3.6 acres (1,799,996 DSAY) of pier removal options along the waterfront or outside the study area to be investigated during the design phase to implement this alternative.

Alternative 1 and 2 would not be implementable as they do not meet the offset necessary to compensate for all the impacts of bayfill. Rather a combination of pile and pier removal would be needed. Some locations identified in Alternative 1 and 2 offer the opportunity for removal of both pier and pile from the same location; however, there may also be either pier or pile removal in other locations. Any combination of these removal strategies would be required to fully offset impacts. A range of combination options were evaluated to determine the least-cost option.

A matrix was developed to determine what combination of pier and pile removal could accomplish the desired offset (**Table K-4**).

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*Table K-4. Matrix of pier and pile removal combinations evaluated to identify an acceptable alternative.*

*Highlighted plans indicate a combination of pier and pile removal that would meet the mitigation offset required.*

| Pier Removal<br>(acres) | Pile Removal (acres) |           |           |           |           |                  |           |                  |           |           |                  |           |                  |           |           |                  |
|-------------------------|----------------------|-----------|-----------|-----------|-----------|------------------|-----------|------------------|-----------|-----------|------------------|-----------|------------------|-----------|-----------|------------------|
|                         | 0                    | 1         | 2         | 3         | 4         | 5                | 6         | 7                | 8         | 9         | 10               | 11        | 12               | 13        | 14        | 15               |
| 0                       | -                    | 299,999   | 599,998   | 899,997   | 1,199,996 | 1,499,995        | 1,799,994 | 2,099,993        | 2,399,992 | 2,699,991 | 2,999,990        | 3,299,989 | 3,599,988        | 3,899,987 | 4,199,986 | <b>4,499,985</b> |
| 1                       | 500,000              | 799,998   | 1,099,997 | 1,399,996 | 1,699,995 | 1,999,994        | 2,299,993 | 2,599,992        | 2,899,991 | 3,199,990 | 3,499,989        | 3,799,988 | 4,099,987        | 4,399,986 | 4,699,985 | 4,999,984        |
| 2                       | 1,000,000            | 1,299,997 | 1,599,996 | 1,899,995 | 2,199,994 | 2,499,993        | 2,799,992 | 3,099,991        | 3,399,990 | 3,699,989 | 3,999,988        | 4,299,987 | <b>4,599,986</b> | 4,899,985 | 5,199,984 | 5,499,983        |
| 3                       | 1,500,000            | 1,799,996 | 2,099,995 | 2,399,994 | 2,699,993 | 2,999,992        | 3,299,991 | 3,599,990        | 3,899,989 | 4,199,988 | <b>4,499,987</b> | 4,799,986 | 5,099,985        | 5,399,984 | 5,699,983 | 5,999,982        |
| 4                       | 2,000,000            | 2,299,995 | 2,599,994 | 2,899,993 | 3,199,992 | 3,499,991        | 3,799,990 | 4,099,989        | 4,399,988 | 4,699,987 | 4,999,986        | 5,299,985 | 5,599,984        | 5,899,983 | 6,199,982 | 6,499,981        |
| 5                       | 2,500,000            | 2,799,994 | 3,099,993 | 3,399,992 | 3,699,991 | 3,999,990        | 4,299,989 | <b>4,599,988</b> | 4,899,987 | 5,199,986 | 5,499,985        | 5,799,984 | 6,099,983        | 6,399,982 | 6,699,981 | 6,999,980        |
| 6                       | 3,000,000            | 3,299,993 | 3,599,992 | 3,899,991 | 4,199,990 | <b>4,499,989</b> | 4,799,988 | 5,099,987        | 5,399,986 | 5,699,985 | 5,999,984        | 6,299,983 | 6,599,982        | 6,899,981 | 7,199,980 | 7,499,979        |
| 7                       | 3,500,000            | 3,799,992 | 4,099,991 | 4,399,990 | 4,699,989 | 4,999,988        | 5,299,987 | 5,599,986        | 5,899,985 | 6,199,984 | 6,499,983        | 6,799,982 | 7,099,981        | 7,399,980 | 7,699,979 | 7,999,978        |
| 8                       | 4,000,000            | 4,299,991 | 4,599,990 | 4,899,989 | 5,199,988 | 5,499,987        | 5,799,986 | 6,099,985        | 6,399,984 | 6,699,983 | 6,999,982        | 7,299,981 | 7,599,980        | 7,899,979 | 8,199,978 | 8,499,977        |
| 9                       | <b>4,500,000</b>     | 4,799,990 | 5,099,989 | 5,399,988 | 5,699,987 | 5,999,986        | 6,299,985 | 6,599,984        | 6,899,983 | 7,199,982 | 7,499,981        | 7,799,980 | 8,099,979        | 8,399,978 | 8,699,977 | 8,999,976        |

From the matrix, four combinations could achieve the necessary offset. The acreage from the matrix were slightly fine-tuned to the nearest tenth-acre that most closely met the mitigation need. No combination of pier and pile removal could equate to exactly 4,500,000 DSAY/acre because the removal equivalency (i.e., 1 acre pier removal = 499,999 DSAY/acre) is not round even numbers.

- **Alternative 3:** Remove 5.1 acres abandoned, derelict, or unnecessary piles and 6 acres of piers, which equate to 4,529,989 DSAY. Piers or piles for removal could be selected from locations described in Alternatives 1 and 2, but would also require additional options to be located during PED.
- **Alternative 4:** Remove 7 acres abandoned, derelict, or unnecessary piles and 4.9 acres of piers, which equate to 4,549,988 DSAY. Piers or piles for removal could be selected from locations described in Alternatives 1 and 2, but would also require additional options to be located during PED.
- **Alternative 5:** Remove 10 acres abandoned, derelict, or unnecessary piles and 3.1 acres of piers, which equate to 4,549,987 DSAY. Piers or piles for removal could be selected from locations described in Alternatives 1 and 2, but would also require additional options to be located during PED.
- **Alternative 6:** Remove 12 acres abandoned, derelict, or unnecessary piles and 1.9 acres of piers, which equate to 4,549,986 DSAY. Piers or piles for removal could be selected from locations described in Alternatives 1 and 2, but would also require additional options to be located during PED.

### 3.5 Cost of Mitigation Plan Increments

#### 3.5.1 Cost of Mitigation Plan and Increments

Cost estimates were prepared for each alternative. The team used various information sources to estimate the costs of the alternatives. Available information included records of recent mitigation bank credit and in-lieu fee program credit sales and details from recently completed nearby ecosystem projects. The study team also considered other cost factors such as site access, fuel and equipment, and the disposal of materials.

**Table K-5** displays the costs and outputs for each alternative plan.

For pier removal, the cost was assumed to be \$80/square foot or \$3,484,800/acre and includes removal and disposal of all decking, piles, and other structural materials. For pile removal, a number of factors can influence the cost including pile material, disposal needs (e.g. creosote material may need special handling and disposal compared to concrete), spacing/quantity of piles in the location. Cost estimates can range from \$1,000 to \$6,000 per pile or anywhere from \$200,000 to \$6,000,000 per acre. For purposes of this analysis, the median price of \$3,100,000/acre was used.

**Table K-5: Estimated Cost of Alternative Plans**

| <b>Alternative</b> | <b>Acres</b>                                        | <b>Cost</b>  | <b>Output (DSAY)</b> |
|--------------------|-----------------------------------------------------|--------------|----------------------|
| No Action          | 0                                                   | \$0          | 0                    |
| Alternative 1      | 15.1 acres pile removal                             | \$46,810,000 | 4,529,985            |
| Alternative 2      | 9.1 acres pier removal                              | \$31,711,680 | 4,549,991            |
| Alternative 3      | 5.1 acres pile removal and 6 acres of pier removal  | \$36,718,800 | 4,529,989            |
| Alternative 4      | 7 acres pile removal and 4.9 acres pier removal     | \$38,775,520 | 4,549,988            |
| Alternative 5      | 10 acres pile removal and 3.1 acres of pier removal | \$41,802,880 | 4,549,989            |
| Alternative 6      | 12 acres pile removal and 1.9 acres pier removal    | \$43,821,120 | 4,549,986            |

### 3.6 Plan Considerations

As briefly mentioned in Section 3.5.1, there is significant uncertainty in the cost of pier removal as a number of factors can influence the cost of the action. Additionally, there is a lot of effort throughout the Bay to remove old piers and piles through grants, funding for water quality improvements, special interest working group efforts, and as a form of mitigation for other projects. As a result, the number of piles and piers needing removal lowers every year. The costs and incremental analysis are considered valid based on the information today but will need to be updated during the design phase to ensure that the alternatives have not changed that would result in a new cost-effective or best-buy plan being identified.

During the design phase, if Alternatives 1 or 2 are selected, additional sites will need to be identified within or outside the immediate project area to obtain enough acreage of removal and offset the DSAY losses. If sites are selected outside of the study area, consideration should be given to finding locations as close as possible to the area of impact; however, real estate challenges could be presented, particularly if needing to obtain ownership or perform condemnation at a site under another city or county's ownership. Needing to acquire real estate would increase the overall cost of the action and would also contribute to a potentially different array of best buy or cost-effective plans.

Specifically for piles, during the design phase each individual site will need to be reviewed and, if possible, a standard set to ensure that one acre of restoration will provide sufficient habitat improvement. For example, a site with greater spacing in piers will have a higher starting service life than is assumed and modeled for this study thus requiring more restoration than original assumed. One possible metric for standardization would be to measure the cubic yards of piles being removed and determine an acceptable cubic yardage of material that would equate to one acre of service life at 75%. For piers, the presence of decking is what defines the service life and thus the acreage of decking would contribute to that acreage of habitat once removed.

None of these alternatives should require long-term operation or maintenance, which is a significant savings over some other potential measures that were initially identified, if those are being reconsidered.

## 4.0 Plan Selection

Based on the information available today, Alternative 2 is the recommended mitigation plan as it delivers the necessary offset for the least cost. However, there are several factors that must be taken into account that cannot rule out any of the other alternatives at this time. It is intended that this plan would be revisited during the design phase as designs are refined.

### 4.1 Implementation Risks

A suite of foreseeable implementation risk factors across each phase of implementation (Pre-Construction Engineering and Design, Construction, and Operations) have been identified (**Table K-6**). These factors are based upon experience from similar projects and the consideration of regional risks generally associated with design and construction work in wet environments. Each risk was assessed and assigned a significance level. Potential risk management measures were identified and will be considered should the need arise during implementation or adaptive management.

**Table K-6: Implementation Risks**

| Risk Factor                                     | Risk Potential | Risk Rating | Risk Management Measures                                       |
|-------------------------------------------------|----------------|-------------|----------------------------------------------------------------|
| <b>Planning, Engineering, and Design Phase</b>  |                |             |                                                                |
| Decrease in Habitat Impacts                     | Moderate       | High        | Incorporate avoidance, minimization, and NNBF into the designs |
| Increase in Total Project Habitat Benefits      | High           | Moderate    | Revise habitat modeling and recalculate mitigation need        |
| Sites no longer available (completed by others) | Moderate       | High        | Complete mitigation efforts as soon as practicable             |

| Risk Factor                        | Risk Potential | Risk Rating | Risk Management Measures                                                                                                                                            |
|------------------------------------|----------------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                    |                |             | Coordinate with resource agencies, USACE regulatory, and special interest groups in the Bay to identify other sites.                                                |
| Identification of additional sites | Moderate       | Moderate    | While designs are underway, the USACE and NFS can identify additional piers/pilings that could be removed that have not already been identified in an existing plan |
| Costs Change                       | High           | High        | Consider alternative mitigation sites or methods to construction.                                                                                                   |
| Removal of creosote pilings        | Moderate       | High        | Implementation by the NFS would be required if creosote pilings were removed as part of this strategy.                                                              |
| <b>Construction</b>                |                |             |                                                                                                                                                                     |
| Construction Management            | Moderate       | Varies      | Monitor use of BMPs during construction work. Confirm construction as-built requirements are met. Document all pre- and post-construction at site.                  |
| <b>Long-Term Operation</b>         |                |             |                                                                                                                                                                     |
| None                               |                |             | Once construction is complete, no long-term O&M is necessary.                                                                                                       |

In general, the abandoned, derelict, or damaged piers and piles that have been identified for removal in this plan could be used in any of the alternatives. The alternatives listed piers and piles that have been identified in other plans as areas of interest for removal; however, those plans did not offer an exhaustive list of potential sources. During designs, additional acreage of piers or piles would need to be identified to implement any of the alternatives.

## 4.2 Additional Mitigation Requirements

There may be requirements for compliance with statutes where another Federal agency has decision-making authority. These may include additional specific compensation for ecological impacts to special status fish and wildlife species or other resources. These additional requirements may be necessary to comply with laws such as the Endangered Species Act, the Magnuson – Stevens Fishery Conservation and Management Act, or other Federal laws. If the agencies identify any additional mitigation requirements to obtain project approval, the details of the need will be added here during the design phase.

To date, coordination with National Marine Fisheries Service has not indicated any additional compensatory mitigation requirements given that the Recommended Plan incorporates NNBF at a 3:1 offset (27 acres NNBF : 9 acres bayfill).

### 4.3 Ecological Success, Monitoring, and Adaptive Management

For open/water subtidal habitat and the type of compensatory mitigation measures being considered, the benefit is nearly immediately realized and has a high success potential. Therefore, adaptive management would not be necessary to implement this mitigation plan successfully. Rather, it is intended this mitigation plan would be included in the construction contract of the feature responsible for incurring the impact. Presently, Subreach 2C of the Recommended Plan incurs the full 9 acres of bay fill. Thus, at construction of Subreach 2C, the mitigation and monitoring for this plan must be included as part of that effort to ensure successful implementation of the mitigation strategy.

After removal of the piles and/or piers, the open water area and bay bottom should be monitored to ensure that no fill or debris remains at the removal site. Additionally, the site should be monitored to confirm that any holes in the bay bottom have been adequately filled in to meet the same bottom profile as surrounding areas, so that scouring or deep holes do not form or remain after construction is complete (**Table K-7**).

**Table K-7: Ecological Success Criteria and Monitoring of Mitigation Features**

| <b>Metric</b>      | <b>Success Criteria</b>                                                                                               | <b>Monitoring Methodology</b>                              |
|--------------------|-----------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| Fill Material      | 0% of fill material (old piles, decking, debris, etc.) remains on site                                                | Visual Inspection, post-construction                       |
| Bay Bottom Profile | 95% of the bay bottom profile is consistent with the surrounding bay bottom, with no deep holes or areas of scouring. | Visual Inspection/ Subsurface Profiling, post-construction |

## 5.0 References

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