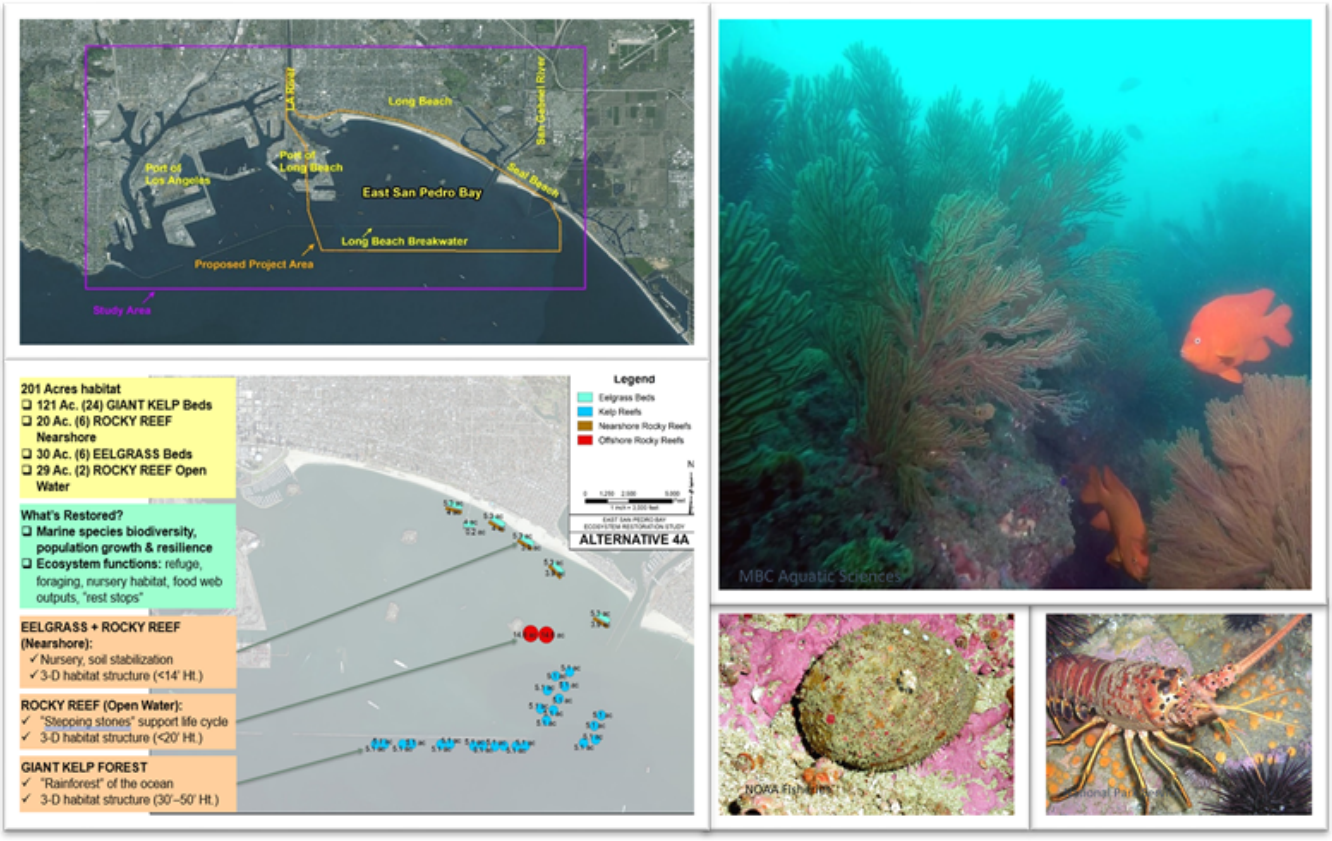
FINAL INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT/ ENVIRONMENTAL IMPACT REPORT (EIS/EIR)

APPENDIX F: MONITORING AND ADAPTIVE MANAGEMENT PLAN

EAST SAN PEDRO BAY
ECOSYSTEM RESTORATION STUDY
Long Beach, California

January 2022



US Army Corps of Engineers ®

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1 INTRODUCTION

The U.S. Army Corps of Engineers, Los Angeles District (Corps) in partnership with the City of Long Beach (City), has developed plan alternatives for aquatic ecosystem restoration in East San Pedro Bay. This document outlines the feasibility level Monitoring and Adaptive Management Plan (MAMP) for the East San Pedro Bay Ecosystem Restoration Study (study) in Long Beach, California. This MAMP identifies and describes the monitoring and adaptive management activities proposed and estimates the costs and durations for the Recommended Plan (RP)/NER plan.

The general purpose of the MAMP is to provide a systematic approach for improving resource management outcomes and a structured process for recommending decisions, with an emphasis on uncertainty about resources response to management actions and the value of reducing that uncertainty to improve management.

More specifically, this MAMP will establish:

- a framework for effective monitoring, assessment of monitoring data, and establishment of project performance standards in the areas of habitat restoration;
- a process for decision-making related to implementation of adaptive management activities in the project area;
- suggested adaptive management actions if the monitoring demonstrates that restoration measures are not achieving established performance standards; and
- estimated cost and duration of monitoring and adaptive management measures.

This plan will be reviewed and revised as needed during the Pre-construction, Engineering, and Design (PED) phase as specific design details are made available. It will adhere to requirements in the Implementation Guidance for Section 1161 of the Water Resources Development Act of 2016 (WRDA 2016), Completion of Ecosystem Restoration Projects, and apply the adaptive management guidelines provided in Fischenich and Vogt (2012).

1.1 STATUTORY BASIS FOR MONITORING AND ADAPTIVE MANAGEMENT

Section 1161 of WRDA 2016 amended Section 2039 of WRDA 2007 to specify information required to be included in monitoring plans for ecosystem restoration projects, and to direct when non-Federal operation and maintenance responsibilities of these projects may cease.

Section 2039 of WRDA 2007, as amended by Section 1161 of WRDA 2016 (Corps 2017), directs the Secretary of the Army to ensure that, when conducting a feasibility study for a project (or component of a project) for ecosystem restoration, the recommended project includes a plan for monitoring the success of the ecosystem restoration. The monitoring plan must include a description of the types and number of restoration activities to be carried out, the physical actions to be undertaken to achieve project objectives, functions and values that will result from the restoration plan, monitoring activities to be carried out, criteria for ecosystem restoration success, estimated cost and duration of the monitoring, and a contingency plan (adaptive management plan) for taking corrective actions in cases in which monitoring demonstrates restoration measures are not achieving ecological success in accordance with criteria described in the monitoring plan. The monitoring plan will also specify that monitoring shall continue until such time as the Secretary determines success criteria are met. Monitoring within 10 years of completion of project construction is a cost shared project cost. Any additional monitoring beyond 10 years is a non-federal responsibility.

This MAMP includes all elements required by the Implementation Guidance for Section 1161 of WRDA 2016 including:

- Types and number of restoration activities to be carried out (Section 1.4);
- Physical actions to be undertaken to achieve project objectives (Section 1.4);
- Functions and values that will result from the restoration plan (Section 1.3);
- Monitoring activities to be carried out (Section 2.2);
- Criteria for ecosystem restoration success (Section 2.2);
- Estimated cost and duration of the monitoring (Section 5.0); and
- A contingency plan for taking corrective actions in cases in which the monitoring demonstrates that restoration measures are not achieving ecological success in accordance with criteria described in the monitoring plan (Section 3.0).

1.2 ADAPTIVE MANAGEMENT TEAM

The MAMP provides the framework and guidance for an Adaptive Management Team (AMT) to review and assess monitoring results and consider and recommend adaptive management actions when ecological success is not achieved, and decision criteria are triggered. The purpose of the AMT is for members to work together to make recommendations relevant to implementing the MAMP. The AMT should be composed of staff from the Corps, the City, and interested resource agencies. Although the Corps and City have coordinated with the entities that will compose the AMT in development of the Final IFR, the AMT will be officially established during the PED phase.

The AMT will focus on the ecological function of the habitats through related management actions to maintain and provide functional marine habitat for general species and Special-Status Species (threatened and endangered species) within the study area. The MAMP provides a monitoring plan and identifies triggers upon which an adaptive management action may be implemented. The AMT will review the monitoring results and advise on and recommend actions that are consistent with the project goals and reflect the current and future needs of the habitat and the species they support within the study area. The Corps will have final determination on all recommended adaptive management actions. If these actions involve physical modification to the project, the cost must be agreed upon by the non-Federal sponsor.

The Corps will be responsible for ensuring that monitoring data and assessments are properly used in the adaptive management decision-making process. If the Corps determines that adaptive management actions are needed, it will coordinate with the AMT on implementation of those actions. The Corps will also be responsible for project documentation, reporting, and external communication.

Once the AMT is established, it will meet at a minimum of once per year, as scheduled by the Corps during the cost-shared monitoring period, to review the results of monitoring and assess whether study objectives are being met. If objectives are not being met, the AMT may recommend that adaptive management actions be taken in response to monitoring results as compared to decision-making triggers.

The AMT may also consider other related projects in the Southern California Bight in determining the appropriate adaptive management actions, and may consult with other recognized experts or stakeholders, as appropriate, to achieve project goals. Furthermore, any proposed changes to the adaptive management plan would need to be coordinated with and approved by Planning Corps Headquarters.

Recommendations for adaptive management should be based on monitoring data collected from current and previous years (including baseline site data). These data will inform the past and predicted response by target species. In addition, current and potential threats to habitat establishment success can also inform appropriate adaptive management techniques or corrective actions.

1.2.1 TEAM STRUCTURE

The AMT will include representatives from the Corps, the City (non-Federal sponsor), and interested resource agencies.

1.2.1.1 U.S. ARMY CORPS OF ENGINEERS

The Corps may be represented by a Project Biologist/Ecologist as well as a Project Hydrology and Hydraulics representative and a Project Geotechnical representative, as needed. Other Corps attendees may include the Project Manager, the Project Environmental Coordinator, and/or Operations and Maintenance designees, as needed.

1.2.1.2 CITY OF LONG BEACH

The City, as the non-Federal sponsor, would ultimately be responsible for all Operations, Maintenance, Repair, Replacement, and Rehabilitation activities once the Corps notifies the City of project completion. Prior to final project completion, the Corps will transfer responsibility for OMRRR of functional elements of the project to the City as they are completed. The City may be represented by a Project Engineering designee. Other City participants may include the City Manager, Director of Planning, City Engineer, Director of Public Works, or their designees.

1.2.1.3 RESOURCE AGENCIES

The AMT should also include representatives from resource agencies who would serve in an advisory capacity, to assist in evaluation of monitoring data and assessment of adaptive management needs. The agencies could include, upon their acceptance:

- U.S. Fish and Wildlife Service (USFWS), Carlsbad Field Office
- National Oceanic and Atmospheric Agency – National Marine Fisheries Service (NMFS), Long Beach Field Office
- California Department of Fish and Wildlife (CDFW), South Coast Region 5
- California Department of Fish and Wildlife (CDFW), Marine Region 7
- California Regional Water Quality Control Board (RWQCB), Los Angeles Region

Additional expertise may be provided by other entities and stakeholders with knowledge of the Southern California Bight ecosystem, hydrology, and wildlife species, at the discretion of the primary AMT participants.

1.3 PROJECT OBJECTIVES

In accordance with specific authorizations, prior reports, and collaborative interactions with the City and other stakeholders, the Corps has defined the study's primary restoration objective as follows: Restore and support the sustained functioning of aquatic habitats such as kelp reef, rocky reef, coastal wetlands, and other types historically present in San Pedro Bay of sufficient quality and quantity to support diverse resident and migratory species within San Pedro Bay during the period of analysis (50 years).

The following sub-objectives have been identified to achieve the primary restoration objective:

a. Increase the extent (total area) of complex aquatic habitats within the project area.

b. Increase the diversity and spatial heterogeneity of complex aquatic habitat types (e.g., rocky reef, kelp forest, etc.) within the project area.

c. Increase the overall connectivity of complex aquatic habitat types within and adjacent to the project area by restoring habitat areas in a way to facilitate the movement of species between habitat nodes to support and enhance existing food webs.

Meeting the requirements for these sub-objectives will improve aquatic ecosystem physical structure and function within the study area, increase biodiversity and/or biomass of associated species within these aquatic habitats, and enhance the ecosystem value of the Southern California Bight.

Expanded habitat areas that could support larger and more diverse populations of native species would further promote the sustainability and resiliency of restored ecosystems/habitats within the project area to sea level rise and coastal storm disturbance. Establishing multiple nodes of similar habitat types would provide further resiliency in the event that one is damaged or degraded.

1.4 RESTORATION ACTIONS

The project development team performed a thorough plan formulation process to identify potential management measures and restoration actions that address the project objectives. Many alternatives for habitat restoration in East San Pedro Bay (ESPB) were considered, evaluated, and screened in producing a final array of alternatives. Of these alternatives, Alternative 4A is the NER Plan (Recommended Plan) and includes the creation or enhancement of nearshore rocky reef and eelgrass, kelp reefs, and open water rocky reefs.

The MAMP provides monitoring and adaptive management information for the NER Plan. A description of the plan can be found in Chapter 4 of the Final IFR and a brief summary is provided in this section.

1.4.1 ALTERNATIVE 4A

Nearshore Rocky Reef and Eelgrass: Six eelgrass habitat restoration areas would be created with associated near-shore rocky reefs. The eelgrass beds would total approximately 30.3 acres and the associated rocky reefs would total approximately 20 acres. The establishment of eelgrass habitat would require building the rocky reefs and bringing in sand from a designated borrow site to create a bench behind the reef to support growth and expansion of eelgrass.

Kelp Reefs: A total of 24 kelp reefs would be created in two locations. Twelve kelp reefs would be located adjacent to the seaward side of the breakwater and twelve would be located in open water. Each reef location would total approximately 61 acres, for a total kelp reef area of approximately 121 acres.

Open Water Rocky Reefs: Two rocky reef complexes would be created in the open water. Each complex would contain several individual reefs. Each reef complex would contain approximately 14.6 acres of reef, for an approximate total of 29 acres.

2 MONITORING

An effective monitoring program measures project changes over time and determines if the outcomes are consistent with project goals and objectives. Consistent, well-designed monitoring is essential to adaptive management because it allows changes in site condition to guide ongoing maintenance activities and management strategies.

The following discussion outlines a monitoring plan that will support the East San Pedro Bay Ecosystem Restoration Study Adaptive Management Program. The plan identifies the monitoring period, performance targets, monitoring design, monitoring procedures, and results and analysis. Each performance measure includes specific feature(s) to be monitored to evaluate project performance. Additional monitoring is identified as supporting information needs that will help to further understand the interrelationships of restoration features and external environmental variability and to corroborate project effects.

Overall, monitoring results will be used to evaluate the progress of habitat restoration toward meeting project objectives and sub-objectives, and to inform the need for adaptive management actions to ensure successful restoration is achieved.

2.1 RATIONALE FOR MONITORING

An adaptive management plan should be closely integrated with a well-designed monitoring program that provides information to guide management decisions. To be effective, monitoring should be developed with the project objectives and performance standards in mind. It should focus on the target habitats and the hydrologic and geomorphic processes that support them, it needs to track changes over time and space at a resolution that is useful to the project, and it needs to be able to distinguish between ecosystem responses that result from project implementation (*i.e.*, management actions) and natural ecosystem variability.

According to the Corps' implementation guidance memo for Section 1161 of WRDA 2016 (Corps 2017),

> Monitoring includes the systemic collection and analysis of data that provides information necessary to determine if the project is meeting its performance standards, and to determine when ecological success has been achieved or whether adaptive management measures are necessary to ensure that the project will attain project benefits.

2.2 MONITORING PERIOD

Upon completion of construction of each phase or group of measures (*e.g.*, breakwater kelp reefs) of the East San Pedro Bay Ecosystem Restoration Project, cost-shared monitoring for ecological success and adaptive management will be initiated and will continue for a period of up to ten (10) years, depending on the restoration measure, or until restoration success is achieved. The monitoring and adaptive management period requirement would vary based on the data needs of the site-specific monitoring programs to assess a particular measure. Concurrent monitoring of one or more nearby reference sites with similar conditions to the desired restored habitat is recommended to differentiate changes at the restoration site that are attributable to the restoration activity versus normal environmental variability affecting the region. Should success criteria not be met for any given measure after ten (10) years of cost-shared monitoring and adaptive management post construction completion,

additional monitoring and adaptive management extending beyond ten (10) years will be a requirement and cost of the non-Federal sponsor.

Although Section 1161 of WRDA 2016 allows for up to ten years of cost-shared monitoring when necessary, this plan currently anticipates that five years of monitoring will be sufficient to achieve restoration success of each feature. However, once the Secretary determines that ecological success for a feature has been achieved, even if this occurs in less than five years, no further monitoring will be performed. If performance criteria for project objectives have not been met within the first five years after the completion of construction of a group of measures (*e.g.*, should construction of one half of the nearshore rocky reefs, "Nearshore RR1", be completed at year "X" and the construction of the second half of nearshore rocky reefs, "Nearshore RR2", be completed one year later), cost-shared monitoring and adaptive management would then continue within those areas until performance criteria are met for a group of constructed measures or for a maximum of five additional years, whichever is less.

If the performance targets cannot be met within the ten-year period of cost-shared monitoring allowed by law, any additional monitoring and management will be a non-Federal responsibility.

Monitoring Approach

This section describes the general approach to monitoring the habitat condition of each habitat type being proposed in the RP. The desired outcome presented for each habitat describes the target condition that would indicate successful restoration and satisfy project objectives. The performance measure for each habitat type is an approximate measurement of desired outcome. Specific interim performance standards (*i.e.*, annual standards for each project year) should be defined prior to project initiation but are not fully outlined here. Additionally, comparisons of predicted and realized Average Annual Habitat Units (AAHU) benefits as described in section 2.3 for a given monitoring period will be performed to explore the effectiveness of restoration measures in generating predicted Habitat Units (HU). However, as performance measures are described for each restoration measure, this exploration is for informational purposes (*i.e.*, refinement of future models, planning and design of future marine ecosystem restoration project measures, etc.) and realized AAHUs will not be used to measure performance or restoration success.

2.2.1 HABITAT TYPE 1: KELP REEF

Desired Outcome: The desired outcome is to both increase the size and lateral extent of existing giant kelp beds and create new beds within the project area to a minimum target size of five (5) acres that contain a medium-to-dense canopy at the water's surface during the peak annual growth period.

Performance Measure: Kelp must adhere to at least 50 percent of the initial rock placement area with medium-to-dense canopy on the water's surface (50–75 percent coverage) in each habitat node where kelp habitat is expected to occur (*e.g.*, open water or breakwater zones).

Monitoring Procedures: Kelp reefs will be monitored quarterly during the performance period using true-color or multi-spectral aerial imagery taken from a small plane or drone. Methods and protocols will adhere to those provided in the Central Region Kelp Survey Consortium (CRKSC; http://kelp.sccwrp.org/home.html) which requires quarterly synoptic monitoring of kelp. The CRKSC was formed in 2003 and consists of various ocean dischargers that monitor kelp along the coast of the Southern California Bight. The images will be used to delineate and digitize the specific locations of the kelp and to measure both total lateral area (*i.e.*, surface area of the water) that is covered by kelp and

surface canopy density. Quarterly images will be used to capture seasonal maximums as well as variability during the year that may be due to project activities, disturbances, and/or seasonal variation.

A reference reef will also be imaged and measured during each monitoring period. The reference reef will be a separate portion of the existing kelp coverage along the Long Beach Breakwater that will not be impacted by restoration activities (*i.e.*, this reference site will be a kelp bed at the breakwater that is not contiguous with the bed to be expanded by the project). Reference sites are areas that are physically and biologically similar to the area being restored (according to pre-determined characteristics) but that do not require restoration (Kennedy and Sanford, 1999; Beck *et al.*, 2011; zu Ermgassen *et al.*, 2012; Baggett *et al.*, 2014). These sites provide a benchmark of how much progress is needed to achieve adequate restoration progress and help control for effects of broad scale natural disturbances when assessing restoration progress. The differences between the restoration project site(s) and the matched reference site(s) are expected to be relatively large before restoration and increasingly small after restoration. Reference sites can also provide information on the effect of naturally occurring disturbances and expectation with respect to natural variability.

The rationale for requiring that the value of a resource be similar to that on natural reefs is based on the requirement that to be successful the restoration reef must provide the types and amounts of resources that occur on natural reefs. One way to help ensure that this will be the case is to select reference reefs that are close to and physically similar to the restoration reef. The premise here is that nearby reefs with similar physical characteristics should support similar biota, which should fluctuate similarly over time. Temporal variability, especially of the sort associated with changes in oceanographic conditions, can be accounted for more easily by sampling the experimental and natural reference reefs concurrently. Concurrent monitoring of the natural reefs will help ensure that regional changes in oceanographic conditions affecting the restored reef will be reflected in the performance criteria, because nearby natural reefs will be subjected to similar changes in oceanographic conditions. Although portions of the Long Beach breakwater are targeted for restoration by increasing the coverage of existing kelp, some areas of the breakwater will not receive additional rock and would be appropriate to serve as a reference site.

In addition to the quantitative monitoring, biological communities and reef production would be qualitatively monitored during Years 3 and 5 by underwater survey and results will be used to assess condition and inform corrective actions. During these surveys, non-native/invasive species (*i.e.*, nuisance species) known to exist either within the Southern California Bight or within the Study Area will also be monitored and managed during the monitoring and adaptive management period. Although not an exhaustive list, monitoring of relevant nuisance species within project features will include species of algae (*e.g.*, *Caulerpa* spp, *Sargassum horneri*, etc.), sessile invertebrates including bryozoans (*e.g.*, *Bugula neritina*), mussels (*e.g.*, *Arcuatula senhousia*), Pacific oyster (*Crassostrea gigas*), and tunicates (*e.g.*, *Botrylloides* spp., *Ciona* spp., etc.). Results of this monitoring will be shared with all relevant natural resource agencies.

2.2.2 HABITAT TYPE 2: EELGRASS

Desired outcome: The desired outcome is to increase the extent (acreage) of eelgrass within the nearshore zone by a minimum extent of 20 acres within the nearshore areas targeted for restoration

Performance Measure: Eelgrass covers at least 85 percent of the initial transplant area with the portion of vegetated cover at least 80 percent of that at the reference site(s).

Monitoring Procedures: The eelgrass beds will be monitored annually using a combination of field survey and visual or acoustic remote sensing methods (*e.g.*, aerial imagery or side-scan sonar) consistent with the California Eelgrass Mitigation Policy (CEMP) and Implementing Guidelines (National Marine Fisheries Service 2014). Parameters that would be assessed are spatial distribution, areal extent, percent vegetated cover, and the turion (shoot) density. Other monitoring parameters would include qualitative assessment of localized wave action and water circulation patterns at restored bed sites. As the CEMP parameters are the standard for measuring and determining the health and resilience of eelgrass and eelgrass is sensitive to wave action and water circulation, these monitoring parameters are considered important for assessing the success of restored eelgrass and will be used to determine appropriate adaptive management measures should they be necessary. Monitoring will be conducted during the peak growing period for eelgrass, which is typically March through October for southern California. A reference population of established eelgrass within the nearshore zone of the study area will also be imaged and measured during each monitoring period. During field surveys, nuisance species known to exist either within the Southern California Bight or within the Study Area will also be monitored and managed during the monitoring and adaptive management period. Although not an exhaustive list, monitoring of relevant nuisance species within project features will include species of algae (*e.g.*, *Caulerpa* spp, *Sargassum horneri*, etc.), sessile invertebrates including bryozoans (*e.g.*, *Bugula neritina*), mussels (*e.g.*, *Arcuatula senhousia*), Pacific oyster (*Crassostrea gigas*), and tunicates (*e.g.*, *Botrylloides* spp., *Ciona* spp., etc.). Results of this monitoring will be shared with all relevant natural resource agencies. Adaptive management results will indicate if more than one reference site in an alternative location will be needed.

2.2.3 HABITAT TYPE 3: ROCKY REEF

Desired outcome: The desired outcome is to increase the extent of submerged hard substrate within the study area where rocky reef habitat is expected to occur (*e.g.*, nearshore and open water zones) by 49 acres.

Performance Measure: The area of exposed rocky reef substrate is sustained at 90 to 100 percent of the implementation area.

Monitoring Procedures: The rocky reef will be monitored during Years 1, 3, and 5 using acoustic survey (*e.g.*, side-scan or multi-bean sonar). The surface area of rocky reef will be digitized from the images to provide estimates of total coverage. As a monitoring option, biological communities and reef production would be qualitatively monitored during Years 3 and 5 by underwater survey. Although not used as a performance metric, the settlement and recruitment of rocky reef associated species to restored reefs along with the establishment of rocky reef communities is expected to also demonstrate the successful restoration of rocky reefs. During these surveys, nuisance species known to exist either within the Southern California Bight or within the Study Area will also be monitored and managed during the monitoring and adaptive management period. Although not an exhaustive list, monitoring of relevant nuisance species within project features will include species of algae (*e.g.*, *Caulerpa* spp, *Sargassum horneri*, etc.), sessile invertebrates including bryozoans (*e.g.*, *Bugula neritina*), mussels (*e.g.*, *Arcuatula senhousia*), Pacific oyster (*Crassostrea gigas*), and tunicates (*e.g.*, *Botrylloides* spp., *Ciona* spp., etc.). Results of this monitoring will be shared with all relevant natural resource agencies.

2.3 MONITORING PROCEDURES

This section provides additional detail about the monitoring procedures provided in Section 2.2.

AAHU Estimate Comparisons:

To explore the effectiveness of measures to generate predicted HUs, during monitoring periods (annually, year 3, year 5, etc.) environmental data relevant to individual restored habitat measures (*e.g.*, temperature, turbidity, etc.) will be obtained and inputted into the San Pedro Bay Habitat Model for each restored habitat and combined with the assessed area to determine HUs for that habitat during the monitoring period. These estimated HUs will be compared to predicted HUs generated during the planning phase at discrete time intervals (3 years, 5 years, etc.).

Acoustic Surveys: Acoustic surveys use active remote sensing methods to provide a visual representation of objects and surface contours; it is an effective technique for mapping bathymetry in underwater locations where light penetration is limited. Side-scan sonar is typically mounted to a submersible and multi-beam sonar is mounted to a ship on the surface of the waters. Monitoring methods for this project will be consistent with the California Eelgrass Mitigation Policy (National Marine Fisheries Service 2014).

Aerial Imagery: True-color and/or multi-spectral aerial imagery provide a visual assessment of the study area. True-color imagery captures light in the visible spectrum while multi-spectral imagery captures light both inside and outside of the visible spectrum. For the purposes of this project, aerial imagery should be captured from a small plane or drone. Images will be geo-referenced and ortho-rectified prior to delivery. Surface resolution of the images should be at least 0.5 foot (0.15 meter) in order to accurately assess the metrics being assessed. Commercially available satellite imagery may be used in lieu of (or in conjunction with) aerial imagery if the product meets the needs of the project.

2.4 RESULTS AND ANALYSIS

The results of the monitoring will be provided to the AMT who will compare data to project objectives and decision-making triggers to evaluate whether the habitat restoration features are functioning as planned. The AMT will use the monitoring results to assess habitat responses to management actions, evaluate overall performance, and make recommendations as appropriate. If monitoring results show that objectives are not being met, the AMT will evaluate causes of failure and recommend adaptive management alternatives to remedy the underlying problems.

As data is gathered through monitoring, more information will be available to address uncertainties and fill information gaps. Uncertainties such as effective operational regimes, benefits generated by restored features, and accuracy of hydrologic models can be evaluated to inform adaptive management actions and future restoration needs.

3 ADAPTIVE MANAGEMENT

Adaptive management planning is a critical component of successful habitat restoration. It provides a framework for actions that will be undertaken to achieve the project objectives if the project is not performing to standards. This section outlines the adaptive management planning framework, identifies triggers for implementation, and lists sources of uncertainty that may impact the need for adaptive management actions.

The level of detail provided is based on currently available data and information developed during plan formulation as part of the Final IFR. Uncertainties may remain concerning the exact project features, monitoring elements, and adaptive management opportunities. Uncertainties will be addressed in the PED phase, and the MAMP may be amended to incorporate additional detail as part of that phase.

3.1 RATIONALE FOR ADAPTIVE MANAGEMENT

The primary incentive for implementing an adaptive management program is to increase the likelihood of achieving desired project outcomes given the identified uncertainties and unknown factors that may influence the outcome of project success. Given these uncertainties and unknown factors, adaptive management provides an organized, coherent, and documented process that suggests management actions in relation to measured project performance compared to study objectives and outcomes. The adaptive management program utilizes the results of continued monitoring to manage restoration actions in order to achieve the study objectives. Adaptive management establishes the critical feedback of information from project monitoring to inform project management and promote learning through reduced uncertainty.

The objectives of the monitoring and adaptive management program are to ensure successful habitat establishment, document maintenance and monitoring efforts, and evaluate the progress of restoration towards performance standards. Implementation of the MAMP would provide flexibility to account for changing environmental conditions. Data collected through monitoring would allow project success to be measured, though it will not alleviate all uncertainty. The MAMP provides a mechanism to evaluate the effectiveness of the restoration implemented and to implement adaptive changes, if required to realize study objectives.

3.2 SOURCES OF UNCERTAINTY

Adaptive management provides a coherent process for making decisions in the face of uncertainty. Scientific uncertainties and technological challenges are inherent with any large-scale ecosystem restoration project. Uncertainties associated with restoration of aquatic habitats within the project area include:

- correct engineering and design to fully address project objectives;
- future operation and maintenance regime required to maintain project objectives;
- ability of hydrologic models to predict project impacts and benefits;
- climate change variability, such as storm frequency, intensity, and timing;
- climate change effects in redistributing sand placed as part of the project;
- the long-term fate of placed material;
- projected recovery time and recruitment for benthic invertebrates; and

- other factors which are not completely within the Corps' or City's ability to predict or prevent,
  such as extreme weather conditions, vandalism, watershed changes, or storm surge events that may occur before the restored habitat has fully established.

Uncertainties may remain concerning specific project features, monitoring elements, and adaptive management opportunities.

3.3 DECISION MAKING PROCESS

The information generated by the monitoring program will be used by the Corps and City in consultation with the other AMT members to guide decisions on adaptive management actions that may be needed to ensure that the ecosystem restoration project achieves success. Final decisions on implementation of adaptive management actions are made by the Corps.

3.4 ADAPTIVE MANAGEMENT TRIGGERS

The adaptive management trigger is a threshold value that is used to determine whether or not corrective action is needed. It can be qualitative or quantitative and should be based on project performance standards, overall performance measures, and the level of information required to assess condition.

If results of the monitoring are poor and trigger adaptive management action, the Corps would consult with the AMT to discuss which adaptive management action is warranted. Further monitoring may be required to determine the cause of system stress and/or project failure in order to choose the appropriate adaptive management action.

3.5 ADAPTIVE MANAGEMENT ACTIONS

Adaptive management measures will be based on the results of qualitative and quantitative monitoring data. Achieving the key objectives and goals of the restoration program and establishing self-sustaining target habitats will be the focus of all adaptive management decisions.

Initial decision criteria are identified below, based on project objectives and performance measures. More specific decision criteria, based on other parameters such as hydrology, geomorphology, and vegetation dynamics will be developed during the PED phase of the project.

3.5.1 HABITAT TYPE 1: KELP REEF

Adaptive Management Trigger: Adaptive measures will be implemented if the study area is not on track to meet project goals and if reasons cannot be explained by environmental factors (*i.e.*, are not observed in the reference area). Specifically, adaptive measures will be implemented if after three years the cover of kelp reef is less than 50 percent of the initial rock placement area with canopy density less than 50 percent, and if coverage of the reference site is greater than 50 percent of its three-year average.

Adaptive Management Tasks: Monitoring results will inform adaptive strategies or corrective actions to achieve performance criteria which will increase the resilience of kelp forest ecosystems to the stressors associated with urban environments (*e.g.*, overfishing, sedimentation, and runoff events) and global phenomena which may be associated with climate change (*e.g.* frequency of El Nino Southern Oscillation (ENSO) and large storm events). Corrective actions may include (1) extension of reef area, (2)

active restoration of kelp (*e.g.,* possible active restoration efforts include outplanting of laboratory-reared juvenile kelp, seeding barren reefs with spores from *Macrocystis*, transplanting drift *Macrocystis*, etc.), (3) removal of nuisance species, and/or (4) repair of existing reef substrate.

3.5.2 HABITAT TYPE 2: EELGRASS

Adaptive Management Trigger: Adaptive measures will be implemented if the study area is not on track to meet project goals and if reasons cannot be explained by environmental factors (*i.e.*, are not observed the reference area). Specifically, adaptive measures will be implemented if (1) after three (3) years eelgrass covers less than 85 percent of the initial transplant area, and/or (2) if the portion of vegetated cover within the eelgrass beds is less than or equal to 50 percent relative to the reference site(s).

Adaptive Management Tasks: These could include activities such as (1) remedial transplanting of eelgrass within the restoration eelgrass bed in order to increase vegetative cover and survival, (2) addition of sand or other unconsolidated material to maintain appropriate bathymetry and depth profiles, (3) addition of material to rocky shoals if wave or circulation patterns are determined to be inhibiting eelgrass establishment and/or growth, and (4) removal of nuisance species. If none of these techniques are demonstrated to be successful, relocation of the restoration measure may be considered.

3.5.3 HABITAT TYPE 3: ROCKY REEF

Adaptive Management Trigger: Adaptive measures will be implemented if the area of exposed rocky reef substrate in any habitat node is less than 90 percent of the desired outcome during any survey year.

Adaptive Management Tasks: These could include activities such as (1) placement of additional hard substrate, 2) re-positioning of existing hard substrate to increase/decrease interstitial spacing, and (3) removal of nuisance species.

4 ASSESSMENT OF PERFORMANCE

The assessment phase of the adaptive management framework describes the process by which the results of the monitoring efforts are compared to the project performance measures to identify whether or not the restoration actions have successfully fulfilled project objectives.

The results of the monitoring program will be assessed annually through the AMT. Monitoring results will be compared to the desired project outcomes as set forth by the project performance measures. This assessment process will measure the progress of the project in relation to the stated project objectives. The AMT will compare monitoring results to decision-making triggers to evaluate project effectiveness and consider if adaptive management actions are needed.

The assessments will indicate if the habitat responses to management actions are undesirable (*e.g.*, are moving away from restoration goals) or if the responses have met the success criteria for the project. Assessments will also inform the AMT if other factors are influencing the response that may warrant further research.

4.1 DATABASE MANAGEMENT

Database management is an important component of the monitoring plan and the overall adaptive management program. As part of the AMT, individuals with responsibility for data management activities in support of an adaptive management program (data managers) will be identified by the Corps. The data managers should collaborate with the AMT in developing a data management plan to support the adaptive management program. The data management plan should describe how and where data will be archived, data standards, data upload process and format, quality assurance and quality control procedures, metadata standards, and public data release. Storage of all data will be handled by the Corps.

Data analysis and reporting will be the responsibility of the Corps who will provide reports for the AMT to facilitate evaluation of adaptive management needs.

4.2 DOCUMENTATION AND REPORTING

The Corps will document the monitoring results, assessments, and the results of the AMT deliberations. The Corps will produce annual reports that will measure progress towards meeting project objectives as characterized by the performance measures. Results of assessments will be used to evaluate adaptive management needs and inform decision-making.

4.3 PERFORMANCE STANDARDS

Performance standards as described above for each of the restored habitats are specific and are used to assess project performance and the trajectory of ecological progress. They are often provided for each year of the project to ensure the project is on track to reach success by the end of the restoration maintenance and monitoring period. Ultimately, performance standards will be used to help determine when ecological success has been achieved and determine whether monitoring may cease prior to the end of the 10-year post-construction monitoring period. For this project, final and interim performance standards will be developed for each habitat type using the performance measures provided in Section 2.0 of this Plan.

4.4 CONCLUSION OF MONITORING FOR PROJECT FEATURES

Ecological success of a project feature will be confirmed when desired outcomes have been achieved, as measured by meeting or exceeding the 5-year or 10-year achievement thresholds. Once ecological success has been documented by the District Engineer in consultation with the Federal and State resources agencies, and a determination has been made by the Division Commander that ecological success has been achieved; no further monitoring will be required specifically for adaptive management. The City will still monitor features following protocols and timelines established for routine maintenance. Ecological success will be documented through an evaluation of the predicted outcomes as measured against the actual results.

When monitoring has shown that project objectives and performance standards have been met, structural measures are required to be maintained in perpetuity by the non-Federal sponsor, while nonstructural measures are required to be maintained only for 10 years after the determination of ecological success.

5 COSTS FOR IMPLEMENTATION OF MONITORING AND ADAPTIVE MANAGEMENT PROGRAMS

The costs associated with implementing the monitoring and adaptive management plan were estimated based on currently available data, methods, and comparable projects. The monitoring methods and potential adaptive management actions as described in this Plan were used as a basis for cost estimating. Because uncertainties remain as to detailed designs and adaptive management needs and opportunities, the costs estimated here will be refined in PED during the finalization of the detailed monitoring and adaptive management plans for each habitat type that is implemented.

5.1 MONITORING AND ADAPTIVE MANAGEMENT PROGRAM COSTS

Cost calculations for monitoring are displayed as a total cost including all labor and expenses. If ecological success is determined earlier than planned, some portions of the monitoring program will end early, and costs will decrease accordingly. Costs for the adaptive management program are based on estimated levels of effort and potential frequency of need and include participation in the AMT and reporting. The current total estimate for implementing the monitoring and adaptive management plan described in Sections 2.0 and 3.0 for the NER Plan, Alternative 4A, is approximately $6 million without factoring in inflation and contingencies.

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