Grant Information

Title of Project
Natural Shoreline Infrastructure in Humboldt Bay for Intertidal Coastal Marsh Restoration and Transportation Corridor Protection

Total Amount Requested	$ 124,999.07
Matching Contributions Proposed	$125,000.00
Proposed Grant Period	02/17/ 2020 - 07/12/ 2021

Project Description
The project will perform site characterization and prepare preliminary design (50%) for a project utilizing tidal benches or similar natural infrastructure techniques to help protect a critical transportation corridor along Humboldt Bay from flood hazards. The project will lay the groundwork for implementation of an innovative approach to restore and perpetuate intertidal coastal marsh, increase community resilience to flooding, and demonstrate the use of natural ecological systems for sea level rise adaptation.

Project Abstract
Funds are requested to develop design plans for a multi-benefit project utilizing natural shoreline infrastructure along a 1.25-mile section of Humboldt Bay. The purpose of the project is to restore and enhance intertidal coastal marsh habitat, protect transportation infrastructure, and create an adaptable space for intertidal marsh migration. The project site is a highly vulnerable segment of transportation corridor (state highway, share-use path, railroad) where managed retreat is not feasible. The habitat along the shoreline is primarily intertidal mudflat with intermittent narrow fringes of intertidal coastal marsh. Coastal marsh has high ecological value by providing habitat for sensitive plant species, benthic and terrestrial invertebrates, larval stages of fish species, and roosting and foraging areas for birds. The extent of existing coastal marsh is reduced from historical conditions due to erosion, and these remnant patches are projected to be lost with sea level rise. Areas of erosion on the railroad prism correlate with the absence of tidal marsh, pointing to the flood protection value of the marsh plain. California actively supports natural infrastructure as an alternative or supplement to coastal armoring. The project site is an excellent candidate for a tidal bench or horizontal levee to create an ecotone transition slope habitat that can expand intertidal coastal marsh while also dissipating wave energy and reducing erosion on adjacent infrastructure.

Organization and Primary Contact Information

Organization	Humboldt County Department of Public Works
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Full Proposal Project Narrative

Project Title: Natural Shoreline Infrastructure in Humboldt Bay for Intertidal Coastal Marsh Restoration and Transportation Corridor Protection

1. **Coastal Community Context:**

Project Summary

The project will integrate the natural flood risk reduction properties of salt marsh into a shoreline management strategy to help protect a critical transportation corridor along Humboldt Bay from flood hazards. The project will perform site characterization and prepare preliminary design (50%) for a project utilizing tidal benches or similar natural infrastructure techniques. The project will lay the groundwork for implementation of an innovative approach to restore and perpetuate intertidal coastal marsh, increase community resilience to flooding, and demonstrate the use of natural ecological systems for sea level rise adaptation.

Location and Setting

Humboldt Bay is located on the coast of northern California approximately 265 miles north of San Francisco and 100 miles south of the border with Oregon (Map 1). Humboldt Bay is the second largest enclosed bay (approximately 17,000 acres) within California and supports more than 250 species of birds, 95 species of fish, 50 species of mammals, 20 species of reptiles and amphibians, and 300 invertebrates with its diverse subtidal and intertidal habitats (Harbor District, 2007). Humboldt Bay is comprised of two wide, shallow basins connected by a narrow entrance channel which is stabilized by jetties (Map 2). The project is located along an approximately 1.25-mile section of the eastern shoreline of the northern basin (known as North Bay or Arcata Bay), situated between the cities of Eureka and Arcata, the two largest cities in the county (Maps 3 and 4). Approximately 65,000 people, nearly half the population of Humboldt County, live in the vicinity of Humboldt Bay. The majority of the census blocks in the Humboldt Bay region are economically disadvantaged based on median household income.

Humboldt Bay is dominated by marine influences with relatively little freshwater inflow. The northern and southern basins are sheltered from ocean wave exposure by two large sand spits stabilized with extensive dune systems. Habitat types include deep-water channels, tidal channels and sloughs, mudflats and eelgrass beds, coastal marsh, coastal prairie, agricultural wetlands, and riparian forest. At low tide, extensive intertidal areas are exposed, comprising nearly two thirds of the bay's total area. At high tide, water depths in intertidal areas can exceed six feet. North Bay has a fetch of approximately four miles, resulting in strong local wind waves with wave heights of two to three feet.

The project site is a highly vulnerable segment of the Eureka-Arcata transportation corridor which includes railroad line, U.S. Highway 101, and future multi-use trail (Maps 3 and 4). The railroad serves as the hardened shoreline and de facto levee for the transportation corridor. U.S. Highway 101 (managed by the California Department of Transportation [Caltrans]) is the primary highway route along the California north coast and serves both regional and interregional transportation. The segment of Highway 101 within the project area is a four-lane expressway with average annual daily traffic of nearly 40,000. Most of the residents of the Humboldt Bay region travel the Eureka-Arcata corridor on a daily or weekly basis. Humboldt County is currently designing the Humboldt Bay Trail South project which will be situated between the railroad and Highway 101, with construction expected to start in 2021. This 4.2-mile project will complete a 14-mile network of regional multi-use trails around Humboldt Bay. The project area encompasses the portion of the Eureka-Arcata corridor with the lowest railroad elevations (9.5 to 11 feet NAVD88). As part of the Humboldt Bay Trail South project, the crown of the railroad embankment will be raised to a minimum elevation of 11.5 feet NAVD88 and revetment along the shoreline will be repaired.

The sheltering of the northern and southern basins of Humboldt Bay from ocean waves allowed large areas of intertidal coastal marsh (also called salt marsh) to form historically along the bay margins (Curtis, 2019). Salt marsh occupies a relatively narrow band of elevation in the upper intertidal zone (approximately 5.0 to 8.5 feet NAVD88) in

areas where there is sufficient sediment supply and a relatively low energy environment. Salt marsh has high ecological value by providing habitat for sensitive plant species, benthic and terrestrial invertebrates, larval stages of fish species, and roosting and foraging areas for birds. Slight variations in marsh elevation influence the frequency and duration of tidal inundation, which in turn influence salinity and the distribution and abundance of plant species (Eicher, 1987; H.T. Harvey, 2012). Approximately 25 plant species are found in Humboldt Bay salt marshes. Two dominant species include the native pickleweed (*Salicornia pacifica*) and the non-native dense-flowered chordgrass (*Spartina densiflora*), with the associated plant species varying based on elevation.

Historically, extensive coastal marshes, mudflats, and sloughs surrounded Humboldt Bay. Construction of dikes around former tidelands to support land conversion for agriculture and other development occurred starting in the late 19th century and continuing through the first half of the 20th century (Laird, 2013). The Northwest Pacific Railroad line was constructed starting in 1900 along the eastern margin of the bay. Highway 101 was constructed parallel to the railroad starting in 1920. Prior to development, Humboldt Bay contained approximately 10,250 acres of coastal marsh (Schlosser, 2012). Currently Humboldt Bay contains approximately 905 acres of coastal marsh, less than 10% of the estimated historic extent (Schlosser, 2012). Shoreline segments with more extensive salt marsh areas adjacent to the railroad are situated north and south of the project area (Map 3). Within the project area, the habitat adjacent to the shoreline is primarily mudflat with intermittent narrow patches of salt marsh (Map 4). Based on maps from 1870, salt marsh extended further into the bay within the project area prior to construction of the railroad (Maps 5 and 6).

Flood Hazard and Sea Level Rise Vulnerability

This project responds to the fundamental problem that infrastructure constructed 75 to over 100 years ago along Humboldt Bay was built for the sea level and flooding hazards of the time, but without accounting for future sea level rise. These historical dikes and embankments were typically built with one to two feet of freeboard which has largely been lost due to sea level rise over the last century. The north coast of California is experiencing the combined effects of global sea level rise, regional sea level variability due to ocean-atmosphere circulation dynamics (e.g., El Niño Southern Oscillation), and significant downward vertical land motion (subsidence) associated with the off-shore Cascadian subduction zone. The current estimate for regional sea level rise along the Pacific coast is approximately 2.3 mm/year (NHE, 2018). Vertical land motion in the Humboldt Bay region compounds the magnitude of sea level rise to generate the highest rate of local sea level rise in California. The most recent estimate of local sea level rise at the North Spit tide gauge station is 4.97 mm/year, more than twice the current estimate for regional sea level rise (NHE, 2018). This analysis indicates that sea level rise will affect Humboldt Bay faster than other parts of the Pacific coast and highlights the urgency for implementing adaptation measures.

In December 2005, storm surge combined with high tides resulted in the highest recorded water level in Humboldt Bay (9.54 feet NAVD88), concurrent with heavy winds and wind waves, resulting in overwashing of the railroad and closure of Highway 101 for several hours due to flooding (see photos in Section 6). Portions of the railroad embankment within the project area experienced significant erosion damage (see photos in Section 7). Future impacts will be more severe with sea level rise and continued deterioration of shoreline structures. Notably, flood damage during the December 2005 storm event was highest along segments of the railroad where salt marsh is absent and the railroad is directly adjacent to mudflat. These segments are exposed to stronger waves due to a deeper water column and the lack of wave attenuation that would be provided by the roughness of salt marsh vegetation.

The vulnerability of the transportation corridor in the project area has been identified through multiple technical studies and planning efforts, as summarized below. These documents reflect a progression of increased understanding of vulnerability and a gradual shift from general assessment toward identifying adaptation options and developing specific adaptation strategies.

- **FEMA Coastal Flood Study for Humboldt Bay (FEMA, 2014).** FEMA performed a detailed coastal engineering analysis and mapping for the Pacific coast of California, including Humboldt Bay. Tidal stillwater levels, wind waves, and wave runup were analyzed to generate predictions for total water levels along the shoreline for current conditions (not reflecting sea level rise projections). Total water levels within the project area range from 11 to 14 feet NAVD 88. Prior to this work, the base flood elevation for Humboldt Bay on FEMA flood maps was a uniform 9.37 feet NAVD88. The analysis of wind waves in this study was relatively simplified but provided the first bay-wide estimate of total water levels.

- **Caltrans District 1 Climate Change Vulnerability Assessment and Pilot Studies (Caltrans, 2014).** Caltrans evaluated the vulnerabilities of state-owned transportation assets to climate change throughout the four-county district and identified a range of adaptation options at four prototype locations. The Eureka-Arcata Highway 101 corridor was identified as highly vulnerable to tidal inundation and classified as a priority area for future work. Initial concepts for adaptation were listed but not developed in detail.

- **Humboldt Bay Sea Level Rise Adaptation Planning Project, Phase 2 Report (Laird, 2015).** This report synthesized information on vulnerability around Humboldt Bay and presented concepts for a regional collaborative adaptation planning process. The Eureka-Arcata Highway 101 corridor was analyzed in one of the two detailed case studies focusing on critical regional assets at risk.

- **Humboldt Bay Sea Level Rise, Hydrodynamic Modeling, and Inundation Mapping (NHE, 2015).** This technical report documented the development of a sophisticated hydrodynamic model to evaluate the spatial distribution of flood elevations throughout Humboldt Bay, which can vary several feet due to tidal amplification and other processes. The NHE Humboldt Bay model provides estimates for stillwater levels throughout the bay (not including wind waves). The report provided estimates for the extent of inundation for various increments of sea level rise and supported the vulnerability assessment performed by Laird (2015). The NHE Humboldt Bay model continues to be the primary tool for predicative modeling of stillwater elevations for extreme high water events and sea level rise scenarios around Humboldt Bay.

- **Caltrans District 1 US Route 101 Transportation Concept Report (Caltrans, 2017).** This report was a long-range planning document for Highway 101 on the North Coast that identified existing and future conditions as well as future needs. The report identified the ultimate facility concept for the Eureka-Arcata Highway 101 corridor as a "climate resilient corridor" to address the impacts of sea level rise.

- **Humboldt Bay Area Plan Sea Level Rise Vulnerability Assessment (Laird, 2018a).** This report synthesized information on sea level rise vulnerability around Humboldt Bay to inform Humboldt County's update of the Humboldt Bay Area Plan (in progress). The Humboldt Bay Area Plan contains policies and standards for land use and new development and will provide a framework for initiating proactive sea level rise adaptation measures. This report notes that the Eureka-Arcata corridor traverses diked former tidelands, making it susceptible to tidal inundation if the railroad grade is breached and susceptible to flooding from extreme storm events. The Eureka-Arcata corridor is rated as "highly vulnerable."

- **Humboldt Bay Area Plan Diked Shoreline Sea Level Rise Adaptation Feasibility Study (Laird, 2018b).** This study was prepared to support the Humboldt Bay Area Plan update by analyzing the vulnerability of the diked shoreline around Humboldt Bay and exploring adaptation measures applicable to diked shoreline structures. The hydrologic sub-unit encompassing the project area received the highest vulnerability rating out of the 23 total hydrologic sub-units around Humboldt Bay.

- **Humboldt Bay Trail South Sea-Level Rise Vulnerability and Adaptation Report (ESA, 2018).** This study was developed to refine the technical understanding of vulnerability of the Humboldt Bay Trail South project, to inform the design process and provide guidance for developing a strategy for implementing future adaptation measures. This study provided estimates of wave heights and wave runup within the project area and developed engineering criteria for evaluating the impacts of stillwater flooding and wave overtopping.

- **US Geologic Survey Coastal Storm Modeling System (CoSMoS) – Assessing Coastal Hazards Due to Sea Level Rise and Storms on the North Coast (in progress).** USGS initiated a two-year study in 2018 to apply the CoSMoS model along the North Coast of California, including Humboldt Bay. This study will develop more advanced estimates of wind waves along with modeling tools to predict the geomorphic response (e.g., shoreline erosion, bluff retreat) caused by extreme storm events.

Sea Level Rise Adaptation Planning and Policies

General categories for sea level rise adaptation include protection, accommodation, and retreat (Coastal Commission, 2018). Protection involves defending development in its current location with "hard" or "soft" defensive measures.

Accommodation involves modifying existing development or designing new development to decrease hazard risks, often with a "letting water in" approach. Retreat involves relocation or removal of existing development out of hazard areas. Hybrid approaches combine multiple strategies, such as planning to protect and accommodate in the short-term and retreat in the long-term. The presence of several established communities, steep forested hillslopes, and environmentally sensitive habitat areas around the outer margin of the historic Humboldt Bay footprint makes the concept of re-locating the Eureka-Arcata transportation corridor infeasible, at least before 2100 (Caltrans, 2018). Therefore, a strategy of protecting and/or accommodating to the greatest extent possible is needed to ensure the resilience of the Eureka-Arcata transportation corridor and avoid major economic and social disruption.

Various efforts are underway to develop strategies for communities and critical assets around Humboldt Bay:

- **Humboldt Bay Management Plan (Harbor District, 2007).** This plan was adopted by the Humboldt Bay Harbor, Recreation and Conservation District to provide a comprehensive framework for balancing and integrating conservation goals and economic opportunities in a cooperative manner for the management of Humboldt Bay's resources. The plan contains a policy to "Identify needs for potential shoreline improvements necessary to accommodate bay water surface elevation changes, including potential effects of climate change" (HSM-7), and a policy to "Require the use of non-structural shoreline protection [such as marsh vegetation] where feasible and appropriate" (HSWM-6).

- **Humboldt Bay Area Plan Update (in progress).** Humboldt County is updating the Humboldt Bay Area Plan to incorporate policies and strategies consistent with the guiding principles recommended by the California Coastal Commission (2018). One of the draft policies is: "Encourage construction of protective shoreline structures with living shoreline components to protect existing assets and coastal resources, and minimize the need for shoreline fortifications" (Policy Option 1.8).

- **Sea Level Rise Adaptation Plan for Humboldt Bay Transportation Infrastructure in the Eureka Slough Hydrologic Sub-unit (in progress).** Humboldt County is collaborating with several partners to develop an adaptation plan for transportation infrastructure and other assets of the Eureka Slough hydrologic sub-unit, which encompasses the project area for this NFWF proposal. Work is funded through a Caltrans Adaptation Planning Grant ($425,000) and will be completed in June 2020. This planning effort focuses on evaluating the geomorphic setting and specific physical processes that are most likely to cause flooding impacts; identifying a range of hazard scenarios; identifying at least four feasible project design concepts; and developing implementation strategies. One of the primary goals is to build relationships and an organizing framework for advancing collaborative efforts among public and private landowners at a regional scale.

- **Caltrans Long-Term Sea Level Rise Phased Adaptation Plan for the Eureka-Arcata Highway 101 Corridor (future).** Caltrans is in the process of implementing a major safety improvement project along the Eureka-Arcata corridor including the construction of a large separated grade intersection. The draft coastal development permit from the California Coastal Commission contains a condition requiring Caltrans to prepare a long-term Phased Adaptation Plan for the Eureka-Arcata corridor, including a requirement to consider the feasibility of "living shoreline" and other natural features as elements of the adaptation strategy.

Conservation Needs

The need for conservation and protection strategies for salt marsh around Humboldt Bay is documented in the following plans and studies:

- **Humboldt Bay Management Plan (Harbor District, 2007).** This plan discusses the goal of restoring substantial areas of salt marsh composed of native species to resemble the marshes present prior to historical conversion, in order to better support the native ecological communities that are present in Humboldt Bay. According to the plan, "Salt marshes in the Bay have been reduced substantially in area with respect to their pre-settlement extent, and they continue to be lost. In addition, the extant salt marshes are degraded by the dominant presence of dense-flowered cordgrass. The benefits of shoreline-protecting salt marshes for stabilizing sediment and protecting shoreline structures from wave impacts combine with a conservation focus on maintaining or restoring salt marshes to make the restoration or enhancement of salt marshes an important concern for the District."

- **Humboldt Bay and Eel River Estuary Benthic Habitat Project (Schlosser, 2012).** This comprehensive study synthesized existing and new information on habitat distribution around Humboldt Bay. The study describes how the benthic invertebrates in salt marshes are primary components of the bay's food web and how salt marshes are a key source of primary productivity. The study describes the function of salt marshes as refuge for larval stages of fish species and roosting or foraging areas for numerous species of birds, especially during high tides. According to the study, "Community adaptation strategies to rising sea level are needed for long-term conservation of Humboldt Bay salt marshes…. One reason for this concern is the restricted ability of intertidal coastal marshes to expand their range landwards. Most intertidal coastal marshes in the region are truncated at their upper margin by levees."

- **Assessing Marsh Response from Sea Level Rise Applying Local Site Conditions (USGS, 2013; USGS, 2016).** This two-part study evaluated the vulnerability of salt marshes in Humboldt Bay to different rates of sea level rise by collecting detailed baseline data, assessing sedimentation patterns, and modeling elevation and habitat changes under sea level rise scenarios. The study concluded that marsh vertical growth is unlikely to keep pace with sea level rise and the majority of salt marsh in Humboldt Bay is projected to convert to unvegetated intertidal mudflat or subtidal habitat by 2100.

The need for restoration and protection of salt marsh is driven by two aspects: (1) the loss of 90% of salt marsh habitat around Humboldt Bay as a result of the historical diking of intertidal areas for agriculture and infrastructure, and (2) the threat that the narrow elevation band suitable for salt marsh will be flooded as sea level rise proceeds and existing development will prevent landward marsh expansion.

Natural Shoreline Infrastructure

For protection against flooding and erosion caused by rising sea levels and extreme storms, California is emphasizing a design approach called natural shoreline infrastructure which is defined as "using natural ecological systems or processes to reduce vulnerability to climate change related hazards while increasing the long-term adaptive capacity of coastal areas by perpetuating or restoring ecosystem services" (Newkirk, 2018). This approach is prioritized in the California Coastal Commission's Sea Level Rise Policy Guidance (2018). Similarly, the Federal Highway Administration (2018) encourages "nature-based solutions" to prevent coastal highway flood damage and/or disruption by implementing approaches that mimic characteristics of natural features and protect or improve the build environment while maximizing the habitat value associated with the natural system.

Newkirk (2018) provides technical guidance for six natural shoreline infrastructure measures (sand dunes, cobble berms, marsh sills, tidal benches, oyster reefs, and eelgrass beds) which are intended to have coastal habitats act as natural, self-sustaining buffers that provide protection from storms and sea level rise. Although highly compelling as a concept and encouraged by public agencies, relatively few natural shoreline infrastructure projects have been implemented in California to date. One challenge is the need to understand site-specific physical processes and account for knowledge gaps and uncertainty. Other challenges include the need to demonstrate an overall net ecological benefit to the intertidal habitats affected; the need to develop site-specific designs with interdisciplinary teams; and aligning the innovative approach with existing permitting paradigms. The proposed project was developed specifically to address these challenges.

Project Concept

As described above, the communities around Humboldt Bay are embarking on a pathway to develop and employ a variety of strategies for sea level rise adaptation in multiple stages over the course of several decades. The project area has been identified as a highly vulnerable segment of critical transportation corridor, and the correlation between areas of erosion on the railroad and the absence of adjacent salt marsh indicates that the project site is an excellent candidate for a natural shoreline project centered around restoring or creating new salt marsh. Although the railroad prism will be repaired as part of the upcoming trail project, sea level rise adaptation measures are urgently needed to protect the overall Eureka-Arcata transportation corridor.

The project concept is to design a tidal bench or horizontal levee to create an ecotone transition slope habitat that can create new salt marsh habitat while also dissipating wave energy and reducing erosion and wave overtopping. Tidal benches and horizontal levees both utilize a gentle sloping surface constructed with fill material and subsequently

vegetated, with slopes designed to provide transitional habitat between intertidal areas and terrestrial uplands. Tidal benches generally extend up to mean higher high water while horizontal levees extend higher to include the upland transition zone (Newkirk et al, 2018). By attenuating wave energy, these landforms can help minimize shoreline armoring and delay the need for hardened features or raising the elevations of protective structures. The project will develop a site-specific design for a tidal bench or horizontal levee based on geomorphic evaluation, hydraulic modeling, characterization of existing conditions, and review of reference sites. The project area is especially favorable for this design concept because salt marsh extended further out into the bay historically compared to current conditions (Maps 5 and 6). The general project goal is to maximize ecological function by restoring historical areas of salt marsh and creating new areas of salt marsh. Existing data and information about the project area are extensive and the availability of existing models and analytical tools provides a solid foundation for success.

2. **Activities:**

Task 1 - Grant Management and Administration

This task includes financial and contract administration and meeting the terms and conditions of the grant agreement for invoicing and reporting. This task also includes procurement of consultants and all project communications.

Task 2 – Stakeholder Engagement and Consultation

This task includes engagement with stakeholders and consultation with a technical working group. Stakeholders include various public agencies, environmental organizations, hunting and fishing organizations, and interested community members. Stakeholders will assist in defining the specific project goals and objectives, identifying community interests, evaluating constraints and opportunities, sharing pertinent information, refining the design process, and reviewing preliminary work products. The County's project team will reach out to stakeholders and engage through a series of individual meetings or communications as appropriate. A project website will be developed to facilitate sharing of documents and information. A presentation will be given at the next Humboldt Bay Symposium. This task is consistent with previous adaptation planning efforts on Humboldt Bay which identified collaboration, community input, and early consultation as critical for success.

Engagement with regulatory agencies is especially important to ensure that the proposed project is consistent with applicable environmental laws and regulations. This task includes a regulatory constraints analysis of the California Coastal Act, Clean Water Act, Endangered Species Act, Porter-Cologne Water Quality Control Act, California Environmental Quality Act, and Humboldt Bay Harbor District policies and regulations. Coastal Commission staff have offered to be actively involved. In addition to general stakeholder engagement, local scientists and engineers from public agencies with experience working on related conservation or adaptation projects will be invited to participate in a technical working group to provide guidance, recommendations, and assistance as appropriate. Six technical working group meetings are planned. Several local experts have prepared support letters detailing their offers to participate and provide vital contributions to the project (Section 8).

Task 3 – Site Assessment

Task 3.1 – Topographic and bathymetric survey

Multiple local partners have contributed for total funding of $144,000 to acquire high-resolution imagery and LiDAR elevation data in the greater Humboldt Bay area in July 2019. The flight was flown in at low tide to capture as much intertidal areas as possible. Imagery was acquired at 1.5-inch pixel resolution and the LiDAR data will be used to create a one-meter resolution digital elevation model. As part of the NFWF-funded project, additional topographic and bathymetric data will be collected to supplement the July 2019 LiDAR flight as needed (for example, if more accurate survey data are needed for certain features, or if certain areas were submerged and not captured by the July 2019 LiDAR flight). Both topographic and bathymetric data can likely be collected with standard real-time kinematic global position system (RTK-GPS) surveying techniques. The existing and new data will be processed to create an integrated surface model and base map.

Task 3.2 – Sediment characterization

Existing information includes the results of the geotechnical study for the Humboldt Bay Trail South project (Crawford, 2019). Field work for this study included four drilled borings and four cone penetrometer soundings along the railroad prism within the project area. Additional sampling will be conducted to characterize the sediment substrate within the mudflat and remnant salt marsh areas of the project area. Samples will be tested for particle size

distribution, salinity, organic content, and water content. This work will support the development of specifications for the fill material to be used to create the natural shoreline features, and to ensure that the properties of the surface layer will support the target vegetation species in the re-vegetation plan (Task 4.4).

Task 3.3 – Habitat evaluation and vegetation mapping
The existing habitat types within the project area will be mapped and significant microhabitat features such as tidal channels will be identified. This task includes a survey for special-status species following the protocols established by the California Natural Resources Agency (2018). Field work will be performed during seasonally-appropriate times of the year. Vegetation within the existing salt marsh remnants will be sampled using the quadrat method. A one-square-meter quadrat will be positioned randomly across transects distributed throughout the marsh units. Species composition will be recorded and percent cover will be estimated for each cover class. Transects will be positioned to ensure adequate representation of the vegetation zones that may be present along the gradient from low marsh to high marsh. Salt marsh vegetation types will be classified to the alliance level following Sawyer (2009). The topographic data collected in Task 3.1 will be used to correlate vegetation zones with elevation ranges. This work will support the development of the re-vegetation plan and the comparison between pre- and post-project conditions (Task 4.7).

Task 3.4 – Geomorphic evaluation
The geomorphic context within the project area will be characterized. This work is needed to support a process-based restoration approach based on an understanding of the physical processes that affect the landforms and habitat in the project area. The geomorphic evaluation will include a preliminary conceptual model that identifies historic conditions (based on historical maps and photographs), characterizes existing landforms, identifies patterns of erosion and sediment deposition, analyzes landscape evolution, and predicts the anticipated geomorphic response to post-project and future conditions. The review of historical conditions is important to address the question whether it is desirable to attempt to closely replicate historical salt marsh boundaries, or if the geomorphic context has changes significantly such that more design freedom is appropriate. The geomorphic evaluation will identify the likely sources of sediment supply and compare the anticipated sediment accretion rate with local sea level rise to predict the likely trajectory of the site. This work is important to inform the salt marsh design elevations. This task will also assess the stability of the existing salt marsh remnants and identify any areas of erosion, to help determine whether there is a need to enhance the stability of these remnants as part of the project. This task will also assess the existing drainage network and develop recommendations for drainage features within the project design.

Task 3.5 - Hydraulic analysis
The hydrodynamic model from NHE (2015) will be utilized to specify tidal datums within the project area for current conditions and various sea level rise scenarios. This sub-task includes an analysis of the relationship between marsh plain elevations and the Mean Higher High Water tidal datum, which will support the project design (Task 4). This work will provide the technical basis for designing the project to provide space for salt marsh to migrate upward with sea level rise. Existing analysis from ESA (2018) and new information from USGS regarding wind waves will be utilized to characterize the wave environment. New analysis will be performed using a suitable model (such as Simulated WAves Nearshore [SWAN] or Wave Height Analysis for Flood Insurance Studies [WHAFIS]) to model the wave attenuation effects under existing conditions and with the project. This work is important for sizing the rock in the marsh sill portion of the project, developing the re-vegetation plan, and optimizing the geometry of the project. This subtask includes an evaluation whether the project has any potential adverse impacts on wave reflection or circulation patterns in the bay.

Task 4 – Preliminary Design

Task 4.1 - Goals and objectives
The purpose of the project is to restore and enhance salt marsh habitat, protect transportation infrastructure, and create an adaptable space for salt marsh migration. The overarching goal is to optimize ecosystem benefits and habitat resiliency, substantially alleviate flood risks, and avoid or minimize adverse impacts. This task involves developing specific project goals and objectives which will be informed by stakeholder engagement and consultation (Task 2).

Task 4.2 - Options evaluation
This task involves a detailed evaluation of options for natural infrastructure within the project area. The differences between tidal benches and horizontal levees will be analyzed and compared by reviewing the literature and design reports from analogous projects (e.g, in San Francisco Bay). This work is important to provide a sound, viable basis

for project design. This task includes consideration of potential project elements such as a breakwater feature and/or options for stabilizing the bayward edge of the project. Another important design question is how to integrate restored/new salt marsh with existing salt marsh. This task includes evaluating construction best management practices especially with regard to minimizing impacts to water quality and sensitive species. This task includes scoping for potential material sources, such as beneficial reuse of dredged sediment. Opportunities for beneficial reuse of sediment is a regional priority and the Humboldt Bay Harbor District is developing an integrated approach by establishing storage areas, planning material handling logistics, and conducting programmatic permitting. This work is important to identify opportunities for reduced project costs and environmentally beneficial construction practices.

Task 4.3 – Engineering design
Engineering design will be performed in three iterations using AutoCAD computer aided design software. The plan set will include schematics in plan view superimposed on the base map (Task 3.1) along with typical cross-sections. The first iteration will be an initial conceptual design (10% design level) consistent with the goals and objectives and informed by early feedback from stakeholders and the technical working group (Task 2), along with the preliminary results of the site assessment (Task 3). The second iteration (35% design level) will be refined based on comments from the technical working group. This design set will provide the basis for the initial hydraulic analysis (Task 3.5). The third iteration (50% design level) will reflect further refinement based on completion of the site assessment and further review from the technical working group and stakeholders. The second (35%) and third (50%) design sets will include design details and estimates of material quantities, construction costs, and impact areas.

Task 4.4 – Re-vegetation plan
A plan for establishing vegetation in the restored habitat areas will be developed. The plan will specify species mix, planting methods, and maintenance activities. The plan will be informed by the vegetation mapping of the existing salt marsh remnants and evaluation of nearby reference sites. The plan will address the challenge of establishing vegetation on disturbed ground subject to frequent inundation. The plan will address the critical goal of avoiding establishment of the invasive dense-flowered chordgrass (H.T. Harvey, 2012). Sustained periodic maintenance will likely be required.

Task 4.5 – Access and staging plan
The Humboldt Bay Trail South project will be planned with the intent to accommodate future access to the project area for construction of the natural shoreline infrastructure project. An access and staging plan will be developed to identify construction methods, equipment types and sizes, material types and quantities, travel routes, and locations for site access, equipment staging, and material stockpiling. This plan is important to ensure that the project is feasible within the constraints of a tightly constrained project area and to avoid disturbance of environmental sensitive habitat areas. This plan will be needed to obtain an encroachment permit from Caltrans and a coastal development permit from the Coastal Commission.

Task 4.6 – Monitoring plan
A robust plan for effectiveness monitoring will be developed including key monitoring questions, performance criteria, parameters, scale, sampling methods, analysis approach, and reporting. The monitoring plan will be consistent with Roni and Beechie (2013).

Task 4.7 – Habitat effects analysis
Habitat type and ecological function will be analyzed within the project area under three basic scenarios: (1) existing conditions, (2) future conditions if no action is taken, and (3) future conditions with the proposed project. This analysis will characterize the function and quality of habitat for fish (including the endangered tidewater goby, three threatened salmonid species, and species that are important for recreational and commercial fisheries), birds (including waterfowl and shorebirds), mammals, amphibians, and plant communities (including eel grass and sensitive plant species). The future-condition scenarios will be developed based on the geomorphic evaluation (Task 3.4) and projected sea level rise rates (Task 3.5). This analysis will be documented in the Final Report (Task 5).

Task 5 – Reporting
This task includes preparation of a Final Report summarizing the work performed in Tasks 2 through 4. The report will document the basis of project design and provide recommendations for next steps to implement the project.

3. **Outcome(s):**

The work products for this project include 50% design plans that will be ready for a benefit-cost analysis, pursuit of construction funding, and environmental review and permitting. The project will also develop plans to support project implementation and a Final Report.

The project will benefit the Humboldt Bay community by:

1. Developing the design for a feasible project to help substantially reduce flooding risks along the Eureka-Arcata transportation corridor. Implementation of this project with future funding will result in reduced road closures, interruption of service, unsafe conditions, and damage to public infrastructure. The amount of reduction in total water level will be quantified (Task 3.5).
2. Raising awareness of sea level rise vulnerability and opportunities to implement natural shoreline infrastructure project as part of an integrated strategy for sea level rise adaptation.
3. Developing a model framework for successful implementation of natural shoreline infrastructure that could be replicated at other locations around Humboldt Bay and elsewhere along the coast. The project will be an important case study for understanding the context and conditions where natural shoreline infrastructure is appropriate, trade-offs with existing habitat function, and how to optimize ecosystem benefits and habitat resiliency while minimizing adverse effects.

The project will benefit Humboldt Bay ecological resources by:

1. Restoring and enhancing approximately 15 to 30 acres of salt marsh habitat. The specific acreage of new salt marsh habitat will be quantified (Task 4.3).
2. Creating high tide refugia for fish and wildlife and allowing landward transgression of salt marsh with future sea level rise.

These benefits align with, and advance, policies contained in the Humboldt Bay Management Plan and Humboldt Bay Area Plan described earlier. These benefits also advance the concept of a "climate resilient corridor" described in the Highway 101 Transportation Concept Report (Caltrans, 2017) and the plans and studies described in Section 1.

IMPLEMENTATION TABLE	
Date	**Milestones**
Month 1-3	Execute grant agreement; select consultant team; initiate stakeholder engagement; kick-off meeting for technical working group
Month 4-6	Initial site assessment and preliminary design tasks; technical working group meeting; stakeholder engagement; 10% design plans
Month 7-9	Technical working group meeting; stakeholder engagement; continued site assessment and preliminary design tasks
Month 10-12	Technical working group meeting; stakeholder engagement; continued site assessment and preliminary design tasks; 35% design plans
Month 13-15	Technical working group meeting; stakeholder engagement; complete site assessment
Month 16-18	Technical working group meeting; complete preliminary design (50% design plans, supporting plans, Final Report); final invoice

4. **Tracking Metrics:**

Metric	**Monitoring and Assessment**
Resilience – Community benefits projected - # of critical facilities or infrastructure	The protection provided for the railroad, Highway 101, and future Humboldt Bay Trail within the Eureka-Arcata transportation corridor will be documented in the 50% design plans and Final Report.
Resilience – Marine habitat restoration – Acres restored	The number of acres of restored salt marsh will be documented in the 50% design plans and Final Report. The monitoring plan will support the long-term monitoring of this metric to verify project performance.

Resilience – Outreach/Education/Technical Assistance - # govt entities participating	The number of participating agencies will be documented in meeting minutes from the technical working group
Resilience – Restoration planning/design /permitting - # E&D plans developed	The project will generate 50% design plans for a natural shoreline infrastructure project

5. **Project Team:**
Humboldt County will retain a consultant team to perform the technical work described in this proposal using a qualifications-based selection process. The selected team will provide integrated services with expertise in engineering, ecological restoration, biological assessment, geomorphology, hydraulic analysis, and geospatial analysis. The following individuals have offered to serve on the technical working group to guide and assist the County's consultant team:

- **Jennifer Curtis, U.S. Geological Survey.** Ms. Curtis works for the USGS-California Water Science Center in the Watershed-Integrated Hydrologic Modeling group. Ms. Curtis will provide technical assistance with sediment transport, marsh accretion and stability, and geospatial analysis.

- **Julia Elkin, State Coastal Conservancy.** Ms. Elkin began serving as the Coastal Conservancy's lead representative for Humboldt Bay in 2018. The Coastal Conservancy has been a longstanding partner on Humboldt Bay sea level rise planning, habitat restoration, and increasing public access and recreation.

- **Cristin Kenyon, California Coastal Commission.** Ms. Kenyon is Supervising Analyst and leads the coastal development permitting process for most projects on Humboldt Bay. Ms. Kenyon will assist with ensuring that the project design is consistent with Coastal Commission policies and guidance.

- **Aldaron Laird, Humboldt State University (HSU) Sea Level Rise Initiative.** Mr. Laird is co-chair of the HSU Sea Level Rise Initiative and has led sea level rise vulnerability studies on Humboldt Bay for nearly 10 years. Mr. Laird will assist with stakeholder engagement and collaborative regional planning.

- **Conor Shea, U.S. Fish and Wildlife Service.** Dr. Shea is an environmental engineer and fluvial geomorphologist with over ten years of experience working in similar projects in Humboldt Bay. Dr. Shea was the lead designer for the White Slough Tidal Wetlands Restoration Project on the Humboldt Bay National Wildlife Refuge in South Bay which is an important reference project. Dr. Shea will provide technical assistance with geomorphic evaluation, hydraulic analysis, restoration design, and construction planning.

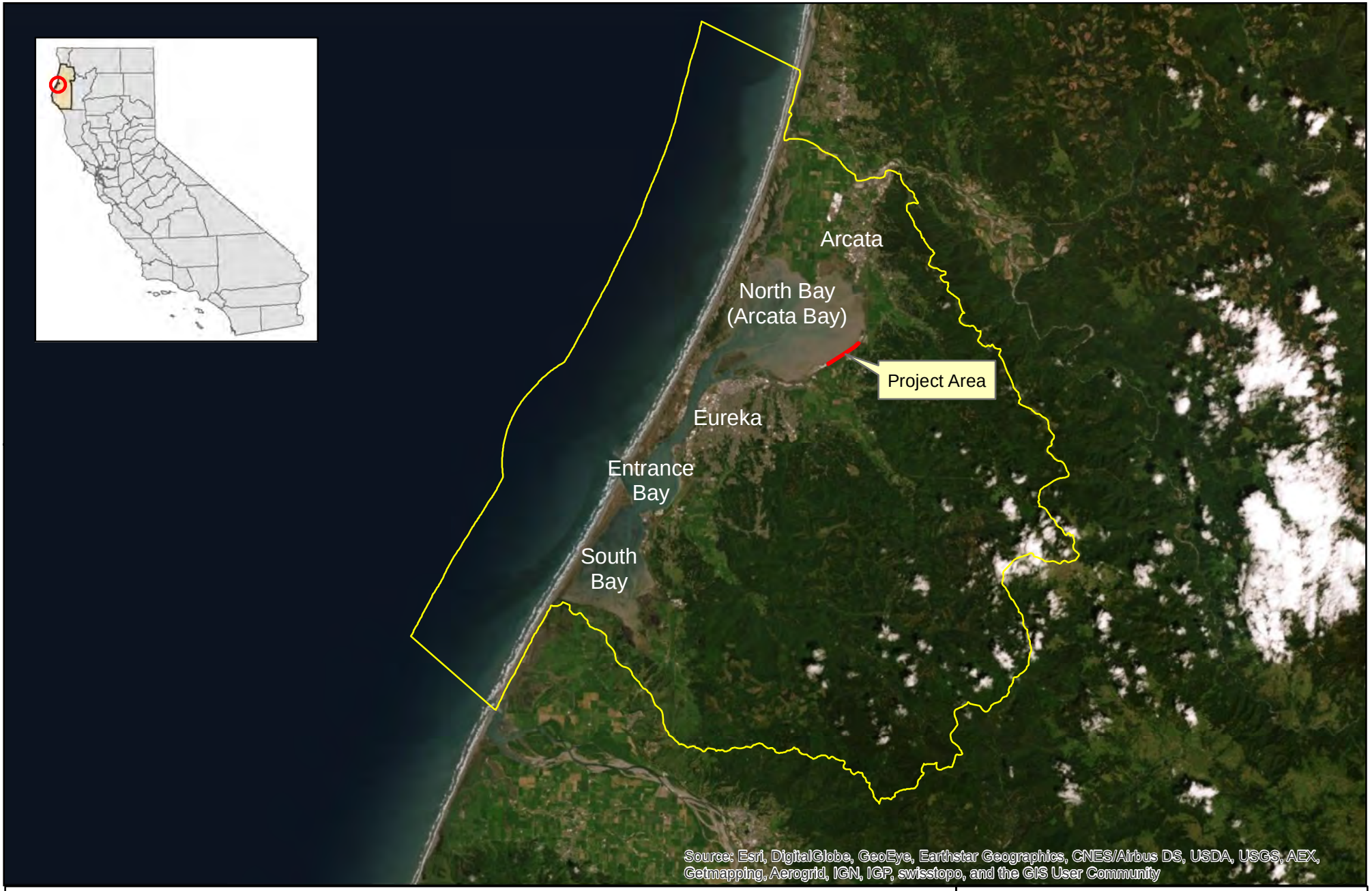
- **Michael Van Hattem, California Department of Fish and Wildlife (CDFW).** Mr. Van Hattem is Senior Environmental Scientist and has represented CDFW on sea level rise planning and Humboldt Bay conservation and restoration efforts for over ten years. Mr. Van Hattem's technical assistance will focus on maximizing the project benefits for fish and wildlife.

- **Adam Wagschal, Humboldt Bay Harbor, Conservation and Recreation District.** Mr. Wagschal is director of harbor operations and has worked on conservation initiatives and projects in Humboldt Bay for over 15 years. Mr. Wagschal was the lead author for the Humboldt Bay Regional *Spartina* Eradication Plan and has worked extensively on wetland restoration projects around the bay.

6. **Other (Optional):** (1) Pictures from the December 2005 storm event and (2) References

7. **Representative Project Photos:**
Photo 1: G. Nada, Humboldt Aerial Imagery. Southern project area along Eureka-Arcata corridor.
Photo 2: G. Nada, Humboldt Aerial Imagery. Erosion areas along the railroad with intermittent remnant salt marsh.
Photo 3: G. Nada, Humboldt Aerial Imagery. Erosion areas along the railroad with salt marsh mostly absent.

8. **Designs, Site Maps and Letters of Support:** Nine letters of support are uploaded.



Project: Natural Shoreline Infrastructure in Humboldt Bay for Intertidal Coastal Marsh Restoration and Transportation Corridor Protection

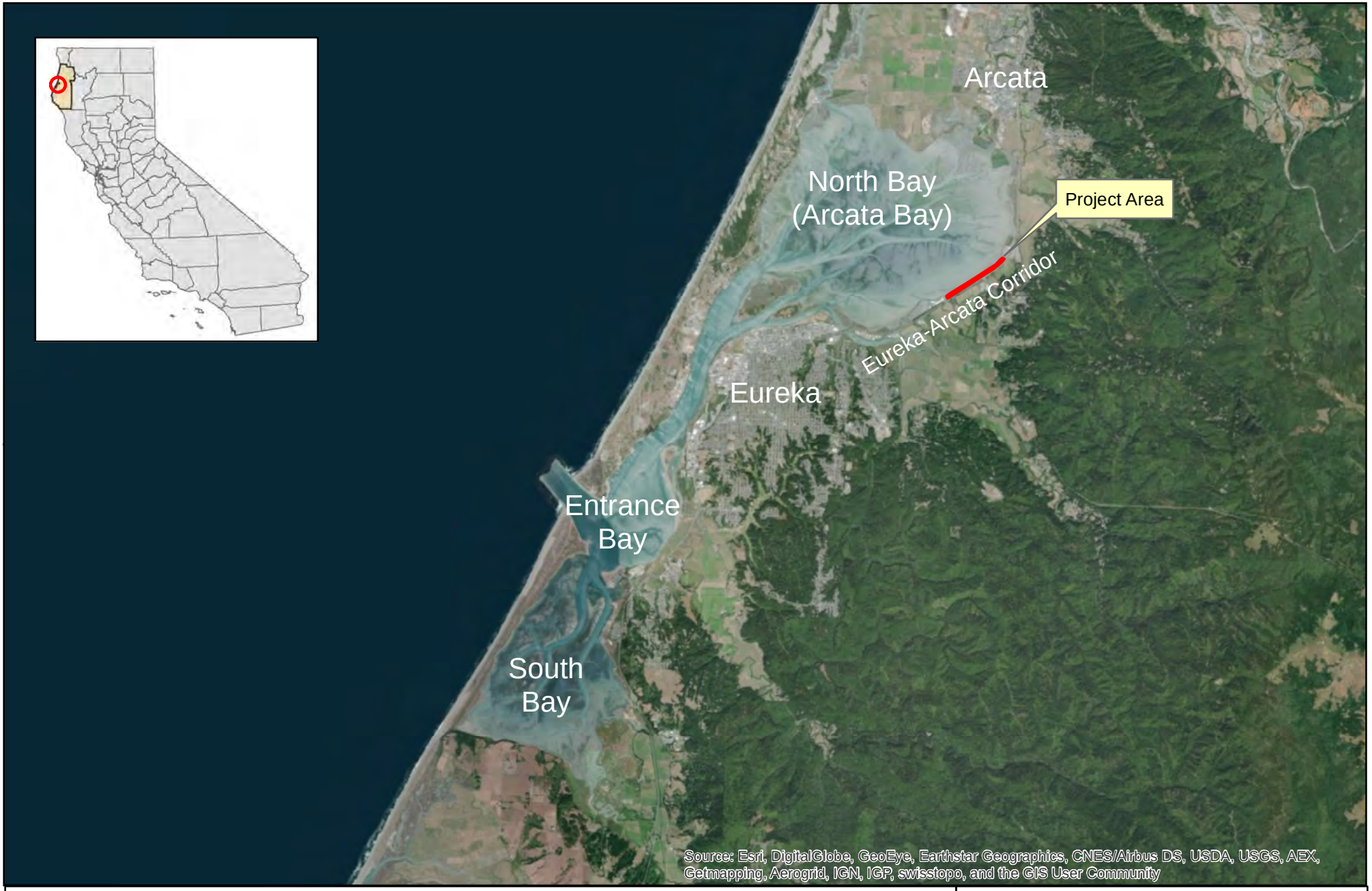
Humboldt Bay Watershed

Imagery: ESRI Basemap
Created: July 22, 2019
Humboldt County Public Works

0 11,500 23,000 Feet

1:275,000

Map 1



Project: Natural Shoreline Infrastructure in Humboldt Bay for Intertidal Coastal Marsh Restoration and Transportation Corridor Protection

Humboldt Bay

Imagery: ESRI Basemap
Created: July 22, 2019
Humboldt County Public Works

0 6,500 13,000 Feet

1:150,000

Map 2

Project: Natural Shoreline Infrastructure in Humboldt Bay for Intertidal Coastal Marsh Restoration and Transportation Corridor Protection

Project Area / North Bay

Imagery: ESRI Basemap
Created: July 22, 2019
Humboldt County Public Works

0 2,150 4,300 Feet

1:50,000

Map 3

Project: Natural Shoreline Infrastructure in Humboldt Bay for Intertidal Coastal Marsh Restoration and Transportation Corridor Protection

Project Area

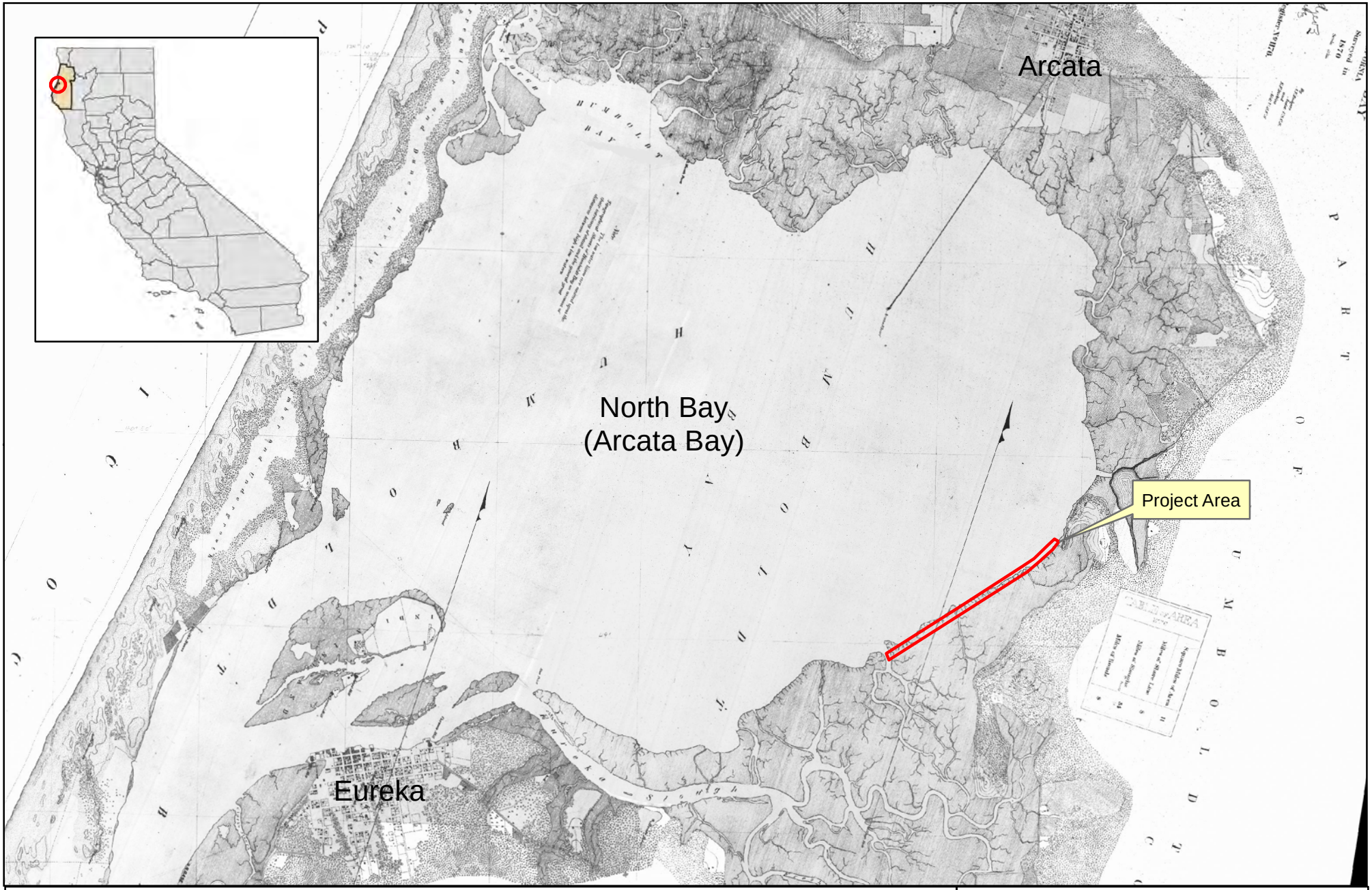
Imagery: USDA NAIP (2016)
Created: July 22, 2019
Humboldt County Public Works

N W E S

0 435 870 Feet

1:10,000

Map 4



Project: Natural Shoreline Infrastructure in Humboldt Bay for Intertidal Coastal Marsh Restoration and Transportation Corridor Protection

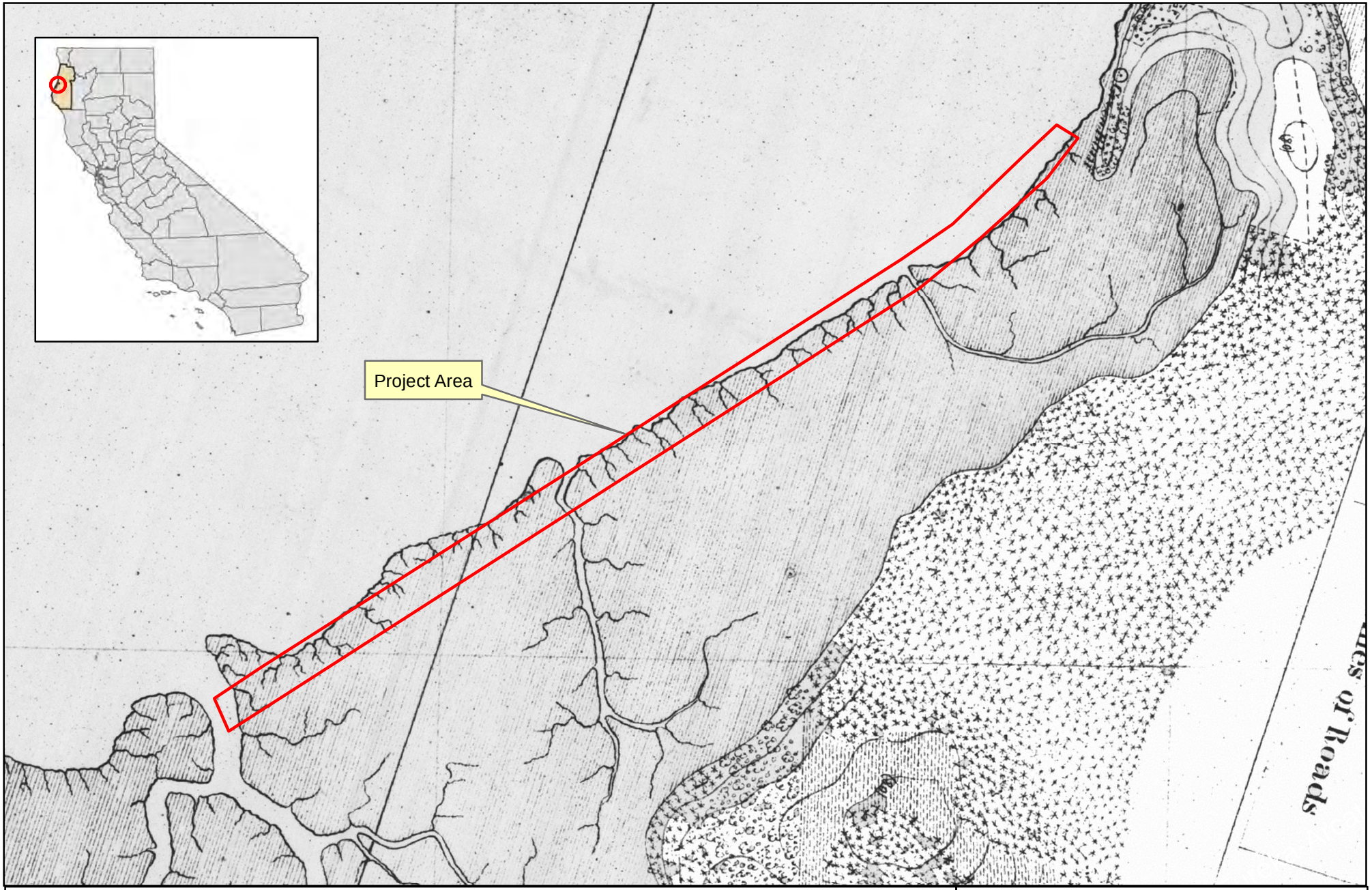
Project Area / North Bay (1870)

Imagery: US Coastal Survey (1870)
Created: July 22, 2019
Humboldt County Public Works

0 2,150 4,300 Feet

1:50,000

Map 5



Project: Natural Shoreline Infrastructure in Humboldt Bay for Intertidal Coastal Marsh Restoration and Transportation Corridor Protection

Project Area (1870)

Imagery: US Coastal Survey (1870)
Created: July 22, 2019
Humboldt County Public Works

0 435 870 Feet

1:10,000

Map 6

DEPARTMENT OF TRANSPORTATION
DISTRICT 1, P.O. BOX 3700
PHONE (707) 445-6413
FAX (707) 445-6314
TTY 711
www.dot.ca.gov

Making Conservation a California Way of Life.

July 19, 2019

Hank Seemann, Deputy-Director
Humboldt County Department of Public Works
1106 Second Street
Eureka, CA 95501

Subject: National Fish and Wildlife Foundation – National Coastal Resilience Fund 2019

Project: Natural Shoreline Infrastructure in Humboldt Bay for Intertidal Coastal Marsh Restoration and Transportation Corridor Protection

Dear Mr. Seemann:

On behalf of California Department of Transportation (Caltrans) District 1, I am writing to express support for Humboldt County's proposal to conduct technical studies and develop preliminary design for a natural shoreline infrastructure project to help protect a vulnerable portion of the transportation corridor along the shoreline of Humboldt Bay. Caltrans' mission is to provide a safe, sustainable, integrated and efficient transportation system to enhance California's economy and livability. The Humboldt County proposal supports the Caltrans mission by helping to preserve the integrity of US Highway 101, the life-line corridor for California's north coast.

The Natural Shoreline Infrastructure Project may limit coastal erosion where transportation infrastructure is vulnerable to climate change. U.S. Route 101 would be one of the primary beneficiaries of the project. If the National Fish and Wildlife Foundation selects Humboldt County's project for funding, we offer to assist the project by participating in the Technical Advisory Committee or otherwise providing technical assistance within our specific areas of expertise, as needed. We may also be able to provide support through related planning initiatives and/or projects and to contribute transportation/mitigation funding needed for implementation.

We appreciate Humboldt County's efforts to advance the implementation of natural shoreline infrastructure in Humboldt Bay and we appreciate the National Fish and Wildlife Foundation for funding coastal resilience projects.

Sincerely,

BRAD R. METTAM
Deputy District 1 Director
Planning & Local Assistance

State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Northern Region
601 Locust Street
Redding, CA 96001
www.wildlife.ca.gov

GAVIN NEWSOM, Governor
CHARLTON H. BONHAM, Director

July 19, 2019

Hank Seemann, Deputy Director
Humboldt County Department of Public Works
1106 Second Street
Eureka, CA 95501
hseemann@co.humboldt.ca.us

Subject: National Fish and Wildlife Foundation – National Coastal Resilience Fund 2019

Dear Mr. Seemann:

On behalf of the California Department of Fish and Wildlife (CDFW), I am writing to express support for Humboldt County's proposal to conduct technical studies and develop preliminary design for a natural shoreline infrastructure project to help protect a vulnerable portion of the transportation corridor along the shoreline of Humboldt Bay.

As you are aware, CDFW is the Trustee Agency for the State's fish and wildlife resources and the habitat upon which they depend. CDFW staff have participated in several of the recent sea level rise planning exercises with Humboldt County, local municipalities, and resource agencies. CDFW Senior Environmental Scientist Specialist Michael van Hattem will continue to assist with technical assistance on ecological aspects of the project and all sea-level rise planning and implementation efforts on Humboldt Bay. In addition, the Fay Slough Wildlife Area, just east of the project area, will indirectly benefit from the implementation of this project.

By using the best available science, and a combination of tidal benches and horizontal levees sloped up to mean higher high-water, transitional habitat that currently does not exist will be created. This will provide both substrate for native vegetation establishment and wave attenuation. The created transitional habitat will provide a gradient for shorebird and waterfowl loafing where it currently does not exist. If the National Fish and Wildlife Foundation selects Humboldt County's project for funding, CDFW will assist by participating on the Technical Advisory Committee, as a non-federal match if needed.

We appreciate Humboldt County's efforts to lead the implementation of natural shoreline infrastructure on Humboldt Bay and we appreciate the National Fish and Wildlife Foundation for funding coastal resilience projects.

Sincerely,

Signed for Regional Manager
Jeffrey Stoddard X

Tina Bartlett
Regional Manager

ec: page 2

ec: Gordon Leppig, Michael van Hattem, Shawn Fresz, Jeffrey Stoddard
California Department of Fish and Wildlife
Gordon.Leppig@wildlife.ca.gov, Michael.vanHattem@wildlife.ca.gov,
Shawn.Fresz@wildlife.ca.gov, Jeffrey.Stodard@wildlife.ca.gov

CALIFORNIA COASTAL COMMISSION
NORTH COAST DISTRICT OFFICE
1385 EIGHTH STREET, SUITE 130
ARCATA, CA 95521
VOICE (707) 826-8950
FAX (707) 826-8960
WWW.COASTAL.CA.GOV

July 11, 2019

Humboldt County Department of Public Works
Attn: Hank Seemann, Deputy Director
1106 Second Street
Eureka, CA 95501

Dear Mr. Seemann,

We understand that Humboldt County is applying for grant funding to pursue a natural shoreline infrastructure project on Humboldt Bay to restore intertidal coastal saltmarsh to protect an existing transportation corridor from flood hazards exacerbated by sea level rise. The proposed project is located within the California Coastal Zone on tidelands within the California Coastal Commission's retained coastal development permit (CDP) jurisdiction, and as such will require CDP authorization from the Commission. The purpose of this letter is to discuss the Commission's general perspective on "green" infrastructure shoreline protection and express Commission staff's commitment to coordinating on this project should the project proposal get funded.

In August of 2015, the Commission unanimously adopted its Sea Level Rise (SLR) Policy Guidance, which are interpretive guidelines intended to assist local governments and permit applicants in preparing for sea level rise within the context of the Coastal Act. This adopted policy guidance is supportive of living shorelines as a viable adaptation strategy that capitalizes on the natural ability of coastal systems to protect coastlines from coastal hazards while also providing benefits such as habitat, more pleasing visual impacts, and the continuation or enhancement of ecosystem services. The Commission's framing principles for addressing sea level rise, as outlined in the policy guidance, include a principle to maximize natural shoreline values and processes, including, in cases where existing development is threatened by sea level rise hazards, giving priority to shoreline protection options that enhance and maximize coastal resources and access, including innovative nature-based approaches such as living shoreline techniques.

Commission staff has also recently developed a draft document titled Residential Adaptation Policy Guidance[1] that includes model sea-level-rise-related policies as a tool to assist local governments in developing their own Local Coastal Program (LCP) policies consistent with the Coastal Act. One of the draft model policies calls for encouraging the use of soft or natural shoreline protection methods, including living shorelines, horizontal levees, and other green infrastructure as alternatives to hard shoreline protective devices.

[1] This guidance has not yet been adopted by the Commission. The most recent draft at the time of writing of this letter is dated March 2018 and may be accessed online at: https://documents.coastal.ca.gov/assets/climate/slr/vulnerability/residential/RevisedDraftResidentialAdaptationGuidance.pdf.

The engineering of green infrastructure is a somewhat newer concept in some cases, and because of this, the effectiveness of different strategies in different types of environments is not necessarily well-known or tested. As mentioned in the Commission's adopted Sea Level Rise Policy Guidance, the Commission aspires to produce future guidance on the use of living shorelines and other innovate adaptation strategies, including an assessment of areas or coastal situations where these strategies could be effective, what they need to succeed, monitoring requirements, and maintenance. The analysis, design, permitting, implementation, and monitoring of this project will provide valuable information for future Commission decision making and policy guidance on this topic.

In summary, this project has the potential (1) to complement the goals of the Commission's policy guidance to plan for long-term sustainability of communities and coastal resources in the face of climate change and (2) provide valuable information on green infrastructure engineering on the California coast. As a result, Commission staff commits to coordinating closely with County staff on this project, including active participation during the early project design and development phases in order to identify and avoid potential permitting obstacles and ensure the project is designed in a manner consistent with the Chapter 3 policies of the Coastal Act.

If you have any questions or need additional information, please feel free to contact me at (707) 826-8950.

Sincerely,

Cristin Kenyon

CRISTIN KENYON
Supervising Analyst

Humboldt State University
Marine and Coastal Sciences Institute
Sea Level Rise Initiative

July 21, 2019

Hank Seemann, Deputy-Director
Humboldt County Department of Public Works
1106 Second Street
Eureka, CA 95501
hseemann@co.humboldt.ca.us

Subject: National Fish and Wildlife Foundation – National Coastal Resilience Fund 2019

Project: Natural Shoreline Infrastructure in Humboldt Bay for Intertidal Coastal Marsh Restoration and Transportation Corridor Protection

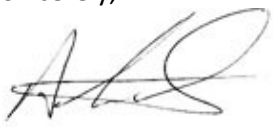
Dear Mr. Seemann:

On behalf of Humboldt State University's Sea Level Rise Initiative, I am writing to express support for Humboldt County's proposal to conduct technical studies and develop preliminary design for a natural shoreline infrastructure project to help protect a vulnerable portion of the transportation corridor along the shoreline of Humboldt Bay. The Initiative seeks opportunities to support regional sea level rise research and outreach through interdisciplinary scholarship to inform regional decision making through collaborative forums. The proposed project is in an area that formerly supported salt marsh, of which less than ten percent remains on Humboldt Bay, restoration of salt marsh as a living shoreline structure can serve many purposes, not the least would be protection of valuable transportation infrastructure.

Over the last 10 years, Aldaron has been involved in the first generation of sea level rise assessments that characterize vulnerabilities and risks to coastal resources and critical utility and transportation infrastructure in the Humboldt Bay region. He was also lead planner for the region's initial sea level rise adaptation planning effort. If the National Fish and Wildlife Foundation selects Humboldt County's project for funding, we would be an active participant in enabling a collaborative regional planning process, providing technical assistance, and coordination with other stakeholder efforts.

We appreciate Humboldt County's efforts to advance the implementation of natural shoreline infrastructure in Humboldt Bay and we appreciate the National Fish and Wildlife Foundation for funding coastal resilience projects.

Sincerely,



Aldaron Laird
Co-Chair,
Humboldt State University Sea Level Rise Initiative

OCEAN PROTECTION COUNCIL

July 18, 2019

Kaity Goldsmith
Manager, Marine Conservation
National Fish and Wildlife Foundation
1133 Fifteenth St., N.W., Suite 1000
Washington, DC 20005

Dear Ms. Goldsmith,

On behalf of the California Ocean Protection Council (OPC), I am writing to express support for Humboldt County's proposal to conduct technical studies and develop preliminary design for a natural shoreline infrastructure project to help protect a vulnerable portion of the transportation corridor along the shoreline of Humboldt Bay. This project supports OPC's mission to maintain healthy, resilient, and productive ocean and coastal ecosystems for the benefit of current and future generations. If the National Fish and Wildlife Foundation selects Humboldt County's project for funding, OPC intends to provide cost share up to 1:1 match funding.

We appreciate Humboldt County's efforts to advance the implementation of natural shoreline infrastructure in Humboldt Bay and we appreciate the National Fish and Wildlife Foundation for funding coastal resilience projects.

Sincerely,

Mark Gold
Executive Director
California Ocean Protection Council

1416 Ninth Street • Suite 1311 • Sacramento, CA 95814
Website • www.opc.ca.gov
Email • COPCpublic@resources.ca.gov
Phone • (916) 653-5656

Coastal Conservancy

July 15, 2019

Hank Seemann, Deputy-Director
Humboldt County Department of Public Works
1106 Second Street
Eureka, CA 95501

Subject: National Fish and Wildlife Foundation – National Coastal Resilience Fund 2019

Project: Natural Shoreline Infrastructure in Humboldt Bay for Intertidal Coastal Marsh Restoration and Transportation Corridor Protection

Dear Mr. Seemann:

I am writing you to express support for Humboldt County's proposal to conduct technical studies and develop preliminary design for a natural shoreline infrastructure project to help protect a vulnerable portion of the transportation corridor along the shoreline of Humboldt Bay.

The Coastal Conservancy is a State agency established in 1976 to protect and improve natural lands and waterways, help people access and enjoy the outdoors, and sustain local economies along the length of California's coast. Our agency works closely with local government and non-profit partners to make our coastal communities more resilient to the impacts of climate change.

The Coastal Conservancy is a thought leader for green infrastructure solutions to climate change impacts, including the design and implementation of living shorelines. Though a relatively new climate adaptation technique, living shorelines are proving to be an effective approach to protecting coastal resources and shoreline communities. In 2012, our agency implemented the state's first living shoreline project: the San Francisco Bay Living Shoreline Nearshore Linkages Project. Since that time, we have funded and helped manage over a dozen living shoreline projects, ensuring that lessons learned are documented, communicated and serve to improve the state of practice throughout the West Coast.

If the National Fish and Wildlife Foundation selects Humboldt County's project for funding, we plan to provide assistance by participating in the project's Technical Advisory Committee and coordinating with related planning initiatives and/or projects both in the Humboldt Bay Region and throughout the state.

We appreciate Humboldt County's efforts to advance the implementation of natural shoreline infrastructure in Humboldt Bay and we appreciate the National Fish and Wildlife Foundation for funding coastal resilience projects.

Sincerely,

Samuel Schuchat
Executive Officer, California State Coastal Conservancy

1515 Clay Street, 10th Floor
Oakland, California 94612-1401
510·286·1015 Fax: 510·286·0470

Humboldt Bay
Harbor, Recreation and Conservation District
(707) 443-0801
P.O. Box 1030
Eureka, California 95502-1030

July 12, 2019

Hank Seemann, Deputy-Director
Humboldt County Department of Public Works
1106 Second Street
Eureka, CA 95501

RE: National Fish and Wildlife Foundation – County of Humboldt Natural Shoreline Infrastructure Funding Proposal

Dear Mr. Seemann,

On behalf of the Humboldt Bay Harbor, Recreation and Conservation District (District), I am writing to express support for the County of Humboldt's proposal to design natural shoreline infrastructure for shoreline protection and habitat restoration. As described below, the development of natural shoreline infrastructure is consistent with goals outlined in the Humboldt Bay Management Plan and is a high priority for bay restoration and sea level rise adaptation. In time, we expect that creation of natural shoreline infrastructure may occur at a large scale throughout the bay. However, information is needed regarding design, logistical, regulatory and environmental consideration for this type of work. The County's proposed project would produce this information.

The statutory purpose of the District is to manage Humboldt Bay for the promotion of commerce, navigation, fisheries, recreation and the protection of natural resources. District policy is currently guided by the Humboldt Bay Management Plan which was developed by local agency representatives and stakeholders in 2007. The proposed work would support the following management plan policies:

- HSM-3: Develop appropriate, consistent shoreline protection guidelines for commercial, industrial, and residential development around Humboldt Bay.
- HSM-5: Require evidence that shoreline protection proposals protect the environment and meet District requirements.
- HSM-6: Require the use of non-structural shoreline protection where feasible and appropriate.

It is estimated that 90% of Humboldt Bay's salt marsh has been lost due to conversion to agriculture uses and other factors. Restoration of salt marsh is a high conservation priority. Additionally, Humboldt Bay has a high rate of relative sea level rise, which threatens infrastructure adjacent to the bay's shoreline. Historically, shoreline protection has primarily occurred in response to emergency flooding and consisted of shoreline hardening. However, it is broadly recognized that development of natural shoreline infrastructure is preferred, particularly because of the habitat benefits that can be realized.

With funding from the State Resources Agency, the District is currently developing a Program Environmental Impact Report that will assess alternative methods for dredging and beneficially using dredged sediments for sea level rise protection and habitat restoration projects. This project and the County's proposed project would complement each-other.

In addition to providing information valuable for future projects around Humboldt Bay, the project site itself is a critical location for habitat restoration and sea level rise protection. Retreat of infrastructure adjacent to the site (Hwy 101, railroad, future trail) is likely not feasible. Retreat costs would be high and the potential retreat area consists mainly of important wetland habitat. I urge funding of this project due to its potential benefits at the project site and its potential to produce information that will benefit similar efforts around Humboldt Bay.

Respectfully Submitted,

Larry Oetker, Executive Director
Humboldt Bay Harbor, Recreation and Conservation District

United States Department of the Interior
FISH AND WILDLIFE SERVICE
Arcata Fish and Wildlife Office
1655 Heindon Road
Arcata, California 95521
(707) 822-7201, FAX (707) 822-8411

Hank Seemann
Deputy Director
Humboldt County Department of Public Works
1106 Second Street
Eureka, California 95501

JUL 19 2019

Subject: U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office Support to Natural Shoreline Infrastructure in Humboldt Bay Project

Dear Mr. Seeman,

The County of Humboldt has proposed a project, Natural Shoreline Infrastructure, to develop and implement a living shoreline for better protection of a vulnerable portion of the transportation corridor along the shoreline of Humboldt Bay. Implementation of this project will help restore tidal-marsh habitat and create accommodation space for intertidal coastal habitat, while also providing significant protection benefits to local transportation infrastructure.

The U.S. Fish and Wildlife Service Arcata Fish and Wildlife Office's (AFWO) Coastal Program, will be a partner in this effort. Once this project receives funding, we will enter into a Memorandum of Agreement with Humboldt County Department of Public Works that details our contributions to this project. We are prepared to offer technical assistance to this project in the form of geomorphic assessment support, assistance in developing concept plans, and providing direct engineering design support for development of sustainable shoreline features. I anticipate AFWO's Dr. Conor Shea will participate on the project's Technical Advisory Team. Dr. Shea is an environmental engineer and fluvial geomorphologist on my staff. Dr. Shea has over a decade of expertise in developing living shoreline projects in Humboldt Bay, and prior to that, he worked on similar projects in the mid-Atlantic region. Dr. Shea's expertise will be invaluable as this project moves forward and we are excited that AFWO can provide this assistance. Additionally several scientists here at AFWO on my staff are knowledgeable regarding migratory birds, coastal fisheries, tidal marsh restoration, and the Endangered Species Act consultation processes, and may be available for further assistance to this project, if needed.

The mission of the Coastal Program is to protect and recover threatened and endangered species, migratory birds, and inter-jurisdictional fish by supporting voluntary restoration and enhancement of high-priority coastal habitats. The U.S. Fish and Wildlife AFWO works cooperatively with numerous public and private stakeholders and partners to conserve and protect our trust resources along the North Coast of California. If you have further questions, please contact Dr. Conor Shea by phone at (707) 825-5188.

Sincerely,

Jennifer L. Norris
Deputy Field Supervisor

United States Department of the Interior
FISH AND WILDLIFE SERVICE
Humboldt Bay National Wildlife Refuge Complex
1020 Ranch Road
Loleta, California 95551

11 July 2019

Hank Seemann, Deputy-Director
Humboldt County Department of Public Works
1106 Second Street
Eureka, CA 95501

Subject: National Fish and Wildlife Foundation – National Coastal Resilience Fund 2019

Project: Natural Shoreline Infrastructure in Humboldt Bay for Intertidal Coastal Marsh Restoration and Transportation Corridor Protection

Dear Mr. Seemann:

On behalf of the U.S. Fish and Wildlife Service, Humboldt Bay National Wildlife Refuge (NWR), I am writing to express support for Humboldt County's proposal to conduct technical studies and develop preliminary design for a natural shoreline infrastructure project to help protect a vulnerable portion of the transportation corridor along the shoreline of Humboldt Bay. This type of project not only aides in the protection of Humboldt County's main transportation corridor from Sea Level Rise but will create habitat previously lost.

Humboldt Bay NWR has led numerous Sea Level Rise research and adaptation projects in and around Humboldt Bay. Our Climate Ready project at the Lanphere Dunes Unit of the refuge is utilizing cutting-edge research to understand the roles that dunes play in the face of sea level rise as well as their adaptability. Additionally, our White Slough Living Shoreline Project, in southern Humboldt Bay, is closing in on completion which will ultimately provide over 40 acres of salt marsh habitat adjacent to Highway 101 increasing the resiliency of that stretch of shoreline. If the National Fish and Wildlife Foundation selects Humboldt County's project for funding, we are willing to provide technical assistance and participate in advisory committees to support this endeavor.

We appreciate Humboldt County's efforts to advance the implementation of natural shoreline infrastructure in Humboldt Bay and we appreciate the National Fish and Wildlife Foundation for funding coastal resilience projects.

Sincerely,

Kurt Roblek
Acting Refuge Manager


Renner
QUALITY FUEL
QUALITY PRICE


SPEED LIMIT 50
SAFEWAY
Save up to 20¢ / gal
Chevron
Diesel
Car Wash
$1.00
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OUT

December 31, 2005. Concurrent sustained wind speeds from the Arcata Eurkea Airport were from the west to southwest at 45 mph. ESA estimated that wind setup present at the project site was approximately 1 foot using standard methods (SPM 1984). Some wind waves may also have been traveling across the flooded water, resulting in a Still Water Level between 10.5 and 11 feet NAVD. This scenario is similar to the Case 3 or Case 4 conditions.

Humboldt Bay Trail South / D150852.00

SOURCE: U.S. DOT, FHWA & Caltrans (2016)

Figure 18
Photos of Extreme Flooding Event on December 31, 2005

Figure 19 shows a photo that was taken during the same storm as Figure 18, but shows a wave splashing up vertically on the shore. The wave runup height in the photo was estimated to be on the order of 5 feet, which is similar to our estimates of wave runup for Cases 3 and 4. The photo also shows that even though SWF extends landward from the shore, the wave runup is still a potential impact that should be managed.

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SOURCE: County of Humboldt

Figure 19
Photo of Extreme Coastal Flood Event on December 31, 2005

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