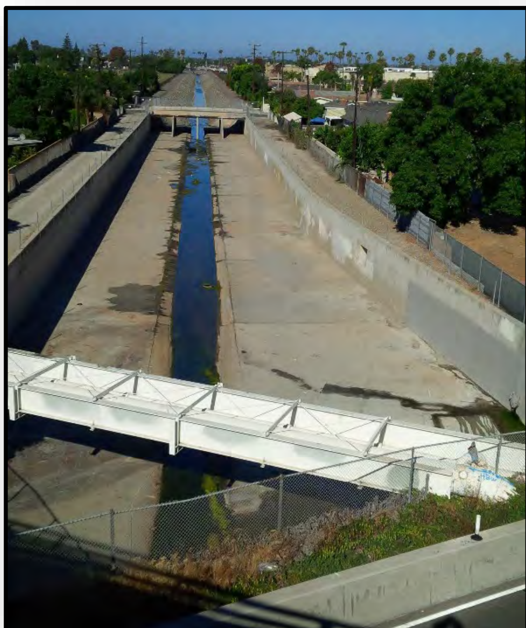
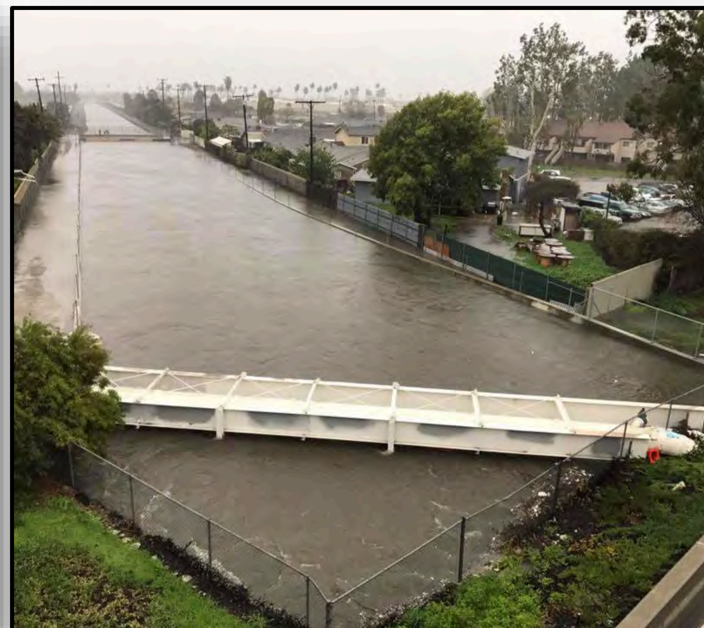
APPENDIX M – CONCEPTUAL MITIGATION PLAN

For

WESTMINSTER, EAST GARDEN GROVE

FLOOD RISK MANAGEMENT STUDY





December 2019

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WESTMINSTER, EAST GARDEN GROVE

FLOOD RISK MANAGEMENT STUDY

1.0 Introduction

The Chicago District of the U.S. Army Corps of Engineers (USACE) is preparing a Final Integrated Feasibility Report/Environmental Impact Statement/Draft Environmental Impact Report (Final IFR) for the Westminster East Garden Grove Orange County, California Flood Risk Management Study. This document serves to provide a conceptual mitigation plan to offset impacts to wetlands/aquatic habitat, eelgrass, and fish and wildlife. This Conceptual Mitigation Plan (CMP) provides concepts and implementation components to create and enhance areas within the Bolsa Chica Ecological Reserve located along the coast in the northwestern portion of Orange County.

1.1 Study Area

The study area is located entirely within the Westminster watershed in western Orange County, California, approximately 25 miles southeast of the City of Los Angeles (*Figure 1*). The watershed is approximately 87 square miles in area and lies on a flat coastal plain. The study area is almost entirely urbanized. Cities in the watershed include Anaheim, Stanton, Cypress, Garden Grove, Westminster, Fountain Valley, Los Alamitos, Seal Beach, and Huntington Beach.

The project area includes portions of four non-federal drainage channels within the watershed and the receiving waters of one of the channel systems in the Bolsa Chica Ecological Reserve (BCER). Drainage channels within the Westminster watershed that collect local storm water runoff vary in size, geometry, and lining material.

<u>C02 – Bolsa Chica Channel</u>

This study includes the portion of C02 that extends from Huntington Harbour to the confluence with the C04 channel near Bolsa Chica Street. This channel segment is approximately 1.5 miles long and provides flood risk management for Huntington Beach, Huntington Harbour, and the Seal Beach Naval Weapons Station.

<u>C04 – Westminster Channel</u>

The C04 channel is approximately 7.8 miles and provides flood risk management for the cities of Garden Grove, Westminster, and Huntington Beach. The channel begins at Highway 22 and continues downstream past Westminster Memorial Park Cemetery, I-405, and the Westminster Mall, before joining with the C02.

<u>C05 – East Garden Grove/Wintersburg Channel</u>

The C05 channel is approximately 11.6 miles and provides flood risk management for the cities of Santa Ana, Garden Grove, Westminster, and Huntington Beach. The channel begins west of the intersection of Highway 5, Highway 57, and Highway 22 in the city of Santa Ana and flows southwest through Haster

Basin, under I-405, and through the BCER before discharging into Outer Bolsa Bay and eventually the Pacific Ocean.

<u>C06 – Ocean View Channel</u>

The C06 channel is approximately 4.1 miles in length and provides flood risk management for the cities of Fountain Valley and Huntington Beach. The channel begins in the City of Fountain Valley and flows westward through Mile Square Regional Park and under I-405, ultimately discharging into the C05 channel at the confluence near Gothard Street in Huntington Beach. Mile Square Regional Park is a 640-acre park and one of few open spaces or outdoor recreation resources in this densely developed watershed.

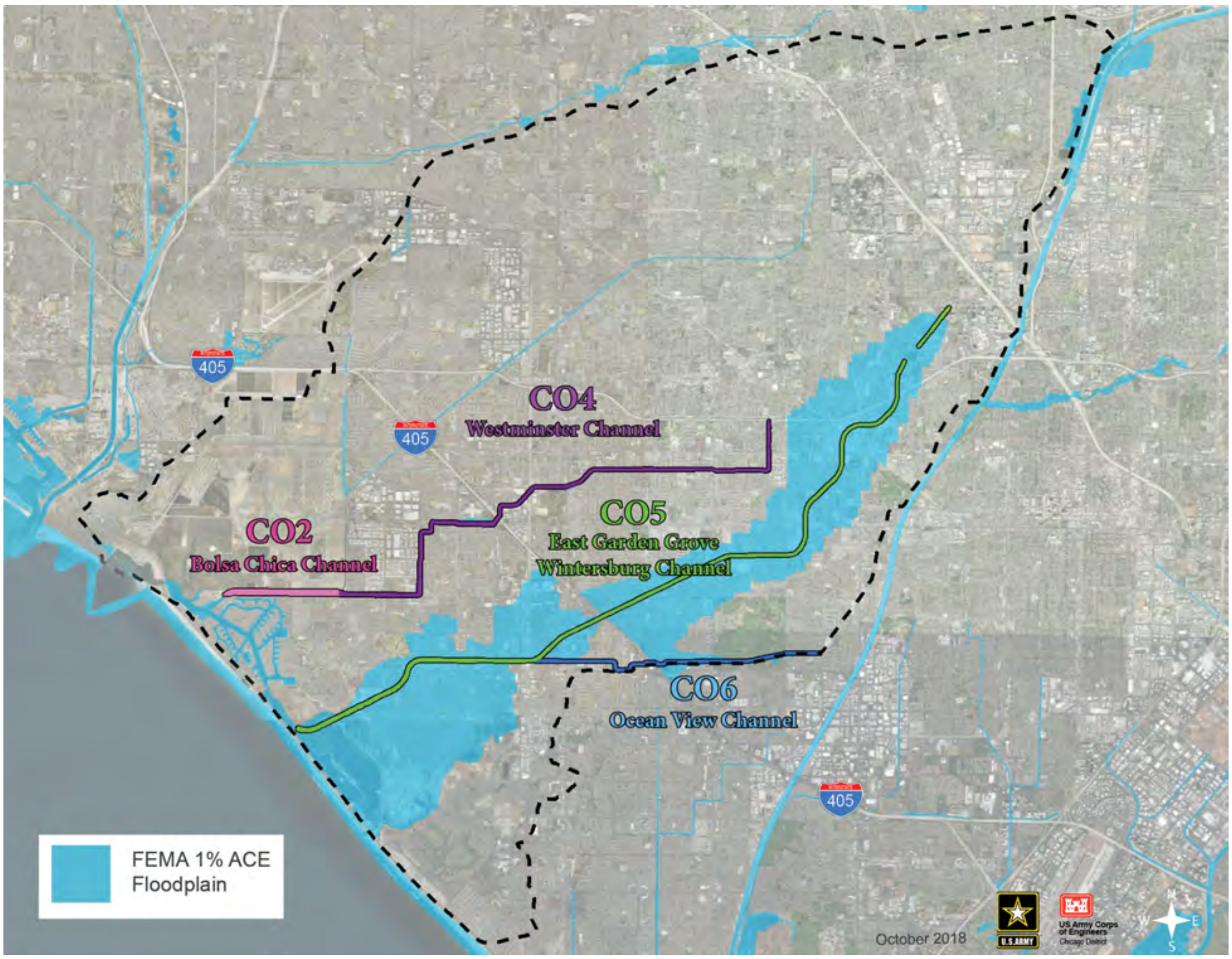

Figure 1: Westminster watershed and the study channels overlaid on the FEMA 1% ACE floodplain (Source: FEMA National Flood Hazard Layer (NFHL)).

1.2 Final Array of Alternative Plans

The final array of alternative plans includes three alternative plans including the No Action Plan.

<u>Alternative: No Action Plan</u> – Under the No Action Plan, no management measures would be implemented to reduce the current risk of flood damage in the project area. Flooding will continue throughout the Westminster watershed due to the insufficient capacity of the existing channel systems.

This will continue to cause damages to structures and road closures in the project area as a result of channel overtopping.

Alternative: NED Plan (Minimum Channel Modifications Plan) – This NED Plan would reduce flood risk within the watershed by improving conveyance efficiency of existing channels. Trapezoidal channels within C02, C04, C05, and C06 that currently have an earthen bottom and either earthen or riprap banks would be lined with concrete. There would be no alteration to reaches that are rectangular in shape or lined with concrete, nor to reaches of in-channel box and pipe structures.

The leveed areas in the downstream reaches of C02 and C05 (reaches 23 and 1, respectively) would be improved to reduce the risk of levee failure. Modifications in these reaches would include installation of steel sheet pile channel walls and preservation of existing soft bottom, tidally-influenced habitat.

Additional downstream measures would be combined with the in-channel measures to address existing flooding in Outer Bolsa Bay and to account for increased flow volumes that result from increased conveyance capacity in the channels. The tide gates on C05 would be removed in order to improve the flow conditions through the lower reaches of the C05 channel. The current tide gates leak and therefore allow saltwater to intrude upstream in C05. This saltwater influence extends upstream of Outer Bolsa Bay for approximately 2.7 miles. By removing the tide gates, tidal influence would continue with Reach 1 of C05. An access bridge would be constructed in the location of the tide gates to continue to allow access to recreational users of the BCER as well as maintenance and emergency vehicle access from the south levee to the north levee of C05.

This alternative also includes the widening of the Outer Bolsa Bay channel just upstream of the Warner Avenue Bridge. Widening of the channel would require that the Warner Avenue Bridge and the pedestrian bridge at the Bolsa Chica Conservancy be increased in span. Widening of the Outer Bolsa Bay channel would improve conveyance as well as they hydraulic efficiency of the lower reaches of C05.

Alternative: LPP (Maximum Channel Modifications Plan) – Under the LPP, trapezoidal channels within C02, C04, C05, and C06 will be replaced with rectangular concrete (or steel sheet pile) channels to contain a 0.01 annual chance of exceedance (ACE) storm event. Additionally, floodwalls would be constructed in the existing channel right-of-way where necessary. The LPP also includes increasing the span of Warner Avenue Bridge and removing the tide gates on C05 which are discussed in detail under the NED.

1.3 Alternative Recommendation

The LPP is the recommended plan that USACE is proposing to implement. However, both the NED Plan and LPP are discussed throughout the mitigation plan for comparison purposes.

1.3.1 National Economic Development (NED) Plan

Under the NED Plan (*Table 1*, *Table 2*, and *Figure 2*), earthen or riprap lined channels would be paved with concrete to increase conveyance efficiency. Hydrologic and hydraulic modeling determined that increasing the span of the Warner Avenue Bridge and removing the tide gates on C05 Reach 1 were all necessary measures to implement in the NED Plan. The leveed areas in the downstream reaches of C02 and C05 (reaches 23 and 01, respectively) would be modified to reduce the risk of levee failure. Modifications in reach 01 would include installation of dual-steel sheet pile channel walls and preservation of existing soft bottom, tidally-influenced habitat. In Reach 23, a single line of sheetpile would be driven at the crest of the existing levee along the entire south side of the channel within the reach and tied back into C04 near Bolsa Chica Street. This would reduce the risk of levee failure in this reach.

Table 1: Channel Modifications within C02/C04 under the NED Plan.

C02/C04 Channels			
Channel	**Reach**	**Existing Conditions**	**NED Plan Modifications**
C02	23	Earthen trapezoidal	Single steel sheetpile driven at levee crest on south side of channel only. No excavation of material in the channel. Top of sheetpile may extend ~3 feet above current levee crest elevation. Tie back into C04 at Bolsa Chica Street.
C04	20	Riprap lined trapezoidal from C02 to Bolsa Chica St.; Earthen & riprap trapezoidal from Bolsa Chica St. to Graham St.; Earthen trapezoidal from Graham St. to McFadden Ave.; Riprap trapezoidal from McFadden Ave. to Bolsa Ave.; Earthen & riprap trapezoidal from Bolsa Ave. to Edwards St. Concrete lined rectangular from Edwards St. to I-405.	Concrete lined trapezoidal from C02 to Edwards Street; Concrete lined rectangular from Edwards Street to I-405 (existing).
C04	21	Concrete lined rectangular	No Action
C04	22	Concrete lined compound from Beach Blvd. to Magnolia St.; Concrete rectangular with soft bottom from Magnolia St. to Brookhurst; Riprap trapezoidal from Brookhurst St. to Westminster Ave.; Concrete lined trapezoidal from Westminster Ave. to SR-22.	Concrete lined compound from Beach Blvd. to Magnolia St.; Concrete rectangular from Magnolia St. to Brookhurst St.; Concrete lined trapezoidal from Brookhurst St. to SR-22.

Table 2: Channel Modifications within C05/C06 under the NED Plan.

C05/C06 Channels			
Channel	**Reach**	**Existing Conditions**	**NED Plan Modifications**
C05	1	Earthen levee from tide gates to Warner Ave. w/ some SSP on south bank near Graham St.; SSP rectangular from Graham St. to Warner Ave.; Earthen levees from Warner Ave. to 1,300 ft upstream of Edwards Ave.	Sheet pile/soft bottom/splash walls (various heights) from tide gates to existing rectangular channel west of Goldenwest Street. 3 crossings replaced of different sizes.
C05	2	Concrete lined rectangular	Concrete lined rectangular with 1' splash walls from Golden West St. to Gothard St.; Concrete lined rectangular from Gothard St. to C05/C06 confluence; Replace crossing at Goldenwest St.
C05	3	Riprap lined trapezoidal from C05/C06 confluence to Woodruff St.; Concrete rectangular from Woodruff St. to I-405	Concrete lined trapezoidal from confluence with C06 to Beach Blvd.; Concrete lined rectangular from Beach Blvd. to I-405
C05	4	Concrete lined rectangular from I-405 to Quartz St.; Riprap lined trapezoidal from Quartz St. to Bushard St.	Concrete lined rectangular from I-405 to Magnolia St.; Concrete lined trapezoidal from Magnolia St. to Bushard St.
C05	5	Riprap lined trapezoidal from Bushard St. to Brookhurst St.; 1,300 ft of concrete lined trapezoidal upstream of Brookhurst St.; Riprap lined trapezoidal to 3rd St.	Concrete lined trapezoidal
C05	6	Concrete lined trapezoidal	No Action
C05	7	Covered concrete conduit	No Action
C05	8	Concrete lined trapezoidal	No Action
C05	9	Concrete lined trapezoidal	No Action
C05	10	Covered concrete conduit	No Action
C05	11	Covered concrete conduit	No Action
C05	12	Concrete lined trapezoidal (first 1400') and covered concrete conduit (next 1000')	No Action
C06	13	Earthen trapezoidal from C05/C06 confluence to Bolsa Ave./RT-39; Riprap lined trapezoidal from Bolsa Ave./RT-39 to Ross Lane	Concrete lined trapezoidal
C06	14	Concrete lined rectangular	No Action
C06	15	Covered concrete conduit	No Action
C06	16	Concrete lined rectangular	No Action
C06	17	Earthen and riprap lined trapezoidal	Concrete lined trapezoidal
C06	18	Mile Square Park-concrete low flow v-channel	No Action
C06	19	Riprap lined trapezoidal	Concrete lined trapezoidal

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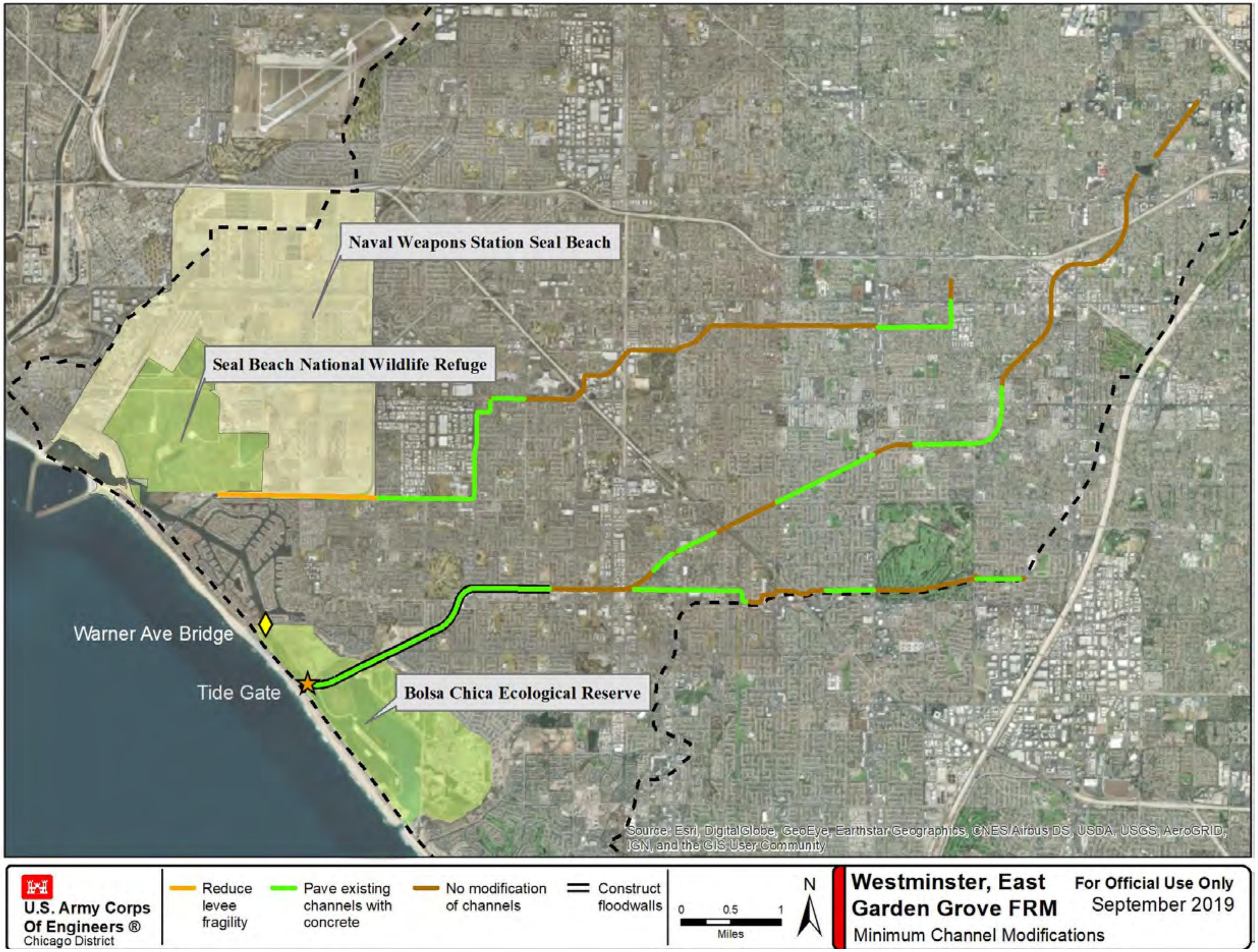

Figure 2: Minimum Channel Modifications Plan

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1.3.2 Locally Preferred Plan (LPP)

Under the LPP (*Table 3*, *Table 4*, and *Figure 3*), trapezoidal channels would be reconfigured to have a rectangular cross sectional geometry. This would increase both conveyance and capacity. This alternative is designed to contain the 1% annual chance of exceedance (ACE) storm event. For reaches that do not contain the 1% ACE event after conversion to a concrete rectangular channel, floodwalls are added. Hydrologic and hydraulic modeling determined that increasing the span of the Warner Avenue Bridge and removing the tide gates on C05 Reach 1 were all necessary measures to implement the LPP.

Table 3: Channel Modifications within C02/C04 under the LPP.

C02/C04 Channels			
Channel	**Reach**	**Existing Conditions**	**LPP Modifications**
C02	23	Earthen trapezoidal	Dual sheetpile system located at existing levee crest on south side of channel only. Excavation of material on the channel side of the sheetpile.
C04	20	Riprap lined trapezoidal from C02 to Bolsa Chica St.; Earthen & riprap trapezoidal from Bolsa Chica St. to Graham St.; Earthen trapezoidal from Graham St. to McFadden Ave.; Riprap trapezoidal from McFadden Ave. to Bolsa Ave.; Earthen & riprap trapezoidal from Bolsa Ave. to Edwards St. Concrete lined rectangular from Edwards St. to I-405	80' Concrete rectangular with middle 48' left earthen from C02 to McFadden Ave.; 68' Concrete rectangular with middle 40' left earthen from McFadden Ave.to Bolsa Ave.; 55' Concrete rectangular from Bolsa Ave. to Edwards St.; 3 crossings replaced of different dimensions.
C04	21	Concrete lined rectangular	Diversion channel at Westminster Mall
C04	22	Concrete lined compound from Beach Blvd. to Magnolia St.; Concrete rectangular with soft bottom from Magnolia St. to Brookhurst; Riprap trapezoidal from Brookhurst St. to Westminster Ave.; Concrete lined trapezoidal from Westminster Ave. to SR-22	Base of concrete lined channel increased to 35' from Beach Blvd. to Magnolia St.; Soft bottom channel from Magnolia St. to Brookhurst St. concrete lined; Concrete lined trapezoidal from Brookhurst Street to Westminster Ave.; 18' Concrete rectangular from Westminster Ave. to SR-22; 12 crossings replaced of different dimensions.

Table 4: Channel Modifications within C05/C06 under the Maximum Channel Modifications Plan.

C05/C06 Channels			
Channel	**Reach**	**Existing Conditions**	**LPP Modifications**
C05	1	Earthen levee from tide gates to Warner Ave. w/ some SSP on south bank near Graham St.; SSP rectangular from Graham St. to Warner Ave.; Earthen levees from Warner Ave. to 1,300 ft upstream of Edwards Ave.	Sheet pile/soft bottom/splash walls (various heights) from tide gates to existing rectangular channel west of Goldenwest St. 3 crossings replaced of different sizes.
C05	2	Concrete lined rectangular	Concrete lined rectangular with 1' splash walls from Golden West St. to Gothard St.; Concrete lined rectangular from Gothard St. to C05/C06 confluence;
C05	3	Riprap lined trapezoidal from C05/C06 confluence to Woodruff St.; Concrete rectangular from Woodruff St. to I-405	Concrete lined rectangular; Some sections of 1' splash wall between Beach Blvd. and Woodruff Rd.; 2 crossings replaced of different dimensions.
C05	4	Concrete lined rectangular from I-405 to Quartz St.; Riprap lined trapezoidal from Quartz St. to Bushard St.	Concrete lined rectangular with splash walls (various heights); 3 crossings replaced of different dimensions.
C05	5	Riprap lined trapezoidal from Bushard St. to Brookhurst St.; 1,300 ft of concrete lined trapezoidal upstream of Brookhurst St.; Riprap lined trapezoidal to 3rd St.	Concrete lined rectangular with splash walls (various heights); 6 crossings replaced of different dimensions.
C05	6	Concrete lined trapezoidal	Concrete lined rectangular; 1 crossing replaced.
C05	7	Covered concrete conduit	Replace crossing at New Hope and Hazard Ave.
C05	8	Concrete lined trapezoidal	Concrete lined rectangular; 3 crossings replaced of different dimensions.
C05	9	Concrete lined trapezoidal	Concrete lined rectangular; 5 crossings replaced of different dimensions.
C05	10	Covered concrete conduit	Replace crossing at Aspenwood; Haster Baasin inlet culverts modified
C05	11	Covered concrete conduit	No Action
C05	12	Concrete lined trapezoidal (first 1400') and covered concrete conduit (next 1000')	No Action
C06	13	Earthen trapezoidal from C05/C06 confluence to Bolsa Ave./RT-39; Riprap lined trapezoidal from Bolsa Ave./RT-39 to Ross Lane	Concrete lined rectangular at confluence; Concrete lined trapezoidal from confluence to Ross St.; 2 crossings replaced of different dimensions.
C06	14	Concrete lined rectangular	Concrete lined rectangular from Ross St. to Asari Lane; Concrete lined rectangular with splash walls (1.5-2') from Asari Lane to Riverbend Dr.
C06	15	Covered concrete conduit	Covered concrete conduit; 1 crossing replaced.
C06	16	Concrete lined rectangular	Concrete lined rectangular, widened to 30’.

Appendix M – Mitigation Strategy

C05/C06 Channels			
Channel	**Reach**	**Existing Conditions**	**LPP Modifications**
C06	17	Earthen and riprap lined trapezoidal	Concrete lined trapezoidal, ~1 ft. splash walls.
C06	18	Mile Square Park-concrete low flow v-channel	No Action
C06	19	Riprap lined trapezoidal	Concrete lined trapezoidal

Appendix M – Mitigation Strategy

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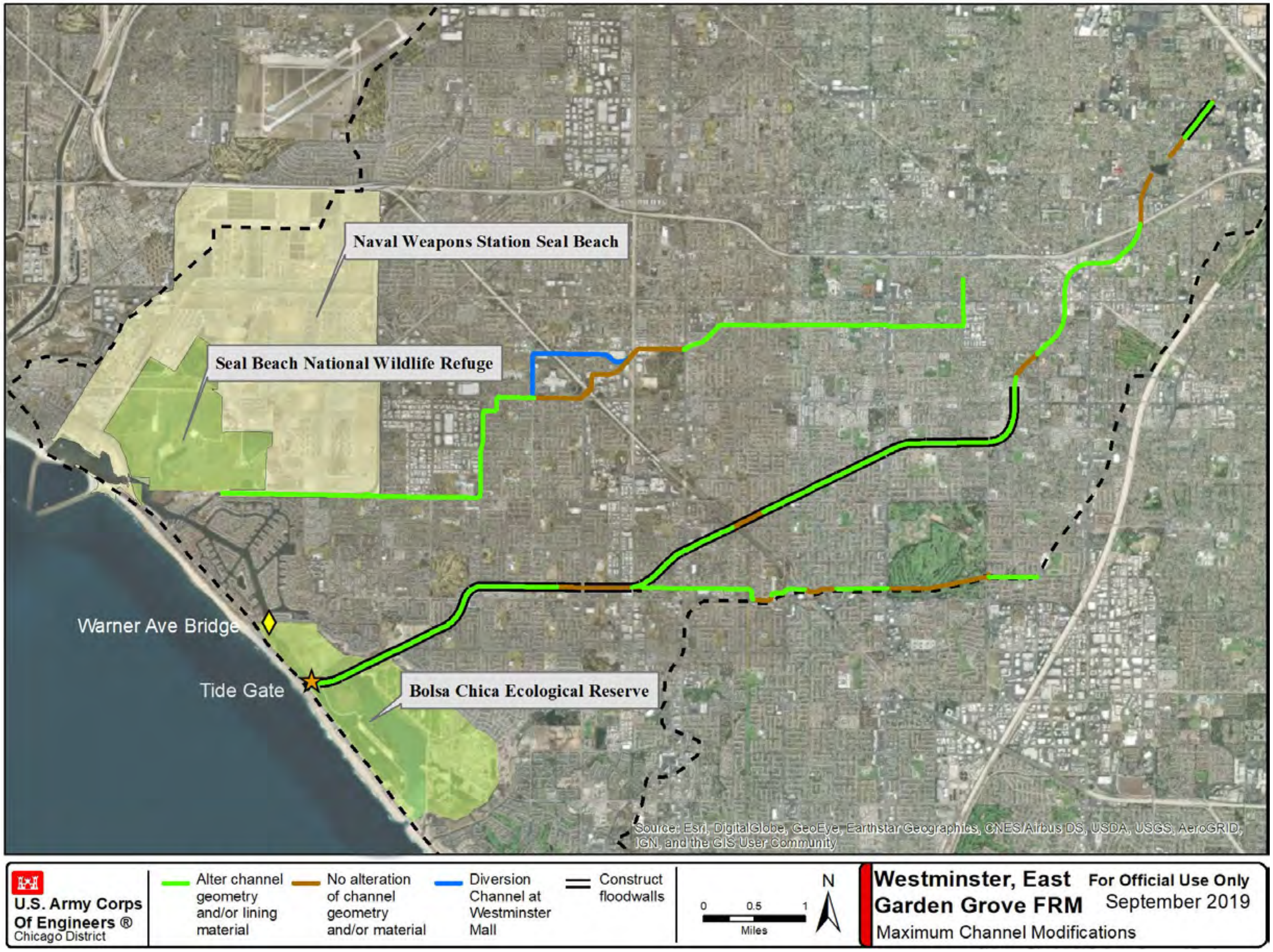

Figure 3: Maximum Channel Modifications Plan (LPP)

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1.4 Significant Impacts Requiring Mitigation

Both the NED Plan and LPP would have indirect impacts to eelgrass, direct impacts to estuarine wetlands, and temporary impacts to special status wildlife species. These impacts are discussed below for each alternative plan.

1.4.1 National Economic Development Plan

Eelgrass

In regards to the drainage channels, eelgrass has not been observed within a majority of the channel system due to lack of suitable habitat. The exception is the downstream end of C02 Reach 23 where eelgrass has been observed, but only downstream of Edinger Avenue Bridge. A reconnaissance level survey in July 2019 upstream of Edinger Avenue Bridge, confirmed that no eelgrass is present above the bridge. While eelgrass is not known to occur within a majority of the drainage channels, it has been documented in the Sunset and Huntington Harbour complex since the early 1980s. In 1986, the amount of eelgrass in Sunset Bay/Huntington Harbour was 3.87 acres (MBC 1986). By 1996, the amount of eelgrass in Sunset Bay/Huntington Harbour had increased to 5.79 acres (CRM 1997). Recent eelgrass surveys within Huntington Harbour were queried to determine the recent distribution and amount of eelgrass within the study area that could potentially be impacted either directly or indirectly by implementation of the NED Plan.

On April 3, July 30, and July 31, 2013, Merkel and Associates, Inc. surveyed eelgrass within the Anaheim Bay/Huntington Harbour area as part of a contract from NOAA/National Marine Fisheries Service to conduct comprehensive eelgrass (*Zostera marina*) surveys within multiple embayments and lagoons within southern California in support of development of a superior understanding of regional eelgrass distribution patterns (NMFS 2014a). During this survey, the Bolsa Chica Channel (C02) up to Edinger Avenue Bridge was surveyed as well as the area downstream of Warner Avenue Bridge. A total of 89.2 acres of eelgrass were mapped during the survey (*Figure 4*). The majority of the eelgrass mapped (81.4 acres) was located in northern Anaheim Bay within Naval Weapons Station Seal Beach. The remaining eelgrass mapped, 7.8 acres, was located in the developed channel system of Huntington Harbour.

On September 24-26, September 30, October 1-3, and December 15, 2013, CRM surveyed eelgrass within Huntington Harbour, including Sunset Aquatic Park Marina, C02, and downstream of Warner Avenue Bridge for the presence of eelgrass in order to identify potential impacts and provide a mitigation plan for proposed maintenance dredging by the County of Orange. A total of 4.451 acres of eelgrass was mapped during the survey. Of that total, eelgrass within Sunset Aquatic Park Marina and C02 only accounted for 0.126 acre (*Figure 5*) while downstream of Warner Avenue Bridge accounted for less than 0.001 acre (*Figure 6*) of eelgrass. The following was noted about the presence of the eelgrass beds within the Sunset Aquatic Park Marina and C02 area at the time of the surveys.

- Sunset Aquatic Park Marina – In the main marina located on the Bolsa Channel, eelgrass grew in small patches beds at depths between -3.2 and -6.5 ft MLLW (0.058 acre). In 2004, 0.058 acre of eelgrass was also mapped in this area of the Marina.
- Bolsa Channel – Thirteen small eelgrass beds were located in the outer half of the Bolsa Channel totaling 0.068 acres extending approximately 400 ft into the Bolsa Channel from the Main Channel. Four small patches were located on the shoal at the located of the Sunset Shipyard. A single patch was located on the south side of the channel in front of the sand beach. This channel can be severely

affected by flood flows, like that which occurred during 1995 which separated boat docks and floats from the Portofino Cove bulkhead.

The following was noted about the presence of the eelgrass beds downstream of Warner Avenue Bridge at the time of the surveys.

- Eight small patches of eelgrass were located at the south end of the project near Warner Avenue Bridge, totaling 0.0005 acre. In a previous survey, 0.01 acre of eelgrass was located in the same general area as the patches observed during this survey.

The County of Orange and the City of Huntington Beach conducted the Sunset/Huntington Harbour Maintenance Dredging and Waterline Installation Projects in the summer of 2016. Dredging was conducted to depths of between -9 and -18 ft in the Sunset Aquatic Park Marina and C02. Eelgrass observed downstream Warner Avenue Bridge was located on the periphery of the dredging project and was not impacted.

On July 6-7, 2019, Anghera Environmental and Ecomarine Consulting LLC conducted reconnaissance level surveys for the presence of eelgrass within reaches of C02/C04, C05/C06, vicinity of C05 Reach 1, vicinity of Warner Avenue Bridge, and the C02 outlet in order to identify potential impacts for the proposed Westminster East Garden Grove-Wintersburg Flood Risk Management Study. No eelgrass was observed in any of the channel reaches. Salinity measurements indicated that conditions in the channels are not ideal for eelgrass to thrive.

<u>Eelgrass Impacts</u>

No direct impacts to eelgrass due to implementation of the NED Plan are anticipated. Eelgrass that has been observed downstream of Warner Avenue Bridge during the 2013 surveys is outside the project action area that would be directly impacted through excavation activities. Eelgrass that has been observed within C02 Reach 23 downstream of Edinger Bridge during the 2013 surveys is also outside the project action area that would be directly impacted. Under the NED Plan, a single steel sheetpile wall would be driven along the levee crest on the south side of the channel only on C02 Reach 23. No excavation of material from C02 Reach 23 would occur, therefore, no direct impacts to eelgrass due to excavation of sediment would occur.

No indirect impacts to eelgrass located downstream of Warner Avenue Bridge would occur since the lengthening of Warner Avenue Bridge would reduce velocities below existing condition velocities. Specifically, during a 100-year storm event at Mean Higher High Water (MHHW), the existing velocity downstream of the bridge is approximately 5.5 feet per second (ft/sec) at peak discharge, while the with-project velocity would be approximately 4.2 ft/sec at peak discharge. In addition, during a 100-year storm event at Mean Low Water (MLW), the existing velocity downstream of the bridge is approximately 7.8 ft/sec at peak discharge, while the with-project velocity would be approximately 6.0 ft/sec at peak discharge.

Indirect impacts to eelgrass located downstream of Edinger Avenue Bridge in C02 Reach 23 are possible since modification of the channels upstream would increase velocities above existing condition velocities. *Table 5* shows existing and with-project velocities during a 100-year storm event at MHHW and MLW.

Table 5: Velocities downstream of Edinger Avenue Bridge for existing and with-project condition

Condition	Tide	Velocity (ft/sec)				
		Location				
		800 ft downstream Edinger Ave. Bridge				1825 ft downstream Edinger Ave. Bridge
		LDB	Middle	RDB		Middle
Existing	**MHHW**	4.4	5.8	4.4		1.25
	MLW	7.0	9.7	5.2		1.85
With-Project	**MHHW**	5.1	6.3	4.7		1.57
	MLW	8.0	8.8	4.6		1.78

Water velocity plays an important role in determining where eelgrass can grow (Koch 2001, de Boer 2007). However, eelgrass critical velocity thresholds are difficult to determine and very few studies have reported these thresholds. Fonseca et al. (1983) found that maximum velocity thresholds for eelgrass appear to range between 3.94 and 4.92 feet/second. Referring to *Table 5*, existing velocities 800 feet downstream of Edinger Avenue Bridge during a 100-year storm event at MHHW and MLW are already at or above maximum velocity thresholds for eelgrass, yet the species has been observed in this area as recently as 2013. The with-project condition would increase velocities 800 feet downstream of Edinger Avenue Bridge during a 100-year storm event at MHHW and MLW significantly above the existing condition velocities and the maximum velocity thresholds for eelgrass.

While velocities are expected to increase at the downstream end of C02 Reach 23 where eelgrass has been observed, it is important to note that no recent surveys of the area have been conducted to determine the current distribution of eelgrass. The most recent surveys are from 2013, during which the survey conducted early in the year by Merkel & Associates mapped 7.8 acres of eelgrass throughout Huntington Harbour; however, the survey conducted later in the year by CRM mapped only 0.126 acre of eelgrass specifically within the area of potential indirect impact, Sunset Aquatic Park Marina and C02. In addition, since the surveys conducted in 2013, maintenance dredging has occurred (i.e., 2016) in the Sunset Aquatic Park Marine and C02 which could have impacted the presence of eelgrass. Without a recent survey of the area it is impossible to say whether eelgrass is present in Sunset Aquatic Park Marina and C02 since the 2016 maintenance dredging.

Since a recent survey of the area was not conducted, to assess the potential indirect impact of the NED Plan the USACE assumed presence of eelgrass based on the Merkel & Associates, Inc. 2013 survey. This survey mapped a larger amount of eelgrass in 2013 than the survey conducted in the same area by CRM in 2013. By assuming the presence of this greater amount of eelgrass, USACE is taking a conservative approach in estimating the potential indirect impact to eelgrass due to implementation of the NED Plan. In addition, in order to account for fluctuating eelgrass distribution and functional influence around eelgrass cover, USACE included a 16.4 ft (5 m) buffer around the eelgrass mapped within 800 ft downstream of Edinger Avenue Bridge, the assumed extent of potential indirect impacts. Based on the above stated assumptions, the implementation of the NED Plan would have an indirect impact on approximately 1.70 acres of eelgrass.

Figure 4: Eelgrass presence within Anaheim Bay/Huntington Harbour during eelgrass surveys in April and July 2013 (Source: Merkel & Associates Inc., 2014).

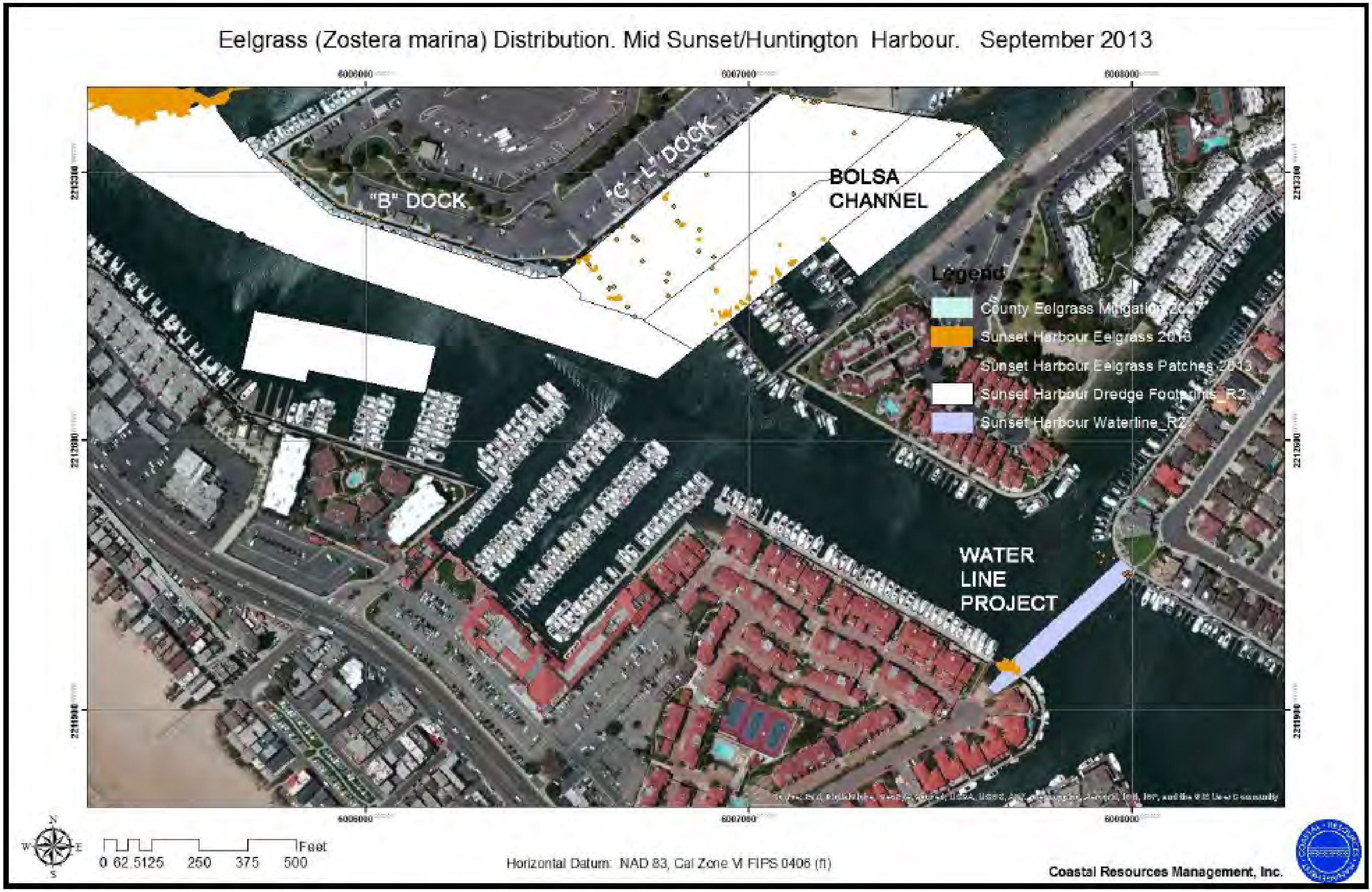

Figure 5: Eelgrass presence within Sunset Aquatic Park Marina and C02 during September 2013 surveys

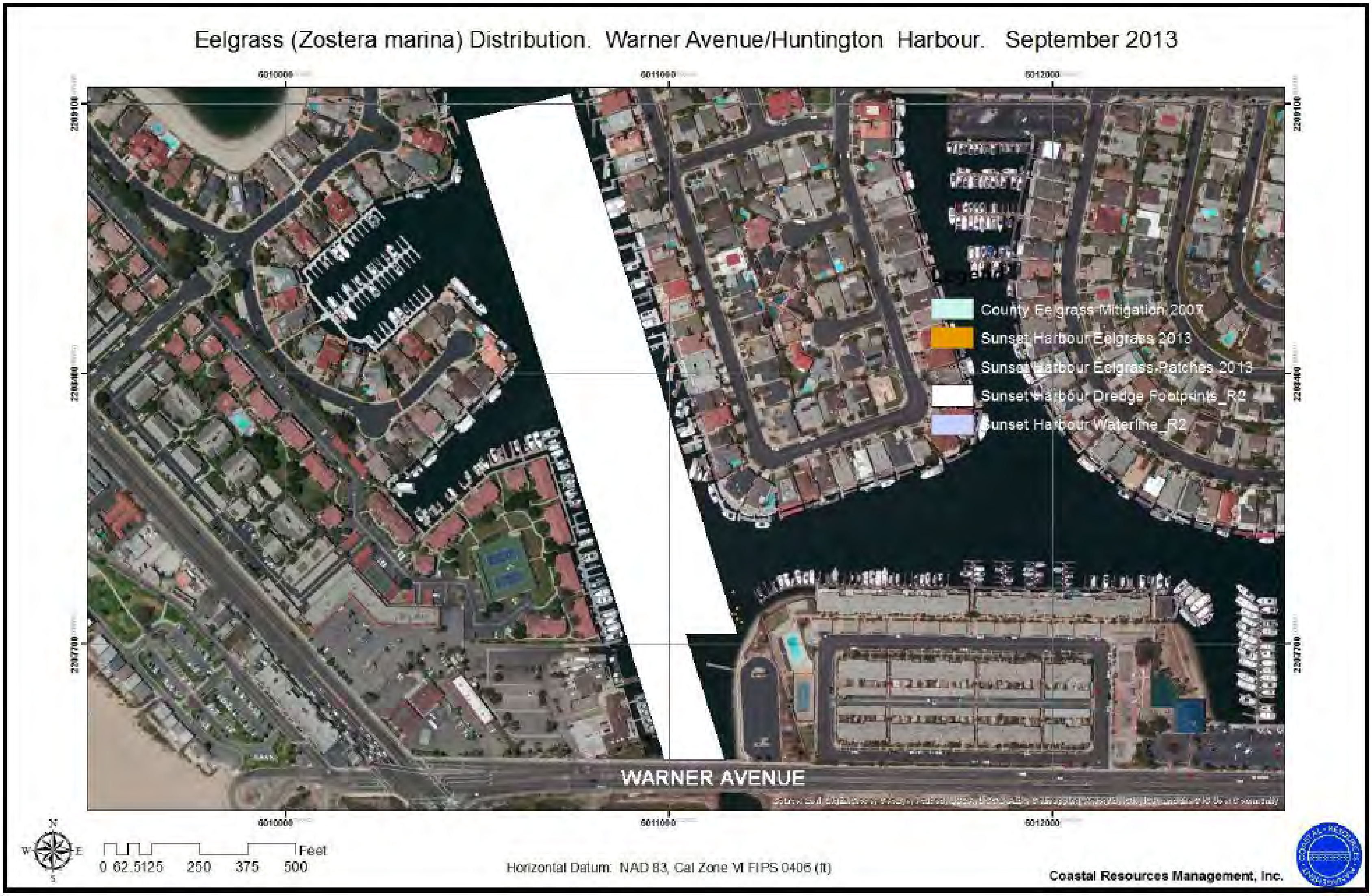

Figure 6: Eelgrass presence downstream of Warner Avenue Bridge during September 2013 surveys

<u>Wetland Habitat</u>

In April 2019, a jurisdictional determination for the study area was completed by the USACE Los Angeles District Regulatory Branch. The determination identified approximately 0.15 total acres of wetland habitat adjacent to the Warner Avenue Bridge (*Table 6* and *Figure 7*). No jurisdictional wetland habitat was identified within the C02/C04 or C05/C06 flood control channels. Where present, channel vegetation is dominated by annual, weedy, and ruderal species. Correspondingly, native as well as non-native and invasive vegetation types are found here. While the vegetation within the flood control channels provides some habitat value, the value provided is considered minimal. Ongoing vegetation maintenance activities are taking place throughout the channels, which has had some impacts on extant biological communities. In some areas (C04 Reach 22 for example) it appears that habitat is being altered via vegetation management activities, and in other places (C06 Reach 18 for example) vegetation management is maintaining the existing habitat conditions. In addition, the County of Orange has a vegetation maintenance program which includes pesticide applications to manage, reduce, and control the growth of vegetation within the flood control channels.

Table 6: Acres of Wetland Habitat within the Vicinity of Warner Avenue Bridge.

Wetland Habitat Type	Acres
Estuarine Bordering Mudflat	0.01
Estuarine Bordering Wetland	0.03
Estuarine Neighboring Wetland	0.11

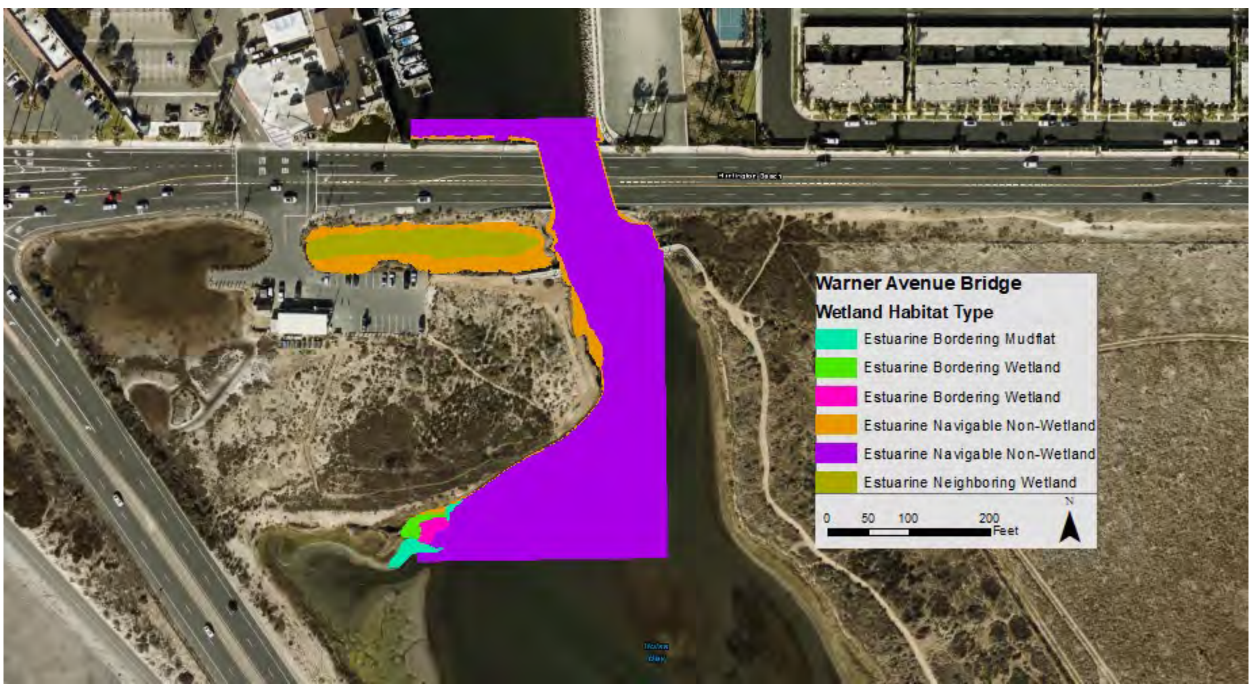

Figure 7: Wetland Habitat Types within the Vicinity of Warner Avenue Bridge.

<u>Wetland Impacts</u>

With the implementation of the NED Plan, there would be direct impacts to wetland habitat located within the vicinity of the Warner Avenue Bridge. Approximately 0.01 acre of estuarine bordering mudland, 0.03 acre of estuarine bordering wetland, and 0.11 acre of estuarine neighboring wetland would be directly impacted by the implementation of the NED Plan. This direct impact would be caused by the excavation of the constriction upstream of the Warner Avenue Bridge to widen the channel where Outer Bolsa Bay outlets into Huntington Harbour (*Figure 8*).

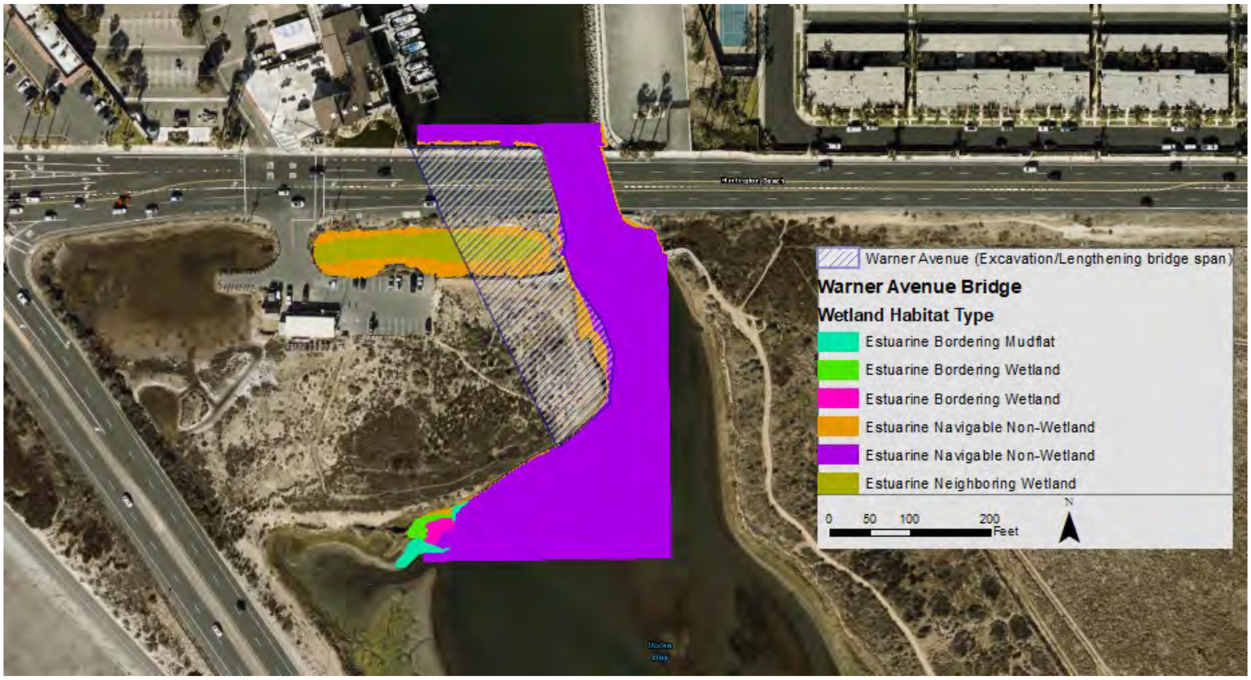

Figure 8: Wetland Habitat Types Located within the Vicinity of the Warner Avenue Bridge and the Extent of Excavation Activities that would Directly Impact Wetlands

No indirect impacts to wetland habitat types are anticipated to occur. Potential indirect impacts that were assessed included potential habitat conversion in Outer Bolsa Bay due to larger volumes of freshwater reaching the bay, and scouring of habitats in the bay due to increased flow velocities caused by upstream channel modifications. In general, the NED Plan would not be increasing the amount of storm flow reaching Outer Bolsa Bay, instead a larger volume of freshwater would be reaching Outer Bolsa Bay in a shorter period of time. The widening of Warner Avenue Bridge under the NED Plan would allow for these freshwater storm flows that are reaching Outer Bolsa Bay quicker to exit the bay faster, thereby, reducing the residence time of freshwater within Outer Bolsa Bay over the existing condition (i.e., unmodified Warner Avenue Bridge). Since residence time of freshwater storm flows within Outer Bolsa Bay would be reduced under the NED Plan, no indirect impacts to wetland habitat types due to habitat conversion are expected.

In addition to there being no indirect impact to wetland habitat types within Outer Bolsa Bay due to habitat conversion, scouring of wetland habitat types within Outer Bolsa Bay are also not expected. Modeling of the velocity hydrograph within Outer Bolsa Bay shows that the implementation of the NED Plan does not significantly increase flow velocities above the existing condition. For example, under the mean higher high water (MHHW) tide condition and 100-year storm event, the existing condition flow velocity is 1.55 feet/second (ft/sec) whereas the with-project condition (i.e., implementation of the NED Plan) flow velocity is 2.45 ft/sec; an increase of less than 1.0 ft/sec over the existing condition. Similarly, under the mean low water (MLW) tide condition and 100-year storm event, the existing condition flow velocity is 2.8 ft/sec whereas the with-project condition flow velocity is 3.65 ft/sec; an increase of less than 1.0 ft/sec over the existing condition. Since the with-project condition flow velocity does not increase significantly over the existing condition, scouring of wetland habitat within Outer Bolsa Bay is not expected to occur and there would be no indirect impact.

Special Status Wildlife

The downstream reaches to be modified as part of the NED Plan (i.e., C05 Reach 1) are adjacent to the Bolsa Chica Ecological Reserve, where several special status species are known to occur. Special status species that could be temporarily impacted during construction of the project are the California least tern, coastal California gnatcatcher, Ridgway's rail, western snowy plover, and Belding's savannah sparrow. As shown in *Figure 9*, California least tern, Ridgway's rail, western snowy plover, and Belding's savannah sparrow nest adjacent to C05 Reach 1. In addition, California least tern, coastal California gnatcatcher, Ridgway's rail, and Belding's savannah sparrow forage adjacent to C05 Reach 1 (*Figure 10*). California least tern, specifically, is known to forage within the downstream portions of C05 Reach 1 that are adjacent to the Bolsa Chica Ecological Reserve (*Figure 10*).

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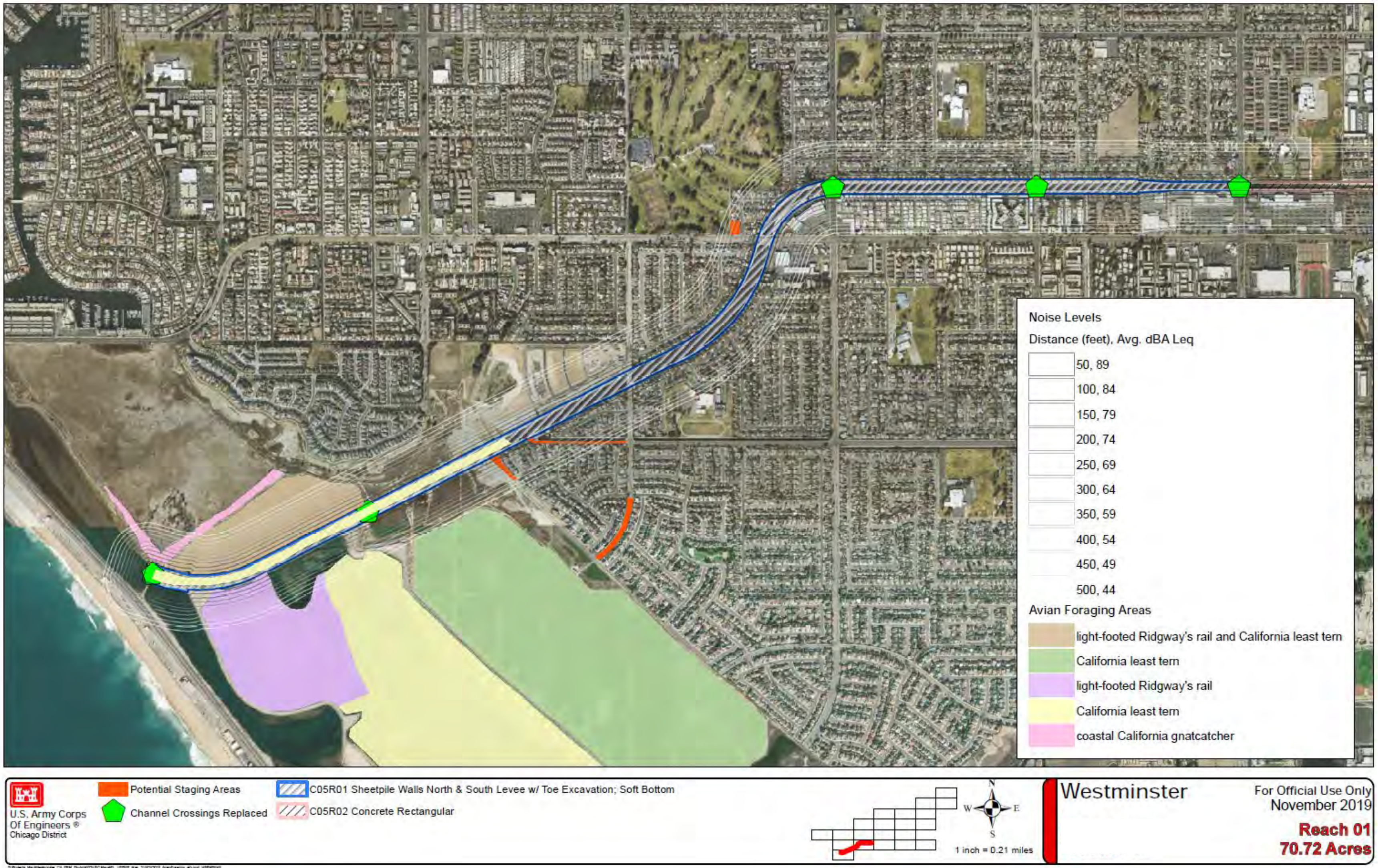

Figure 9: Map of C05 Reach 1 with Location of Special Status Avian Species Foraging Areas Along with During Construction Noise Levels.

Figure 10: Map of C05 Reach 1 with Location of Special Status Avian Species Nesting Areas Along with During Construction Noise Levels.

<u>Special Status Wildlife Impacts</u>

The implementation of the NED Plan could have a potential temporary direct impact to special status avian species located within the Bolsa Chica Ecological Reserve and the Seal Beach National Wildlife Refuge and an indirect impact to green turtle (*Chelonia mydas*). The potential for a temporary direct impact to avian species would primarily be due to noise created during construction activities that could in turn disrupt nesting and foraging behavior. While a direct impact to nesting behavior would be significant, this impact is reduced to less than significant by scheduling construction activities within reaches adjacent to Bolsa Chica Ecological Reserve and the Seal Beach National Wildlife Refuge outside of the breeding and nesting season. Therefore, construction activities adjacent to Bolsa Chica Ecological Reserve and the Seal Beach National Wildlife Refuge would occur between October and February.

A temporary direct impact to foraging behavior is expected to occur since this is a year-round activity that cannot be avoided. While the coastal California gnatcatcher, Ridgway's rail, and Belding's savannah sparrow forage adjacent to the flood control channel, the California least tern is known to forage within the downstream portions of C05 Reach 1, and would experience the highest potential for disruption to foraging behavior while construction activities are occurring. No direct mortality of special status avian species, including the California least tern, is anticipated as a result of construction activities associated with implementation of the NED Plan.

In regards to the green turtle, the NED Plan would not have any direct impact on green turtle foraging. However, foraging habitat (i.e., eelgrass beds) for this species could be indirectly impacted by the project. Potential indirect impacts to eelgrass were discussed above under the subheading *eelgrass impacts*.

1.4.2 Locally Preferred Plan

<u>Eelgrass and Eelgrass Impacts</u>

The location and distribution of eelgrass within the vicinity of the project was discussed in detail under *Section 1.4.1 National Economic Development Plan*. The potential direct and indirect impacts to eelgrass due to implementation of the LPP would be the same as that discussed above for the NED Plan. Therefore, the implementation of the LPP would have an indirect impact on approximately 1.70 acres of eelgrass.

<u>Wetlands and Wetland Impacts</u>

The location and distribution of wetlands within the vicinity of the project was discussed in detail under *Section 1.4.1 National Economic Development Plan*. The potential direct and indirect impacts to wetland habitat types due to implementation of the LPP would be the same as that discussed above for the NED Plan. Therefore, the implementation of the LPP would have a direct impact on approximately 0.15 acre of estuarine wetland habitat types.

<u>Special Status Wildlife and Special Status Wildlife Impacts</u>

The location of special status wildlife within the vicinity of the project was discussed in detail under *Section 1.4.1 National Economic Development Plan*. The potential temporary direct impact to special status avian species foraging behavior and the indirect impact to green turtle foraging habitat due to implementation of the LPP would be the same as that discussed above for the NED Plan. Therefore, the implementation of the LPP would have a temporary direct impact on avian species foraging behavior, primarily California least tern, and an indirect impact on green turtle foraging habitat.

Table 7: Summary of Direct and Indirect Impacts to Eelgrass, Wetlands, and Special Status Wildlife for the NED Plan and LPP

Category	Alternative Plan			
	NED Plan		LPP	
	Direct Impact	Indirect Impact	Direct Impact	Indirect Impact
Eelgrass				
Warner Avenue Bridge	-	-	-	-
C02 Reach 23	-	Yes - 1.70 acre	-	Yes - 1.70 acre
Wetlands				
Warner Avenue Bridge	Yes - 0.15 acre	-	Yes - 0.15 acre	-
Flood Control Channels	-	-	-	-
Special Status Species				
C05 Reach 1	Yes - foraging	-	Yes - foraging	-
C02 Reach 23	-	Yes - foraging	-	Yes - foraging

1.5 Mitigation Goals and Objective

The goal of the mitigation plan is to offset the increment of loss in eelgrass, wetlands, and special status wildlife resulting from the implementation of the NED Plan or the LPP. As discussed in *Section 1.4 Significant Impacts Requiring Mitigation*, and summarized in *Table 7*, implementation of the NED Plan or LPP would have a long-term indirect impact to eelgrass, a long-term direct impact to wetlands, a temporary direct impact to special status avian species, and a long-term indirect impact to green turtle. Therefore, the mitigation objective is to offset these impacts.

1.6 Planning Constraints

USACE considered each of the following in the development of the NED Plan and LPP:

- Avoiding the impact altogether by not taking a certain action or part of an action;
- Minimizing impacts by limiting the degree or magnitude of the action and its implementation;
- Rectifying the impact by repairing, rehabilitating, or restoring the affected environment;
- Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action;
- Compensating for the impact by replacing or providing substitute resources or environments.

Because the impacts were unavoidable, USACE formulated a range of mitigation alternatives and quantitatively evaluated the output of all mitigation alternatives. USACE considered the guidance in the following sections of the Planning Guidance Notebook (USACE 2000) in the development of this mitigation strategy:

- USACE must identify the least cost mitigation plan that provides full mitigation of losses specified in mitigation planning objectives [Paragraph C-3 e.(8)];
- USACE must conduct incremental cost analyses to demonstrate that the most cost effective mitigation measure(s) has been selected [Paragraph C-3e. (2) and (8)];
- Habitat-based evaluation methodologies shall be used to the extent possible [Paragraph C-3 d.(6)];
- Mitigation planning shall address a range of alternatives up to the full compensation of significant ecological resource losses [Paragraph C-3 E (4)];

- The evaluation of effects is a comparison of the with-project and without-project conditions for each alternative [Paragraph 2-3 d.(1)];
- Characterize the effects by magnitude, location, timing and duration [Paragraph 2-3 d.(2)];
- USACE must consider monitoring time and cost limits [Paragraphs C-3 e.(10); G-63 (b)];
- Fish and wildlife mitigation costs are subject to cost sharing to the same extent as other project costs [Paragraph C-3 e. (12)(c)].

1.7 Mitigation Requirements

In order to determine mitigation requirements for a project that is going to have a significant unavoidable adverse impact, USACE policy requires a scientific-based approach through the use of habitat evaluation through functional assessment instead of standardized ratios. The functional assessment is used to provide a quantitative valuation of existing and mitigation features to support a mitigation functional equivalent to offset unavoidable losses due to project implementation. USACE guidance for establishing mitigation requirements in the Civil Works Program is provided in ER 1105-2-100. USACE planning policy is clear on the use of functional habitat evaluation assessment or functional assessments: “Mitigation planning objectives are clearly written statements that prescribe specific actions to be taken to avoid and minimize adverse impacts, and identifies specific amounts (units of measurement, e.g., habitat units) of compensation required to replace or substitute for remaining, significant unavoidable losses” [ER 1105-2-100, App C, Paragraph C-3.b (13) 22 April 2000] and “habitat-based evaluation methodologies…shall be used to describe and evaluate ecological resources and impacts” [ER 1105-2-100, App C, Paragraph C-3.d (5)].

Both the NED Plan and LPP have similar impacts as discussed under *Section 1.4 Significant Impacts Requiring Mitigation*, therefore, the mitigation requirements are the same for the two alternative plans. The following discusses the mitigation requirements as well as the development of mitigation measures for both alternative plans.

1.7.1 Eelgrass

Quantitative Assessment

As discussed above under *Eelgrass Impacts*, modification of the channels, specifically channels within the C02/C04 system, could have an indirect impact on approximately 1.70 acres of eelgrass located at the downstream end of C02 Reach 23 due to increased flow velocities.

The Southern California Coastal Bay Ecosystem Model (Bay Model) was used to assess the potential indirect impact to eelgrass habitat. The Bay Model includes six habitat types: rocky reef (non-kelp), kelp forest, eelgrass, oyster reef, tidal salt marsh, and sandy islands. Each habitat type had between two and six critical parameters that were identified for which curves and equations were developed. For each habitat type, values from these individual curves are then combined to calculate a habitat suitability index score. The HSI score is a geometric mean of all individual habitat index values for a given habitat.
Since eelgrass is included in the model, the critical parameters identified for eelgrass were used to assess the current habitat value of the 1.70 acres of eelgrass habitat that would be potentially indirectly impacted by the project. The habitat value for the eelgrass habitat is assumed to be a function of (V1) circulation, (V2) depth, (V3) substrate, and (V4) temperature. The equation used to calculate the habitat value (HV) was the following:

$$HV = (V1 \times V2 \times V3 \times V4)^{1/4}$$

Since eelgrass was the only habitat type assessed for the existing condition, the HV calculated for the eelgrass existing condition is synonymous with the eelgrass HSI.

HSI Calculation

The existing condition of the eelgrass habitat that would potentially be indirectly impacted due to implementation of the project was assessed using the critical parameters identified for eelgrass in the Bay Model. *Table 8* shows the estimated values of the eelgrass critical parameters that were used to calculate the existing condition HSI.

Table 8: Index Values for Eelgrass Parameters used to Calculate Existing Condition HSI Value for Eelgrass to be Indirectly Impacts by Project.

Habitat Type	Critical Parameters				HSI
	Circulation	Depth	Substrate	Temperature	
Eelgrass	0.5	0.2	0.7	0.7	0.47

Eelgrass HSI

The HSI calculated for the eelgrass to be potentially impacted by the project was then taken times the acreage that would potentially be indirectly impacted to determine the average annual habitat units (AAHUs).

Table 9: Summary of Eelgrass HSI Value and AAHUs.

Habitat Type	Acres	HSI	AAHUs
Eelgrass	1.70	0.47	0.80

Under existing conditions, the eelgrass habitat in the downstream portion of C02 Reach 23 that would potentially be indirectly impacted by implementation of the project provides approximately 0.80 AAHUs. In order to be conservative in the calculation of mitigation required, it was assumed that the potential indirect impact to the eelgrass as a result of the project would be a complete loss of the 0.80 AAHUs.

In terms of mitigating for the indirect impact to eelgrass, suitable habitat for transplanting eelgrass within the vicinity of the indirect impact is limited. In the general vicinity of the project area, transplants have occurred in the past within the full tidal basin of the Bolsa Chica Ecological Reserve and along Tern Island, which is adjacent to Sunset/Huntington Harbour. In addition, Naval Weapons Station Seal Beach is proposing to modify area within Anaheim Bay for transplanting eelgrass as mitigation for their proposed modernization of the Station. Due to the limited availability of transplant sites within the vicinity of the project area, USACE considered in-kind and out-of-kind mitigation opportunities for offsetting impacts to eelgrass due to project implementation. The function of in-kind eelgrass mitigation would provide benefits to the in-kind mitigation site that are currently being experienced at the impact site. Since eelgrass would be established within the basin as part of in-kind mitigation, the functionality of the mitigation site would be the same as the existing condition.

For out-of-kind mitigation, USACE looked at restoring habitat that would generate services similar to eelgrass habitat. Kelp forests are highly productive habitats that support a wide variety of fishes, invertebrates, and marine mammals similar to eelgrass. In addition, like eelgrass, kelp forests have been identified by the Pacific Fishery Management Council identified as a HAPC. Kelp forests form on top of rocky reefs and create a structurally complex environment that provides refuge for numerous fishes, invertebrates, and marine mammals. Like eelgrass, kelp is considered a foundational species, modifying the environment to create suitable habitat for a great diversity of species. Kelp forests are also among the most productive ecosystems in the world, allowing them to support the diverse assemblage of life that inhabits them. Even fishes that do not live in kelp benefit from the animals that grow there as forage items. When kelp dislodges from its holdfast, it forms a floating mat known as a kelp paddy. These floating microhabitats provide rare shelter in open water to many fishes and invertebrates, often times attracting pelagic fishes including sharks and mola mola, the ocean sunfish.

Since both eelgrass and kelp are 1) foundational species, 2) HAPC designated species, and 3) support a wide variety of fishes, invertebrates, and marine mammals, the habitat function provided by these two species is considered similar.

Outer Bolsa Bay (In-Kind)

Outer Bolsa Bay is located within the Bolsa Chica Ecological Reserve, extending south from Huntington Harbour to Inner Bolsa Bay and the outlet of C05 Reach 1. The submerged lands to be used by the mitigation project are owned by the State of California and administered by the California State Lands Commission. The area is large enough to support many acres of eelgrass habitat, however, the site is considered high risk since eelgrass is not currently supported nor has it been supported in the past. It is possible that project modifications such as widening the channel under Warner Avenue Bridge and allowing a greater tidal prism into Outer Bolsa Bay as well as reducing sedimentation within Outer Bolsa Bay by modifying the flood control channels within the C05/C06 system could create favorable conditions for eelgrass establishment. Work at this location would include transplanting eelgrass from donor beds in Huntington Harbour.

To determine the amount of habitat units that would be achieved by transplanting eelgrass within Outer Bolsa Bay, the eelgrass component from the Bay Model was used. *Table 10* shows the estimated values of the eelgrass critical parameters that were used to calculate the HSI.

Table 10: Index Values for Eelgrass Parameters used to Calculate HSI Value for Eelgrass Transplanting in Outer Bolsa Bay.

Habitat Type	Critical Parameters				HSI
	Circulation	Depth	Substrate	Temperature	
Eelgrass	0.17	1.0	0.7	0.7	0.54

The HSI value was then multiplied by the eelgrass acreage that would be required to offset the indirect impact to 1.70 acres of eelgrass. This acreage was calculated using recommendations in the CEMP for in-kind mitigation (NMFS 2014b). Based on the recommendations in the CEMP, the ratio used to calculate the required acreage was 1.2:1.

Table 11: Summary of Acres, HSI Value, Habitat Units, and AAHUs for Potential Eelgrass Habitat in Outer Bolsa Bay.

Habitat Type	Acres	HSI	HUs	AAHUs
Eelgrass	2.04	0.54	1.10	1.10

Table 11 shows that potentially 1.10 AAHUs could be achieved by transplanting 2.04 acres of eelgrass in Outer Bolsa Bay.

Palos Verdes Rocky Reef Restoration Project (Out-of-Kind)

The Palos Verdes Rocky Reef Restoration Project is located offshore of the City of Rancho Palos Verdes which is approximately 16 miles west of Huntington Harbour. The submerged lands to be used by the project are owned by the State of California and administered by the California State Lands Commission. This site allows for restoration of valuable fish and abalone habitat in the vicinity of the project. The purpose of the Palos Verdes Reef Restoration Project is to restore historic rocky reef habitat that was buried by sedimentation from nearby landslides, thereby providing essential fish habitat and substrate for kelp, other marine algae, and marine invertebrates, creating a productive rocky-reef ecosystem in an area with limited hard substrate. This site is currently being restored by NOAA-NMFS and can help offset potential losses to eelgrass by improving submerged hard and soft bottom fish habitat.

To determine the amount of habitat units that could be achieved by restoring rocky reef habitat at Palos Verdes, the rocky reef component from the Bay Model was used. The habitat value for the rocky reef habitat is assumed to be a function of (V1) connectivity, (V2) reef relief, (V3) residence time, and (V4) substrate. The equation used to calculate the habitat value (HV) was the following:

$$HV = (V1 \times V2 \times V3 \times V4)^{1/4}$$

Since rocky reef was the only habitat type assessed for out-of-kind mitigation, the HV calculated for the rocky reef habitat is synonymous with the rocky reef HSI. *Table 12* shows the estimated values for the rocky reef critical parameters that were used to calculate the HSI.

Table 12: Summary of Acres, HSI Value, HUs, and AAHUs for the Potential Rocky Reef Habitat at Palos Verdes.

Habitat Type	Critical Parameters				HSI
	Connectivity	Reef Relief	Residence Time	Substrate	
Rocky Reef	1.0	0.95	0.8	1.0	0.93

The HSI value was then multiplied by the eelgrass acreage that would be required to offset the indirect impact to 1.70 acres of eelgrass. This acreage was calculated using recommendations in the CEMP for out-of-kind mitigation (NMFS 2014b). Based on the recommendations in the CEMP, the ratio used to calculate the required acreage was 2.4:1.

Table 13: Summary of Acres, HSI Value, Habitat Units, and AAHUs for Potential Rocky Reef Habitat at Palos Verdes.

Habitat Type	Acres	HSI	HUs	AAHUs
Rocky Reef	3.6	0.93	3.81	3.81

Table 13 shows that potentially 3.81 AAHUs could be achieved by establishing 3.6 acres of rocky reef habitat at Palos Verdes.

Eelgrass Mitigation Measures

As described above, there are two potential methods — in-kind and out-of-kind mitigation — for mitigating indirect impacts to eelgrass due to implementation of the project. Since two methods were available, three eelgrass mitigation measures were developed. The first measure is in-kind mitigation only, the second measure is out-of-kind mitigation only, and the third measure is a combination of in-kind and out-of-kind.

Calculation of the HSI's for the in-kind (Measure A.1) and out-of-kind (Measure A.2) mitigation were described above. To calculate the HSI for the combination of in-kind and out-of-kind (Measure A.3), the geometric mean of the HSI values calculated for the in-kind and out-of-kind mitigation measures was taken. The HSI value was then multiplied by the eelgrass acreage that would be required to offset the indirect impact to 1.70 acres of eelgrass. This acreage was calculated using recommendations in the CEMP for in-kind and out-of-kind mitigation (NMFS 2014b), therefore, both the 1.2:1 and 2.4:1 ratio were used.

The three eelgrass mitigation measures and the amount of in-kind, out-of-kind, or both acreages are presented below in *Table 14*. A summary of the acres, HSI values, HUs, AAHUs, and NAAHUs for each measure is presented in *Table 15*. These are independent measures that are not combinable. The Net AAHUs for each measure (*Table 15*) were calculated by taking the AAHUs achieved by each measure minus the AAHUs currently provided by the 1.70 acres of eelgrass that would be indirectly impacted by implementation of the project (*Table 9*).

Table 14: Eelgrass Mitigation Measures for both the NED Plan and LPP.

Measure	Measure Description	Outer Bolsa Bay (Acres)	Palos Verdes (Acres)
A.1	Mitigate entirely in-kind at Outer Bolsa Bay	2.6	0
A.2	Mitigate entirely out-of-kind at Palos Verdes	0	4.1
A.3	Combination of in-kind and out-of-kind mitigation	0.5	3.6

Table 15: Summary of Acres, HIS Value, HUs, AAHUs, and NAAHUs for the Three Eelgrass Mitigation Measures.

Measure	Measure Description	Acres	HSI	HUs	AAHUs	NAAHUs
A.1	Mitigate entirely in-kind at Outer Bolsa Bay	2.6	0.54	1.10	1.10	0.30
A.2	Mitigate entirely out-of-kind at Palos Verdes	4.1	0.93	3.81	3.81	3.01
A.3	Combination of in-kind and out-of-kind mitigation	4.1	0.71	3.27	3.27	2.47

In summary, the existing eelgrass habitat at the downstream end of C02 Reach 23 that would potentially be indirectly impacted by implementation of the project provides 0.80 AAHUS. To offset this loss, three measures were evaluated. Cost Effectiveness and Incremental Cost Analysis was run to determine which eelgrass mitigation measure is the most effective and efficient to implement (*Section 1.9 Comparison of Alternative Mitigation Plans*). In general, however, if measure A.1 were to be implemented it would provide 1.10 AAHUs which would offset the loss of 0.80 AAHUS, and provide a net gain of 0.30 AAHUs. If measure A.2 were to be implemented it would provide 3.81 AAHUs which would offset the loss of 0.80 AAHUs, and provide a net gain of 3.01 AAHUs. If measure A.3 were to be implemented it would provide 3.27 AAHUs which would offset the loss of 0.80 AAHUs, and provide a net gain of 2.47 AAHUs.

1.7.2 Wetlands

Quantitative Assessment

As discussed above under *Wetland Impacts*, excavation of the constriction upstream of the Warner Avenue Bridge would directly impact a total of approximately 0.15 acre of estuarine wetland habitat. A species habitat model was not readily available that adequately assessed the impact to wetland habitat due to implementation of the NED Plan or LPP. This was primarily due to the direct impact to wetlands from implementation of either project being less than one acre. Although the wetland impact is less than one acre, the impacted wetlands are located in a built-out environment where there is less than approximately 10 acres of vacant land. Being located in a primarily built-out environment means that the wetland habitat that would be impacted is crucial to the special status species that reside and/or migrate through the area simply due to the paucity of habitat.

Since no species habitat model was readily available that adequately assess the wetland habitat impact, a qualitative assessment was conducted. The variables that were qualitatively assessed included the following basic wetland functions: (1) surface water storage, (2) subsurface water storage, (3) nutrient cycling, (4) retention of particles, and (5) maintenance of plant and animal communities. Qualitative values used for the above variables included: (1) Very Low, (2) Low, (3) Moderate, (4) High, and (5) Very High. In order to quantify the qualitative assessment and fulfill the USACE policy requirement that a functional assessment must be used to provide a quantitative valuation of existing and mitigation features, numerical values on a 0 to 1 scale were given to the above qualitative values. A 0 to 1 scale was used to normalize the values and ensure they were comparable to the functional assessment used for eelgrass (refer to *Section 1.7.1 Eelgrass*) and special status wildlife (refer to *Section 1.7.3 Special Status Wildlife*). Refer to *Table 16* for an explanation of the qualitative variables and their associated numerical values.

Table 16: Qualitative Variables and their Associated Quantitative Values Used to Assess the Impact to Wetlands Due to Implementation of the NED Plan or LPP.

Variable Symbol	Variable	Variable Description	Qualitative Value	Numerical Value
V1	Surface Water Storage	This function helps prevent flooding by temporarily storing water, allowing it to soak into the ground or evaporate. This temporary storage can help reduce peak water flows after a storm by slowing the movement of water into tributary streams which allows potential floodwaters to reach mainstream rivers over a longer period of time. Water quality is also improved by removing nutrients, pesticides, and bacteria from surface waters as they are absorbed or broken down by plants, animals, and chemical processes within the wetland.	Very Low	0.2
			Low	0.4
			Moderate	0.6
			High	0.8
			Very High	1.0
V2	Subsurface Water Storage	Wetlands are reservoirs for rainwater and runoff. As this water is released into the ground, it recharges water tables and	Very Low	0.2
			Low	0.4
			Moderate	0.6
			High	0.8

Variable Symbol	Variable	Variable Description	Qualitative Value	Numerical Value
		aquifers, and extends the period of stream flows in many parts of the United States.	Very High	1.0
V3	Nutrient Cycling	Wetlands enhance the decomposition of organic matter, incorporating nutrients back into the food chain.	Very Low	0.2
			Low	0.4
			Moderate	0.6
			High	0.8
			Very High	1.0
V4	Retention of Particles	By filtering out sediments and particles suspended in runoff water, wetlands help prevent lakes, reservoirs, and other resources from being affected by downstream sediment loading. This improves water quality and extends the life of water bodies by reducing sedimentation rates.	Very Low	0.2
			Low	0.4
			Moderate	0.6
			High	0.8
			Very High	1.0
V5	Maintenance of Plant and Animal Communities	Both coastal and inland wetlands provide breeding, nesting, and feeding habitat for millions of waterfowl, birds, fish, and other wildlife. Wetlands in the United States support about 5,000 plant species, 190 species of amphibians, and a third of all native bird species. Coastal wetlands are an integral part of the life cycle for many marine organisms; they are the nursery and spawning grounds for 60 to 90 percent of U.S. commercial fish catches. Fresh-water wetland vegetation can provide valuable forage for livestock, particularly during drought years in many of the Plains States. Forested wetlands are also an important source of timber from such valuable trees as white cedar, bald cypress, and tupelo.	Very Low	0.2
			Low	0.4
			Moderate	0.6
			High	0.8
			Very High	1.0

The Habitat Suitability Index (HSI) for wetland habitat is assumed to be a function of all the variables listed above. The equation to calculate the HSI value is the following:

$$HSI = (V1 \times V2 \times V3 \times V4 \times V5)^{1/5}$$

HSI Calculation

To assess the function of the wetland habitat to be impacted by the modification of the Warner Avenue Bridge under both the NED Plan and LPP, a qualitative assessment of the wetland habitat to be directly impacted was conducted. *Table 17* shows the results of the qualitative assessment along with the associated numerical values.

Table 17: Calculated HSI for the Wetland Habitat within the Vicinity of the Warner Avenue Bridge Directly Impacted by Implementation of the Project.

Variable Symbol	Variable	Qualitative Value	Numerical Value
V1	Surface Water Storage	Very Low	0.2
V2	Subsurface Water Storage	Very Low	0.2
V3	Nutrient Cycling	Very Low	0.2
V4	Retention of Particles	Very Low	0.2
V5	Maintenance of Plant and Animal Communities	Very Low	0.2
		Calculated HSI	**0.2**

The HSI calculated for the wetland habitat within the vicinity of the Warner Avenue Bridge was then taken and multiplied by the total acreage of wetland habitat to be impacted by the project to get the habitat units that are currently produced by the wetland habitat. Refer to *Table 18* for the habitat units calculated for the wetland habitat within the vicinity of the Warner Avenue Bridge.

Table 18: Summary of HSI Value, AAHUs, and Net AAHUs for the Existing Wetland Habitat within the Vicinity of Warner Avenue Bridge that would be Directly Impacted by the Project.

Habitat Type	Acres	HSI	HUs	AAHUs
Estuarine Wetland	0.15	0.2	0.03	0.03

Under existing conditions, the wetland habitat within the vicinity of the Warner Avenue Bridge that would be directly impacted by implementation of the project provides approximately 0.03 AAHUs.

Muted Tidal Pocket (Enhancement)

Although the implementation of either the NED Plan or LPP would only directly impact less than one acre of wetland habitat, the area where the project is located is limited in mitigation opportunities due to the primarily built out nature of the project area. In addition, there are no mitigation banks currently online within the project area. The USACE coordinated with California State Lands Commission, California Department of Fish and Wildlife, and the U.S. Fish and Wildlife Service for appropriate mitigation opportunities that would offset the direct loss of approximately 0.03 AAHUs of estuarine wetland habitat. Although the addition of wetland habitat within the project area was not feasible, it was recommended that the USACE offset direct impacts to estuarine wetland habitat by enhancing the muted tidal pocket located within the Bolsa Chica Ecological Reserve.

The muted tidal pocket is located north of C05 Reach 1 within the Bolsa Chica Ecological Reserve. The lands to be used for the proposed mitigation are owned by the State of California, administered by the California State Lands Commission, and managed by the California Department of Fish and Wildlife. The muted tidal pocket (pocket) currently receives only muted tidal flows from a culvert located at the southwest corner of the pocket. Mitigation would include the construction of a hydraulic stoplog structure along the southeast corner of the pocket and daylighting the culvert at the southwest corner of the pocket. These features would allow for the restoration of a more tidal habitat and hydrologic regime. In particular, the proposed daylighting of the culvert at the southwest corner of the pocket would increase the tidal influence within the muted tidal pocket. Greater tidal exchange within the muted tidal pocket would provide biological benefits. For example, plant species that require a full tidal range to flourish, such as cordgrass and pickleweed, would be able to thrive and expand within the muted tidal pocket. The expanded cordgrass and pickleweed marsh habitat would support nesting by the federally-listed Ridgway's rail and the state-listed Belding's savannah sparrow, respectively. In addition, the increased quality of saltmarsh vegetation due to increased tidal influence may improve habitat value for the salt marsh shrew.

A biological benefit from daylighting of the culvert at the southwest end of the muted tidal pocket, as discussed above, is plausible since mitigation credits for the muted tidal pocket at the Bolsa Chica Ecological Reserve were given to the Ports of Los Angeles and Long Beach for a similar effort in 2005 (The Port of Los Angeles 2005). An additional 15.4 credits for the 35 acre site were given based on enlarging the culverts between Outer Bolsa Bay and the muted tidal pocket (enlarged size 1.220 m by 1.220 m [4 ft by 4 ft]), significantly increasing the tidal influence of the muted tidal area and allowing for significantly increased biological benefits associated with the better flushed muted tidal area (The Port of Los Angeles 2005). The mitigation effort proposed by the USACE would daylight the culvert thereby further increasing the tidal exchange between Outer Bolsa Bay and the muted tidal pocket allowing for even greater tidal exchange and flushing as well as allowing easier access to the muted tidal pocket for special status species such as the green turtle that may forage in the area. This would be an enhancement to the previous mitigation and also offset temporary impacts to green turtle foraging.

To determine the amount of habitat units that would be achieved by enhancing the muted tidal pocket, the existing condition function of the muted tidal pocket was qualitatively assessed (*Table 19*). In addition, the enhanced condition function of the muted tidal pocket was also qualitatively assessed (*Table 20*). The HSI calculated for the existing condition and the enhanced condition of the muted tidal pocket was then taken and multiplied by the total acreage of the muted tidal pocket that would receive benefits from the enhancement. Refer to *Table 21* for a summary of the habitat units calculated for the muted tidal pocket under both conditions.

Table 19: Calculated HSI for the Existing Condition of the Muted Tidal Pocket within the Bolsa Chica Ecological Reserve.

Variable Symbol	Variable	Qualitative Value	Numerical Value
V1	Surface Water Storage	Moderate	0.6
V2	Subsurface Water Storage	High	0.8
V3	Nutrient Cycling	High	0.8
V4	Retention of Particles	Moderate	0.6
V5	Maintenance of Plant and Animal Communities	Very High	1.0
		Calculated HSI	**0.75**

Table 20: Calculated HSI for the Enhancement Condition of the Muted Tidal Pocket within the Bolsa Chica Ecological Reserve.

Variable Symbol	Variable	Qualitative Value	Numerical Value
V1	Surface Water Storage	High	0.8
V2	Subsurface Water Storage	High	0.8
V3	Nutrient Cycling	High	0.8
V4	Retention of Particles	High	0.8
V5	Maintenance of Plant and Animal Communities	Very High	1.0
		Calculated HSI	**0.84**

Table 21: Summary of HSI Value, AAHUs, and Net AAHUs for the Muted Tidal Pocket under Existing Condition and Enhancement Condition.

Habitat Type	Acres	HSI	HUs	AAHUs	NAAHUs
Existing Condition Muted Tidal Pocket	35	0.75	26.25	26.25	-
Enhancement Condition Muted Tidal Pocket	35	0.84	29.4	29.4	3.15

Under the existing condition, the muted tidal pocket provides approximately 26.25 AAHUs. If the muted tidal pocket is enhanced as discussed above, the site would provide approximately 29.4 AAHUs. This is a net difference of 3.15 AAHUs which are gained by enhancing the muted tidal pocket. As discussed above under *HSI Calculation*, the direct impact to the estuarine wetland habitat within the vicinity of the Warner Avenue Bridge would result in the loss of approximately 0.03 AAHUs. Therefore, the enhancement of the muted tidal pocket would sufficiently offset the loss of 0.03 AAHUs at Warner Avenue Bridge by providing 3.15 AAHUs. This is a net gain of 3.12 AAHUs.

Wetland Mitigation Measures

Due to the primarily built out nature of the project area, the muted tidal pocket provided the only opportunity for wetland mitigation. In addition, there are no mitigation banks currently online within the project area. Therefore, only one wetland mitigation measure was developed for evaluation (*Table 22*).

Table 22: Wetland Mitigation Measures for both the NED Plan and LPP

Measure	Measure Description	NAAHUs
B	Enhancement of the muted tidal pocket	3.12

1.7.3 Special Status Wildlife

Quantitative Assessment

As discussed above under *Special Status Wildlife Impacts*, airborne noise from construction activities could disrupt foraging behavior for special status avian species. While the coastal California gnatcatcher, Ridgway's rail, and Belding's savannah sparrow forage adjacent to the channels, the California least tern is known to forage within the downstream portion of C05 Reach 1. During construction activities, a total of approximately 12.3 acres of foraging habitat for the California least tern within the downstream portion of C05 Reach 1 would be temporarily impacted due to the presence of construction equipment and construction activities. It is important to note that construction along the entire downstream portion of C05 Reach 1 (i.e., 12.3 acres) would not happen concurrently. Instead, construction within the downstream portion of C05 Reach 1 would occur along approximately 2 acres at a time, meaning that only 2 acres at a time would be temporarily impacted by construction activities.

The Least Tern Habitat Suitability Index Model prepared by the U.S. Fish and Wildlife Service (Carreker 1985) was used to assess the potential impact to California least tern foraging habitat during construction of the NED Plan and LPP. The least tern habitat model considers the ability of the habitat to meet the food and nesting needs of the species as an indication of overall breeding season habitat suitability. The model includes a food component and a reproduction component. Since construction would not occur during the breeding season (refer to *Section 1.4.1 National Economic Development Plan* for discussion), only the food component of the model was used to assess the temporary direct impact to California least tern foraging habitat. The food component requirement looks at percent aquatic area (SIV1) and number of disparate aquatic wetlands (SIV2). In regards to percent aquatic area, it is assumed in the model that an area composed of ≥ 50% water within the average maximum flight distance from the potential nesting habitat will provide optimum foraging habitat area (*Figure 11*). This is based on the assumption that a nesting habitat that borders an expansive aquatic system (e.g., the ocean or a large river and floodplain) will provide a potential nesting population with ample foraging habitat. The model assumes that the average maximum flight distance for coastal least terns is 3.2 km (approximately 2 miles).

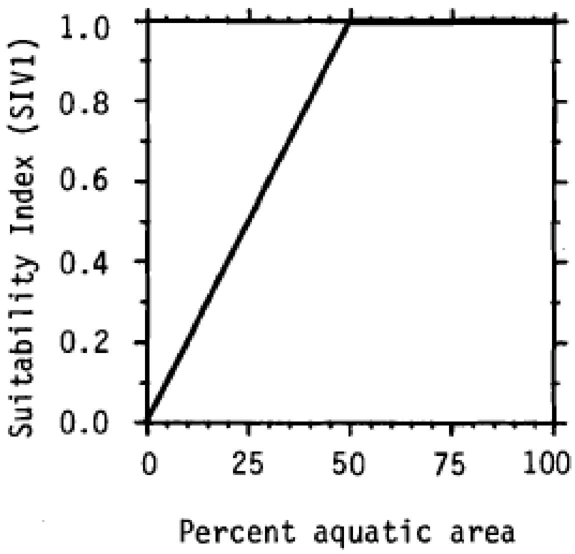

Figure 11: The Relationship between the Percent of the Area within the Average Maximum Flight Distance from the Potential Nesting Habitat that is Aquatic Habitat and the Suitability Index Value for Least Tern Food.

Least terns use and, at times, depend on a variety of foraging habitats. It is assumed that an area that contains a diversity of aquatic habitat types will be: (1) more productive than less diverse areas; (2) more likely to continue to provide food during the incubation and chick-rearing period if one of the aquatic habitat types fails to provide sufficient food supplies; and (3) able to adequately accommodate any possible change in foraging habitat use as the breeding season progresses. Habitat with two or more disparate aquatic systems (marine [M], estuarine [E], riverine [R], lacustrine [L], and palustrine [P]) within the average maximum flight distance is assumed to provide optimum diversity. However, a single, diverse aquatic system such as an estuary (E) or large riverine floodplain (P) can also be highly productive. Therefore, it is assumed that an area composed of a single aquatic system will provide optimum diversity of foraging habitat when it contains two or more disparate aquatic (i.e., flooded) wetlands within the average maximum flight distance from the potential nesting habitat (*Figure 12*).

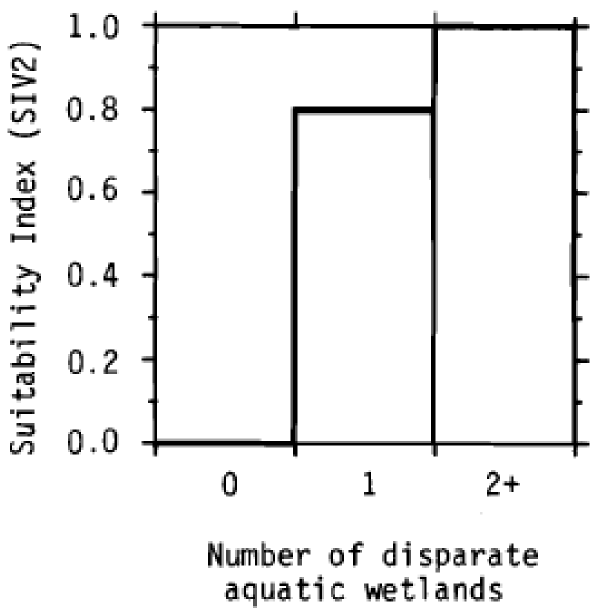

Figure 12: The Relationship between the Number of Disparate Aquatic Wetlands within the Average Maximum Flight Distance from the Potential Nesting Habitat and the Suitability Index Value for Least Tern Food.

The suitability index value for food (SIF) is assumed to be a function of the areal extent of surface water and diversity of foraging habitat within the average maximum flight distance from the potential nesting habitat. The relationship between suitability values calculated using *Figures 11* and *12* is illustrated in the following equation:

$$\mathrm{SIF} = \frac{2(\mathrm{SIV1}) + \mathrm{SIV2}}{3}$$

SIV1 is weighted to reflect the assumed greater relative significance of the quantity of foraging habitat.

SIV1 Calculation

To assess the suitability index value for percent aquatic area (i.e., SIV1), a nesting site within the Bolsa Chica Ecological Reserve was selected and a 3.2 kilometer (2 miles) buffer (representing the average maximum flight distance from the potential nesting habitat) was drawn around the nesting site (*Figure 13*). While there are multiple nesting sites within the Bolsa Chica Ecological Reserve, a single nesting site that was centrally located amongst the other nesting sites in the reserve was selected to represent all of the nesting sites used by the California least tern within the reserve.

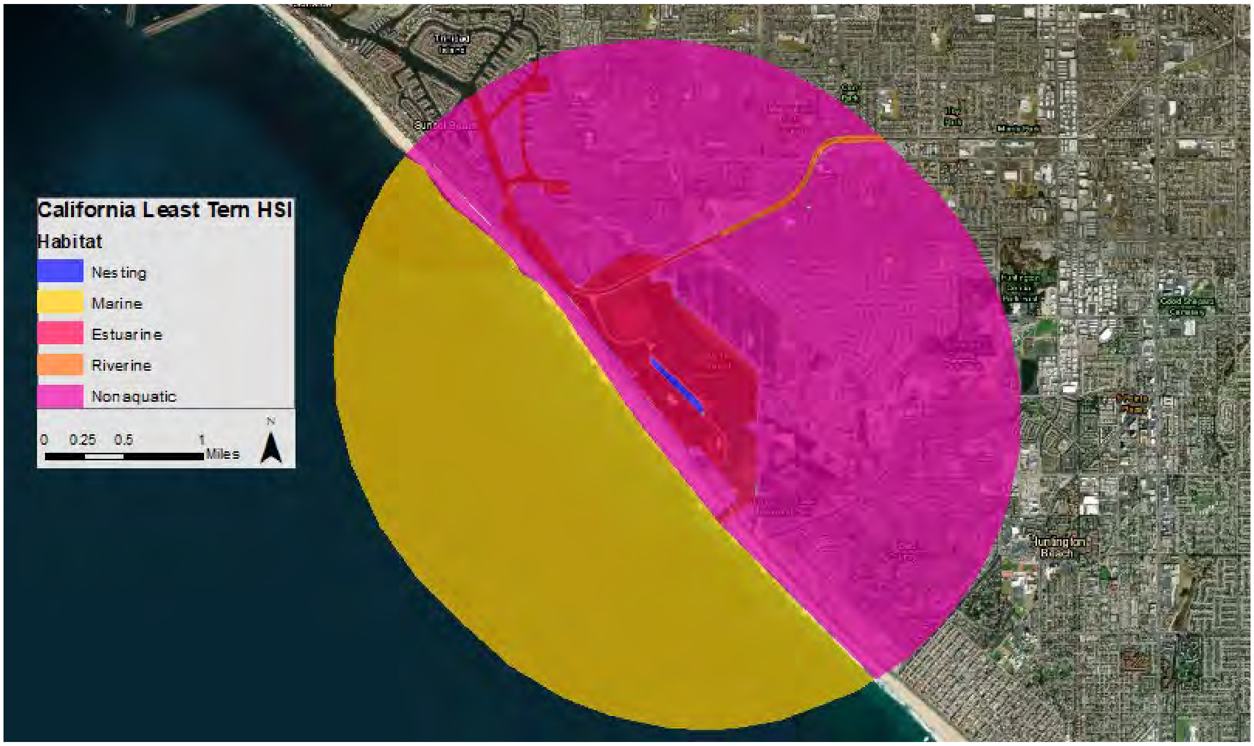

Figure 13: California Least Tern Nesting Site (Blue Polygon) Selected for Assessing Foraging Habitat Suitability and Designation of Aquatic and Nonaquatic Habitat within a 3.2 km Buffer Around the Nesting Site.

Using *Figure 13*, the following acreages in *Table 23* were estimated for existing condition aquatic and nonaquatic habitat within a 3.2 kilometer (2 mile) buffer of the centrally located nesting site within the Bolsa Chica Ecological Reserve. As stated above, approximately 2 acres of estuarine foraging habitat within a 12.3 acre portion in C05 Reach 1 would be temporarily impacted at a time during construction activities. Once construction is complete, this estuarine foraging habitat would once again be available for the California least tern. *Table 23* shows the during construction and post construction acreages of aquatic and nonaquatic habitat within a 3.2 kilometer (2 mile) buffer around the California least tern nesting site in the Bolsa Chica Ecological Reserve.

Table 23: Existing Condition, During Construction, and Post Construction Estimated Acreages of Aquatic and Nonaquatic Habitat within a 3.2 km Buffer Around a California Least Tern Nesting Site in the Bolsa Chica Ecological Reserve.

Habitat Type	Existing Condition		During Construction		Post Construction	
	Acres	Percentage	Acres	Percentage	Acres	Percentage
Marine	3,769	40.4%	3,769	40.4%	3,769	40.4%
Estuarine	680	7.3%	678	7.3%	680	7.3%
Riverine	33	0.4%	33	0.4%	33	0.4%
Aquatic Total	**4,482**	**48.1%**	**4,480**	**48.1%**	**4,482**	**48.1%**
Nonaquatic Total	**4,840**	**51.9%**	**4,840**	**51.9%**	**4,840**	**51.9%**
All Total	**9,322**	**100%**	**9,320**	**100%**	**9,322**	**100%**

Using the information in *Table 23*, *Figure 11*, and *Figure 13*, the suitability index for percent aquatic area was calculated to be the following for existing condition, during construction, and post construction (*Table 24*):

Table 24: Existing Condition, During Construction, and Post Construction Suitability Index Values for Percent Aquatic Area.

Project Phase	% Aquatic Area	Suitability Index Value
Existing Condition	48.1%	0.96
During Construction	48.1%	0.96
Post Construction	48.1%	0.96

SIV2 Calculation

Similar to SIV2, to assess the suitability index value for number of disparate aquatic wetlands (i.e., SIV2), a centrally located nesting site within the Bolsa Chica Ecological Reserve was selected and a 3.2 kilometer (2 mile) buffer (representing the average maximum flight distance from the potential nesting habitat) was drawn around the nesting site (*Figure 13*). While there are multiple nesting sites within the Bolsa Chica Ecological Reserve, this nesting site was selected to represent all of the nesting sites used by the California least tern within the reserve since it is centrally located amongst the other nesting areas. Per the mapping in *Figure 13*, there are three types of aquatic wetlands under the existing condition (i.e., marine, estuarine, and riverine). All three of these aquatic wetland types would still be available during construction and post construction. Although during construction approximately 2 acres of estuarine habitat at a time along a 12.3 acre portion of C05 Reach 1 would be temporarily unavailable for foraging by the California least tern, there would still remain approximately 678 acres of estuarine wetland still available for foraging within the 2.3 kilometer (2 mile) buffer around the centrally located nesting site within the Bolsa Chica Ecological Reserve. Post construction, the temporarily impacted estuarine habitat would once again be available for foraging, bringing the total acreage of estuarine habitat available to approximately 680 acres. Using the above information as well as *Table 25*, *Figure 12*, and *Figure 13*, the suitability index for number of disparate aquatic wetlands was calculated to be the following for existing condition, during construction, and post construction (*Table 26*):

Table 25: Existing Condition, During Construction, and Post Construction Suitability Index Values for Number of Disparate Aquatic Wetlands.

Project Phase	# of Disparate Aquatic Wetlands	Suitability Index Value
Existing Condition	3	1.0
During Construction	3	1.0
Post Construction	3	1.0

Foraging Habitat HSI

A summary of the calculations for SIV1 and SIV2 is shown in *Table 27*.

Table 26: Summary of Calculations for SIV1 and SIV2.

Project Phase	Variable SIV1 (% Aquatic Area)	Suitability Index Value		Variable SIV2 (# Disparate Aquatic Wetlands)	Suitability Index Value
Existing Condition	48.1%	0.96		3 (M, E, & R)	1.0
During Construction	48.1%	0.96		3 (M, E, & R)	1.0
Post Construction	48.1%	0.96		3 (M, E, & R)	1.0

The suitability index values for SIV1 and SIV2 were then used in the equation shown above to calculate the suitability index for food (SIF) value. This value was then taken times the aquatic acreage that would be available during each phase of the project to determine the average annual habitat units (AAHUs).

Table 27: Summary of HSI Value, AAHUs, and Net AAHUs for California Least Tern Foraging Habitat.

Project Phase	Acres	SIV1	SIV2	SIF (HSI Value)	AAHUs	NAAHUs
Existing Condition	4,482	0.96	1.0	0.97	4362.5	-
During Construction	4,480	0.96	1.0	0.97	4360.5	-2.0
Post Construction	4,482	0.96	1.0	0.97	4362.5	0

Under existing conditions, the current area provides approximately 4,362.5 AAHUs in California least tern foraging habitat. During construction, the temporary loss of approximately 2 acres of estuarine aquatic foraging habitat at a time would cause a temporary decrease in approximately 2.0 AAHUs in California least tern foraging habitat (i.e., 4,480 acres of aquatic habitat multiplied by the 0.97 calculated HSI value equals 4,360.5 AAHUs 'during construction'. To compute the temporary decrease in AAHUs, the 'existing condition' AAHUs are subtracted from the 'during construction' AAHUs (4,360.5 minus 4,362.5 equals -2.0)). Once construction of C05 Reach 1 is completed, the area would once again provide approximately 4,362.5 AAHUs in California least tern foraging habitat, the same AAHUs that were provided prior to implementation of the project. This would be the same for both the NED Plan and LPP.

<u>Tern Islands</u>

Although the project would temporarily impact foraging habitat for the California least tern, the area where the project is located is limited in mitigation opportunities due to the primarily built out nature of the project area. In addition, there are no mitigation banks currently online within the project area. The USACE coordinated with California State Lands Commission, California Department of Fish and Wildlife, and U.S. Fish and Wildlife for appropriate mitigation opportunities that would offset the temporary loss of approximately 2.0 AAHUs of California least tern foraging habitat. Although addition of foraging habitat within the project area was not feasible, it was recommended that USACE could offset temporary impacts to California least tern foraging habitat by improving California least tern nesting habitat within the project area. Specifically, there are two man-made tern islands (i.e., north and south tern island) located in Inner Bolsa Bay of the Bolsa Chica Ecological Reserve that are experiencing severe erosion and impacts due to sea level rise. The north tern island is approximately 2.0 acres while the south tern island is approximately 1.3 acres in area. Although the project would not impact these islands, if no mitigation is implemented to protect these man-made nesting sites they could cease to provide nesting habitat in the future.

The Least Tern Habitat Suitability Index Model prepared by the U.S. Fish and Wildlife Service (Carreker 1985) was used to assess the potential impact to California least tern nesting habitat if no action is undertaken to protect the north and south tern islands from erosion and future sea level rise. As stated above, the model includes a food component and a reproduction component. The reproduction component was used to assess the impact to the islands if nothing is done to protect them. The reproduction component requirement looks at percent herbaceous and shrub canopy cover (SIV3). Reproductive (i.e., nesting) habitat suitability for the least tern is related to a combination of several factors: percent vegetation cover, average height of vegetation cover, type of substrate, susceptibility to flooding, and the amount of predation and human-related disturbance. The first variable, percent vegetation cover, is used to assess the habitat quality of the existing nesting sites and the future nesting sites. Currently, within the Bolsa Chica Ecological Reserve there are four suitable areas for California least tern nesting, totaling 18.1 acres. All four sites have less than 25% vegetation coverage giving them a suitability index value of 0.9 (*Figure 14*).

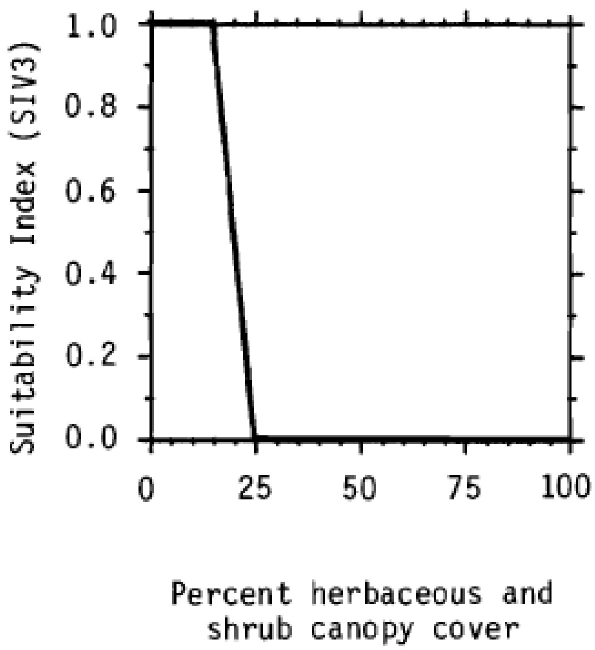

Figure 14: The Relationship between Vegetation Cover and the Suitability Index Value for Least Tern Reproduction.

It was assumed for the future condition of the tern nesting islands that vegetation cover would not change, however, loss of nesting acreage would occur due to continued erosion of the north and south tern islands and sea level rise. This would potentially cause a decrease of 3.3 acres in future nesting habitat for the California least tern. *Table 28* shows the existing suitability index and nesting acreage and the future without mitigation suitability index.

Table 28: Existing Condition and Future Condition Suitability Index Values for Vegetation Cover on Least Tern Nesting Habitat.

Project Phase	% Herbaceous and Shrub Canopy Cover	Suitability Index Value
Existing Condition	20%	0.9
Future Condition	20%	0.9

The suitability index values for SIV3 was then used to calculate the suitability index for vegetation cover (SIC) value. This value was then taken times the nesting habitat acreage that is available currently, and the anticipated acreage available in the future if no mitigation is implemented to protect the north and south tern islands to determine the average annual habitat units (AAHUs).

Table 29: Summary of HSI Value, AAHUs, and Net AAHUs for California Least Tern Nesting Habitat.

Condition	Acres	SIV3	SIC (HSI Value)	AAHUs	NAAHUs
Existing Condition	18.1	0.90	0.90	16.3	-
Future Condition	14.8	0.90	0.90	13.3	-3.0

Under existing conditions, the current area provides approximately 16.3 AAHUs in California least tern nesting habitat. If the north and south tern islands are not protected against future sea level rise it could result in the loss of 3.0 net AAHUS of least tern nesting habitat (*Table 29*).

Therefore, to offset the temporary loss of California least tern foraging habitat during project construction, nesting habitat would be enhanced. Enhancement of the north and south tern islands by increasing their resiliency to future sea level rise would avert the loss of 3.0 AAHUs of least tern nesting habitat. Averting the loss of 3.0 AAHUs of nesting habitat offsets the temporary loss of 2.0 AAHUs of least tern foraging habitat during project construction. This is a net enhancement of 1.0 AAHUs.

Special Status Wildlife Mitigation Measures

Due to the primarily built out nature of the project area, the tern islands provided the only opportunity for in-kind special status wildlife mitigation. Therefore, only one special status wildlife mitigation measure was developed for evaluation (*Table 30*).

Table 30: Special Status Wildlife Mitigation Measure for both the NED Plan and LPP

Measure	Measure Description	NAAHUs
C	Increase resiliency of nesting habitat for the federally-listed California least tern at the North and South Tern Islands at the Bolsa Chica Ecological Reserve	1.0

1.7.4 Summary of Mitigation Measures

Table 31: Summary of Mitigation Measures for both the NED Plan and LPP

Measure	Measure Description	NAAHUs
A.1	Mitigate entirely in-kind at Outer Bolsa Bay	0.30
A.2	Mitigate entirely out-of-kind at Palos Verdes	3.01
A.3	Combination of in-kind and out-of-kind mitigation	2.47
B	Enhancement of the muted tidal pocket	3.12

Measure	Measure Description	NAAHUs
C	Increase resiliency of nesting habitat for the federally-listed California least tern at the north and south tern islands at the Bolsa Chica Ecological Reserve	1.0

1.8 Formulation of Alternative Plans

The five mitigation measures summarized in *Table 31* and described in *Section 1.7 Mitigation Requirements* were combined into the following three alternative plans to be evaluated for implementation.

1.8.1 Alternative 1 – Project with No Mitigation

If the project is constructed with no mitigation, there would be a permanent loss of 1.7 acres of eelgrass habitat, increased flow velocities, and temporary impacts to special wildlife species. The Project with No Mitigation alternative is used as a baseline for this evaluation to compare other mitigation alternatives.

1.8.2 Alternative 2 – In-Kind Eelgrass, In-Kind Wetland, and In-Kind Special Status Wildlife Mitigation

Alternative 2 includes the transplanting of approximately 2.04 acres of eelgrass from donor beds in Huntington Harbour within Outer Bolsa Bay. In addition, the muted tidal pocket at the Bolsa Chica Ecological Reserve will be hydraulically modified to increase tidal flow within the pocket, creating a more tidally influenced salt marsh than a muted tidal salt marsh. Lastly, the north and south tern islands at the Bolsa Chica Ecological Reserve will be amended with sand to increase their resiliency to future sea level rise and to continue to provide nesting habitat for the California least tern.

Planning level mitigation costs including monitoring and adaptive management were estimated for Alternative 2 and are shown in *Table 32*. Planning level costs were annualized over the 50-year project life for the incremental cost analysis.

Table 32: Estimated Planning Level Costs for Mitigation Alternative 2.

Measure	Cost
Eelgrass A.1	$184,800
Muted Tidal Pocket Enhancement	$2,118,000
Tern Islands Sand Addendum	$509,500
Subtotal	**$2,812,300**
Adaptive Management[a]	$750,000
Quantity Markup[b]	$712,500
Monitoring and OMRR&R[c]	$1,500,000
Total Planning Level Cost	**$4,274,800**
Average Annual Cost	**$186,000**

[a] Adaptive management assumed $150,000/year for five years
[b] 20% quantity markup assumed
[c] Monitoring and OMRR&R assumed $50,000/year for 10 years and $25,000/year for 40 years

1.8.3 Alternative 3 – Out-of-Kind Eelgrass, In-Kind Wetland, and In-Kind Special Status Wildlife Mitigation

Alternative 3 includes the restoration of approximately 3.6 acres of rocky reef habitat at the Palos Verdes Rocky Reef Restoration Project. In addition, the muted tidal pocket at the Bolsa Chica Ecological Reserve will be hydraulically modified to increase tidal flow within the pocket, creating a more tidally influenced salt marsh than a muted tidal salt marsh. Lastly, the north and south tern islands at the Bolsa Chica Ecological Reserve will be amended with sand to increase their resiliency to future sea level rise and continue to provide nesting habitat for the California least tern.

Planning level mitigation costs including monitoring and adaptive management were estimated for Alternative 3 and are shown in *Table 33*. Planning level costs were annualized over the 50-year project life for the incremental cost analysis.

Table 33: Estimated Planning Level Costs for Mitigation Alternative 3.

Measure	Cost
Eelgrass A.2	$371,500
Muted Tidal Pocket Enhancement	$2,118,000
Tern Islands Sand Addendum	$509,500
Subtotal	**$2,999,000**
Adaptive Management[a]	$750,000
Quantity Markup[b]	$749,800
Monitoring and OMRR&R[c]	$1,500,000
Total Planning Level Cost	**$4,498,800**
Average Annual Cost	**$204,000**

[a] Adaptive management assumed $150,000/year for five years
[b] 20% quantity markup assumed
[c] Monitoring and OMRR&R assumed $50,000/year for 10 years and $25,000/year for 40 years

1.8.4 Alternative 4 – Combination of In-Kind/Out-of-kind Eelgrass, In-Kind Wetland, and In-Kind Special Status Wildlife Mitigation

Alternative 4 is a combination of in-kind and out-of-kind eelgrass mitigation. Under this alternative, approximately 0.5 acres of eelgrass from donor beds in Huntington Harbour will be transplanted in Outer Bolsa Bay in addition to the restoration of approximately 3.6 acres of rocky reef habitat at the Palos Verdes Rocky Reef Restoration Project. In addition, the muted tidal pocket at the Bolsa Chica Ecological Reserve will be hydraulically modified to increase tidal flow within the pocket, creating a more tidally influenced salt marsh than a muted tidal salt marsh. Lastly, the north and south tern islands at the Bolsa Chica Ecological Reserve will be amended with sand to increase their resiliency to future sea level rise and continue to provide nesting habitat for the California least tern.

Planning level mitigation costs including monitoring and adaptive management were estimated for Alternative 4 and are shown in *Table 34*. Planning level costs were annualized over the 50-year project life for the incremental cost analysis.

Table 34: Estimated Planning Level Costs for Mitigation Alternative 4.

Measure	Cost
Eelgrass A.3	$416,800
Muted Tidal Pocket Enhancement	$2,118,000
Tern Islands Sand Addendum	$509,500
Subtotal	**$3,044,300**
Adaptive Management[a]	$750,000
Quantity Markup[b]	$758,900
Monitoring and OMRR&R[c]	$1,500,000
Total Planning Level Cost	**$4,553,200**
Average Annual Cost	**$203,000**

[a] Adaptive management assumed $150,000/year for five years
[b] 20% quantity markup assumed
[c] Monitoring and OMRR&R assumed $50,000/year for 10 years and $25,000/year for 40 years

1.9 Comparison of Alternative Mitigation Plans

Cost effectiveness and incremental cost analysis (CE/ICA) are two distinct analyses that must be conducted to evaluate the effects of alternative plans according to USACE policy. First, it must be shown through cost effectiveness analysis that a restoration plan's output cannot be produced more cost effectively by another alternative.

Cost effectiveness means that, for a given level of non-monetary output, no other plan costs less and no other plan yields more output at a lower cost.

Incremental cost analysis means that the subset of cost effective plans are examined sequentially to ascertain which plans are most efficient in the production of environmental benefits. Those most efficient plans are called "best buys". As a group of measures, they provide the greatest increase in output for the lease increases in cost. They have the lowest incremental costs per unit of output. In most analyses, there will be a series of best buy plans, in which the relationship between the quantity of outputs and the unit cost is evident. As the scale of best buy plans increases (in terms of output produced), average costs per unit of output and incremental costs per unit of output will increase as well. The incremental cost analysis by itself will not point to the selection of any single plan. The results of the incremental analysis must be synthesized with other decision-making criteria (i.e., significance of outputs, acceptability, completeness, effectiveness, risk and uncertainty, reasonableness of costs) to help the study team select and recommend a particular plan.

The USACE's Institute of Water Resources (IWR) developed procedures and software to assist in conducting CE/ICA. The IWR Planning Suite Beta MCDA software package was used to conduct this analysis. *Table 35* shows the values that were put into the IWR Planning Suite and used for cost-effectiveness and incremental cost analysis. Habitat unit gains or losses are annualized by summing the cumulative HUs calculated across all target years in the period of analysis and dividing the total (cumulative HU) by the number of years in the life of the project (i.e., 50 years). This calculation results in the AAHUs.

Table 35: Summary of Mitigation Alternative Costs and Outputs Used in CE/ICA.

Alternative	Description	Average Annual Cost[a]	Net AAHUs[b]
1	Project with No Mitigation	$0.00	0
2	In-Kind Eelgrass, Wetland, and Special Status Wildlife	$186,000	4.42
3	Out-of-Kind Eelgrass, Wetland, and Special Status Wildlife	$204,000	7.13
4	Combination In-Kind/Out-of-Kind Eelgrass, Wetland, and Special Status Wildlife	$203,000	6.59

[a] Average annual cost includes construction, project performance monitoring, adaptive management, interest during construction, and operations and maintenance (O&M). LERRDS are not included since no real estate would need to be acquired as the lands are owned by the State of California.
[b] Net AAHUs for an alternative were calculated by taking the sum of the Net AAHUs achieved by each individual measure. For example, the Net AAHUs for Alternative 4 were calculated by summing the Net AAHUs achieved by A.3, B, and C. The acreages of these measures do not overlap, therefore, summing the Net AAHUs is appropriate.

1.9.1 Cost Effectiveness

The cost effectiveness analysis was used to ensure that certain options would be screened out if they produced the same amount or less output at a greater cost than other options with a lesser cost. Four alternatives were analyzed for cost effectiveness, including the project with no mitigation. Of these, two cost effective combinations were identified (*Table 36* and *Figure 15*), with two of the four plans also being identified as “Best Buys”. No alternatives were screened out as “non-cost effective”.

Table 36: Cost Effective Analysis on Four Alternative Plans.

Alternative	Description	Average Annual Cost[a]	Net AAHUs	Cost Effectiveness
1	Project with No Mitigation	$0.00	0	Best Buy
2	In-Kind Eelgrass, Wetland, and Special Status Wildlife	$186,000	4.42	Cost Effective
3	Out-of-Kind Eelgrass, Wetland, and Special Status Wildlife	$204,000	7.13	Best Buy
4	Combination In-Kind/Out-of-Kind Eelgrass, Wetland, and Special Status Wildlife	$203,000	6.59	Cost Effective

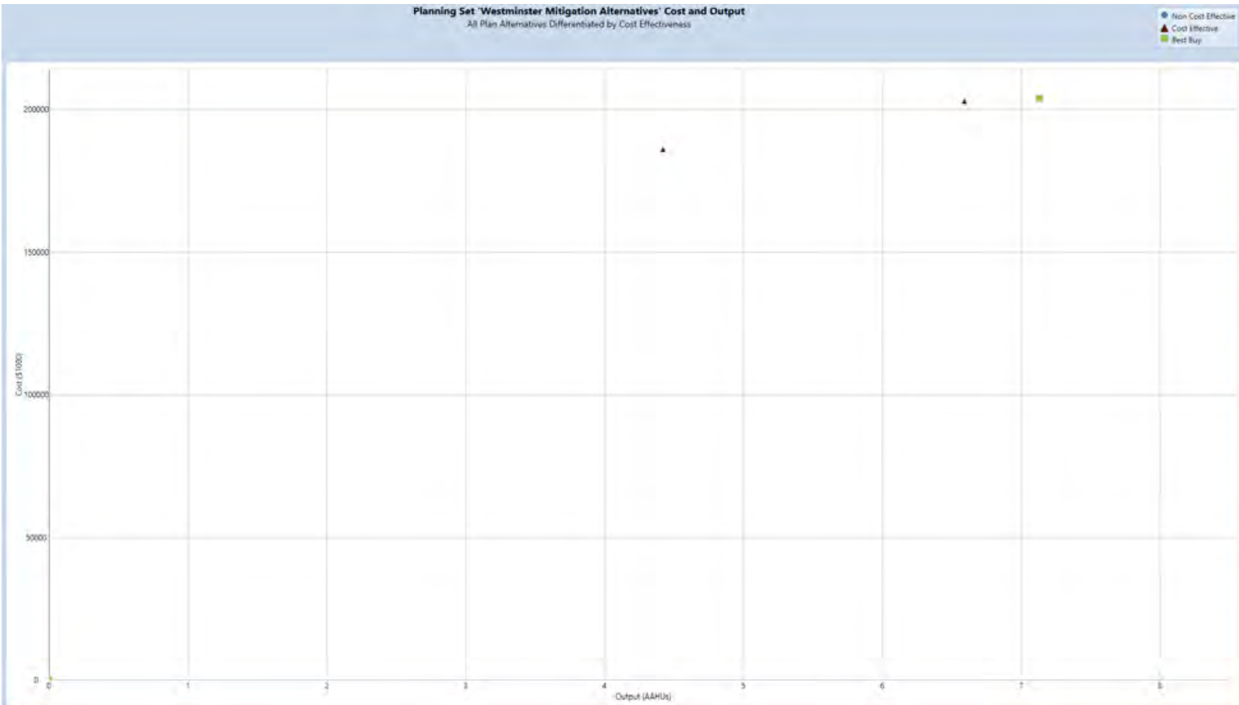

Figure 15: Summary of Mitigation Alternative Costs and Outputs Used in CE/ICA

1.9.2 Incremental Cost Analysis

An incremental cost analysis was performed on the Best Buy Plans identified from the cost effectiveness analysis, including the No Action plan. The objective of the incremental cost analysis is to assist in determining whether the additional output provided by each successive plan is worth the additional cost. This incremental cost analysis (*Table 37* and *Figure 16*) compares the mitigation alternatives that were considered for selection.

Table 37: Summary of CE/ICA "Best Buy" and "Cost-Effective" Alternative Plans

Alternative	AAHUs	AA Cost	AA Cost/AAHUs	Incremental Cost	Incremental AAHUs	Incremental Cost/Incremental AAHUs
1	0	$0	$0.00	$0.00	0.00	$0.00
3	7.13	$204,000	$28,600	$204,000	7.13	$28,600

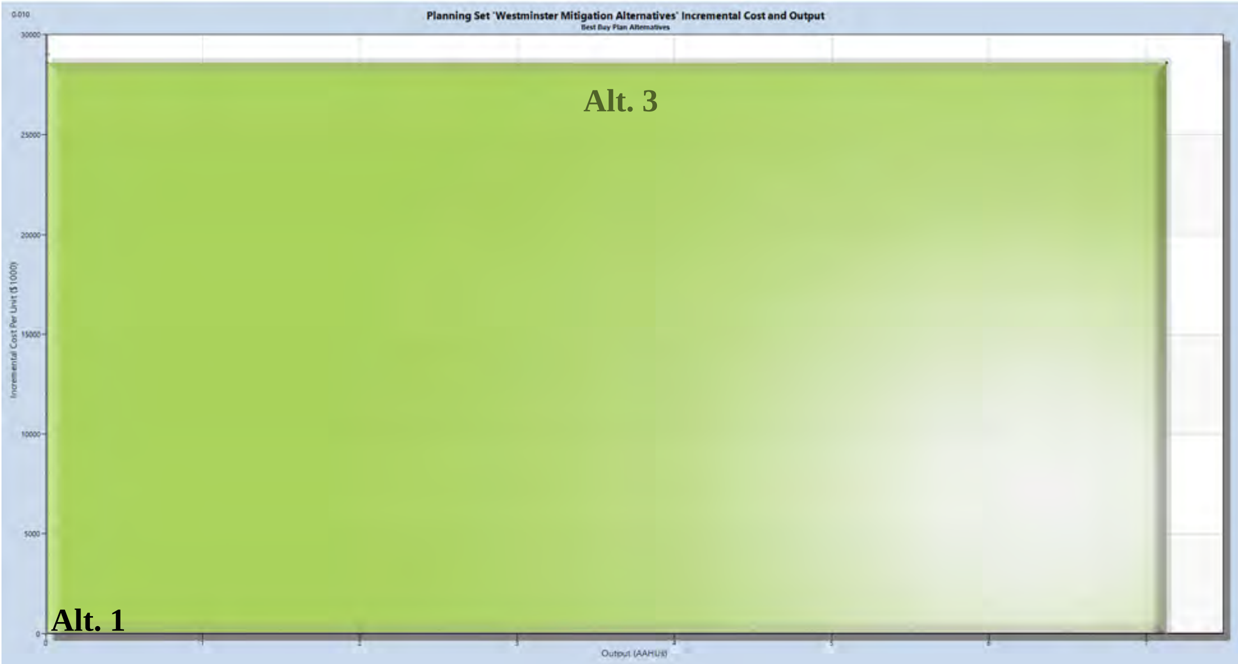

Figure 16: Incremental Cost and Output of "Best Buy" Alternative Plans

1.10 Selecting a Mitigation Plan

There are a number of ways to conduct CE/ICA, thereby determining which alternative plans are cost-effective and, from the set of cost-effective plans, identifying those alternative plans that are most efficient in producing outputs (i.e., best buys). In this case the selected plan, a "cost effective" plan, was chosen over "best buy" alternatives because it is the least cost mitigation plan that provided full mitigation of losses specified in mitigation planning objectives, and it was preferred over the other alternative plans by federal and state resource agencies.

1.10.1 Selected Mitigation Plan

The selected mitigation alternative was Alternative 4, which includes a combination of in-kind and out-of-kind eelgrass mitigation, wetland mitigation, and special status wildlife mitigation (*Table 38* and *Figure 17*).

Measures within the selected mitigation alternative (Alternative 4) include:

1) Eelgrass – a combination of in-kind mitigation that would include the transplanting of 0.5 acre of eelgrass habitat in Outer Bolsa Bay and out-of-kind mitigation that would include restoring approximately 3.6 acres of rocky reef habitat at Palos Verdes.
2) Muted Tidal Pocket Enhancement – enhancement of the muted tidal pocket located within the Bolsa Chica Ecological Reserve. A hydraulic stoplog structure would be constructed at the southeast corner of the site and the culvert at the southwest corner of the site would be daylighted.

3) Tern Islands Sand Addendum – the north and south tern islands located within the Bolsa Chica Ecological Reserve would be increased in height so as to increase their resiliency to future sea-level rise.

Figure 17: Bolsa Chica Ecological Reserve Proposed Mitigation Sites for Impacts to Eelgrass, Wetland, and Special Status Wildlife Species. Figure Does Not Show Rocky Reef Restoration Area at Palos Verdes.

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1.11 Details of the Selected Mitigation Plan

The selected mitigation alternative plan, Alternative 4, includes eelgrass measure A.3, enhancement of the muted tidal pocket at the Bolsa Chica Ecological Reserve, and increasing the height of the north and south tern islands at the Bolsa Chica Ecological Reserve to increase their resiliency to future sea level rise. The following subsections provide a more detailed look at the selected mitigation alternative plan.

1.11.1 Eelgrass

In-Kind Mitigation

Approximately 0.5 acre of eelgrass will be transplanted to mitigate for indirect impacts to eelgrass. The sites are to be planted as identified in *Table 38*.

Table 38: Eelgrass planting area planting density and planting unit counts by area.

Transplant Site	Planting Area (m^2)	Planting Density	Planting Units
Outer Bolsa Bay	10522	1.5 m grid	912
Total	**1052**		**912**

Donor Sites

Donor eelgrass for the transplants of eelgrass is to be derived from eelgrass donor beds in Huntington Harbour.

In order to prevent any adverse impacts to the donor beds, no more than 10% of the eelgrass within any donor bed will be harvested; this will allow the beds to recover quickly. Donor beds within Huntington Harbour were primarily selected based on a number of factors:

1) Proximity to the transplant receiver site that favors both logistic convenience and selection of appropriate plant materials for the area;
2) Suitability of donor site size and eelgrass density to provide necessary transplant materials;
3) Diversity of environments represented by donor sites and the likelihood that eelgrass from blended donor areas will provide greater genetic diversity than a single donor site;
4) Recovery potential for the donor site; and,
5) Accessibility of the donor site and diver safety.

Reference Sites

An eelgrass reference site is to be established within the vicinity of Outer Bolsa Bay. The site will be selected based on proximity to and similarity in physical and biological characteristics to the project impact areas and the proposed restoration site. The reference site will be finalized at the time of the first post-planting monitoring event. Monitoring of the reference site will be conducted coincident with the monitoring of the transplant area. Changes in the reference area over time will be considered to represent natural environmental variability when evaluating the performance of the transplant area (see Monitoring Program sections).

Restoration Methods

Letter of Permission and Notifications. Prior to commencing eelgrass transplantation work, a letter of permission to harvest and plant eelgrass will be obtained from the SLC and CDFW. A notification and a preliminary transplanting schedule would be provided to SLC and CDFW prior to commencement of the transplant work.

Plant Collection. Bare-root eelgrass plant material will be salvaged from the donor bed by "raking" rhizomes out of the surface sediment layers and loosely filling a mesh bag with salvaged material. In collecting eelgrass, care will be taken to work the rhizomes free as opposed to ripping the plants free of the sediment. This will preserve as much root material as possible. Salvaging is a mobile exercise and divers will move systematically through an area and collect/groom no more than 10% of the plant material. Salvaged materials should consist of no less than three healthy intermodal segments with well-developed root initiates and vigorous shoots. More intact rhizome segments and roots are preferred for use in the planting unit bundles.

Collected material will be held in a flow-through seawater source until it is processed into planting units. No material will be stored for over 8 hours from harvesting to unit preparation. Once units are prepared, they will be stored in open water for no longer than 24 hours.

Transplant Units. The proposed eelgrass mitigation plan will utilize anchored bare-root transplant units. Bare-root transplants are the preferred means of transplanting eelgrass in most situations, and anchored bare-root units are the principal planting units used in large-scale restoration projects at the current time. The survival of such planting units has been shown to be quite high when properly prepared (Fonseca et al. 1982; Merkel 1987, 1990a). Similarly, bare-root units have shown an ability to rapidly expand and colonize bare substrate (Merkel 1990b). In addition to offering high unit survival and rapid expansion rates, bare-root units can be prepared with limited damage to the donor bed. Unlike plug extractions, bare-root units can be prepared using materials collected without substantial sediment disturbance. Each transplant unit for the project work will consist of 6-10 turions.

The anchors used in this plan will be biodegradable and pliable anchors such as those developed initially for transplants in Mission Bay's Sail Bay (Merkel 1987) and which have subsequently been used in more than 50 eelgrass restoration projects throughout California, Oregon, Washington, and Alaska. These units have been used in more than a dozen eelgrass restoration projects for USACE and U.S. Navy.

Planting Eelgrass Units. Staging and work areas will be situated on the levee along the north side of C05 Reach 1. Work areas will be set up within the channel right-of-way to avoid conflicts with hikers and bikers using the BCER trail system. Planting will be conducted using divers working on a defined planting grid with temporary bounding lines to control planting areas. This layout will allow for ease of tracking work progress and completion of quality control reviews.

The plant materials will be planted by excavating a hole in the sediments with a small trowel or by hand. The root/rhizome bundle will be planted approximately 1 to 2 inches below the sediment surface with the anchor being placed approximately 5 inches below the sediment surface. During planting, spot checks of the plantings will be made to ensure proper planting depth and firmness of the anchoring system.

Planting unit spacing is typically determined by balancing the rate of bed establishment with the cost of the transplant project. In some instances, rapid bed establishment is required to minimize potential storm damage or scouring of unconsolidated rhizome mats. In other cases, rapid recovery rates are desirable to meet bed establishment milestone objectives. Taking into account the rate of eelgrass growth, a planting unit spacing of 1 meter on grid center will be used for the transplant within Outer Bolsa Bay (*Table 39*).

Timing of the Restoration Work. Transplanting of the eelgrass will require approximately two days. It is currently scheduled to take place in September 2023 following site preparation, completion of removal of the tide gates, and in order to fall within the growing season (i.e., typically March through October).

Out-of-Kind Eelgrass Mitigation

Out of kind eelgrass mitigation would be conducted through an agreement with NOAA-NMFS or an approved contractor. Work would be performed at the Palos Verdes Reef Restoration Project to establish rocky reef, soft bottom, and abalone habitat. Approximately 3.6 acres are targeted to be restored through this mitigation. This work can commence as early as September 2021.

1.11.2 Wetlands

Muted Tidal Pocket

Enhancement Methods

Letter of Permission and Notifications. Prior to commencing the breaching of the north C05 Reach 1 levee and daylighting of the culvert, a water quality certification would be obtained from the Santa Ana Regional Water Quality Control Board (RWQCB) and a letter of permission would be obtained from the SLC to work within the BCER. A notification would be provided to SLC and CDFW prior to commencement of the restoration work.

Breaching of the Levee. Staging and work areas will be situated along the maintenance road on the north side of C05 Reach 1 within the channel right-of-way. An excavator would be used to remove soil along approximately 20 linear feet of the levee, extending from approximately the Oil Field Bridge downstream. Soil that is removed from the levee would be disposed of at an appropriate landfill. Once the breech is complete, a hydraulic stoplog structure would be constructed in the area. Large stone will be placed around the stoplog structure to protect the area from erosion and scour.

Daylighting Culvert. Staging and work areas will be situated along the maintenance road on the north side of C05 Reach 1 within the channel right-of-way. An excavator would be used to remove the existing culvert. Soil that is removed from the area would be disposed of at an appropriate landfill. Large stone will be placed around the daylighted portion to protect the area from erosion and scour.

Timing of the Restoration Work. The breaching of the north C05 Reach 1 levee and daylighting of the culvert at the southwest end of the muted tidal pocket will require approximately 5 months. It is currently scheduled to take place in October 2021 to January 2022 to avoid the breeding season for resident and migratory birds.

1.11.3 Special Status Wildlife

North and South Tern Islands

Enhancement Methods

Letter of Permission and Notifications. Prior to commencing the sand addendum to the north and south tern islands, a water quality certification would be obtained from the Santa Ana Regional Water Quality Control Board (RWQCB) and a letter of permission would be obtained from the SLC to work within the BCER. A notification would be provided to SLC and CDFW prior to commencement of work.

North Tern Island Addendum. Staging and work areas will be situated along the maintenance road to the east of the island. A crane would be used to place sand on top and around the north tern island. Sand would be clean, inert material purchased from a commercial supplier.

South Tern Island Addendum. Staging and work areas will be situated along the maintenance road to the east of the island. A crane would be used to place sand on top and around the south tern island. Sand would be clean, inert material purchased from a commercial supplier.

Timing of Enhancement Work. The sand addendums to the north and south tern islands would require approximately one month. It is currently scheduled to take place in September 2021 to avoid the breeding season for resident and migratory birds.

1.12 Monitoring Program for the Selected Mitigation Alternative Plan

1.12.1 Eelgrass

In-Kind Eelgrass Mitigation

Establishment Monitoring. Upon completion of the transplanting effort, a monitoring program would be initiated and continued for a 60-month (5-year) period as outlined in the CEMP (NMFS 2014b). Aerial extent and density of the transplanted eelgrass sites, control sites, and predicted indirect impact sites should be monitored using the same sidescan sonar techniques discussed above.

The monitoring program should be conducted at intervals of 6, 12, 24, 36, 48, and 60-months post-transplant. When monitoring dates fall outside of the normal eelgrass-growing season, dates should be shifted to coincide with the growing season to ensure that valuable information on growth and survival is collected. For each monitoring interval, a draft monitoring report should be prepared and submitted to the USACE within 15 days of completion of the monitoring survey. Within 30 days of completion of the monitoring interval, a final report shall be submitted, incorporating or addressing any USACE comments received.

Monitoring reports should include information from previous monitoring intervals, including numerical comparisons and graphical presentations of changing bed configurations. Graphical comparisons will include generalized bathymetry. The monitoring report should include an analysis of any declines or expansions in eelgrass coverage based on physical conditions of the site, as well as any other significant observations. Finally, the monitoring report should provide a prognosis for the future of the eelgrass bed and should identify the timing for the next monitoring period.

Mitigation Success Criteria. Mitigation should be deemed successful when it has met the success criteria outlined in the CEMP (NMFS 2014b). Criteria for determination of transplant success should be based upon a comparison of vegetation coverage (area) and density (turions per square meter) between the reference sites and the transplant sites. The extent of vegetation cover is defined as the area where eelgrass is present and where gaps in coverage are less than one meter between individual turion clusters. Density of shoots is identified as the number of turions per meter, as measured from representative areas within the control or transplanted beds. Key success criteria are as follows:

A) A minimum of 70 percent areal coverage and 30 percent density should be achieved after the first year.
B) A minimum of 85 percent areal coverage and 70 percent density should be achieved after the second year.
C) A minimum of 100 percent areal coverage and 85 percent density should be achieved for the third, fourth, and fifth years.

Areas that do not meet the above success criteria may be revegetated, and again monitored until the final goal is achieved. Should replanting of the area at the project site fail to meet the success criteria; adaptive management measures may be required to carry out this revegetation. Should the reference area fail or decline alongside the mitigation area for reasons outside the control of the USACE, the USACE and the non-federal sponsor should not be held responsible for similar declines in the mitigation area. If expected declines in the predicted indirect impact sites do not occur, and project site fails to meet success criteria, USACE and the non-federal sponsor will not be held responsible for further mitigation.

1.12.2 Wetlands

Muted Tidal Pocket

Monitoring. Upon completion of enhancement of the muted tidal pocket, a monitoring program would be initiated and continued for a 60-month (5-year) period to ensure the area is becoming more tidal than muted. The monitoring program would be conducted at intervals of 6, 12, 24, 36, 48, and 60-months post-project. For each monitoring interval, a draft monitoring report would be prepared and submitted to the USACE within 15 days of completion of the monitoring survey. Within 30 days of completion of the monitoring interval, a final report would be submitted, incorporating or addressing any USACE comments received.

Monitoring reports would include information from previous monitoring intervals, including numerical comparisons and graphical presentations. The monitoring report would also identify the timing of the next monitoring period.

Mitigation Success Criteria. Mitigation would be deemed successful when it has met the success criteria outlined below. Key success criteria are as follows:

A) Achieve a salinity gradient more indicative of full tidal than muted tidal (range between 0.5 parts per thousand [ppt] to 35 ppt).
B) At a minimum, maintain pre-mitigation California Rapid Assessment Method (CRAM) score.

Areas that do not meet the above success criteria may require the implementation of adaptive management measures, and again monitored until the final goal is achieved. Should the success criteria not be met due to reasons outside the control of the USACE, the USACE and the non-federal sponsor should not be held responsible.

1.12.3 Special Status Wildlife

North and South Tern Islands

Monitoring. Upon completion of enhancement of the tern islands, a monitoring program would be initiated and continued for a 60-month (5-year) period to ensure the area is being utilized by terns, including the California least tern. The monitoring program would be conducted at intervals of 6, 12, 24, 36, 48, and 60-months post-project. California least terns in southern California typically appear on their breeding grounds from April through October, and nest from about late May through August. If monitoring dates fall outside of the normal nesting season, dates would be shifted to coincide with the nesting season to ensure valuable information is collected on number of nests, eggs, and young hatched. For each monitoring interval, a draft monitoring report would be prepared and submitted to the USACE within 15 days of completion of the monitoring survey. Within 30 days of completion of the monitoring interval, a final report would be submitted, incorporating or addressing any USACE comments received.

Monitoring reports would include information from previous monitoring intervals, including numerical comparisons and graphical presentations of changing nest numbers and successful hatches. The monitoring report would include an analysis of any declines or increases in nests and successful hatches, as well as any other significant observations. Finally, the monitoring report would identify the timing of the next monitoring period.

Mitigation Success Criteria. Mitigation should be deemed successful when it has met the success criteria outlined below. Criteria for determination of success should be based upon a comparison of past nest numbers and nest success prior to mitigation. Key success criteria are as follows:

A) No decline in nest numbers when compared to nest numbers prior to mitigation, unless the decline is for reasons outside the control of the USACE.
B) No decline in nest success when compared to nest success prior to mitigation, unless the decline is for reasons outside the control of the USACE.

Areas that do not meet the above success criteria may require the implementation of adaptive management measures, and again monitored until the final goal is achieved. Should the number of nests and/or nest success decline at the mitigation sites for reasons outside the control of the USACE, the USACE and the non-federal sponsor should not be held responsible.

1.13 Program Schedule for the Selected Mitigation Alternative Plan

1.13.1 Eelgrass

Based on the presently planned transplant window, the schedule of work is as follows:

Activities	Time Period	Reporting Period
1. Complete Eelgrass Transplant	September 2023	October 2023
2. Complete 6-Month Survey	March 2024	April 2024
3. Complete 12-Month Survey	September 2024	October 2024
4. Complete 24-Month Survey	September 2025	October 2025
5. Complete 36-Month Survey	September 2026	October 2026
6. Complete 48-Month Survey	September 2027	October 2027
7. Complete 60-Month Survey	September 2028	October 2028

1.13.2 Wetlands

Muted Tidal Pocket

The schedule of work is as follows:

Activities	Time Period	Reporting Period
1. Complete enhancement	January 2022	February 2022
2. Complete 6-Month Survey	June 2022	July 2022
3. Complete 12-Month Survey	January 2023	February 2023
4. Complete 24-Month Survey	January 2024	February 2024
5. Complete 36-Month Survey	January 2025	February 2025
6. Complete 48-Month Survey	January 2026	February 2026

Activities	Time Period	Reporting Period
7. Complete 60-Month Survey	January 2027	February 2027

1.13.3 Special Status Wildlife

North and South Tern Islands

The schedule of work is as follows:

Activities	Time Period	Reporting Period
1. Complete placement of sand addendum	October 2021	November 2021
2. Complete 6-Month Survey	April 2022	May 2021
3. Complete 9-Month Survey	July 2022	August 2021
4. Complete 12-Month Survey	October 2022	November 2022
5. Complete 24-Month Survey*	July 2023	August 2023
5. Complete 36-Month Survey	July 2024	August 2024
6. Complete 48-Month Survey	July 2025	August 2025
7. Complete 60-Month Survey	July 2026	August 2026

*Due to the timing of when terns nest, yearly surveys will be conducted during nesting season and not on annual basis from when the project was completed.

1.14 Mitigation Costs

The total cost for the proposed mitigation alternative, Alternative 4, for both the NED Plan and LPP is presented below in *Table 39*.

Table 39: Estimated Mitigation Costs for Alternative 4.

Measure	Cost
Eelgrass A.3	$416,800
Muted Tidal Pocket Enhancement	$2,118,000
Tern Islands Sand Addendum	$509,500
Subtotal	**$3,044,300**
Adaptive Management[a]	$750,000
Quantity Markup[b]	$594,400
Monitoring and OMRR&R[c]	$1,500,000
Construction Management, Planning, Engineering & Design[d]	$1,139,300
Contingency[e]	$2,221,600
Total Cost	**$7,918,100**

[a] Adaptive management assumed $150,000/year for five years
[b] 15% quantity markup assumed
[c] Monitoring and OMRR&R assumed $50,000/year for 10 years and $25,000/year for 40 years
[d] Assumed 25% for Construction Management and PED
[e] Assumed 39% contingency

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