Attachment C

Alternatives Analysis

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Section 404 Alternatives Analysis

For

Commercial Oyster Shell Mining by

Lind Tug and Barge, Inc.

within South San Francisco Bay

Prepared for:

U.S. Army Corps of Engineers

San Francisco District

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Table of Contents

1. INTRODUCTION

This Section 404 Alternatives Analysis has been prepared to support the US Army Corps of Engineers permitting for ongoing oyster shell mining in South San Francisco Bay by the project proponent, Lind Tug and Barge, Inc. (LTB). LTB has submitted an application to the U.S. Army Corps of Engineers requesting authorization to mine historic oyster shell from a California State Lands Commission (CSLC) lease area in South San Francisco Bay located adjacent to the San Mateo Bridge (Figure 1).

The level of analysis in a Section 404(b)(1) Alternatives Analysis should be "commensurate" with the level of impact and the significance and complexity of the discharge activity (40 CFR 230.6(b)). The oyster shell mining at issue has been ongoing for approximately 100 years, yet no significant adverse impacts have been specifically identified during that time or in the public comments received to date. The State Lands Commission spent years analyzing the environmental impacts of this project and found it appropriate to issue a Mitigated Negative Declaration, finding that there are no significant impacts of the project with the mitigation measures already in place.

The project applicant has evaluated potential alternatives to the Proposed Project equipment and operations in the past and has implemented a number of refinements in an effort to minimize and avoid environmental impacts. The most recent alternative actions implemented included installation of state-of-the-art positive barrier fish screens that meet or exceed State and Federal resource agency design criteria (implemented in 2017), and most recently, modification to the suction pipe priming system to reduce and avoid the potential for fish and macroinvertebrate entrainment during the priming and clearing phases of a shell mining event (implemented in 2020).

Regardless, the applicant has committed to prepare a revised and updated 404(b)(1) Alternatives Analysis to assist USACE in the permitting process. The qualitative Alternatives Analysis considers a variety of potential alternatives based on factors such as source availability, feasibility of harvest, transportation, nutrient value of the oyster shell as a dietary supplement, and economics. This Alternatives Analysis presents technical information about the Proposed Project and resulting actions and assesses potential alternatives to the Proposed Project.

The Project description is provided in Section 2 and includes details of the equipment and methods used in oyster shell mining. The Proposed Project also includes avoidance and minimization measures (Best Management Practices – BMPs) described in Section 2.7 as part of the Project description. Mining activities employ a variety of conservation measures designed to avoid and minimize potential adverse effects to aquatic resources. The conservation measures provide increased protection for all aquatic resources within the South San Francisco Bay CSLC designated lease area including listed salmonids, green sturgeon and their critical habitat, and longfin smelt, as well as the other species, and Essential Fish Habitat for managed fish populations.

2. PROJECT DESCRIPTION

2.1 Description of Action

The US Army Corps of Engineers has received an application from Lind Tug and Barge for a permit to conduct an oyster shell mining operation over the next 10 years within a designated lease area located in South San Francisco Bay. As part of the permitting process the US Army Corps of Engineers is evaluating potential environmental impacts and alternatives to the Proposed Project.

2.2 Purpose and Need

The purpose of the Proposed Project is to continue harvesting relic oyster shell deposits as a source of calcium carbonate for processing and commercial sale principally as a calcium and nutrient food supplement for poultry and livestock diets, and as a pharmaceutical calcium supplement. As an agricultural dietary supplement, oyster shell has unique physical and chemical characteristics that make it superior to other calcium sources especially for poultry. Oyster shell tablets are widely used as a high-quality dietary supplement and source of calcium and nutrients (such as iron, copper, iodine, magnesium, etc.) by humans, and other commercial beneficial uses. Pharmaceutical use of oyster shell calcium has a long history of acceptability and benefit to humans as a dietary supplement and nutrient source due to its texture, digestibility, and solubility. Calcium as a dietary supplement is an essential mineral for maintaining teeth, bone density (osteoporosis), and proper enzyme activity. Although oyster shell mined from San Francisco Bay has been used in the past for a variety of purposes, including the manufacture of cement, oyster shell mined by LTB is currently used primarily as a high-grade nutrient additive for poultry and livestock diets, and as a pharmaceutical calcium supplement.

2.3 Oyster Shell Mining Location and Volume

Oyster shell mining occurs exclusively within the California State Lands Commission designated lease area PRC 5534.1, located in South San Francisco Bay adjacent to the San Mateo Bridge (Figure 1). The lease area is approximately 1,560 acres in size within a shallow (water depths are typically 15 feet or less), open water subtidal area of the bay.

LTB is currently limited by the CSLC lease and other regulatory permits to annual harvest volumes of 80,000 cubic yards. LTB proposes to continue to harvest oyster shells at or below this limit for the remainder of the term of the CSLC lease (through 2028), then plans renewal of the lease at that time.

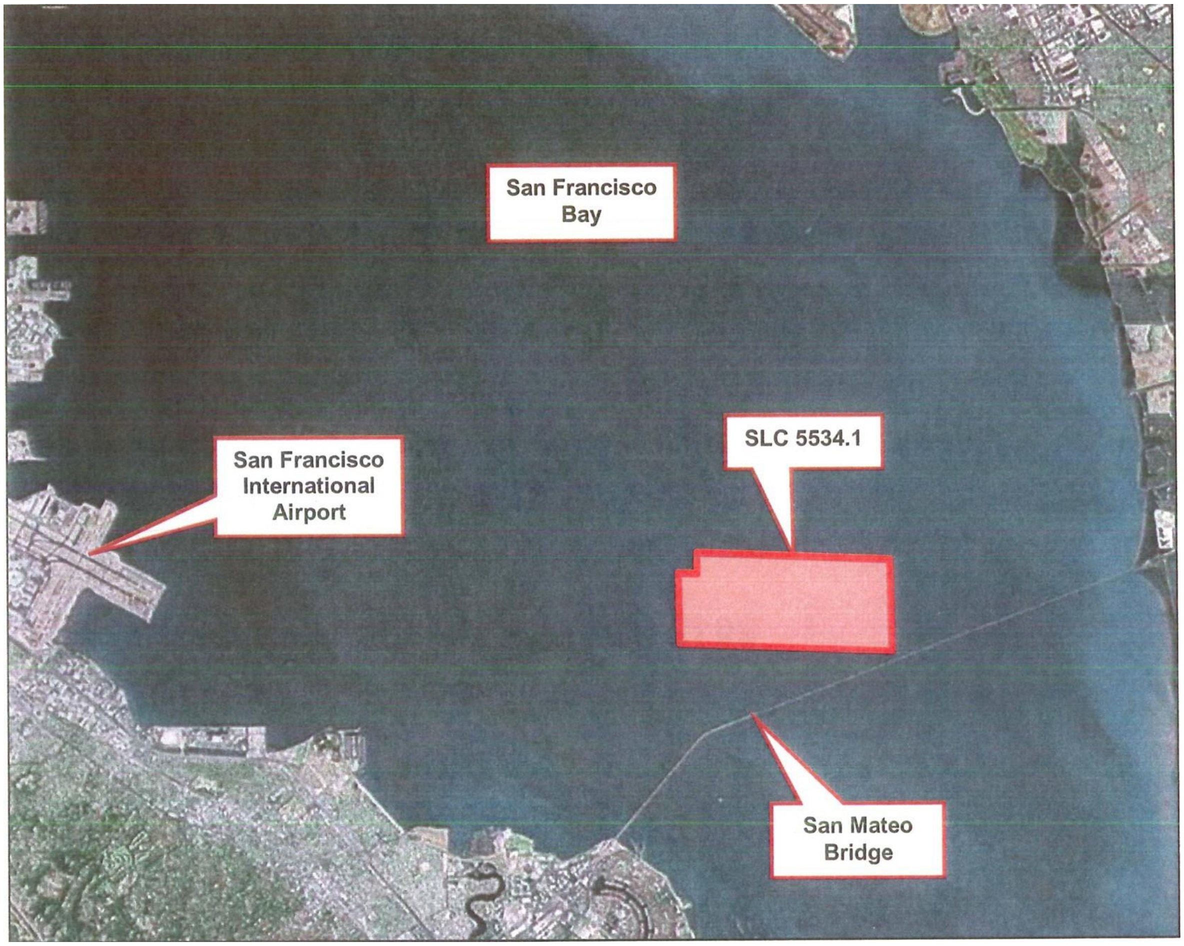

Figure 1. Oyster Shell Mining Vicinity Map

2.4 Oyster Shell Mining Methods and Equipment

LTB mines oyster shell deposits using a hydraulic suction dredge, which mines and washes the shell, then places the shell into an adjacent hopper barge. A new shell dredge, custom designed exclusively to harvest oyster shells from South San Francisco Bay, was placed into service by LTB in 2013. This new shell dredge employs the same mining and washing methods as the previous equipment, but with newer and more efficient equipment, which has been updated and refined from 2013 until present.

The shell dredge harvests oyster shell using the "trailing suction method of trolling" (Figure 2). A tugboat is used to push the shell dredge and shell hopper barge to the lease area, and to propel the barges as mining occurs. Shell deposits are mined with a suction drag head buried typically 2-3 feet into the bottom substrate by slowing trolling over the deposits within the lease area between 1-2 nautical miles per hour (knots).

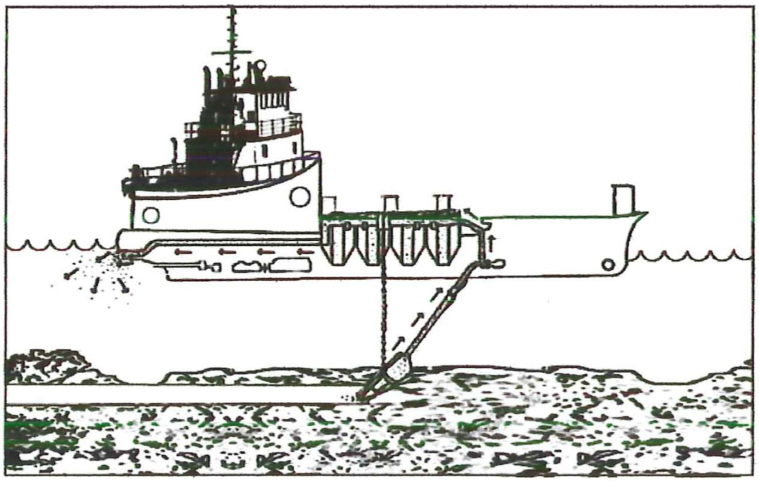

Figure 2. Schematic diagram of "trailing suction trolling" method used by Lind Tug and Barge while shell dredging.

During mining, a 12-inch diameter suction pipe equipped with a 24-inch x 32-inch drag head is lowered to the bottom (water depths in the mining area typically range from 8-15 feet deep) approximately 2-3 feet into the substrate (reducing potential entrainment of species). The suction pipe is mounted on the side of the barge and raised and lowered by an electric winch. The suction pipe is connected to the shell pump (12-inch diameter pumping approximately 6,000 gpm), which transports a shell, water, and silt slurry from the Bay bottom up to the barge.

The slurry contains approximately 50 percent shell, 45 percent water, and 5 percent silt; the ratios vary depending on characteristics of the localized shell-sediment deposits. Most of the water used to make the slurry is drawn through the interstices of the shell substrate itself; however, a small 4-inch diameter line on top of the drag head enables water from above the substrate to enter the drag head to facilitate formation of the slurry. To protect against entraining any adult or juvenile fish or other organisms into the drag head through this line, a single stationary positive barrier cylindrical fish screen is mounted on the suction pipe.

The slurry is pumped to the raised rear of a large rotating trommel screen for washing and screening. In the trommel screen, additional water is added through spray bars. The additional wash water is supplied from a wash pump (12-inch diameter pumping approximately 3,700 gpm) through an intake hose through the side of the barge. This intake is equipped with a pair of stationary positive barrier cylindrical fish screens. As the trommel rotates, silt falls from the shells, and the incidental water and silt are returned back to the Bay through a pipe extending through the bottom of the shell dredge (approximately 5 feet underwater). Excess water, silt and wash water released in this manner results in a localized temporary suspended sediment plume during mining. The suspended sediment concentrations and areal extent of the plume vary based on a number of factors including the quantity of silt and mud associated with a specific shell deposit, tidal currents, and naturally occurring ambient suspended sediment concentration within the South Bay in the area where mining occurs.

The washed shell is then conveyed to a hopper barge from the trommel using a 24-inch conveyor belt. The barge is kept "trim" (level) at all times by moving the conveyor from side to side, and by re-positioning the barge next to the shell dredge. Once the hopper barge is loaded, the tugboat pushes the loaded barge and shell dredge to Mare Island in Vallejo, where the dredge is moored between mining events. The loaded hopper barge is transported by tug to one of two shell processing sites in Petaluma on the Petaluma River or Collinsville (along Montezuma Slough upstream of Suisun Bay), operated by an affiliate of LTB, Lind Marine Incorporated (LMI). At the offload site, a hydraulic excavator is used to scoop the shell from the hopper barge to a conveyor system that stockpile the shell for processing at the processing facility. The processed shell is bagged or loaded into bulk trucks for distribution to accommodate market demand for the shell product in California and the western U.S.

2.5 Temporal Distribution and Duration of Mining Episodes

Shell mining activity may occur at any time of the day, depending on tides, currents, winds, weather, the size of the hopper barge being loaded, intermittent delays/breakdowns, transit times to the lease, etc. Transit time between the lease area and one of the two land-based facilities (Petaluma or Collinsville) is approximately 8 hours (empty barge) to 12 hours (loaded barge) one way depending on the onshore facility used. It takes 6 hours to over 24 hours to fill a barge depending on the size of the barge, and 6-8 hours to offload at the delivery site. Product demand dictates the frequency and number of mining events that occur. Limited land-based storage of mined shell product and demand dictate the mining event frequency.

Use of new, more efficient equipment and larger volume barges has resulted in significantly fewer mining events needed to meet demand, even though the duration of individual events has increased. For example, the estimated number of mining events required to mine 80,000 cy of shell is as follows: the historical dredge *South Bay* operations required approximately 91 mining events over 910 hours annually; new mining equipment and barge configurations require only about 28 mining events over an estimated 409 hours to mine the maximum annual volumes. These reductions in time and number of mining events result in fewer local temporal disturbances, and significantly lower fuel consumption and associated air emissions associated with vessel transit and mining compared to the historic operations.

2.6 Mining Volumes and Seasonal Distribution

The amount and seasonal timing of mining volumes are largely dictated by demand for shell product; seasonality has very little influence, as the majority of the product is used for agricultural feed supplement. Mining volumes may also be indirectly limited by the maximum cubic yardage allowed under the respective lease and permits. The current annual permitted volume of shell that can be harvested from the shell lease is 80,000 cy (40,000 tons). Table 1 shows the actual annual volumes of shell mined by LTB from 2006-2019.

Replacement of the prior oyster shell mining equipment with new, specifically designed and more efficient equipment has resulted in a substantial improvement in mining efficiency and an associated reduction in environmental impacts (e.g., reduction in GHG and other air quality emissions). Table 2 shows a summary of the number of mining events per year over the period from 2006 through 2017. Between 2006 and 2016 the number of mining events ranged from 31 to 68 events per year. With implementation of the new mining equipment the number of mining events was reduced to 13 to 18 events per year in 2017-2019. Mining during the proposed 10-year period of the USACE permit would be conducted using the new more efficient mining equipment.

For future events, LTB proposes to alter the seasonal distribution of mining episodes to avoid sensitive spawning periods for longfin smelt and the presence of their larvae in the mining area by ceasing mining for two full months during a period between February and June of each year. LTB will cease mining activity in these months to prevent the larval life stage of these species of concern within the South Bay from being entrained through mining activity. The actual two-month curtailment period will be selected each year by January 31 through notice to the California Department of Fish and Wildlife (CDFW). Mining would be spread throughout the remaining months, with periods of inventory buildup and recovery if required to maintain appropriate shell supply.

Table 1. Actual Shell Mining Volumes – 2006-2019.

YEAR	TONS MINED	CUBIC YARDS MINED
2006	32,771	65,542
2007	31,809	63,618
2008	29,916	59,832
2009	27,758	55,516
2010	33,108	66,216
2011	31,255	62,510
2012	33,196	66,392
2013	36,017	72,034
2014	32,394	64,788

YEAR	TONS MINED	CUBIC YARDS MINED
2015	29,509	59,018
2016	30,838	61,676
2017	26,120	52,240
2018	24,115	48,230
2019	22,485	44,970
Average	30,092	60,184

Table 2. Number of oyster shell mining events per year (2006-2017)

YEAR	# OF MINING EPISODES
2006	67
2007	61
2008	59
2009	54
2010	61
2011	59
2012	68
2013	64
2014	50
2015	31
2016	34
2017	18
2018	16
2019	13

2.7 Avoidance and Minimization Measures

As part of LTB's participation in the CSLC CEQA process and Mitigated Negative Declaration (MND; CSLC 2018), and the issuance of an Incidental Take Permit by CDFW, a number of protective measures (avoidance, minimization, and mitigation) were proposed by LTB or adopted through the permitting and CEQA processes. Measures included are outlined below.

2.7.1 Turbidity Reduction During Mining

The oyster harvesting barge was custom designed by LTB to include a subsurface return (located approximately 5 feet below the surface) of the overflow material to increase dispersal of the “overflow plume”. As part of ongoing activities, LTB reviews information being developed by the marine mining industry and other investigators on modifications to marine mining equipment and techniques designed to minimize the potential effects of overflow plume exposure on listed fish, macroinvertebrates, birds, mammals, and the visual aesthetics of the plume.

2.7.2 Limited Volume per Year

The CSLC lease and State and Federal permits regulate the annual volume of shell that can be harvested from the lease area. These limits serve to reduce the potential risk of adverse effects of oyster shell mining on subtidal habitat and aquatic resources.

The maximum allowable oyster shell volume that would be permitted to be harvested by LTB during the permit period would be 80,000 cy per year.

2.7.3 Water Depth Limitation to Avoid Sensitive Habitat

Within the region of the South Bay lease area, oyster shell mining occurs in open water subtidal areas. The lease area is located in the central part of the South Bay (Figure 1) and is not located near shallow water shoreline areas. Mining occurs at depths below the photic zone in the South Bay and therefore potential impacts to eel grass beds and other sensitive habitat areas are avoided.

2.7.4 Limited Mining (Lease) Areas

As shown in Figures 1, oyster shell mining is restricted to the specific lease area designated by CSLC in the South Bay. Mining is not permitted outside of the lease area. Limiting the mining area to a specific location within the South Bay avoids potential mining in sensitive habitats (e.g., eel grass beds, etc.) and concentrates mining in limited areas thereby reducing benthic disturbance and other potential effects of mining in the majority of subtidal habitats within the South Bay. This lease area, and specific locations within the lease area where oyster shell deposits occur and mining activity is most frequent, are characterized by water depths of 7 to 20 feet with young bay mud deposits overlaying historic oyster shell deposits. The lease area, as with the entire South Bay, typically experiences high levels of turbidity and suspended sediment concentrations associated with relatively shallow water depths, fine substrate, and wind and tidal current sediment resuspension.

2.7.5 Hazardous Material Control and Spill Prevention and Response Plan

LTB utilizes a written “Hazardous Material Control and Spill Prevention and Response Plan”, which includes measures to prevent and control hazardous materials spills, and training for personnel. Required cleanup equipment is available to the tugboat and mining crew. LTB’s oil spill response and emergency procedures include the following steps as a minimum:

- Stop the product flow;
- Warn personnel;
- Shut off ignition sources;
- Contain / Control the spill;
- Notify company environmental officer;
- Notify company emergency response contractor, the US Coast Guard, the California Office of Emergency Services, and the US EPA;
- Notify other agencies as required and as appropriate;
- If needed, mobilize an appropriate response, including salvage and recovery-cleanup operations; and
- Consult and study the detailed contingency information concerned with spill response and the spill action plan (assessment, response options, containment, recovery, cleanup and decontamination).

Licensed and accredited fuel jobbers approved by both CDFW and the U.S. Coast Guard conduct all the marine fueling. The jobber handles all aspects of refueling including flag boats, oil booms and warning signals. The fueling is conducted under the supervision of the jobber.

Marine contractors at their permitted facilities accomplish all major maintenance. Personnel trained in the care of marine equipment conduct minor and routine maintenance at the LTB/Lind Marine offloading facilities.

2.7.6 Limit Pumping Depths

By keeping the drag head in contact with the bottom during pumping, the risk of fish entrainment through the drag head is virtually eliminated. In order to minimize potential entrainment of fish, especially pelagic species including steelhead, Chinook salmon and longfin smelt LTB previously limited pumping for priming or clearing of the suction pipe to when the end of the pipe was within less than 3 feet off of the bottom. As part of these previous standard operating procedures, LTB had committed not only to keeping the suction pipe within less than 3 feet off of the bottom, but also to limiting the time the pump operated while the drag head was off the bottom to no more than 5 minutes during each mining event in the South Bay lease area. Through recent consultation with the operating staff and pumping engineers, LTB has completed system modifications to allow priming and clearing of the shell slurry pumping system with water injected into the suction pipe from the wash pump system, which draws all of its water through a positive barrier fish screen. This allows all priming and clearing of the shell suction pump to occur when the drag head is in contact with the bottom substrate, thereby completely excluding juvenile and adult steelhead, Chinook salmon, green sturgeon, longfin smelt, and other species from the suction pipe and avoiding the risk or entrainment losses.

2.7.7 Limit Pump Priming/Clearing Time

In order to further minimize potential entrainment of fish, LTB had previously limited the time the pumps are operated while the drag head is off the bottom to no longer than 5 minutes per mining episode. As described in the previous section, system modifications have been completed that allow the pumps to be primed and cleared while the drag head is in contact with the bottom substrate. All oyster shell mining starting in October 2020 is conducted using the newly modified priming and clearing system. Therefore, LTB will limit pump priming and clearing to only when the drag head is in contact with the bottom substrate.

2.7.8 Installation of Positive Barrier Fish Screens

The suction pipe of the LTB barge is equipped with a small opening on the top of the drag head that pulls water into the suction pipe to help create the shell-water slurry when the drag head is buried in the substrate. This vent entrains water, and would potentially entrain fish and macroinvertebrates, into the suction pipe. In addition to the shell suction drag head, an additional wash water pump draws water from directly beneath the bottom of the shell dredge hull, for the shell washing process. Concern has been expressed regarding the potential entrainment of fish, including longfin smelt, steelhead, juvenile Chinook salmon, and green sturgeon as well as other species, during shell mining. In an effort to reduce and avoid the potential risk of fish entrainment, LTB has installed positive barrier fish screens designed by Intake Screens, Inc. (ISI) and approved by CDFW for the drag head vent, and on the intake of the wash water pump that effectively exclude juvenile and adult fish from entrainment during shell mining. The design of the fish screens was based on a variety of factors that include guidance from the CDFW, NMFS, and USFWS on fish screen design criteria (e.g., approach velocity of 0.2 ft/sec, 1.75 mm intake screen mesh opening, etc.) as well as specific requirements related to the equipment used in shell mining. The fish screens are constructed using stainless steel to avoid rust and corrosion and to facilitate long-term reliable integrity of the screens. As required by the CDFW Incidental Take Permit (ITP) for longfin smelt, the fish screens are to be in place during all mining events and are inspected for damage and impinged species and debris following each mining event.

LTB has completed modifying the shell wash system: starting in October 2020 only screened water from the wash system is injected into the suction pipe to prime the pump at the beginning of a mining event and clear the pipe at the end of a mining event, while maintaining contact between the suction head and bottom. This additional modification to the mining equipment is expected to eliminate the risk of entrainment of larger juvenile and adult fish (larger than approximately 15 mm long), however fish eggs and larvae less than 15 mm long may still be entrained through the 1.75 mm intake screen mesh.

2.7.9 Seasonal Curtailment of Mining Activities

Eggs and larval stages of longfin smelt, herring, anchovy, and other species may be present in the mining area during the late winter and early spring and could remain vulnerable to entrainment through the mesh of the fish screen. To reduce and avoid entrainment risk for larval stages of species into the fish screens, LTB will curtail all oyster shell mining activity during a two-month period between February and June of each calendar year. LTB will notify CDFW each year of the selected two-month curtailment period for that year. This two-month curtailment avoids larval life stage of protected or other aquatic species present in the South Bay from being entrained through the drag head or the wash water intake during these months.

LTB will also curtail oyster shell mining when notified by CDFW that Pacific herring have spawned and eggs are incubating in the vicinity of the lease area.

2.7.10 Purchase of Covered Species Credits to Fully Mitigate Incidental Take

Based on results of the analysis of oyster shell mining by LTB in the South Bay, and in an abundance of caution that potential effects were fully mitigated, it was concluded that potential incidental take could occur. The highest risk for take was associated with the risk of entrainment into the suction pipe during short periods when the pipe is not in contact with the substrate associated with pump priming and clearing. LTB has installed and operates positive barrier fish screens that substantially reduce and minimize entrainment of juvenile and adult fish during oyster shell mining.

Modification to the mining equipment to allow priming of the pump and clearing of the suction pipe while the suction head is in contact with the bottom will serve to eliminate the risk of entrainment of protected fish species and other species with the exception of the egg and early larval life stages. To fully mitigate incidental take of California Endangered Species Act (CESA) protected larval longfin smelt, LTB has implemented the conservation measures identified above, as well as purchased shallow water mitigation habitat within the estuary that would provide habitat for longfin smelt to therefore fully mitigate all take.

LTB has completed purchase of 0.2 acres of Covered Species credits at Liberty Island for longfin smelt.

2.7.11 Provide Shell to Habitat Restoration Projects

To provide mitigation for potential impacts to fisheries habitat in the oyster shell mining lease area from benthic disturbance and other factors, LTB is proposing to provide a portion of the oyster shell mined each year for various projects to enhance physical habitat restoration within the South Bay (see Appendix A). For the South Bay projects, LTB proposes to mine, deliver and offload the shell material to a site in the Port of Redwood City, where the restoration project owners would pick up the material and deliver it by truck to the restoration project sites. The quantity of oyster shell provided for habitat enhancement is proposed to be a percentage of the total shell actually mined annually over the duration of the permit. LTB is proposing to provide 3% of the annual total shell mined for habitat restoration projects, up to an annual maximum of 1,800 c.y.. In no event would the total annual shell mining volumes exceed the annual permit limit, INCLUDING any shell provided for restoration projects.

2.7.12 Replacement of Diesel Pump Engines with Electric Motors

LTB has replaced the diesel engines previously used to power the shell dredge and wash water pumps with electric motors, which are powered by a single Tier 4 diesel generator, contributing to a significant reduction in air emissions associated with mining activity.

2.7.13 Periodic Bathymetric Surveys

LTB will conduct periodic bathymetric surveys to assess current and future bathymetric conditions within the shell mining lease area. Three surveys are proposed to be conducted over the 10-year CSLC lease period to help evaluate potential trends and impacts with regard to South Bay bathymetry. LTB has also agreed to conduct an assessment of relic oyster shell resources in the subtidal region of South Bay CSLC lease area and the relative changes in shell deposits and water depths within the lease as a result of oyster shell mining.

2.7.14 Water Quality Wash Water Plume Study

LTB will collaborate with the SFRWQCB to design, fund, conduct and report results of a plume water quality monitoring study as part of updating the permitting under the Water Board.

2.7.15 Vessel Traffic Notification

LTB contacts US Coast Guard District 11 San Francisco Bay Vessel Traffic Control to notify them of transit and mining activities inbound and outbound to and from the lease area in the South Bay and transiting to Mare Island or the offloading facilities, to avoid conflicts with other marine traffic and uses.

3. AFFECTED ENVIRONMENT

This section presents baseline information necessary for consideration of the Proposed Project and alternatives and describes the aquatic resources that would be affected by the alternatives, as well as environmental components that would affect the alternatives if they were to be implemented. The effects of the Alternatives on the environment are discussed in Section 4.

3.1 Aquatic Habitats

San Francisco Bay provides habitat to a diverse assemblage of marine and estuarine organisms (Hanson *et al.* 2004). The biological environment is a complex community of plants and animals inhabiting the saltwater, estuarine (brackish-water), and freshwater habitats within the Bay-Delta estuary. The Bay-Delta is a complex estuarine ecosystem, a transition zone between inland sources of freshwater and saltwater from the ocean. Along the salinity gradient extending from the Golden Gate upstream into the Delta, the species composition of the aquatic community changes dramatically, although the basic functional relationships among organisms (e.g., predator-prey, etc.) remain similar throughout the system.

The primary energy input to the system is solar radiation, which is used, along with nutrients, by the primary producers (phytoplankton are a food resource for many zooplankton as well as some larval and adult fish; vascular plants and macroalgae are also important primary producers) to convert inorganic carbon and nutrients to organic matter through photosynthesis. Zooplankton (e.g., copepods, cladocerans, *mysid* shrimp) prey on the phytoplankton. The vascular plants and macroalgae are grazed on and also produce detritus, which is decomposed by microbes and consumed by detritivores (e.g., polychaete worms, amphipods, cladocerans, and a diverse group of other fish and macroinvertebrates). The primary consumers are in turn preyed upon by secondary consumers, consisting mainly of a variety of invertebrates (polychaete worms, snails, copepods, *mysid* shrimp, bay shrimp, and crabs) and fishes (green and white sturgeon, delta and longfin smelt, northern anchovy, Pacific herring, topsmelt, white croaker, flatfish, gobies, sculpin, shad, juvenile Chinook salmon, and a variety of other resident and migratory fish species). These in turn are preyed on by top consumers, such as fish (striped bass, largemouth bass, catfish, sturgeon, halibut, sharks, and rays), marine mammals, birds, and man. The role of a species in the food web may be different at different life stages, or it may utilize various levels of the food web simultaneously.

Fish species may utilize the South Bay, and potentially the oyster shell mining area, for any or all of their life history stages. They may have planktonic, epibenthic (demersal), and pelagic (open water) life histories. The majority of fish species inhabiting the estuary have planktonic larval stages; as plankton they feed on zooplankton and in some cases phytoplankton. Many of these species forage on plankton during the larval and early juvenile life stages, and then as juveniles and adults become more selective predators and feed on large invertebrates and fish. Demersal fish such as sturgeon, flatfish, gobies, sculpin, and croaker, are planktivorous as larvae but begin to feed on epibenthic invertebrates and fish as juveniles. Many smaller fish including smelt, silversides, northern anchovy and Pacific herring are planktivorous throughout their lives.

Some estuarine fish do not rely on plankton as a major food source at any life stage. The live-bearing surfperch, for example, predominantly feed on epibenthic invertebrates, such as mollusks, crustaceans, and polychaetes throughout their life. Sharks and some skates and rays feed on benthic and epibenthic invertebrates by shoveling through the substrate, and also feed on fish and large invertebrates in the water column. Many freshwater fish prey primarily on benthic and drifting insect larvae and crustaceans, because zooplankton abundance is low in the swifter flowing freshwater sloughs and rivers.

The abundance and species composition of fish inhabiting the South Bay vary in response to salinity gradients (Baxter *et al.* 1999). The most abundant taxa inhabiting the high-salinity areas of the South Bay include the schooling pelagic forage fish such as northern anchovy, Pacific herring, topsmelt, jacksmelt, and true smelt (whitebait, surf smelt, and night smelt). Other members of the San Francisco Bay fish community include flatfish, rockfish, surfperch, gobies, and sharks. In the low-salinity areas of Suisun Bay and the western Delta the most abundant taxa include striped bass, prickly sculpin, Pacific staghorn sculpin, threadfin shad, yellowfin goby, and starry flounder. Anadromous fish species such as Chinook salmon, steelhead, American shad, striped bass, and sturgeon utilize the entire estuarine system as a migration corridor and foraging habitat.

Factors affecting the abundance and geographic distribution of fish within the South Bay include tidal water velocities, substrate, salinity gradients, water temperature, and food availability. Many of the fish that inhabit the estuary reside in coastal marine waters, entering the estuary on a seasonal basis for foraging or reproduction. The seasonal cycles of fish abundance vary in response to migration patterns, reproductive cycles, foraging patterns, and environmental conditions occurring both within the estuary and coastal marine waters.

The aquatic habitats of the South Bay are characteristic of marine inshore environments. These habitats include intertidal and subtidal zones, as well as offshore open water subtidal areas.

3.1.1 Intertidal Zone

The intertidal zone comprises that area along the margin of the South Bay that is submerged at high tide and exposed at the lowest tide. Shoreline development within many areas along the margins of the South Bay have extensively influenced intertidal habitat. Concrete rubble, riprap, shoreline stabilization materials, and pilings and wharves are common in many areas. The intertidal zone is primarily composed of sand and mud substrate (mudflats) in areas where low current velocities and low or reduced turbulence occur with coarser sand and gravel substrate within the intertidal areas characterized by higher current velocities and increased turbulence. Mud and sand substrate within the intertidal zone provide habitat for benthic organisms, particularly polychaete worms, crustaceans such as amphipods, and clams. Rocky substrate and large outcroppings, including pilings and riprap, provide areas for attachment of sessile organisms such as barnacles, mussels, and algae. Various species of shore crabs also inhabit intertidal rocky areas. Fish commonly associated with intertidal areas include sculpin, surfperch, gobies, topsmelt, and flatfish. In the South Bay, Pacific herring spawn in intertidal and shallow subtidal habitats having hard substrate.

3.1.2 Subtidal Zone

The subtidal zone extends offshore from the lowest area exposed by the tide (MLLW). In this zone, water currents, water depth, and texture of the substrate are important factors influencing the species composition, abundance, and distribution of benthic infauna and bottom dwellers. Benthic infauna and epibenthic invertebrates inhabiting the subtidal zone include polychaete worms, crustaceans, clams, and mussels. Polychaete worms are generally the most diverse taxa, with amphipods the dominant crustacean, and several species of clams widely distributed within South Bay subtidal habitat. Bay shrimp, represented by the genus *Crangon,* is a common macroinvertebrate occupying the subtidal zone. The subtidal zone also provides habitat for a variety of fish. Some of the more common fish found in subtidal areas include surfperch, flounder, sole, California halibut, Pacific herring, northern anchovy, striped bass, topsmelt, sculpin, sharks, and rays. Around many of the areas of the South Bay, and especially in the Oakland Estuary, the waterfront consists of wharfs and pilings. Wharfs provide shade and shelter to fish and bottom-dwelling invertebrates, and untreated pilings provide additional cover and habitat for mussels, barnacles, hydroids, crabs, amphipods, and borrowing worms. These organisms provide an additional food source for resident fish including surfperch and flatfish.

3.1.3 Open water (Pelagic) and Deep Subtidal Zone

The offshore open waters and deep subtidal habitat begins at a depth of about 15-20 feet, reflecting differences in light penetration and other variables. A variety of planktonic and free-swimming organisms utilize this habitat. Plankton consist of phytoplankton (plants), zooplankton (typical small invertebrates that float or drift passively with the prevailing current), and ichthyoplankton (fish eggs and larvae). Actively swimming organisms (nekton) include juvenile and adult fish, crustaceans such as bay shrimp and crabs, and marine mammals. Macroinvertebrates that inhabit the deep-water areas of the South Bay include several species of bay shrimp, juvenile Dungeness crab, and several other crab species. The open water areas of South San Francisco Bay provide habitat for a variety of marine and anadromous fish species. Fish inhabiting the deep-water pelagic habitat include northern anchovy, Pacific herring, Chinook salmon, steelhead, green and white sturgeon, and other migratory fish, several species of flatfish including California halibut, surfperch, and striped bass. Water depth, current velocity, salinity, temperature, and substrate are important factors affecting habitat use within the deep-water areas of the South Bay by fish and macroinvertebrates.

4. ALTERNATIVES TO THE PROPOSED ACTION

The NEPA implementing regulations (40 CFR § 1502.14) and US Environmental Protection Agency 404(b)(1) Alternatives Analysis Guidelines provide guidance on the consideration of alternatives to a federal proposed action and require rigorous exploration and objective evaluation of all reasonable alternatives. Each alternative must be feasible and reasonable in accordance with the President's Council on Environmental Quality (CEQ) regulations (40 CFR §§ 1500-1508). This section describes the range of potential actions (alternatives) determined reasonable with respect to achieving the stated project purpose and need, or which have been suggested for study by commenters, as well as alternatives eliminated from detailed study.

The US Army Corps of Engineers will assess the environmental impacts of the project in accordance with the requirements of the National Environmental Policy Act of 1969 (42 U.S.C. §§4321-4347), the Council on Environmental Quality's Regulations at 40 C.F.R. Parts 1500-1508, and USACE Regulations at 33 C.F.R. Part 325. The final NEPA analysis will normally address the direct, indirect, and cumulative impacts that result from regulated activities within the jurisdiction of the USACE.

This section specifically analyzes alternatives to the Proposed Project to consider their consistency with the basic project purpose; the impacts to jurisdictional waters; other environmental impacts; and cost, logistical, and technological considerations. NEPA allows the elimination of alternatives that are not reasonable or feasible or do not meet the purpose and need of the project. For the purposes of NEPA, reasonable means those alternatives which may be feasibly carried out based on technical, economic, environmental, and other factors. After comparing and weighing the benefits and impacts of all of the feasible alternatives, the analysis concludes that the **Proposed Project Alternative** is the practicable alternative that would have the least impact to aquatic resources without having other significant environmental impacts and fulfilling the proposed Project purpose and need.

This section evaluates the potential alternatives to ensure that they would fulfill the Proposed Project purpose and need.

4.1 Alternatives Analysis Approach

Guidelines for conducting an alternatives analysis require that the practicability of any alternative be evaluated on the basis of whether the alternative is capable of being implemented and achieving the overall project purpose. The range of alternatives to be reviewed cannot be so broad as to make the analysis unmanageable, or so narrow as to effectively preclude potentially practicable alternatives.

Several alternatives were considered for analysis. These alternatives were analyzed in order to answer the following fundamental questions:

- Whether there are practicable alternatives that are technically and economically feasible and satisfy the primary purpose and needs of the project
- Whether there are practicable alternatives consistent with the basic project purpose that would result in fewer impacts to waters of the U.S. in the Project Area, and
- Whether there are practicable alternatives consistent with the basic project purpose that would result in an avoidance or reduction of other environmentally adverse effects.

The project team examined several alternatives. The purpose of these examinations was to determine if an alternative was technically and economically feasible and could attain the overall project purpose while causing fewer impacts to aquatic resources than the Proposed Project design, as well as avoiding other significant adverse environmental consequences. The baseline for use in this comparison of potential alternatives, as described above in Section 2, is the Proposed Project which includes avoidance, minimization, and conservation measures identified by LTB through previous oyster shell mining, discussions with State and Federal resource and permitting agencies, comments from the public, and input through the CSLC (2018) CEQA environmental review process (see Section 2.7).

Pertinent to the analysis of most of the alternatives is a summary of LTB's oyster shell market area. As previously described, the primary use of shell is as high-grade nutrient additive for poultry and livestock diets, and as a pharmaceutical calcium supplement. LTB's primary market area is northern California; although processed oyster shell products have been shipped as far as the East Coast, over 70% are utilized in California (with the vast majority used in central and northern California), and over 90% are utilized in the western Pacific states and western Canada.

STATE / AREA	% OF TOTAL MARKET
California	71.7%
Canada	11.7%
Oregon	7.9%
Washington	1.0%

SOURCE: Lind Analysis of Sales by Location, 2020

A total of 6 alternatives were examined. The alternatives included:

1) No Project (including resulting alternatives)
2) Alternative In-Bay Mining Locations
3) Long-Term Strategy (LTMS) Management Plan Conformance (Seasonal Work Windows)
4) Clamshell Dredge Mining
5) Reduced Project Annual Mining Volume
6) On-shore Oyster Shell Washing

The following discussion considers and evaluates each alternative in terms of its a) consistency with the Proposed Project purpose and need as described in the permit application (Section 2.2); b) potential impacts to the environment including aquatic habitat in South San Francisco Bay and Bay Area air quality; and c) cost, logistic, and technological considerations. If an alternative is considered substantially inconsistent with the project purpose and need, no further evaluation was considered.

4.2 Alternative 1: No Project

Under the No Project Alternative, it is assumed that the demand for sources of calcium carbonate as a dietary supplement, and for other uses, would be tried to be met either by sources other than oyster shell, or would be imported from more distant locations, or by some combination of these alternatives. Alternate sources could include mined limestone (quarries, etc,), shell from oyster aquaculture, or shell imported from distant locations. These alternate sources are examined further below.

Under the No Project Alternative, oyster shell mining in South San Francisco Bay would be curtailed resulting in economic impacts to LTB and stranding of equipment and crew currently mining oyster shell from South Bay as well as processing facilities in Petaluma and Collinsville. There would be a loss of direct employment of those workers who operate and maintain the tug and barge fleet. While significant to the employer, this number of workers is small relative to the work force in the San Francisco Bay Area.

The No Project Alternative would result in the cessation of oyster shell mining from the South Bay. Therefore, the direct biological impacts such as benthic disturbance, and temporary changes in water quality in the South Bay associated with the oyster shell mining overflow plume that would occur under the Proposed Project would not occur under the No Project Alternative.

As introduced prior, the No Project Alternative would require the demand for sources of calcium as a dietary supplement to be met by alternative sources. Alternative sources examined by the analysis of the No Project Alternative include the following:

1) Import of oyster shell from other sources or outside the Bay Area;
2) Utilization of mined limestone, either from the Bay Area or beyond, as an alternate source of dietary calcium supplement.

4.2.1 Import of Oyster Shell from Outside the Bay Area

This alternative would involve importation of oyster shell from sources outside the Bay Area. Material would be imported by ocean barge or ship, or overland by transport truck or rail. LTB does not own or operate oyster production facilities. Oyster shell would need to be purchased from outside sources and imported to the existing processing facilities prior to distribution to meet market demand within LTB's market area of California and western states. This arrangement could utilize existing LTB offloading and processing facilities, resulting in some retention of employment. Calcium derived from oyster shell has been found to be a superior nutrient and mineral source when compared to inorganic limestone and other sources (discussed in further detail below).

LTB's San Francisco Bay operations are the only source of oyster shells mined commercially in California. LTB has examined the potential to use oyster shell from commercial oyster producers within the Pacific Northwest and elsewhere as an alternative source of oyster shell to mining within the South Bay. These examinations have shown that the quantities of oyster shell available from commercial oyster producers are not adequate to meet the existing or future market demand. Commercial oyster aquaculturists typically use the shell of oysters they have produced as a renewable substrate for settling and cultivating oyster larvae, rather than as a calcium supply for dietary supplementation. There is not adequate excess oyster shell available to import to substitute for LTB's existing shell mining operations.

The purchase of oyster shell from outside locations and transporting to the Bay Area processing facilities would (1) dramatically increase costs, (2) increase air quality emissions associated with increased long-haul transportation, more than offsetting the air quality emissions of the Proposed Project, and (3) is not feasible as quantities of oyster shell from commercial aquaculture operations in California and the Pacific Northwest are not available to meet current and future market demand.

4.2.2 Utilization of Mined Limestone as an Alternative Source

Utilization of mined limestone as an alternate source of dietary calcium supplement could involve either purchasing and importing limestone from existing limestone quarries for processing and distribution to the agricultural industry, or as LTB does not own or operate limestone operations, developing a limestone quarry in the Bay Area to replace oyster shell mining.

There are no existing limestone quarries near the Bay Area which produce the quality of limestone (calcium content) required to be used as a feed supplement. The nearest limestone mine, the Permanente Quarry located in Cupertino, has varying grades of limestone, but all are lower grade than shell, and are used exclusively for construction aggregate and cement manufacture. There are only two active limestone quarries in California currently marketing quantities of processed limestone as agricultural feed supplement. These quarries are located near Paso Robles, CA and Columbia, CA, which are 287 and 113 miles away from the Collinsville facility, respectively. Products are shipped by truck only from these facilities.

As with import of shell from outside sources, limestone product would need to be purchased from outside sources and imported to the existing processing facilities for distribution to meet market demand within LTB's market area of California and western states. This arrangement may utilize existing LTB processing facilities, resulting in some retention of employment.

The purchase of limestone from outside locations and transporting to the Bay Area processing facilities would dramatically increase costs and increase air quality emissions associated with increased long-haul transportation, more than offsetting the air quality emissions of the Proposed Project. Impacts from truck traffic, air emissions, and other impacts would increase at the quarry sites. Most importantly, mined limestone is not a direct or equal replacement for oyster shell in agricultural feed.

Since the early 1900's it has been recognized by poultry producers that oyster shell is an effective source of calcium, particularly for quality eggshell production. The unique physical properties of oyster shell and the mineral composition have been found to be especially beneficial as a calcium source in poultry diets to aid in eggshell formation. Calcium derived from oyster shell has been found to be a superior nutrient and mineral source when compared to inorganic limestone and other sources.

The use of oyster shell as a calcium source and diet supplement to aid eggshell quality and reduce shell breakage has been tested in comparison to conventional limestone as a dietary supplement in several studies. Scott *et al.* (1971) reported that substituting pulverized limestone with oyster shell was effective in improving eggshell quality. The beneficial effect of oyster shell was attributed to the fact that particles of shell remain in the gizzard longer, providing laying hens with a more uniform supply of calcium, particularly at night when shell calcification is in process and hens do not have access to feed. (Scott *et al.*, 1971). A study by March, ME and M Amin (1981) concluded that shell density was greater for eggs laid by birds fed oyster shell supplement, regardless of the composition of the diet. (March, Amin, 1981). In 1981, Brister *et al.* concluded that the calcium from oyster shell in any form was more available than that of limestone for egg shell formation, and the addition of large particle oyster shell significantly improves egg shell quality when substituted for other pulverized calcium source. (Brister *et al.*, 1981). In 1992, a study by K Keshavarz and S Nakajima indicated that the beneficial effect of oyster shell on egg shell quality was consistent with the Scott *et al.* (1971) report, and that the presence of oyster shell had a beneficial effect on shell quality. (Keshavarz *et al.*, 1992).

Development of a new Bay Area limestone source by LTB would be highly speculative, and require a process that would take several years, even decades, to complete. Development of a new quarry would require 1) exploration and location of a limestone source with calcium content suitable for agricultural feed supplement; 2) acquisition of the property through purchase or lease to develop the source; 3) completion of significant environmental review and permitting processes; 4) significant capital investment in quarry and facility development. Financial outlay would likely be in the tens of millions of dollars, not economically practical.

Environmental impacts for a land based quarry typically include the following:

- Aesthetics / Visual Quality / Light: changing land conditions and viewshed;

- Agriculture / Forest Resources: impact on changing land use resourced depending on location;
- Air Quality: GHG, emissions from mining and transportation, dust from processing;
- Biological Resources: impact on local habitat and species, could be significant based on location;
- Water Quality and Hydrology: impacts could be significant based on location; water resources and potential for pollutant runoff could be significant for mining / processing
- Noise: from mining, process, traffic. Could be significant to surrounding receptors.
- Land Use / Planning: Potential land uses forever altered.
- Transportation / Traffic: Would require integration of new roads / intersections and associated traffic into existing infrastructure and traffic levels.
- Public Services / Utilities: Would require new utility services and infrastructure.

(*non-exhaustive list of impact areas from Lehigh Permanente Draft Reclamation Plan Amendment EIR, 2011*)

The potential environmental impacts from all these areas would likely be significantly greater than those of the Proposed Project. The environmental impacts of a limestone source from beyond the Bay Area would also include significant additional greenhouse gas emissions associated with importing the limestone to LTB's processing facilities in the Bay Area. These factors, the dim likelihood of suitable available resource, and the huge economic cost render this alternative infeasible.

In summary, the No Project Alternative would result in the cessation of oyster shell mining from the South Bay. Therefore, the biological impacts such as benthic disturbance that would occur under the Proposed Project would not occur under the No Project Alternative, nor would the temporary changes in water quality in the South Bay associated with the oyster shell mining overflow plume. However, impacts from resulting import of shell or limestone to meet the market requirements, or the development of a new limestone quarry source in or outside the Bay Area would likely result in significant increases in air emissions and other associated environmental impacts.

The No Project Alternative (1) would not meet the basic project purpose and need (2) would be impractical due to economic impacts to LTB and its employees and (3) would result in increased adverse impacts.

4.3 Alternative 2: In-Bay Mining Locations

Hart (1966 and 1978) provide an overview of relic oyster shell deposits in South San Francisco Bay. Hart (1966) estimated 75 million tons of relic oyster shell deposits in the South Bay based on a 4- by 3-mile area with an average thickness of 5 feet, and shell composition of 70%, for an estimated shell deposit of 43.4 million cubic yards of shell as of 1966 (it has been estimated that approximately 3.7 million cubic yards of oyster shell has been mined from South Bay since 1966 of which 3.3 million cubic yards are estimated to have been mined from the CSLC area). Hart (1978) reported that core sampling done by Ideal Cement Company showed shell deposits in the area of the current CSLC lease from 4 to 15 feet thick. Applying an average thickness of 9.5 feet to the Hart (1966) estimated area of shell deposits would yield shell resources of 82.5 million cubic yards. Mining oyster shell deposits from alternative subtidal areas with South Bay would meet the purpose and needs of the Proposed Project. The CSLC lease area (1,560 acres) is shown in Figure 1 (Section 2.3), and the lease area overlaid on the Hart (1978) shell resource area is shown in Figure 3.

Within the 1,560 acre CSLC lease area, estimated reserves are between 5.5 million cubic yards and 16.5 million cubic yards, based on deposit thickness between 5-15 feet and 70% shell composition, and subtracting the estimated 3.3 million cubic yards mined from the lease area since 1966. LTB will assess oyster shell resources within the CSLC lease area, and the effects of shell mining during the lease period on the existing shell deposit and bathymetry within the lease area, as part of the Proposed Project over the 10-year term of the lease.

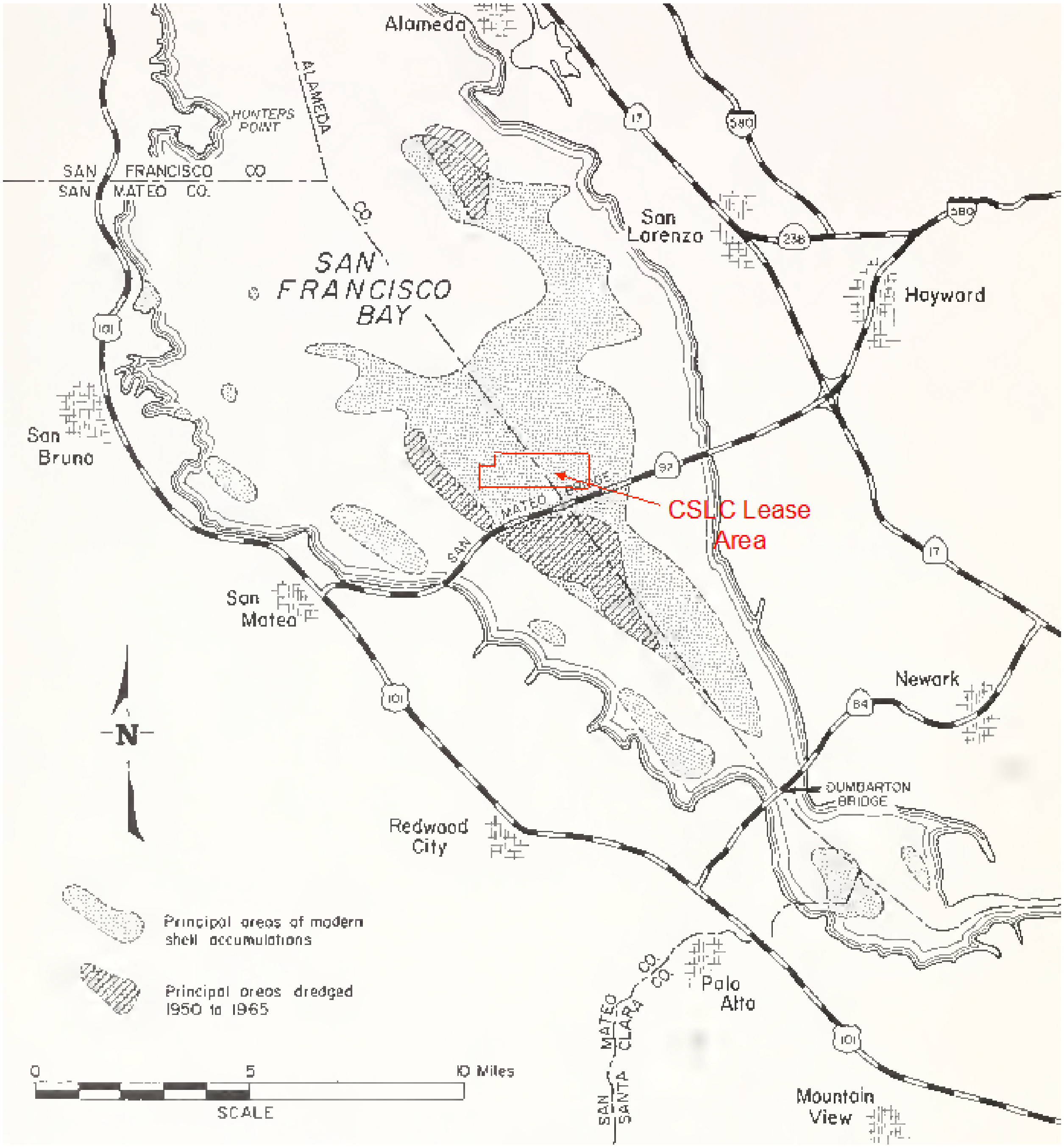

Figure 3: Approximate location of California State Lands lease overlaid on Hart (1978) shell resource area map

Although the Hart (1966 and 1978) reports show extensive relic oyster shell deposits in subtidal areas of South Bay, shell mining in alternative locations using current mining methods and limits would result in comparable levels of environmental disturbance (e.g., benthic disturbance, risk of entrainment, overflow plume, air quality impacts) as the Proposed Project. By limiting shell mining to only the existing CSLC lease area, benthic disturbance under the Proposed Project is limited to a smaller geographic area than potentially if mining were expanded to alternative subtidal locations. Based on these considerations, it was concluded that shell mining in alternative subtidal areas of South San Francisco Bay, although there are extensive shell deposits, would provide no environmental or economic benefit over the Proposed Project but would result in habitat disturbance in areas of the South Bay where mining is not currently occurring.

Oyster shell hash occurs at several intertidal shoreline beaches in South Bay. Relic oyster shell and young bay muds have also been used in the past as fill in South Bay shoreline reclamation projects that could potentially serve as an alternative mining location. Hart (1978) references fragmented shells in sand, which was used extensively for hydraulic fill in Foster City. In the early 1960's about 18 million cubic yards of this shelly sand was dredged from San Bruno Shoals and placed hydraulically to form Brewer Island and Foster City. It has been suggested that these now upland deposits of "shelly sand" could be used as an alternative mining site that would avoid the need for in-water mining and discharge of an overflow plume with suspended sediment. However, these deposits are in areas that were created for development, and are now developed. It is unknown how much of the sediment is shell fragment, and the sediment would need to be processed to remove the useful shell fractions. Given these factors, use of upland shell deposits within the San Francisco Bay area is not practical and would not meet the Proposed Project purpose and need.

4.4 Alternative 3: Long Term management Strategy (LTMS) Plan Conformance (Seasonal Work Windows)

This alternative would require oyster shell mining to comply with seasonal restrictions on maintenance dredging activities contained in the *Long-Term Management Strategy for the Placement of Dredged Material in the San Francisco Bay Region Management Plan 2001* (LTMS Management Plan). The LTMS Management Plan is an interagency strategy and plan for maintenance dredging of federally designated navigation channels in San Francisco, San Pablo, and Suisun Bays, and the disposal of dredged materials in San Francisco Bay, the Pacific Ocean, and upland disposal sites for beneficial use. The following is excerpted from the LTMS Management Plan:

"Federal and state lead agencies involved in the development of the LTMS Environmental Impact Statement/Environmental Impact Report (EIS/EIR) worked closely with US Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and California Department of Fish and Game (CDFG) to identify potential impacts on listed species during dredging and disposal operations. Additionally, the LTMS agencies entered into formal consultation pursuant to Section 7 of the [Federal] Endangered Species Act (ESA) with the resource agencies to address the potential impacts that implementing the LTMS could have on listed species. The purpose of consultation was to provide the LTMS agencies, the resource agencies, and the dredging community with a set of common guidelines to minimize adverse impacts on listed species from dredging and disposal activities, and to establish a more predictable regulatory environment for these activities."

"The consultations with NMFS, USFWS, and CDFG resulted in each of these agencies issuing a Biological Opinion addressing listed species and designated critical habitats under their respective jurisdictions. The Biological Opinions adopted the proposed restrictions on the timing and design of dredging and disposal projects developed in the LTMS planning effort. The Biological Opinions evaluate dredging and disposal activities relative to the LTMS guidelines and environmental windows. If the project can be accomplished during the work windows, the project is authorized for incidental take under the [State and Federal] ESAs. However, this section also describes the process that should be followed if a Proposed Project does not fall within the environmental windows set forth in the ROD [Record of Decision]."

"When planning dredging activities, project proponents should consider whether their project could be accomplished during the work window for that geographic area. If the activity proposed is in the work window, the project is covered by the existing Biological Opinions and can take place with the normal permits and conditions. However, if the activity is proposed outside the work windows for that geographic area, project proponents will need to request that the US Army Corps of Engineers initiate either informal or formal consultation on their behalf, with the appropriate resource agency for listed species and designated critical habitats."

"If a listed species is not federally listed, but is state listed (e.g., Pacific herring), the project proponent must consult with CDFG. This process involves contacting CDFG directly and discussing the rationale for dredging or disposal during the restricted period. If CDFG concurs with the determination of *no adverse effect* on listed species or designated critical habitat, it drafts a waiver for the project, which may contain additional conditions, and sends the waiver to the appropriate permitting agencies."

To ensure protection of biological resources in the Bay, the LTMS agencies implement the following measure:

"Dredging and dredged material disposal activities that are conducted within the work windows [as shown in Figure 3-1 of this EIR]… do not require further Endangered Species Act consultation. The permitting agencies will closely review the rationale for any dredging and disposal projects proposing work outside the work windows. Pursuant to the federal and California Endangered Species Acts, any projects proposing deviation from the work windows are required to undergo consultation with the appropriate resource agency."(LTMS Management Plan, pages 3-11, 3-14)

The LTMS alternative would place seasonal restrictions on oyster shell mining to conform with the environmental or "work windows" designated for San Francisco Bay described below:

Oyster shell mining in the South Bay would be restricted to the period June 1 through November 30, to avoid impacts on steelhead, Chinook salmon, and Pacific herring.

Given the increased efficiency of oyster shell mining supported by the new mining equipment implemented by LTB as described above mining within restricted to the June 1 through November 30 LTMS work window is considered to be feasible to meet market demand but would require additional upland area to stockpile oyster shell prior to processing. Additional equipment may also be needed for transporting stockpiled shell to the existing processing facilities. Limiting oyster shell mining seasonally may require additional equipment due to scheduling conflicts between the use of the tug and barge during the designated work window for maintenance dredging and shell mining. Limiting work to only a six-month seasonal period would make it difficult to maintain a full-time trained and qualified crew during the period when mining can not be conducted. The fundamental purpose to limiting dredging to the designated work window is to minimize and avoid potential impacts such as entrainment of protected fish into the drag head while using a suction head for maintenance dredging or, in this case, oyster shell harvest. LTB has implemented avoidance measures (see Section 2.7) specifically intended to avoid environmental impacts such as fish entrainment through modifications to the mining equipment, such as installation of the state-of-the-art positive barrier fish screen and suction pipe priming and clearing using on screen water supplies, as well as seasonal curtailment of mining to protect larval longfin smelt and Pacific herring, that accomplish the same environmental benefits as the designated work windows.

Additional considerations are relevant and applicable to both the Proposed Project as well as the LTMS Alternative 4 to protect special status species including:

- Measures required as conditions of the Biological and Conference Opinion (BO) issued by NMFS for oyster shell mining operations address the effects of mining on Essential Fish Habitat (EFH) for Chinook salmon and other managed fish, steelhead, and green sturgeon and are proposed as avoidance and minimization measures for the Proposed Project (Section 7 consultation is currently underway for the Proposed Project and would also apply to this alterative) .
- CDFW has issued LTB an Incidental Take Permit (ITP) for potential effects of oyster shell mining on longfin smelt. Additional mitigation measures that must be implemented by the Proposed Project and would also apply to this alternative include:

- Applicant shall implement operational measures to minimize the potential for entrainment and mortality of longfin smelt.
- Restrictions on pump priming, limiting the total mining volume, prohibiting mining in areas of shallow water depth and in proximity to shorelines, restricting mining to the designated lease areas which are away from sensitive habitat, and monitoring and reporting the location of each mining event.
- Applicant has provided off-site mitigation to compensate for the impacts of the taking that may be unavoidable.

The total volume of oyster shell that would be permitted to be mined under this alternative (LTMS Alternative 4) would be the same as under the Proposed Project.

This alternative might prompt LTB to add mining equipment (such as additional tug-barge combinations) and mine more intensively in order to mine the full permitted volume within the work window and avoiding schedule conflicts for equipment also used during the work window for maintenance dredging. Furthermore, this alternative would likely require LTB obtain additional upland area to stockpile materials at the offloading facilities for shipment during the periods when mining would not be allowed. Given the limited size of the offloading facilities, this could constrain mining operations, or prompt LTB to expand existing facilities or develop new offloading facilities. Therefore, the LTMS Alternative would result in increased costs for LTB when compared to the Proposed Project, and may not be feasible due to available property constraints for material storage.

This alternative would require proposed oyster shell mining operations to comply with the seasonal restrictions on dredging contained in the Long-Term Management Strategy for the Placement of Dredged Material in the San Francisco Bay Region Management Plan 2001 (LTMS Management Plan). The LTMS Management Plan Conformance Alternative would restrict oyster shell mining in the South Bay CSLC lease area to a six-month period each year (June-November). This alternative would allow for the same volume of oyster shell extraction as in the Proposed Project. Under this alternative more mining would be expected to occur during the allowable work window, then no mining for the remainder of the year. This could be expected to cause incrementally greater daily air emissions, followed by periods of lower emissions, such that the annual emissions of criteria pollutants, GHGs, and TACs would be about the same as with the Proposed Project.

This alternative would allow for the same volume of oyster shell extraction as in the Proposed Project, but mining would likely be more intensive during the LTMS work window, followed by no mining for the remainder of the year. Because mining would occur in the same location as the Proposed Project, this alternative would have the potential to cause disturbance and damage to the benthic communities inhabiting the South Bay lease area and overflow plumes that are comparable to the Proposed Project, but the expected intensity of mining activity during the work window would be increased.

The LTMS was specifically intended to protect special status species, and the protective measures required by its biological opinions would remain in effect. The Proposed Project includes a number of BMPs, including installation and operation of state-of-the-art positive barrier fish screens, two-month mining curtailment each year, and other actions specifically designed to minimize and avoid entrainment effects on fish and macroinvertebrates (Section 2.7). A comparison between the Proposed Project and Alternative 4 (seasonal work windows) showed that (1) air quality emissions would be comparable between the Proposed Project and Alternative 4 although emissions under the alternative would be compressed into a 6-month period; (2) the overflow plumes would be comparable between the Proposed Project and alternative; (3) the magnitude of benthic disturbance would be comparable between the Proposed Project and alternative; (4) protection of juvenile and adult fish from entrainment into the suction pipe would be comparable between the Proposed Project and alternative; (5) Alternative 4 would require additional upland area to stockpile oyster shell; and (6) the alternative would potentially result in increased costs for equipment and crew to avoid potentially conflicting schedules for oyster shell mining and maintenance dredging during the designated work window. Based on implementation of the BMPs, effects of the Proposed Project on fish and aquatic habitat within the South Bay are expected to be similar between the Proposed Project and Alternative 4. Alternative 4 is not considered to be environmentally superior to the Proposed Project, yet would likely result in increased costs and reduced practicality.

4.5 Alternative 4: Clamshell Dredge Mining

The Clamshell Dredge Mining Alternative would employ a clamshell bucket and crane, not a suction dredge, to mine oyster shell. Clamshell dredging is accomplished by using a barge-mounted crane to lower a clamshell bucket to the sea floor until it sinks into the shell deposit and sediment. A bucketload of shell and sediment is scooped up and brought back to the barge and deposited on it. Clamshell dredging does not require the creation of a slurry and does not therefore use a large volume of seawater during mining although the volume of seawater required for shell washing is expected to be comparable to the Proposed Project assuming that shell washing is conducted using the same equipment and methods as the Proposed Project. Consideration of onshore shell washing for both the hydraulic suction (as in Proposed Project) and clamshell mining is presented in Alternative 7 (Section 4.1.7). Accidental capture or injury to fish is unlikely, as fish can avoid the bucket which would be comparable to fish avoiding the positive barrier fish screen under the Proposed Project.

The shell deposit is overlain by a thin layer (2-3 feet) of fine sediment in the project area. The Proposed Project uses a suction drag head for oyster shell mining that is buried approximately 2-3 feet into the bottom substrate which helps avoid and minimize disturbance of fine sediment overlaying the shell deposit. Mining using a clamshell dredge would result in disturbance to the surface sediments as well as the shell deposit and would result in greater benthic disturbance and impacts to the sediment budget within the lease area for the same volume of harvested shell when compared to the Proposed Project.

In addition to avoiding some disturbance to surface sediments, hydraulic suction mining avoids extracting these surface sediments. The clamshell method would result in the removal of the overlying fine sediment during mining, in addition to the shell below. Compared to suction dredge mining, mining using the clamshell method may then mobilize more sediment into the water column, create a more extensive or severe turbidity plume during mining - and would certainly increase the turbidity plume if washing was conducted as present with washing equipment on the barge. The additional material removed and the lower efficiencies associated with this method would result in significantly longer mining times (at least twice as long) to extract the same amount of shell, and utilize equipment that is not electrified and powered with efficient Tier 4 generators, thus resulting in significantly higher amounts of air emissions. As discussed in Alternative 7, if washing were done onshore, then the higher volume of sediment would be transported along with the shell to the processing site - resulting in at least 25% more material being transported, further increasing emissions and associated impacts.

All other aspects of this alternative, including mining location, offloading locations, and mining volumes, would be the same as for the Proposed Project, and as described in the Project Description of the USACE application.

The clamshell dredging work crew would likely be similar in size to a suction dredge crew, but the productivity of the clamshell operation is lower than that of the suction dredge as discussed above. Consequently, this alternative could result in an increase in local employment if there is a market for all of the oyster shell allowed to be extracted. However, if the cost of clamshell dredging is higher than suction dredging, the market for oyster shell may be limited by the higher price of the product, resulting in extracted volumes below the limits set by the CSLC lease. A reduction in extraction crew worker hours would be one consequence of higher prices and reduced oyster shell demand. Therefore, for this alternative, the socioeconomic effects are not predictable. In the context of all employment within the San Francisco Bay Area, however, the overall economic effects would be extremely small. Additional economic impacts to LTB would occur as a result of the need for new equipment, increased fuel as a result of reduced mining efficiency, and the potential reduction in market demand as a result of increased production costs.

Clamshell dredge mining would require an additional barge to operate the clamshell crane. Mining could occur only in areas of the lease and times of the day when surrounding currents are minimal or with the assistance of a tug to keep the crane barge stable and on station. The barge needs to be stationary during digging, so would be anchored in one spot as digging occurs, then moved frequently to an adjacent area. This method would result in much deeper, localized excavations within the lease area, which could have increased localized impacts to the benthic disturbance, and sediment transport conditions. Use of a clamshell dredge would not reduce the potential risk of fish entrainment when compared to the Proposed Project with operations of the state-of-the-art positive barrier fish screen. Therefore, with respect to this project element, the Clamshell Alternative is not considered practicable from an environmental, logistical and economical perspective.

4.6 Alternative 5: Reduced Volume of Mining

This alternative would reduce the permitted annual mining volume to a level equivalent to current baseline mining volumes (i.e., the 2006 to 2019 average mined; Table 1). The total average amount of material mined would be 60,184 cy/yr (Table 1), averaged over the 10-year proposed permit duration, with an annual maximum volume of 80,000 cubic yards. Over the course of the 10-year permit, this would be 198,160 cubic yards less than under the Proposed Project. As shown in Table 1 the annual volume of oyster shell harvested between 2006 and 2019 varied between approximately 45,000 and 72,000 cy, reflecting annual variation in market demand. Using a rolling average in calculating the average annual oyster shell harvest volume retains flexibility to meet variable mining conditions, mining restrictions, and market demand. Mining methods and offloading would be the same as those described in Section 2 for the Proposed Project.

Although Alternative 6 would mine less oyster shell than under the Proposed Project, Alternative 6 is feasible and could attain most of the Project purpose and need because it reflects the Applicants' current mining levels averaged over a 14-year period. The baseline volumes on which Alternative 6 is based address fluctuations that can occur from year-to-year in the mining industry. Total mining revenues would be reduced 25% compared to the Proposed Project, assuming a future market demand for oyster shell calcium of 80,000 cy/yr. Among the factors that render this alternative infeasible and inconsistent with the project purpose and needs are:

- Costs associated with maintenance, dry docking, engine upgrades, environmental cost and mitigation are essentially fixed. They do not scale down with project size and would likely be approximately the same under the Alternative 6 . The Reduced Project Alternative reduces the prospect that these costs can be paid for by sufficient volume and revenues (revenue would be reduced 25% under this alternative compared to the Proposed Project assuming a future market demand for oyster shell calcium of 80,000 cy/yr);
- A consistent, steady, well-trained workforce is important for safety considerations, since competent, experienced crews are vital to safe operations. Experienced, qualified captains and crew are increasingly difficult to find because of strict and costly licensing requirements.

To the extent that market demand exceeds the supply provided under Alternative 6, increased import of limestone or oyster shell from outside of the Bay Area would result in increased air quality emissions associated with transportation of calcium carbonate longer distances to the processing facilities. Because this alternative would limit oyster shell mining in the South Bay to baseline levels, it would not result in an increase in direct emissions of GHGs or other air quality contaminants. Both GHG emissions and criteria pollutant emissions from other sources (e.g., additional mining at upland quarry sites and increased transportation of material) would, however, likely be significant, and would remain significant and unavoidable. Therefore, with respect to this project element, the Reduced Project Alternative is not considered practicable from an environmental or economical perspective if market demand increases over current average levels.

4.7 Alternative 6: On-shore Shell Washing

Under the Proposed Project oyster shell washing is conducted offshore using a trommel screen on the barge and seawater (Section 2.3) with an overflow from the barge into the South Bay that creates a temporary plume with elevated suspended sediment concentrations. The cleaned oyster shell is then transported to the onshore offloading and processing facilities. Under Alternative 7 unwashed oyster shell (along with seawater and fine sediments) would be loaded onto the hopper barge and transported to the offloading site where new onshore washing facilities would be constructed. The unwashed shell would then be cleaned prior to processing with no overflow plume released into the Bay. This alternative would apply to the Proposed Project but could also be applied to the LTMS seasonal work window (Alternative 4), clamshell mining (Alternative 5), or the reduced volume mining alternative (Alternative 6).

The onshore shell washing facility may be equipped with either freshwater or water supplied from the estuary using a screen intake. There is currently no freshwater supply available at the processing site. Containment would be provided with drainage to avoid direct discharge back into the Bay. Wash water from the operation could be discharged into a municipal sewage system for treatment and disposal or potentially could be treated (filtered) before being discharged into the Bay depending on permit terms and conditions; no sewage system is currently available at the processing site. The fine sediment removed from the shell during washing could be beneficially reused (e.g., upland deposits, wetland supplementation, etc.) or sold as a soil amendment. The fine sediments would be lost from the South Bay sediment budget.

This alternative would result in the harvest of both oyster shell and fine sediments from the South Bay, contribute to greater changes in subtidal bathymetry, and avoid the temporary overflow plume associated with oyster shell mining. Transporting shell, excess seawater, and sediment from the South Bay to the upland offloading and washing facility would significantly reduce barge transport efficiency (reduced shell volume per load), increasing the number of barge loads required to meet oyster shell demand by as much as 100% or more, doubling transport costs and air quality emissions.

This alternative would substantially increase the time and cost of shell washing and processing. First, it would assume that additional land for washing the shell and processing and handling the sediment washed from the shell is available. The current processing site lease footprint is not large enough to accommodate the processing equipment and subsequent water and sediment handling and disposal that this alternative would require. Second, this alternative would require significant investment in equipment and increased processing costs. Processing equipment and installation costs could easily exceed $1-2 million. Processing costs would increase dramatically, and would also increase with the addition of sediment handling and disposal.

This alternative may meet the project purpose and needs but is not considered practical, and would have greater environmental impacts, based on the increased sediment reduction in the South Bay, the increased emissions associated with the required extra transportation, the increased cost of facilities for shell washing and sediment disposal, and the fact that the existing overflow plume is temporary, has not been shown to contain harmful contaminants from Bay sediment deposits, and has not been shown to adversely impact the South Bay aquatic ecosystem.

5. MITIGATION

As part of the Proposed Project LTB has committed to implement a number of BMPs designed to minimize and avoid adverse impacts. The Proposed Project also includes the purchase of 0.2 acres of subtidal habitat to fully mitigate losses of longfin smelt as a result of oyster shell mining. To provide mitigation for potential impacts to fisheries habitat in the oyster shell mining lease area from benthic disturbance and other factors, the Proposed Project also includes the proposal to provide approximately 3% of their annual oyster shell harvest, up to 1,800 cubic yards, to habitat restoration projects in San Francisco Bay. The project alternatives identified and evaluated do not include mitigation for adverse effects on aquatic or air quality resources.

6. DETERMINATION OF LEDPA

After comparing and weighing the benefits and impacts of all of the feasible alternatives, the analysis concludes that the **Proposed Project Alternative,** as described in Section 2 and the USACE permit application, as modified by terms and conditions of the current Section 7 ESA consultation with NMFS, is the practicable alternative that would have the least impact to aquatic resources, without having other significant economic and environmental impacts (LEDPA).

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