National Marine Fisheries Service

Application for Incidental Harassment Authorization for Marine Mammals

Central Bay Operations and Maintenance Facility Project

Prepared for

San Francisco Bay Area Water Emergency Transportation Authority

Prepared by

AECOM

300 Lakeside Drive, Suite 400
Oakland, CA 94612

Revised June 8~~May 23~~~~17~~, 2017

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ACRONYMS AND ABBREVIATIONS

Bay Trail	San Francisco Bay Trail
BCA	bubble curtain attenuation
Caltrans	California Department of Transportation
CFR	Code of Federal Regulations
cSEL	cumulative sound exposure level
dB	decibels
EOC	Emergency Operations Center
ESA	Endangered Species Act
FHWG	Fisheries Hydroacoustic Working Group
GGCR	Golden Gate Cetacean Research
Hz	hertz
IHA	Incidental Harassment Authorization
IWC	International Whaling Commission
kHz	kilohertz
L_{max}	maximum sound level measurement
µPa	microPascal
MMPA	Marine Mammal Protection Act
NAS	Naval Air Station
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
OCC	Operations Control Center
PTS	Permanent Threshold Shift
RMS	root mean square
SEL	sound exposure level
SFOBB	San Francisco – Oakland Bay Bridge
Simon	Sanctuary Integrated Monitoring Network
SPCC	Spill Prevention Control and Countermeasure
SPL_{peak}	peak sound pressure level
TMMC	The Marine Mammal Center
UME	unusual mortality event
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
WETA	San Francisco Bay Area Water Emergency Transportation Authority

1.0 INTRODUCTION

The San Francisco Bay Area Water Emergency Transportation Authority (WETA) is constructing a Central Bay Operations and Maintenance Facility (project) to serve as the central San Francisco Bay base for WETA's ferry fleet, Operations Control Center (OCC), and Emergency Operations Center (EOC). The project area and vicinity are shown on Figure 1.

This Incidental Harassment Authorization (IHA) request has been prepared because the project will occur in marine waters that support marine mammals. The 1972 Marine Mammal Protection Act (MMPA) prohibits the taking of marine mammals, which is defined as to "harass, hunt, capture or kill, or attempt to harass, hunt, capture or kill," except under certain situations. Section 101(a)(5)(D) allows for the issuance of an IHA, provided an activity results in negligible impacts on marine mammals and would not adversely affect subsistence use of these animals.

The timing, duration, and specific activities (i.e., pile driving) associated with the project may result in the incidental taking of marine mammals protected under the MMPA. WETA is requesting an IHA from the National Marine Fisheries Service (NMFS) for seven marine mammal species that may occur in the vicinity of the project: Pacific harbor seal (*Phoca vitulina*), California sea lion (*Zalophus californianus*), harbor porpoise (*Phocoena phocoena*), northern elephant seal (*Mirounga angustirostris*), northern fur seal (*Callorhinus ursinus*), bottlenose dolphin (*Tursiops truncates*), and gray whale (*Eschrichtius robustus*).

This IHA addresses in-water construction activities for the second year of construction, scheduled from August 1 through November 30, coinciding with regulatory in-water work windows for the area of San Francisco Bay where the project is located. In-water construction activities for the first year of construction (2016) were covered under a previous IHA for the project issued by NMFS on February 10, 2015.

1.1 PROJECT PURPOSE

The project will provide maintenance services such as fueling, engine oil changes, concession supply, and light repair work for WETA ferry boats operating in the central San Francisco Bay. In addition, the project will be the location for operational activities of WETA, including day-to-day management and oversight of services, crew, and facilities. In the event of a regional disaster, the facility will also function as an EOC, serving passengers and sustaining water transit service for emergency response and recovery.

2.0 DESCRIPTION OF SPECIFIED ACTIVITY

2.1 PROJECT DESCRIPTION

The specific project location, construction limits, layout, and design of the project are presented in Figures 2 and 3. The following sections provide a more detailed description of the proposed landside and waterside structures and construction activities associated with the project. Many elements of the project were completed in 2016. The activities that would impact marine mammals in 2017, and thus requiring an IHA, are further described in Section 2.2.

2.1.1 Landside Facility

The proposed landside building will be a four-story, approximately 29,150-square-foot structure designed to Essential Facilities Standards, in accordance with the California Building Code. The building will provide maintenance functions and storage for vessel spare parts, office and meeting space for WETA's OCC and EOC, crew facilities, and concession support.

An existing unimproved (on-street) portion of the San Francisco Bay Trail (Bay Trail) runs along the undeveloped park east of the project site and stops at West Hornet Avenue; the designated off-street portion of the Bay Trail connects directly north of the project site on Main Street (San Francisco Bay Trail, 2010). In consultation with the Bay Conservation and Development Commission, the project includes extension of the Bay Trail and related improvements to connectivity and public access for users of the Bay Trail around Alameda Point.

2.1.2 Marine Facility

The proposed marine facility will have an overwater coverage of approximately 18,600 square feet (0.43 acre) and will provide berthing slips for as many as 12 vessels, with limited berthing capacity for vessels in transit (Figure 3). Each berthing slip will be supplied by fresh water, wash water, sanitary sewer, shore power, and fire suppression systems. Four of the slips will also have connections for refueling, and two of these four will also have oil and bilge connections. The floating docks will also provide access for the loading and offloading of sundries, the removal of waste, and the installation of parts and equipment required for regular maintenance service. Although no regular passenger loading is anticipated at this site, berths will be capable of loading and unloading passengers in the event of an emergency. The marine facility will also provide diver platforms for underwater inspections, one boom reel assembly for spill containment, a 25-foot skiff, and one crane for vessel maintenance.

The vessel types held at the facility will include small-crew boats, and ferry vessels with propeller propulsion and 1,000- to 1,750-gallon fuel tanks on each side. The facility will typically operate from 5 a.m. to 11 p.m., with 80 percent utilization (i.e., 80 percent of the time, the vessels will be moored for servicing and layover).

The berthing facility will include a system of ramps and platforms to facilitate access between the gangway and the vessel doors, and to allow access to the floating dock for line handling and servicing the vessel. The facility-wide deck elevation will be at a level that would allow direct access to the optimum number for boats serviced at the facility. To accommodate other boats that do not align with the deck elevation, adjustable portable platforms will be provided to allow access between shore and boat, and would be suitable for relocation as needed.

2.1.3 Berthing Floats

The berthing floats will consist of compartmented concrete pontoons approximately 120 feet by 10 feet in dimension. The float length was determined to be the minimum necessary for access to both the forward and aft loading doors, and for efficient service of the vessels. The berthing floats will include vertical strake[1] fenders and appropriate mooring fittings for safe docking and holding of the vessels. The floats will be outfitted with fire protection and life safety devices, as required by the City of Alameda.

All floats will have approximately 2 feet of freeboard and an elevated steel walkway at approximately 7 feet above waterline, with a utility chase below the walkway. The head walk and finger floats will be approximately 8 feet wide. All systems will be modular and compatible with other WETA facilities (i.e., finger float connections, utility layout, material, sizes, etc.).

2.1.4 Gangway

The gangway will be an aluminum structure approximately 90 feet long by 8 feet wide, with a nonskid walking surface. The gangway walking surface will be grated, if determined to be feasible with intended

[1] A strake is a single continuous line of planking or metal plating extending on a vessel's hull from stem to stern.

uses. The gangway will have a maximum one vertical to eight horizontal (1V:8H) slope over the majority of the tidal range to satisfy Americans with Disabilities Act rules for gangways.

2.1.5 Fueling Facility

The fuel storage facility will be contained below grade in vaults upland of the existing seawall. The facility will consist of as many as four vaulted underground storage tanks, with a combined capacity of up to 48,000 gallons. Multiple vaults and tanks are used to provide system redundancy and layout efficiency. The fuel tanks will be National Fire Protection Association-approved and installed in buried concrete vaults that will be equipped with vapor and liquid detection systems as well as a fire suppression system. Systems will be provided to recover liquid from the vault.

2.1.6 Utilities

Water, sanitary sewer, and electrical public utility connections are available on West Hornet Avenue adjacent to the project site. Buried utility lines will pass underground through the site and will be suspended beneath the fixed concrete pier. Berthing floats will connect with shoreside utilities by flexible lines attached to the gangway. A pump on the float system will discharge sanitary sewer effluent from the floating system into the landside system.

2.1.7 Stormwater Drainage

An existing 12-inch concrete storm drain line crosses the eastern end of the site (running north to south), with an outfall in the rock slope at the southern side of the site. This pipe collects stormwater from areas north of the site. The storm drain line will be rerouted to the east around the project area, with a new outfall installed approximately 100 feet east of its current location. Site runoff will be treated by oil/water separators and treatment vaults (if needed), in accordance with applicable stormwater regulations, before discharge from the site.

2.1.8 Site Access

Terrestrial access to the project site will be provided by West Hornet Avenue. Public access will be restricted; the site will be fully secured with an 8-foot-tall vertical picket fence. The proposed fencing/ concrete wall will be in compliance with the requirements of the United States Coast Guard (in accordance with the Vessel Security Plan required by Marine Transportation Security Act of 2002; 33 Code of Federal Regulations [CFR] 104) and WETA. The Vessel Security Plan requires security measures for employee access and for delivery of vessel stores and bunkers for facilities with boats certified for more than 150 passengers.

During both construction and operation of the project, all vessels will travel the same channel used by the United States Department of Transportation Maritime Administration fleet to access Alameda Point. The channel begins just west of the proposed WETA facility and proceeds approximately 1 mile northwest to San Francisco Bay.

2.2 COMPONENTS OF THE ACTIVITY THAT MAY RESULT IN TAKE

Construction of the project improvements requires pile driving, including impact or vibratory pile driving associated with construction of berthing slips and a system of platforms and access ramps. All piles would be steel, including temporary template piles used for the pile driving. Pile types, numbers, and sizes are described in Table 1. Underwater sound and acoustic pressure resulting from pile driving could affect marine mammals by causing behavioral avoidance of the construction area, and/or injury to sensitive species. The anticipated impact of these activities is described in detail in Section 8.

Table 1
Summary of Pile Removal and Installation

Project Element	Pile Diameter	Pile Type	Method	Total Number of Piles/Driving Days
Float Guide Pile Installation	42 inches	Steel Pipe	Impact Driver, 60025 blows/pile **OR** Vibratory Driver, 320 seconds/pile	15 piles/8 days (2 piles per day)
Donut Pile Installation	36 inches	Steel Pipe	Impact Driver, 600 blows/pile **OR** Vibratory Driver, 300 seconds/pile	6 piles/3 days (2 piles per day)
Dolphin Pile Installation	24 inches	Steel Pipe	Impact Driver, 450 blows/pile **OR** Vibratory Driver, 205 seconds/pile	8 piles/3 days (3 piles per day)
Template Pile Installation and Extraction	14 inches	Steel H-piles	Vibratory Driver, 120 seconds/pile	20 piles/8 days (5 piles per day, installation and extraction)

3.0 DATES, DURATION, AND SPECIFIED GEOGRAPHIC REGION

Construction of the project will require approximately 16 months total. Durations of construction activities will overlap. Generally, site preparation, construction of the seawall, and ground improvements will occur over 75 days; construction of the building will require 240 days; dredging and in-water work will be completed in 90 days; and the overwater work will occur over 225 days. As noted above, construction commenced in 2016.

Due to NMFS in-water work timing restrictions to protect Endangered Species Act (ESA)-listed salmonids, all construction dredging and other in-water work activities, including pile removal/ installation and seawall demolition/construction, will occur between August 1 and November 30.

The in-water portion of project construction commenced in August 2016, and in-water work for 2016 was completed by November 30. The seawall construction and floating marina pile removal occurred in 2016. A small-boat floating marina with a landside building for maintenance and a snack bar was constructed on the site by the Navy in the mid-1950s. The facility was used to house and maintain small recreational boats for base residents. It was in operation until the base was closed, and the small building was demolished a few years later. The floating dock associated with the marina had been slowly deteriorating before being removed in 2016.

In-water work for 2017 will commence August 1 and be completed by November 30. The float guide piles, donut piles, and dolphin piles will be installed in 2017.

For the project, structural piles in the water will be driven in place by a diesel impact hammer or with a vibratory hammer. Vibratory driving is the preferred method and will be used unless a pile encounters harder substrate that requires the use of an impact hammer to complete installation. Vibratory driving would require 120200 to 320 seconds of driving per pile. For impact driving, each pile will require approximately 450 to 60025 hammer strikes to put each pile in place. This required number of strikes is estimated, because only limited geotechnical explorations at the site have been performed and the required structural capacity of the piles is yet to be determined. It is estimated that two to three piles will be driven per day during in-water pile-driving operations. Temporary template piles will be installed to guide pile installation. These template piles will consist of steel H-piles and would be vibrated in and extracted out using vibratory methods.

A total of 29 steel pipe piles, ranging from 24 inches to 42 inches in diameter, will be driven in 2017; 20 (14-inch) H-piles will temporarily be installed and then removed in 2017 (see Table 1).

The project site is in the Alameda Naval Air Station (NAS) Base Realignment and Closure area, now known as Alameda Point (Figure 1). The project site includes approximately 21,500 square feet (0.5 acre) of landside space and approximately 3 acres of waterside space in San Francisco Bay.

The landside portion of the project site is nearly flat, asphalt-paved, and crossed by a nonfunctioning railroad spur line. The site elevation is approximately 6 to 10 feet above mean sea level. The project site is bounded on the east by the Bay Trail and an undeveloped park; and on the north by a paved open area and West Hornet Avenue (presently not a public right-of-way), which is defined by curbs and pavement stripes. Pier 3 lies to the west of the site, along with the USS Hornet, a functioning museum and designated national historic landmark. The United States Department of Transportation Maritime Administration leases the property west and north of the site, including a landside building and several piers from the City of Alameda. A concrete seawall delineates the southern edge of the landside portion; the seawall is tilted and cracked, and riprap and broken concrete span the area between the seawall and the water.

There is a riprap breakwater (referred to as “Long Breakwater”) that starts at the Alameda shoreline southeast of the project site, proceeds southward for approximately 700 feet, and then westward for approximately 4,800 feet. This breakwater is accessible from the shoreline. There is a small 180-foot gap between the first breakwater and Breakwater Island, which is referred to as “Breakwater Gap.” Breakwater Island consists of a riprap breakwater approximately 2,800 feet in length, oriented southeast to northwest. Breakwater Island is not accessible from the shoreline. No vegetation is found at the breakwaters.

4.0 SPECIES AND NUMBERS OF MARINE MAMMALS IN THE REGION

Although at least 35 species of marine mammals can be found off the coast of California, very few species venture into San Francisco Bay; only Pacific harbor seals (*Phoca vitulina richardsi*), California sea lions (*Zalophus californianus*), and possibly harbor porpoises (*Phocoena phocoena*) maintain residential status, meaning they are sighted year-round. Other marine mammal species that have been seen occasionally in San Francisco Bay include the gray whale (*Eschrichtius robustus*), individual humpback whales (*Megaptera novaeangliae*), the bottlenose dolphin (*Tursiops truncates*), the northern elephant seal (*Mirounga angustirostris*), the Guadalupe fur seal (*Arctocephalus townsendi*), and the northern fur seal (*Callorhinus ursinus*). Most cetacean sightings tend to occur in the central Bay (the area bound by the Golden Gate Bridge, the San Francisco – Oakland Bay Bridge (SFOBB), and Richmond Bridge). The most common marine mammals in San Francisco Bay are Pacific harbor seals and California sea lions, which are the species most likely to occur in the project area. Table 2 summarizes the status of marine mammal stocks potentially present in San Francisco Bay.

4.1 PACIFIC HARBOR SEAL

The Pacific harbor seal is one of five subspecies of *Phoca vitulina*, or the common harbor seal, and belongs to the family Phocidae. They are a true seal, with a rounded head and visible ear canal, distinct from the eared seals, or sea lions, which have a pointed head and an external ear. Males and females are similar in size and can exceed 6 feet and 300 pounds. Harbor seals generally do not migrate annually.

They display year-round site fidelity, although they have been known to swim several hundred miles to find food or suitable breeding habitat.

Table 2
Stock Assessment of Marine Mammal Stocks Potentially Present in San Francisco Bay

Species	Stock Name/ Status*	Stock Abundance	Relative Occurrence in San Francisco Bay	Season(s) of Occurrence
Pacific harbor seal *Phoca vitulina*	California stock/NS	30,968	Common	Year-round
California sea lion *Zalophus californianus*	Eastern United States stock/NS	296,750	Common	Year-round
Harbor porpoise *Phocoena phocoena*	San Francisco-Russian River Stock/NS	9,886	Common in the vicinity of the Golden Gate and Richardson's Bay. Rare elsewhere.	Year-round
Gray whale *Eschrichtius robustus*	Eastern North Pacific stock/NS	20,990	Rare to occasional	February and March
Humpback whale (*Megaptera novaeangliae*)	California/Oregon/ Washington stock/ D,S; ESA-E	1,918	Rare	Summer and fall
Bottlenose dolphin *(Tursiops truncates)*	California Coastal stock/NS	346	Common in the vicinity of the Golden Gate and Richardson's Bay. Rare elsewhere.	Year-round
Northern elephant seal (*Mirounga angustirostris*)	California Breeding Stock/NS	179,000	Rare	Spring and fall
Guadalupe fur seal (*Arctocephalus townsendi*)	Entire/D,S; ESA-T	15,830	Rare; stranding may occur in San Francisco Bay during El Niño years.	Year-Round
Northern fur seal (*Callorhinus ursinus*)	California stock/NS	14,050	Rare; stranding may occur in San Francisco Bay during El Niño years.	Year-round

*Status: NS = No special designation under the MMPA, not listed in the ESA.
D.S = Designated as Depleted and Strategic under the MMPA.
ESA-E = listed in the ESA as Endangered.
ESA-T = listed in the ESA as Threatened.

Source: NMFS, 2015d; NMFS 2016d

Harbor seals forage in shallow waters on a variety of fish and crustaceans that are present throughout much of San Francisco Bay, and therefore could occasionally be found foraging in the action area. They are opportunistic, generalist foragers (Gibble, 2011). The harbor seal diet generally consists of fish, although they also consume shrimp and shellfish. In San Francisco Bay, harbor seals forage in shallow, intertidal waters on a variety of fish, crustaceans, and a few cephalopods (e.g., octopus). The most numerous prey items identified in harbor seal fecal samples from haul-out sites in San Francisco Bay include yellowfin goby (*Acanthogobius flavimanus*), northern anchovy (*Engraulis mordax*), Pacific herring (*Clupea harengus pallasi*), staghorn sculpin (*Leptocottus armatus*), plainfin midshipman (*Porichthys notatus*), and white croaker (*Genyonemus lineatas*) (Harvey and Torok, 1994).

Although generally solitary in the water, harbor seals come ashore at haul-outs—shoreline areas where pinnipeds congregate to rest, socialize, breed, molt—as well as for thermoregulation, birthing, and nursing pups. Habitats used as haul-out sites include tidal rocks, bayflats, sandbars, and sandy beaches (Zeiner et al., 1990). Haul-out sites are relatively consistent from year-to-year (Kopec and Harvey, 1995), and females have been recorded returning to their own natal haul-out when breeding (Cunningham et al., 2009). Although harbor seals haul-out at approximately 20 locations in San Francisco Bay, there are three locations that serve as primary locations: Mowry Slough in the south Bay, Corte Madera Marsh and Castro Rocks in the north Bay, and Yerba Buena Island in the central Bay (Grigg, 2008; Gibble, 2011). Detailed information regarding the number and distribution of Pacific harbor seals in the project area is provided in Section 5.1.

4.2 CALIFORNIA SEA LION

The California sea lion (*Zalophus californianus*) belongs to the family Otariidae or "eared seals," referring to the external ear flaps not shared by other pinniped families. California sea lions are sexually dimorphic: males can reach up to 8 feet long and weigh 700 pounds; whereas females are smaller, at approximately 6 feet long and 200 pounds. Sexual maturity occurs within 4 to 5 years. Although California sea lions forage and conduct many activities in the water, they also use haul-outs. California sea lions breed in Southern California and along the Channel Islands during the spring. Although most females remain in southern California waters year-round, males and some subadult females range widely and occupy protected embayments like San Francisco Bay throughout the year (Caltrans, 2012). Pupping does not occur in San Francisco Bay. They are extremely intelligent and social, and spend much of their time aggregated at communal haul-outs. Group hunting is common and they may cooperate with other species, such as dolphins, when hunting large schools of fish. The California sea lion feeds on a mixture of fish species and squid (NMFS, 2015b). Detailed information regarding the number and distribution of California sea lions in the project area is provided in Section 5.2.

4.3 HARBOR PORPOISE

The harbor porpoise (*Phocoena phocoena*) is a member of the Phocoenidae family. They generally occur in groups of two to five individuals, and are considered to be shy, relatively nonsocial animals. The harbor porpoise has a small body, with a short beak and medium-sized dorsal fin. They can grow to approximately 5 feet and 170 pounds. Females are slightly larger than the males, and reach sexually maturity at 3 to 4 years. They are typically found in waters less than 250 feet deep in coastal waters, bays, estuaries, and harbors. Their prey base consists of demersal and benthic species, such as schooling fish and cephalopods (NMFS, 2014a). Detailed information regarding the number and distribution of harbor porpoise in the project area is provided in Section 5.3.

4.4 GRAY WHALE

Gray whales (*Eschrichtius robustus*) are large baleen whales. They grow to approximately 50 feet in length and weigh as much as 40 tons. They are one of the most frequently seen whales along the

California Coast, easily recognized by their mottled gray color and lack of dorsal fin. Adult whales carry heavy loads of attached barnacles, which add to their mottled appearance. Gray whales are the only baleen whales known to feed on the sea floor, where they scoop up bottom sediments to filter out benthic crustaceans, mollusks, and worms (NMFS, 2015c). They feed in northern waters primarily off the Bering, Chukchi, and western Beaufort seas during the summer, before heading south to the breeding and calving grounds off Mexico over the winter. Between December and January, late-stage pregnant females, adult males, and immature females and males will migrate southward. The northward migration occurs between February and March. During this time, recently pregnant females, adult males, immature females, and females with calves move north to the feeding grounds (Calambokidis et al., 2014). A few individuals will enter into San Francisco Bay during their northward migration. Detailed information regarding the number and distribution of gray whales in the project area is provided in Section 5.4.

4.5 NORTHERN ELEPHANT SEAL

Northern elephant seals are common on California coastal mainland and island sites where they pup, breed, rest, and molt. The largest rookeries are on San Nicolas and San Miguel islands in the Northern Channel Islands. In the vicinity of San Francisco Bay, elephant seals breed, molt, and haul out at Año Nuevo Island, the Farallon Islands, and Point Reyes National Seashore (Lowry et al., 2014). Adults reside in offshore pelagic waters when not breeding or molting. Northern elephant seals haul out to give birth and breed from December through March, and pups remain onshore or in adjacent shallow water through May, when they may occasionally make brief stops in San Francisco Bay (Caltrans, 2015b). The most recent sighting was in 2012 on the beach at Clipper Cove on Treasure Island, when a healthy yearling elephant seal hauled out for approximately 1 day. Approximately 100 juvenile northern elephant seals strand in San Francisco Bay each year, including individual strandings at Yerba Buena Island and Treasure Island (fewer than 10 strandings per year) (Caltrans, 2015b). When pups of the year return in the late summer and fall to haul out at rookery sites, they may also occasionally make brief stops in San Francisco Bay.

4.6 NORTHERN FUR SEAL

The range of the northern fur seal (*Callorhinus ursinus*) extends from southern California, north to the Bering Sea and west to the Okhotsk Sea and Honshu Island, Japan (NMFS, 2014b). During the breeding season, the majority of the worldwide population is found on the Pribilof Islands in the southern Bering Sea, with the remaining animals spread throughout the North Pacific Ocean. On the coast of California, small breeding colonies are present at San Miguel Island off southern California, and the Farallon Islands off central California (NMFS, 2014b). Northern fur seal are a pelagic species and are rarely seen near the shore away from breeding areas. Juveniles of this species occasionally strand in San Francisco Bay, particularly during El Niño events (TMMC, 2016). The shoreline in the vicinity of the project is developed waterfront, consisting of piers and wharves where northern fur seal are unlikely to strand. Incidental take of this species is being requested in the rare event they are present in San Francisco Bay during pile driving.

4.7 BOTTLENOSE DOLPHIN

Since the 1982-83 El Niño, which increased water temperatures off California, bottlenose dolphins have been consistently sighted along the central California coast (NMFS, 2008). The northern limit of their regular range is currently the Pacific coast off San Francisco and Marin County, and they occasionally enter San Francisco Bay, sometimes foraging for fish in Fort Point Cove, just east of the Golden Gate Bridge. In the summer of 2015, a lone bottlenose dolphin was seen swimming in the Oyster Point area of South San Francisco (GGCR, 2016). Members of the California Coastal Stock are transient and make movements up and down the coast, and into some estuaries, throughout the year. Incidental take of this species is being requested in the rare event they are present in San Francisco Bay during pile driving.

4.8 EXTRALIMITAL SPECIES

The following species may be occasionally or incidentally present in San Francisco Bay. A review of the status of these species is presented below, indicating why take of these species is not being requested. For the pinnipeds described below, such occurrences often take the form of stranded individuals that are sick or malnourished.

4.8.1 Guadalupe Fur Seal

The Guadalupe fur seal (*Arctocephalus townsendi*) is listed as threatened under the ESA. Currently, the only breeding colonies are on Isla Guadalupe off Baja California, Mexico, and a few other small islands in that area (Simon, 2016). Outside of the breeding season, this species occasionally ranges into the waters of Northern California and the Pacific Northwest. The Farallon Islands (off central California) and the Channel Islands (off southern California, including San Miguel, San Nicolas, Santa Barbara and San Clemente Islands) are used as haul outs during these movements (Simon, 2016). Juvenile Guadalupe fur seal occasionally strand in the vicinity of San Francisco, and stranding rates increase during El Niño events. The potential for this species to occur in the project area is very low; therefore, no take is being requested. Because this is a threatened species under the ESA, in the rare event that Guadalupe fur seal are detected in the Level A or Level B zones, work will cease until the animal has left the area.

4.8.2 Humpback Whale

During the summer and fall months, humpback whales (*Megaptera noveangliae*) are sometimes seen outside of or just within the Golden Gate. Humpback whales are rare—although well-publicized—visitors to the interior of San Francisco Bay. A humpback whale nicknamed “Humphrey” journeyed through San Francisco Bay and up the Sacramento River in 1985 and re-entered San Francisco Bay in the fall of 1990, stranding on mudflats near Candlestick Park (Fimrite, 2005). In May 2007, a humpback whale mother and calf spent just over 2 weeks in San Francisco Bay and the Sacramento River before finding their way back out to sea. Although it is possible that a humpback whale will enter San Francisco Bay and find its way into the project area during construction activities, their occurrence is unlikely, and measures taken to minimize and mitigate for effects to gray whales would adequately protect a stray humpback whale if one did enter the project vicinity. This species will not be considered further in this application, because incidental take of humpback whale is not being requested.

5.0 AFFECTED SPECIES STATUS AND DISTRIBUTION IN THE ACTION AREA

5.1 PACIFIC HARBOR SEAL

Pacific harbor seals have the broadest range of any pinniped, inhabiting both the Atlantic and Pacific oceans. In the Pacific, they are found in near-shore coastal and estuarine habitats from Baja California to Alaska, and from Russia to Japan. Of the three recognized populations of Pacific harbor seals along the west coast of the continental United States, the California stock occurs in California coastal waters. Although there is genetic distinction among some populations, geographical boundaries define the difference between the Oregon, Washington, and California Coastal stocks. Population assessments are extrapolated from observations of the number of Pacific harbor seals ashore during the peak haul-out period (May to July) across an estimated 400 to 600 haul-out sites during periodic surveys. The number of pacific harbor seals observed was multiplied by a correction that is equal to the “inverse of the estimated fraction of seals on land” (NMFS, 2015a). The estimated population of the California stock is 30,968 (Table 2).

The 2016 Draft Marine Mammal Stock Assessment Report for the Pacific Region does not include a write-up of the California Stock, so information from the 2012 Marine Mammal Stock Assessment Report for the Pacific Region was used to describe the California stock (NMFS, 2015b). Between 1981 and 2004, the Pacific harbor seal population increased, followed by a steady decrease between 2005 and 2010. A partial reason for this decrease could be mortalities associated with commercial hook and line fisheries, vessel strikes, entrainment in power plants, and research-related deaths (NMFS, 2015a).

Long-term monitoring studies have been conducted at the largest harbor seal colonies in Point Reyes National Seashore and Golden Gate National Recreation Area since 1976. Castro Rocks and other haul-outs in San Francisco Bay are part of the regional survey area for this study and have been included in annual survey efforts. Between 2007 and 2012, the average number of adults observed ranged from 126 to 166 during the breeding season (March through May), and from 92 to 129 during the molting season (June through July) (Truchinski et al., 2008; Flynn et al., 2009; Codde et al., 2010; Codde et al., 2011; Codde et al., 2012; Codde and Allen, 2015). Marine mammal monitoring at multiple locations inside San Francisco Bay was conducted by the California Department of Transportation (Caltrans) from May 1998 to February 2002, and determined that at least 500 harbor seals populate San Francisco Bay (Green et al., 2002). This estimate agrees with previous seal counts in San Francisco Bay, which ranged from 524 to 641 seals from 1987 to 1999 (Goals Project, 2000). The main pupping areas in San Francisco Bay are at Mowry Slough and Castro Rocks (Caltrans, 2012). Pupping season for harbor seals in San Francisco Bay spans from approximately March 15 through May 31, with pup numbers generally peaking in late April or May (NMFS, 2015a). Births of harbor seals have not been observed at Corte Madera Marsh and Yerba Buena Island, but a few pups have been seen at these sites.

Harbor seals occasionally use the westernmost tip of Breakwater Island as a haul-out site and forage in the Breakwater Gap area. The tip is approximately 1 mile west of the project site. Aerial surveys of seal haul-outs conducted in 1995-97 and incidental counts made during summer tern foraging studies conducted in 1984-93 usually counted fewer than 10 seals present at any one time. There is some evidence that more harbor seals have been using the westernmost tip of Breakwater Island in recent years, or that it is more important as a winter haul-out. Seventy-three seals were counted on Breakwater Island in January 1997, and 20 were observed hauled-out on April 4, 1998. A small pup was observed during May 1997; however, site characteristics are not ideal for the island to be a major pupping area (USFWS, 1998). Recent observations indicate that as many as 32 harbor seals irregularly haul out on Breakwater Island (Klein, 2017).

Harbor seals had also been using an abandoned small craft marina dock at the project site for haul-out purposes since sometime after closure of the NAS. This dock was previously connected to land, and its accessibility by people, dogs, and other animals may have decreased its desirability for use by seals. The dock was not maintained and had been deteriorating over time. In 2010, the portion connecting the floating dock to land broke off and sank, leaving remnant parts of the floating dock isolated from land. After that, seals were regularly observed by local residents hauling out on the portion of the dock that was farthest from shore. The abandoned dock, including both the remnant floating elements and the sunken elements, was removed by WETA in 2016 after an alternative haul-out platform was constructed.

WETA constructed a floating haul-out platform to replace the deteriorating dock that was removed as part of this project. This new platform is approximately 1,000 feet southwest of the project site and was constructed in June 2016. Use of the platform by seals has increased steadily since its installation, with as many as 70 seals observed on the platform at once (Bay Nature, 2017). Volunteer monitoring of harbor seal use of the haul-out platform has been conducted since its installation. The average number of animals hauled out from June 2016 to April 2017 is 15.

The nearest harbor seal pupping location is Yerba Buena Island, approximately 4.5 miles from the project vicinity. Harbor seals use Yerba Buena Island year-round, with the largest numbers seen during winter months, when Pacific Herring spawn (Grigg, 2008). During marine mammal monitoring for construction of the new Bay Bridge, harbor seal counts at Yerba Buena Island ranged from zero to a maximum of 188 individuals (Caltrans, 2012). Higher numbers also occur during molting and breeding seasons. Foraging areas in the vicinity are concentrated between Yerba Buena Island and Treasure Island, and an area southeast of Yerba Buena Island (Caltrans, 2015b). Scat analysis from Yerba Buena Island in 2007-2008 concluded that harbor seal diet changes seasonally, with an emphasis on northern anchovy in the spring and summer during pupping season (Gibble, 2011).

5.2 CALIFORNIA SEA LION

Based on genetic variations in the mitochondrial DNA, there are five genetically distinct populations of California sea lions: Pacific temperate, Pacific subtropical, Southern Gulf of California, Central Gulf of California, and the Northern Gulf of California. Members of the Pacific temperate population, which range between Canada and Baja California, occur in the project area. This population is estimated to be around 296,750 individuals (Table 2). Because different age and sex classes are not all ashore at any given time, the population assessment is based on an estimate of the number of births and number of pups in relation to the known population. The current population estimate is derived from visual surveys, conducted in 2007, 2008, and 2011 of the different age and sex classes observed ashore at the primary rookeries and haul-out sites in southern and central California, coupled with an assessment done in 2008 of the number of pups born in the southern California rookeries (NMFS, 2015a). Because the 2016 Draft Marine Mammal Stock Assessment Report for the Pacific Region does not include a write-up of the Pacific temperate population (NMFS, 2015b), information from the 2012 Marine Mammal Stock Assessment Report for the Pacific Region was used to describe the California stock (NMFS, 2015a).

Statistical analysis of the pup counts between 1975 and 2011 determined an approximate 5.4 percent annual increase between 1975 and 2008. However, this does not take into account decreases associated with El Niño years observed in 1983, 1984, 1992, 1993, and 2003. During these periods, pup counts decreased by between 20 and 64 percent. Although pup counts reached pre-El Niño levels within 2 years of the 1992-1993, 1997-1998, and 2003 El Niño events, it took 5 years after the 1983-1984 El Niño event for pup production to reach pre-1982 levels. According to the National Oceanic and Atmospheric Administration (NOAA), one of the reasons for this could be that during El Niño events, there is an increase in pup and juvenile mortality, which in turn affects future age and sex classes. Additionally, because there are fewer females present in the population after such events, pup production is further limited. The decline in pup production observed during 2000 and 2003 can be attributed in part to previous El Niño events, which affected the number of reproductive females in the population; and in part to domoic poisoning and an infestation of hookworms, which caused an increase in pup mortality (NMFS, 2015b). There was an unusual mortality event (UME) declared in 2013 due to a high number of strandings with reasons unknown, but hypothesized to be associated with low forage fish availability close to pupping areas (NOAA, 2014).

In San Francisco Bay, sea lions haul out primarily on floating K docks at Pier 39 in the Fisherman's Wharf area of the San Francisco Marina. The Pier 39 haul out is approximately 6.5 miles from the project vicinity. The Marine Mammal Center (TMMC) in Sausalito, California has performed monitoring surveys at this location since 1991. A maximum of 1,706 sea lions was seen hauled out during one survey effort in 2009 (TMMC, 2015). Winter numbers are generally more than 500 animals (Goals Project, 2000). In August to September, counts average from 350 to 850 (NMFS, 2004). Of the California sea lions observed, approximately 85 percent were male. No pupping activity has been observed at this site or at other locations in San Francisco Bay (Caltrans, 2012). The California sea lions usually frequent Pier 39 in August after returning from the Channel Islands (Caltrans, 2013). In addition to the Pier 39 haul-out, California sea lions haul out on buoys and similar structures throughout San Francisco Bay. They mainly are seen swimming off the San Francisco and Marin shorelines within San Francisco Bay, but may occasionally enter the project area to forage.

California sea lions have not been documented using the Alameda breakwater or haul-out platform, though it is anticipated that they may occasionally use the structures in Alameda Harbor that are known to be used by harbor seals.

Although there is little information regarding the foraging behavior of the California sea lion in southern San Francisco Bay, they have been observed foraging on a regular basis in the shipping channel south of Yerba Buena Island. Foraging grounds have also been identified for pinnipeds, including sea lions, between Yerba Buena Island and Treasure Island, as well as off the Tiburon Peninsula (Caltrans, 2001). The California sea lions that use the Pier 39 haul-out site may be feeding on Pacific herring (*Clupea harengus*), northern anchovy, and other prey in the waters of San Francisco Bay (Caltrans, 2013).

5.3 HARBOR PORPOISE

Harbor porpoise have a broad range in both the Atlantic and Pacific Oceans. In the Pacific, they are found from Point Conception, California to Alaska; and from Kamchatka to Japan. Distribution is discontinuous due to a habitat preference of continental shelf waters and partially enclosed areas such as bays or fjords. The harbor porpoise population along the Pacific coastline consists of nine distinct stocks (the Morro Bay, Monterey Bay, San Francisco-Russian River, northern California/southern Oregon, northern Oregon/Washington coast, Inland Washington, Southeast Alaska, Gulf of Alaska, and Bering Sea stocks). The San Francisco-Russian River stock is the population that could occur in the project area. The San Francisco-Russian River stock consists of an estimated 9,886 individuals. These estimates are based on aerial surveys that were conducted between 2007 and 2011. The current population estimate is similar to the 2002-2007 estimates of 9,189 individuals (NMFS, 2014a) (Table 2). Over the last 5 years, there have been no reported fishery-related deaths or injury of harbor porpoises within the range of the San Francisco-Russian River stock (NMFS, 2014a).

In the last 6 decades, harbor porpoises were observed outside of San Francisco Bay. The few harbor porpoises that entered were not sighted past central Bay, and were observed closer to the Golden Gate Bridge. In recent years, however, there have been increasingly common observations of harbor porpoises in central, north, and south San Francisco Bay. According to observations by the Golden Gate Cetacean Research team as part of their multi-year assessment, more than 100 porpoises may be seen at one time entering San Francisco Bay; and more than 600 individual animals are documented in a photo-ID database. Porpoise activity inside San Francisco Bay is thought to be related to foraging and mating behaviors (Keener, 2011; Duffy, 2015). Sightings are concentrated in the vicinity of the Golden Gate Bridge and Angel Island, with lesser numbers sighted south of Alcatraz and west of Treasure Island (Keener, 2011).

5.4 NORTHERN ELEPHANT SEAL

Because all age classes are not ashore simultaneously, northern elephant seal population size is estimated by approximation from the number of pups produced. Based on counts of elephant seals at rookeries in the United States in 2010, Lowry et al. (2014) reported that 40,684 pups were born. From this, a total population estimate of approximately 179,000 elephant seals has been made (Lowry et al., 2014), of which approximately 81,000 are the California Breeding stock.

Northern elephant seals haul out to give birth and breed from December through March. Pups remain onshore or in adjacent shallow water through May. Both sexes make two foraging migrations each year: one after breeding and the second after molting (Stewart and DeLong, 1995). Pup mortality is high when they make the first trip to sea in May, and this period correlates with the time of most strandings. Pups of the year return in the late summer and fall to haul out at rookery sites, but may occasionally make brief stops in San Francisco Bay. Approximately 100 juvenile northern elephant seals of the California

Breeding stock strand in San Francisco Bay each year, including individual strandings at Yerba Buena Island and Treasure Island (fewer than 10 strandings per year) (Caltrans, 2015b).

5.5 GRAY WHALE

Although gray whales were once found in three populations across the globe, the Atlantic population is believed extinct, and the species is now limited to the Pacific Ocean, where they are divided into the Eastern North Pacific stock and Western North Pacific stocks. Both Eastern North Pacific and Western North Pacific gray whales migrate each year along the west coast of continental North America and Alaska. They may consequently enter San Francisco Bay, although the Eastern North Pacific stock is much larger and more likely to occur in the area. Based on surveys from 2010/2011, the population of the Eastern North Pacific stock is estimated to consist of 20,990 individuals (NMFS, 2015c) (Table 2). With the exception of an UME in 1999 and 2000, the population of the Eastern North Pacific gray whale stock has increased over the last 20 years, and has been stable since the 1990s (NMFS, 2015c). Those Eastern North Pacific stock gray whales that summer along the west coast of North America to forage are additionally defined as the Pacific Coast Feeding Group, and are separately monitored between June 1 and November 1 between northern California and northern British Columbia by the International Whaling Commission (IWC, 2012). The Pacific Coast Feeding Group stock has increased in abundance estimates since the 1990s, and has been stable since 2003 (Calambokidis et al., 2014).

Caltrans Richmond-San Rafael Bridge project monitors recorded 12 living and two dead gray whales in the surveys performed in 2012. All sightings were in either the central or north Bay; and all but two sightings occurred during the months of April and May. One gray whale was sighted in June, and one in October (the specific years were unreported). The Oceanic Society has tracked gray whale sightings since they began returning to San Francisco Bay regularly in the late 1990s. The Oceanic Society data show that all age classes of gray whales are entering San Francisco Bay, and that they enter as singles or in groups of as many as five individuals. However, the data do not distinguish between sightings of gray whales and number of individual whales (Winning, 2008). It is estimated that two to six gray whales enter San Francisco Bay in any given year.

5.6 NORTHERN FUR SEAL

The nearest pupping location to San Francisco Bay is on the Farallon Islands, which supports a colony of approximately 500 seals, based on surveys conducted in 2011 (Dewar, 2012). The vast majority of northern fur seals use the Pribilof Islands off of Alaska for breeding, but a colony of approximately 12,000 animals breed on San Miguel Island off southern California (NMFS, 2014b). Northern fur seal populations experience significant declines as a result of El Niño events, which reduced food availability for the species (NMFS, 2014b). In normal years, TMMC in Sausalito admits about five northern fur seals that strand on the Central California Coast (TMMC, 2016). During El Niño years, this number dramatically increases; for example, during the 2006 El Niño event, 33 fur seals were admitted (TMMC, 2016). Some of these stranded animals were collected from shorelines in San Francisco Bay.

5.7 BOTTLENOSE DOLPHIN

The California Coastal Stock of bottlenose dolphins is relatively small (340 to 515 animals) (NMFS, 2016d), but they are frequently seen because they spend the majority of time in nearshore waters (NMFS, 2008). As described in Section 4.7, bottlenose dolphin are a rare visitor to San Francisco Bay and are most often seen just within the Golden Gate when they are present (GGCR, 2016). This stock is highly transitory in nature, and is generally not expected to spend extended periods of time in San Francisco Bay. West of Breakwater Island, one bottlenose dolphin has been regularly sighted near a navigational buoy (Perlman, 2017). It is believed that this is the same individual that regularly frequents the area

(Perlman, 2017). Such behavior may be considered abnormal as bottlenose dolphins almost always live in social groups.

6.0 TYPE OF INCIDENTAL TAKING AUTHORIZATION REQUESTED

6.1 TAKE AUTHORIZATION REQUEST

Under Section 101 (a)(5)(D) of the MMPA, WETA requests an authorization from the NMFS for incidental take by Level A and Level B harassment (as defined by Title 50 CFR, Part 216.3) (i.e., IHA) of small numbers of marine mammals—specifically, Level A harassment of Pacific harbor seals; and, Level B harassment of Pacific harbor seals, California sea lions, harbor porpoise, gray whales, northern elephant seal, northern fur seals, and bottlenose dolphin—during pile-driving activities associated with the project. With implementation of the measures outlined in Section 12, no ~~slight injury from Permanent Threshold Shift (PTS) in an animal's hearing (Level A harassment),~~ serious injury~~,~~ or mortality of marine mammals is anticipated.

The noise exposure assessment methodology used in this IHA request attempts to quantify potential exposures to marine mammals resulting from underwater and airborne noise generated during pile extraction and pile installation. Section 7 presents a detailed description of the acoustic exposure assessment methodology. Results from this approach tend to provide an overestimation of exposures because all animals are assumed to be available to be exposed 100 percent of the time. The effects will depend on the species, pile-driving methods, received level of sound, and distance from the work area; however, temporary behavioral reactions are most likely to occur. The analysis for the project predicts potential exposures (see Section 7 for estimates of exposures by species) over the course of the construction that could be classified as Level A and Level B harassment, as defined under MMPA.

6.2 METHOD OF TAKE

The project, as outlined in Sections 2 and 3, has the potential to result in incidental take of marine mammals by underwater and airborne noise disturbance during the removal of temporary piles and driving of new piles. These activities have the potential to affect hearing capabilities and disturb or displace marine mammals. Specifically, the proposed activities may result in "take" in the form of Level A (Permanent Threshold Shift [PTS]) and Level B harassment (behavioral disturbance only) from airborne or underwater noise generated from pile extraction and installation. Level A harassment ~~is not anticipated, given~~will be minimized by the methods of installation and measures designed to minimize the possibility of injury to marine mammals. Section 12 contains additional details on impact reduction and mitigation measures that are proposed for this project.

7.0 TAKE ESTIMATE FOR MARINE MAMMALS

Project activities may result in temporary behavioral changes in marine mammals, primarily from underwater and airborne noise levels generated during extraction and pile-driving activities. This section describes the noise levels that are expected to be generated by the project activities, and the potential impacts of the noise levels on marine mammal species that could be found in the project area.

7.1 FUNDAMENTALS OF SOUND

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water. Sound is generally characterized by several variables, including frequency and intensity. Frequency describes the pitch of a sound, and is measured in the number of cycles per second, or hertz (Hz). Intensity describes the pressure per unit of area (i.e., loudness) of a sound, and is measured in decibels (dB). A dB is a unit of measurement describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. For underwater sounds, a reference pressure of 1 microPascal (µPa) is commonly used to describe sounds in terms of dB, and is expressed as "dB re 1 µPa." Therefore, 0 dB on the decibel scale would be a measure of sound pressure of 1 µPa. Sound levels in dB are calculated on a logarithmic basis. An increase of 10 dB represents a tenfold increase in acoustic energy, while 20 dB is 100 times more intense, 30 dB is 1,000 times more intense, etc. For airborne sound pressure, the reference amplitude is usually 20 µPa, and is expressed as "dB re 20 µPa."

The method commonly used to quantify airborne sounds consists of evaluating all frequencies of a sound according to a weighting system that reflects of human hearing. This method is less sensitive at low frequencies and extremely high frequencies than at the mid-range frequencies. The method is called A-weighting, and the dB level that is measured using this method is called the A-weighted sound level. Sounds levels measured underwater are not weighted, and include the entire frequency range of interest.

When a pile-driving hammer strikes a pile, a pulse is created that propagates through the pile and radiates sound into the water, substrate, and air. The sound pressure pulse is a function of time, and is referred to as the waveform. The instantaneous peak sound pressure level (SPL_{peak}) is the highest absolute value of pressure over the measured waveform, and can be a negative or positive pressure peak. In this document, the SPL_{peak} is also referenced as the peak levels or thresholds. Sound is frequently described as a root mean square (RMS) level, which is a statistical average of the sound wave amplitude. The RMS level is determined by analyzing the waveform and computing the average of the squared pressures over the time that constitutes the portion of the waveform containing 90 percent of the sound energy (Richardson et al., 1995). Sound levels are also described in relation to cumulative sound exposure levels (cSEL) where the A-weighted instantaneous sound pressures are squared and summed[2] throughout the duration of an event, referenced to 1 µPa.

Table 3 contains definitions of these terms. In this document, dB for underwater sound is referenced to 1 µPa and 1 μPa^{2-}sec (RMS and cSEL, respectively), and dB for airborne noise is referenced to 20 µPa. The practical spreading model has been used to estimate underwater noise in this analysis. In common use, noise refers to any unwanted sound. This meaning of noise will be used in the following discussion in reference to marine mammals; that is—pile driving noise may harass marine mammals.

Table 3
Definitions of Underwater Acoustical Terms

Term	Definition
dB, Decibel	A unit describing, the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference pressure for air is 20 µPa, and 1 µPa for underwater.
SPL_{peak}, Peak Sound Pressure Level (dB)	Peak sound-pressure level, based on the largest absolute value of the instantaneous sound pressure. This pressure is expressed in this report as a decibel (referenced to 1 µPa), but can also be expressed in units of pressure, such as µPa or pounds per square inch.
cSEL, cumulative Sound Exposure Level (dB)	cSEL is calculated by summing the cumulative pressure squared over the measurement duration, integrating over time, and normalizing to 1 second, referenced to 1 μPa^{2-}second.
RMS, root mean square level,	The average of the squared pressures over the time that comprise that portion of

2 Sound exposure level (SEL) values are logarithms and must first be converted to antilogs for summation. Because the single strike SEL varies over the sequence of strikes, a linear sum of the energies for all the different strikes needs is computed. This is done as follows: divide each SEL decibel level by 10 and then take the antilog to convert the decibels to linear units (or $uPa^{2-}s$). Then the linear units can be summed and converted back into dB by taking 10Log10 of the value. This will be the cumulative SEL for all of the pile strikes.

(NMFS Criterion)	the waveform containing 90 percent of the sound energy for one pile-driving impulse (referenced to a pressure of 1 µPa).
Notes: µPa = microPascal NMFS = National Marine Fisheries Service	

7.2 APPLICABLE NOISE THRESHOLDS

In 2010, NMFS established interim thresholds regarding the exposure of marine mammals to high-intensity noise that may be considered take under the MMPA. Updated NOAA guidance on assessing the effects of underwater noise on marine mammals for agency impact analysis was adopted in 2016 (NMFS, 2016a). The 2016 guidance includes sound thresholds for slight injury to an animal's hearing, or PTS (Level A Harassment). The underwater sound pressure threshold for slight injury or PTS (Level A harassment) is a dual metric criterion for impulse noise (e.g., impact pile-driving), including both a peak pressure and cSEL threshold, which is specific to the species hearing group (i.e., high-frequency cetaceans [i.e., harbor porpoise], mid-frequency cetaceans [i.e., bottlenose dolphin], low-frequency cetacean [i.e., gray whale], phocids [i.e., Pacific harbor seal and northern elephant seal], and otariids [i.e., California sea lion and northern fur seal]). For continuous noise (e.g., vibratory pile extraction or driving), the PTS threshold is based on cSEL for each species hearing group.

The 2010 thresholds for Level B behavioral harassment levels are still applicable: 160 dB RMS for impulse sounds and 120 dB for nonimpulsive or continuous sounds. Level B Behavioral harassment is considered to have occurred when marine mammals are exposed to noise of 160 dB RMS or greater for impulse noise and 120 dB RMS for continuous noise. In some instances, ambient noise levels may be used in place of the 120-dB RMS threshold for continuous noise. For continuous noise, RMS levels are based on a time constant of 10 seconds, and those RMS levels should be averaged across the entire event. For impact pile-driving, the overall RMS level should be characterized by integrating sound energy for each acoustic pulse across 90 percent of the acoustic energy in each pulse, and averaging all the RMS levels for all pulses. Harassment thresholds for the various types of airborne and underwater noise are shown in Table 4.

Table 4
Injury and Behavioral Disruption Thresholds for Airborne and Underwater Noise

Hearing Group and species considered in this IHA	Airborne Threshold (Impact and Vibratory Pile-Driving)	Underwater Continuous Noise Thresholds (e.g., Vibratory Pile-Driving)		Underwater Impulse Noise Thresholds (e.g., Impact Pile-Driving)		
	Level B RMS Threshold[1]	Level A cSEL Threshold	Level B RMS Threshold	Level A Peak Threshold[2]	Level A cSEL Threshold[2]	Level B RMS Threshold
Phocids (Pacific harbor seals, northern elephant seals)	90 dB (unweighted)	201 dB	120 dB	218 dB	185 dB	160 dB
Otariids (California sea lions, northern fur seals)	100 dB (unweighted)	219 dB	120 dB	232 dB	203 dB	160 dB
Low-Frequency Cetaceans (gray whales)	N/A	199 dB	120 dB	219 dB	183 dB	160 dB
Mid-Frequency Cetaceans (bottlenose dolphins)	N/A	198 dB	120 dB	230 dB	185 dB	160 dB
High-Frequency Cetaceans (harbor porpoises)	N/A	173 dB	120 dB	202 dB	155 dB	160 dB

Notes:
1 The airborne disturbance guideline applies to hauled-out pinnipeds.
2 Level A threshold for impulse noise is a duel criterion based on peak pressure and cSEL. Thresholds are based on the NMFS 2016 Technical

Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing.
Underwater peak and RMS are re: 1 µPa; cSEL is re: 1 µPa^{2-}sec; Airborne RMS is re: 20 µPa.
cSEL = cumulative sound exposure level
dB = decibel
IHA = Incidental Harassment Authorization
N/A = Not applicable, no thresholds exist
NMFS = National Marine Fisheries Service
RMS = root mean square
sec = second

The application of the standard 120-dB RMS threshold for underwater continuous noise can sometimes be problematic, because this threshold level can be either at or below the ambient noise level of certain locations, and not all species may respond to noise at that level. Exposure thresholds for continuous noise have been developed based on the best available scientific information on the response of gray whales to underwater noise. To date, there is very little research or data supporting a response by pinnipeds or cetaceans to continuous noise from vibratory pile extraction and driving as low as the 120-dB threshold. Southall et al. (2007) summarized numerous behavioral observations made of low-frequency cetaceans to a range of nonpulse noise sources, such as vibratory pile-driving. Generally, the data suggest no or limited responses to received levels of 90 to 120 dB RMS, and an increasing probability of behavioral effects in the 120- to 160-dB RMS range. There is limited data available on the behavioral effects of continuous noise on pinnipeds while underwater; however, field and captive studies to date collectively suggest that pinnipeds do not react strongly to exposures between 90 and 140 dB re 1 µPa RMS (Southall et al., 2007). Additionally, ambient underwater noise levels in urbanized estuaries often far exceeds 120 dB RMS, as a result of the nearly continuous noise from recreational and commercial boat traffic.

Background underwater sound levels in the action area are considered in the assessment of the project's construction impacts. Ambient noise levels have been used as a threshold for behavioral harassment from pile driving in other IHA authorizations, such as for the Mukilteo Multimodal Project Tank Farm Pier Removal in Washington and the Anacortes Ferry Terminal Tie-up Slip Dolphin and Wingwall Replacement Project in Washington, both authorized on September 1, 2015. Underwater noise in the project area is regularly generated by small- to medium-sized boats. However, site-specific ambient noise data are not available for Alameda Harbor. As a result, the standard Level B threshold of 120 dB RMS will be used in this assessment.

Airborne noise levels at which pinniped behavioral disturbance at haul-out sites has been documented are used to determine potential disturbance from airborne construction noise. It should be noted that these are not official thresholds, but are used as guidelines to determine impacts associated with changes in airborne noise levels.

7.3 ESTIMATION OF PILE EXTRACTION AND DRIVING NOISE

A review of underwater sound measurements for similar projects was undertaken to estimate the near-source sound levels for vibratory pile extraction and driving, and impact pile-driving. Pile-driving sounds from similar types and sizes of piles have been measured from other projects and can be used to estimate the noise levels that the project would generate. This analysis uses the practical spreading loss model, which NMFS and United States Fish and Wildlife Service have accepted to estimate transmission loss of sound through water.

The significant sources of underwater noise during construction would be pile-driving and extraction. Two different methods will be used to install new piles in San Francisco Bay: (1) vibratory hammer installation; and (2) impact hammer installation. This includes installing 24-inch, 36-inch, and 42-inch hollow-steel piles and installing and removing 14-inch temporary H-piles, as described in Section 3. Piles will be removed using vibratory equipment. Pile installation and extraction would occur in water depths ranging from approximately 14 to 38 feet, depending on location and tidal phase. The substrate at the pile-driving locations is primarily Bay Mud.

When available, reference sound levels were based on underwater sound measurements documented for a number of pile-driving projects with similar pile sizes and types at similar sites (i.e., estuarine areas of soft substrate where water depths are less than 40 feet [Caltrans, 2009]). The noise energy would dissipate as it spreads from the pile at a rate of at least 4.5 dB per doubling of distance (Caltrans, 2009). This is a conservative value for areas of shallow water with soft substrates, and actual dissipation rates would likely be higher.

Using this information, and the number and size of piles presented in Tables 5 and 6, underwater sound levels were estimated using the practical spreading model to determine whether and over what distance the thresholds would be exceeded. The calculations of the distances over which thresholds may be exceeded are provided in Appendix A. As noted in Section 12, Mitigation Measures, during impact pile-driving of steel piles, WETA will also use a bubble curtain to attenuate underwater sound levels. According to Caltrans guidance, it can be assumed that an air bubble curtain will provide approximately 10 dB of sound reduction (Caltrans, 2015a). Because it is anticipated that ambient noise levels in the vicinity of the project will often exceed 120 dB, the actual area of Level B harassment is likely much smaller than what is presented below. Tables 5 and 6 show the expected underwater sound levels for pile-driving activities and the estimated distances to the Level A and Level B thresholds.

Table 5
Expected Pile-Driving Noise Levels and Distances of Level A Threshold Exceedance with Impact and Vibratory Driver

Project Element Requiring Pile Installation	Source Levels at 10 meters[1] (dB)		Distance to Level A Threshold[2], in meters[3]				
	Peak[4]	cSEL	Phocids	Otariids	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans
42-Inch Steel Piles – Vibratory Driver	185	175	11	1.0	19	2	27
42-Inch Steel Piles – Impact Driver (BCA)	~~198~~200	173~~0~~	~~84~~130	~~6~~9~~10~~	~~158~~243	~~6~~9	~~188~~289
36-Inch Steel Piles – Vibratory Driver	180	170	5.0	< 1.0	8	1	12
36-Inch Steel Piles – Impact Driver (BCA)	200	173	130	~~9~~9~~10~~	243	9	289
24-Inch Steel Piles – Vibratory Driver	183	160	1	< 1.0	2	< 1.0	3
24-Inch Steel Piles – Impact Driver (BCA)	193	167	56	4	105	4	125
14-Inch H-piles – Vibratory Driver	165	150	< 1.0	< 1.0	< 1.0	< 1.0	1
14-Inch H-piles – Vibratory Extraction	165	150	< 1.0	< 1.0	< 1.0	< 1.0	1

Notes:
1 Source levels taken from Caltrans, 2015a; a 10-dB reduction was assumed for impact driving due to the BCA.
2 Level A thresholds are based on the NMFS 2016 Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing; cSEL threshold distances are shown. See footnote 3 below.
3 Where noise will not be blocked by land masses or other solid structures.
4 All distances to the peak Level A thresholds are less than 10 meters.

Distances are rounded to the nearest meter or to "<1.0" for values less than 1 meter.

BCA will be used during impact driving of steel piles.

Peak and cSEL are re: 1 µPa and 1 µPa^{2}-sec, respectively.

BCA = bubble curtain attenuation
cSEL = cumulative sound exposure level
dB = decibels
µPa = microPascal
NMFS = National Marine Fisheries Service

Table 6
Expected Pile-Driving Noise Levels and Distances of Level B Threshold Exceedance with Impact and Vibratory Driver

Project Element Requiring Pile Installation	Source Levels at 10 meters[1] (dB)		Distance to Level B Threshold, in meters[2]	Area of Potential Level B Threshold Exceedance in Square Kilometers
	Peak	RMS	160/120 dB RMS (Level B)[3]	
42-Inch Steel Piles – Vibratory Driver	185	175	46,416	12.97
42-Inch Steel Piles – Impact Driver (BCA)	~~198~~200	~~185~~183	~~464~~341	0.~~41~~27
36-Inch Steel Piles – Vibratory Driver	180	170	21,544	12.97
36-Inch Steel Piles – Impact Driver (BCA)	200	183	341	0.27
24-Inch Steel Piles – Vibratory Driver	183	160	4,642	4.92
24-Inch Steel Piles – Impact Driver (BCA)	193	180	215	0.13
14-Inch H-piles – Vibratory Driver	165	150	1,000	1.01
14-Inch H-piles – Vibratory Extraction	165	150	1,000	1.01

Notes:
1 Source levels taken from Caltrans 2015; assume a 10-dB reduction in sound levels due to the use of a bubble curtain for impact driving.
2 Where noise will not be blocked by land masses or other solid structures.
3 For underwater noise, the Level B harassment (disturbance) threshold is 160 dB for impulsive noise and 120 dB for continuous noise.

BCA will be used during impact driving of steel piles resulting in a reduction of 10 dB from the original source levels.

Peak and RMS are re: 1 µPa.

BCA = bubble curtain attenuation
dB = decibels
RMS = root mean square

7.3.1 Impact Pile Driving of 24-, 36-, and 42-inch Steel Pipes

Piles will be driven to approximately 60 feet below mean low lower water level, and will consist of 24-, 36-, or 42-inch-diameter steel pipes. Installation of these pipe piles will require as many as 600~~25~~ blows per pile from an impact hammer using a DelMag D46-32, or similar diesel hammer, producing approximately 122,000 foot-pounds maximum energy per blow, and 1.5 seconds per blow average. Table 1 provides a summary of the blow count and piles per day for each pile type. For these piles, the total active driving time per day will be approximately 30 to 40 minutes.

Other projects conducted under similar circumstances were reviewed to estimate the approximate noise produced by the 24-, 36-, and 42-inch steel piles. These projects include the driving of similarly sized piles at the Alameda Bay Ship and Yacht project for the 42-inch piles and the Trinidad Pier Reconstruction project, as well as generalized values (Caltrans, 2015a). Appendix A provides details of the underwater source levels used to estimate underwater noise. Bubble curtains will be used during the installation of these piles, which, based on guidance provided by Caltrans for a mid-sized steel pile (with a dimension greater than 24 but less than 48 inches), is expected to reduce noise levels by about 10 dB

RMS (Caltrans, 2015a). Based on the above sound levels, installation of the 24- and 36-inch steel pipe piles could have the potential to produce cSEL and peak values above Level A thresholds and the Level B RMS threshold at distances summarized in Tables 5 and 6. It is estimated that two of the 42- and 36-inch piles may be installed per day, and three of the 24-inch piles would be installed per day. Figures 4a and 4b show the distances to the Level A thresholds for impact pile driving and vibratory pile driving. Figures 5a and 5b show the distances to the Level B thresholds for pinnipeds and cetaceans for impact pile driving and vibratory pile driving.

7.3.2 Vibratory Pile Driving of 24-, 36-, and 42-Inch Steel Pipe Piles

The best fit data for 24-inch-diameter steel shell piles comes from the Trinidad Pier Reconstruction project (Caltrans, 2015a). In the absence of data for vibratory driving of 42-inch piles, the "Loudest" values for 36-inch piles are used, while "typical" values are used for 36-inch piles (Caltrans, 2015a). As indicated in Table 1, up to 320 seconds of driving will be required to drive each pile, and for an active driving time per day of up to ~~10 minutes~~640 seconds per day. Appendix A provides details of the underwater source levels and noise calculation results.

It is estimated that two of the 42- and 36-inch piles and three of the 24-inch piles may be installed per day. Based on the analysis provided in Appendix A, vibratory installation of the 24-, 36-, and 42-inch steel pipe piles could have the potential to exceed the Level A thresholds within short distances of the piles (less than 30 meters) (Table 5), and produce RMS values above the Level B threshold at distances summarized in Table 6 and displayed on Figures 4b and 5b.

7.3.3 Vibratory Installation and Extraction of Steel H-Piles

Approximately 20 temporary steel H-piles with a width of 14 inches would be installed and extracted using a vibratory pile driver. Extraction occurs with an upward force applied to the pile, with the vibratory hammer activated to remove it from the sediment. Extraction time needed for each pile may vary greatly, but could require approximately 120 seconds (approximately 2 minutes) from an APE 400B King Kong or similar driver. On average, five of these piles would be vibrated in or extracted per work day, for a total active driving time of approximately ~~10 minutes~~ 600 seconds per day.

In the absence of a better match for source levels, generalized underwater noise values for vibratory driving of H-piles is used, as displayed in Appendix A (Caltrans, 2015a).

Based on the analysis provided in Appendix A, vibratory driving and extraction of the steel H-piles would not produce noise levels above the Level A thresholds (Table 5). The radius over which the Level B 120-dB RMS threshold could be exceeded is approximately 3,280 feet (1,000 meters), as summarized in Table 6, and displayed on Figure 5b.

7.3.4 Airborne Noise

Pile driving generates airborne noise that could potentially result in behavioral disturbance to pinnipeds (e.g., sea lions and harbor seals) that are hauled-out or at the water's surface. As with the underwater noise, the practical spreading model is used to determine the extent over which sound levels may result in harassment of marine mammals. A 20 $\log_{10}$ attenuation rate was used to calculate the distances to the NMFS thresholds for pinnipeds, presented in Table 7.

Table 7
Modeled Extent of Sound Pressure Levels for Airborne Noise

Pile Driving Activity	**Distance to Level B Guideline Thresholds**	
	100 dB RMS (California Sea Lions)	**90 dB RMS (Pacific Harbor Seals)**
Impact Driving – All pile types	200 feet (61 meters)	630 feet (192 meters)
Vibratory Driving – All pile types	62 feet (19 meters)	196 feet (60 meters)

Notes:
RMS is re: 20 µPa.
dB = decibel
µPa = microPascal
RMS = root mean square

The closest haul-out sites to the project area is the WETA installed haul-out platform, approximately 1,000 feet from the project site; and the western end of Breakwater Island, approximately 1 mile from the project site. Construction noise will be audible at the haul-out platform, but is unlikely to be above background noise (i.e., lapping waves or periodic boat traffic) at the western end of Breakwater Island.

Measured sound levels of airborne noise from impact pile driving used in this analysis are also based on measurements made during the Navy Test Pile Project in Bangor, Washington (NAVFAC, 2012), where 24- and 36-inch steel shell piles were used. The unweighted maximum sound level measurement (L_{max})[3] was 112 dB, and the average L_{max} was 103 dB at 50 feet (15 meters). To conservatively estimate the distances to the specified airborne noise thresholds for pinnipeds, the L_{max} will be used, which for a typical noise event is higher than the average airborne RMS value.

Measured airborne noise levels from vibratory driving used in this analysis are also based on measurements made during the Navy Test Pile Project (NAVFAC, 2012). For vibratory driving of 36-inch steel shell piles, the greatest L_{max} value measured was 105 dB, and the average L_{max} was 97 dB (standardized to 50 feet [15 meters]). Airborne noise source levels for vibratory installation and removal of steel H-piles could not be located, so values for steel pipe piles will be used.

Table 7 provides distances using the average L_{max} levels, which should conservatively estimate the distance to the NMFS threshold, because L_{max} is typically higher than the RMS value for a noise event.

Airborne noise levels at the haul-out platform installed by WETA will not exceed the Level B thresholds, but may elicit some behavioral responses because it will be audible to hauled-out animals. WETA conducted dredging between September and November 2016 less than 100 feet from the haul-out platform. During that period, observed use of the haul out seemed to be consistent with the previous 3-month period and began to increase as the winter months approached, indicating that the animals did not avoid the area. Airborne noise generated due to project pile driving is expected to have similar or lesser effects. Any pinnipeds that surface in the area over which the airborne noise thresholds may be exceeded would have already been exposed to underwater noise levels above the applicable thresholds; therefore, no additional incidental take would occur.

[3] The L_{max} level is the typical maximum RMS sound level measured with a Sound Level Meter set to the "fast" response (or 1/8th second response time).

7.4 DESCRIPTION AND ESTIMATION OF TAKE

The potential numbers of some species that may be exposed to take as defined in the MMPA is determined by comparing the calculated areas over which the Level A and Level B ~~and Level A~~ harassment thresholds may be exceeded, as described in Section 7.3, with the expected density of marine mammal species within the vicinity of the proposed project, as described in Section 5. Estimates here are determined by using observational data taken during marine mammal monitoring associated with the Richmond-San Rafael Bridge retrofit project, the SFOBB replacement project, and other marine mammal observations for San Francisco Bay. The estimation of take for harbor seals will also be based on the observed use of the harbor seal platform in Alameda Harbor. For some species that rarely occur in San Francisco Bay, at-sea density values are not available, and take estimates will be provided based on the limited observations of species in the vicinity of the proposed project.

Authorization is being requested for Level A take of Pacific harbor seals through exposure to underwater noise exceeding the PTS thresholds only. ~~The~~ For all other species, the mechanisms of take requested are expected to have no more than a behavioral effect on individual animals, and no effect on the populations of these species. Any effects experienced by individual marine mammals are anticipated to be limited to short-term disturbance of normal behavior or temporary displacement of animals near the source of the noise. Monitoring will ensure that no cetaceans or ~~pinnipeds~~ otariids are present in the Level A harassment area during pile driving.

7.4.1 Pacific Harbor Seal

Level A Take

Pacific harbor seal is the only species that is expected to regularly occur in the vicinity of pile driving, and may frequently enter the Level A harassment zone during active impact pile driving, which is up to 130 meters in size, depending on the size of the pile. The presence of the breakwater around the Alameda Harbor forces all animals travelling to and from the haul-out platform to traverse near the pile driving area (see Figures 4a and 5a). To prevent excessive delays in project implementation, which could result in in-water work not being completed within the regulatory work windows specified for the project, Level A harassment of this species is being requested. Only impact driving of the steel shell piles would create a Level A zone large enough to overlap with many of the potential pathways taken by individuals travelling to/from the haul-out platform. As described in Section 5.1, an average of 15 Pacific harbor seals is expected to use the haul-out platform each day. Animals that remain on the haul-out platform for the duration of pile driving would not be exposed to Level A take. It is only when transit periods overlap pile driving periods that the potential for Level A take is greatly increased.

The September and November of 2016 marine mammal monitoring data conducted for prior project activities is being used to estimate the Level A take requested. The monitoring data for all in-water disturbance point sources (i.e., pile driving, excavator operation, dredging), not just pile driving, is being used as a proxy. Monitoring during pile driving work in September 2016 found that approximately 0.5 harbor seal per day were observed within 130 meters of the point source. During dredging monitoring in November 2016, approximately 1.6 harbor seals per day were observed within 130 meters of the source (i.e., the dredge bucket). The increase i~~ns~~ seal observations may be due to seasonal changes, or may be due to increased visitation of the platform as more seals became aware and familiar with the structure that was installed in June of 2016. Using the higher (November 2016) average, it is estimated that up to 18 harbor seals (1.6 seals per day times 11 anticipated days of impact driving = 18 seals) may enter the 130 meter Level A zone during impact pile driving of the 42- and 36-inch steel piles. Impact driving of the 24-inch steel piles would create a smaller 56-meter Level A zone, so no additional Level A take is requested for those piles. It is assumed that the estimated take by Level A harassment of 18 individuals will be sufficient for all impact pile driving that occurs during construction of the proposed project.

Level B Take

The new platform constructed as part of the project provides a regularly used haul out near the project site. Given that the platform has been in place for less than a year, there are very few data available to determine seasonal use trends; however, it has been observed that as many as 70 animals have been hauled out at one time (Klein, 2017). Since the construction of the platform, an average of 15 harbor seals has been observed hauled out per day. Harbor seals are more likely to be hauled out in the late afternoon and evening, and are more likely to be in the water during the morning and early afternoon (Green et al., 2002). However, during the molting season, harbor seals spend more time hauled out, and tend to enter the water later in the evening. Tidal stage is a major controlling factor of haul-out use by harbor seals, with more seals present during low tides than high-tide periods (Green et al., 2002). Therefore, the number of harbor seals in the vicinity of the project will vary throughout the work period.

Monitoring of marine mammals in the vicinity of the SFOBB has been ongoing for 15 years; from those data, Caltrans has produced at-sea density estimates for Pacific harbor seal of 0.83 animal per square kilometer for the fall-winter season (Caltrans, 2015b). Given the proximity to the new platform, the average daily haul out numbers (15 animals per day) were added to the at-sea densities to calculate the average daily take for the areas over which the Level B harassment thresholds may be exceeded (Table 6). The daily average takes are estimated as follows:

§ Impact driving of 24-inch steel piles: Based on an at-sea density of 0.83 animal per square kilometer, and the 0.13-square-kilometer area over which the Level B harassment may be exceeded, 0.83 × 0.13 + 15 animals using the haul out = 15.11 animals per day that may be exposed to Level B harassment.

§ Impact driving of 36-inch steel piles: Based on an at-sea density of 0.83 animal per square kilometer, and the 0.27-square-kilometer area over which the Level B harassment may be exceeded, 0.83 × 0.27 + 15 animals using the haul out = 15.22 animals per day that may be exposed to Level B harassment.

§ Impact driving of 42-inch steel piles: Based on an at-sea density of 0.83 animal per square kilometer, and the 0.27-square-kilometer area over which the Level B harassment may be exceeded, 0.83 × 0.27 + 15 animals using the haul out = 15.22 animals per day that may be exposed to Level B harassment.~~Based on an at-sea density of 0.83 animal per square kilometer, and the 0.41-square-kilometer area over which the Level B harassment may be exceeded, 0.83 × 0.41 + 15 animals using the haul out = 15.34 animals per day that may be exposed to Level B harassment.~~

§ Vibratory driving and of 24-inch steel piles: Based on an at-sea density of 0.83 animal per square kilometer, and the 4.92-square-kilometer area over which the Level B harassment may be exceeded, 0.83 × 4.92 + 15 animals using the haul out = 19.08 animals per day that may be exposed to Level B harassment.

§ Vibratory driving of 36-inch steel piles: Based on an at-sea density of 0.83 animal per square kilometer, and the 12.97-square-kilometer area over which the Level B harassment may be exceeded, 0.83 × 12.97 + 15 animals using the haul out = 25.77 animals per day that may be exposed to Level B harassment.

§ Vibratory driving of 42-inch steel piles: Based on an at-sea density of 0.83 animal per square kilometer, and the 12.97-square-kilometer area over which the Level B harassment may be exceeded, 0.83 × 12.97 + 15 animals using the haul out = 25.77 animals per day that may be exposed to Level B harassment.

- Vibratory driving and extraction of 14-inch steel H-piles: Based on an at-sea density of 0.83 animal per square kilometer, and the 1.01-square-kilometer area over which the Level B harassment may be exceeded, 0.83 × 1.01 +15 animals using the haul out = 15.84 animals per day that may be exposed to Level B harassment.

Total take by Level B harassment by pile type is summarized in Section 7.5.

7.4.2 California Sea Lion

As described in Section 5.2, summer counts average of California sea lion at Pier 39 ranged from 350 to 850 (NMFS, 2004). Monitoring of marine mammals in the vicinity of the SFOBB has been ongoing for 15 years; from those data, Caltrans has produced at-sea density estimates for California sea lion of 0.09 animal per square kilometer for the late summer-fall season (Caltrans, 2015b). Using this density, the potential average daily take for the areas over which the Level B harassment thresholds may be exceeded (Table 6) is estimated as follows:

- Impact driving of 24-inch steel piles: Based on an at-sea density of 0.09 animal per square kilometer, and the 0.13-square-kilometer area over which the Level B harassment may be exceeded, 0.09 × 0.13 = 0.012 animal per day that may be exposed to Level B harassment.

- Impact driving of 36-inch steel piles: Based on an at-sea density of 0.09 animal per square kilometer, and the 0.27-square-kilometer area over which the Level B harassment may be exceeded, 0.09 × 0.27 = 0.024 animal per day that may be exposed to Level B harassment.

- Impact driving of 42-inch steel piles: Based on an at-sea density of 0.09 animal per square kilometer, and the 0.27-square-kilometer area over which the Level B harassment may be exceeded, 0.09 × 0.27 = 0.024 animal per day that may be exposed to Level B harassment.~~Based on an at-sea density of 0.09 animal per square kilometer, and the 0.41-square-kilometer area over which the Level B harassment may be exceeded, 0.09 × 0.41 = 0.037 animal per day that may be exposed to Level B harassment.~~

- Vibratory driving of 24-inch steel piles: Based on an at-sea density of 0.09 animal per square kilometer, and the 4.92-square-kilometer area over which the Level B harassment may be exceeded, 0.09 × 4.92 = 0.44 animals per day that may be exposed to Level B harassment.

- Vibratory driving of 36-inch steel piles: Based on an at-sea density of 0.09 animals per square kilometer, and the 12.97-square-kilometer area over which the Level B harassment may be exceeded, 0.09 × 12.97 = 1.17 animals per day that may be exposed to Level B harassment.

- Vibratory driving of 42-inch steel piles: Based on an at-sea density of 0.09 animals per square kilometer, and the 12.97-square-kilometer area over which the Level B harassment may be exceeded, 0.09 × 12.97 = 1.17 animals per day that may be exposed to Level B harassment.

- Vibratory driving and extraction of 14-inch steel H-piles: Based on an at-sea density of 0.09 animal per square kilometer, and the 1.01-square-kilometer area over which the Level B harassment may be exceeded, 0.09 × 1.01 = 0.09 animal per day that may be exposed to Level B harassment.

During El Niño conditions, the density of California sea lions in San Francisco Bay may be much greater than the value used above. To account for this potentiality, daily take estimated from the observed density has been increased by a factor of 10 for each day that pile driving occurs. Rounding of the take numbers occurred at the end of the calculations and is included in Table 8. Total take by Level B harassment by pile type is summarized in Section 7.5.

Table 8
Summary of Estimated Take by Species (Level B Harassment)

Pile Type	Pile Driver Type	# of Piles	# of Driving Days	Estimated Take by Level B Harassment (take per day/total)						
				Harbor Seal	California Sea Lion[1]	Northern Elephant Seal	Harbor Porpoise[2]	Gray Whale[2]	Northern Fur Seal[2]	Bottlenose Dolphin[3]
42-inch steel pile	Vibratory[4]	15	8	25.77/206	1.17/93~~4~~	NA	NA	NA	NA	1/8
36-inch steel pile	Vibratory[4]	6	3	25.77/77	1.17/35	NA	NA	NA	NA	1/3
24-inch steel pile	Vibratory[4]	8	3	19.08/57	0.44/13	NA	NA	NA	NA	1/3
14-inch steel H-pile	Vibratory and Extraction	20	8[5]	15.84/127	0.09/7	NA	NA	NA	NA	1/8
Project Total		**49**	**22**	**467**	**148~~9~~**	**~~11~~18**	**10**	**2**	**10**	**52[3]**

Notes:
1 To account for potential 2017 El Niño conditions, take calculated from at-sea densities for California sea lion has been increased by a factor of 10.
2 Take is not calculated by activity type for these species with a low potential to occur, only a total is given.
3 Total take includes an additional 30 takes for transitory groups of bottlenose dolphins.
4 Piles of this type may also be installed with an impact hammer, which would reduce the estimated take. The take was calculated using vibratory methods only because it is the most conservative scenario and results in the greatest take. Only one type of driving will occur in a day.
5 Piles will be vibrated in and then extracted, so the number of days includes both methods.

7.4.3 Harbor Porpoise

As described in Section 4.3, a small but growing population of harbor porpoises uses San Francisco Bay. Harbor porpoises are typically spotted in the vicinity of Angel Island and the Golden Gate Bridge (Keener, 2011), but may use other areas in the Central Bay in low numbers, including the project area. Monitoring of marine mammals in the vicinity of the SFOBB has been ongoing for 15 years; from those data, Caltrans has produced an estimated at-sea density for harbor porpoise of 0.004 animal per square kilometer (Caltrans, 2015b). If this density value were used to calculate potential take, the resultant Level B take would be vanishingly small on a daily basis. Harbor porpoise generally travel individually or in small groups of two or three (Sekiguchi, 1995). It is possible that small groups of individuals (five harbor porpoises) may enter the Level B harassment area (Table 6) on as many as 2 days of pile driving, and therefore we request take by Level B harassment of as many as ten harbor porpoises per year that pile driving occurs.

Marine mammal monitoring, as outlined in Section 14, would ensure that impact pile driving does not occur if harbor porpoises are within the Level A exclusion zone for high-frequency cetaceans (up to 188 meters).

7.4.4 Northern Elephant Seal

As described in Section 4.5.1, small numbers of this species haul out or strand on Yerba Buena Island and Treasure Island. Monitoring of marine mammals in the vicinity of the SFOBB has been ongoing for 15 years; from those data, Caltrans has produced an estimated at-sea density for northern elephant seal of 0.06 animal per square kilometer (Caltrans, 2015b). Most sightings of northern elephant seal in San Francisco Bay occur in spring or early summer, and are less likely to occur during the periods of in-water work for this project. As a result, densities during pile driving for the proposed action would be much lower. It is possible that a lone northern elephant seal may enter the Level B harassment area (Table 6) once per week during pile driving, for a total of ~~11~~ 18 takes (22 total days of pile driving~~/average 2 days of pile driving per work week~~ over an 18-week work window).

7.4.5 Whales

The only whale species that enters San Francisco Bay with any regularity is the gray whale. As described in Section 4.4.1, gray whales occasionally enter San Francisco Bay during their northward migration period of February and March. Pile driving is not expected to occur during this time, and gray whales are not likely to be present at other times of year. As described in Section 5.4, it is estimated that two to six gray whales enter San Francisco Bay in any given year, but they are unlikely to be present during the work period (June 1 through November 30). However, individual grey whales have occasionally been spotted in San Francisco Bay during the work period (Section 5.4), and therefore it is estimated that at most, one gray whale may be exposed to Level B harassment during 2 days of pile driving per year if they enter the areas over which the Level B harassment thresholds may be exceeded (Table 6).

Because the Level A zone for low-frequency cetaceans is similar to that of high-frequency cetaceans for impact pile driving, marine mammal monitoring, as outlined in Section 14, would ensure that pile driving does not occur if gray whales are within their respective exclusion zone.

7.4.6 Northern Fur Seal

The incidence of northern fur seal in San Francisco Bay depends largely on oceanic conditions, with animals more likely to strand during El Niño events. The likelihood of El Niño conditions occurring in 2017 is increasing and if the trends continue, would be expected to begin again in the late summer and fall months, after a La Niña event that occurred during the late 2016/early 2017 period (NOAA, 2017). Using guidance provided by NMFS, it is anticipated that at most 10 animals would be in San Francisco Bay and enter the area of Level B Harassment (Table 6) during each year of construction (NMFS, 2016b).

7.4.7 Bottlenose Dolphin

When this species is present in San Francisco Bay, it is more typically found close to the Golden Gate. Recently, one individual was observed in the vicinity of Oyster Point for several weeks in 2015 (GGCR, 2016). The average reported group size for bottlenose dolphins is five. Reports show that a group normally comes into San Francisco Bay, is seen near Yerba Buena Island once per week for an approximately 2-week stint, and then leaves (NMFS, 2016b). Assuming that transient groups of dolphins come into San Francisco Bay approximately three times per year, 30 takes for as many as five individuals would be anticipated, if the group enters the areas over which the Level B harassment thresholds may be exceeded (Table 6).

Additionally, there is one bottlenose dolphin that has been regularly observed west of Breakwater Island (Perlman, 2017). The movements and residency of this individual are not known, but it is anticipated that this individual may be exposed to Level B harassment during vibratory driving, when noise above the 120-dB threshold will extend beyond Breakwater Island. This adds an additional 22 takes of bottlenose dolphin, for a total of 52 takes.

Although a small Level A zone for mid-frequency cetaceans is estimated during impact driving of the 24-, 36-, and 42-inch piles with the use of a bubble curtain (up to a 6-meter radius), marine mammal monitoring, as outlined in Section 14, would ensure that driving does not occur if bottlenose dolphins are in the exclusion zone.

7.5 SUMMARY AND SCHEDULE OF ESTIMATED TAKE BY YEAR

Pile driving associated with the proposed project would occur within the in-water work window (August 1 through November 30) in 2017. Take that would occur through Level A or Level B harassment would occur during short periods of pile driving within these windows. Table 8 summarizes the estimate of take by Level B harassment for each species by pile-driving activity.

Take by Level A harassment is limited to harbor seals and is estimated as follows:

§ 11 days of driving times 1.6 animals per day = 17.6 animals, rounded to 18 animals for potential impact driving of 42-, 36-, and 24-inch steel piles.

The estimates are based on the number of individuals assumed to be exposed per day; the number of piles driven; and the number of days of pile driving expected, based on an average installation rate. These totals assume ~~that only one pile driver would be installing one type of pile work per day, and that vibratory driving is used,~~impact driving for Level A harassment and vibratory driving for Level B harassment, which results in ~~a greater area of threshold exceedance, and therefore a~~the highest~~r~~ amount of estimated take by Level A or Level B harassment. It is also assumed that an individual animal can only be taken once per method of installation during a 24-hour period. There will be day-to-day variability in the presence of marine mammals in the area; therefore, the take per day is only included to demonstrate how the total take was calculated.

8.0 ANTICIPATED IMPACT OF THE ACTIVITY

The proposed project will produce underwater noise that may potentially harass marine mammals, as described in Section 7. The estimated level of take by such harassment, as estimated in Section 7, is low when compared to the overall size of the affected stocks provided in Section 5.

Exposure to high-intensity underwater noise may cause a loss of hearing sensitivity in marine mammals. If loss of hearing is permanent (i.e., PTS), NMFS considers it a nonserious injury and Level A harassment; whereas temporary hearing loss is considered Level B harassment. PTS is presumed to be likely if the hearing threshold is reduced by equal to or greater than 40 dB (i.e., 40 dB of temporary threshold shift) (NMFS, 2010). Behavioral effects, such as fleeing and the temporary cessation of feeding or social behaviors, could also result from underwater noise. However, the above criteria do not address these effects. In assessing the potential effects of noise, Richardson et al. (1995) have suggested criteria for defining four zones of effect. These zones are discussed in Sections 8.1.1 through 8.1.4, from greatest effect to least.

Marine mammals reviewed in this document are considered solitary foragers; however, underwater communicative signals for social reasons or predator avoidance may be disrupted during pile-driving activity that could lead to adverse impacts. Pinniped communication occurs mostly in low-frequency signals underwater (NMFS, 2010). Harbor porpoises are considered high-frequency cetaceans with an estimated auditory bandwidth range from 200 Hz to 180 kilohertz (kHz). Gray whales, like other baleen whales, are in the low-frequency hearing group. Underwater sounds produced by gray whales range from 20 Hz to 20 kHz (NMFS, 2010). San Francisco Bay is highly industrialized; other vessels and anthropogenic noise in the action area would mask construction sounds. Seals, sea lions, and harbor porpoises have also shown habituation to anthropogenic noise and activity in San Francisco Bay, which would decrease behavioral reactions to construction activity.

8.1.1 Zone of Hearing Loss, Discomfort, or Injury

The zone of hearing loss, discomfort, or injury is the area in which the received sound energy is potentially high enough to cause discomfort or tissue damage to auditory or other systems. The possible effects of damaging sound energy are a temporary hearing threshold shift,[4] a temporary loss in hearing, PTS, and a loss in hearing at specific frequencies, or deafness. Nonauditory physiological effects or injuries that can theoretically occur in marine mammals exposed to strong underwater noise are stress, neurological effects, bubble formation, resonance effects and other types of organ or tissue damage. These effects would be considered Level A harassment; applicable NMFS acoustic thresholds for this type of harassment are species-specific, depending on the hearing group and use duel criteria metrics, including peak pressure and cSEL. The Level A Harassment thresholds are summarized in Table 4, and the distances to those thresholds are summarized in Table 5. These distances are considered very conservative, because they are based on cumulative noise from a full day of pile driving, and an animal would have to be present within that distance for an extended period to potentially experience PTS.

Only Pacific Harbor Seals may experience~~No~~ PTS or other physiological responses ~~are expected~~ from pile-driving operations occurring during project construction; however, it would be for a very short duration, because any animal exposed to the PTS sound levels would be traversing through the area. Vibratory pile extraction and driving does not generate high-peak sound-pressure levels commonly associated with physiological damage. Impact driving can produce noise levels in excess of the Level A thresholds~~, but only during impact-driving of 24- and 36-inch piles~~. Harbor seals, in the numbers summarized in Table 8, may be exposed to Level A harassment through PTS. For other species, ~~M~~marine mammal observers will monitor the exclusion zone for the presence of marine mammals (Section 12 provides a detailed discussion of mitigation measures). They will alert work crews to the presence of ~~pinnipeds~~ otariids or cetaceans in or near the exclusion zone, and advise when to begin or stop work to reduce the potential for acoustic harassment. The exclusion zone will be equivalent to the area over which Level A harassment may occur.

[4] On exposure to noise, the hearing sensitivity may decrease as a measure of protection. This process is referred to as a shift in the threshold of hearing, meaning that only sounds louder than a certain level will be heard. The shift may be temporary or permanent.

8.1.2 Zone of Masking

The zone of masking is the area in which noise may interfere with the detection of other sounds, including communication calls, prey sounds, and other environmental sounds. This effect would be considered Level B harassment; the applicable thresholds for the zone where this effect occurs are 160 dB for impulse sounds (i.e., impact pile driving), and 120 dB for continuous sounds (i.e., vibratory pile driving).

8.1.3 Zone of Responsiveness

The zone of responsiveness is the area in which animals react behaviorally. The behavioral responses of marine mammals to noise depend on a number of factors, including (1) the acoustic characteristics of the noise source of interest; (2) the physical and behavioral state of the animals at the time of exposure; (3) the ambient acoustic and ecological characteristics of the environment; and (4) the context of the noise (e.g., does it sound like a predator?) (Richardson et al., 1995; Southall et al., 2007). However, temporary behavioral effects are often simply evidence that an animal has heard a noise, and may not indicate lasting consequence for exposed individuals (Southall et al., 2007). These types of effects would be considered Level B harassment; the applicable thresholds for the zone where these effects occur are 160 dB for impulse sounds, and 120 dB for continuous sounds.

8.1.4 Zone of Audibility

The zone of audibility is the area in which the marine mammal may hear the noise. Marine mammals as a group have functional hearing ranges of 10 Hz to 180 kHz, with best thresholds near 40 dB (Southall et al., 2007). The Level A harassment thresholds capture the different hearing groups that are present in San Francisco Bay. No thresholds apply to the zone of audibility, because it is difficult to determine the audibility of a particular noise for a particular species. This zone does not fall within the noise range of a take as defined by NMFS. The zone of audibility is also limited by background noise levels, which may mask the particular noise in question. Background noise is produced both by natural (waves, rain, and other organisms) and anthropogenic sources (watercraft, bridges, etc.).

8.2 EXPECTED RESPONSES TO PILE EXTRACTION AND DRIVING

With both vibratory extraction and vibratory and impact pile-driving, it is likely that the onset of activities could result in temporary, short-term changes in typical behavior, and/or avoidance of the affected area. A marine mammal may show signs that it is startled by the noise, and/or may swim away from the noise source and avoid the area. Other potential behavioral changes could include increased swimming speed, increased surfacing time, and decreased foraging in the affected area. Pinnipeds may increase their haul-out time, possibly to avoid in-water disturbance. Because pile replacement work would occur for a just few hours a day, it is unlikely to result in permanent displacement of animals. Any potential impacts from pile-extraction and -driving activities could be experienced by individual marine mammals, but would not cause population-level impacts or affect the long-term fitness of the species in San Francisco Bay.

The expected responses to pile-driving noise depend partly on the average ambient background noise of the site. Alameda Harbor experiences frequent boat traffic, foot traffic on the shoreline and nearby historic site, and other recreational uses. For marine mammals that use Alameda Harbor regularly, such as the harbor seals that haul out on the nearby platform, responses to noise may be lessened due to habituation. When WETA recently conducted dredging in the vicinity of the harbor seal haul-out, observed use of the haul out seemed to be consistent with previous 3-month period and began to increase as the winter months approached, indicating that the animals did not avoid the area due to the visual disturbance and noise of construction.

8.3 EFFECTS OF AIRBORNE NOISE ON MARINE MAMMALS

Airborne noise levels generated by the proposed project would not exceed thresholds at the harbor seal haul-out platform. Swimming pinnipeds that surface near active pile driving could be exposed to airborne noise levels at sound-pressure levels that would constitute Level B harassment during impact or vibratory pile-driving (see Section 7 for results). However, such exposure would occur to animals that have already been exposed to underwater noise above the Level B threshold, and therefore would not constitute additional take. Injury or Level A harassment is not expected to occur from airborne noise.

Pile -driving noise will be audible to harbor seals that are hauled out on the platform. Airborne noise would likely cause limited behavioral responses such as head raising, but is not expected to cause flushing.

As with underwater noise, because of the relatively short duration of the work and the limited amount of time per day when pile replacement work would occur, exposure to airborne noise would not result in population-level impacts or affect the long-term fitness of these species.

8.4 EFFECTS OF HUMAN DISTURBANCE ON MARINE MAMMALS

There is regular and daily activity in the project area as part of baseline conditions related to marine traffic, recreational use, and other urban uses. The haul-out platform near the project area has a clear line of sight; however, given the normal human activity from the everyday use of the harbor and the continued construction activities already occurring in the area, additional in-water activities in 2017 are not expected to disturb the animals that use the haul out. As a result, visual disturbance associated with the proposed project will not affect haul-out locations.

9.0 ANTICIPATED IMPACTS ON SUBSISTENCE USES

No subsistence uses of marine mammals occur in San Francisco Bay. No impacts are expected to the availability of the species stock as a result of the proposed project.

10.0 ANTICIPATED IMPACTS ON HABITAT

10.1 UNDERWATER NOISE DURING PILE DRIVING

Pile driving involved with the Central Bay Maintenance facility may temporarily impact marine mammals in the action area due to elevated in-water noise levels. A temporary, small-scale loss of foraging habitat may occur for marine mammals, if marine mammals avoid the area during pile-extraction and -driving activities.

Harbor seals and California sea lions around the project site would likely be transiting or opportunistically foraging. Frequency of pinniped activity could increase in the event of a herring spawn. Herring spawning events have historically occurred between December and February, which could result in sporadic, unpredictable pinniped congregations near the project area if the event occurs in Alameda Harbor. WETA plans to conduct all piling installation and dredging between approved work windows, between August 1 and November 30, which avoids the herring spawn period.

Acoustic energy created during pile replacement work would have the potential to disturb fish in the vicinity of the pile replacement work. As a result, the affected area could temporarily lose foraging value to marine mammals. During pile driving, high noise levels may exclude fish from the vicinity of the pile driving; Hastings and Popper (2005) identified several studies that suggest fish will relocate to avoid areas of damaging noise energy. The frequency and dB ranges that have been shown to negatively impact fish (FHWG, 2008), and an analysis of potential noise output of the proposed project, indicates that the maximum distance[5] from underwater pile driving at which noise has the potential to cause temporary hearing loss in fish is a distance of approximately 900 feet (124 meters) from pile-driving activity (NMFS, 2016c). Therefore, if fish leave the area of disturbance, pinniped foraging habitat may have temporarily decreased foraging value when piles are driven using impact hammering.

10.2 OVERWATER STRUCTURES

The project would replace an overwater structure, resulting in an overall reduction of 1,620 square feet of floating and shading fill over the waters of San Francisco Bay. Overwater or floating structures that shade marine waters are typically located in intertidal and shallow subtidal areas, and these structures can alter the primary physical processes, including depth (elevation), substrate type, wave energy, light, and water quality (USACE, 2009). Additionally, installation of the new piles would permanently remove soft-bottomed subtidal benthic habitat, while creating a proportionally larger area of hard-substrate benthic habitat in the water column. Effects from shading due to implementation of the project would be expected to be relatively minor and would actually decrease the amount of shading in San Francisco Bay, and so would be a net gain to open water. Reduction in photosynthesis would not be significant due to the tidal influence and constant water circulation in the area; in fact, photosynthesis could be increased, given the reduction in shading.

11.0 ANTICIPATED EFFECTS OF HABITAT IMPACTS ON MARINE MAMMALS

The project's activities are not expected to result in any habitat-related effects that could cause significant or long-term consequences for individual marine mammals or populations. Foraging and dispersal habitat for marine mammals will be temporarily modified by disturbance from increased airborne and underwater noise levels during pile extraction and driving. This modification is expected to have no impact on the ability of marine mammals to disperse and forage in undisturbed areas within their foraging range. The project would result in a small net increase in Bay fill; this would not have a measurable influence on habitat for marine mammals in San Francisco Bay.

Pupping season for harbor seals in San Francisco Bay spans approximately March 15 through May 31, with pup numbers generally peaking in late April or May (NMFS, 2014a). In-water work is scheduled during a time that will avoid the primary pupping season. The harbor seal haul-out platform is not used for pupping. The majority of sea lions that inhabit San Francisco Bay are young males, and the only sea lion pupping event documented in San Francisco Bay was during a domoic acid event, which creates irregular behavior and can result in neurological damage (NMFS, 2015b). For these reasons, construction activity is not anticipated to effect pinnipeds' reproductive or pupping success.

12.0 MITIGATION MEASURES

WETA is committed to implementing the following best management practices to further minimize impacts of the project.

§ All in-water construction will be limited to the period between August 1 and November 30.

§ Work would occur only during daylight hours (7 a.m. to 7 p.m.) so that marine mammals are visible at all times during pile driving/removal activities.

[5] Distance where underwater noise exceeded the Fisheries Hydroacoustic Working Group threshold of 187 dB SEL for adult fish during impact driving of the 36-inch steel piles.

§ WETA will develop a hydroacoustic and biological monitoring plan that provides details on the methods used to monitor and verify sound levels during pile-driving activities. The sound monitoring results will be made available to NMFS. For more information, see Section 14. The Hydroacoustic Monitoring Plan is provided in Appendix B, and the Marine Mammal Monitoring Plan is provided in Appendix C.

§ An "exclusion zone" (i.e. shut down zone) would be enforced during dredging and pile driving/ removal operations. A marine mammal monitor would survey the area prior to the startup of dredging or pile removal/driving equipment. Installation or removal would not begin until no marine mammals are sighted in the designated "exclusion zone" for at least 30 minutes prior to the initiation of the activity or are observed to have left the exclusion zone. Monitoring requirements are described in more detail in Appendix C, Marine Mammal Monitoring Plan.

§ To avoid physical or acoustic injury, if a marine mammal is observed within ~~10~~ 30 meters of pile driving, regardless of the distance to the Level A threshold zone (i.e., if the zone is less than 3~~1~~0 meters), work will cease until the animal has left the area.

§ Temporary piles will be removed by direct pull or vibratory extraction.

§ Piles driven with an impact hammer will employ a "soft start" technique to give fish and marine mammals an opportunity to move out of the area before full-powered impact pile-driving begins. This soft start will include an initial set of three strikes from the impact hammer at reduced energy (40 percent), followed by a 1-minute waiting period, then two subsequent three-strike sets. Soft start will be required at the beginning of each day's impact pile driving work and at any time following a cessation of impact pile driving of 30 minutes or longer.

§ Impact hammers will be cushioned using a 12-inch-thick wood cushion block and a bubble curtain (see below).

§ Only a single-impact or vibratory hammer will be operated at a time.

§ During impact pile driving of steel piles, the contractor will use a bubble curtain to attenuate underwater sound levels. Care will be taken to ensure that the bubble ring seats well onto the substrate and that tidal currents are not disrupting or displacing the bubbles during use. If needed, confinement around the bubble curtain will be used to maintain integrity of the bubble field around the pile.

§ If any Guadalupe fur seal are observed in the Level A or Level B zones, all pile driving will cease until the animal has left the area.

§ A 500-foot access corridor has been established to protect wildlife along the shoreline at the adjacent Alameda National Wildlife Refuge. All construction, maintenance, and ferry vessels will use this access corridor and adhere to a maximum 5-mile-per-hour speed limit.

§ WETA will closely coordinate with TMMC in Sausalito, California, to determine whether there are any sightings of marine mammals in the larger Level B harassment zones (Table 6) that could affect pile driving for the day. Appropriate work stoppages will occur if necessary.

§ A Spill Prevention Control and Countermeasure (SPCC) plan will be prepared to address the emergency cleanup of any hazardous material, and will be available on site. The SPCC plan will incorporate SPCC, hazardous waste, stormwater, and other emergency planning requirements.

Fueling of land and marine-based equipment will be conducted in accordance with procedures outlined in the SPCC.

- Well-maintained equipment will be used to perform work, and except in the case of a failure or breakdown, equipment maintenance will be performed off site. Equipment will be inspected daily by the operator for leaks or spills. If leaks or spills are encountered, the source of the leak will be identified, leaked material will be cleaned up, and the cleaning materials will be collected and properly disposed.
- Fresh cement or concrete will not be allowed to enter San Francisco Bay.
- All construction materials, wastes, debris, sediment, rubbish, trash, fencing, etc., will be removed from the site once project construction is complete, and transported to an authorized disposal area.

13.0 ARCTIC PLAN OF COOPERATION

Not applicable. The proposed activity would take place in San Francisco Bay and no activities would occur in or near a traditional Arctic subsistence hunting area.

14.0 MONITORING AND REPORTING

WETA developed detailed monitoring plans for conducting acoustic measurements and documenting marine mammal observations. The acoustic monitoring plan will ensure that measurements are recorded to provide data on actual noise levels during construction, and provide data to ensure that the marine mammal exclusion zone is enforced during pile-extraction and -driving activities. The marine mammal monitoring portion of the plan provides details on data collection for each distinct marine mammal species observed in the project area during the construction period. Monitoring will include the following: marine mammal behavior observations, count of the individuals observed, and the frequency of the observations. The monitoring plan sections are described in more detail below.

14.1 ACOUSTIC MONITORING

The proposed hydroacoustic monitoring plan is provided as Appendix B.

14.2 MARINE MAMMAL MONITORING

The proposed marine mammal monitoring plan is provided as Appendix C. The plan includes specific details of the biological monitoring that will be conducted during construction, including all data recording and reporting requirements.

15.0 SUGGESTED MEANS OF COORDINATION

All marine mammal data gathered during construction will be made available to NMFS, researchers, and other interested parties, as specified in Section 12 and 14 above. To minimize the likelihood that impacts will occur to the species, stocks, and subsistence use of marine mammals, construction activities will be conducted in accordance with federal, state, and local regulations; and the minimization measures proposed in Section 12 to protect marine mammals. WETA will coordinate all activities as needed with relevant federal and state agencies. These include, but are not limited to: NMFS, the United States Army Corps of Engineers, and the California Department of Fish and Wildlife.

Marine mammal and acoustic monitoring reports would provide useful information that would allow design of future projects to reduce incidental take of marine mammals. WETA will share field data and behavioral observations on marine mammals that occur in the project area. Results of each monitoring effort will be provided to NMFS in a summary report at the conclusion of monitoring. This information could be made available to federal, state, and local resource agencies, scientists, and other interested parties upon written request to NMFS.

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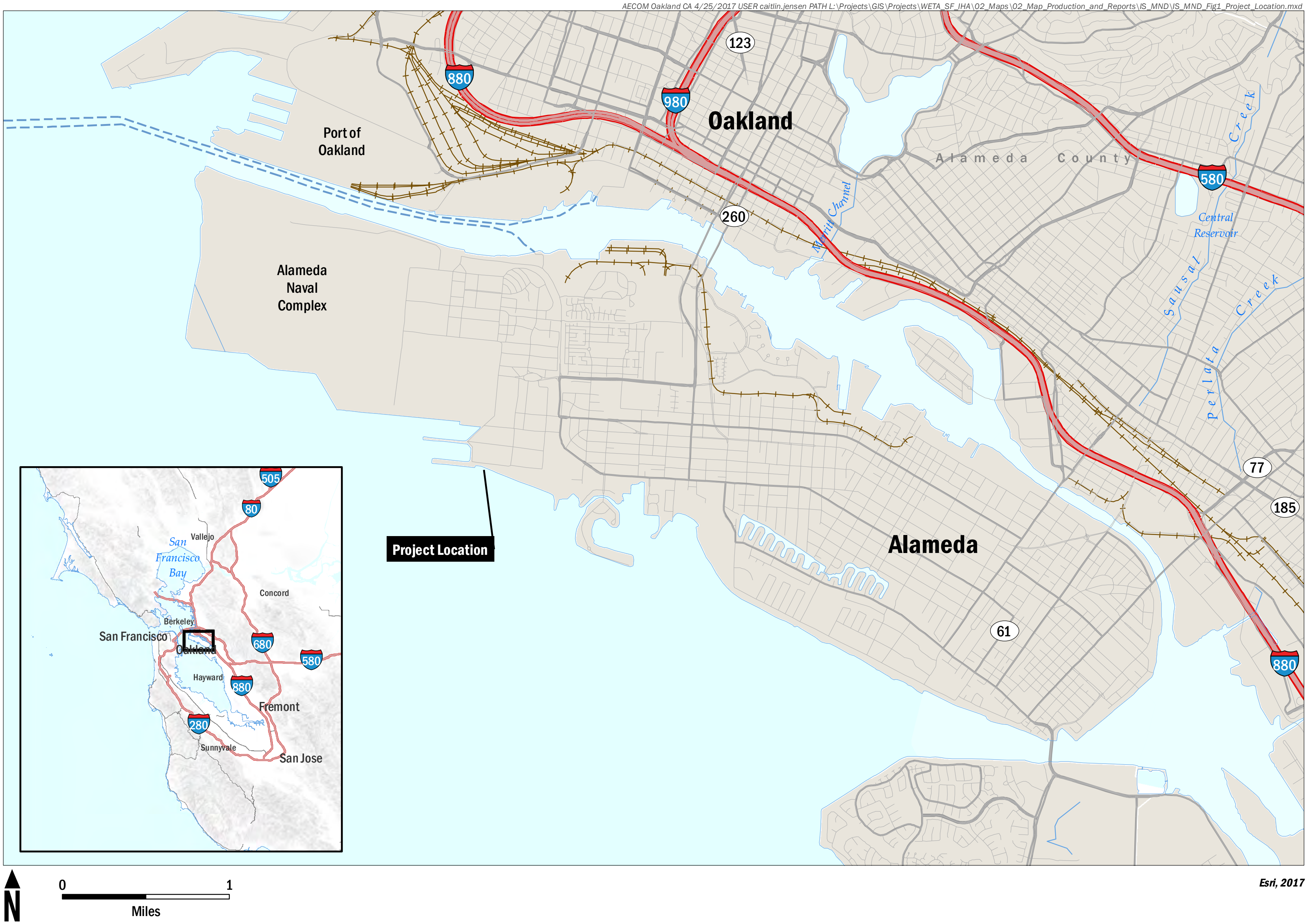


AECOM

San Francisco Bay Area Water Emergency Transportation Authority

Central Bay Operations and Maintenance Facility Project

28067812

FIGURE 1

Project Location

AECOM Oakland CA 4/26/2017 USER caitlin.jensen PATH L:\Projects\GIS\Projects\WETA_SF_IHA\02_Maps\02_Map_Production_and_Reports\IS_MND\IS_MND_Fig2_Project_Site.mxd

NAIP Imagery, USDA FSA, 2016

AECOM

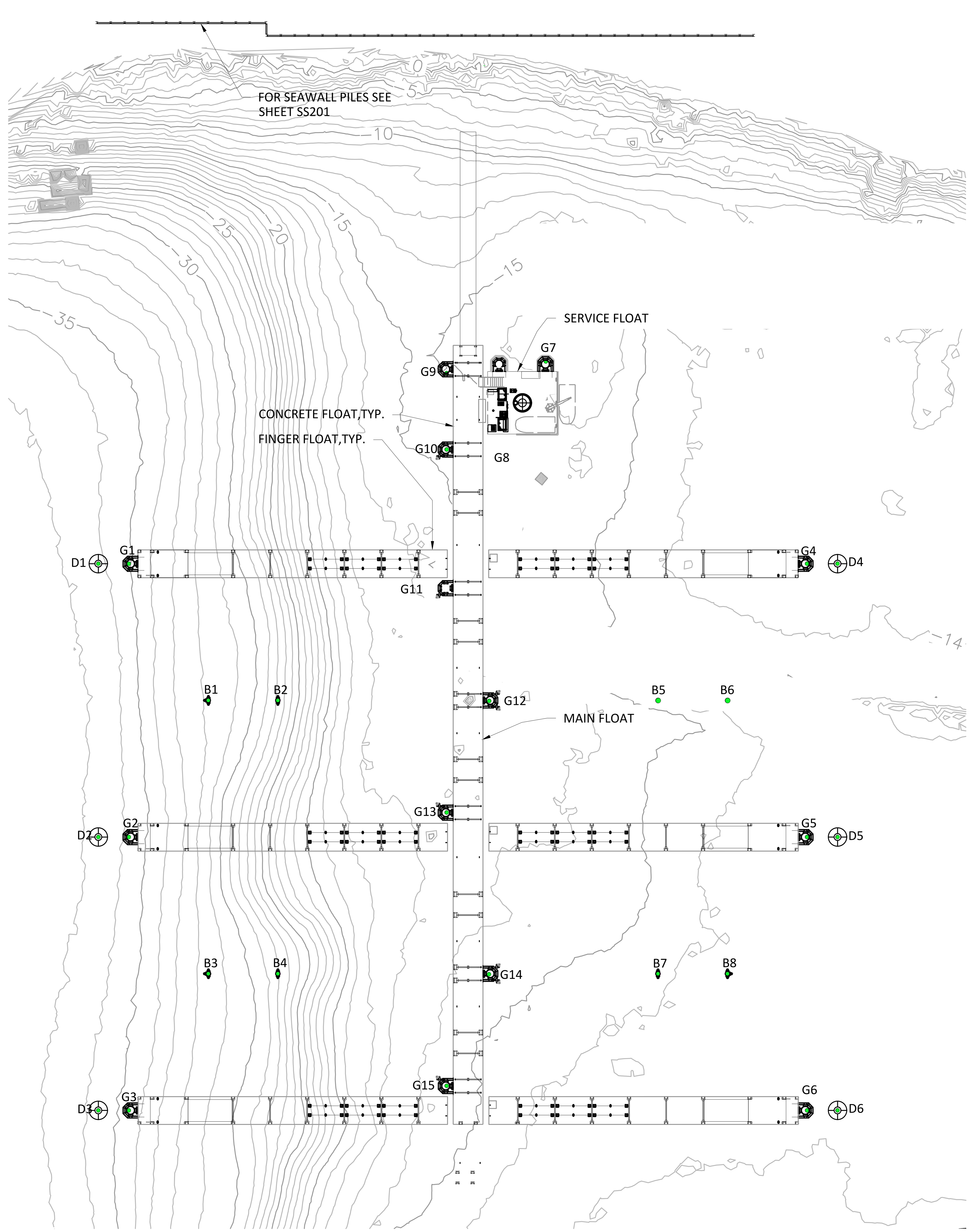
San Francisco Bay Area Water Emergency Transportation Authority

Central Bay Operations and Maintenance Facility Project

28067812

FIGURE 2

Project Site



1 MS201 PILE PLAN
SCALE: 1/16"=1'-0"

PILE SCHEDULE

Type	ID	Section & Material: OD (in)	t wall initial (in)	t wall checked (in)	Fy Min (ksi)	Design Elevations, NAVD88: Top [5, 6] (ft)	Tip (ft)	Design Mudline (ft)	Coating Bottom [2] (ft)	L, Lengths: L Design (ft)	L add Bott [1] (ft)	L add Top [3] (ft)	L Order (ft)	L coated [2,3] (ft)
	G1	42	1	0.720	60	20	-90	-35	-60	110	0	1	111	80
	G2 (w/crane) [5]	42	1	0.720	60	**18**	-90	-35	-60	108	0	1	109	78
	G3	42	1	0.720	60	20	-90	-35	-60	110	0	1	111	80
	G4	42	7/8	0.595	55	20	-80	-15	-40	100	0	1	101	60
	G5	42	7/8	0.595	55	20	-80	-15	-40	100	0	1	101	60
	G6	42	7/8	0.595	55	20	-80	-15	-40	100	0	1	101	60
	G7	42	3/4	0.470	36	20	-75	-15	-40	95	0	1	96	60
	G8	42	3/4	0.750	36	20	-75	-15	-40	95	0	1	96	60
Float	G9	42	1	0.720	55	20	-80	-15	-40	100	0	1	101	60
Guide	G10	42	1	0.720	55	20	-80	-15	-40	100	0	1	101	60
Piles	G11	42	1	0.720	55	20	-80	-15	-40	100	0	1	101	60
	G12	42	1	0.720	55	20	-80	-15	-40	100	0	1	101	60
	G13	42	1	0.720	55	20	-80	-15	-40	100	0	1	101	60
	G14	42	1	0.720	55	20	-80	-15	-40	100	0	1	101	60
	G15	42	1	0.720	55	20	-80	-15	-40	100	0	1	101	60
Donut	D1-D3	36	3/4	0.470	50	25	-95	-35	-60	120	0	1	121	85
Piles	D4-D6	36	3/4	0.470	50	25	-80	-15	-40	105	0	1	106	65
Dolphin	B1-B4	24	3/4	0.470	50	25	-100	-35	-60	125	0	1	126	85
Piles	B5-B8	24	3/4	0.470	50	25	-85	-15	-40	110	0	1	111	65

Notes:
1. Includes 5' for overdriving in case vertical capacity is less than required.
2. Bottom of coating planned for 25' below design mudline. Includes 5' allowance for not driving pile to depth.
3. Start coating 1' from top end of pile. Top 1' of pile will be clamped with the hammer and cut off after driving.
4. Pile axial ASD design loads for P1-P2 = 90 kips, P3-P4 = 115 kips.
5. Top elevation of crane supporting pile at elev +18 NAVD88. A stem with walkway and crane mount will be connected above.
6. Pier deck and soffit elevation slopes 1% towards water starting at edge of pile cap (elev 16.75 NAVD88). Deck = 2' thick. Piles P1-P2 are 10.5 ft waterside of cap, P3-P4 are 34.5 ft.

LEGEND

- —XX— EXISTING BATHYMETRY MAJOR CONTOUR
- EXISTING BATHYMETRY MINOR CONTOUR
- "B", DOLPHIN PILE
- "G", GUIDE PILE
- "D", DONUT FENDER PILE
- "B", DOLPHIN FENDER PILE

100% INITIAL CRITICAL PATH

REVISIONS		
NO.	DATE	DESCRIPTION
0	8/26/16	ISSUED FOR CONSTRUCTION

WATER EMERGENCY TRANSPORTATION AUTHORITY
WETA

OVERAA Construction / POWER — A Joint Venture

PRIME: Liftech — LIFTECH CONSULTANTS INC.

SUBCONSULTANTS

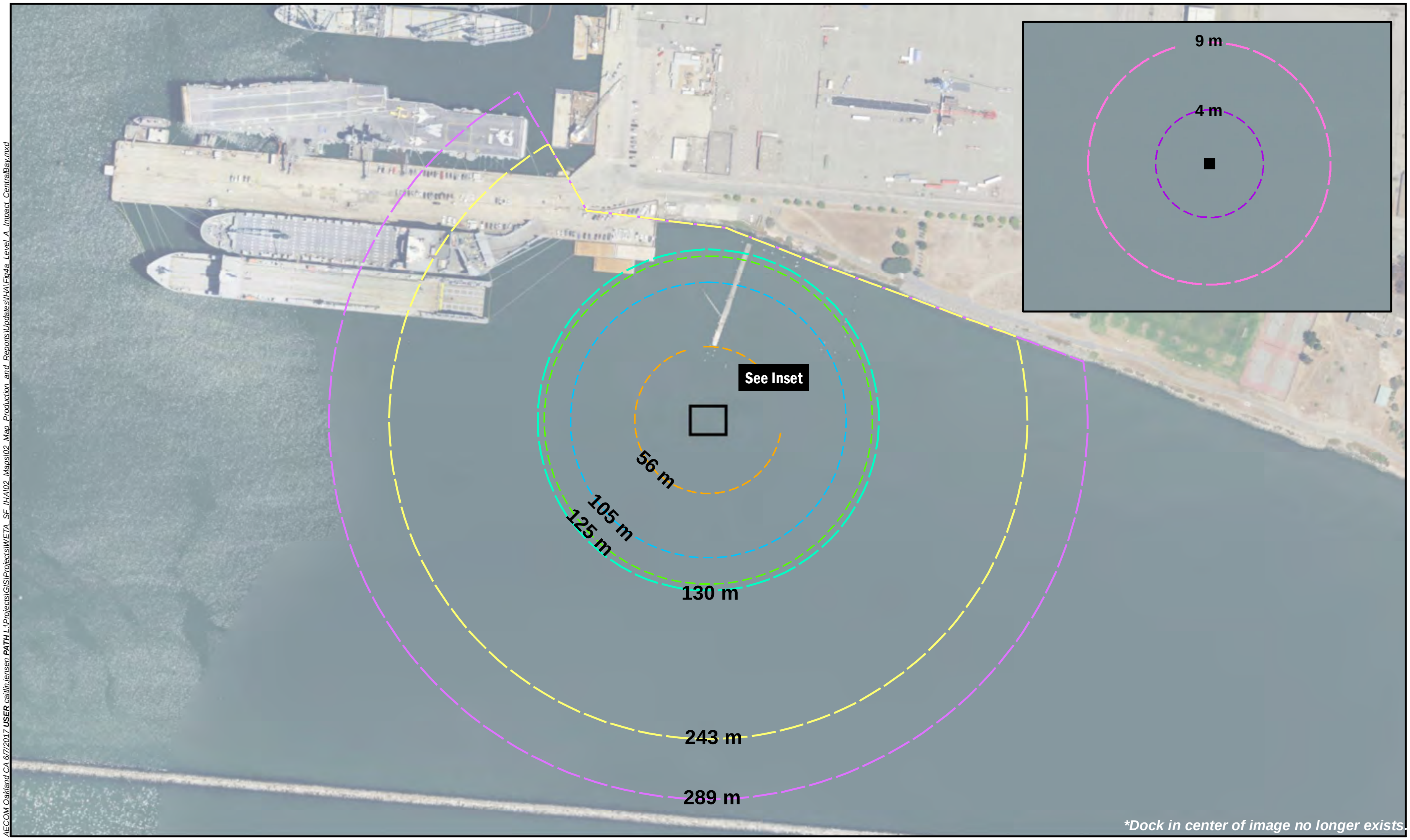
SEAL/SIGNATURE: REGISTERED PROFESSIONAL ENGINEER, Erik G. Soderberg, No. S4426, Exp. 12-31-16, STRUCTURAL, STATE OF CALIFORNIA — FOR LIFTECH CONSULTANTS INC SIGNATURE DATE:

DESIGNED BY: LMO\CAM
DRAWN BY: AH
CHECKED BY: ES

PROJECT: CENTRAL BAY OPERATIONS AND MAINTENANCE FACILITY, ALAMEDA, CA

SHEET: FIGURE 3: PILE PLAN

DATE: 8/26/16
SHEET X OF
DRAWING NO. MS211
JOB NO.



Pile Driving Location	PTS Isopleth to Threshold	24-inch Steel Pile	42- and 36-inch Steel Piles
	Mid-Frequency Cetaceans	4 m	9 m
	Otariid Pinnipeds	4 m	9 m
	Phocid Pinnipeds	56 m	130 m
	Low-Frequency Cetaceans	105 m	243 m
	High-Frequency Cetaceans	125 m	289 m

N

0 50 100 Meters

LEVEL A HARASSMENT AREA - IMPACT PILE DRIVING

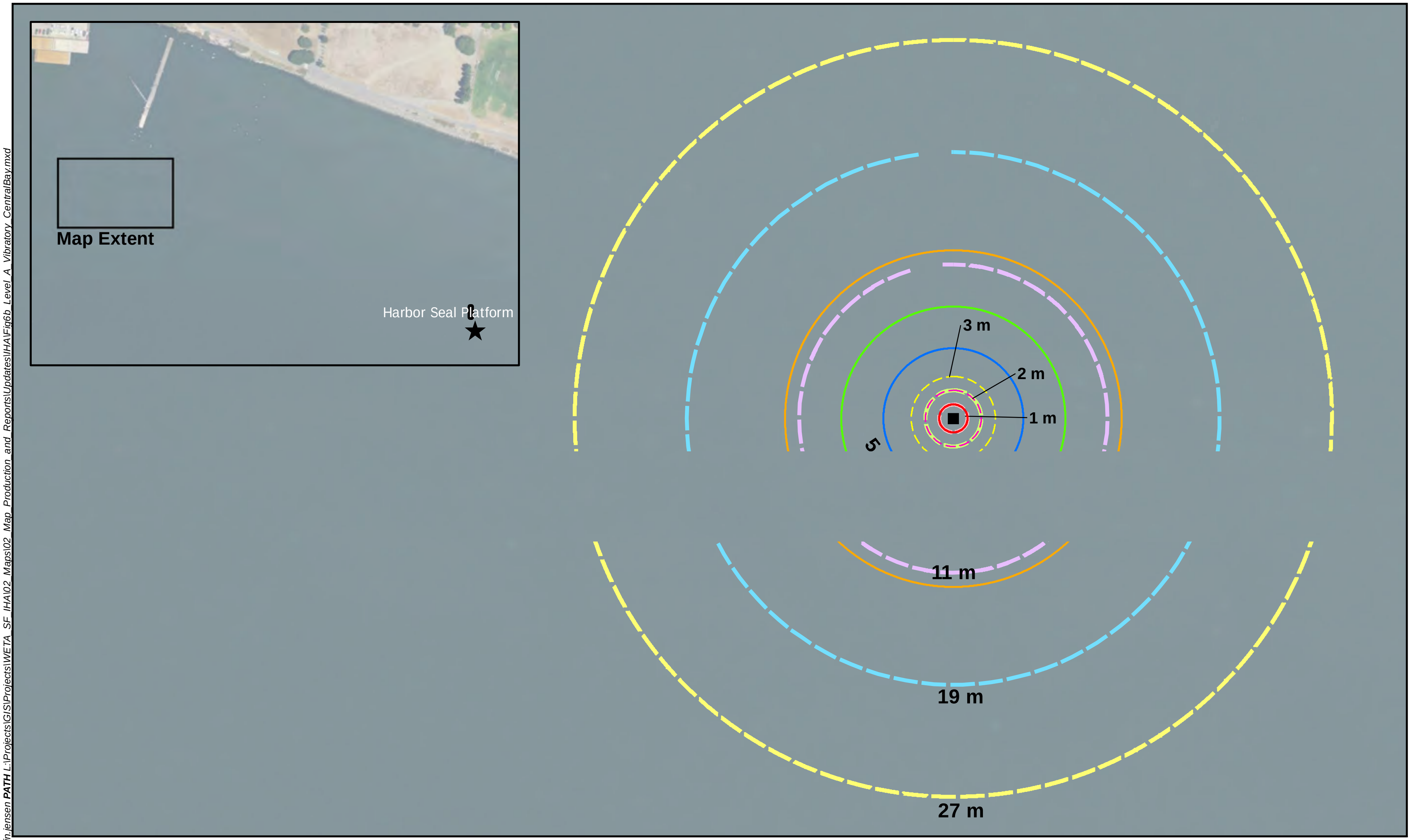
Central Bay Operations and Maintenance Facility Project

28067812 San Francisco Bay Area Water Emergency Transportation Authority

FIGURE 4A

Source: NAIP Imagery, USDA FSA, 2016

AECOM Oakland CA 6/7/2017 USER caitlin.jensen PATH L:\Projects\GIS\Projects\WETA_SF_IHA\02_Maps\02_Map_Production_and_Reports\Updates\IHA\Fig4a_Level_A_Impact_CentralBay.mxd



Pile Driving Location	PTS Isopleth to Threshold	14-inch H-Piles	24-inch Steel Pile	36-inch Steel Pile	42-inch Steel Pile
	Mid-Frequency Cetaceans	< 1.0 m	< 1.0 m	1 m	2 m
	Otariid Pinnipeds	< 1.0 m	< 1.0 m	< 1.0 m	1 m
	Phocid Pinnipeds	< 1.0 m	1 m	5 m	11 m
	Low-Frequency Cetaceans	< 1.0 m	2 m	8 m	19 m
	High-Frequency Cetaceans	1 m	3 m	12 m	27 m

N

0 10 20 Meters

LEVEL A HARASSMENT AREA - VIBRATORY PILE DRIVING

Central Bay Operations and Maintenance Facility Project

28067812 San Francisco Bay Area Water Emergency Transportation Authority

FIGURE 4B

AECOM Oakland CA 4/28/2017 ***USER*** *caitlin.jensen* ***PATH*** *L:\Projects\GIS\Projects\WETA_SF_IHA\02_Maps\02_Map_Production_and_Reports\Updates\IHA\Fig6b_Level_A_Vibratory_CentralBay.mxd*

Source: NAIP Imagery, USDA FSA, 2016

■ **Pile Driving Location**

160 dB RMS Threshold - All Species

- **24-inch Steel Pile (215 m)**
- **42- and 36-inch Steel Pile (341 m)**

N

0 100 200 Meters

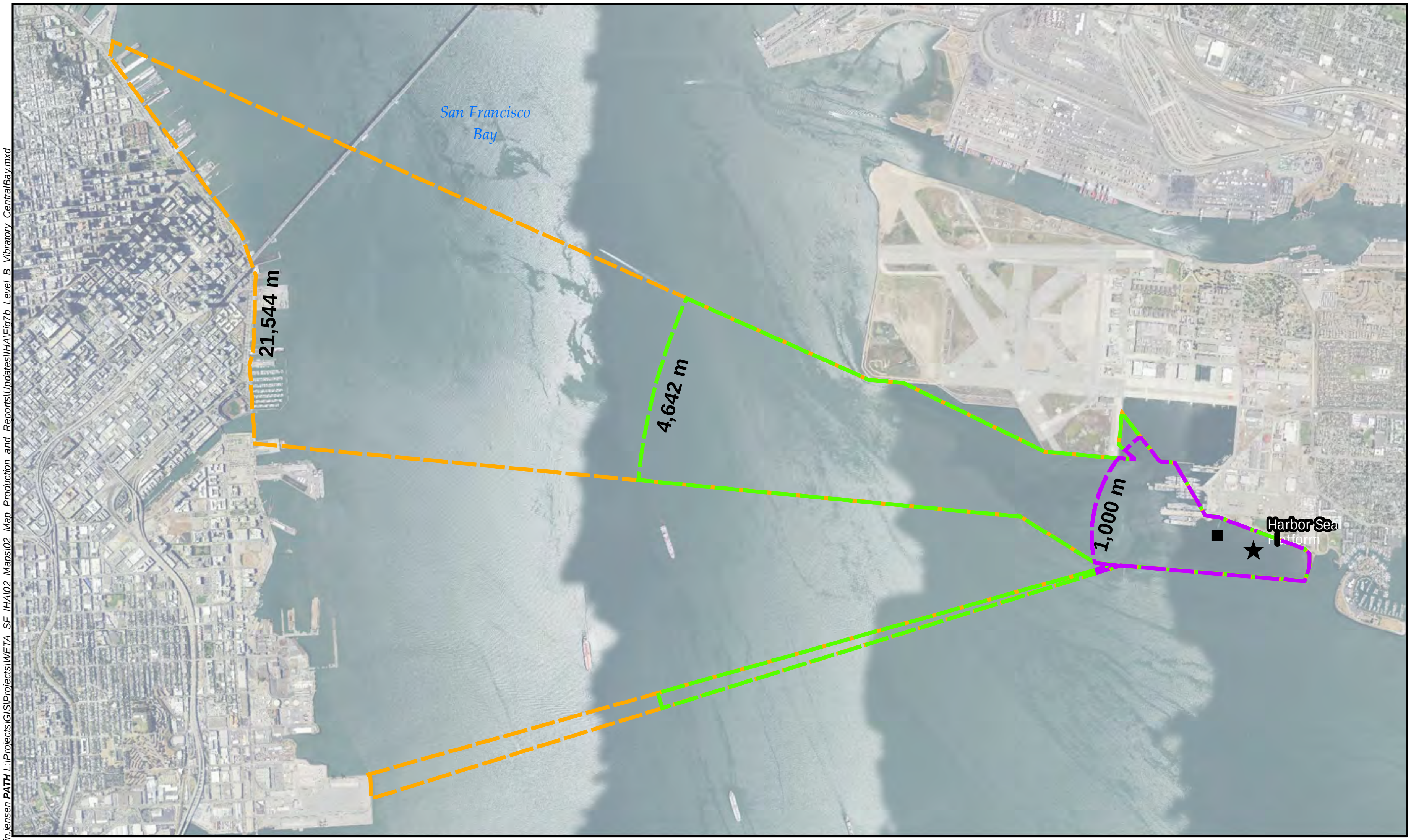
LEVEL B HARASSMENT AREA - IMPACT PILE DRIVING

Central Bay Operations and Maintenance Facility Project

28067812 San Francisco Bay Area Water Emergency Transportation Authority

FIGURE 5A

Source: NAIP Imagery, USDA FSA, 2016



■ Pile Driving Location

120 dB RMS threshold - All Species

- 14-inch H-pile (1,000 m)
- 24-inch Steel Pile (4,642 m)
- 36-inch Steel Pile (21,544 m)

LEVEL B HARASSMENT AREA - VIBRATORY PILE DRIVING

Central Bay Operations and Maintenance Facility Project

28067812 San Francisco Bay Area Water Emergency Transportation Authority

FIGURE 5B

AECOM Oakland CA 4/18/2017 **USER** caitlin.jensen **PATH** L:\Projects\GIS\Projects\WETA_SF_IHA\02_Maps\02_Map_Production_and_Reports\Updates\IHA\Fig7b_Level_B_Vibratory_CentralBay.mxd

Source: NAIP Imagery, USDA FSA, 2016

Appendix A
Underwater Source Levels and Noise Calculations

A-1: Summary of Underwater Noise Source Levels for Each Pile and Installation Method

Pile Size and Type	Drive Method	Total Count	Piles per Day	Blows/Seconds per pile	Attenuation System	Source Levels (dB) (Unattenuated)			Source	Water Depth	Note
						peak	RMS	SEL			
42 inch steel	Impact	15	2	600	Bubble Curtain	210	193	183	Table I.2-1. Summary of Near-Source (10-Meter) Unattenuated Sound Pressure Levels for In-Water Pile Driving Using an Impact Hammer	Water depth ~10m	Using the general values for 36-inch steel piles, as requested by NMFS
36 inch steel	Impact	6	2	600	Bubble Curtain	210	193	183	Table I.2-1. Summary of Near-Source (10-Meter) Unattenuated Sound Pressure Levels for In-Water Pile Driving Using an Impact Hammer	Water depth ~10m	
24 inch steel	Impact	8	3	450	Bubble Curtain	203	190	177	Table I.2-1. Summary of Near-Source (10-Meter) Unattenuated Sound Pressure Levels for In-Water Pile Driving Using an Impact Hammer	Water depth ~5m	
42 inch steel	Vibratory	15	2	320	None	185	175	175	Table I.2-2. Summary of Near-Source (10-Meter) Unattenuated Sound Pressure Levels for In-Water Pile Installation Using a Vibratory Driver/Extractor	Water depth ~5m	Using "Loudest" values for 36-inch piles in the absence of data for vibratory driving of 42-inch piles
36 inch steel	Vibratory	6	2	300	None	180	170	170	Table I.2-2. Summary of Near-Source (10-Meter) Unattenuated Sound Pressure Levels for In-Water Pile Installation Using a Vibratory Driver/Extractor	Water depth ~5m	Using "typical" values for 36-inch piles.
24 inch steel	Vibratory	8	3	205	None	201 max, 183 typical	160	160	24-Inch-Diameter Steel Piles—Trinidad Pier Reconstruction, Humboldt County, CA	3 to 5 m	
14 inch H piles	Vibratory	20	5	120	None	165	150	150	Table I.2-2. Summary of Near-Source (10-Meter) Unattenuated Sound Pressure Levels for In-Water Pile Installation Using a Vibratory Driver/Extractor	Water depth <5m	
					Bubble curtain is assumed to provide 10dB of attenuation						

A-2: Level B Harassment Zone Calculation Summary

Attenuation Factor:	15

Impact Driving

		RMS, dB	distance to 190 dB RMS (meters)	distance to 180 dB RMS (meters)	distance to 160 dB RMS (meters)	distance to 140 dB RMS (meters)	distance to 190 dB RMS (feet)	distance to 180 dB RMS (feet)	distance to 160 dB RMS (feet)	distance to 140 dB RMS (feet)
42-inch steel pile	Bubble Curtain	183	3	16	341	7,356	11	52	1,120	24,129
36-inch steel shell	Bubble Curtain	183	3	16	341	7,356	11	52	1,120	24,129
24-inch steel shell	Bubble Curtain	180	2	10	215	4,642	7	33	707	15,224

Vibratory Driving

Pile Type	Attenuation Device	RMS, dB	distance to 190 dB RMS (meters)	distance to 180 dB RMS (meters)	distance to 120 dB RMS (meters)	distance to 140 dB RMS (meters)	distance to 190 dB RMS (feet)	distance to 180 dB RMS (feet)	distance to 120 dB RMS (feet)	distance to 140 dB RMS (feet)
42-inch steel pile	None	175	1	5	46,416	2,154	3	15	152,244	7,067
36-inch steel pile	None	170	0	2	21,544	1,000	2	7	70,665	3,280
24-inch steel piles	None	160	0	0	4,642	215	0	2	15,224	707
14-inch H piles	None	150	0	0	1,000	46	0	0	3,280	152

A-3: Level A Harassment Zone Calculation Worksheets

USER SPREADSHEET INTRODUCTION

VERSION: 1.1 Aug-16

Companion User Spreadsheet to:

National Marine Fisheries Service (NMFS): Technical Guidance For Assessing the Effects of Anthropogenic Noise on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts (JULY 2016)

http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm

*For more information on the optional methodology provided within this User Spreadsheet, see Appendix D of Technical Guidance

DISCLAIMER: NMFS has provided this spreadsheet as an optional tool to provide estimated effect distances (i.e., isopleths) where SEL_{cum} PTS onset thresholds may be exceeded. Results provided by this spreadsheet do not represent the entirety of the comprehensive effects analysis, but rather serve as one tool to help evaluate the effects of a proposed action on marine mammal hearing and make findings required by NOAA's various statutes. Input values are the responsibility of the individual user.

NOTE: An action proponent is **not obligated** to use these associated spreadsheets. The alternative methods, within this User Spreadsheet, include multiple conservative assumptions and therefore would be expected to typically result in higher estimates of instances of hearing impairment. The larger the scale of the activity, the more these conservative overestimates would be compounded if the alternative methodologies were used.

DIRECTIONS

STEP 1: Determine what spreadsheet is appropriate for activity

HOW TO DETERMINE WHICH SPREADSHEET TO USE

1) Is the sound source NON-IMPULSIVE or IMPULSIVE? (If it is unclear which category describes your source, consult NOAA)
- a) NON-IMPULSIVE (e.g., drilling, vibratory pile driving, tactical sonar): Go to Question 2
- b) IMPULSIVE (e.g., explosives, impact pile driving, seismic): Go to Question 5

2) Is the NON-IMPULSIVE sound source STATIONARY or MOBILE?
- a) STATIONARY: Go to Question 3
- b) MOBILE: Go to Question 4

3) Is the NON-IMPULSIVE, STATIONARY source CONTINUOUS or INTERMITTENT?
- a) CONTINUOUS: Use Spreadsheet A — **RED TAB**
- b) INTERMITTENT: Use Spreadsheet B — **YELLOW TAB**

4) Is the NON-IMPULSIVE, MOBILE source CONTINUOUS or INTERMITTENT?
- a) CONTINUOUS: Use Spreadsheet C (methodology from Sivle et al. 2014) — **BLUE TAB**
- b) INTERMITTENT: Use Spreadsheet D (methodology from Sivle et al. 2014) — **ORANGE TAB**

5) Is the IMPULSIVE sound source STATIONARY or MOBILE?
- a) STATIONARY: Use Spreadsheet E* — **GREEN TAB**
- *If source is impact pile driving: Use Spreadsheet E.1 — **EVRGRN TAB**
- b) MOBILE: Use Spreadsheet F (methodology from Sivle et al. 2014) — **PURPLE TAB**

STEP 2: Within the appropriate spreadsheet, fill-in: **SAGE BOXES** specific to the activity
- a) Please provide information used to support values in provided in sage boxes (e.g., surrogate data, direct measurements, etc.)
- b) If information is unavailable to fill-out one or more of the sage boxes, please consult NMFS

STEP 3: Estimated PTS isopleths (meter) will be provided in: **SKY BLUE BOXES** by marine mammal hearing group

STEP 4: When using this spreadsheet to estimate marine mammal takes, please provide a copy of completed spreadsheet used to estimate isopleths
- a) **Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds), which are not included in this spreadsheet.**

ASSUMPTIONS & ADDITIONAL INFORMATION

1) Marine mammals remain stationary during activity
2) Currently, recovery between intermittent sounds is not considered regardless of time between sounds (i.e., all sounds within the accumulation period are counted)
3) This User Spreadsheet currently only provides isopleth estimates associated with SEL_{cum} PTS onset thresholds. NMFS assumes action proponents will be able to perform exposure modeling using acoustic thresholds expressed using the PK metric (i.e., methodology is similar to that used with NMFS previous thresholds but with a different metric), and reminds action proponents since the Technical Guidance presents dual thresholds for impulsive sounds, they must evaluate thresholds using both metrics.

Suggested (Default*) Weighting Factor Adjustments (WFA), If Input Value is Unknown for Broadband Source:

Source	WFA	Example Supporting Sources
Seismic	1 kHz	Breitzke et al. 2008; Tashmukhambetov et al. 2008; Tolstoy et al. 2009;
Impact pile driving	2 kHz	Blackwell 2005; Reinhall and Dahl 2011
Vibratory pile driving	2.5 kHz	Blackwell 2005; Dahl et al. 2015
Drilling	2 kHz	Greene 1987; Blackwell et al. 2004; Blackwell and Greene 2006

* NMFS acknowledges default WFAs are likely conservative
Since spectra associated with underwater explosives vary by detonation size and depth (Urick 1983), a default WFA is not provided

Literature Cited

Blackwell, S.B. 2005. Underwater Measurements of Pile Driving Sounds during the Port MacKenzie Dock Modifications, 13-16 August 2004. Juneau, Alaska: Federal Highway Administration.

Blackwell, S.B., C.R. Greene, Jr., and W.J. Richardson. 2004. Drilling and operational sounds from an oil production island in the ice-covered Beaufort Sea. Journal of the Acoustical Society of America 116: 3199-3211.

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Breitzke, M., O. Boebel, S. El Naggar, W. Jokat, and B. Werner. 2008 Broad-band calibration of marine seismic sources used by R/V Polarstern for academic research in polar regions. Geophysical Journal International 174: 505-524.

Dahl, P.H., D.R. Dall'Osto, and D.M. Farrell. 2015. The underwater sound field from vibratory pile driving. Journal of the Acoustical Society of America 137: 3544–3554.

Madsen, P.T. 2005. Marine mammals and noise: Problems with root mean square sound pressure levels for transients. Journal of the Acoustical Society of America 117:3952–3957.

Greene, R. 1987. Characteristics of oil industry dredge and drilling sounds in the Beaufort Sea. Journal of the Acoustical Society of America 82: 1315-1324.

Reinhall, P.G., and P.H. Dahl. 2011. Underwater Mach wave radiation from impact pile driving: Theory and observation. Journal of the Acoustical Society of America 130: 1209–1216.

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Tolstoy, M., J. Diebold, L. Doermann, S. Nooner, S.C. Webb, D.R. Bohnenstichl, T.J. Crone, and R.C. Holmes. 2009. Broadband calibration of the R/V *Marcus G. Langseth* four-string seismic sources. Geochemistry Geophysics Geosystems 10: 1-15.

Urick, R.J. 1983. Principles of Underwater Sound. New York, New York: McGraw-Hill Book Company.

Technical questions or suggestion on User Spreadsheet: Please contact Amy Scholik-Schlomer (amy.scholik@noaa.gov)

UPDATES (will be posted when change results in the need to recalculate an isopleth; other non-substantive changes may be made periodically but will not result in a version number change)

Original Version	Updated Version	Change	Date Posted
1.0	1.1	Sheet A, error with formula for phocid pinniped	Aug. 22, 2016

A: STATIONARY SOURCE: Non-Impulsive, Continuous

VERSION: 1.1 (Aug-16)

KEY

(green)	Action Proponent Provided Information
(pink)	NMFS Provided Information (Acoustic Guidance)
(blue)	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	WETA Central Bay Facility
PROJECT/SOURCE INFORMATION Please include any assumptions	See Table A-1
PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)[¥]	2.5

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 43), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

* BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	150
Activity Duration (hours) within 24-h period	0.166666667
Activity Duration (seconds)	600
10 Log (duration)	27.78
Propagation (xLogR)	15
Distance of source level measurement (meters)[+]	10

[+]Unless otherwise specified, source levels are referenced 1 m from the source.

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*
Phocid pinnipeds (PW):true seals
Otariid pinnipeds (OW):sea lions and fur seals

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**0.4**	**0.0**	**0.6**	**0.2**	**0.0**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.05**	**-16.83**	**-23.50**	**-1.29**	**-0.60**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

A: STATIONARY SOURCE: Non-Impulsive, Continuous

VERSION: 1.1 (Aug-16)

KEY

(green)	Action Proponent Provided Information
(pink)	NMFS Provided Information (Acoustic Guidance)
(blue)	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	WETA Central Bay Facility
PROJECT/SOURCE INFORMATION Please include any assumptions	See Table A-1
PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)[¥]	2.5	

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 43), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	160
Activity Duration (hours) within 24-h period	0.170833333
Activity Duration (seconds)	615
10 Log (duration)	27.89
Propagation (xLogR)	15
Distance of source level measurement (meters)[+]	10

[+]Unless otherwise specified, source levels are referenced 1 m from the source.

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*
Phocid pinnipeds (PW):true seals
Otariid pinnipeds (OW):sea lions and fur seals

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**1.8**	**0.2**	**2.7**	**1.1**	**0.1**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.05**	**-16.83**	**-23.50**	**-1.29**	**-0.60**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a\,[1+(f/f_2)^2]^b}\right\}$$

A: STATIONARY SOURCE: Non-Impulsive, Continuous

VERSION: 1.1 (Aug-16)

KEY

(green)	Action Proponent Provided Information
(pink)	NMFS Provided Information (Acoustic Guidance)
(blue)	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	WETA Central Bay Facility
PROJECT/SOURCE INFORMATION	See Table A-1
Please include any assumptions	
PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)[¥]	2.5

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 43), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	170
Activity Duration (hours) within 24-h period	0.166666667
Activity Duration (seconds)	600
10 Log (duration)	27.78
Propagation (xLogR)	15
Distance of source level measurement (meters)[+]	10

[+]Unless otherwise specified, source levels are referenced 1 m from the source.

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*
Phocid pinnipeds (PW):true seals
Otariid pinnipeds (OW):sea lions and fur seals

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**8.2**	**0.7**	**12.2**	**5.0**	**0.4**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.05**	**-16.83**	**-23.50**	**-1.29**	**-0.60**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

A: STATIONARY SOURCE: Non-Impulsive, Continuous

VERSION: 1.1 (Aug-16)

KEY

(green)	Action Proponent Provided Information
(pink)	NMFS Provided Information (Acoustic Guidance)
(blue)	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	WETA Central Bay Facility
PROJECT/SOURCE INFORMATION	See Table A-1
Please include any assumptions	
PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)[¥]	2.5

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 43), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	175
Activity Duration (hours) within 24-h period	0.177777778
Activity Duration (seconds)	640
10 Log (duration)	28.06
Propagation (xLogR)	15
Distance of source level measurement (meters)[+]	10

[+]Unless otherwise specified, source levels are referenced 1 m from the source.

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*
Phocid pinnipeds (PW):true seals
Otariid pinnipeds (OW):sea lions and fur seals

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**18.5**	**1.6**	**27.4**	**11.3**	**0.8**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-0.05**	**-16.83**	**-23.50**	**-1.29**	**-0.60**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent)

VERSION: 1.1 (Aug-16)

KEY	
(green)	Action Proponent Provided Information
(pink)	NMFS Provided Information (Acoustic Guidance)
(blue)	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	WETA Central Bay Facility
PROJECT/SOURCE INFORMATION	See Table A-1
Please include any assumptions	
PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)[¥]	2

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 64), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD USING RMS SPL SOURCE LEVEL

Source Level (RMS SPL)	
Activity Duration (h) within 24-h period OR Number of piles per day	
Pulse Duration[Δ] (seconds)	
Number of strikes in 1 h OR Number of strikes per pile	
Activity Duration (seconds)	0
10 Log (duration)	#NUM!
Propagation (xLogR)	
Distance of source level measurement (meters)[+]	

[Δ]Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

[+]Unless otherwise specified, source levels are referenced 1 m from the source.

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*
Phocid pinnipeds (PW):true seals
Otariid pinnipeds (OW):sea lions and fur seals

RESULTANT ISOPLETHS*

*Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds)

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!

E.1-2: ALTERNATIVE METHOD (SINGLE STRIKE EQUIVALENT)

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	199.3

Source Level (Single Strike/shot SEL)	168
Number of strikes in 1 h OR Number of strikes per pile	450
Activity Duration (h) within 24-h period OR Number of piles per day	3
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)[+]	10

[+]Unless otherwise specified, source levels are referenced 1 m from the source.

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*
Phocid pinnipeds (PW):true seals
Otariid pinnipeds (OW):sea lions and fur seals

RESULTANT ISOPLETHS*

*Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds)

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	122.0	4.3	145.3	65.3	4.8

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.01	-19.74	-26.87	-2.08	-1.15

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent)

VERSION: 1.1 (Aug-16)

KEY	
(green)	Action Proponent Provided Information
(pink)	NMFS Provided Information (Acoustic Guidance)
(blue)	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	WETA Central Bay Facility
PROJECT/SOURCE INFORMATION	See Table A-1
Please include any assumptions	
PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)[¥]	2

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 64), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD USING RMS SPL SOURCE LEVEL

Source Level (RMS SPL)	
Activity Duration (h) within 24-h period OR Number of piles per day	
Pulse Duration[Δ] (seconds)	
Number of strikes in 1 h OR Number of strikes per pile	
Activity Duration (seconds)	0
10 Log (duration)	#NUM!
Propagation (xLogR)	
Distance of source level measurement (meters)[+]	

[Δ]Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

[+]Unless otherwise specified, source levels are referenced 1 m from the source.

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*
Phocid pinnipeds (PW):true seals
Otariid pinnipeds (OW):sea lions and fur seals

RESULTANT ISOPLETHS*

*Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!

E.1-2: ALTERNATIVE METHOD (SINGLE STRIKE EQUIVALENT)

Unweighted $SEL_{cum\ (at\ measured\ distance)} = SEL_{ss}$ + 10 Log (# strikes)	**200.8**

Source Level (Single Strike/shot SEL)	170
Number of strikes in 1 h OR Number of strikes per pile	600
Activity Duration (h) within 24-h period OR Number of piles per day	2
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)[+]	10

[+]Unless otherwise specified, source levels are referenced 1 m from the source.

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*
Phocid pinnipeds (PW):true seals
Otariid pinnipeds (OW):sea lions and fur seals

RESULTANT ISOPLETHS*

*Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	153.3	5.5	182.6	82.0	6.0

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.01	-19.74	-26.87	-2.08	-1.15

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

E.1: IMPACT PILE DRIVING (STATIONARY SOURCE: Impulsive, Intermittent)

VERSION: 1.1 (Aug-16)

KEY	
(green)	Action Proponent Provided Information
(pink)	NMFS Provided Information (Acoustic Guidance)
(blue)	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	WETA Central Bay Facility
PROJECT/SOURCE INFORMATION Please include any assumptions	See Table A-1
PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)[¥]	2

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 64), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

* BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: Choose either E1-1 OR E.1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD USING RMS SPL SOURCE LEVEL

Source Level (RMS SPL)	
Activity Duration (h) within 24-h period OR Number of piles per day	
Pulse Duration[Δ] (seconds)	
Number of strikes in 1 h OR Number of strikes per pile	
Activity Duration (seconds)	0
10 Log (duration)	#NUM!
Propagation (xLogR)	
Distance of source level measurement (meters)*	

[Δ]Window that makes up 90% of total cumulative energy (5%-95%) based on Madsen 2005

*Unless otherwise specified, source levels are referenced 1 m from the source.

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*
Phocid pinnipeds (PW): true seals
Otariid pinnipeds (OW): sea lions and fur seals

RESULTANT ISOPLETHS*

*Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!

E.1-2: ALTERNATIVE METHOD (SINGLE STRIKE EQUIVALENT)

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	203.8

Source Level (Single Strike/shot SEL)	173
Number of strikes in 1 h OR Number of strikes per pile	600
Activity Duration (h) within 24-h period OR Number of piles per day	2
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)*	10

*Unless otherwise specified, source levels are referenced 1 m from the source.

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*
Phocid pinnipeds (PW): true seals
Otariid pinnipeds (OW): sea lions and fur seals

RESULTANT ISOPLETHS*

*Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	243.0	8.6	289.4	130.0	9.5

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.01	-19.74	-26.87	-2.08	-1.15

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a\,[1+(f/f_2)^2]^b}\right\},$$

WEIGHTING FACTOR ADJUSTMENTS (WFA) **VERSION: 1.1 (Aug-16)**

Numerical criteria presented in the Technical Guidance consist of both an acoustic threshold and auditory weighting function associated with the SELcum metric. NMFS recognizes that the implementation of marine mammal weighting functions represents a new factor for consideration, which may extend beyond the capabilities of some action proponents. Thus, NMFS has developed simple weighting factor adjustments (WFA) for those who cannot fully apply auditory weighting functions associated with the SELcum metric.

WFAs consider marine mammal auditory weighting functions by focusing on a single frequency. This will typically result in similar, if not identical, predicted exposures for narrowband sounds or higher predicted exposures for broadband sounds, since only one frequency is being considered, compared to exposures associated with the ability to fully incorporate the Technical Guidance's weighting functions.

WFAs have the advantage of allowing everyone to use the same acoustic thresholds and allows for adjustments to be made for each hearing group based on source-specific information.

For Narrowband Sounds: The selection of the appropriate frequency for consideration associated with WFAs is fairly straightforward. WFAs for a narrowband sound would take the weighting function amplitude, for each hearing group, associated with the particular frequency of interest and use it to make an adjustment to better reflect the hearing's group susceptibility to that narrowband sound.

For Broadband Sounds*: The selection of the appropriate frequency for consideration associated with WFAs is more complicated. The selection of WFAs associated with broadband sources is similar to the concept used for to determine the 90% total cumulative energy window (5 to 95%) for consideration of duration associated with the RMS metric and impulsive sounds (Madsen 2005) but considered in the frequency domain, rather than the time domain. This is typically referred to as the 95% frequency contour percentile (Upper frequency below which 95% of total cumulative energy is contained; Charif et al. 2010).

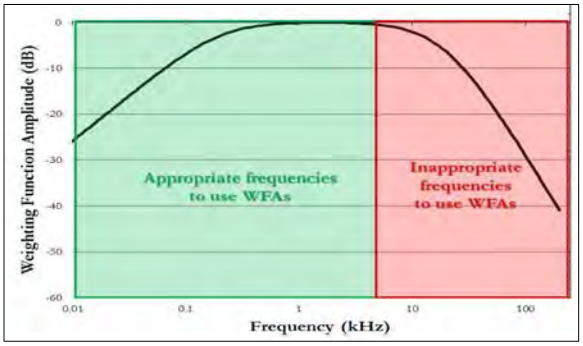
* Special Considerations for Broadband Sounds: Since the intent of WFAs is to broadly account for auditory weighting functions below the 95% frequency contour percentile, it is important that only frequencies on the "left side" of the weighting function be used to make adjustments (i.e., frequencies below those where the weighting function amplitude is zero or below where the function is essentially flat; resulting in every frequency below the WFA always having a more negative amplitude than the chosen WFA) (Figure below). It is inappropriate to use WFAs for frequencies on the "right side" of the weighting function (i.e., frequencies above those where the weighting function amplitude is zero). For a frequency on the "right side" of the weighting function (Table below), any adjustment is inappropriate and WFAs cannot be used (i.e., an action proponent would be advised to not use weighting functions and evaluate its source as essentially unweighted; see "Use" frequencies in Table below, which will result in a weighting function amplitude of 0 dB).

TABLE

Hearing Group	Applicable Frequencies	Non-Applicable Frequencies*
Low-Frequency Cetaceans (LF)	4.8 kHz and lower	Above 4.8 kHz (Use: 1.7 kHz)
Mid-Frequency Cetaceans (MF)	43 kHz and lower	Above 43 kHz (Use: 28 kHz)
High-Frequency Cetaceans (HF)	59 kHz and lower	Above 59 kHz (Use: 42 kHz)
Phocid Pinnipeds (PW)	11 kHz and lower	Above 11 kHz (Use: 6.2 kHz)
Otariid Pinnipeds (OW)	8.5 kHz and lower	Above 8.5 kHz (Use: 4.9 kHz)

* With non-applicable frequencies, user should input the "use" frequency in the User Spreadsheet, which will result in a weighting function amplitude/adjustment of 0 dB (i.e., unweighted). NOTE: "use" frequency is only appropriate for that particular hearing group. Thus, if unweighted isopleths are required for more than one hearing group, users will need to provide multiple spreadsheets supporting isopleths (i.e., separate spreadsheets for each different WFA used).

FIGURE



Example weighting function illustrating where the use of weighting function adjustments are (Green: "left side") and are not (Red: "right side") appropriate for broadband sources.

Appendix B
Proposed Hydroacoustic Monitoring Plan

SAN FRANCISCO BAY AREA
WATER EMERGENCY TRANSPORTATION AUTHORITY
CENTRAL BAY OPERATIONS AND MAINTENANCE FACILITY PROJECT

UNDERWATER ACOUSTIC MONITORING PLAN

Prepared for:
San Francisco Bay Area Water Emergency Transportation Authority
and
Power Engineering Construction Co.
1501 Viking Street, Suite 200 I, Alameda

Prepared by:
ILLINGWORTH & RODKIN, INC.
Acoustics • Air Quality
423 4th Street, Suite S1W
Marysville, California   95901

Updated by:

AECOM
300 Lakeside Drive, Suite 400
Oakland, CA   94612

June~~April~~ 2017

INTRODUCTION

The San Francisco Bay Area Water Emergency Transportation Authority (WETA) is constructing the Central Bay Operations and Maintenance Facility at Alameda Point in Alameda, California. The Operations and Maintenance Facility will serve as the Central San Francisco Bay base for WETA's ferry fleet, and will include the Operations Control Center and Emergency Operations Center. The project site is in the Alameda Naval Air Station Base Realignment and Closure area (now referred to as Alameda Point) in the City of Alameda, Alameda County, California (Figure 1). WETA is the lead planning agency and local public agency for the Project. Pile driving is scheduled to occur in 2017. All in-water construction will be limited to the period between August 1 and November 30.

Figure 1 - Vicinity Map Showing Location of Central Bay Maintenance Facility

The Central Bay Operations and Maintenance Facility will be situated southeast of the intersection of West Hornet Avenue and Ferry Point Road near Pier 3 along the Alameda waterfront in Central San Francisco Bay. The new facility will occupy approximately 0.36 acre of landside space and 1 acre of waterside space in San Francisco Bay. It will provide berthing space for boats, maintenance services (such as fueling, engine oil changes, spare parts storage, and concession supply), and light repair facilities for WETA's Central San Francisco Bay ferry fleet. As WETA's Operations Control Center, the facility will also provide a centralized location for day-to-day management and oversight of services and crews.

The prosed project can be broken down into two phases, the first consisting of work on land or landside Project Elements and the second being the in-water work or Waterside Project Elements. This monitoring plan only addresses the pile driving in-water work needed to support the waterside elements of the project.

The waterside facilities consist of berthing slips for as many as 12 passenger ferries and associated gangway structures. Construction of the waterside facilities will be performed with support and material barges, work boats, a barge-mounted pile driver, a wheeled crane, a support boat, and an occasional tug. Both an impact hammer and a vibratory hammer will be used to install new piles, and a vibratory hammer will be used to remove temporary piles.

The project proposes to drive 29 permanent piles in the water, as well as 20 temporary piles that will be removed prior to the completion of construction.

This monitoring plan addresses underwater acoustic monitoring that is proposed as part of this project. Monitoring would be conducted by placing hydrophones in the water at set distances from impact pile driving. The plan addresses the frequency of monitoring, positions that hydrophones would be deployed, techniques for gathering and analyzing acoustic data, quality control measures, and proposed reporting activities.

PROJECT AREA

The project location is in San Francisco Bay, north of the Oakland San Francisco Bay Bridge (United States Geological Survey Hydrologic unit 18050004).

The project site is near Pier 3 of the Naval Air Station Base Realignment and Closure area known as Alameda Point (see map below) and includes development of approximately 1 acre of landside property and 0.5 acre in San Francisco Bay.

The water depth in the project area ranges from zero during lower tides to about 50 feet deep, and is subject to tidal currents. The Alameda Breakwater partially encloses Alameda Harbor, in which the project area is located, as shown in the vicinity map (Figure 1).

PERMIT/ESA CONDITIONS

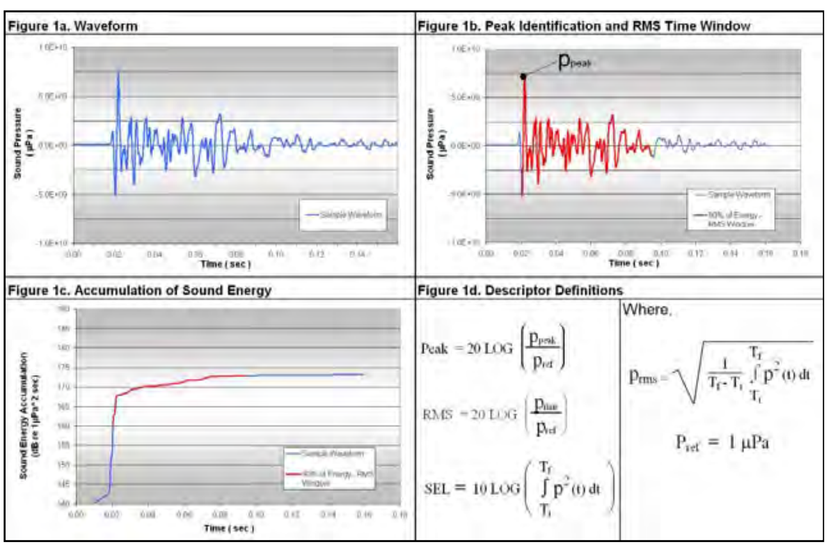
WETA understands that National Oceanic and Atmospheric Administration (NOAA)/National Marine Fisheries Service (NMFS), the San Francisco Bay Conservation and Development Commission (BCDC), and the United States Fish and Wildlife Service (USFWS) expect proposed sound mitigation measures and an Underwater Acoustic Monitoring Plan (Plan) for pile-driving activities anticipated for this project. These mitigation measures and the Plan would meet the requirements outline in the USFWS Biological Opinion 08ESMFF00-2012-F-0229, the NMFS Incidental Harassment Authorization, the NMFS Biological Opinion 2011/05520, and the BCDC permit 2014.002.00. The Plan is based on the dual metric criteria that include:

- Establish the distance to the 206-decibel (dB) peak sound pressure criteria;
- Establish field locations that will be used to document the extent of the area experiencing 187 dB cumulative sound exposure level (cSEL) for fish larger than 2 grams and 183 dB cSEL for smaller fish;
- Establish the underwater behavioral zone of 150-dB root mean square (RMS) for fish;
- Verify the extent of Level A harassment zones for marine mammals; and
- Verify the attenuation provided by bubble curtains.

UNDERWATER SOUND DESCRIPTORS

Several noise metrics are used to describe sounds in the environment (Figure 2). Two common descriptors used to describe underwater sounds from pile installation projects or other noise sources are the peak sound pressure level (SPL) and the RMS SPL. The peak SPL is the instantaneous maximum of the absolute positive or negative pressure and is presented in this report as a dB value referenced to 1 microPascal (dB re: 1 µPa). The RMS SPL is also presented in dB re: 1 µPa and is the maximum RMS averaged over 35 milliseconds of the pulse. This RMS value is referred to as the RMS_{imp} and is measured using the standard impulse setting on a Sound Level Meter (SLM) meeting American National Standards Institute (ANSI) Standard S1.4-1983 standards for a Type 1 Precision SLM. Another RMS value is the RMS averaged over the duration of the pulse containing 90 percent of the energy where the first and last 5 percent of the energy is excluded. This value is referred to as the $RMS_{90\%}$. An additional measure describing the pressure waveform is the sound exposure level (SEL), a common unit of

Figure 2 - Characteristics of Underwater Impact Pile-Driving Pulse



sound energy used in airborne acoustics to describe short-duration events. The unit is dB referenced at 1 microPascal squared- second (dB re: $1\mu Pa^2$-sec). The total sound energy in an impulse accumulates over the duration of the impulse and is referred to as the $SEL_{\text{single strike}}$. The cSEL is the logarithmic sum of the $SEL_{\text{single strike}}$ for all pile strikes that were used to install the pile. It can be estimated by the equation shown in *Eq. 1*:

$$cSEL = SEL_{\text{single strike}} + 10 \log (\text{\# of pile strikes}) \qquad \{Eq.\ 1\}$$

The sound levels described are measured over the frequency range of 20 to 20,000 hertz. Note that sound levels described are considered "unweighted," which means that there is no frequency weighting to account for the sensitivity of different species to different frequency ranges.

PILE INSTALLATION LOCATION

The WETA Central Bay Operations and Maintenance Facility Project includes the installation of guide piles, fender piles, and donut piles for the new berthing slips. Table 1 describes the piles that are anticipated for this in-water construction. Twenty-nine steel shell piles ranging from 24-inch-diameter to 42-inch-diameter would be driven in water as part of this construction. Additionally, 20 temporary H-piles will be driven with a vibratory driver to provide a template during construction. These H-piles will be removed with a vibratory driver prior to the completion of construction.

Table 1 - Piles Associated with Construction Activities

Location	Quantity	Size (inches)	Top of Pile (feet)	Estimated Pile Tip Elevation (feet)
Float Guide Piles	15	42	+25	-105 to -125
Dolphin Piles	8	24	+25	-85 to -105
Donut Piles	6	36	+25	-85 to -105
Temporary Template Piles	20	14	+25	-25

PILE-DRIVING ACTIVITIES

WETA anticipates using a combination of vibratory and impact hammers to install the steel shell piles. Piles will initially be installed using a vibratory driver. An impact pile driver would be necessary to complete pile driving for driving in harder substrates or to provide engineering information (e.g., blow counts for engineering considerations).

Several measures to minimize acoustic impacts from pile driving would be incorporated into construction plans. These include the following:

- In-water work activities will be between August 1 and November 30. This is outside of the peak juvenile outmigration period for federally listed fish species.

- A vibratory pile driver will be used when feasible. Use of bubble curtains is not required with a vibratory pile driver.

- Sound levels will be monitored. Real-time sound data will be used to adjust bubble curtains, if necessary, to minimize underwater noise from impact pile driving.

- Noise Attenuation System. An air bubble curtain, or similar system, shall be properly placed around all in-water piles during impact hammer pile driving activities to effectively attenuate underwater sound levels. Examples of potentially effective systems include a confined air bubble curtain, dewatered casing, multi-stage air bubble curtains system, or encapsulated bubble curtain demonstrated to effectively reduce underwater sound. These systems will be employed in water 1 meter (3.3 feet) or deeper.

- Hydroacoustic Monitoring. Underwater sound measurements would be conducted and reported on a bi-weekly basis to monitor compliance with injury and behavior acoustic thresholds.

A detailed pile-driving schedule has not been developed for the project, so it is not possible to show which piles will be monitored.

ACOUSTIC MONITORING EVENTS

In-Water Pile Driving

A minimum of five piles of each size and type of piles to be driven will be monitored. Piles chosen to be monitored will be representative of the different sizes and range of typical water depths at the project location where piles will be driven with an impact hammer. This would include five of the 36-inch-diameter donut piles, five of the 42-inch-diameter guide piles; and five of the 24-inch-diameter dolphin piles.

Hydrophones will be placed at mid-depth or at least 1 meter (3.3 feet) below the surface. Two hydrophones will be used to assist in calculating the transmission loss over distance. Depths during in-water pile driving for the project are expected to range from < 3 meters (10 feet) to approximately 11 meters (36 feet). The primary hydrophone will be placed 10 meters (33 feet) from the pile being driven. A second hydrophone will be placed approximately 20 to 30 meters from the same pile being driven. At WETA's discretion, a third hydrophone may be deployed for some piles to better define the acoustic propagation rate over longer distances (i.e., greater than 50 meters). Hydrophones will be located with a clear acoustic line of sight between the pile and the hydrophone.

Note that hydroacoustic measurements are not proposed during vibratory pile driving events.

Once the underwater acoustic measurements are conducted during initial pile driving, the sizes of the exclusion zones and zone of influence shall be adjusted only if the measured exclusion zones and zone of influence are larger than modeled zones.

ACOUSTIC MONITOR REQUIREMENTS

The acoustic monitoring contractor will have appropriate qualifications, which include a minimum of a bachelor's degree in a related field[1] and 3 years of experience in noise monitoring and analysis. The contractors' proposed sound level monitoring equipment shall meet the specifications shown in Table 2. In addition to the equipment selection, quality control/quality assurance procedures identified in this plan will be implemented (e.g., how will system responses be verified and how will data be managed).

Table 2. Sample Equipment for Underwater Sound Monitoring

Item	Specifications	Quantity	Usage
Hydrophone	Receiving Sensitivity – 211 dB ±3 dB re 1V/μPa	2	Capture underwater sound pressures and convert to voltages that can be recorded/analyzed by other equipment.
Signal Conditioning Amplifier	Amplifier Gain – 0.1 mV/pC to 10 V/pC Transducer Sensitivity Range – 10^{-12} to 10^{3} C/MU	2	If necessary, used to adjust signals from hydrophone to levels compatible with recording equipment.
Calibrator (pistonphone-type)	Accuracy – IEC 942 (1988) Class 1	1	Calibration check of hydrophone in the field.
Sound Level Meter and Digital Recorder	ANSI S1.4-1983 Type 1 SLM Sampling Rate – >48 kilohertz	2 SLMs 2 DR	SLMs measure and DR records data.
Laptop computer	Compatible with digital analyzer	1	Store and analyze digital data
Post-analysis	Real time Analyzer-	1	Monitor real-time signal and post-analysis of sound signals.

To facilitate further analysis of data full bandwidth, time-series underwater signal shall be recorded, preferably as a ~~text file (.txt),~~ wave file (.wav)~~,~~ or similar format. Recorded data shall not use data compression algorithms or technologies (e.g., MP3 or compressed.wav).

[1] This can include Institute of Noise Control Engineering of the USA certification or related fields such as acoustics, physics, oceanography, geology, or other physical sciences that have required coursework in physics.

METHODOLOGY

Hydrophone Positions

Hydroacoustic monitoring will be conducted for a minimum of five piles of each type and size of in-water piles struck with an impact hammer. Piles chosen to be monitored will be representative of the different sizes and range of typical water depths at the project location where piles will be driven. One hydrophone will be placed at mid-water depth at the nearest distance, approximately 10 meters, from each pile being monitored. An additional hydrophone will be placed at mid-water depth at a distance of 20 to 50 meters from the pile to provide two sound-level readings during ambient and pile driving conditions. A third hydrophone may be deployed at a greater distance (e.g., 100 meters or further) for the purpose of better defining the long-distance sound propagation.

A weighted tape measure will be used to determine the depth of the water. The hydrophones will be attached to a nylon cord or a steel chain if the current is swift enough to cause strumming of the line. One end of the nylon cord or chain will be attached to an anchor that will keep the hydrophone at the specified distance from the pile. The opposite end of the nylon cord or chain will be attached to a float or tied to a static line at the surface at the specified recording distance from the pile. The distance will be measured by a tape measure, where possible, or a range finder. To the extent practicable, there will be a direct line of sight between the pile and the hydrophones.

Underwater sound levels will be continuously monitored during the entire duration of each pile being driven. The peak, RMS (impulse level), and SEL level of each strike will be monitored in real time. The cSEL will also be monitored live, assuming no contamination from other noise sources. Sound levels will be measured in dB re: 1 µPa.

Prior to and during the pile-driving activity, environmental data will be gathered, including but not limited to wind speed and direction, air temperature, water depth, wave height, weather conditions, and other factors (e.g., aircraft or boats) that could contribute to influencing the underwater sound levels. The start and stop time of each pile driving event will be recorded.

Ambient underwater sound levels will be measured for a minimum of 1 minute in the absence of construction activities, to determine background levels. Ambient levels will be reported as RMS and include a spectral analysis of the frequencies.

When collecting sound measurements in an area with tidally influenced currents, appropriate measures will be taken to ensure that the flow-induced noise at the hydrophone will not interfere with the recording and analysis of the relevant sounds. As a general rule, current speeds of 1.5 meters/second (2.9 knots) or greater are expected to generate substantial flow-induced noise, which may interfere with the detection and analysis of low-level sounds, such as the sounds from a distant pile driver or background sounds. If it becomes necessary to reduce the flow-induced noise at the hydrophone, a flow shield will be described and installed around the hydrophone to provide a barrier between the irregular, turbulent flow and the hydrophone.

Quality Control

Calibration of measurement systems will be established prior to use in the field each day. An acoustical piston phone and hydrophone coupler will be used supported by manufacturer calibration certificates. Calibration of measurement systems will be established using an acoustically certified piston phone and hydrophone coupler that fits the hydrophone and that directly calibrates the measurement system. The volume correction of the hydrophone coupler using the hydrophone is known, so that the piston phone produces a known signal that can be compared against the measurement system response. The response of the measurement system will be noted in the field book and applied to all measurements.

The SLMs will be calibrated or checked to the calibration tone prior to use in the field. The tone will then be measured by the SLM and recorded on to the beginning of the digital audio recordings that will be used. The system calibration status will be checked by measuring the calibration tone and recording the tones. The recorded calibration tones will be used for subsequent detailed analyses of recorded pile strike sounds. National Institute of Standards and Technology traceable calibration forms will be provided for all relevant monitoring equipment. Prior to the initiation of pile driving, the hydrophone will be placed at the appropriate distance and depth, as described above.

Field Data

The onsite inspector/contractor will inform the acoustics specialist when pile driving is about to start, to ensure that the monitoring equipment is operational. Underwater sound levels will be continuously monitored during the entire duration of each selected pile being driven, with a minimum one-third octave band frequency resolution. The broadband instantaneous absolute peak pressure and SEL values of each strike and the daily cSEL should be monitored in real time during construction to evaluate whether the project exceeds its authorized take level. Peak and RMS pressures will be reported in dB re:1 µPa. SEL will be reported in dB re: 1 $\mu Pa^2 \cdot sec$.

Wideband time series recording is strongly recommended during all impact pile driving.

Prior to and during the pile driving activity, environmental data will be gathered, such as water depth and tidal level, wave height, and other factors that could contribute to influencing the underwater sound levels (e.g., aircraft and boats). The start and stop time of each pile driving event and the time at which the bubble curtain or functional equivalent[2] is turned on and off will be logged.

The contractor will provide the following information, in writing, to the contractor conducting the hydroacoustic monitoring for inclusion in the final monitoring report: a description of the substrate composition, approximate depth of significant substrate layers, hammer model and size, pile cap or cushion type, hammer energy settings, and any changes to those settings during the piles being monitored, depth pile driven, blows per foot for the piles monitored, and total number of strikes to drive each pile that is monitored.

Sound Attenuation Monitoring

An approved noise attenuation system will be in use during all in-water impact driving. Testing of this system, in terms of turning the system off during pile driving, is not anticipated.

SIGNAL PROCESSING

Post-analysis of the underwater pile driving sounds will include:

- The number of pile strikes per pile and per day;
- For each recorded strike (or each strike from a subset), determination of the following:
  - The peak pressure, defined as the maximum absolute value of the instantaneous pressure (overpressure or underpressure);
  - The RMS sound pressure across 90 percent of the pile strike's acoustic energy ($RMS_{90\%}$) or $RMS_{impulse}$[3];
  - The pulse duration for the computation of the ($RMS_{90\%}$); and
  - SEL, measured across the accumulated sound energy during the pile strike;
- The maximum, mean, and range of the peak pressure with and, if applicable, without attenuation;
- The maximum, mean, range, and Cumulative Distribution Function (CDF) of the $RMS_{90\%}$, both with and, if applicable, without attenuation where the CDF is used to report the percentage of $RMS_{90\%}$ or $RMS_{impulse}$ values above the thresholds;

[2] A functional equivalent must function as well as or better than the attenuation device that was proposed during consultation or required by the Endangered Species Act (ESA) consultation or applicable permits. It must achieve sound level reductions the same as or better than those that were used in the calculations during ESA consultation or the permitting process.

[3] Analysis of the data from the San Francisco-Oakland Bay Bridge Pile Installation Demonstration project indicated that 90 percent of the acoustic energy for most pile-driving impulses occurred over a 50- to 100-millisecond period, with most of the energy concentrated in the first 30 to 50 milliseconds.

- The maximum, mean, and range of cumulative 187-and 183-dB SEL, both with and, if applicable, without attenuation; and

- The accumulated SEL across all of the pile strikes for each pile measured. If SEL is to be calculated based on the number of strikes, accumulated SEL is estimated as follows: cSEL = SEL_{mean} + 10*log (total # strikes).

REPORTING

Preliminary results for the daily monitoring activities, if required, will be submitted/reported to the primary point of contact for WETA within 24 hours after monitoring concludes for the day. A bi-weekly report that includes summarized hydroacoustic data from all monitoring locations will be submitted to WETA and designated NOAA/NMFS staff. Within 90 days of the completion of hydroacoustic monitoring, a Hydroacoustic Monitoring Report will be prepared and submitted to WETA and NOAA/NMFS. The results will be summarized in tabular and graphical form and will include summary statistics and time histories of impact sound values for each pile. If comments are received, a final report will be prepared and submitted within 30 days following receipt of comments on the draft report. The report shall include:

1. Size and type of piles;
2. A detailed description of the noise attenuation device, including design specifications;
3. ~~The impact hammer energy rating used to drive the piles, and T~~The make and model of the hammer and the output energy;

The physical characteristics of the bottom substrate into which the piles were driven~~;~~

4. ;
5. The depth of water in which the pile was driven;
~~3.~~6. The depth into the substrate that the pile was driven;
~~4.~~7. A description of the sound monitoring equipment;
~~5.~~8. The distance between hydrophones and pile;
~~6.~~9. The depth of the hydrophones and depth of water at hydrophone locations;
~~7.~~10. The distance from the pile to the water's edge;
~~8. The depth of water in which the pile was driven;~~
~~9. The depth into the substrate that the pile was driven;~~
~~10.~~1. ~~The physical characteristics of the bottom substrate into which the piles were driven;~~
11. The total number of strikes to drive each pile and for all piles driven during a 24-hour period;
12. The results of the hydroacoustic monitoring, as described under Signal Processing (an example table is provided in Figure 3 for reporting the results of the monitoring);
13. The distance at which peak, cumulative SEL, and RMS values exceed the respective threshold values; and
14. A description of any observable fish, marine mammal, or bird behavior in the immediate area and, if possible, correlation to underwater sound levels occurring at that time.

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Figure 3 – Example Table for Required Information for Reporting the Results of Hydroacoustic Monitoring of Pile Driving

Date and Time	Pile ID	Impact Hammer	# Strikes	Distance to Pile from Hydrophone (m)	Water Depth (m)		Peak (dB)		$SEL_{90\%}$ (dB)			$RMS_{90\%}$ (dB)		Notes
					At Pile	At H-phone	Max	Mean	Max	Mean	$cSEL_{90\%}$	Max	Mean	

Appendix C
Proposed Marine Mammal Monitoring Plan

MARINE MAMMAL MONITORING PLAN
CENTRAL BAY OPERATIONS AND MAINTENANCE FACILITY PROJECT

Marine mammal monitoring will be implemented during pile driving associated with the Central Bay Operations and Maintenance Facility Project (or project), as detailed in this Marine Mammal Monitoring Plan (plan).

1.0 PURPOSE OF THE MONITORING PLAN

The purpose of this plan is to establish procedures to ensure compliance with authorization requirements, thereby recording Level A harassment as authorized for Pacific harbor seal, avoiding ~~slight and serious injury (~~ Level A harassment~~)~~ of other marine mammals and minimizing behavioral disturbance (Level B harassment) to the extent practicable. Serious injury or l~~L~~ethal take of marine mammals is not expected to occur as a part of this project.

The objectives of the monitoring plan are to:

- Establish parameters to monitor site locations for the disturbance of marine mammals during the construction activities;
- Record Level A harassment of harbor seals to ensure that the authorized amount is not exceeded;
- Avoid injury to other marine mammal species through visual monitoring of identified zones of influence (e.g., zones where Level A harassment criteria may be exceeded), and provide ancillary observations of marine mammals in adjacent work areas;
- Ensure that coordination with the acoustic monitoring team occurs during pile driving to modify zones of influence related to noise thresholds for fish and marine mammals, if needed and approved by the National Marine Fisheries Service (NMFS); and
- Describe field operations to obtain data as follows:
  - Make daily observations and record presence or absence of marine mammals;
  - Record marine mammal behavior observations; and
  - Establish/confirm threshold distances delineated in the Incidental Harassment Authorization (IHA) request.

2.0 OVERVIEW OF PROJECT ACTIVITIES AND PROJECT LOCATION

The San Francisco Bay Area Water Emergency Transportation Authority (WETA) is constructing an operations and maintenance facility in Alameda Harbor to support existing and future planned water transit services operated on San Francisco Bay by WETA and WETA's emergency operations. The project area and vicinity are shown on Figure 1.

The project will provide berthing slips for as many as 12 vessels, with limited berthing capacity for vessels in transit. The floating docks will also provide access for the loading and offloading of sundries, the removal of waste, and the installation of parts and equipment required for regular maintenance and service. Although no regular passenger loading is anticipated at this site, berths will be capable of loading and unloading passengers in the event of an emergency. The marine facility will also provide diver platforms for underwater inspections, one boom reel assembly for spill containment, a 25-foot skiff, and one crane for vessel maintenance. Table 1 provides a summary of the pile driving that will be needed to construct the facility.

Table 1
Summary of Pile Removal and Installation

Project Element	Pile Diameter	Pile Type	Method	Total Number of Piles/Driving Days
Float Guide Pile Installation	42 inches	Steel Pipe	Impact Driver, 60025 blows/pile **OR** Vibratory Driver, 320 seconds/pile	15 piles/8 days (2 piles per day)
Donut Pile Installation	36 inches	Steel Pipe	Impact Driver, 600 blows/pile **OR** Vibratory Driver, 300 seconds/pile	6 piles/3 days (2 piles per day)
Dolphin Pile Installation	24 inches	Steel Pipe	Impact Driver, 450 blows/pile **OR** Vibratory Driver, 205 seconds/pile	8 piles/3 days (3 piles per day)
Template Pile Installation and Extraction	14 inches	Steel H-piles	Vibratory Driver, 120 seconds/pile	20 piles/84 days (5 piles per day, installation and extraction

2.1 Species that Could Be Affected

As described in detail in Section 3 of the IHA application, seven species of marine mammals could be affected by project construction activities: Pacific harbor seal, California sea lion, harbor porpoise, gray whale, northern elephant seal, northern fur seal, and bottlenose dolphin.

2.2 Description of Activities that May Result in Take

Construction of the project improvements requires pile driving. Pile driving for the project would include impact or vibratory pile driving associated with construction of the berthing structures. All permanent piles would be steel shell piles, as described in Table 1. Underwater sound and acoustic pressure resulting from pile driving could affect marine mammals by causing behavioral avoidance of the construction area (Level B harassment) and/or injury to sensitive species (Level A harassment). Activities are not anticipated to result in lethal take or serious injury of marine mammals.

For pile removal and driving, distances from pile-driving activities where marine mammals could be impacted are described in Tables 2 and 3; additional detail can be found in Section 7 of the of the IHA application. It is anticipated that, due to the conservative nature of the calculations used to estimate the Level B zone, the actual area of Level B harassment is likely much smaller than what is presented below in Table 3.

For all species with the exception of Pacific harbor seal, aAreas where Level A thresholds could be exceeded are considered the exclusion zones and therefore work shutdown zones. For these species, nNo pile driving activities will occur if an animal is an exclusion zone. Because Level A take will be authorized for Pacific harbor seal, pile driving may continue when animals enter the Level A zone, and Level A take will be recorded by the marine mammal observers (MMOs). To simplify monitoring, three exclusion zones will be established ~~based on the Level A harassment zones~~ for the various hearing groups: one for otariids and mid-frequency cetaceans (i.e., California sea lion, northern fur seal, and bottlenose dolphin); one for ~~phocids (i.e., Pacific harbor seal and~~ northern elephant seal~~)~~; and one for all other cetaceans (i.e., gray whale and harbor porpoise). Values were rounded up to values that will be more easily implemented during monitoring. See Table 4 for a summary of these exclusion zones. Additionally, as a conservative measure, a 30-meter exclusion zone will be maintained for harbor seal regardless of the Level A take authorization. If the authorized number of Level A take for harbor seals is reached, the exclusion (shutdown zone) for harbor seals will revert back to the calculated Level A zone. See Figure~~s~~ 2 ~~through 5~~ for the exclusion zones.

Table 2
Expected Pile-Driving Noise Levels and Distances of Level A Threshold Exceedance with Impact and Vibratory Driver

Project Element Requiring Pile Installation	Source Levels at 10 meters[1] (dB)		Distance to Level A Threshold[2], in meters[3]				
	Peak[4]	cSEL	Phocids	Otariids	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans
42-Inch Steel Piles – Vibratory Driver	185	175	11	1.0	19	2	27
42-Inch Steel Piles – Impact Driver (BCA)	~~198~~200	17~~0~~3	~~84~~130	~~6~~9	~~158~~243	~~6~~9	~~188~~289
36-Inch Steel Piles – Vibratory Driver	180	170	5.0	< 1.0	8	1	12
36-Inch Steel Piles – Impact Driver (BCA)	200	173	130	9	243	9	289
24-Inch Steel Piles – Vibratory Driver	183	160	1	< 1.0	2	< 1.0	3
24-Inch Steel Piles – Impact Driver (BCA)	193	167	56	4	105	4	125
14-Inch H-piles – Vibratory Driver	165	150	< 1.0	< 1.0	< 1.0	< 1.0	1
14-Inch H-piles – Vibratory Extraction	165	150	< 1.0	< 1.0	< 1.0	< 1.0	1

Notes:
[1] Source levels taken from Caltrans, 2015a; a 10-dB reduction was assumed for impact driving due to the BCA.
[2] Level A thresholds are based on the NMFS 2016 Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing; cSEL threshold distances are shown. See footnote 3 below.
[3] Where noise will not be blocked by land masses or other solid structures.
[4] All distances to the peak Level A thresholds are less than 10 meters.

Distances are rounded to the nearest meter or to "<1.0" for values less than 1 meter.

BCA will be used during impact driving of steel piles.

Peak and cSEL are re: 1 µPa and 1 µPa^2-sec, respectively.

BCA = bubble curtain attenuation
cSEL = cumulative sound exposure level
dB = decibels
µPa = microPascal
NMFS = National Marine Fisheries Service

Table 3
Expected Pile-Driving Noise Levels and Distances of Level B Threshold Exceedance with Impact and Vibratory Driver

Project Element Requiring Pile Installation	Source Levels at 10 meters[1] (dB)		Distance to Level B Threshold, in meters[2]	Area of Potential Level B Threshold Exceedance in Square Kilometers
	Peak	RMS	160/120 dB RMS (Level B)[3]	
42-Inch Steel Piles – Vibratory Driver	185	175	46,416	12.97
42-Inch Steel Piles – Impact Driver (BCA)	198200	1835	464341	0.410.27
36-Inch Steel Piles – Vibratory Driver	180	170	21,544	12.97
36-Inch Steel Piles – Impact Driver (BCA)	200	183	341	0.2713
24-Inch Steel Piles – Vibratory Driver	183	160	4,642	4.92
24-Inch Steel Piles – Impact Driver (BCA)	193	180	215	0.13
14-Inch H-piles – Vibratory Driver	165	150	1,000	1.01
14-Inch H-piles – Vibratory Extraction	165	150	1,000	1.01

Notes:
1 Source levels taken from Caltrans 2015; assume a 10-dB reduction in sound levels due to the use of a bubble curtain for impact driving.
2 Where noise will not be blocked by land masses or other solid structures.
3 For underwater noise, the Level B harassment (disturbance) threshold is 160 dB for impulsive noise and 120 dB for continuous noise.
BCA will be used during impact driving of steel piles resulting in a reduction of 10 dB from the original source levels.
Peak and RMS are re: 1 µPa.
BCA = bubble curtain attenuation
dB = decibels
RMS = root mean square

Table 4
Level A Harassment – Exclusion (Shut-Down) Monitoring Zones in Meters[1]

Hearing Groups	Impact Pile Driving – All Pile Types (meters) 24-Inch Steel Piles 36-Inch Steel Piles 42-Inch Steel Piles	Vibratory Driving – All Pile Types (meters)
Pacific Harbor Seal (Phocid)s	6530[2] 85 85	1530
Northern Elephant Seal (Phocid)	130	30
Otariids and Dolphins	1030 10	1030

	10	
Cetaceans	150300 200 200	30

Notes:

[1] Exact values of the Level A Zones have been rounded up to easily identifiable values for purposes of monitoring.

[2] A minimum shut down zone of 30 meters is established for Pacific harbor seal, in the event that all Level A take authorized for this species is used, an exclusion zone of 130 meters for 42- and 36 -nch piles, and an exclusion zone of 60 meters for 24-inch piles will be used for the remainder of impact pile driving.

3.0 MARINE MAMMAL MONITORING

Two ~~National Marine Fisheries Service (~~NMFS~~)~~-approved biologists or ~~marine mammal observers (~~MMO~~)~~ will be designated for visual monitoring, record keeping, and reporting for the project. A minimum of two MMOs will be used for ~~vibratory pile driving activities, and one MMO will be used for impact~~ all pile-driving activities. The proposed locations of the MMOs are provided on Figure 2.

3.1 Baseline Monitoring

The MMO(s) will survey the potential Level A and nearby Level B harassment zones (areas within approximately 2,000 feet of the pile-driving area observable from the shore) on 2 separate days—no earlier than 7 days before the first day of construction—to establish baseline observations. Special attention will be given to the harbor seal haul-out sites in proximity to the project (i.e., the harbor seal platform and Breakwater Island). Monitoring will be timed to occur during various tides (preferably low and high tides) during daylight hours from locations that provide the best vantage point available, including the pier, breakwater, and adjacent docks within the harbor. The information collected from baseline monitoring will be used for comparison with results of monitoring during pile-driving activities.

3.2 Construction Monitoring

In several cases, the Level A thresholds would only be expected to be exceeded within a few feet of pile driving; in other cases, the Level A thresholds could be exceeded out to approximately ~~200~~ 300 meters (see Table 2). A minimum exclusion zone size of 30 meters has conservatively been established for all pile driving and extraction.

As described above, for purposes of monitoring, there will be ~~four sets of~~one set of exclusion zones ~~depending on the activity:~~ for impact driving of ~~24-inch steel~~ piles~~, impact driving of 36-inch steel piles, impact driving of 42-inch piles,~~ and a 30-meter exclusion zone for vibratory pile driving and extraction. For impact pile driving of these steel shell piles, the exclusion zones for pinnipeds are split between ~~phocids (harbor seals and~~ northern elephant seal~~s), and~~ Pacific harbor seal, otariids and dolphins (includes sea lions, northern fur seals and bottlenose dolphins), and then one exclusion zone ~~is used~~ for all other cetacean species (i.e., gray whales and harbor porpoises). See Figure~~s~~ 2 ~~through 5~~ for the exclusion zones that will be monitored during pile driving.

The exclusion zones will be monitored for 30~~15~~ minutes prior to any pile extraction and driving activities to ensure that the area is clear of any marine mammals. If marine mammals are sighted in the exclusion zone, the start of pile extraction and driving activities will be delayed to allow the animals to move out of the area. If a marine mammal is seen above water and then dives below, the contractor will wait 15 minutes for pinnipeds and small cetaceans, and 30 minutes for gray whales; and if no marine mammals are observed in that time, it will be assumed that the animal has moved beyond the exclusion zone and work can commence.

Harbor seals that swim within 130 meters of active pile driving of 42- and 36-inch piles or 60 meters of 24-inch piles will be recorded as having been exposed to Level A harassment. Such occurrences will be recorded by the MMOs and pile driving work would not need to be interrupted. A tally of all Level A harassment occurrences will be kept. In the event that the total authorized take limit is met, a 130-meter exclusion (shutdown) zone for 42- and 36-inch piles and 60-meter exclusion zone for 24-inch piles will then be maintained for Pacific harbor seal.

If a marine mammal is observed in the Level B zone but is outside of the respective exclusion zone during pile extraction and driving, activity will continue and the behavior of the animal will be monitored and documented. If the animal appears disturbed by the pile extraction and driving activity, work may be stopped at the MMO's discretion, in conjunction with the construction manager, until the animal leaves the Level B zoneexclusion zone. The MMO will observe the Level B zones and the exclusion zones from the most practicable vantage point possible.

For activities where the Level B threshold could be exceeded (i.e., vibratory pile driving), observations will be made of the area potentially exposed to underwater noise levels at or above 160 decibels (dB) root mean square (RMS) for impact driving and 120 dB RMS for vibratory driving (Table 2). MMO observations will be made to the extent possible using binoculars from publicly accessible locations along the waterfront. Behavioral observations will document take by Level B harassment, if it occurs. Special attention will be given to the behaviors of the harbor seals using the haul-out platform, approximately 320 meters southeast of the pile-driving locations.

3.3 Post-Construction Monitoring

The MMO will continue to observe the exclusion zone and surrounding areas for a minimum of 30 minutes after pile driving stops.

4.0 QUALIFICATIONS AND RESPONSIBILITIES FOR MMOS

4.1 Minimum Qualifications for MMOs

To be considered qualified to record observations of marine mammals for the project, observers must meet the following criteria:

- Visual acuity in both eyes (correction is permissible) sufficient for discernment of moving targets at the water's surface, with the ability to estimate target size and distance; use of binoculars may be necessary to identify marine mammals;
- Experience in conducting field observations and collecting data according to assigned protocols (this may include academic experience), and ability to perform these tasks;
- Experience or training in the identification of marine mammal species and behaviors;
- Sufficient training, orientation, or experience with the construction operation to provide for personal safety during observations;
- Writing skills sufficient to prepare a report of marine mammal observations, including marine mammal species observed within the exclusion and behavioral disturbance zones; and
- Ability to communicate with project personnel orally, by radio and in person, to provide real-time information on marine mammals observed in the area, as necessary.

All monitoring personnel will be provided a copy of this monitoring plan and the IHA. Monitoring personnel must read and understand the contents of this plan—as well as the IHA—as they relate to coordination, communication, and identification and reporting of incidental harassment of marine mammals.

4.2 MMO Responsibilities

MMO tasks associated with monitoring and reporting requirements for each of the project activities are summarized below:

- Establishing exclusion zone distances from the pile to be extracted/installed, in coordination with the acoustic monitors;
- Monitoring the exclusion zone 15 minutes before pile driving is initiated to ensure that marine mammals are not present;
- Monitoring the exclusion zone for a minimum of 30 minutes after pile driving stops;
- Recording instances of Level A harassment, as authorized, for Pacific harbor seal;
- Monitoring any marine mammal activity in the vicinity of the pile-driving activity;
- Observing marine mammal behavior and recording observations, as described in Section 3.0;
- In the event that a marine mammal is observed within the behavioral disturbance zone, recording a Level B take and documenting behaviors;
- Coordinating with WETA, construction contractor(s), and other monitors on site;
- Preparing Monitoring Data Sheets; and
- Preparing a post-construction report.

5.0 DATA COLLECTION AND REPORTING

5.1 Monitoring Data

Observations will be recorded, and will include the following, to the extent available:

- Environmental conditions (weather, sea state, tides, etc.)
- Species;
- Sex and age class;
- Number of animals;
- Description of behavior, including the location and direction of movement;
- Time of observation;
- Construction activity, including the time that pile driving begins and ends; and
- Other acoustic or visual disturbances.

The reactions of marine mammals will be recorded based on the following classifications: 1) no response; 2) head alert (e.g., looks towards the source of disturbance); 3) approaches in water (but does not leave); and 4) retreat or flush (e.g., leaves the area or flushes from the haul-out site).

If a marine mammal carcass is found in the area, the event would be reported to NMFS according to the following schedule:

1. If a carcass is found and it is determined that it was caused by the contractor's activities, the contractor will immediately cease all activities and NMFS will be notified immediately. The MMO will gather required data and report to NMFS.

2. If a carcass is found and the cause is unknown, NMFS will be notified immediately, and the MMO will report the required data. Activities could continue while NMFS reviews the incident.

3. If a carcass is found and the cause is determined to not be associated with the contractor's activities, the MMO will report it to NMFS within 24 hours, with the required data. Construction activities would not be interrupted.

If accessible to the MMO, the carcass would be tagged; if possible, the MMO would determine and record the species, age, and sex for reporting to NMFS.

5.2 Monitoring Equipment

The following equipment will be used by the MMOs:

- A rangefinder capable of achieving an accuracy of ± 5 feet at a range of 100 feet;
- Binoculars;
- Radio or cell phone; and
- Monitoring Data Sheets.

The MMOs will use high-quality binoculars to monitor marine mammals at distant locations. A radio or cell phone will be used to coordinate with the construction contractor, the acoustics team, and other MMOs. To the extent practicable, digital video or 35 millimeter still cameras will be used to document the behavior and response of marine mammals to construction activities or other disturbances.

5.3 Reporting

The following sections detail the NMFS reporting requirements pursuant to the IHA.

5.3.1 Monitoring Data Sheets

Monitoring Data Sheets that summarize the monitoring results, construction activities, and environmental conditions would be compiled and submitted with the post-construction monitoring report.

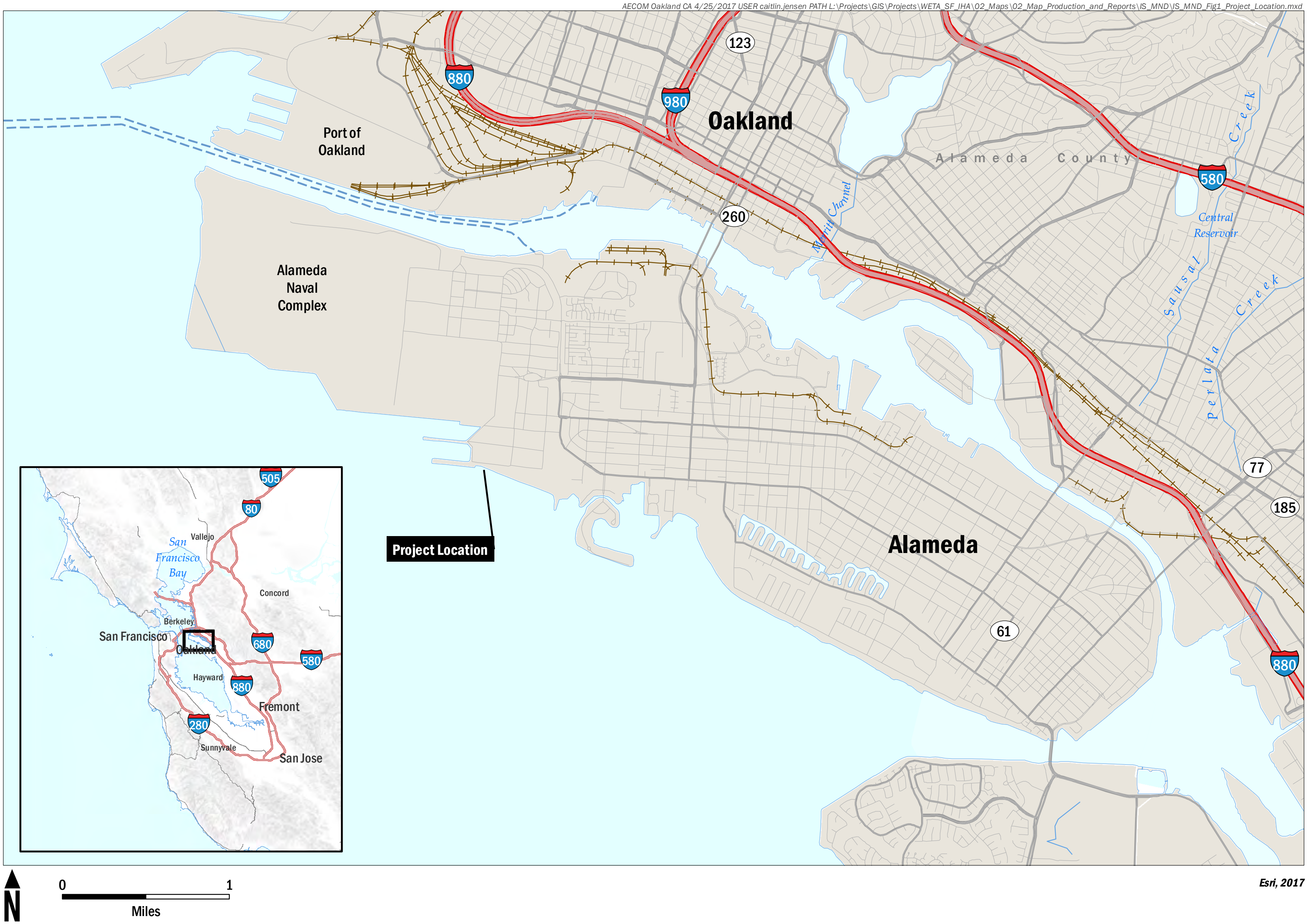
5.3.2 Post-Construction Monitoring Report

A draft report would be submitted to NMFS within 90 days after completion of the project. The draft report would include a description of the materials and methods used in monitoring, an overall summary of the project results, a summary of Level A harassment for harbor seal, a discussion of the compliance record over the course of the entire program, and a discussion of the effectiveness of monitoring methods.

A final report would be prepared and submitted to the services within 30 days following receipt of any comments on the draft report. Copies of the final report would be issued to pertinent regulatory agencies by WETA.

An acoustic data report, including data collected and summarized from all monitoring positions, would be submitted to NMFS in a similar manner, as described in the project Acoustic Monitoring Plan. The marine mammal and acoustic monitoring reports would provide useful information that would allow design of future projects to reduce incidental take of marine mammals. WETA would share field data and behavioral observations on marine mammals that occur in the project area. This information could be made available to federal, state, and local resource agencies, scientists, and other interested parties upon written request.

Figures



AECOM

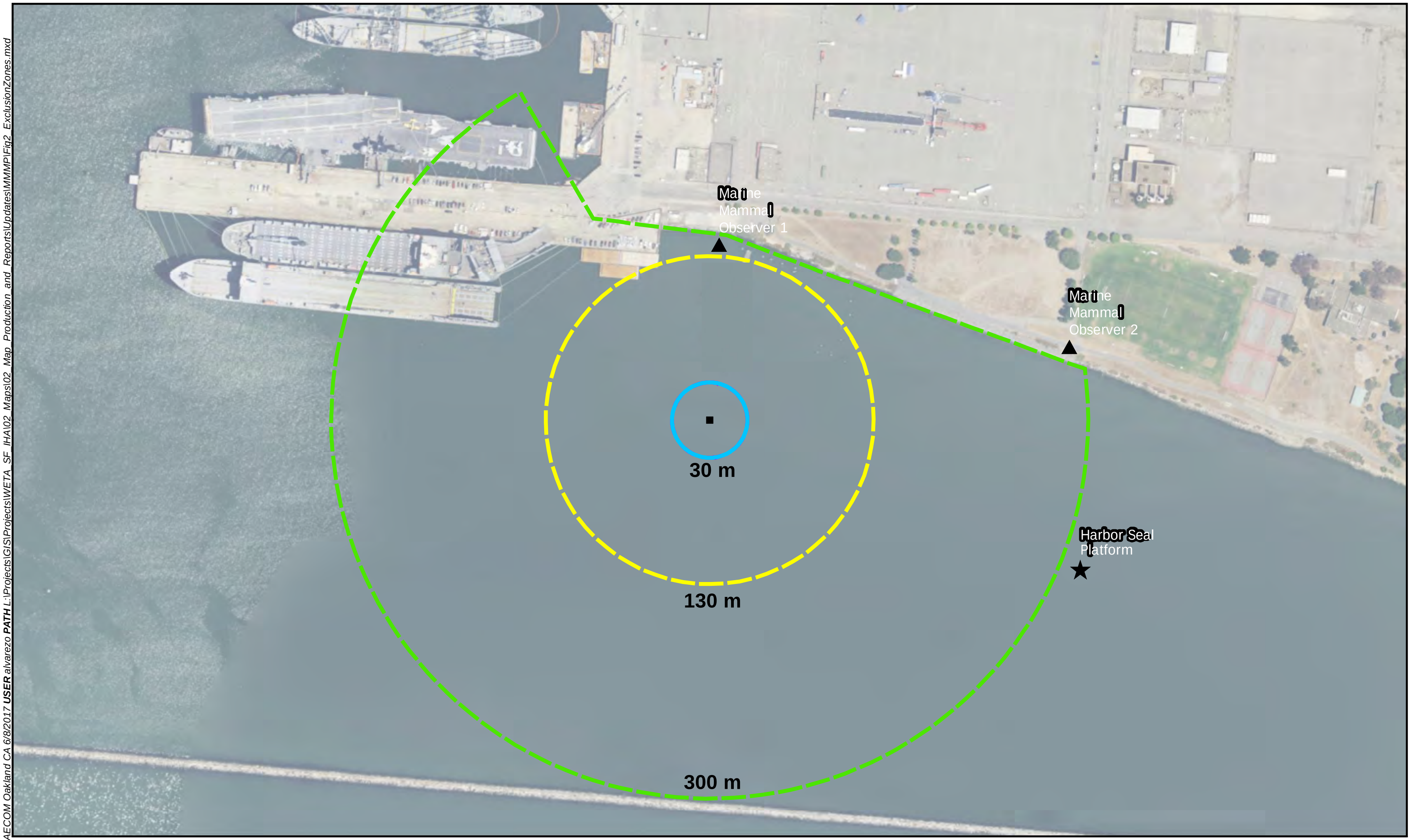
San Francisco Bay Area Water Emergency Transportation Authority

Central Bay Operations and Maintenance Facility Project

28067812

FIGURE 1

Project Location

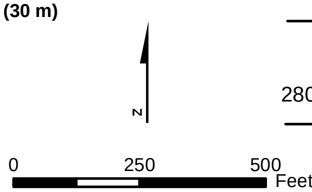


Pile Driving Location

Impact Pile Driving
- **Harbor Seals* and Dolphins (30 m)**
- **Elephant Seals (130 m)**
- **Cetaceans (300 m)**

Vibratory Driving
- **All Hearing Groups (30 m)**

*In the event that Level A take authorized for harbor seals is reached, a 130-meter exclusion zone for 42- and 36-inch piles and a 60-meter exclusion zone for 24-inch piles will then be maintained for Pacific harbor seal.



Source: NAIP Imagery, USDA FSA, 2016

EXCLUSION ZONES FOR PILE DRIVING - ALL PILE TYPES

Central Bay Operations and Maintenance Facility Project

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FIGURE 2