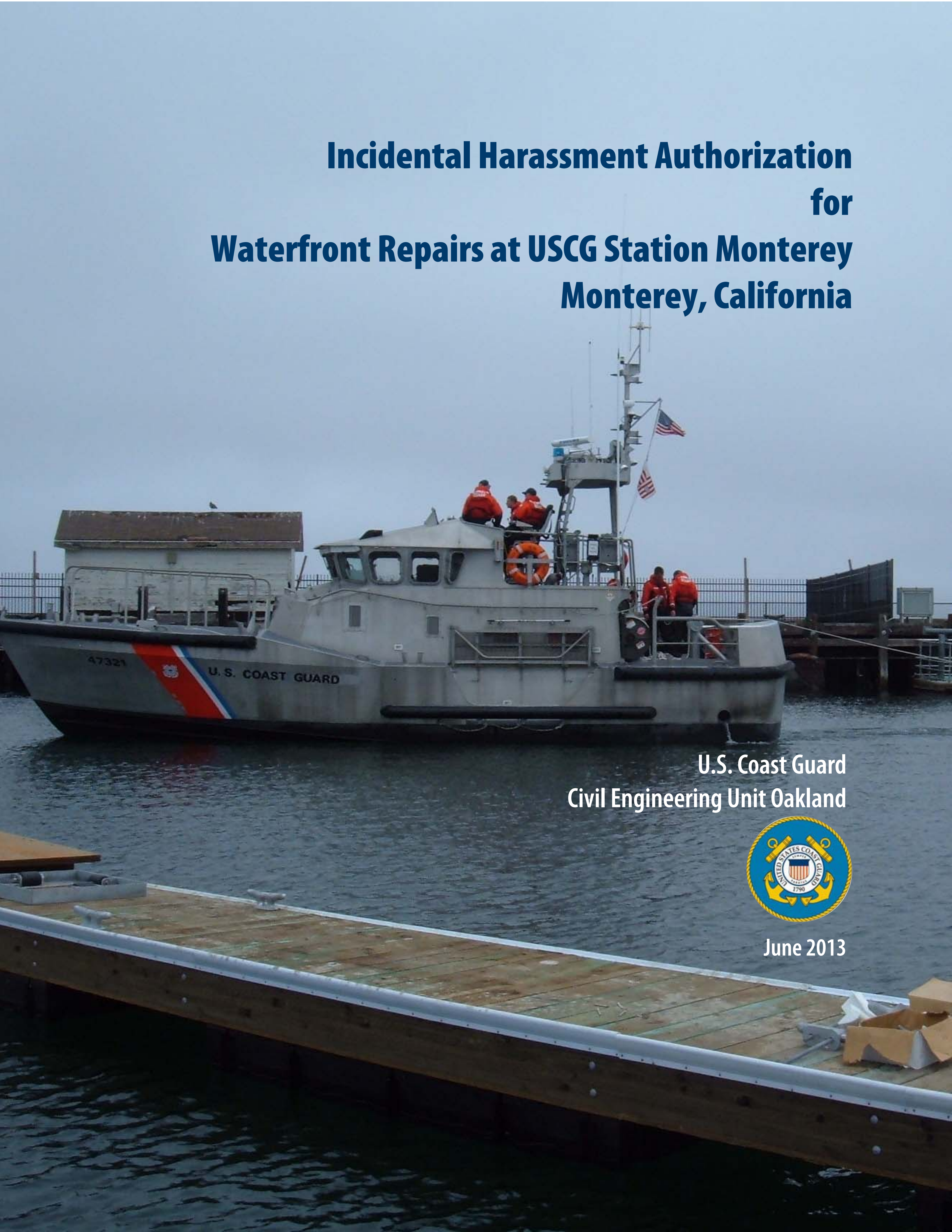
Incidental Harassment Authorization
for
Waterfront Repairs at USCG Station Monterey
Monterey, California



U.S. Coast Guard
Civil Engineering Unit Oakland

June 2013

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Monterey, California

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Acronyms and Abbreviations

μPa	microPascal
AOI	Area of Influence
Caltrans	California Department of Transportation
dB	decibel
EFH	Essential Fish Habitat
ESA	Endangered Species Act
FHWG	Fisheries Hydroacoustic Working Group
HAPC	Habitat Area of Particular Concern
Hz	hertz
IHA	Incidental Harassment Authorization
kHz	kilohertz
km	kilometer
km^2	square kilometer
L_{max}	maximum sound level
MMPA	Marine Mammal Protection Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NCCOS	National Centers for Coastal Ocean Science
Pier	USCG Station Monterey patrol boat pier
psi	pounds per square inch
PVC	polyvinyl chloride
RMS	root mean square
SPL_{peak}	peak sound pressure level
Station	United States Coast Guard Station Monterey
USCG	United States Coast Guard
USFWS	United States Fish and Wildlife Service

Chapter 1
Detailed Description of the Activity

1.1 Introduction

The United States Coast Guard (USCG) proposes to improve and maintain the structural integrity of the patrol boat pier (Pier) and potable waterline at USCG Station Monterey (Station) through the replacement of Pier piles and the water line (Proposed Action).

The Station's area of responsibility extends 50 miles offshore for approximately 120 nautical miles of coastline, from Point Año Nuevo south to the Monterey-San Luis Obispo County line, encompassing 5,000 square miles. The Station's missions include maritime homeland security, search and rescue, maritime law enforcement, and public affairs. The Station works jointly with other agencies governing the Monterey Bay National Marine Sanctuary. The vessels that are used to support the Station's missions are 21- to 25-foot rigid-hull inflatable boats, a 41-foot utility boat, a 47-foot motor life boat, and an 87-foot patrol boat. In addition, a National Oceanic and Atmospheric Administration (NOAA) boat also uses the Pier.

Levels of harassment for marine mammals are defined in the Marine Mammal Protection Act (MMPA) of 1972. Level A harassment is defined as "Any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild." Level B harassment is defined as "Any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including but not limited to migration, breathing, nursing, breeding, feeding or sheltering." High intensity underwater sound, such as that produced during pile driving, has the potential to cause Level A and/or Level B harassment, depending on the specifics of the pile driving.

Repairs to the Pier facilities will involve pile extraction and driving that may exceed the National Marine Fisheries Service (NMFS) underwater and airborne noise threshold levels; and may result in incidental take by Level B harassment, as defined by Title 50, Code of Federal Regulations, Part 216.3. This Incidental Harassment Authorization (IHA) request evaluates the potential for harassment of marine mammals, provides an estimate of the incidental take by species, and outlines measures to minimize take by harassment. For marine mammals listed as threatened or endangered under the Endangered Species Act (ESA), additional take authorization as described in the ESA will also be required.

In addition to incidental take resulting from construction noise, intentional take to encourage animals to leave the work zone may be required. Such take is allowed under Section 109(h)(1) of the MMPA, which permits federal, state, and local officials to take marine mammals in the course of official duties. Such duties include the protection or welfare of a marine mammal, protection of public health and welfare, and non-lethal removal of nuisance animals. Because this take is intentional in nature, authorization is not requested in this incidental harassment authorization request.

1.2 Project Location

The Monterey Peninsula is 85 miles south of San Francisco, California, on the southern end of Monterey Bay. The Station is located at 100 Lighthouse Avenue in the City and County of Monterey, California (Figure 1-1).

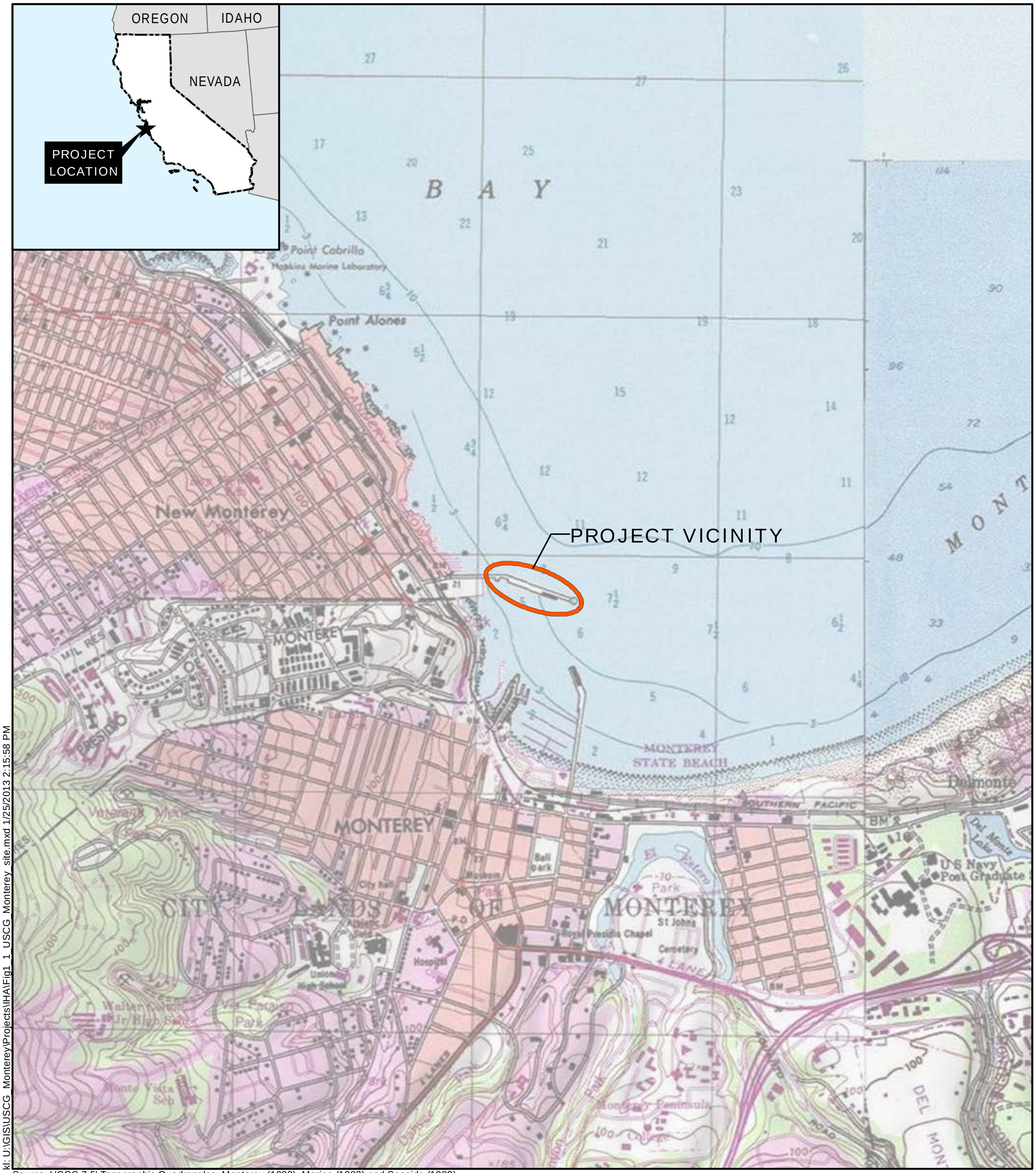
The Pier is on the eastern portion of the Station's waterfront facility, along a jetty (Jetty) that extends approximately 1,300 feet east into Monterey Harbor. The Pier and floating docks are on the southern side of the Jetty. A paved access road runs approximately 800 feet along the Jetty. The Pier access road is accessible to the general public; however, the USCG facilities are secured by fencing. The eastern end of the Jetty is not accessible to the public. This area is inhabited throughout most of the year by seabirds, which use the Jetty for nesting during spring and summer; and by California sea lions, which use the Jetty as a haul-out site. Pacific harbor seals also use rocky outcroppings and waters within the larger Monterey Bay area for haul-out and foraging, respectively.

1.3 Project Background

The Pier was constructed in 1934, of timber and steel material, and is supported by 64 piles. In 1995, 47 of the original timber piles were replaced with 14-inch steel pipe piles, and the remaining 17 piles were covered polyvinyl chloride (PVC) wraps to extend their service life. These 17 timber piles are bearing piles that have exceeded their service life due to marine borers (i.e., marine organisms, such as mollusks, that feed on wood particles) and exposure to the marine environment, and are therefore in need of replacement. The Pier deck and floating docks require repairs due to deterioration that has occurred from exposure to the marine environment and regular use of these facilities.

A galvanized steel pipe runs under the Pier and provides potable water to the Pier's floating docks. Exposure to the marine environment over time has resulted in severe corrosion of the water line, warranting its replacement.

The extensive use of the Jetty by seabirds and California sea lions poses a unique challenge for conducting the waterfront repairs. The seabirds and California sea lions in the immediate project area are regularly exposed to human presence, heavy boat traffic, and other common and continual disturbances at the project site and within Monterey Harbor, and are not easily deterred from the Jetty. However, the USCG has successfully completed other construction activities at the project site. Monitoring of seabirds and marine mammals at the project site was conducted by the USCG during the installation of the Hawksbill floating dock in 2004, during replacement of an Aid to Navigation device in 2008, and during repairs to small boat and patrol boat floating docks between November 2008 and February 2009. Behavioral disturbance of seabirds and marine mammals during these construction activities was minor and did not cause long-term or permanent changes in behavior (Phillips and Harvey, 2004; Hoover and Harvey, 2008; Harvey and Hoover, 2009).



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Source: USGS 7.5' Topographic Quadrangles; Monterey (1983), Marina (1983) and Seaside (1983).

Project Vicinity

0 1,000 2,000 FEET

PROJECT LOCATION

Waterfront Repairs at
USCG Station Monterey
Monterey, California

28068166

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FIGURE 1-1

1.4 Proposed Action

The USCG proposes to remove and replace 17 timber piles that structurally support the Pier; replace the existing potable water line; and improve associated structures to maintain the structural integrity of the Pier and potable water line. Figure 1-2 shows the locations of repairs within the Harbor area.

The Proposed Action would involve removing the existing timber deck, timber stringers, steel pile caps, steel support beams, and hardware to access the 17 timber piles that need to be replaced. The timber piles, which are approximately 14 to 16 inches in diameter and are covered with PVC wraps, would be removed through use of a vibratory extractor.

Each timber pile would then be replaced with a steel pipe pile that would be up to 18 inches in diameter, have 1/2-inch-thick walls, and be positioned and installed in the footprint of the extracted timber pile. The new steel pipe piles would not be filled with concrete. Other material and hardware removed to conduct the pile replacement would be replaced with in-kind materials. Best management practices would be employed during demolition and construction activities to prevent debris from falling into the water.

Due to dense substrate at the project site, a majority of the steel pipe pile installation may require impact pile driving; however, pile driving would be conducted with a vibratory hammer to the extent feasible, with an impact hammer used for proofing the piles. Pre-drilling would be permitted and would be discontinued when the pile tip is approximately 5 feet above the required pile tip elevation. If the steel pipe pile cannot be driven 30 feet below the mudline with an impact hammer due to the substrate or Jetty armor, the pile would be posted onto the armor stone using 36-inch-diameter concrete pedestals and dowels anchored into the armor stone. Concrete slurry would be used to cement stone within 5 feet of posted steel pipe piles to further secure the piles.

A sound attenuation system (i.e., bubble curtain) would be used during impact hammer pile driving. The bubble curtain creates an underwater wall of air around the pile to dissipate in-water sound waves.

Pile extraction and driving equipment would be located on a barge positioned in a manner that would not impede access to the floating docks; would be at a point along the Pier access road that does not disrupt Pier access; and that is secured from pedestrian movements. Pile extraction and driving equipment would not be located on the existing Pier.

Several proposed ancillary repairs to the Pier deck and floating dock are associated with this project (Figure 1-2). Specifically, under-deck repairs would restore bearings at pedestals and sea walls with nonshrink grout pads, and replace underwater pile struts. Above-deck repairs would include removing abandoned mooring hardware, replacing missing sections of curb, and replacing isolated deck planks that have deteriorated. Repairs to the floating dock would include repairing tie rods, repairing concrete spall, relocating and securing gangway wear plate(s), replacing cleats, replacing missing rubstrips, and replacing underwater pile struts.

Repairs to the potable water line would involve in-kind replacement of approximately 175 feet of 3-inch-diameter galvanized piping. The existing water line is on the outboard beam of the Pier, and is mounted by hangers. The new water line would be supported every 4 feet in the same alignment as the existing configuration. Three top side water standpipes would be replaced as part of the water line replacement. All work for replacement of the potable water line would occur above Mean High Water.

Source: ESRI Imagery Service.

Project Feature/Area of Work

0 150 300 FEET

PROJECT FEATURES

Waterfront Repairs at
USCG Station Monterey
Monterey, California

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FIGURE 1-2

Chapter 2
Dates, Duration, and Region of Activity

2.1 Dates of Construction

The project is proposed for construction as early as the 2013 fiscal year. The proposed pile extraction and driving activities would occur between June 15 and October 15. No work will begin until all required permits and approvals and an approved monitoring plan are in place.

2.2 Duration of Construction

Under the Proposed Action, the repairs will require a maximum of 60 work days for completion. A work day is limited to a period beginning 2 hours after sunrise, and ending 2 hours before sunset. The duration of the repairs, lasting approximately 60 work days, includes the time for removal of existing timber piles, new pile installations, and under-deck and above-deck repairs as described in Chapter 1, Section 4. A 180-day authorization window is requested to take into account construction delays that could occur due to the permitting process, materials availability, and inclement weather.

An average work day (beginning 2 hours after sunrise, and ending 2 hours before sunset) is approximately 8 to 9 hours, depending on the month. Based on the proposed repairs, it is assumed that two piles per day would be both extracted and installed. Pile driving activities would therefore occur for an estimated maximum of 10 days of the total construction time. It is assumed that driving time would be about 20 to 25 minutes per pile (vibratory or impact). It is assumed that vibratory extraction of the existing piles would take about 10 minutes per pile. This would result in—at most—60 to 70 minutes of pile driving per day; or 8.5 to 10 hours of underwater and airborne noise generation from pile driving over the course of the project construction.

2.3 Project Location

As described in Chapter 1, the repair activities would take place at the Station, located at the Monterey Harbor, in Monterey, California (Figure 1-1).

Chapter 3
Species and Numbers of Marine Mammals

There are six marine mammal species that may occur or move through the waters near the project area. These include the California sea lion, Pacific harbor seal, harbor porpoise, southern sea otter, and—in rare instances—gray whales and killer whales (transient or eastern north Pacific offshore stocks). With the exception of the southern sea otter, which is under the jurisdiction of the United States Fish and Wildlife Service (USFWS), these marine mammals are managed under the jurisdiction of the NMFS.

3.1 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. While California sea lions forage and conduct many activities within the water, they also use "haul-outs"—shoreline areas where pinnipeds congregate to rest, socialize, breed, and molt. California sea lions breed in Southern California and along the Channel Islands during the spring. After the breeding season, males migrate up the Pacific Coast and enter the Monterey Bay, where they primarily haul-out at Año Nuevo and the Monterey Jetty. Immature and/or nonbreeding males are year-round residents at the Jetty. They are extremely intelligent and social. 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 (NOAA, 2012a). California sea lions are the most abundant marine mammal in the project area and regularly use the Jetty and portions of the Pier as a haul-out site.

3.2 Pacific Harbor Seal

The Pacific harbor seal is one of five subspecies of *Phoca vitulina*, or the common harbor seal. 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. They display year-round site fidelity, though they have been known to swim several hundred miles to find food or suitable breeding habitat. Although generally solitary in the water, harbor seals come ashore at haul-outs that are used for resting, thermoregulation, birthing, and nursing pups. 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 (Green et al., 2006). According to NOAA's stock assessment for the California stock (NOAA, 2011a), there are approximately 400 to 600 haul-out sites located on a mixture of rock shores, intertidal sand bars, and beaches associated with the mainland and offshore islands. Pacific harbor seals are not known to regularly use the Jetty as a haul-out site, but may use beaches or other relatively low-gradient areas to haul-out in the project area, and in areas north such as beaches along Cannery Row.

3.3 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, 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 within bays, estuaries, and harbors. Their prey base consists of demersal and benthic species, such as schooling fish and cephalopods (NOAA, 2012d). The harbor porpoise is a resident species of Monterey Bay, and could occur within the project area.

3.4 Southern Sea Otter

One species of the Mustelidae family is known to occur within the central California coast: the southern sea otter. The southern sea otter was listed as threatened under the ESA on January 14, 1977. The southern sea otter is the largest member of the Mustelidae and the smallest species of marine mammal in North America (USFWS, 2003). Southern sea otters have evolved to inhabit a narrow ecological zone, adapting to the nearshore ecosystem and preferring rocky shoreline with kelp beds. Adult sea otters average about 65 pounds for males and 45 pounds for females; average lengths are about 4.5 feet and 4 feet for males and females, respectively (USFWS, 2003). The forepaws of southern sea otters are clawed and used for feeding and grooming, while the hind limbs are posteriorly oriented and flipper-like for swimming. The tail is less than one-third the body length, and of uniform thickness from base to tip.

The southern sea otter feeds on a variety of benthic invertebrates (e.g., sea urchins, abalone, octopus, crabs) and are usually found in areas where the water depth is less than 60 feet. Adult female sea otters typically give birth to one pup each year, with births peaking in the spring and fall. Male sea otters aggregate at the northern and southern limits of their range in winter and early spring. Southern sea otters may live for 15 to 20 years in the wild. Kelp beds provide important foraging and shelter habitat for this species (USFWS, 2003).

3.5 Whales

Whales would typically travel offshore within coastal waters; however, in rare instances, whales could occur within or nearby the Monterey Harbor. The two species most likely to occur would be gray and killer whales.

Gray Whale. Gray whales (*Eschrichtius robustus*) are large baleen whales. They grow to approximately 50 feet in length and weigh up to 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 the 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 (NOAA, 2012b). Although gray whales are not resident species within the project area, during their annual migration they can occur within 3 miles of the coast of Monterey Bay (MBNMS, 2012).

Killer Whale. The killer whale (*Orcinus orca*), a highly social animal, is characterized by its distinct black and white color pattern. They exhibit sexual dimorphism; the males reach up to 32 feet and 22,000 pounds, while the females are slightly smaller. Female killer whales become sexually mature after reaching approximately 15 to 18 feet and carry their calves for close to a year and a half. Their diet, which often depends on location or specific stock, consists of fish, sharks, and other marine mammals (NOAA, 2012c). Killer whales moving through Monterey Bay may pass the project area.

Chapter 4
Status and Distribution of the Affected Species

There are six marine mammal species that may occur or move through the waters near the Monterey Jetty. Two of these species are listed under the federal endangered species act: southern sea otter, which are expected to regularly occur in the Monterey Harbor; and the southern resident killer whale stock, a species for which occurrence in Monterey Bay is considered rare. Table 4-1 presents a stock assessment and relative occurrence of marine mammal species that may occur in the project area.

Table 4-1: Stock Assessment of Marine Mammals Present in the Vicinity of the Monterey Jetty

Species	Stock(s)	Stock(s) Abundance	Relative Occurrence in Monterey Jetty	Season(s) of Occurrence
California sea lion *Zalophus californianus*	Eastern U.S. stock	296,750	Common	Year-round
Pacific harbor seal *Phoca vitulina*	California stock	30,196	Common	Year-round
Harbor porpoise *Phocoena phocoena*	Monterey Bay	1,492	Rare to occasional	Year-round
Southern sea otter *Enhydra lutris nereis*	Mainland population	2,792	Common	Year-round
Gray Whale *Eschrichtius robustus*	Eastern North Pacific stock	21,135	Rare to occasional	Year-round
Killer whale *Orcinus orca*	Southern resident stock	86	Rare to occasional	During winter months
	West coast transient stock	243	Rare to occasional	Year-round
	Eastern North Pacific offshore stock	240	Rare to occasional	Year-round

Sources:

NOAA, 2009, 2010, 2011a-e; USGS, 2012.

4.1 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 within the project area. This population is estimated to be around 296,750 individuals. 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, 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 (NOAA, 2011b).

Statistical analysis of the pup counts between 1975 and 2010 determined an approximate 5.4 percent annual increase. 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 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 within the population; and in part to domoic poisoning and an infestation of hookworms, which caused an increase in pup mortality (NOAA, 2011b).

4.2 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. Pacific harbor seals generally do not migrate annually. Of the three recognized populations of Pacific harbor seals along the west coast of the continental United States, the California stock occurs within California coastal waters. Although the different populations are genetically distinct, like the California sea lion, the geographical boundary between the Oregon/Washington Coastal stock (Oregon and Washington Outer Coast and Inland Waters of Washington) and the California stock is determined by the boundary between Oregon and California. The estimated population of the California stock is 30,196. Similar to the California sea lion, population assessments are extrapolated by observations of the number of Pacific harbor seals ashore at a given time. However, unlike sea lion pups, counts are not possible because Pacific harbor seals are precocial, with the pups entering the water right after birth. The current population assessment is based on observations of Pacific harbor seals hauled-out during the 2009 surveys (NOAA, 2011a). 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 (NOAA, 2011a).

4.3 Harbor Porpoise

Harbor porpoise have a broad range in both the Atlantic and Pacific Oceans. In the Pacific, they are found from Monterey, California to the Beaufort Sea; and from Japan to the Chukchi Sea. The harbor porpoise population along the Pacific coastline consists of eight distinct stocks (the Monterey Bay, San Francisco-Russian River, northern California/southern Oregon, Oregon/

Washington coast, Inland Washington, Southeast Alaska, Gulf of Alaska, and Bering Sea stocks). The Monterey Bay stock is the population that could occur within the project area. The Monterey Bay stock consists of 1,492 individuals. These estimates are based on aerial surveys that were conducted between 2002 and 2007 along the coast out to either the 200-meter depth contour or 15 nautical miles from shore. Although aerial estimates conducted between 1988 and 2007 indicated the Monterey Bay stock was declining, an analysis of the data determined that the decline was not statistically significant (NOAA, 2009).

4.4 Southern Sea Otter

Southern sea otters currently range from San Mateo County in the north to Santa Barbara County to the south. Historically, southern sea otters ranged along the coast of Oregon, California, and as far south as Punta Abreojos, Baja California, before the hunting of southern sea otters for their pelts in the 1700s and 1800s extirpated the species throughout most of its range. Overall, southern sea otter populations have increased throughout the 20th century (USFWS, 2003). Currently, the range of this species extends from Pigeon Point in San Mateo County to Gaviota State Park in southern Santa Barbara County (USGS, 2012). Based on current census data, the 3-year running average (calculated from the 2010 and 2012 counts, since the 2011 count was not completed) is approximately 2,800 individuals (USGS, 2012). Southern sea otters are regularly observed within the Monterey Bay Harbor. Sea Otter Census data for 2012 indicate that there are approximately four sea otters per 1,640 feet of coast line within Monterey Harbor and the nearby shoreline areas (USGS, 2012).

4.5 Whales

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 eastern and western stocks. Eastern North Pacific gray whales migrate each year along the west coast of North America. 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 (NOAA, 2003). Based on shore observations done in 2006 and 2007, the population is estimated to consist of 21,135 individuals, with a minimum population of 18,017. With the exception of an unusual mortality event in 1999 and 2000, the population of the Eastern North Pacific gray whale stock has increased over the last 20 years (NOAA, 2011c).

Killer Whale. Killer whales are found all over the world, with the most abundant populations occurring in cooler waters off the coast of Antarctica, Norway, and Alaska. There are eight different killer whales stocks occurring within the North Pacific Ocean that are further classified as being either resident, transient, or offshore populations. These populations differ according to genetics, morphology, behavior, and ecology. Three stocks have potential to occur in the project vicinity: the west coast transient, eastern North Pacific offshore, and the southern resident populations.

The west coast transient killer whale population includes killer whales occurring from California to southeastern Alaska. In the late 1990s, 105 transient killer whales were identified off the coast of California (NOAA, 2010). Based on a 2006 mark-recapture study, the entire west coast transient population is currently estimated at 243 individuals (NOAA, 2010). The difference in these numbers can be attributed to differing sampling methods, geographic range of individual pods, or newly identified individuals. Between the mid-1970s and mid-1990s, the west coast transient stock increased due to higher birth and survival rates, coupled with an increase of individuals immigrating into the area. This growth overlapped with a decrease in their primary prey, the Pacific harbor seal. Since the mid-1900s, growth of the west coast transient stock has slowed (NOAA, 2010). This population of killer whale has potential to occur in Monterey Bay during the work period.

The eastern North Pacific offshore killer whale population occurs between California and Alaska. The current population estimate, based on shipboard line-transect surveys conducted between 2005 and 2008, is 240 individuals, with a minimum population of 162 individuals. However, this is a conservative estimate, due to the lower frequency in observations of offshore stock. According to NOAA's *Killer Whale: Eastern North Pacific Offshore Stock Assessment* (2011e), there are no data available on the current population trend for the eastern North Pacific offshore stock. This population of killer whale has potential to occur in Monterey Bay during the work period.

Resident killer whales that may occur off the coast of California belong to the eastern North Pacific southern resident killer whale population (J, K, and L pods). Although this killer whale population's spring, summer, and fall range typically includes the Puget Sound, Strait of Juan de Fuca, and Southern Georgia Strait, they have been known to occur off the coast of California (NOAA, 2012c). Observations of the southern resident killer whale population within Monterey Bay occurred during the winter months (Black, 2012). Since 1974, the population estimate has fluctuated from a low of approximately 70 to a high of about 100 individuals (NOAA, 2011d). Based on photographic identification surveys conducted in 2010, the minimum population estimate for the southern resident population is estimated to be 86 individuals. This population is not expected to be present in Monterey Bay or Harbor during the work period.

Chapter 5
Type of Incidental Take Authorization Requested

5.1 Take Authorization Request

Under Section 101 (a)(5)(D) of the MMPA, the USCG requests an authorization from the NMFS and USFWS for incidental take by Level B harassment (as defined by Title 50 Code of Federal Regulations, Part 216.3) of small numbers of marine mammals, specifically California sea lions, Pacific harbor seals, harbor porpoise, southern sea otter, gray whales, and killer whales during repairs to the Pier in Monterey Bay. With implementation of the measures outlined in Chapter 11, no serious injury (Level A harassment) is anticipated. The USCG requests an IHA for incidental take of marine mammals described in this application. It is anticipated that the USCG would request an annual renewal of the IHA, if the project was not completed within the year that IHA is issued. The USCG is not requesting a multi-year Letter of Authorization (LOA) at this time because the activities described herein are not expected to rise to the level of injury or death, which would require an LOA.

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 driving. Chapter 6 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, 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 Chapter 6 for estimates of exposures by species) over the course of the repairs that could be classified as Level B harassment, as defined under MMPA.

5.2 Method of Take

The Proposed Action, as outlined in Chapters 1 and 2, has the potential to result in incidental take of marine mammals by underwater and airborne noise disturbance during the removal of existing piles and driving of new piles, and waterline replacement. These activities have the potential to disturb or displace marine mammals. Specifically, the proposed activities may result in "take" in the form of Level B harassment (behavioral disturbance) only from airborne or underwater noise generated from pile extraction and driving. Level A harassment is not anticipated, given the methods of installation and measures designed to minimize the possibility of injury to marine mammals. Chapter 11 contains additional details on impact reduction and mitigation measures that are proposed for this project.

Chapter 6
Number of Marine Mammals that May Be Affected

Project activities may result in behavioral changes in marine mammals, primarily from underwater and airborne noise levels generated during extraction and pile driving activities. This chapter 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.

6.1 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 decibels, 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 that 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. 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). Table 6-1 contains definitions of these terms. In this document, dB for underwater sound is referenced to 1 µPa, and dB for airborne noise is references to 20 µPa.

Table 6-1: Definitions of Underwater Acoustical Terms

Term	Definition
Decibel, dB	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} 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 a pressure of 1 μPa) but can also be expressed in units of pressure, such as μPa or psi.
RMS Level, (NMFS Criterion)	The average of the squared pressures over the time that comprise that portion of the waveform containing 90 percent of the sound energy for one pile driving impulse.

Notes:

dB = decibel
μPa = microPascal
NMFS = National Marine Fisheries Service
psi = pounds per square inch
RMS = root mean square

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.

6.2 Applicable Noise Criteria

In 2010, NMFS established interim thresholds regarding the exposure of marine mammals to high-intensity noise that may be considered take under the MMPA. Cetaceans and pinnipeds exposed to impulsive noise of 180 and 190 dB RMS or greater, respectively, are considered to have been taken by Level A (i.e., injurious) harassment. Based on the proposed construction methodology, mitigations, and the exclusion zone described in Chapter 11, no Level A harassment is anticipated as a result of the Proposed Action. Behavioral harassment (Level B) is considered to have occurred when marine mammals are exposed to noise of 160 dB RMS or greater for impulse noise (e.g., impact pile driving) and 120 dB RMS for continuous noise (e.g., vibratory pile extraction and driving). 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. Currently, neither NMFS nor USFWS have specific take criteria for harassment of sea otters. In the absence of noise thresholds specific to sea otters, USFWS uses the Level A 180 dB RMS threshold and the Level B 160 dB RMS thresholds for impulse noise; and Level B 120 dB RMS for continuous noise (USFWS, 2012).

The application of the 120 dB RMS threshold can sometimes be problematic because this threshold level can be either at or below the ambient noise level of certain locations. Exposure criteria 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 odontocetes 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 are 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).

Airborne noise levels at which pinniped haul-out behavioral disturbance 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 a guideline. The acoustic criteria for marine mammals are shown in Table 6-2.

Table 6-2: Injury and Behavioral Disruption Thresholds for Airborne and Underwater Noise

Marine Mammals	Airborne Marine Construction Criteria (Impact and Vibratory Pile Driving) (re 20 µPa)	Underwater Continuous Noise Criteria (e.g., vibratory pile driving) (re 1 µPa)		Underwater Pulsed Noise Criteria (e.g., impact pile driving) (re 1 µPa)	
	Level B Threshold[1]	Level A Threshold	Level B Threshold	Level A Threshold	Level B Threshold
Cetaceans (whales, porpoises)	N/A	180 dB RMS	120 dB RMS	180 dB RMS	160 dB RMS
Pinnipeds (California sea lions)	100 dB RMS (unweighted)	190 dB RMS	120 dB RMS	190 dB RMS	160 dB RMS
Pinnipeds (Pacific harbor seals)	90 dB RMS (unweighted)	190 dB RMS	120 dB RMS	190 dB RMS	160 dB RMS
(Mustelids) Sothern sea otter[2]	100 dB RMS (unweighted)	180 dB RMS	120 dB RMS	180 dB RMS	160 dB RMS

[1] The airborne disturbance guideline applies to hauled-out pinnipeds or surfaced southern sea otters.

[2] NMFS does not have specific criteria for southern sea otters. The levels for cetaceans are used for purposes of this IHA request.

Notes:

dB = decibel
µPa = microPascal
RMS = root mean square

6.3 Estimation of Pile Extraction and Driving Sound

The primary sources of underwater noise would be from the extraction of old piles, and driving new steel pipe piles to support the Pier. The options for installing these piles include driving the piles the full length with an impact hammer (either diesel or hydraulic); or vibrating in the piles, with limited impact driving to proof the bearing of the piles; or partially installing the piles with an impact hammer and casting a cement footing at the interface of the Jetty. At this time it is not known what method will be used, so an analysis of both pile driving methods was conducted. Support piles would be between 14 and 18 inches in diameter. The analysis conservatively assumed the larger 18-inch size for the noise projections. Impact pile driving produces pulsed-type noise, while vibratory pile extraction and driving produces continuous-type noise.

Analysis of the projected underwater and airborne noise from construction was conducted by Illingworth & Rodkin, Inc. Complete details of the analysis can be found in their report, which is included herein as Appendix A. The following section summarizes the distances to the various sound thresholds that are used in subsequent sections to determine the Area of Influence (AOI) (see Chapter 6, Section 5) and estimate potential take of marine mammals.

6.3.1 Underwater Noise from Vibratory Pile Extraction and Driving

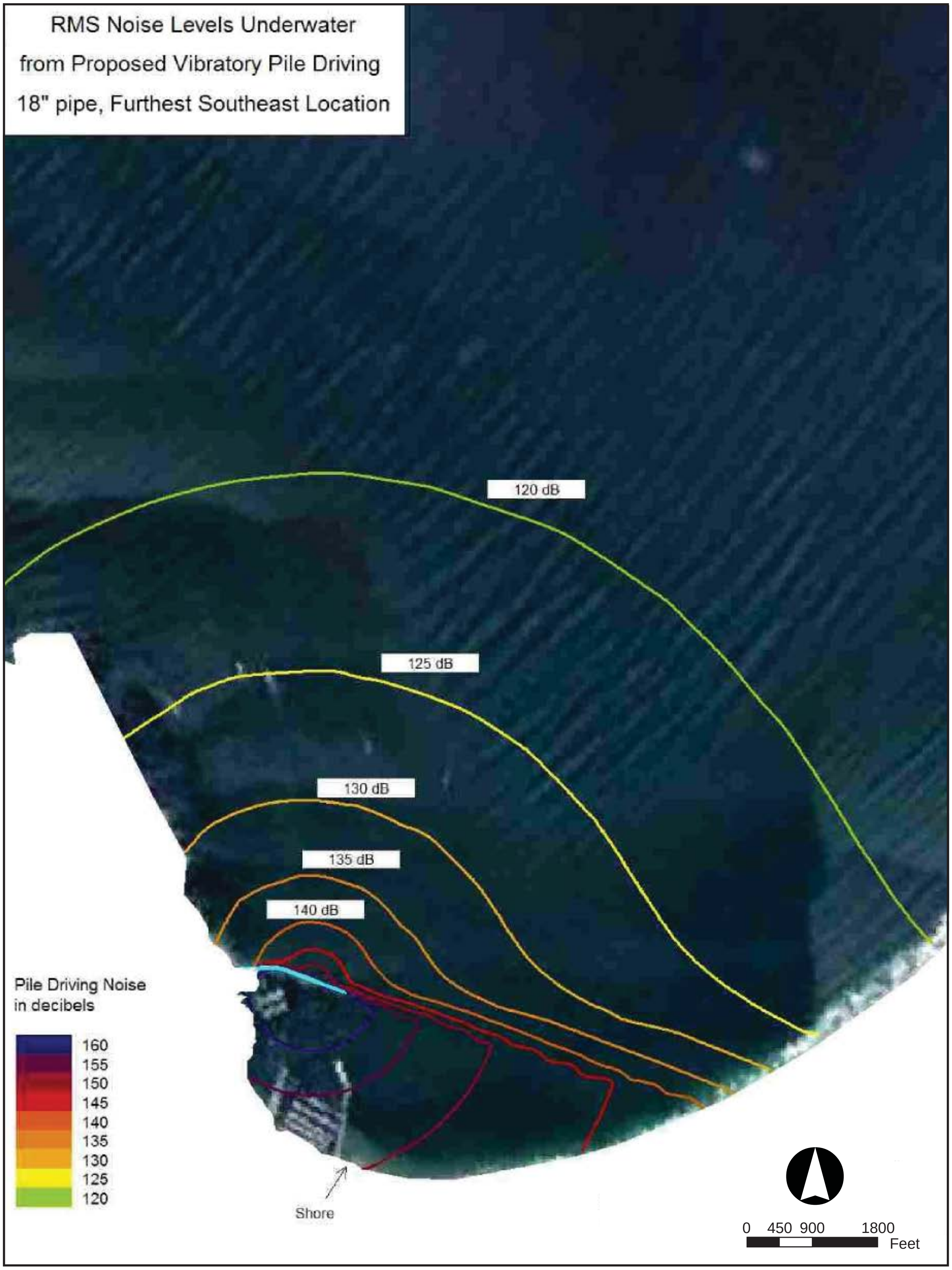
Vibratory sound from pile extraction and driving was modeled using *SoundPlan* to simulate the effect of the Jetty in reducing sound. Unlike impact pile driving, vibratory sound is radiated only from the pile, and tends to have a higher frequency sound content. Therefore, there is little or no groundborne sound energy that could transmit through underwater barriers such as the Jetty. Figure 6-1 shows the pattern of sound expected from vibratory pile extraction and pile installation, taking into account the shielding from the Jetty. Table 6-3 reports the theoretical and modeled distances to where 120 dB RMS (Level B threshold) levels would extend. It is likely that the Jetty would reduce noise considerably more than predicted, so that the distance north from the Jetty to the extent of the120 dB RMS level would be less than what is reported in Table 6-3. The area encompassed by the 120 dB RMS criterion is approximately 7.3 square kilometers (km^2).

Table 6-3: Modeled Extent of Underwater Sound Pressure Levels from Vibratory Pile Extraction and Driving

Modeling Scenario	Distance to 120 dB RMS (Level B Threshold)
Theoretical	10 miles or 16 kilometers
Modeled north	6,650 feet or 2,000 meters
Modeled northeast shoreline	8,000 feet or 2,400 meters
Modeled east to shoreline	6,000 feet or 1,800 meters
Modeled south to shoreline	1,800 feet or 550 meters

Notes:

dB = decibel
RMS = root mean square



UNATTENUATED UNDERWATER RMS LEVELS DURING VIBRATORY PILE EXTRACTION AND DRIVING

Waterfront Repairs at
USCG Station Monterey
Monterey, California

28068166

URS

FIGURE 6-1

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As noted in the previous section, the application of the 120 dB RMS threshold can sometimes be problematic because this threshold level can be either at or below the ambient noise level of certain locations. As part of this project, Illingworth & Rodkin, Inc., measured ambient noise levels at the Monterey Harbor in the project area (Appendix A). The median broadband ambient underwater sound levels (between 80 Hz and 20 kilohertz [kHz]) were measured at 114 dB. Maximum levels were typically around 125 dB. The maximum sound levels were likely from boats. They were a considerable number of pinnipeds in the water near the hydrophones, which may have resulted in elevated localized sounds. Ambient sounds were in the 110 to 120 dB range, but frequent acoustic events, such as boat traffic, typically resulted in sound levels that exceeded 120 dB in the project area.

6.3.2 Underwater Noise from Impact Pile Driving

Average RMS levels from impact driving were predicted using the near source levels for impact pile driving and the practical loss sound propagation assumptions described above. As with vibratory driving, the effects of the Jetty on sound propagation were considered in the modeling. Table 6-4 shows the extent of noise levels for the NMFS marine mammal and fish criteria. Figure 6-2 shows the extent of attenuated RMS levels for impact pile driving out to the NMFS behavioral criterion of 160 dB RMS. The area encompassed by the 160 dB criterion is approximately 0.27 km^2.

Table 6-4: Modeled Extent of Underwater Sound Pressure Levels from Impact Pile Driving

	Distance to Marine Mammal Criteria		
	RMS (dB re: 1μPa)		
Modeling Scenario	**160 (Level B Threshold)**	**180 (Level A Threshold)[1]**	**190 (Level A Threshold)[1]**
Modeled unattenuated north and northeast (through Jetty)	250 feet 76 meters	—	—
Modeled unattenuated east to shoreline	6,070 feet 1,850meters	330 feet 100 meters	75 feet 22 meters
Modeled unattenuated south to shoreline	1,800 feet 550 meters	330 feet 100 meters	75 feet 22 meters
Modeled attenuated north and northeast (through Jetty)	250 feet 76 meters	—	—
Modeled attenuated in all directions (except north and northeast)	1,525 feet 465 meters	75 feet 22 meters	<33 feet <10 meters

Notes:

[1] Level A is the exclusion zone

Distances and method of calculation are presented in Appendix A.

— = Criteria would not be exceeded over any distance
dB = decibel
μPa = microPascal
RMS = root mean square

Imagery Source: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, and the GIS User Community

ATTENUATED UNDERWATER RMS LEVELS DURING IMPACT PILE DRIVING

0 200 400 FEET

Waterfront Repairs at
USCG Station Monterey
Monterey, California

28068166

URS

FIGURE 6-2

Air bubble curtains are commonly used to reduce noise from impact pile driving and this method would be employed during construction. Attenuated noise values shown in Table 6-4 assume that underwater noise could be reduced 10 dB with the use of a properly designed and deployed air bubble curtain attenuation system. Based on the topography where the piles would be driven (on a slope with large size riprap), it will be difficult to get a good seal between the bottom surface and the bubble ring. Special care will be required to obtain the minimum noise reduction of 10 dB. The take estimate provided in subsequent sections assumes 10 dB of attenuation when determining the AOI.[1]

6.3.3 Airborne Noise

Pile driving generates airborne noise that could potentially result in behavioral disturbance to marine mammals (e.g., pinnipeds and sea otters) which are hauled-out or at the water's surface. Measured airborne noise levels from vibratory and impact driving used in this analysis are based on measurements made during the Navy Test Pile Project in Bangor Washington (NAVFAC, 2012). For vibratory driving, the greatest unweighted maximum noise level (L_{max}) measured was 102 dB, and the average L_{max} was 97 dB at 50 feet or 15 meters. For impact driving, the greatest L_{max} was 112 dB, and the average L_{max} was 103 dB at 50 feet or 15 meters. A 20 $\log_{10}$ attenuation rate was used to calculate the distances to the various NMFS thresholds. Table 6-5 provides distances using L_{max} levels, which should conservatively estimate the distance to the NMFS criterion. Figures 6-3 and 6-4 show the areal extent of these noise levels.

Table 6-5: Modeled Extent of Sound Pressure Levels for Airborne Noise

	Distance	
Threshold	100 dB	90 dB
Vibratory Extraction and Driving	65 feet 20 meters	200 feet 60 meters
Impact Driving	200 feet 60 meters	630 feet 190 meters

Notes:

Distances and method of calculation are presented in Appendix A.

dB = decibel

6.4 Basis for Estimating Take by Harassment

The USCG is seeking authorization for the potential taking of California sea lions, Pacific harbor seals, harbor porpoises, southern sea otters, gray whales, and killer whales near the Pier and adjacent Jetty. Takes would occur through Level B harassment resulting from the Proposed Action, with pile replacement work associated with repairs to the Pier accounting for a majority of the takes

[1] Area of Influence = the area encompassed by all locations where the sound pressure levels equal or exceed the threshold being evaluated (see Chapter 6, Section 5 for further discussion and use of this term).

No Scale

AIRBORNE NOISE EXPOSURE AREAS DURING VIBRATORY PILE EXTRACTION AND DRIVING

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FIGURE 6-3

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No Scale

AIRBORNE NOISE EXPOSURE AREAS DURING IMPACT PILE DRIVING

Waterfront Repairs at
USCG Station Monterey
Monterey, California

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FIGURE 6-4

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The takes 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.

6.4.1 California Sea Lion

California sea lions are present year-round in Monterey Bay, with generally lower numbers during the summer months when some individuals return to southern California to breed. Potential takes would likely involve California sea lions using the Jetty as a haul-out site. California sea lions that are taken could exhibit behavioral changes, such as increased swimming speeds, increased surfacing time, or alteration of foraging strategy. California sea lions are expected to move away from the noise source and would be temporarily displaced from the pile replacement work area. During construction, underwater noise generated by pile replacement work may cause California sea lions that might otherwise spend a small portion of their time foraging within the confines of the Harbor to spend more time foraging in areas north of the Jetty. Airborne noise generated during pile replacement work may cause hauled-out California sea lions to flee into the water or move away from the construction area. Potential takes by behavioral disturbance will have a negligible short-term effect on individual California sea lions, and would not result in population-level impacts.

6.4.2 Pacific Harbor Seal

Pacific harbor seals are present year-round in Monterey Bay and would be expected in the project area, though in much lower numbers than California sea lions (Lowry, 2012a). There are no known pupping sites in the vicinity of the project, so Pacific harbor seal pups are not expected to be present during pile driving.

Potential takes would likely involve Pacific harbor seals that are moving through the area on foraging trips during pile replacement work. Pacific harbor seals that are taken could exhibit behavioral changes, such as increased swimming speeds, increased surfacing time or decreased foraging. Pacific harbor seals are expected to move away from the noise source and be temporarily displaced from the pile replacement work area. Airborne noise generated during pile replacement work may cause hauled-out Pacific harbor seals to flee into the water or move away from the construction area. With the absence of any major rookeries and only a few potential haul-out areas near the project area, potential takes by behavioral disturbance will have a negligible short-term effect on individual Pacific harbor seals and would not result in population-level impacts.

6.4.3 Harbor Porpoise

Harbor porpoises may be present year-round in Monterey Bay, but in relatively low numbers. Harbor porpoises are found in shallow sandy bottom regions of the Monterey Bay shelf (Monterey Bay Whale Watch, 2012) often within 300 meters of shore (Sekiguchi, 1995). They tend to be more abundant in areas north of Monterey Bay (Barlow, 1988). Sekiguchi (1995) reported most sightings of harbor porpoise in Monterey Bay in the northern portion of the bay, just north of Moss Landing.

Potential takes of harbor porpoise are expected to be rare, but could occur if harbor porpoises move through or into the area on foraging trips during pile replacement work. Harbor porpoises that are taken could exhibit behavioral changes, such as increased swimming speeds, increased surfacing time or decreased foraging. Harbor porpoises are expected to move away from the noise source and be temporarily displaced from the pile replacement work area. With the absence of any regular occurrence of harbor porpoises in the project area, potential takes by harassment will have a negligible short-term effect on individual harbor porpoises and would not result in population-level impacts.

6.4.4 Southern Sea Otter

Sothern sea otter are expected to be present year round in the Monterey Harbor. Potential takes would likely involve southern sea otters that reside within the Harbor or just north of the Jetty. Southern sea otters that are taken could exhibit behavioral changes, such as increased startle responses, the interruption of rest while rafting, or alteration of foraging strategy. Most likely, southern sea otters would move away from the noise source and would be temporarily displaced from the pile replacement work area. During construction, underwater noise generated by pile driving may cause southern sea otters that rest and/or forage within the confines of the harbor to temporarily relocate to nearby areas. Airborne noise generated during pile replacement work may cause rafting or surfaced southern sea otters to flee the construction area. Potential takes by behavioral disturbance will have a negligible short-term effect on individual southern sea otters, and would not result in population-level impacts.

6.4.5 Whales

A number of whale species occur in Monterey Bay, including, among others, the blue whale, humpback whale, sperm whale, gray whale, and killer whale. Most whale species in Monterey Bay are highly transitory and occur in pelagic, deep water areas, well offshore. Two species that would be rare but could potentially occur in the project area are the gray whale and killer whale.

Gray Whale. During the winter and spring months, the entire California gray whale population migrates the along the coast, generally within 3 kilometers of the Monterey Bay coastline, traveling to their summer feeding grounds in the Bering Sea and to their winter breeding grounds in Baja California. It is expected that gray whales would very rarely venture into the shallow waters of the project area, particularly into Monterey Harbor south of the Jetty.

Killer Whale. Killer whales are relatively uncommon, migratory inhabitants of Monterey Bay. As with gray whales, it would be extremely rare that killer whales would venture into shallow waters close to the project area, particularly within the harbor to the south of the Jetty. They have been included here because in June 2011, four killer whales were sighted in the harbor by local fishermen (NBC Bay Area, 2011), though the article reported that an occurrence such as this, so close to shore, was extremely rare. The west coast transient and eastern North Pacific offshore populations of killer whale may occur in the project area during construction.

Potential takes involving these whale species could be individuals that are moving through or into the area on foraging trips during pile replacement work. Whales that are taken could exhibit behavioral changes, such as increased swimming speeds, increased surfacing time or changes in foraging behavior. Whales may move away from the noise source. With the absence of any regular occurrence of gray whales and killer whales in the project area, potential takes of these species by harassment would have a negligible short-term effect on individuals and would not result in population-level impacts.

6.5 Description of the Take Calculation and Estimation of Take

The take calculations presented here relied on the best data currently available for marine mammal populations at the Jetty and in the nearby waters of Monterey Bay. The population data used are discussed in each species take calculation subsection below. The formula below was developed for calculating take due to pile driving and is applied to each group-specific noise impact threshold. The formula is founded on the following assumptions:

- All piles to be installed would have a noise disturbance distance equal to the pile that causes the greatest noise disturbance (i.e., the piling furthest from shore, in this case the farthest east pile along the Jetty).
- It is estimated that an average of two or three piles will be installed and removed per day. The best estimate of the number of days during which pile driving would occur is 10 days, and this was used in all modeling calculations.
- Mitigation (e.g., a noise attenuation system such as a bubble curtain) would be used during impact pile driving.
- An individual animal can only be taken once per method of installation during a 24-hour period.

The calculation for marine mammal take uses the following formula:

Take Estimate = (n * AOI) * 10 days of activity

Where:

n (number of animals per unit area) = The density estimate used for each species. For southern sea otter, the unit of area is linear km of coastline. For all other species, the unit of area is km^2.

AOI = the area encompassed by all locations where the sound pressure levels equal or exceed the threshold being evaluated.

Multiplying n * AOI produces an estimate of the abundance of animals that could be present in the area of exposure per day. The final take estimate must be a whole number; therefore, values are rounded up to the next whole number.

The AOI impact is the estimated range of noise impact for a given threshold. Because the work will be conducted near the Jetty, underwater noise is not expected to spread spherically from the source. Underwater noise contours were therefore modeled using *SoundPlan*. The contours were then imported to *ArcGIS* to calculate the area within the contours and determine the AOI for each threshold. Underwater noise isopleths for vibratory pile extraction and driving and attenuated impact driving are shown on Figures 6-1 and 6-2. The AOI for vibratory pile driving encompasses the area out to the 120 dB isopleth (Level B threshold), while the AOI for impact driving encompasses the area out to the 160 dB isopleth (Level B threshold). It is assumed that an underwater noise attenuation system, such as a bubble curtain with an estimated 10 dB attenuation, would be used as a mitigation measure. However, the actual attenuation that will be achieved in the field is unknown and would likely vary with each installation.

Airborne noise would spread spherically from the source; therefore, the AOI for airborne impacts was calculated as the area within a circle (Area = pi * radius^2). The AOIs for pinniped and southern sea otter airborne noise exposure criteria are shown on Figures 6-3 and 6-4 for vibratory and impact driving, respectively.

Although 10 days of total in-water work are proposed, pile extraction or driving would only occur periodically in that time, as described in Chapter 2, Section 2. An average work day (beginning 2 hours after sunrise, and ending 2 hours before sunset) is approximately 8 to 9 hours, depending on the month. Although it is anticipated that only 30 to 70 minutes would be spent pile driving per day, to take into account deviations from the estimated times for pile installation and extraction—and to account for the additional use of the impact pile driver in case of failure of the vibratory hammer to reach the desired embedment depth—the potential impacts were modeled as if the entire day could be spent pile driving.

The exposure assessment methodology estimates the number of individuals that would be exposed, because of pile extraction and driving activities, to noise levels that exceed established NMFS thresholds. Results of the acoustic impact exposure assessments should be regarded as conservative estimates that are strongly influenced by limited biological data. Although the numbers generated from the pile driving exposure calculations provide estimates of marine mammal exposures for consultation with NMFS, the short duration and limited extent of the repairs would limit actual exposures.

6.5.1 California Sea Lion Take

California sea lions are by far the most abundant marine mammal in the project area. They are present year-round at the Jetty and harbor area and the Jetty is one of the major haul-out sites for this species in Monterey Bay. Most of the California sea lions at the Jetty are immature males, though large adult males have also been observed (Harvey and Hoover, 2009). Females tend to reside year-round near the southern California breeding grounds (the Channel Islands).

NMFS conducts annual surveys of pinnipeds using aerial photography. Counts of California sea lions hauled-out at the Jetty and harbor area were obtained from Mr. Mark Lowry of NMFS (Lowry, 2012a). Data were available for 16 surveys from 1998 to 2011, with the exception of the years 2000 and 2010. The surveys are generally conducted annually in July, though the data included one survey each from June, September, and December 1998, when additional funds were available for surveys. Counts ranged from 1 to 1,124 individuals. The highest number of individuals was recorded during the December 1998 survey. In 1998, it was an El Niño year, with warmer ocean temperatures in the winter. The December 1998 count was not typical, because many individuals stay north during years with warmer winter ocean temperatures, rather than traveling south to the typically warmer waters of the Channel Islands, where most breeding and pupping occurs (Lowry, 2012b). However, for purposes of the take estimate all of the data were used, resulting in an average of 250 individuals. Breeding rookeries are in southern California; therefore, pups are not expected to be present in the project area. There is one account of a California sea lion pup being born in 2010 on the boat ramp at the Monterey Harbor in the vicinity of the Pier, but this was a very unusual occurrence in what was also an El Niño year.

Exposures were calculated using densities derived from the average of the annual counts described above (250 individuals). Because this number represents the average counts of only the California sea lions out of the water at the time of the aerial flyovers, it was assumed that there were a number of animals in the water and not counted on any given survey. For the purpose of the take estimate, it is assumed that the animals spend about half of the time in the water and that at any given time this same number (250) could be in the water. California sea lions are known to forage over large areas (a radius of approximately 50 kilometers [km] from their haul-out site). Estimating densities of animals in the water is complicated by the fact that the work area is immediately adjacent to the haul-out site. California sea lion densities are expected to be much greater in the immediate vicinity of the haul-out site (the Jetty) when compared to dispersal over a 50-km foraging range. To more conservatively estimate the density of California sea lions in the AOI, we have assumed a foraging area of 5 km from the Jetty for the calculation of a density estimate. In addition to at-sea foraging animals that may be taken by underwater noise, we also assume that up to half of the 250 hauled-out California sea lions (125 individuals) may enter the water during pile driving activity and be exposed to underwater noise above the Level B threshold. The numbers presented in Table 6-6 reflect this, with 125 exposures per day added to the total of foraging animals exposed. Some of these animals entering the water may have already been taken due to airborne noise. The fact that some instances of take may be double-counted makes the numbers presented here more conservative.

Table 6-6: Number of Potential Exposures of California Sea Lions within Various Acoustic Threshold Zones

Density of California Sea Lions	Underwater			Airborne	
	Impact Level A Threshold (190 dB)	Impact Level B Threshold (160 dB)	Vibratory Level B Threshold (120 dB)	Impact Level B Threshold (100 dB)	Vibratory Level B Threshold (100 dB)
At-sea 8.62 per km^2	0	24	631	–	–
Jetty Haul-out 250 animals	–	1,250	1,250	757	319

Notes:

– = Not Applicable
dB = decibel
km^2 = square kilometer

To estimate the densities of California sea lions exposed to airborne harassment, the average annual counts of out-of-water animals was used (i.e., 250 individuals), distributed over the area encompassed by the Pier and the exposed rock portion of the Jetty. Using the formula above, Table 6-6 presents the number of acoustic harassments that are estimated from vibratory and impact pile driving for both underwater and airborne noise.

California sea lions that are taken could exhibit behavioral reactions. Marine mammal observers will be monitoring an exclusion zone (Chapter 11 provides a detailed discussion of mitigation measures) for the presence of marine mammals. They will alert work crews to the presence of California sea lions in or near the exclusion zone (i.e., area where noise pressure levels can exceed Level A criteria) and advise when to begin or stop work to reduce the potential for acoustic harassment. Based on the exposure analysis, California sea lions are anticipated to experience underwater and airborne noise pressure levels that would qualify as Level B harassment, and individuals that are hauled-out may exhibit behavioral reactions to the airborne noise. Potential takes by behavioral disturbance (Level B harassment) would have a negligible short-term effect on individual California sea lions, and would not result in population-level impacts.

6.5.2 Pacific Harbor Seal Take

Pacific harbor seals are much less abundant in the project area than California sea lions. Annual surveys by NMFS counted 28 Pacific harbor seals in the Monterey harbor in 2004, and 1 in 2005 (Lowry, 2012a). Pacific harbor seals hauled-out along Cannery Row, north of the Jetty, ranged from 1 to 24 in 2002, 2004, and 2009. During repairs on the Pier in 2009, Pacific harbor seals were occasionally observed in the nearby waters, but were never observed to haul-out on the Jetty (Harvey and Hoover, 2009). Pacific harbor seals may haul-out on shallow beaches across the harbor from the Jetty.

For purposes of this take estimate, 28[2] individuals were assumed to be in the water at any given time. Pacific harbor seals are known to forage over large areas (a radius of approximately 50 km from their haul-out site). To conservatively estimate the density of Pacific harbor seals in the AOI, we have assumed all individuals are within 5 km of the Jetty for the calculation of a density estimate.

Based on the limited available data, it appears that it is rare for Pacific harbor seals to haul-out on the Jetty in the immediate vicinity of the project. Therefore, it is assumed that the population of Pacific harbor seals that could potentially be exposed to airborne noise are those that are in-water but at the surface. For the purpose of calculating take from airborne noise, we have assumed that all Pacific harbor seals would be at the surface during pile driving, and have therefore used the same population density for both in-water and airborne exposure.

Table 6-7 depicts the number of acoustic harassments that are estimated from vibratory and impact pile driving for both underwater and airborne noise.

[2] This represents the highest count for the harbor area shown in the available data.

Table 6-7: Number of Potential Exposures of Pacific Harbor Seals within Various Acoustic Threshold Zones

Density of Pacific Harbor Seals	Underwater			Airborne	
	Impact Level A Threshold (190 dB)	Impact Level B Threshold (160 dB)	Vibratory Level B Threshold (120 dB)	Impact Level B Threshold (90 dB)	Vibratory Level B Threshold (90 dB)
0.965 per km^2	0	3	64	2	1

Notes:

The airborne exposure calculations assumed that 100 percent of the in-water densities were at the surface and exposed to airborne noise. The model also estimated <1 take, and was rounded up to 1.

dB = decibel

km^2 = square kilometer

Harbor seals that are taken could exhibit behavioral reactions. Disturbance from underwater noise impacts is not expected to be significant because it is estimated that only a small number of Pacific harbor seals may be affected by acoustic harassment. Additionally, marine mammal observers will be monitoring the exclusion zone (i.e., the area where Level A harassment could occur; Chapter 11 contains a detailed discussion of mitigation measures) for the presence of marine mammals. They will alert work crews to the presence of Pacific harbor seals in or near the exclusion zone, and advise when to begin or delay the start of work, to reduce the potential for acoustic harassment. Potential takes by behavioral disturbance (Level B harassment) would have a negligible short-term effect on individual Pacific harbor seals, and would not result in population-level impacts.

6.5.3 Harbor Porpoise Take

Densities of harbor porpoise reported by the NOAA National Centers for Coastal Ocean Science (NCCOS) for the southern portion of Monterey Bay are 0.01 to 0.05 animals/km^2 (NCCOS, 2007). In the absence of any other survey data for the project area, the highest value of density was assumed to occur throughout the project area. Exposures were calculated using the formula presented above. Table 6-8 depicts the number of acoustic harassments that are estimated from underwater noise generated by vibratory and impact pile driving during construction. It is assumed that all takes would result from underwater noise.

Table 6-8: Number of Potential Exposures of Harbor Porpoise within Various Acoustic Threshold Zones

Density of Harbor Porpoise	Underwater		
	Impact Level A Threshold (190 dB)	Impact Level B Threshold (160 dB)	Vibratory Level B Threshold (120 dB)
0.05 per km^2	0	1	3

Note:

dB = decibel

Due to the small number of harbor porpoise that may be affected, disturbances from underwater noise impacts are not expected to be significant. Additionally, marine mammal observers will be monitoring the exclusion zone for cetaceans (Chapter 11 provides a detailed discussion of mitigation measures) for the presence of marine mammals. They will alert work crews to the presence of marine mammals in or near the exclusion zones (i.e., area where sound pressure levels can exceed the adapted Level A criteria), and advise when to begin or stop work to avoid Level A harassment. Potential takes by behavioral disturbance (Level B harassment) would have a negligible short-term effect on individual harbor porpoises, and would not result in population-level impacts.

6.5.4 Southern Sea Otter Take

Southern sea otter Census data for 2012 indicate that there are approximately eight southern sea otters per kilometer of coast line within Monterey Harbor and the nearby shoreline areas (USGS, 2012). At this density, we expect approximately 8 southern sea otters within Monterey Harbor and approximately 40 to 48 throughout the entire AOI for vibratory pile driving. Table 6-9 depicts the number of acoustic harassments that are estimated from underwater and airborne noise generated by vibratory and impact pile driving during construction. Assuming each southern sea otter dives at least once during daily pile driving, all animals within the Level B threshold for airborne noise would also be taken by underwater noise. The fact that some instances of take are double-counted makes the numbers presented here more conservative.

Table 6-9: Number of Potential Exposures of Southern Sea Otter within Various Acoustic Threshold Zones

Density of Southern Sea Otters	Underwater			Airborne	
	Impact Level A Threshold (180 dB)	Impact Level B Threshold (160 dB)	Vibratory Level B Threshold (120 dB)	Impact Level B Threshold (100 dB)	Vibratory Level B Threshold (100 dB)
At-sea underwater 8 per km of coastline	0	44	480	—	—
At-sea above water 8 per km of coastline	—	—	—	10	4

Notes:
— = Not Applicable
dB = decibel
km = linear kilometer

Southern sea otters that are taken could exhibit behavioral reactions. Marine mammal observers will be monitoring an exclusion zone (see Chapter 11 for a detailed discussion of mitigation measures) for the presence of marine mammals. They will alert work crews to the presence of southern sea otters in or near the exclusion zone (i.e., area where sound pressure levels can exceed the adapted Level A criteria), and advise when to begin or stop work to reduce the potential for acoustic harassment. Outside of the exclusion zone, southern sea otters maybe exposed to underwater noise that result in behavioral effects, such as startling or the cessation of feeding. Based on the exposure analysis, southern sea otters are anticipated to experience airborne sound pressure levels that would qualify as harassment, and individuals that are rafting or at the surface may exhibit behavioral reactions to the airborne noise. Potential takes by behavioral disturbance (Level B harassment) would have a negligible short-term effect on individual southern sea otters, and would not result in population-level impacts.

6.5.5 Whales

As described above, the occurrence of gray and/or killer whales would be extremely rare near shore in the project area. The NOAA NCCOS reports densities of gray whales at 0.1 to 0.5 per km^2 (NCCOS, 2007); however, it is unclear how applicable these data are for the very near-shore environment of the project area. Gray whales would be more likely to encroach on the project area during the spring migration north, when they tend to stay closer to shore than during the winter southern migration. As discussed in Chapter 4, Section 4, killer whales were sighted within the harbor once in 2011, but this is not a regular occurrence; therefore, application of the formula to estimate take is not appropriate. However, because the possible occurrence of these species cannot be ruled out near shore, take is estimated at up to four individuals from each species by vibratory driving and two by impact pile driving over the course of construction. It is highly unlikely that take of gray whales would occur by impact driving because there are no reported sightings of gray whales actually entering the Monterey Harbor area. During vibratory driving, the 120 dB contour (criteria for continuous noise) extends farther offshore to the north of the Jetty. If there is take of whales by harassment, it is more likely to be during vibratory driving activities.

Whales that are taken could exhibit behavioral changes. Disturbance from underwater noise impacts is not expected to be significant because of the small number of whales that may be affected by acoustic harassment. Additionally, marine mammal observers will be monitoring the exclusion zone (Chapter 11 for a detailed discussion of mitigation measures) for the presence of marine mammals. They will alert work crews to the presence of cetaceans in or near the exclusion zone (i.e., area where sound pressure levels can exceed the adapted Level A criteria), and advise when to begin or stop work to reduce the potential for acoustic harassment. Potential takes by behavioral disturbance (Level B harassment) would have a negligible short-term effect on individual whales, and would not result in population-level impacts.

6.5.6 Summary

Based on the modeling results presented above, the total number of takes that the USCG is requesting for the six marine mammal species that may occur in the project area during construction is presented below in Table 6-10. There is the potential for up to 2,095 Level B harassment takes of various species due to underwater and airborne noise from impact pile driving operations, and up to 2,760 Level B harassment takes of various species from vibratory pile driving due to underwater and airborne noise. These estimates are conservative to reflect the presence of a substantial haul-out site within the work area.

Table 6-10: Summary of Potential Take for All Species

Species	Impact Driving			Vibratory Driving		
	Level B Underwater (160 dB)	Level B Airborne[1]	Total Estimated Take	Level B Underwater (120 dB)	Level B Airborne[1]	Total Estimated Take
California sea lion	1,274	757	2,031	1,881	319	2,200
Pacific harbor seal	3	2	5	64	1	65
Harbor porpoise	1	—	1	3	—	3
Southern sea otter	44	10	54	480	4[2]	484
Gray whale	2	—	2	4	—	4
Killer whale	2	—	2	4	—	4
Total	1,326	769	2,095	2,436	324	2,760

1 A 90 dB threshold is applied for Pacific harbor seals, and a 100 dB threshold is applied for California sea lions and sea otters.

2 Southern sea otters exposed to airborne noise would also be exposed to underwater noise. To prevent re-counting of animals already taken by Level B harassment, these numbers do not contribute to the total take numbers.

Notes:

— = Not Applicable
dB = decibel

Chapter 7
Anticipated Impact of the Activity on the Species or Stock

7.1 Effects of Underwater Noise on Marine Mammals

Marine mammals use hearing and sound transmission to perform vital life functions. The introduction of noise into their environment could disrupt those behaviors. Sound (hearing and vocalization/echolocation) serves four primary functions: (1) providing information about the environment; (2) communication; (3) prey detection; and (4) predator detection. The distances to which the construction noise associated with the project are audible depend on source levels, frequency, ambient noise levels, the propagation characteristics of the environment, and the sensitivity of the receptor (Richardson et al., 1995).

The effects of noise from pile driving on marine mammals can be physiological or behavioral, and may include one or more of the following: masking of natural sounds, behavioral disturbance, temporary or permanent hearing impairment, or nonauditory physical effects such as damage to other organs (Richardson et al., 1995). 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 7.1.1 through 7.1.4, from greatest effect to least.

7.1.1 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 threshold shift, a temporary loss in hearing, a permanent threshold shift 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 criteria for this type of harassment are 180 dB for cetaceans and 190 dB for pinnipeds. As there is no specific criterion for the southern sea otter, the USCG has used 180 dB as an assumed threshold for purposes of this IHA request.

No physiological responses are expected from pile driving operations occurring during the Pier repairs. 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 criteria; however, USCG will implement measures (Chapter 11) that will greatly reduce the chance that a marine mammal may be exposed to sound pressure levels that could cause physical harm. During impact pile driving, a noise attenuation system (i.e., bubble curtains) would be used to reduce sound pressure levels. Marine mammal observers will be monitoring the exclusion zones (Chapter 11 provides a detailed discussion of mitigation measures) for the presence of marine mammals. They will alert work crews to the presence of pinnipeds, mustelidae 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, including the 180 dB re 1 μPa (cetaceans and mustelidae) and190 dB re 1 μPa (pinnipeds) isopleths, to ensure no marine mammals are injured.

7.1.2 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 criteria for the zone where this effect occurs are 160 dB for impact noise and 120 dB for continuous noise.

7.1.3 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 criteria for the zone where these effects occur are 160 dB for impact noise and 120 dB for continuous noise.

7.1.4 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). Study data show reasonably consistent patterns of hearing sensitivity in three groups: small odontocetes (such as the harbor porpoise), medium-sized odontocetes (such as killer whales), and pinnipeds (such as the California sea lion). No criteria apply to this zone 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.

7.1.5 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 few hours a day over a relatively short period of time, 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.

The expected responses to pile replacement work noise depend partly on the average ambient background noise of the site. The Monterey Harbor experiences frequent boat traffic, foot traffic on accessible portions of the Pier, and noise from the USCG Station and boats. For marine mammals that use the Monterey Harbor area regularly, particularly California sea lions that haul-out on the Jetty or Pier, and southern sea otters that regularly inhabit the Monterey Harbor, responses to noise may be lessened due to habituation.

7.2 Effects of Airborne Noise on Marine Mammals

Marine mammals could be exposed to airborne noise levels at sound pressure levels that would constitute Level B harassment during impact or vibratory pile driving (see Chapter 6 for results). Injury or Level A harassment is not expected to occur from airborne noise.

Marine mammals that occur in the project area would be exposed to airborne noise associated with pile replacement work that has the potential to cause harassment, depending on their distance from pile extraction and driving activities. California sea lions would be impacted the most, due to their heavy use of the Jetty in the immediate project area as a haul-out site. Southern sea otters that are at the surface during pile driving could also be impacted. California sea lions and Pacific harbor seals may also be exposed if they surface in proximity to pile work. Airborne noise would likely cause behavioral responses similar to those discussed above in relation to underwater noise. For instance, the noise generated could cause hauled-out pinnipeds to exhibit changes in their normal behavior, such as causing them to temporarily abandon their habitat and move farther from the noise source. Airborne noise may cause pinnipeds to flush from the Jetty into the water.

Increased sound levels or disturbances that would flush pinnipeds in areas of low disturbance may not elicit a response in the Monterey Harbor. In 2004, construction activities on the Pier generated noise from drilling and coring equipment. Disturbance to hauled-out California sea lions was minimal, and included small behavioral responses such as barking and head turning. Construction noise did not cause any animals to flush (Phillips and Harvey, 2004).

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.

7.3 Effects of Human Disturbance on Marine Mammals

The activities of workers in the project area may also cause behavioral reactions such as flushing from the Jetty or Pier, or moving farther from the disturbance to forage. The Jetty is partially accessible for public use and experiences moderate to heavy foot traffic from fishermen and tourists along the western portion of the Jetty. The California sea lions using the fenced-off eastern portion of the Jetty and the area beneath the Pier as haul-out sites and appear to be well habituated to human activity, often tolerating humans at a distance of just a few feet beyond the fences or dock areas that separate humans from the hauled-out animals.

Observations made by Harvey and Hoover (2009) during previous repairs of the Pier indicated very little disturbance of marine mammals, particularly on the eastern portion of the Jetty. They concluded that the animals did not seem to be behaviorally modified by the presence of the construction activities. The only potential disturbance seemed to occur during diving operations, which may have startled some individuals, particularly a southern sea otter that approached the work area. The presence of workers is likely to affect only animals within close proximity to the workers and is not expected to affect animals on the Jetty outside of the work area. The presence of workers would not result in population level impacts or affect the long-term fitness of the species.

In addition to incidental harassment resulting from construction activity, directed actions to provide incentive for animals to leave the work zone may be required. Such actions are allowed under Section 109 of the MMPA, which permits federal, state, and local officials to take marine mammals in the course of official duties. Such duties include the protection or welfare of a marine mammal, protection of public health and welfare, and non-lethal removal of nuisance animals.

California sea lions frequently haul-out underneath the Pier on the Jetty armor, where construction would occur as a result of the Proposed Action. Interactions of construction workers with these animals could result in injury to both workers and/or California Sea Lions. It may be necessary to deter, using non-lethal methods, hauled-out animals to safely gain access to the work site. For the proposed project, using noise as a deterrent is not recommended. The California sea lions under and around the Pier are habituated to human disturbance and noise associated with marina activities. Loud noises may also unnecessarily harass hauled-out California sea lions outside of the work zone. The use of non-lethal physical deterrence would be used instead. Such methods include the use of a "super soaker" type water gun to spray seawater onto the rump or chest of animals that must be deterred.

Chapter 8
Anticipated Impact on Subsistence Uses

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

Chapter 9
Anticipated Impact of the Activity on the Habitat or the Marine Mammal Populations, and the Likelihood of Restoration of the Affected Habitat

No permanent impacts to habitat are proposed for or would occur as a result of this project. As proposed, the Proposed Action would not increase the Pier's existing footprint and no new structures would be installed that would result in the loss of additional habitat. Therefore, no restoration of the habitat would be necessary. A temporary, small-scale loss of foraging habitat may occur for marine mammals if marine mammals leave the area during pile extraction and driving activities.

Acoustic energy created during pile replacement work would have the potential to disturb fish within 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 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, indicate that the distance from underwater pile driving at which noise has the potential to cause temporary hearing loss in fish over a distance of approximately 42 meters[3] from pile driving activity, or approximately 0.003 km^2 inside the harbor south of the Jetty. Therefore, if fish leave the area of disturbance, pinniped foraging habitat may have temporarily decreased foraging value when piles are driven using impact hammering.

The duration of fish avoidance of this area after pile driving stops is unknown. However, the affected area represents an extremely small portion of the total area within foraging range of marine mammals that may be present in the project area.

Monterey Bay is classified as Essential Fish Habitat (EFH) under the Magnuson-Stevens Fisheries Conservation and Management Act, as amended by the Sustainable Fisheries Act. The EFH provisions of the Sustainable Fisheries Act are designed to protect fisheries habitat from being lost due to disturbance and degradation. The act requires implementation of measures to conserve and enhance EFH. The Monterey Bay is classified as an EFH for 118 species of commercially important fish, 30 of which have potential to occur within the project area. Some of these species are likely prey to pinnipeds and occasionally southern sea otters. In addition to EFH designations, portions of the Monterey Bay are designated as a Habitat Area of Particular Concern (HAPC) for various fish species within the Pacific Groundfish, Pacific Coast Salmon, Highly Migratory Species, and Coastal Pelagic Fisheries management plans. These HAPC areas

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[3] Assuming two piles per day, using a noise attenuation system such as a bubble curtain. See Appendix A, Table 8.

include kelp forest and rocky reef habitats, both of which occur in and adjacent to the Project Area.

Given the short daily duration of increased underwater and airborne noise levels associated with the project, the relatively small areas being affected, and the impact avoidance and minimization measures (Chapter 11), the proposed project is not likely to have a permanent, adverse effect on EFH. Therefore, the project is not likely to have a permanent, adverse effect on marine mammal foraging habitat.

Chapter 10
Anticipated Impact of the Loss or Modification of Habitat

The Proposed Action'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. As described in Chapter 9, 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. There would be no increase in permanent habitat loss as a result of the project.

Chapter 11
Impact Minimization Methods

Chapter 6 describes the maximum potential number of marine mammals—by species—that may be exposed to acoustic sources that would be considered Level B harassment by NMFS. Marine mammals will be protected from Level A harassment through the use of bubble curtains and marine mammal monitoring within the exclusion zone; this chapter describes the methods used to identify the Level A exclusion zone.. The following mitigation measures are proposed by the USCG in order to minimize the number of marine mammals potentially affected by this project.

11.1 Mitigation for Pile Extraction and Driving Activities

To develop mitigation measures for repairs to the Pier, various AOIs were modeled, as described in Chapter 6. The modeling identified the areas that would experience noise in excess of the Level A criteria for pinnipeds and cetaceans. The results of this modeling guided the establishment of an exclusion zone around each pile to prevent Level A harassment to marine mammals. The following measures will be implemented to both prevent Level A harassment (injury) and reduce the area of potential effects from Level B harassment (disturbance) to marine mammals:

1. Noise Attenuation

    - Noise attenuation systems (i.e., bubble curtains) will be used during all impact pile driving to interrupt the acoustic pressure and reduce the impact on marine mammals. By reducing underwater sound pressure levels at the source, bubble curtains would reduce the area over which both Level A and B harassment would occur, thereby potentially reducing the numbers of marine mammals affected.

2. Exclusion Zone

    - The exclusion zone includes all areas where underwater sound pressure levels are expected to reach or exceed the Level A harassment criteria for marine mammals. These correspond to the 180 dB isopleth for cetaceans and sea otter and the 190 dB isopleth for pinnipeds. As shown in Table 6-4, modeled distances are <33 and 75 feet to the 190 dB and 180 dB isopleths, respectively, for attenuated noise. For unattenuated noise, the distances are distances are 75 and 330 feet to the 190 dB and 180 dB isopleths, respectively.

    - To provide a margin of safety, a provisional, conservative exclusion zone will be established during initial pile extraction and driving efforts, while hydroacoustic measurements are made to establish actual field conditions. A bubble curtain would be employed, but during initial pile extraction and driving the exclusion zones will be set at the modeled distances for unattenuated noise. Thus, the initial exclusion zones would be set at 75 feet for pinnipeds and 330 feet for cetaceans and mustelidae. These exclusion zones will be adjusted, in consultation with NMFS, once field conditions have been established through hydroacoustic monitoring.

3. Visual Monitoring

   - The exclusion zone will be monitored for 15 minutes prior to any pile extraction and driving activities to ensure that the area is clear of any marine mammals. Pile extraction or driving will not commence until marine mammals have not been sighted within the exclusion zone for a 15 minute period.

   - If a marine mammal enters the exclusion zone during pile replacement work, activity will continue, and the behavior of the animal will be monitored and documented. If the animal appears disturbed by the pile replacement activity, work will stop until the animal leaves the exclusion zone.

   - Monitoring will be conducted by qualified observers familiar with marine mammal species and their behavior. The observer will monitor the exclusion zone from the most practicable vantage point possible (the Pier itself, the Jetty, adjacent boat docks in the harbor, or a boat) to determine whether marine mammals enter the exclusion zone.

4. Acoustic Monitoring

   - Hydroacoustic monitoring will be conducted during impact pile driving to verify and refine the limits of the exclusion zone and to ensure that marine mammals are not harmed by pile extraction and driving activities. Airborne noise monitoring will also be conducted. This monitoring is described further in Chapter 13.

5. Daylight Construction Period

   - Work would occur only during daylight hours (7:00 a.m. to 7:00 p.m.).

6. Soft Start

   - A "soft-start" technique is intended to allow marine mammals to vacate the area before the pile driver reaches full power. For vibratory hammers, the contractor will initiate the driving for 15 seconds at reduced energy, followed by a 1-minute waiting period when there has been downtime of 30 minutes or more. This procedure shall be repeated two additional times before continuous driving is started. This procedure would also apply to vibratory pile extraction. For impact driving, an initial set of three strikes would be made by the hammer at 40 percent energy, followed by a 1-minute waiting period, then two subsequent three-strike sets before initiating continuous driving.

7. Safe Access to Work Zone

   - If non-lethal deterrence of California sea lions is needed to safely access a work site, the marine mammal monitor will oversee any non-lethal deterrence actions. Non-lethal deterrence methods will be physical in nature and may include the use of a "super soaker" type water gun to spray individual California sea lions on the rump or chest. Non-lethal deterrence methods will not include auditory devices.

- Should any serious injury or mortality result during the course of the proposed activity, the USCG will suspend operations and will immediately contact NMFS.

11.2 Mitigation Effectiveness

Although marine mammals will be protected from Level A harassment through the use of bubble curtains and marine mammal monitoring within the exclusion zone, mitigation from Level B harassment will not be 100 percent effective. Visual observation of marine mammals depends on several factors, including the behavior of the animal (e.g., underwater swimming), the observer's ability to detect the animal, environmental conditions and monitoring platforms.

Marine mammal observers will be experienced biologists with training in the detection and behavior of marine mammals. This training will ensure that marine mammal observers are able to adequately detect marine mammals in the exclusion zone; and to determine their behavior and whether they appear to be harassed by the pile extraction and driving activities.

Because project activities will occur within the Monterey Harbor, protection from waves and wind fetch should make observation of marine mammals in the exclusion zone optimal. Observers will be positioned in locations that provide the best vantage points for monitoring. This is likely to be on the Pier decking adjacent to the work area, at other dock areas within the Harbor or on a nearby vessel to gain an elevated perspective.

Chapter 12
Arctic Subsistence Uses, Plan of Cooperation

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

Chapter 13
Monitoring and Reporting

The USCG would develop two detailed monitoring plans: one for conducting acoustic measurements and one for 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 plan will provide 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 plans are described in more detail below.

13.1 Acoustic Monitoring

Both underwater and airborne noise would be measured. Hydroacoustic monitoring would be conducted by a qualified monitor during pile extraction and driving activities. Details would be developed during work plan preparation, but might include monitoring one pile in every set of three piles during installation. A reference location would be established at the estimated 180 dB contour (approximately 330 feet from the pile). Noise measurements would be taken at the reference location and at locations every 20 feet until the 180 dB level (Level A threshold) is found. Measurements would be taken at two depths: one in mid-water column, and one near the bottom but at least 3 feet above the bottom. Marine mammal exclusion zones would be adjusted to maintain a safe zone outside of 180 dB, according to the results of this monitoring. Additional acoustical monitoring details will be developed in conjunction with NMFS and USFWS prior to the start of construction.

Airborne noise monitoring would be conducted at two locations. One location would be at 15 to 30 meters from the pile driving operation to provide near-source noise measurements. This would likely be a fixed position with an intended clear view of pile driving operations. The second system would be established at the haul-out area on the Jetty. The actual position would be determined in the field, depending on access and security issues. This position is anticipated to be 80 to 150 meters from the piles driven. Airborne sound levels will be continuously monitored for the duration of pile extraction or installation. The maximum 1/8th second average (i.e., Lmax) of each one second (or pile strike) and the energy average level (Leq) for each pile will be measured in real time. Airborne sound levels will be measured in decibels referenced to 20 μPa.

13.2 Marine Mammal Monitoring

Specific details of the biological monitoring will be developed in conjunction with NMFS and USFWS during work plan preparation, but will include monitoring when piles are being extracted or driven. The USCG will collect sighting data and observations on behavioral responses to construction for marine mammal species observed in the region of activity during the period of construction. All observers will be trained in marine mammal identification and behaviors, and would conduct the following general monitoring and reporting tasks:

- Biological monitoring would occur within 1 week before the Proposed Action's start date, to establish baseline observations.
- Observation periods will encompass different tide levels and hours of the day. Monitoring of marine mammals around the construction site will be conducted using high-quality binoculars as necessary (e.g., Zeiss, 10 × 42 power).
- Data collection will consist of a count of all pinnipeds, mustelidae, and cetaceans by species, a description of behavior (if possible), location, direction of movement, type of construction that is occurring, time that pile replacement work begins and ends, any acoustic or visual disturbance, and time of the observation. Environmental conditions such as weather, visibility, temperature, tide level, current and sea state would also be recorded.
- Biological monitoring would occur from appropriate monitoring locations, including the USCG Pier, Jetty, adjacent docks within the harbor or watercraft, to maintain an excellent view of the exclusion zone and adjacent areas during the survey period. Monitors would be equipped with radios or cell phones for maintaining contact with work crews.
- During pile extraction and driving, the underwater exclusion zone will be monitored for 15 minutes prior to commencing work. If marine mammals are within the exclusion zone, the start of extraction or driving will be delayed until no animals are sighted within the zone.
- Weekly monitoring reports that summarize the monitoring results, construction activities and environmental conditions would be submitted to NMFS.
- As part of the reporting requirements under Section 109(h)(1) of the MMPA, the USCG will be required to submit a report to NMFS detailing the method of non-lethal deterrence, the date, time, species, and number of animals deterred from the work area.
- A final report would be submitted to NMFS within 90 days after completion of the proposed project.

Chapter 14
Coordinating Research to Reduce and Evaluate Incidental Take

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 Chapter 11 to protect marine mammals. The USCG will coordinate all activities with the relevant federal and state agencies. These include, but are not limited to: NMFS, USFWS, U.S. 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. The USCG 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 and USFWS 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 or USFWS.

Chapter 15
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Appendix A

Sound Analysis (Illingworth & Rodkin, Inc.)

Final Analysis of Underwater and Airborne Sound Levels for Waterfront Repairs at United States Coast Guard Station Monterey Monterey, California

November 8, 2012

Prepared for

United States Coast Guard
Civil Engineering Unit Oakland
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INTRODUCTION

This study is an assessment of potential sound levels generated by planned pile driving activities involved with the waterfront repairs at the United States Coast Guard (USCG) Station Monterey, in Monterey, California. The USCG proposes to remove and replace the 17 piles supporting the pier; replace the existing potable water line; and improve associated structures to maintain the structural integrity of the pier and potable water line. The purpose of the project is to provide repairs and maintenance of these structures to support the operational requirements of Station Monterey, as well as a National Oceanic and Atmospheric Administration (NOAA) boat, which also uses these facilities.

The proposed project would involve removing the existing timber deck, timber stringers, steel pile caps, steel support beams, and hardware to access the 17 timber piles. The timber piles would then be removed through use of a vibratory extractor. Each timber pile would be replaced with a minimum 14-inch-diameter (up to a maximum of 18-inch-diameter) steel-pipe pile that would be positioned and installed in the footprint of the extracted timber pile. The majority of the pile driving would be conducted with a vibratory hammer, and an impact hammer would be used for proofing the piles. The new steel-pipe piles would not be filled with concrete. Other material and hardware removed to conduct the pile replacement would be replaced with in-kind materials. This project is proposed for construction in the 2013 fiscal year.

This report includes the prediction of underwater and airborne sound levels calculated based on the results of measurements for similar projects. Predicted underwater sound levels are compared against interim thresholds that have been accepted by the Federal Highway Administration (FHWA), Caltrans, and NOAA National Marine Fisheries Service (NMFS). These thresholds are discussed in this report.

Pile driving will produce underwater and airborne noise in and around Monterey Bay. Most of the pile driving activities will be in water about 30 feet deep or less that is adjacent to the jetty.

There is no way to accurately predict underwater sound levels from these activities, other than to rely on acoustic data measured from previous projects. Available underwater sound data for projects involving the installation of similar piles were reviewed. The sound levels for proposed pile driving activities were estimated using these data combined with an understanding of how and where these activities would occur. These predictions are essentially a best estimate based on empirical data and engineering judgment, but by their very nature contain a degree of uncertainty. The duration of driving for each pile installation and number of piles strikes was also estimated as part of the noise prediction process, based on available data from similar projects and engineering estimates. The availability of data for this type of environment (i.e. fairly deep open water) is limited.

Pile driving also causes elevated airborne sound levels, which usually cause annoyance to humans nearby. There is concern that these sound levels may affect marine mammals in the area. This study also reports airborne sounds associated with pile driving, based on measurements of similar pile driving activities.

UNDERWATER SOUNDS FROM PILE DRIVING

Fundamentals of Underwater Noise

Sound is typically described by the *pitch* and loudness. *Pitch* is the height or depth of a tone or sound, depending on the relative rapidity (frequency) of the vibrations by which it is produced. *Loudness* is intensity of sound waves combined with the reception characteristics of the auditory system. Intensity may be compared with the height of an ocean wave in that it is a measure of the amplitude of the sound wave.

In addition to the concepts of pitch and loudness, there are several noise measurement scales which are used to describe sound. *A decibel (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 micro pascal (µPa) is commonly used to describe sounds in terms of decibels. Therefore, 0 dB on the decibel scale would be a measure of sound pressure of 1 µPa. Sound levels in decibels are calculated on a logarithmic basis. An increase of 10 decibels represents a ten-fold increase in acoustic energy, while 20 decibels is 100 times more intense, 30 decibels is 1,000 times more intense, etc.

When a pile driving hammer strikes a pile a pulse is created that propagates through the pile and radiates sound into the water, the ground substrate, and the air. Sound pressure pulse as a function of time is referred to as the waveform. In terms of acoustics, these sounds are described by the peak pressure, the root-mean-square pressure (RMS), and the sound exposure level (SEL). The peak pressure is the highest absolute value of the measured waveform, and can be a negative or positive pressure peak. For pile driving pulses, RMS level is determined by analyzing the waveform and computing the average of the squared pressures over the time that comprise that portion of the waveform containing the vast majority of the sound energy.[1] The pulse RMS has been approximated in the field for pile driving sounds by measuring the signal with a precision sound level meter set to the "impulse" RMS setting and is typically used to assess impacts to marine mammals. Another measure of the pressure waveform that can be used to describe the pulse is the sound energy itself. The total sound energy in the pulse is referred to in many ways, such as the "total energy flux,"[2] The "total energy flux" is equivalent to the un-weighted SEL for a plane wave propagating in a free field, a common unit of sound energy used in airborne acoustics to describe short-duration events referred to as dB re 1µPa^2-sec. Peak pressures and RMS sound pressure levels are expressed in dB re 1 µPa. The total sound energy in an impulse accumulates over the duration of that pulse. Figure 1 illustrates the descriptors used to describe the acoustical characteristics of an underwater pile driving pulse. Table 1 includes the definitions of terms commonly used to describe underwater sounds.

The variation of instantaneous pressure over the duration of a sound event is referred to as the waveform. Studying the waveforms can provide an indication of rise time; however, rise time differences are not clearly apparent for pile driving sounds due to the numerous rapid fluctuations that are characteristic to this type of impulse. A plot showing the accumulation of sound energy over the duration of the pulse (or at least the portion where much of the energy accumulates)

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1 Richardson, Greene, Malone & Thomson, *Marine Mammals and Noise,* Academic Press, 1995 and Greene, personal communication.

2 Finerran, et. al., *Temporary Shift in Masked Hearing Thresholds in Odontocetes after Exposure to Single Underwater Impulses from a Seismic Watergun*, Journal of the Acoustical Society of America, June 2002.

illustrates the differences in source strength and rise time. An example of the characteristics of a typical pile driving pulse is shown in Figure 1.

Table 1 - Definitions of Underwater Acoustical Terms

Term	Definition
Decibel, dB	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 micro pascals (µPa)and 1 µPa for underwater.
Equivalent Noise Level, L_{eq}	The average noise level during the measurement period.
L_{01}, L_{10}, L_{50}, L_{90}	The sound levels that are exceeded 1%, 10%, 50%, and 90% of the time during the measurement period.
Peak Sound Pressure, unweighted (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 a pressure of 1
RMS Sound Pressure Level, (NMFS Criterion)	The average of the squared pressures over the time that comprise that portion of the waveform containing 90 percent of the sound energy for one pile driving impulse.[3]
Sound Exposure Level (SEL), dB re 1 µPa^2 sec	Proportionally equivalent to the time integral of the pressure squared and is described in this report in terms of dB re 1 µPa^2 sec over the duration of the impulse. Similar to the unweighted Sound Exposure Level (SEL) standardized in airborne acoustics to study noise from single events.
Cumulative SEL	Measure of the total energy received through a pile-driving event (for this project defined as pile driving over one day or maximum of 3 piles)
Waveforms, µPa over time	A graphical plot illustrating the time history of positive and negative sound pressure of individual pile strikes shown as a plot of µPa over time (i.e., seconds)
Frequency Spectra, dB over frequency range	A graphical plot illustrating the distribution of sound pressure vs. frequency for a waveform, dimension in rms pressure and defined frequency bandwidth

SEL is an acoustic metric that provides an indication of the amount of acoustical energy contained in a sound event. For pile driving, the typical event can be one pile driving pulse or many pulses such as pile driving for one pile or for one day of driving multiple piles. Typically, SEL is measured for a single strike and a cumulative condition. The cumulative SEL associated with the driving of a pile can be estimated using the single strike SEL value and the number of pile strikes through the following equation:

$$SEL_{CUMULATIVE} = SEL_{SINGLE\ STRIKE} + 10 \log (\#\ of\ pile\ strikes)$$

For example, if a single strike SEL for a pile is 165 dB and it takes 1,000 strikes to drive the pile, the cumulative SEL is 195 dBA (165 dB + 30 dB = 195 dB), where 10 * Log_{10}(1000) = 30.

[3] The underwater sound measurement results obtained during the Pile Installation Demonstration Project indicated that most pile driving impulses occurred over a 50 to 100 millisecond (msec) period. Most of the energy was contained in the first 30 to 50 msec. Analysis of that underwater acoustic data for various pile strikes at various distances demonstrated that the acoustic signal measured using the standard "impulse exponential-time-weighting" (35-msec rise time) correlated to the RMS (impulse) level measured over the duration of the impulse.

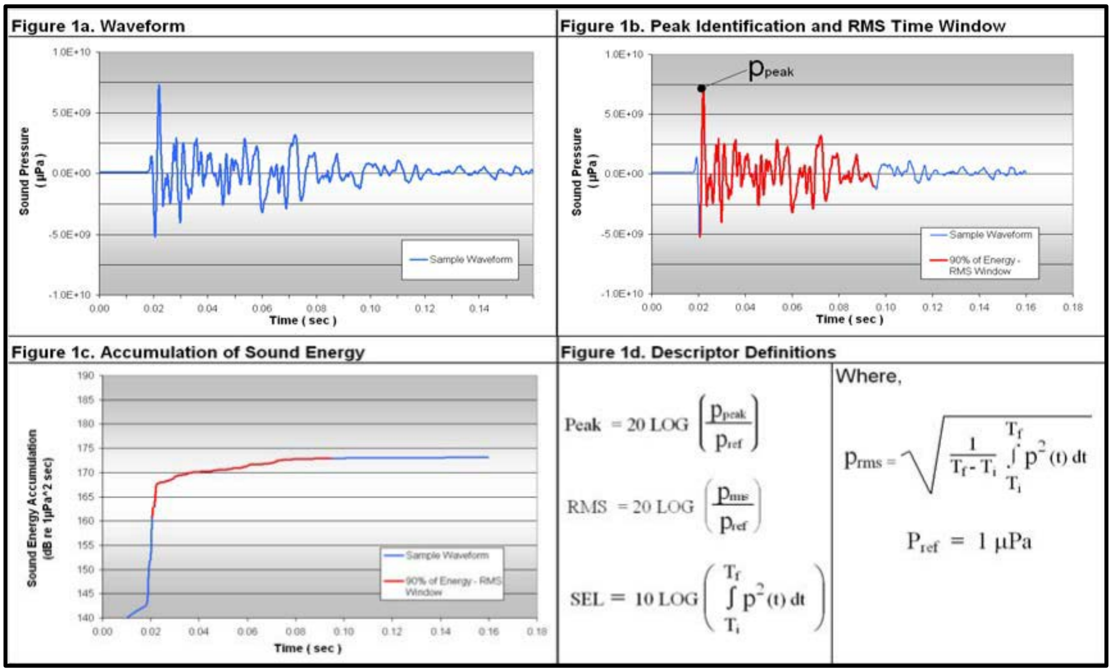

Figure 1. Characteristics of a Pile Driving Pulse

Underwater Sound Thresholds

Underwater sound affects to fish and marine mammals are discussed below. In this report, peak pressures and RMS sound pressure levels are expressed in decibels re 1 µPa. Sound exposure levels are expressed as dB re 1µPa^2-sec.

Fish

A Fisheries Hydroacoustic Workgroup (FHWG) that consisted of transportation officials, resources agencies, the marine construction industry (including Ports), and experts was formed in 2003 to address the underwater sound issues associated with marine construction. The first order of business was to document all that was clearly known about the effects of sound on fish, which was reported in *The* “Effects of Sound on Fish.”[4] This report provided recommended preliminary guidance to protect fish. A graph showing the relationship between the SEL from a single pile strike and injurious effects to fish based on size (i.e., mass) was presented. Fish with a mass of about 0.03 grams were expected to have no injury for a received SEL of a pile strike below 194 dB and suffer 50% mortality at about 197 dB. The report also described possible effects to the auditory system (i.e., auditory tissue damage and hearing loss), based on a received dose of sound. The recommendations were frequency dependent, based on the hearing thresholds of fish or most sensitive auditory bandwidths. For salmonids, hearing effects would be expected at or near the thresholds for injury based on the single strike SEL. Further investigations into the effects of pile driving sounds on fish was also recommended.

Caltrans commissioned a subsequent report to provide additional explanation of, and a practical means to apply, injury criteria recommended in The Effects of Sound on Fish. This report is entitled “Interim Criteria for Injury of Fish Exposed to Pile Driving Operations: A White Paper”,

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[4] Hastings, M and A. Popper. 2005. The Effects of Sound on Fish. Prepared for the California Department of Transportation. January 28 (revised August 23).

(*White Paper*).[5] The White Paper recommended a dual criterion for evaluating the potential for injury to fish from pile driving operations. The dual approach considered that a single pile strike with high enough amplitude, as measured by zero to peak (either negative or positive pressure) could cause injury. A peak pressure threshold for a single strike was recommended at 208 dB. In 2007, Carlson et al provided an update to the White Paper in a memo titled "Update on Recommendation for Revised Interim Sound Exposure Criteria for Fish during Pile Driving Activities."[6] In this memo, they propose criteria for each of three different effects on fish; 1) hearing loss due to temporary threshold shift, 2) damage to auditory tissues, and 3) damage to non-auditory tissues. These criteria vary due to the mass of the fish and if the fish is a hearing specialist or hearing generalist. In preparing this update, Dr. Mardi Hastings summarized information from some current studies in a report titled "Calculation of SEL for Govoni et al. (2003, 2007) and Popper et al. (2007) Studies."

On June 12, 2008, NMFS; U.S. Fish and Wildlife Service; California, Oregon, and Washington Departments of Transportation; California Department of Fish and Game; and the U.S. Federal Highway Administration generally agreed in principal to interim criteria to protect fish from pile driving activities, as shown in Table 2. Note that the peak pressure criteria of 206 dB was adopted (rather than 208 dB), as well as accumulated SEL criteria for fish smaller than 2 grams. NMFS interpretation of the interim criteria is described by Woodbury and Stadler (2009)[7].

Table 2 - Adopted Impact Pile Driving Acoustic Criteria for Fish

Interim Criteria for Injury	Agreement in Principle
Peak	206 dB for all size of fish
Cumulative SEL	187 dB for fish size of two grams or greater. 183 dB for fish size of less than two grams.
Behavior effects threshold 150 dB RMS	

The primary difference between the adopted criteria and previous recommendations is that the single strike SEL was replaced with a cumulative SEL over a day of pile driving. NMFS does not consider sound that produces an SEL per strike of less than 150 dB to accumulate and cause injury. The adopted criteria listed in Table 2 are for pulse-type sounds (e.g., pile driving) and do not address sound from vibratory driving of piles; there are no acoustic thresholds that apply to the lower amplitude noise produced by vibratory pile driving. In fact, the acoustic thresholds developed for fish only apply to impact pile driving.

The Bureau of Ocean Energy Management, (BOEM -formerly Minerals Management Service), Caltrans, and National Cooperation of Highway Research Programs (NCHRP 25–

5 Popper, A., Carlson, T., Hawkins, A., Southall, B. and Gentry, R. 2006. Interim Criteria for Injury of Fish Exposed to Pile Driving Operations: A White Paper. May 14.

6 Carlson, T, Hastings, M and Poper, A. 2007. Memo to Suzanne Theiss, California Department of Transportation, Subject: Update on Recommendations for Revised Interim Sound Exposure Criteria for Fish during Pile Driving Activities. December 21.

7 Stadler, J. and Woodbury, D. 2009. Assessing the effects to fishes from pile driving: Application of new hydroacoustic criteria. Proceedings of inter-noise 2009, Ottawa, Canada. August 23-26.

28)/Transportation Research Board (TRB) have funded studies to identify the onset of injury to fish from impact pile driving. One of the goals of these studies was to provide quantitative data to define the levels of impulsive sound that could result in the onset of barotrauma injury to fish.[8] Laboratory simulation of pulse-type pile driving sounds enabled careful study of the barotrauma effects to Chinook Salmon. The neutrally buoyant juvenile fish were exposed to impulsive sounds and subsequently evaluated for barotrauma injuries. Significant barotrauma injuries were not observed in fish exposed to 960 pulses at 180 dB SEL per pulse or 1,920 pulses at 177 dB per pulse. In both exposures, the resulting accumulated SEL was 210 dB SEL. Results of these studies are under review. At this time, the criteria in Table 2 are used by NMFS to assess impacts to fish. Potential behavior impacts that might occur above 150 dB RMS are not used to restrict pile driving.

Marine Mammals

Under the Marine Mammal Protection Act, NMFS has defined levels of harassment for marine mammals. Level A harassment is defined as "Any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild." Level B harassment is defined as "Any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including but not limited to migration, breathing, nursing, breeding, feeding or sheltering."

Current NMFS practice regarding exposure of marine mammals to high level sounds is that cetaceans and pinnipeds exposed to impulsive sounds of 180 and 190 dB RMS or greater, respectively, are considered to have been taken by Level A (i.e., injurious) harassment. Behavioral harassment (Level B) is considered to have occurred when marine mammals are exposed to sounds 160dB RMS or greater for impulse sounds (e.g., impact pile driving) and 120 dB RMS for continuous noise (e.g., vibratory pile driving). The application of the 120 dB RMS threshold can sometimes be problematic because this threshold level can be either at or below the ambient noise level of certain locations. For continuous sounds, NMFS Northwest Region has provided guidance for reporting RMS sound pressure levels. RMS levels are based on a time-constant of 10 seconds; RMS levels should be averaged across the entire event. For impact pile driving, the overall RMS level should be characterized by integrating sound for each acoustic pulse across 90 percent of the acoustic energy in each pulse and averaging all the RMS for all pulses.

NMFS Northwest Region has defined the estimated auditory bandwidth for marine mammals[9]. For this project location, the functional hearing groups are low-frequency cetaceans (humpback and gray whales), high-frequency cetaceans (harbor porpoises) and pinnipeds (Stellar and California sea lions, harbor and northern elephant seals). For pile driving, the majority of the acoustic energy is confined to frequencies below 2 kHz and there is very little energy above 20 kHz. The underwater acoustic criteria for marine mammals are shown in Table 3.

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[8] Halvorsen MB, Casper BM, Woodley CM, Carlson TJ, Popper AN (2012) Threshold for Onset of Injury in Chinook Salmon from Exposure to Impulsive Pile Driving Sounds. PLoS ONE 7(6): e38968. oi:10.1371/journal.pone.0038968

[9] Note that NMFS Southwest Region has not provided guidance for measuring sound levels from pile driving, so guidance from the Northwest Region is used in this assessment.

Table 3 - Adopted Underwater Acoustic Criteria for Marine Mammals[10]

Species	Underwater Noise Thresholds (dB re: 1µPa)			
	Vibratory Pile Driving Disturbance Threshold	Impact Pile Driving Disturbance Threshold	Injury Threshold	Frequency Range
Cetaceans	120 dB RMS	160 dB RMS	180 dB RMS	7 Hz to 20 kHz (Low) 150 Hz to 20 kHz (Mid) 200 Hz to 20 kHz (High)
Pinnipeds	120 dB RMS	160 dB RMS	190 dB RMS	75 Hz to 20 kHz

Underwater Sound Generating Activities

For the proposed project, the primary sources of underwater sound would be from the driving of round steel piles to support the pier. The options for installing these piles range from driving the piles the full length with an impact hammer (either diesel or hydraulic) to vibrating in the piles with limited impact driving to proof the pile bearing. At this time it is not known what method will be used, so an analysis of the different methods is provided. The pile sizes will be between 14-inch and 18-inch-diameter. This analysis conservatively assumes that larger 18-inch size for the noise projections. Impact pile driving produces pulsed-type sounds, while vibratory pile driving produce continuous-type sounds. The distinction between these two general sound types is important because they have differing potential to cause physical effects, particularly with regard to hearing.

Pulsed sounds, such as impact pile driving, explosions, or seismic air guns are brief, distinct acoustic events that occur either as an isolated event (e.g., explosion) or repeated in some succession (e.g., impact pile driving). Pulsed sounds are all characterized by discrete acoustic events that include a relatively rapid rise in pressure from ambient conditions to a maximum pressure value followed by a decay period that may include a period of diminishing, oscillating maximal and minimal pressures. Pulsed sounds are typically high amplitude events that have the potential to cause hearing injury. Continuous or non-pulsed sounds can be tonal or broadband. These sounds include vessels, aircraft, machinery operations such as vibratory pile driving or drilling, and active sonar systems. This project may involve both pulsed and continuous type sounds from pile installation.

Given the dense substrate at the project, it is possible that much of the pile installation would involve impact pile driving. However, this analysis assumes two methods:

1. Vibratory installation and proofing of piles with an impact hammer
2. Impact pile driving only

Preliminary indications are that MGF RBH 200 vibration hammer and/or Delmag D30/32 diesel impact hammer or equivalent hammer would be required to vibrate and impact-drive these relatively small diameter piles. The driving periods are not likely to be continuous. The piles require a minimum of 35 feet of embedment into the ground.

[10] Based on NOAA 77 FR 43049, July 23, 2012. Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to a Pile Replacement Project.

For vibratory pile installation, it is estimated that it would take approximately 20 minutes (1200 seconds) to vibrate in each pile and between one to two minutes of impact driving of each pile with the impact hammer to proof them. It is also estimated that the pile driving crew could vibrate several piles in one day and complete the impact driving the following day. Approximately 100 blows were assumed for proofing of piles with an impact hammer. In terms of underwater sound effects on fish, the highest cumulative sound levels would occur under a scenario where numerous piles are impact driven in one day.

For the scenario that requires mostly impact pile driving, pile installation are estimated to require up to 20 minutes of pile driving. However, there is no reliable estimate of the pile driving time. Assuming a hammer is used that moves the pile at about 30 to 40 blows per minute, up to 20 minutes of impact pile driving would be required for each pile. A full pile driving event was assumed to require 685 pile strikes. The project would install up to 3 piles in one day. In terms of underwater sound effects on fish, the highest cumulative sound levels would occur under a scenario where three piles are impact driven in one day.

Discussion of Underwater Sound Generation from Pile Driving

A review of underwater sound measurements for similar projects was undertaken to estimate the near-source sound levels for vibratory and impact pile driving. Sounds from similar-sized steel shell piles have been measured in water for several projects.

Vibratory Pile Installation Sound Generation

A review of available acoustic data for pile driving indicates that recent Test Pile Program at Naval Base Kitsap at Bangor, Washington provides the most extensive set of data. The project involved the installation of test piles of 24-, 36- and 48-inches in diameter using a vibratory driver. Most of the installed piles were 36 inches in diameter and only one pile was 24-inch diameter. This Test Pile Program provided the average sound level based on the RMS levels using a 10-second time constant. Most other data reported are based on maximum RMS values using a 1- to 10-second time constant (e.g., Caltrans Fish Guidance Manual 2009).

For 36-inch diameter piles driven by the Navy, the average RMS level for all pile driving events was 159 dB RMS at 33 feet or 10 meters. There was a considerable range in the RMS levels measured across a pile driving event, where the highest average RMS level was 169 dB RMS.

The range of vibratory sound levels at 33 feet or 10 meters reported by Caltrans is 155 dB for 12-inch diameter piles to 175 dB RMS for 36-inch diameter piles (based on maximum 1-second RMS levels). All of these piles were driven in relatively shallow water.

Noting that the piles to be used for this project will be smaller than those driven by the Navy for their Test Pile Program at Bangor, Washington, a near-source level of 168 dB RMS at 33 feet (10 meters) level was used to characterize the sound that would be produced from vibratory pile installation.

Impact Pile Driving Sound Generation

A review of existing data indicates that measurements conducted for the USCG Tongue Point Pier Repairs in the Columbia River are most representative. This project was located on the Columbia

River near Astoria, Oregon. The purpose of the project was to repair the existing Tongue Point pier. The project included installation of 24-inch-diameter steel pipe piles to replace existing wood-piles, along with reconstruction of a concrete deck. Figures 2a and 2b show the installation of these piles.

Figure 2a. Pile layout on Pier. Piles have been vibrated in and are ready to be driven with the impact hammer

Figure 2b. Preparing to impact drive a 24- inch steel trestle pile with bubble rings to attenuate under water noise.

Data measured at the Tongue Point Pier Repair included similar types of pile driving on an existing pier in deep water. Although the length of the installed piles are similar to those proposed for this project, the diameters were larger than proposed for this project. The difference in pile size should not result in much, if any, difference in the expected noise levels from pile driving.

Average sound levels measured at Tongue Point include peak pressures of 189 to 207 dB, RMS sound pressure levels of 178 to 189 dB, and SEL levels of 160 to 175 dB per strike at 33 feet (10 meters). Sound levels associated with vibratory installation of the piles were not measured on this project. The ambient levels measured in between pile driving ranged from a RMS level of 115 to 125 dB. Due to the difference in pile sizes, use of the Tongue Point data would likely overestimate sound levels expected at the proposed USCG Station Monterey project. Based on the Tongue Point sound measurements, unattenuated near-source impact pile driving levels applicable to this project are 208 dB peak, 195 RMS and 175 dB SEL. Note, a substantially higher RMS level of 195 dB was assumed rather than 189 dB that was measured for Tongue Point. Typically, there is an approximately 10 to 15 dB difference in peak and RMS sound pressure levels. Assuming the higher peak pressure of 208 dB, an RMS level of 195 dB would typically occur. To provide a conservative estimate, the higher RMS sound pressure level was assumed for this assessment.

PREDICTION OF UNDERWATER SOUND FROM PROJECT PILE DRIVING

Estimated noise impacts are discussed specifically for each type of pile driving. For vibratory driving, which would provide a continuous sound, a source level of 168 dB RMS was applied. Impact driving, which produces higher amplitude pulse-type sounds would have a near-source level of 208 dB peak, 195 dB RMS and a single strike SEL of 175 dB. These levels represent unattenuated conditions (i.e., no air bubble curtain or other means of reducing underwater sounds).

Sound from pile installation (i.e., impact or vibratory pile driving) would transmit or propagate from the construction area. Transmission loss (TL) is the decrease in acoustic pressure as the sound pressure wave propagates away from the source. TL parameters vary with frequency, temperature, sea conditions, current, source and receiver depth, water depth, water chemistry, and bottom composition and topography. NMFS has developed an underwater acoustic calculator that uses practical spreading (a 15 $\log_{10}$ function) to predict sound levels at various distances from the source. This equates to a 4.5 dB decrease in sound level for every doubling of distance away from the source. The formula for transmission loss is TL = 15 $\log_{10}$ (R), where R is the distance from the source divided by the distance to where a near-source level was measured (i.e., 33 feet or 10 meters for this application). This TL model, based on the default practical spreading loss assumption, was used to predict underwater sound levels generated by pile installation from this project. Measurements conducted during project pile driving could further refine the rate of sound propagation or TL.

Pile installation would be adjacent to a rock jetty that would provide substantial underwater shielding of sound transmission to areas north (or through the jetty). Figure 3 depicts this rock jetty.

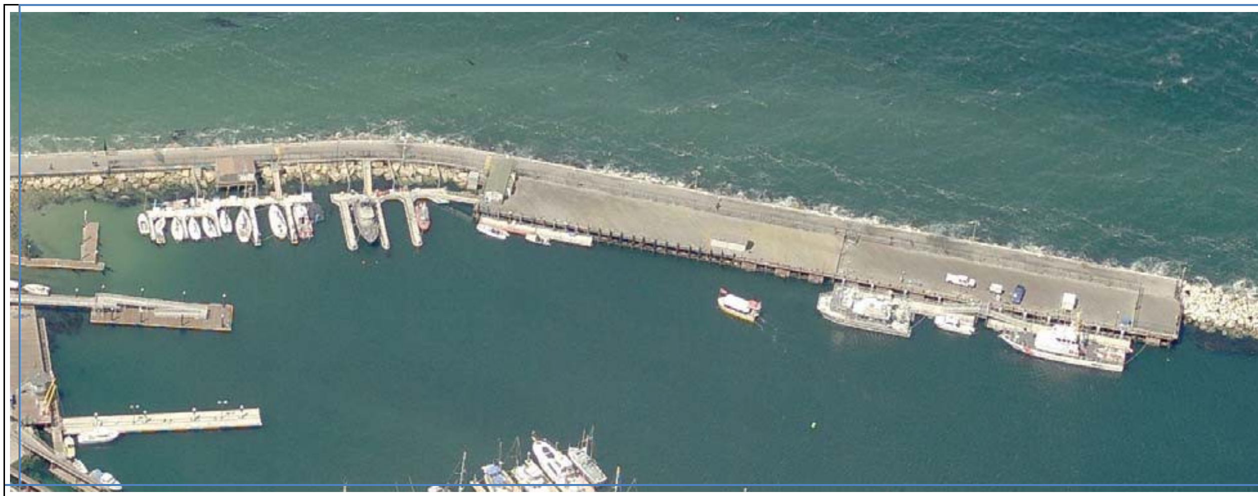


Figure 3. Aerial view of the project site showing the rock jetty that extends along the north side of the project piers

Vibratory Pile Installation

The peak noise level threshold will not be exceeded with the vibratory installation of the piles. The peak levels are expected to be less than 190 dB at 10 meters. There are no cumulative SEL criteria for vibratory pile installation; therefore, an analysis was not conducted to determine SEL levels for the vibratory driving. The criteria for harassment of marine mammals from vibratory pile driving are based on the average RMS levels. Table 4 shows the distance to the different harassment criteria. Note that these distances are based on a standard 15 $\log_{10}$ propagation rate. The actual distances would be less than the projected distances as a result of shielding from the rock jetty and the topography of the bottom of the bay.

Vibratory sound from pile driving was modeled using SoundPlan to simulate the effect of the rock jetty in reducing sound. Unlike impact pile driving, vibratory sound is radiated only from the pile and tends to have a higher frequency sound content. Therefore, there is little or no ground borne sound that could transmit through underwater barriers such as the rock jetty. SoundPlan was used to develop the pattern of sound transmission; however, NMFS practical spreading loss assumptions of 15 $\log_{10}$ sound propagation (as described above) were assumed. Figure 4 shows the pattern of sound expected from vibratory pile installation, taking into account shielding from the rock jetty. The distances to the 120 dB RMS contour are limited by interaction with the rock jetty and shoreline. Table 4 reports the theoretical and modeled distances to where 120 dB RMS sound levels would extend. It is likely that the rock jetty would reduce sound considerably more than predicted, so that the distance north from the jetty to the extent of the 120 dB RMS sound level would be less than reported in Table 4.

Table 4 - Modeled Extent of 120 dB RMS Sound Pressure Levels from Vibratory Pile Installation

Modeling Scenario	Distance to 120 dB RMS
Theoretical	10 miles or 16 kilometers
Modeled North	6,650 feet or 2,000 meters
Modeled Northeast Shoreline	8,000 feet or 2,400 meters
Modeled East to Shoreline	6,000 feet or 1,800 meters
Modeled South to Shoreline	1,800 feet or 550 meters

Impact Pile Driving

Peak sound pressure, average RMS sound pressure levels, and SELs from impact driving were predicted using the near source levels for impact pile driving and the practical loss sound propagation assumptions described above. As with vibratory driving, the rock jetty was considered in the modeling. Table 5 shows the extent of sound levels for the NMFS marine mammal and fish criteria. Figure 5 shows the extent of unattenuated RMS sound pressure levels for impact pile driving out to the NMFS behavioral criterion of 160 dB RMS.

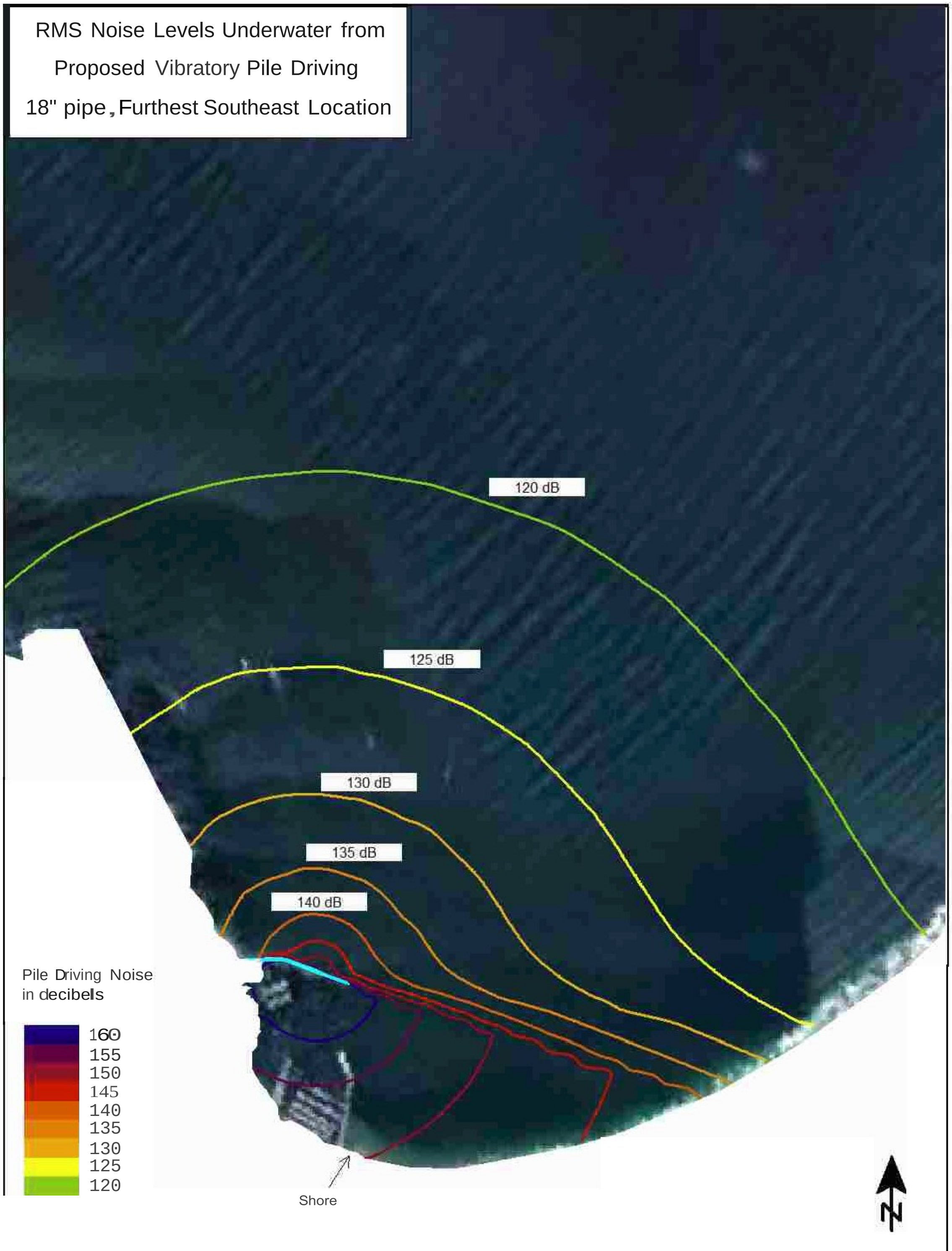


Figure 4. Extent of RMS Sound Pressures from Vibratory Pile Installation

Reducing sounds from impact pile driving using air bubble curtains is common. Caltrans reports a large range in sound reduction from almost no reduction to 30 dB as a result of use of these curtains. During the Tongue Point project (i.e., the source of impact pile driving levels for this assessment) the reduction from an air bubble curtain was between 8 and 14 dB. Therefore, this assessment assumes that underwater sounds could be reduced at least 10 dB with the use of a properly designed and deployed air bubble curtain attenuation system. Based on the topography (on a slope with large rocks- rip rap) it will be difficult to obtain a good seal between the bottom surface of the causeway and the bubble ring. Special care will be required to obtain the minimum sound reduction of 10 dB.

Table 5 - Modeled Extent of Sound Pressure Levels from Unattenuated and Attenuated Impact Pile Driving

	Distance to Marine Mammal Criteria			Distance to Fish Criteria		
	RMS (dB re: 1µPa)			Peak (dB re: 1µPa)	Cumulative SEL* (dB re: 1µPa-sec^2)	
Modeling Scenario	**160**	**180**	**190**	**206 dB**	**187**	**183**
Modeled Unattenuated	7,050 ft. 2,150 m	330 ft 100 m	75 ft 22 m	<70 ft <20 m	400ft 123 m	750 ft 228 m
Modeled North and Northeast (through jetty)	250 ft 76 m	--	--	<33 ft <10 m	<33 ft <10 m	<33 ft <10 m
Modeled East to Shoreline	6,070 ft 1,850m	330 ft 100 m	75 ft 22 m	<70 ft <20 m	400ft 123 m	750 ft 228 m
Modeled South to Shoreline	1,800 ft 550 m	330 ft 100 m	75 ft 22 m	<70 ft <20 m	400ft 123 m	750 ft 228 m
Modeled Attenuated in all directions (except North)	1,525 ft 465 m	75 ft 22 m	<33 ft <10 m	<33 ft <10 m	90 ft 27 m	160 ft 49 m

***** Based on the driving of one pile. SEL criteria apply to impact pile driving events that occur during one day. See Tables 6 through 8 for predicted accumulated SEL for various daily pile driving scenarios.

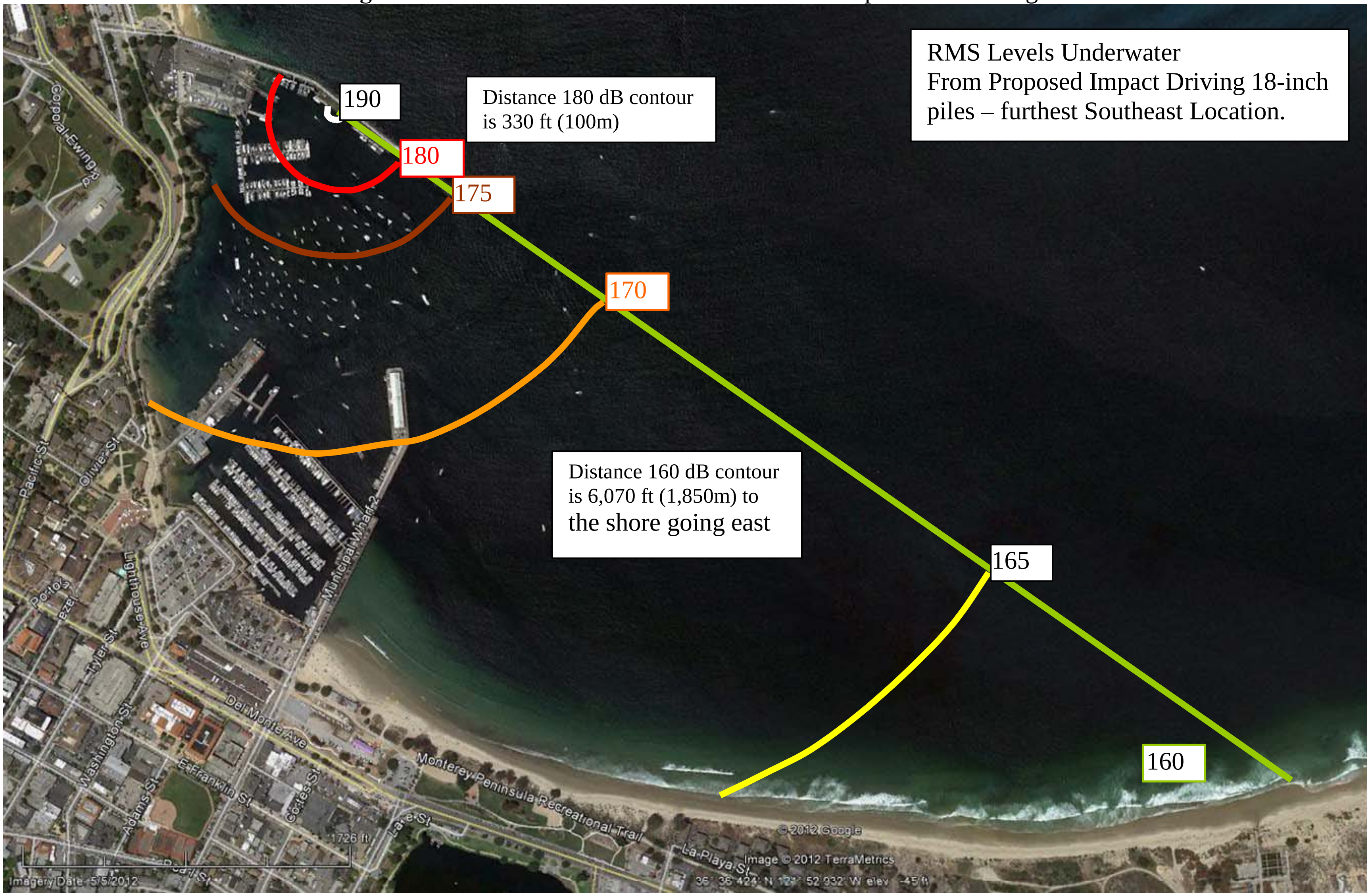
Accumulated SEL levels associated with impact pile driving will vary daily, depending on the amount of pile driving. Two impact pile driving scenarios were considered:

- Full Drive: Assumes the pile would be driven 35 feet into the ground and require 685 pile strikes

- Proofing: Assumes about 2 to 3 minutes of pile driving, requiring up to 100 pile strikes.

Tables 6 and 7 predict the accumulated SEL for the driving or proofing of up to 10 piles. Table 6 reports the accumulated SEL levels based on unattenuated pile driving, while Table 7 assumes a 10-dB reduction in the SEL level when using a properly deployed air bubble curtain system. Table 8 reports the estimated distances to the accumulated 183 and 187 dB SEL level, depending on the number of piles driven or proofed in one day. Note that the calculated distances for the cumulative SEL shown in Table 8 reflect that there is no increase in the cumulative SEL when the single strike SEL is below 150 dB. For example the distance to the 150 dB single strike SEL is 100 meters for impact driving; therefore the cumulative SEL does not change for distances beyond 100 meters.

Figure 5. Extent of RMS Sound Pressures from Impact Pile Driving



Not To Scale

Table 6 -Cumulative SEL levels for Unattenuated Pile Driving at 33 ft (10 m)

Pile Type	Pile size	Blows	Single Strike SEL	Number of Piles Driven in a Day		
				1	2	3
Full Drive	18- inch	685	175	203	206	208
Proofing	18-inch	100	170	190	193	195

Table 7 - Cumulative SEL for Attenuated Pile Driving at 33 ft (10 m)

Pile Type	Pile size	Blows	Single Strike SEL	Number of Piles Driven in a Day		
				1	2	3
Full Drive	18- inch	685	165	193	196	198
Proofing	18-inch	100	160	185	188	190

Table 8 - Distances to the Cumulative SEL Criteria for Attenuated Pile Driving in Meters

Location	Pile size	Blows	Hammer type	RMS	Peak Sound Pressure	Single Strike SEL	Distance to the 187 dB Cumulative SEL - Meters									
							1	2	3	4	5	6	7	8	9	10
Full Drive	18-inch	685	D30/36	185	198	165	27	42	55	67	78	88	97	100	100	100
Proofing	18-inch	100	D30/36	185	198	165	<10	12	15	19	22	24	27	29	32	34

Location	Pile size	Blows	Hammer type	RMS	Peak Sound Pressure	Single Strike SEL	Distance to the 183 dB Cumulative SEL - Meters									
							1	2	3	4	5	6	7	8	9	10
Full Drive	18-inch	685	D30/36	185	198	165	49	78	100	100	100	100	100	100	100	100
Proofing	18-inch	100	D30/36	185	198	165	14	22	28	34	40	45	50	54	59	63

AIRBORNE SOUNDS FROM PILE DRIVING

Pile driving generates airborne sound that could potentially result in disturbance to marine mammals (i.e., pinnipeds) which are hauled out or at the water's surface. The NMFS has adopted thresholds for harassment and injury to marine mammals, as shown in Table 9. The appropriate airborne noise thresholds for behavioral disturbance for all pinnipeds, except harbor seals, is 100 dB re 20 μPa RMS and for harbor seals is 90 dB re 20 μPa RMS. Similar to underwater sounds, these sounds are considered over the frequency range of 75Hz to 20,000 Hz and are assumed to be similar to C-weighted sound levels, which are broadband sound levels that are weighted at very low frequencies below 100 Hz.[11] The thresholds are interpreted to apply to average RMS sound levels during a driving event.

[11] C-weighting is based on a curve defined by IEC 61672:2003 relating to the measurement of sound pressure level. The weighting is employed by arithmetically adding a table of values for one third-octave bands, to the measured levels. There is generally no weighting applied to sounds between about 80 and 8,000 Hz.

Table 9 - Adopted Airborne Criteria for Marine Mammals[12]

Species	Disturbance Airborne Noise Thresholds for Impact & Vibratory Pile Driving (dB re: 20 µPa)
Cetaceans	None
Pinnipeds	90 dB RMS (un-weighted) for harbor seals 100 dB RMS (un-weighted) for sea lions and all other pinnipeds

Fundamentals of Airborne Noise

Sound from a single source (i.e., a “point” source) radiates uniformly outward in a spherical pattern as it travels away from the source. The sound level attenuates (or drops off) at a rate of 6 dBA for each doubling of distance. Usually the noise path between the source and the observer is very close to the ground. Noise attenuation from ground absorption and reflective wave canceling adds to the rate of attenuation. Traditionally, the excess attenuation has also been expressed in terms of attenuation per doubling of distance. This approximation is done for simplification only; for distances of less than 300 feet, prediction results based on this scheme are sufficiently accurate. For acoustically “hard” sites (i.e., sites with a reflective surface, such as a smooth body of water, between the source and the receiver), no excess ground attenuation is assumed.

Sounds generated from construction activities are considered point sources, rather than a line source such as a freeway or roadway. The marine environment around the project site is mostly water and would be considered a “hard” site. The TL drop off rate of sound is based on spherical spreading loss (a 20 $\log_{10}$ function). This equates to a 6-dB reduction in sound per doubling distance. The formula for calculating the drop off is the source level plus $20*\text{Log}_{10}(D_1/D_2)$, where D_1 is the reference position and D_2 is the receiver position. For example, if an impact pile driver has a reference level of 110 dB at 50 feet the noise level at 500 feet would be calculated as follows for conditions where excess attenuation is not anticipated:

Received level = 110dBA +20Log$_{10}$*(50/500) dBA*

Received level =110+(-20) dBA

Received level = 90 dBA

There are relatively few data regarding the un-weighted sound levels for impact or vibratory pile driving. Table 10 shows the Lmax and Leq levels[13] measured while driving relatively small diameter steel shell piles (24- to 36-inch diameter) at the Navy Test Pile Program project in Bangor, Washington.

[12] Based on NOAA 77 FR 43049, July 23, 2012. Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to a Pile Replacement Project.

[13] L_{max} level is the typical maximum RMS sound level measured with a Sound Level Meter set to the “fast” response (or $1/8^{th}$ second response time). The Leq is the energy average sound level measured over a driving event.

Table 10 – Underwater Sound Levels from Driving of Steel Piles Measured at 50 ft (15m)

Sound Descriptor	Sound Level in dB	
	Vibratory Hammer	Impact Hammer
Lmax	102	112
Leq	97	103

Airborne Impacts from Vibratory Pile Driving

Measured sound levels from vibratory pile driving used in this analysis are based on measurements made during the Navy Test Pile Project, as shown in Table 10. The maximum measured unweighted Lmax was 102 dB and the average Lmax was 97 dB at 50 feet or 15 meters. The $20\log_{10}$ attenuation rate was used to calculate the distances to the various NMFS thresholds that are presented in Table 11. The distances shown are based on the Lmax levels. We believe that as NMFS criterion are based on average levels, these distances likely overestimates impacts. Figure 6 shows the extent of these sound levels.

Table 11 – Distance to Thresholds with Vibratory driving

Threshold	Distance (meters)	
	100 dB	90 dB
Lmax	65 ft 20 m	200 ft 60 m
Leq	35 ft 10 m	110 ft 35 m

Airborne Impacts from Impact Pile Driving

Measured sound levels from impact pile driving used in this analysis are also based on measurements made during the Navy Test Pile Project. The maximum measured unweighted Lmax was 112 dB and the average Lmax was 103 dB at 50 feet (15 meters). The $20\log_{10}$ attenuation rate was used to calculate the distances to the various NMFS thresholds that are presented in Table 12. The levels shown are the Lmax levels. Again, these distances likely overestimate impact areas, since they are based on the maximum levels. Figure 7 shows the extent of these sound levels.

Table 12 – Distance to Thresholds for Impact Driving

Threshold	Distance	
	100 dB	90 dB
Based on Lmax	200 ft 60 m	630 ft 190 m
Based on Leq	70 ft 20 m	225 ft 70 m

Figure 6. Extent of Airborne L_{max} Sound Levels from Vibratory Pile Driving

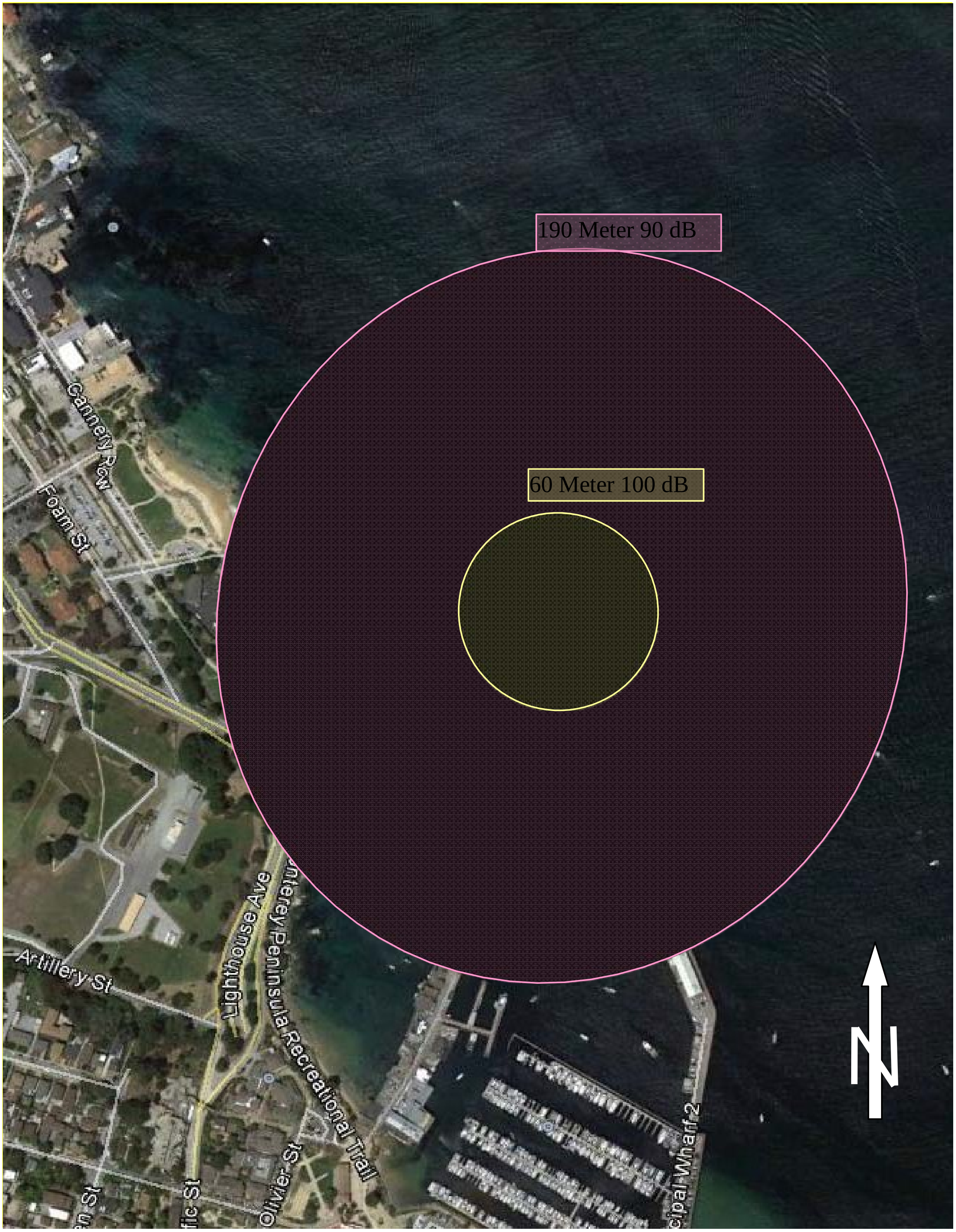


Figure 7. Extent of Airborne L_{max} Sound Levels from Impact Pile Driving

AMBIENT SURVEY

Baseline sound levels, both underwater and in air, were measured in the project area during August 12 through 14, 2012. The results of the baseline acoustic field program are presented in this section and are used to assess potential for adverse noise impacts on marine mammals and fish habitat during the proposed improvements at USCG Station Monterey. Measurements included a continuous two-day measurement at the project site and spot measurements both inside and outside the harbor.

Equipment

Underwater sound measurements were made using Reson TC4033 hydrophones with PCB in- line charge amplifiers (Model 422E13) and PCB Multi Gain Signal Conditioners (Model 80M122). The signals were fed into Larson Davis Model 831 Integrating Sound Level Meter (SLM) (Type 1) and digital recorders. The multi gain signal conditioner provides the ability to lower or raise the signal strength so that measurements are made within the dynamic range of the instruments used to analyze the signals.

Continuous airborne measurements were conducted using a Larson Davis Model 820 Integrating Sound Level Meter (SLM) (Type 1) fitted with precision microphones and windscreens. The sound level measuring assemblies were calibrated before and after the noise monitoring survey, and the response of the systems were always found to be within 0.5 dB of the calibrated level. No calibration adjustments were made to the measured noise levels. In addition, digital recordings with calibration tones were made for backup purposes.

Field Activities

Ambient sound levels were measured at two fixed positions and one vessel based position. All underwater sound measurements were made in decibels referenced to 1 µPa and airborne measurements were in decibels referenced to 20 µPa. At the two fixed positions the hydrophones were placed at mid depth of the water column. The first position was based on the existing USCG Station Monterey Pier and was set up to measure a 24-hour period; this allowed an analysis of the day night differences in the noise levels. The second fixed position was placed on the dock across from the USCG Station Monterey pier. Due to security concerns this system was placed in the morning and picked up at the end of the day. The hydrophone was set at mid water depth. Figures 8 through 11 are photographs of the monitoring positions. Time and date stamped time histories for all relevant datasets were compiled in 1-second Leq intervals. These data are presented in Appendix A.

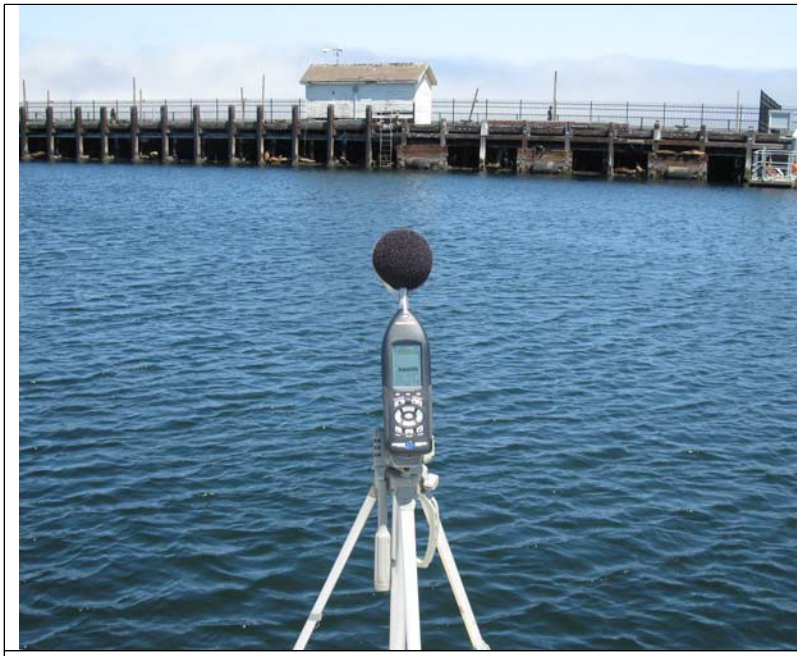


Figure 8. Photo of project site taken at dock monitoring position looking at the monitoring position at the USCG pier.

Figure 9. Photo of airborne and underwater monitoring location at the USCG wharf.

Figure 10. Airborne and underwater acoustic monitoring at new dock across from USCG pier.

Figure 11. Airborne and underwater sound measurement position from floating boat about 1 km east of the project site.

Table 13 summarizes the data collected at the project site and the nearby dock. These data are summarized by day and night periods. The data are presented statistically, where the L_{10} level is the level exceeded 10 percent of the time, the L_{50} is the median level and the L_{90} is the level exceeded 90 percent of the time. Measurements at nighttime were only conducted from the pier.

Table 13 - Summary Results: Underwater Broadband Sound Pressure Levels (80 to 20,000 Hz), in dB reference 1 µPa

Sound Descriptor	USCG Pier			Dock
	Overall	Day	Night	Day
Maximum	143	143	134	142
L_{10}	123	124	117	--
L_{50}	114	116	113	112
L_{90}	112	112	112	--

Table 14 summarizes the median and range of underwater sound levels measured at the pier site and Table 15 provides similar data for the dock site. In the vicinity of the project site, the median broadband ambient underwater sound levels (between 80 Hz and 20 kHz) were measured at 114 dB. Maximum levels were typically around 125 dB, as indicated by the L_{10} level. The maximum sounds were likely from boats. There were a considerable number of harbor seals and California sea lions near the hydrophones that may have resulted in elevated localized sounds. While ambient sounds are in the 110 to 120 dB range, acoustic events, such as boat traffic, typically result in sound levels that exceed 120 dB.

Table 14 - Summary of Underwater Measurement Levels at the USCG Pier in dB reference 1 µPa

Partial day 8/12		Night 8/13 - 8/14	
Max	136	Max	132
Min	112	Min	110
Median	113	Median	113

Night 8/12 - 8/13		Day 8/14	
Max	136	Max	135
Min	110	Min	111
Median	113	Median	116

Day 8/13		For all data	
Max	143	Max	143
Min	110	Min	110
Median	116	Median	114

The ambient sound levels were similar at all locations and were found to be marginally affected by sea state conditions and tidal currents. Light winds and relatively calm seas occurred during the measurement survey. Sources of anthropogenic noise included early morning fishing boats leaving the boat launch and boat traffic throughout the day. There was also a constant cracking or popping sound present at all locations measured. This was attributed to the presence of what is commonly called the Snapping Shrimp. These species have an oversized claw that is used to communicate and hunt, and for defense. The resulting sounds from these shrimp sound like static.

Sound pressure levels recorded at the two measurement locations were consistent; however, periodic deviations on the order of 20 dB were seen for brief periods.

Table 15 - Summary of Underwater Measurement Levels at the Dock Across from USCG Pier in dB reference 1 µPa

Day 8/13	
Max	142
Min	105
Median	112

Summary All data	
Max	142
Min	105
Median	112

Day 8/14	
Max	139
Min	106
Median	114

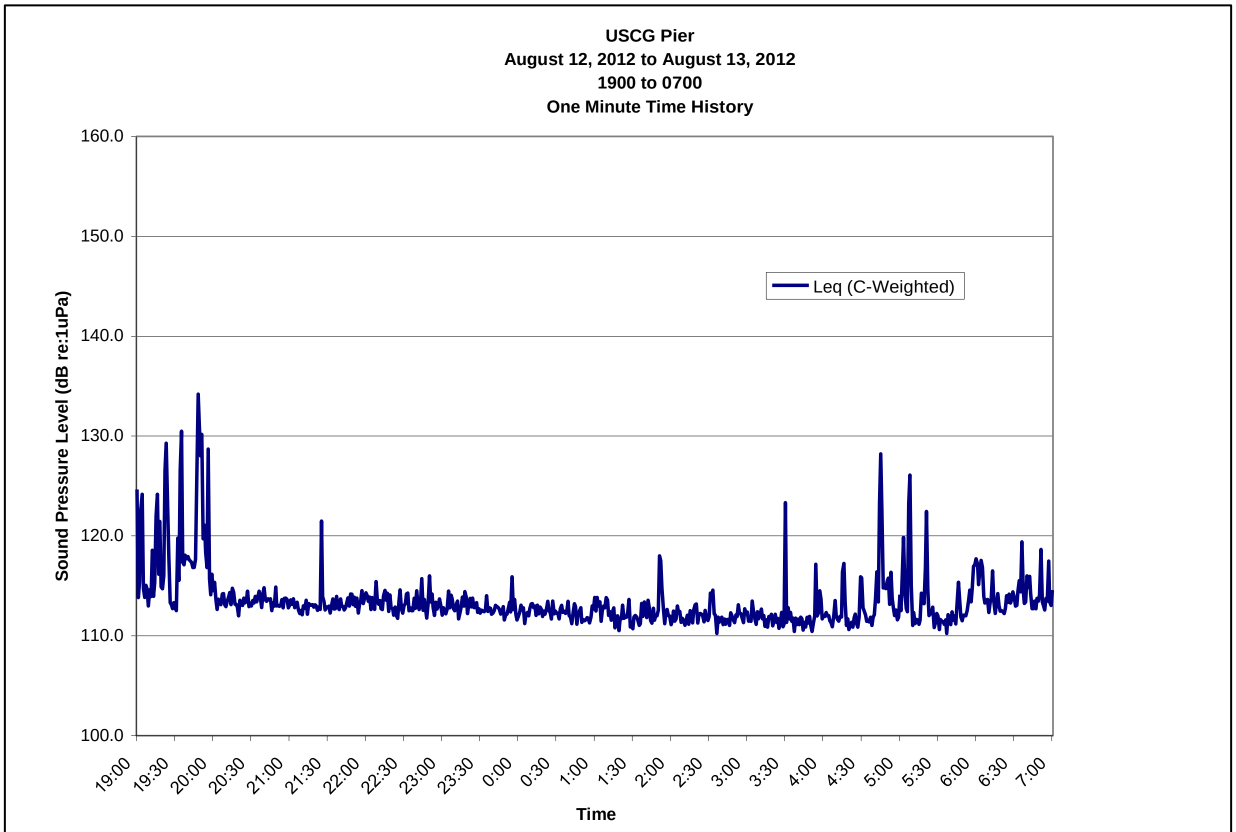
Airborne sound levels were measured in decibels referenced to 20 µPa. Airborne noise levels at the project site vary. The median daytime sound level ranged 62 to 68 dB (C weighted). Ambient sounds included barking seals, boat traffic, birds, distant traffic, and occasional aircraft. Barking seals and seagulls were observed to produce the highest noise levels.

Table 16 - Summary of Airborne Measurement Levels at the USCG Pier in dB reference 20 µPa

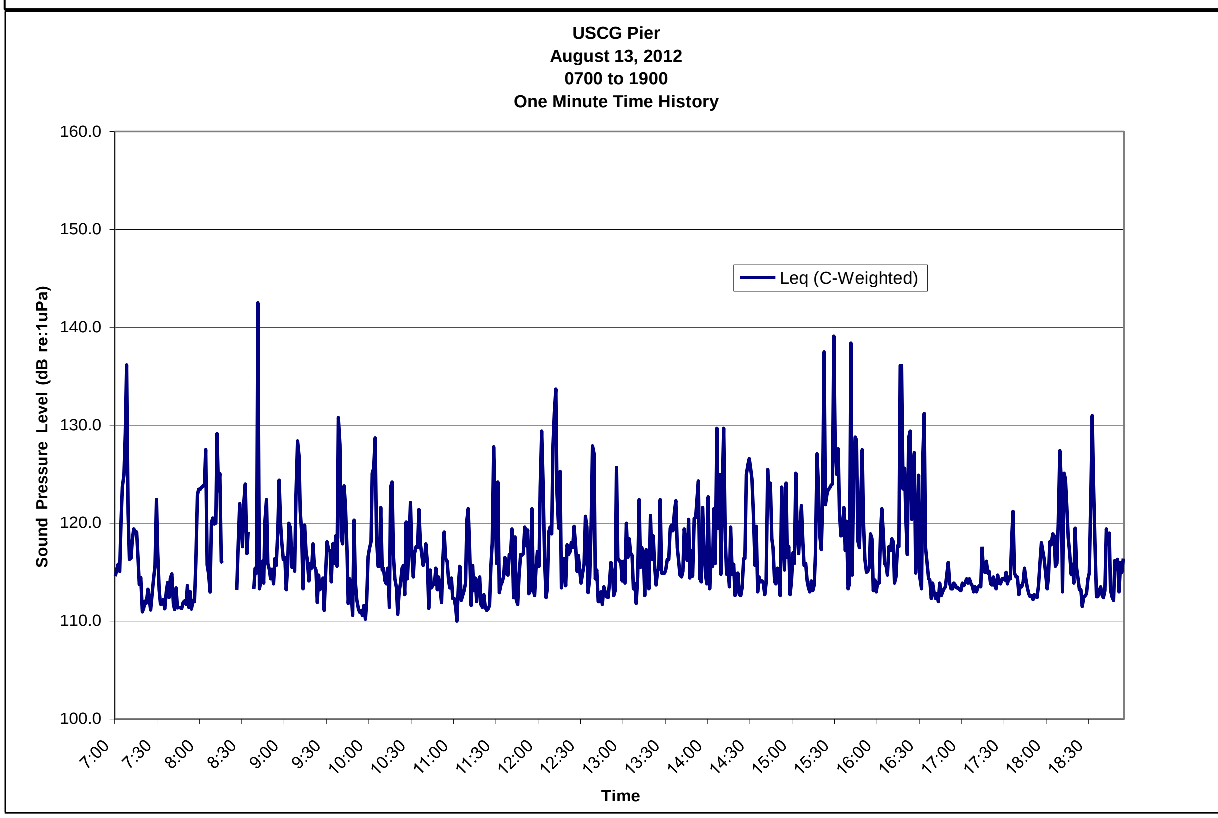
Sound Descriptor	Total		8/12 Night		8/13 Day		8/13 Night		8/14 Day	
	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax
L_{10}	77	85	81	88	74	86	70	79	66	76
L_{50}	65	72	74	81	68	78	60	67	62	67
L_{90}	57	62	65	71	63	71	53	56	60	63

Airborne sounds were measured from a boat floating approximately 1 kilometer east of the project site in Monterey Bay. However, wind waves interacting with the boat caused elevated low frequency noise that raised the overall unweighted sound pressure levels. These were measured at 65 to 75 dB during the daytime (about 0900 to 0930). These levels were typical of sounds measured in the project area (i.e., inside the harbor).

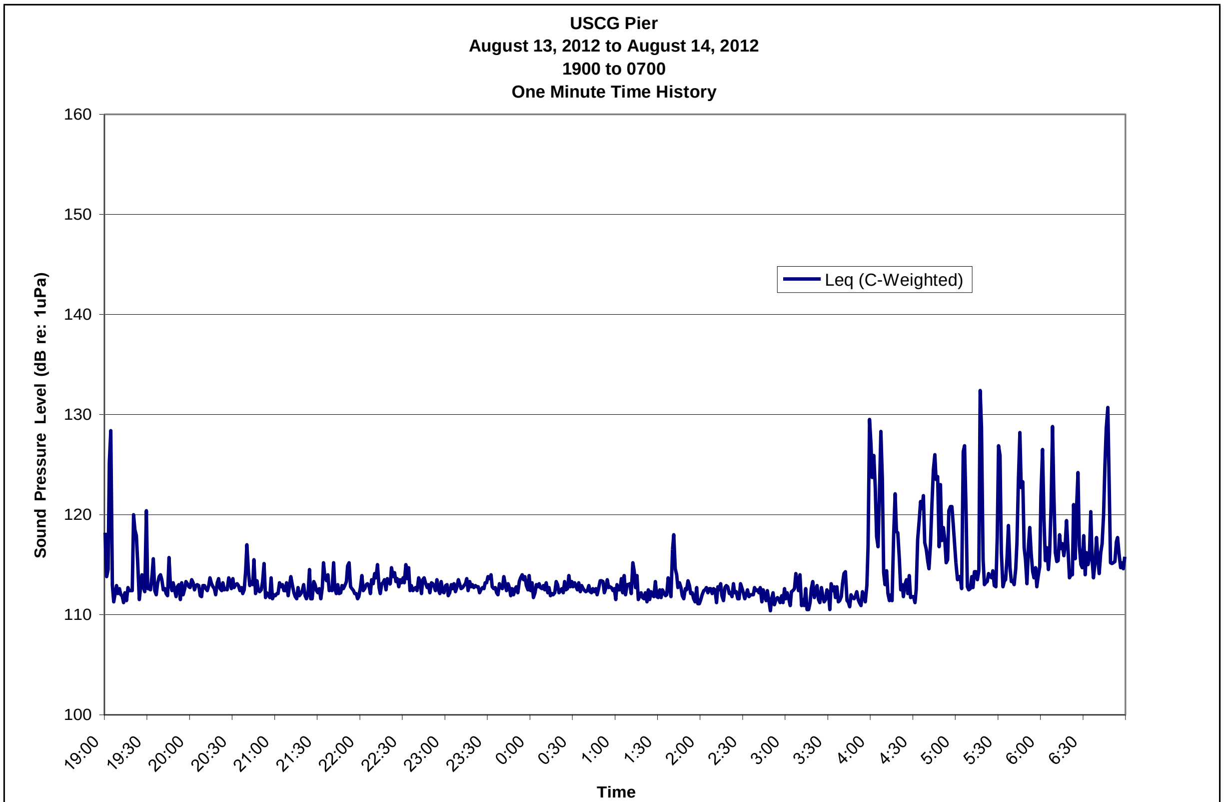
Appendix A Acoustic Data



USCG Pier
August 12, 2012 to August 13, 2012
1900 to 0700
One Minute Time History
Sound Pressure Level (dB re:1uPa)
160.0
150.0
140.0
130.0
120.0
110.0
100.0
Leq (C-Weighted)
19:00 19:30 20:00 20:30 21:00 21:30 22:00 22:30 23:00 23:30 0:00 0:30 1:00 1:30 2:00 2:30 3:00 3:30 4:00 4:30 5:00 5:30 6:00 6:30 7:00
Time



USCG Pier
August 13, 2012
0700 to 1900
One Minute Time History
Sound Pressure Level (dB re:1uPa)
160.0
150.0
140.0
130.0
120.0
110.0
100.0
Leq (C-Weighted)
7:00 7:30 8:00 8:30 9:00 9:30 10:00 10:30 11:00 11:30 12:00 12:30 13:00 13:30 14:00 14:30 15:00 15:30 16:00 16:30 17:00 17:30 18:00 18:30
Time


USCG Pier
August 13, 2012 to August 14, 2012
1900 to 0700
One Minute Time History
Sound Pressure Level (dB re: 1uPa)
160
150
140
130
120
110
100
Leq (C-Weighted)
19:00
19:30
20:00
20:30
21:00
21:30
22:00
22:30
23:00
23:30
0:00
0:30
1:00
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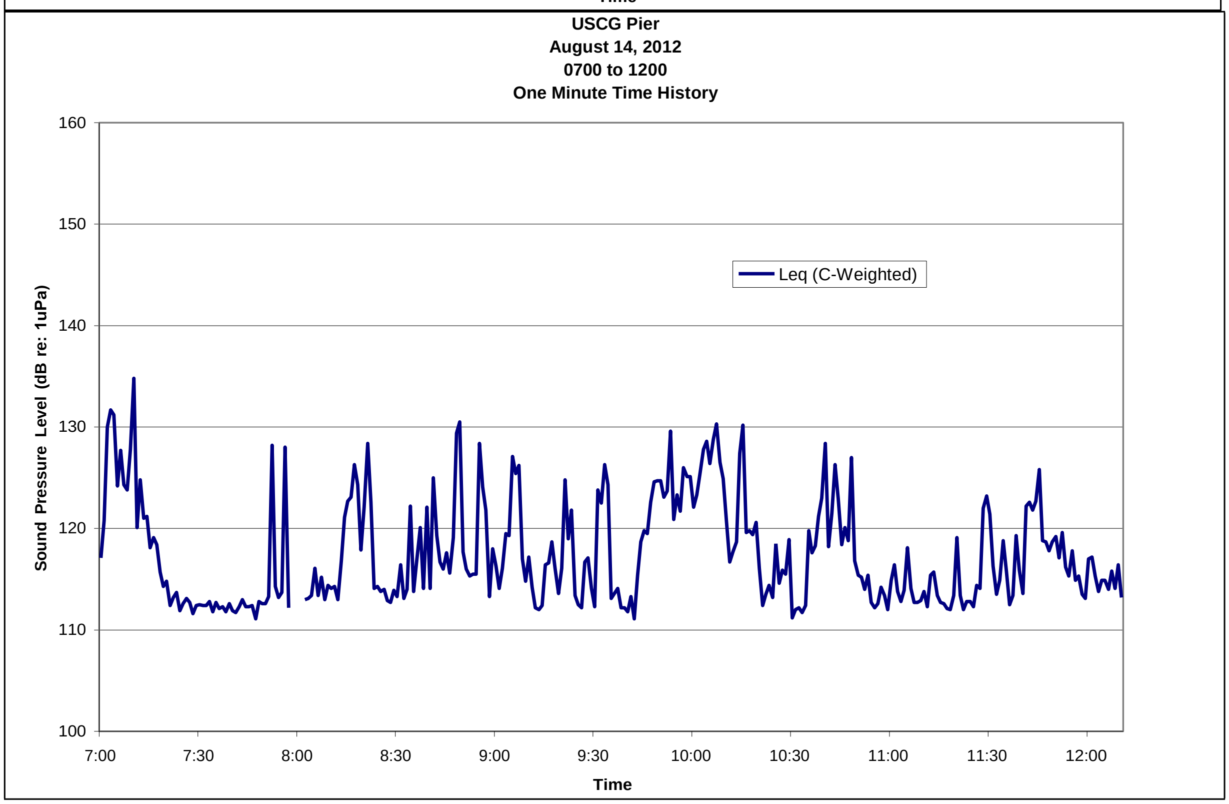
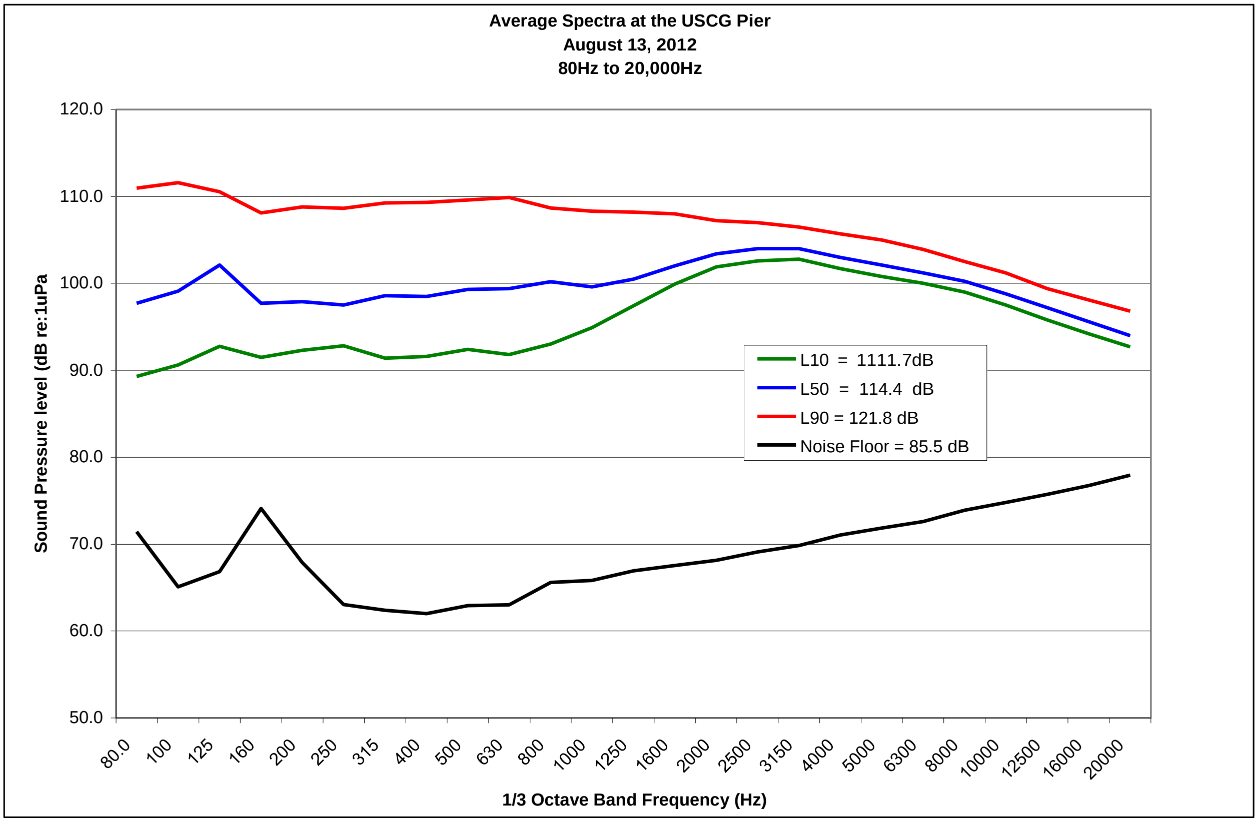
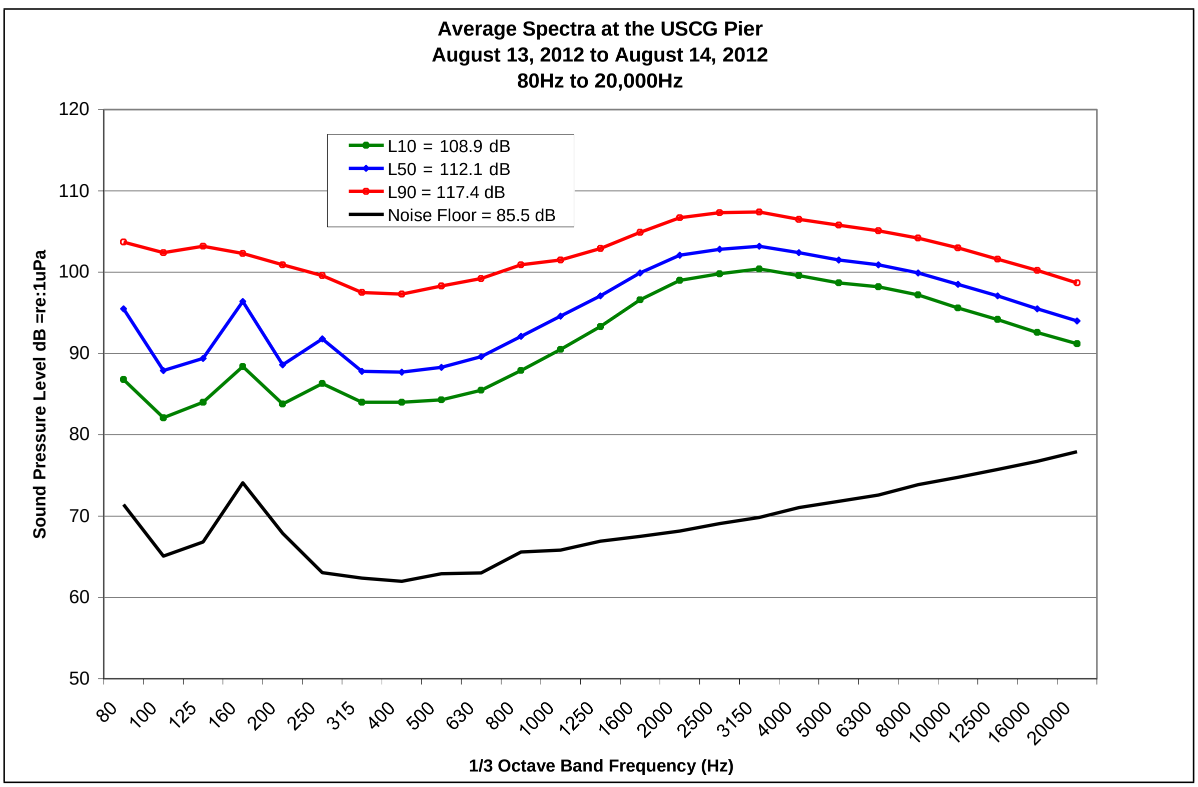
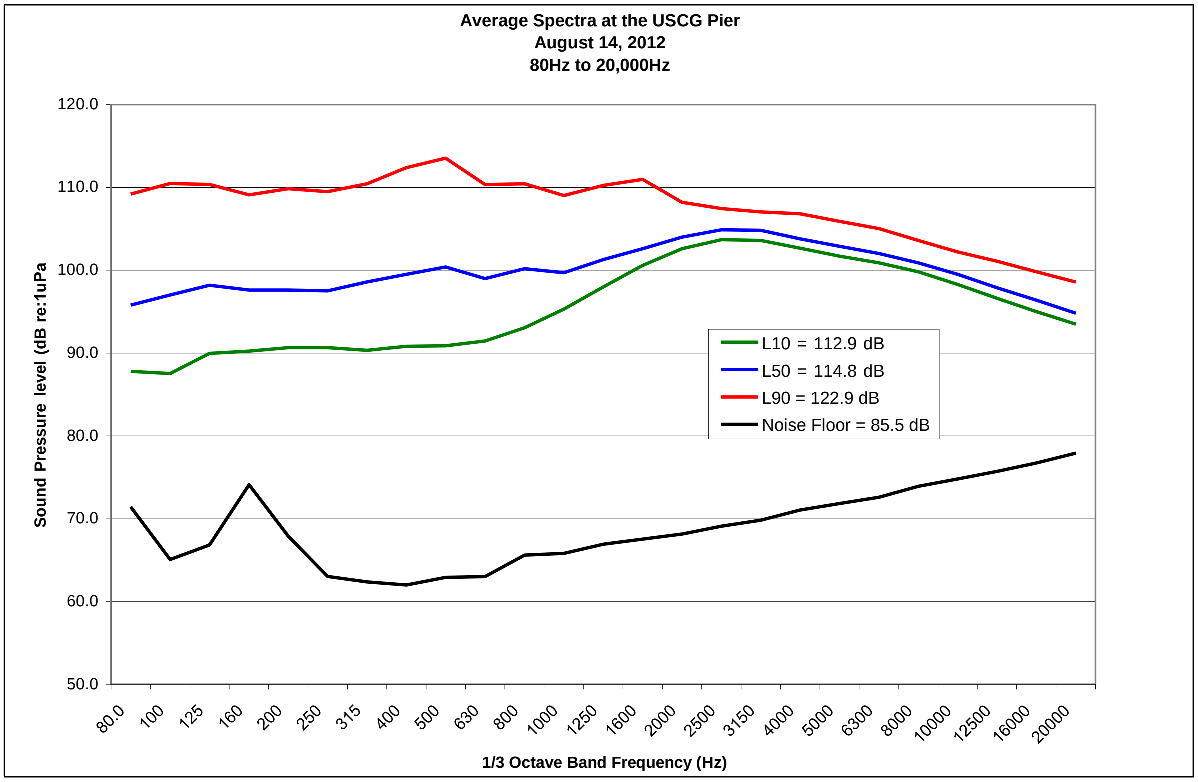
5:30
6:00
6:30
Time

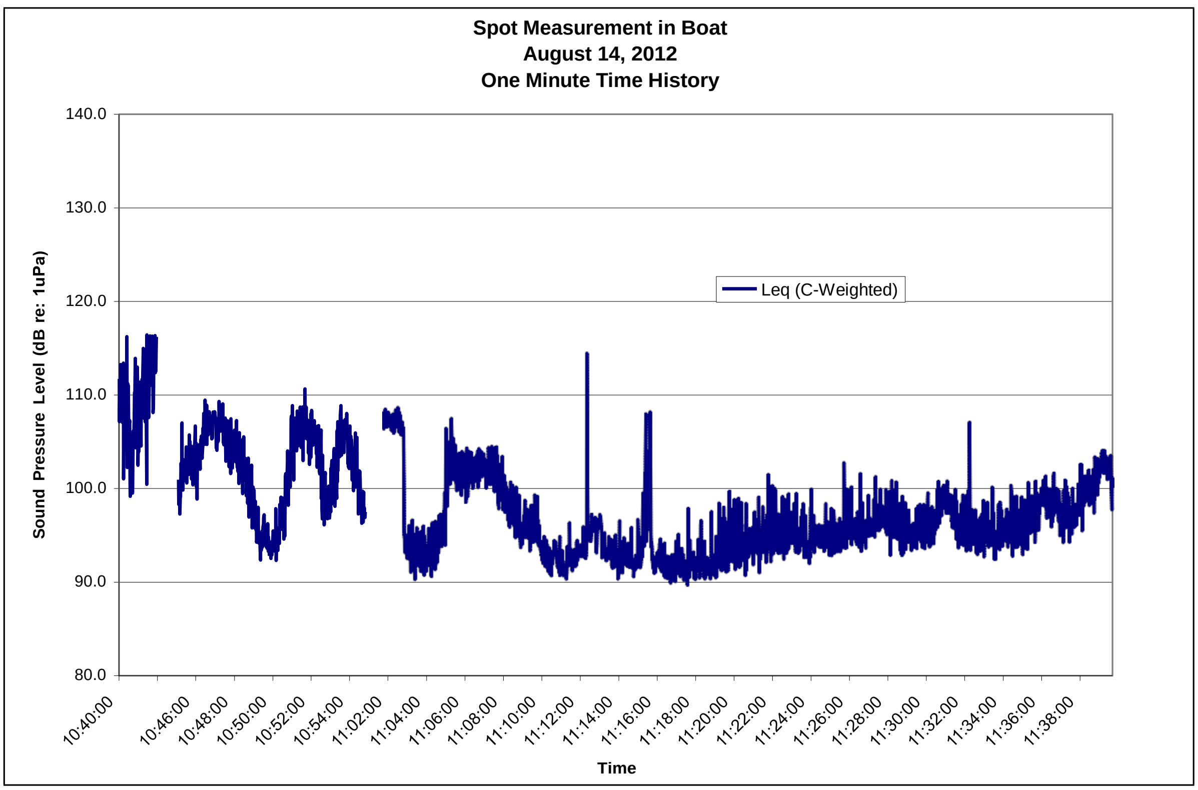

USCG Pier
August 14, 2012
0700 to 1200
One Minute Time History
Sound Pressure Level (dB re: 1uPa)
160
150
140
130
120
110
100
Leq (C-Weighted)
7:00
7:30
8:00
8:30
9:00
9:30
10:00
10:30
11:00
11:30
12:00
Time


Average Spectra at the USCG Pier
August 13, 2012
80Hz to 20,000Hz
Sound Pressure level (dB re:1uPa
1/3 Octave Band Frequency (Hz)
L10 = 1111.7dB
L50 = 114.4 dB
L90 = 121.8 dB
Noise Floor = 85.5 dB

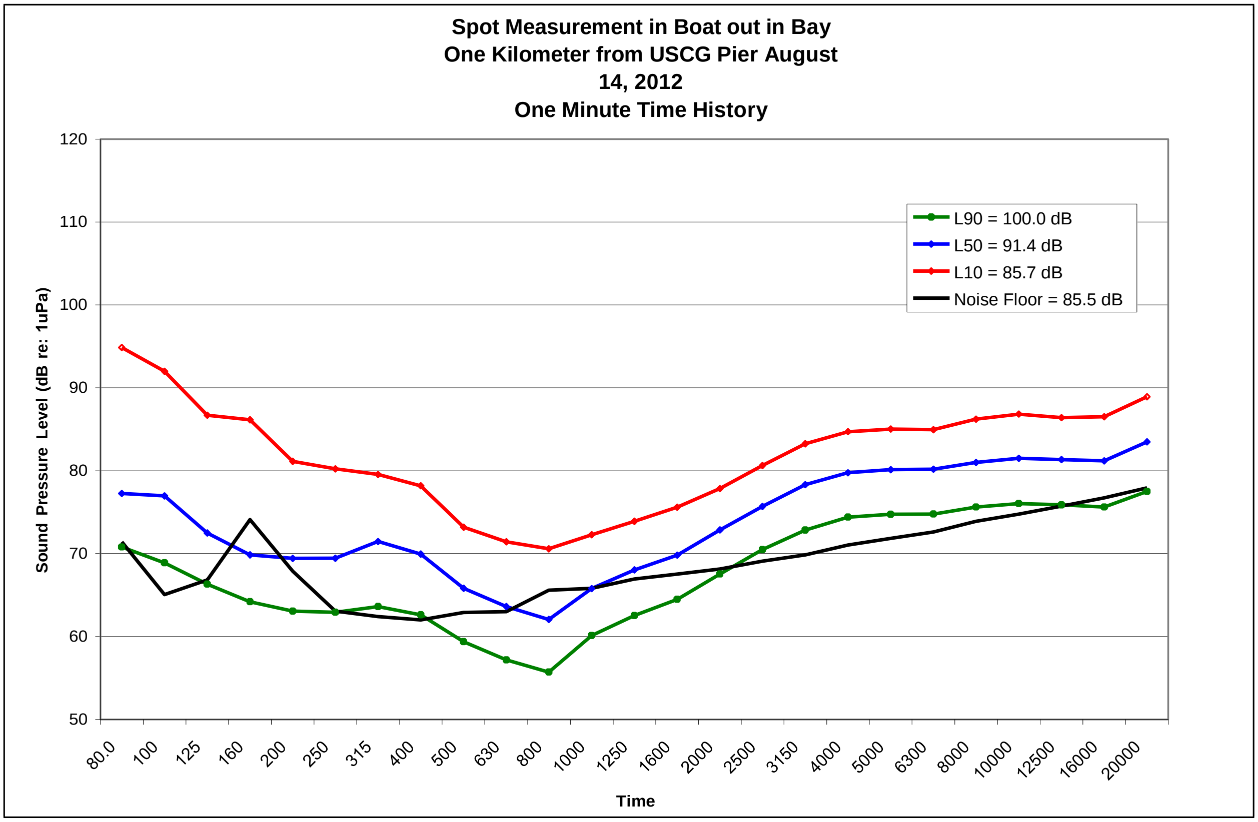

Average Spectra at the USCG Pier
August 13, 2012 to August 14, 2012
80Hz to 20,000Hz
Sound Pressure Level dB =re:1uPa
1/3 Octave Band Frequency (Hz)
L10 = 108.9 dB
L50 = 112.1 dB
L90 = 117.4 dB
Noise Floor = 85.5 dB

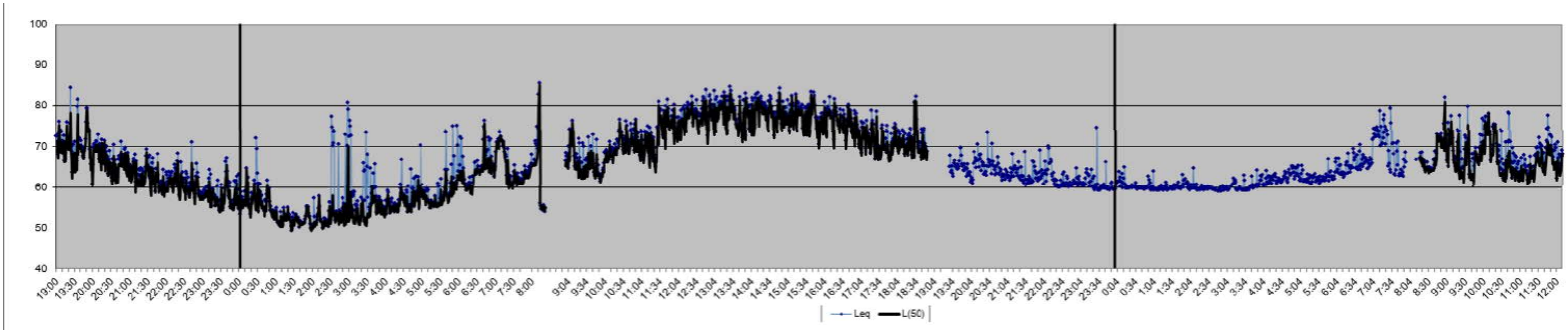


Average Spectra at the USCG Pier
August 14, 2012
80Hz to 20,000Hz
Sound Pressure level (dB re:1uPa
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
80.0
100
125
160
200
250
315
400
500
630
800
1000
1250
1600
2000
2500
3150
4000
5000
6300
8000
10000
12500
16000
20000
1/3 Octave Band Frequency (Hz)
L10 = 112.9 dB
L50 = 114.8 dB
L90 = 122.9 dB
Noise Floor = 85.5 dB

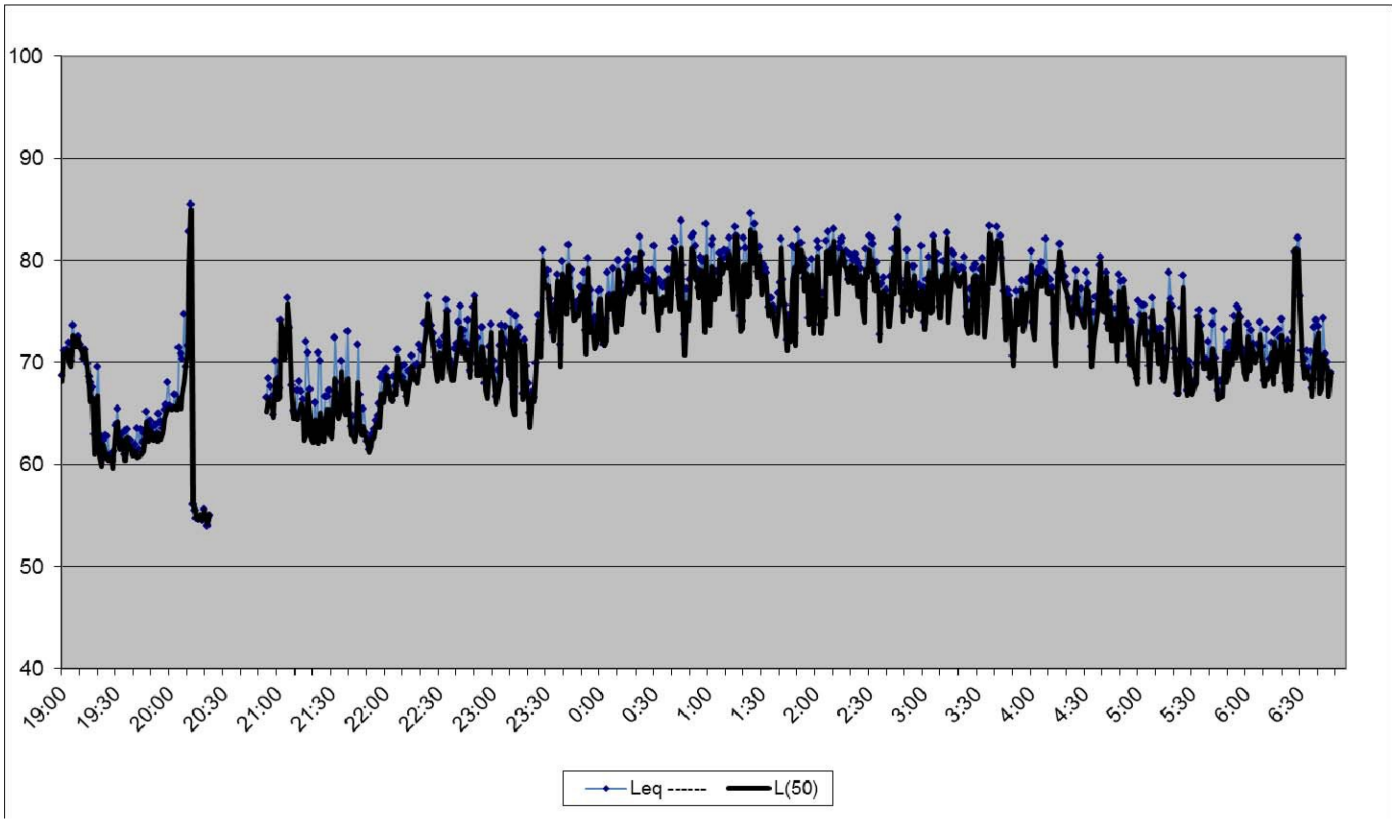


Spot Measurement in Boat
August 14, 2012
One Minute Time History
Sound Pressure Level (dB re: 1uPa)
140.0
130.0
120.0
110.0
100.0
90.0
80.0
Leq (C-Weighted)
10:40:00
10:46:00
10:48:00
10:50:00
10:52:00
10:54:00
11:02:00
11:04:00
11:06:00
11:08:00
11:10:00
11:12:00
11:14:00
11:16:00
11:18:00
11:20:00
11:22:00
11:24:00
11:26:00
11:28:00
11:30:00
11:32:00
11:34:00
11:36:00
11:38:00
Time

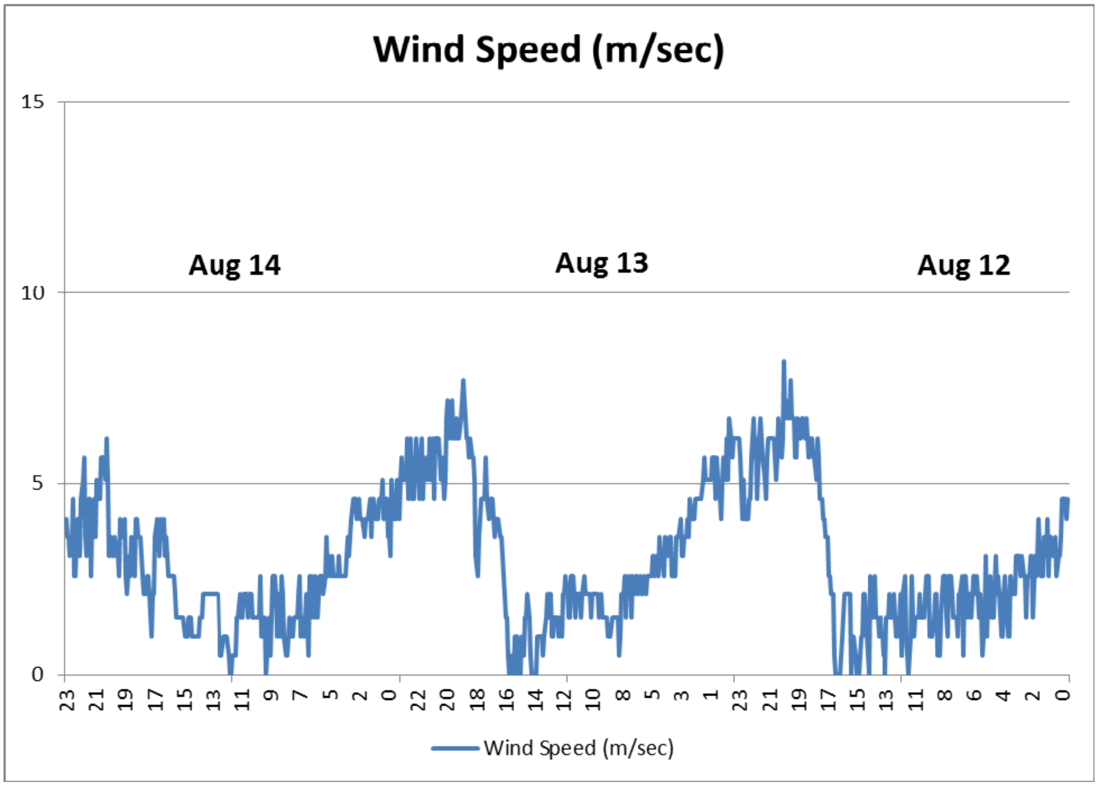

Spot Measurement in Boat out in Bay
One Kilometer from USCG Pier August
14, 2012
One Minute Time History
Sound Pressure Level (dB re: 1uPa)
120
110
100
90
80
70
60
50
L90 = 100.0 dB
L50 = 91.4 dB
L10 = 85.7 dB
Noise Floor = 85.5 dB
80.0
100
125
160
200
250
315
400
500
630
800
1000
1250
1600
2000
2500
3150
4000
5000
6300
8000
10000
12500
16000
20000
Time

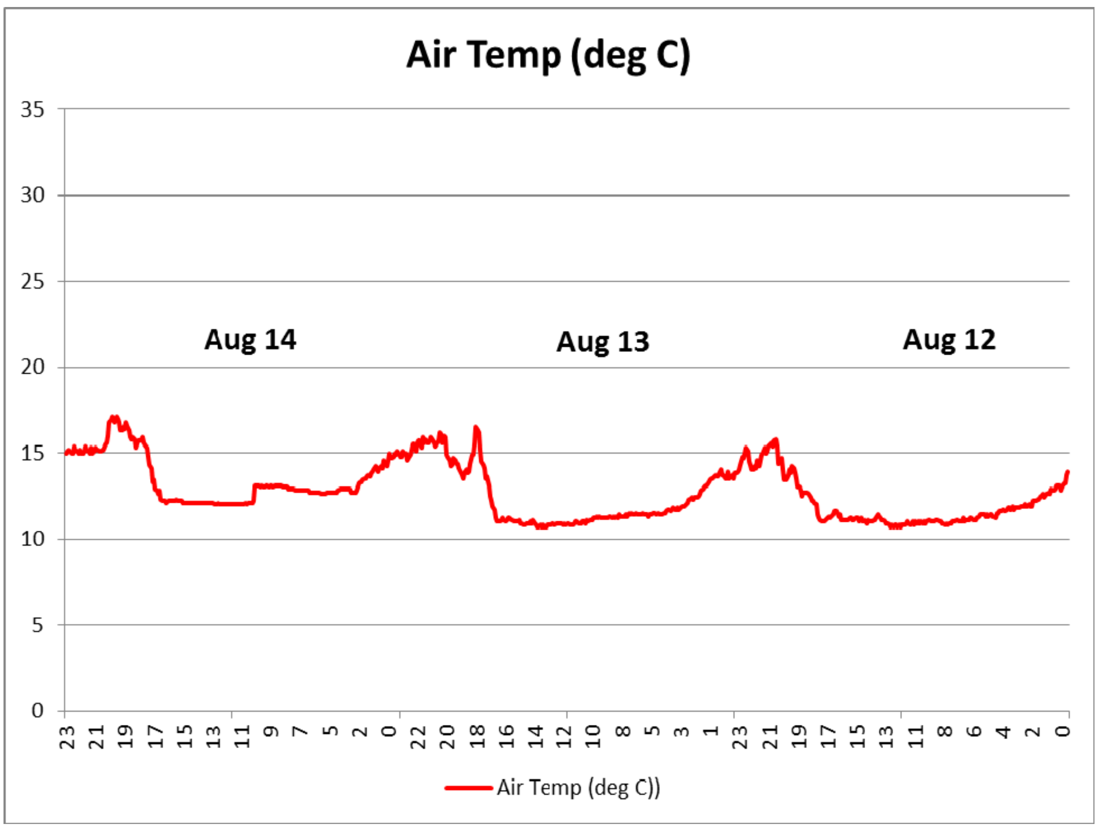


Airborne Sound Levels Measured at the USCG Pier dB re 20 µPa, C-Weighted - Aug 12-14, 2012



Airborne Sound Levels Measured Daytime Only for August 13 (0700 through 1900)





Meteorological Data Measured by NOAA in Monterey Bay

Station MTYC1 - 9413450 - Monterey, CA

[Owned and maintained by NOAA's National Ocean Service]

Water Level Observation Network

36.605 N 121.888 W (36°36'18" N 121°53'18" W)