INCIDENTAL HARASSMENT AUTHORIZATION APPLICATION FOR THE NAVY'S FLOATING DRY DOCK PROJECT AT NAVAL BASE SAN DIEGO

15 March 2024 to 14 March 2025

Submitted to:

Office of Protected Resources,
National Marine Fisheries Service,
National Oceanic and Atmospheric Administration

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For:

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ACRONYMS AND ABBREVIATIONS

%	percent
AFDM	Medium Auxiliary Floating Dry Dock
BMP	Best Management Practice
°C	Celsius
CALTRANS	California Department of Transportation
CI	confidence interval
CV	coefficient of variation
CFR	Code of Federal Regulations
CTR	California Toxics Rule
dB	decibel
dBA	A-weighted sound level
Navy	Department of the Navy
ESA	Endangered Species Act
°F	Fahrenheit
FDD	Floating Dry Dock
ft	foot/feet
Hz	hertz
IHA	Incidental Harassment Authorization
kHz	kilohertz
kg	kilogram
km	kilometer(s)
km^2	square kilometer(s)
LMR	Living Marine Resources
m	meter(s)
mL/L	milliliter(s) per liter
MLLW	mean lower low water
MMPA	Marine Mammal Protection Act
NAVFAC	Naval Facilities Engineering Command (SW = Southwest)
Navy	U.S. Department of the Navy
NBSD	Naval Base San Diego
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NRC	National Research Council
ONR	Office of Naval Research
Pa	Pascal
POSD	Port of San Diego
ppm	parts per million
PSO	protected species observer
PTS	permanent threshold shift
R&D	research and development
RMS	root mean square
sec	second(s)
SEL	sound exposure level (SEL_{cum} = cumulative SEL)
SPL	sound pressure level
TL	transmission loss
TTS	temporary threshold shift

µg/L	milligram(s) per liter
re 1 µPa	referenced to 1 microPascal
µPa	microPascal
U.S.	United States
U.S.C.	U.S. Code
USS	U.S. Ship
ZOI	zone of influence

EXECUTIVE SUMMARY

In accordance with the Marine Mammal Protection Act (MMPA) of 1972, as amended, the United States (U.S.) Navy (Navy) is applying for an Incidental Harassment Authorization (IHA) for activities associated with the proposed Naval Base San Diego (NBSD) Mole Pier South Berth Floating Dry Dock (FDD) Project (Project) in the south-central part of San Diego Bay. For this IHA application, the Navy determined that noise from pile extraction and installation activities has the potential to rise to the level of harassment under the MMPA. This IHA application is intended to cover pile extraction and installation activity between 15 March 2024 and 14 March 2025. Pile extraction and installation activities for the FDD Project are estimated to occur on an estimated 59 in-water workdays within that period.

Three species of marine mammals have a reasonable likelihood of occurrence in the Project area, and during the Project's timeline, including the California sea lions (*Zalophus californianus*), harbor seals (*Phoca vitulina*), and coastal bottlenose dolphins (*Tursiops truncatus*). As a result, these species could be exposed to noise associated with non-impulsive and impulsive underwater noise resulting from extraction and installation of piles. These species

The Mole Pier South Berth FDD Project is needed to ensure NBSD's capability to conduct berth-side repair and maintenance of vessels, thus protecting the Navy's ability to provide training and equipping of combat-capable naval forces ready to deploy worldwide. Current and projected shortfalls of dry dock space reduce overall maintenance capabilities at NBSD. In this regard, the Proposed Action furthers the Navy's execution of its congressionally mandated roles and responsibilities under 10 U.S. Code (U.S.C.) Section 5062.

The proposed FDD installation and associated dredging activities would occur within San Diego Bay at the south berth of the Mole Pier, which is located approximately 1.6 kilometers (km; 1 mile) south of the main entrance gate to NBSD, immediately south of Pier 8 and the Paleta Creek Channel, and north of Pier 10. The pile-supported concrete mooring wharf at the south berth of the Mole Pier is approximately 16 by 179 meters (m; 53 by 588 feet [ft]) and covers approximately 0.7 acre (31,164 square feet). The U.S. Ship (USS) *Curtiss*, which is currently stationed at the Mole Pier mooring wharf, would be relocated to another location within NBSD prior to initiating any dredging activities or modifications necessary to accommodate the proposed FDD.

The scope of the Proposed Action includes the following:

1) Relocation of the USS *Curtiss* and hoteling facilities that are currently moored along the south berth of the Mole Pier;
2) Dredging at the Mole Pier FDD sump, approaches, and turning basin to increase water-depths as well as subsequent sediment disposal activities;
3) Partial demolition of the existing decking at the mooring wharf;
4) Installation of mooring attachments and upgrades at the mooring wharf;
5) Demolition of existing Ramp Pier;
6) Utility modifications;
7) Placement and operation of a steel FDD; and

8) Construction of a new Ramp Pier with vehicle access bridge from the quay wall southeast of the Mole Pier to the FDD.

The relocation of assets, dredging and sediment disposal, utility modifications, above-water demolition activities, and placement and operation of the FDD does not have the potential to result in harassment under the MMPA. Underwater sound associated with pile extraction and installation would have the potential to harass marine mammals. The demolition and construction elements analyzed in the IHA are described below and would occur over 59 days.

Underwater sound producing demolition activities covered under this IHA application would occur over a period of 19 days at two primary locations: 1) the Mole Pier mooring wharf and 2) the Ramp Pier. The piles potentially removed at the mooring wharf would only be removed if they interfere with piles to be installed, while the whole of Ramp Pier is going to be removed and replaced with a new pier. At both locations, the concrete pier deck would be saw cut longitudinally and transversely at mid-span of every bent, allowing for removal in large but manageable sections, with weights of less than 50 tons. While the section is rigged to the derrick crane, a hydraulic shearing tool attached to a barge-mounted excavator would be used to cut the piles just below pile cap. Once freed from the piles, the sections would be set onto a barge. Following the removal of the pier deck, the piles could be removed via multiple methods, including vibratory extraction, high-pressure water jetting, hydraulic pile clipper, wire saw, underwater chain saw, dead pull or via a combination of methods. While any of these pile extraction activities may occur as part of the Project-related activities, vibratory pile extraction is the only activity expected to generate noise that would cross MMPA Level B (behavioral) harassment threshold criteria. Therefore, this is the only pile extraction method that will be analyzed for potential impacts to marine mammals. Up to fifty-two 24-by-24-inch square concrete piles and seven 24-inch square concrete piles would be removed from within the mooring wharf and the Vehicle Access Pier. Throughout the demolition phase, the following equipment would likely be used to remove, collect, and transport the demolition debris: a spud-anchored barge, barge and wharf cranes, one tugboat, mobile construction equipment, transport trucks, and work floats (Navy 2016).

Pile installation activities would occur over 40 days. Similar to pile extraction activities, pile installation activities for the Project are primarily broken up into separate generalized actions: 1) installation and extraction of six 24-inch octagonal concrete piles for a Test Pile Program (TPP); 2) installation of eighty 24-inch octagonal concrete piles at the mooring wharf; and 3) installation of twenty-one 24-inch octagonal concrete piles associated with the Ramp Pier and Intermediate Support Structure for personnel and vehicle access to the FDD. Pile installation will occur via an impact pile driver, high-pressure water jetting, or a combination of both methods. The TPP piles would be installed using an impact hammer, re-struck using the same hammer approximately one week later to provide data for production piles, and then removed prior to production pile driving. Piles installed for the mooring wharf and the Ramp Pier/Intermediate Support Structure would occur via an impact pile driver, high-pressure water jetting, or a combination of both methods. While vibratory pile installation is not expected, if it is required to install piles, then monitoring protocols identified for vibratory pile extraction will be implemented.

In this IHA application, the Navy has used National Marine Fisheries Service (NMFS) promulgated thresholds (NMFS 2018) to estimate the number of Level B (behavior) takes that would result from pile extraction and installation, as outlined in Section 6. The two models used to assess the potential distances to regulatory thresholds (Dall'Osto and Dahl 2019; NMFS 2018, 2020) use Practical Spreading Loss (PSL) to evaluate the potential for Level A/B harassment. Dall'Osto and Dahl (2019) developed acoustic models using point sources at three locations (Pier 1, Pier 6 and Pier 13) along the eastern extent of the south-central San Diego Bay on NBSD. Due do the similar bathymetry and location with respect to the channel, the Navy believes that the Pier 13 modeling location, which is roughly 725 m (2,379 ft) to the south of the Project location, represents the best location to approximate the sound propagation profile from a notional source at the Mole Pier mooring wharf FFD location. Key to this profile is the dampening effect of sound due to the western slope of the dredged navigation channel, as well as channelization of sound to the north and south within the channel. While the Pier 13 point is not in the exact project location, we have used the site-specific model to identify sound propagation in the general project area rather than a generic PSL model, which would not account for environmental variables. We believe that this is the most realistic approach and is based the best available science for the area.

Harbor seals and coastal bottlenose dolphins were not included in the site-specific modeling effort for Level A distance calculations. As a result, the NMFS user spreadsheet (NMFS 2020) was used to determine Level A zones for these species. To determine zones for potential Level B harassment, the site-specific model was used for all species because the threshold criteria for Level B impacts are based solely on continuous or impulsive noise source and are not frequency dependent.

In the event that Level A zones of influence (ZOIs) are less than 10 meters (m; 33 ft), then a minimum 10 m (33 ft) shutdown is required to reduce the likelihood for a physical interaction with Project-related equipment. For those activities with Level A ZOIs larger than 10 m (33 ft), the shutdown ZOIs were rounded up to the next tens of meters. Acoustic analyses are limited to the potential for Level A (minor injury due in the form of permanent threshold shift [PTS]) and Level B (behavioral responses and possible temporary hearing threshold shift) harassment. However, with the implementation of the applicable shutdown ZOIs, no Level A takes are anticipated.

Recent Navy marine mammal monitoring efforts have encountered marine mammals south of the Coronado Bridge during the first eight month demolition and construction phases of the Pier 6 Replacement Project at NBSD (NAVFAC SW 2022). Haul-out locations observed during this monitoring effort included the NBSD security fence and navigation channel marker buoys. The number of California sea lions observed averaged 1.74 per day. This is the basis for a reasonable daily estimate of Level B take of two California sea lions per day within potential acoustic ZOIs for the Project. Similarly, Protected Species Observers (PSOs) at the Pier 6 Replacement Project observed an average of 0.02 harbor seals per day, and 0.73 coastal bottlenose dolphins per day, resulting in a reasonable daily estimate of Level B take of a single individual per day within the acoustic ZOIs for these species.

Pursuant to the MMPA Section 101(a)(5)(D),[1] the Navy submits this application to NMFS for an IHA for the incidental, but not intentional, taking of 116 California sea lions, 58 harbor seals, and 58 coastal bottlenose dolphins. The IHA application would be for a 1-year period beginning on approximately 15 March 2024. The anticipated take of these species would be in the form of non-lethal, temporary harassment and is expected to have a negligible impact on this species. In addition, the taking would not have an immitigable adverse impact on the availability of these species for subsistence use. If in-water activities do not occur within the year anticipated, a request for renewal will be submitted and received by NMFS no later than 60 days prior to the expiration of this IHA. The renewal request will include an explanation that the activities to be conducted are identical to the activities analyzed under the initial IHA, are a subset of the activities, or include changes so minor that the changes do not affect the previous analyses, mitigation and monitoring requirements, or take estimates (with the exception of reducing the

[1] 16 U.S.C. § 1371(a)(5); 50 CFR Part 216, Subpart I.

type or amount of take because only a subset of the initially analyzed activities remain to be completed under the renewal). The renewal request will also include a preliminary monitoring report showing the results of the required monitoring to date and an explanation showing that the monitoring results do not indicate impacts of a scale or nature not previously analyzed or authorized.

Regulations governing the issuance of incidental take under certain circumstances are codified at 50 Code of Federal Regulations Part 216, Subpart I (Sections 216.101–216.108). Section 216.104 sets out 14 specific items that must be addressed in requests for take pursuant to Section 101(a)(5)(D) of the MMPA. These 14 items are addressed in Sections 1 through 14 of this IHA application.

1 DESCRIPTION OF ACTIVITIES

A detailed description of the specific activity or class of activities that can be expected to result in incidental taking of marine mammals.

1.1 Introduction

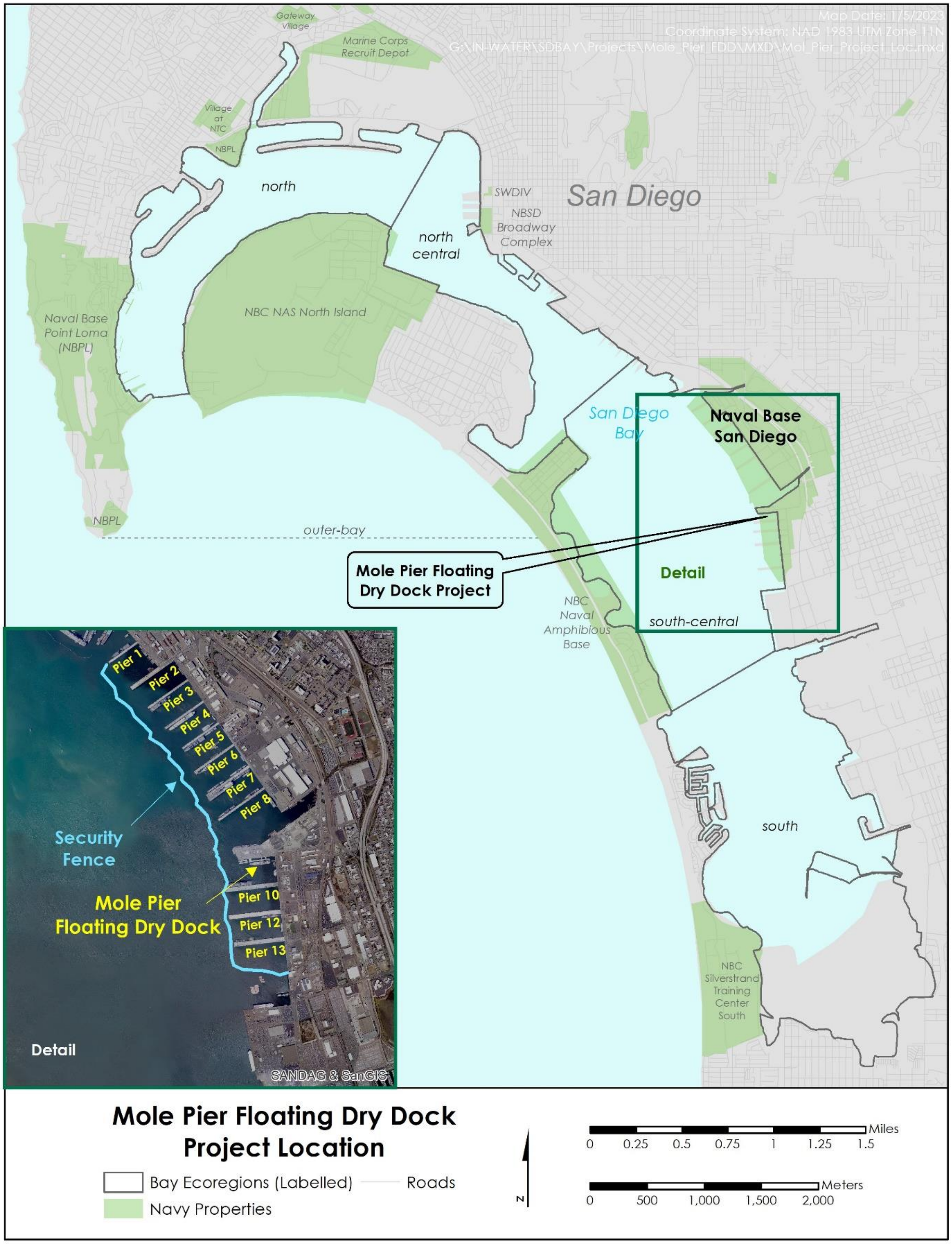
Pursuant to the Marine Mammal Protection Act (MMPA) Section 101(a)(5)(D), the United States (U.S.) Navy (Navy) submits this application to the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) for an Incidental Harassment Authorization (IHA) for the incidental taking of marine mammal species during pile driving and extraction activities associated with the Mole Pier South Berth Floating Dry Dock (FDD) Project at Naval Base San Diego (NBSD). This application is intended to cover all in-water activities that may result in takes of marine mammals between 15 March 2024 and 14 March 2025, inclusive. Code of Federal Regulations (CFR) 50 216.104 sets out 14 specific items that must be included in requests for take pursuant to Section 101(a)(5)(A) of the MMPA; those 14 items are addressed in Sections 1 through 14 of this IHA. If in-water activities are not completed within the year anticipated, a request for renewal will be submitted and received by NMFS no later than 60 days prior to the expiration of this IHA. The renewal request will include an explanation that the activities to be conducted under the requested renewal are identical to the activities analyzed under the initial IHA, are a subset of the activities, or include changes so minor that the changes do not affect the previous analyses, mitigation and monitoring requirements, or take estimates (with the exception of reducing the type or amount of take because only a subset of the initially analyzed activities remain to be completed under the Renewal). The renewal request will also include a preliminary monitoring report showing the results of the required monitoring to date and an explanation showing that the monitoring results do not indicate impacts of a scale or nature not previously analyzed or authorized.

1.2 Proposed Action

1.2.1 Background

NBSD is a major port for Navy ships assigned to the Pacific Fleet and is the major West Coast logistics base for surface forces of the Navy, dependent activities, and other commands. Activities at NBSD include continuous maintenance availabilities and loading supplies for fleet vessels (Navy 2016). The Commander of the U.S. Pacific Fleet has identified a current and projected shortfall of dry dock space for maintenance of the Pacific Fleet. Specifically, port loading for DDG-51 class vessels is nearly at capacity fleet-wide. The annual rate of Continuous Maintenance Availabilities and need for pier laydown space is anticipated to increase with the increase in the number of vessels to be homeported at NBSD by 2020 (Navy 2016). The proposed dry dock installation and associated dredging activities would address this shortfall at NBSD and support maintenance operations for DDG-51, LCS-2, LSD-41, and LSD-49 class vessels.

NBSD contains 12 piers (including a mole pier), two channels, and various quay walls that extend along approximately 9 kilometers (km; 5.6 miles) of shoreline (Figure 1-1). Surface ships, support vessels, and barges receive various ship support services, such as supplies and minor repair or maintenance, when berthed at NBSD.



1 **Figure 1-1. Regional Location of NBSD and Project Area.**

The Mole Pier has three berthing areas: north, west, and south. The south berth of the Mole Pier, which was originally constructed in the early 1980s, is comprised of a mooring wharf, mechanical pier, electrical pier, and access pier. A Ramp Pier that was used for the previous FDD is located to the southeast of the mooring wharf and will also be replaced as part of the Proposed Action (Figure 1-2). The pile-supported concrete mooring wharf is approximately 16 by 179 meters (m; 53 by 588 feet [ft]). The mechanical pier (approximately 16 by 23 m [53 by 75 ft]), electrical pier (approximately 6.4 by 16 m [21 by 53 ft]), and access pier (approximately 13 by 16 m [42 by 53 ft]) were constructed north of the mooring wharf to provide mechanical and electrical servicing, as well as access to the wharf. The Ramp Pier (approximately 7 by 32 m [23 by 105 ft]) is a finger pier located on the quay wall just to the southeast of the wharf between the Mole Pier and Pier 10. A sump was originally dredged at the time of construction to accommodate the Auxiliary Floating Drydock-Medium (AFDM)-14 "Steadfast," which was previously berthed at the south berth of the Mole Pier and later relocated in 1998. The south berth of the Mole Pier was modified in 2002 to accommodate berthing and mooring of the U.S. Ship (USS) *Curtiss*, which is currently stationed at the wharf. Modifications to the mooring wharf involved construction of two pile-supported mooring points for the USS *Curtiss*, including a dolphin at the forward portion of the vessel, and an extension of the mooring wharf at the aft location (Navy 2018).

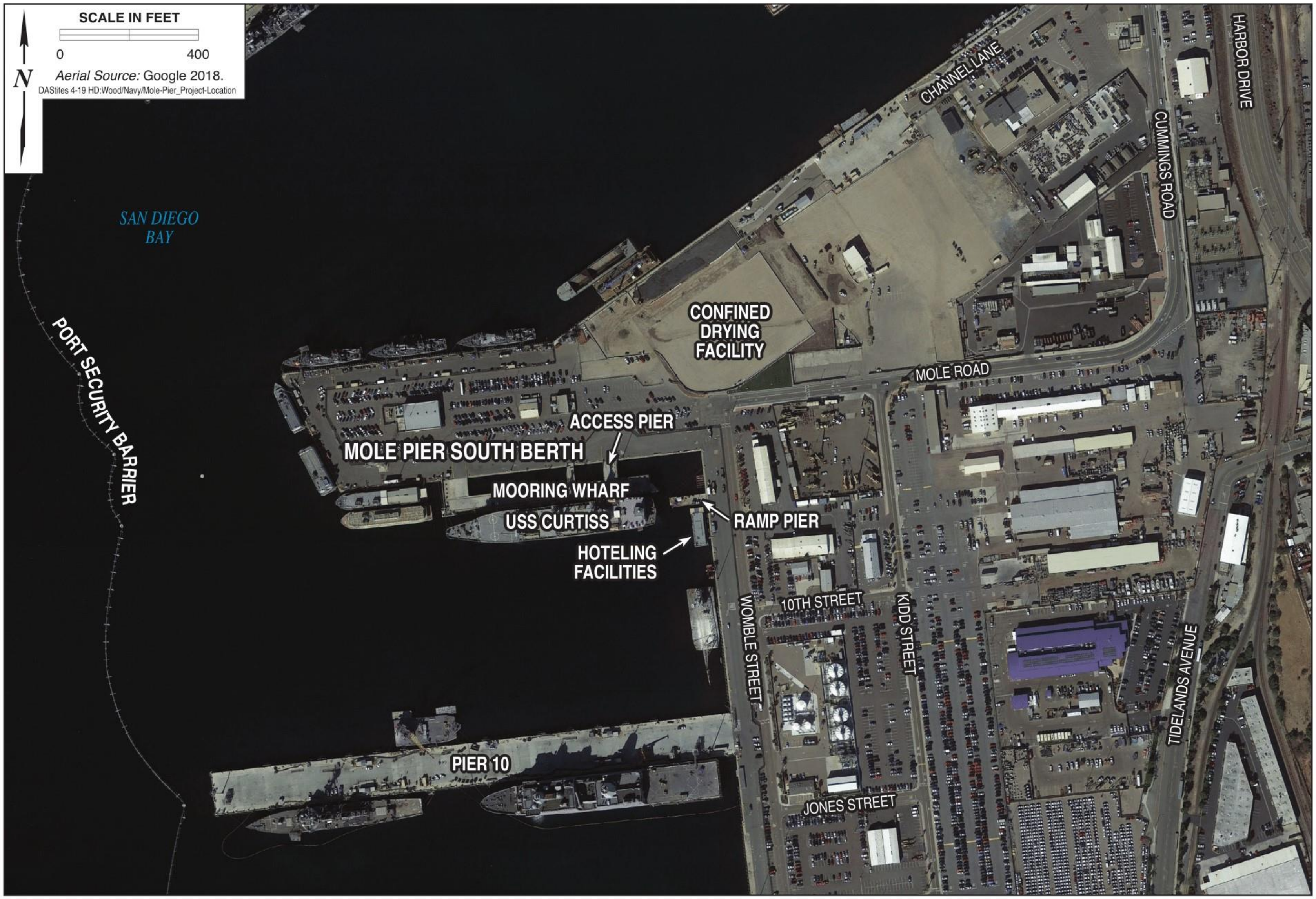
Additionally, floating hotel facilities for the USS *Curtiss* are located immediately adjacent to the Ramp Pier. In order to address the current and projected shortfall of dry dock space required for maintenance of the Pacific Fleet, the placement and operation of a FDD—including all required dredging and sediment disposal, as well as all required demolition and construction activities—has been proposed at the south berth of the Mole Pier at NBSD (Figure 1-2 and Figure 1-3).

1.2.2 Description of Activities

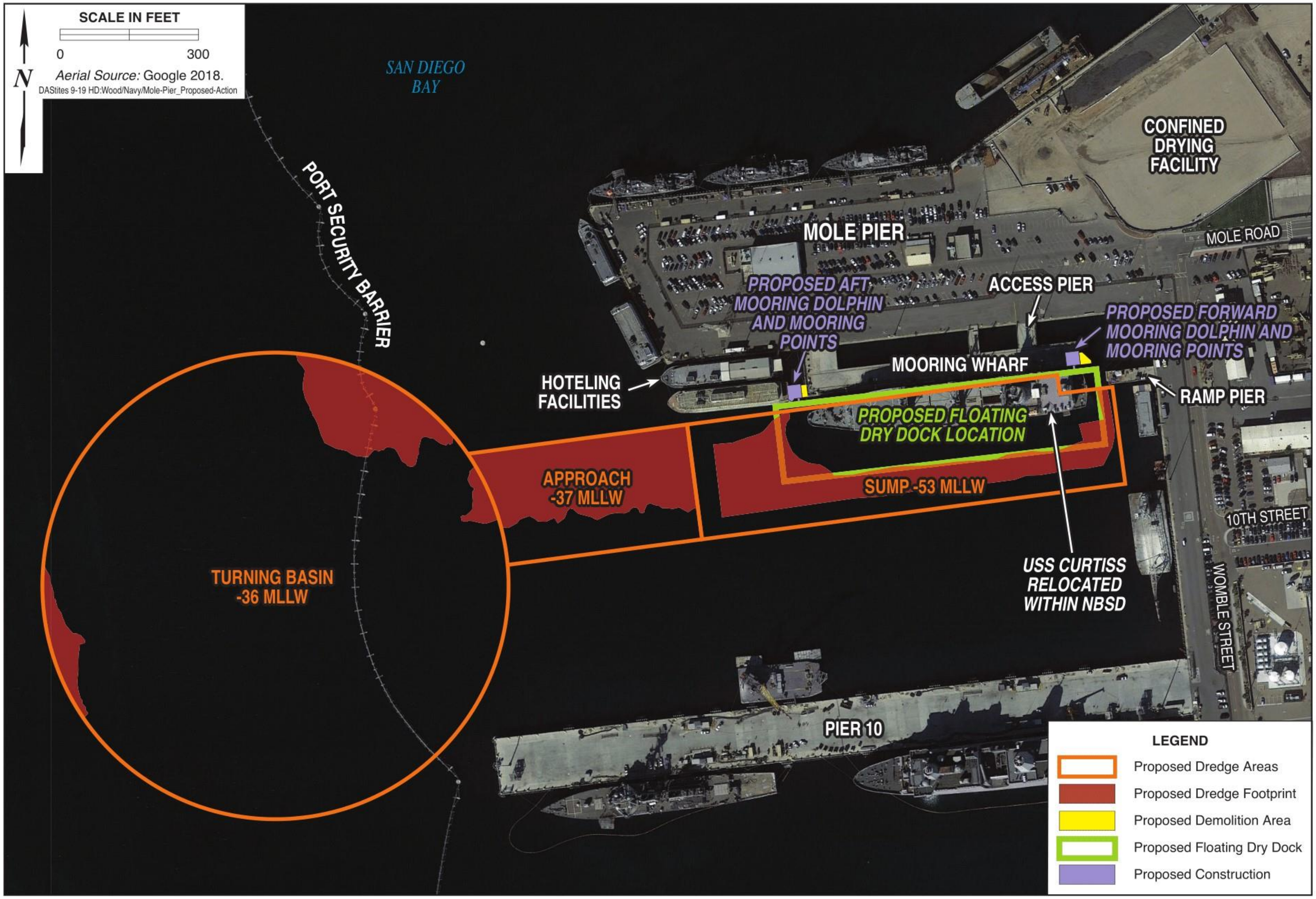
The scope of the Proposed Action includes the following:

1) Relocation of the USS *Curtiss* and hoteling facilities that are currently moored along the south berth of the Mole Pier;
2) Dredging at the Mole Pier FDD sump, approaches, and turning basin to increase water-depths as well as subsequent sediment disposal activities;
3) Partial demolition of the existing decking at the mooring wharf;
4) Installation of mooring attachments and upgrades at the mooring wharf;
5) Demolition of existing Ramp Pier;
6) Utility modifications;
7) Placement and operation of a steel FDD; and
8) Construction of a new Ramp Pier with vehicle access bridge from the quay wall southeast of the Mole Pier to the FDD.

The proposed activities during the demolition phase of the Project with the potential to result in harassment under the MMPA are the extraction of piles by use of a vibratory pile extractor to loosen and pull piles out of the mud or via pile installation using impact hammers. Other pile extraction methods, including removing piles via a hydraulic pile clipper, wire saw, underwater chainsaw, high-pressure water jet, or dead-pull, may also occur, but no Level B harassment is expected via these methods. During the construction phase, piles are expected to be installed using an impact or vibratory hammer with potential aid from a water jet.



1 **Figure 1-2. Mole Pier and Project Area at NBSD.**



1 **Figure 1-3. Proposed Action at Mole Pier South Berth.**

The FDD would not be self-powered or capable of maneuvering without assistance from support vessels; therefore, it would be permanently moored along the south berth of the Mole Pier. Consequently, the USS *Curtiss* would be relocated to another location within NBSD prior to initiating any dredging activities or modifications necessary to accommodate the proposed FDD. Similarly, the existing hoteling facilities along the south berth of the Mole Pier would also be temporarily relocated to another location within NBSD during construction.

Because activities associated with relocating the USS *Curtiss* and hoteling facilities, dredging and corresponding sediment disposal activities, and utility modification work are not expected to impact marine mammals, they are not addressed in this IHA. Demolition and construction details evaluated in this document are described below.

1.2.2.1 Demolition Activities

Demolition activities for the Project have been broken up into two separate generalized actions: 1) potential extraction of 24-inch octagonal and/or 24-inch square concrete piles at the mooring wharf; and 2) extraction of 24-inch square concrete piles associated with the Ramp Pier for vehicle access to the FDD (Figure 1-4). The piles at the mooring wharf would only be removed if they interfere with piles that would be installed as part of the structural support needed to strengthen the mooring wharf; however, engineers have not made the final determination of whether these piles would need to be removed. The Ramp Pier will be completely removed and replaced with a new structure. For both pile extraction actions, the piles could be removed via multiple methods, including vibratory extraction, high-pressure water jetting, hydraulic pile clipper, wire saw, underwater chain saw, dead pull or a via a combination of methods. While any of these pile extraction activities may occur as part of the Project-related activities, vibratory pile extraction is the only activity expected to generate noise that would cross MMPA Level B (behavioral) harassment threshold criteria. Therefore, this is the only pile extraction method that will be analyzed for potential impacts to marine mammals. Throughout the demolition phase, the following equipment would likely be used to remove, collect, and transport the demolition debris: a spud-anchored barge, a materials barge, barge and wharf cranes, one tugboat, mobile construction equipment, transport trucks, and scows (Navy 2016).

All appropriate Best Management Practices (BMPs) would be implemented during demolition activities (see Section 11). For example, a system of rafts would be used under the demolition locations to capture any debris (Navy 2016). Additionally, concrete slurry from the cut operation would be vacuumed as saw cutting occurs (Navy 2016).

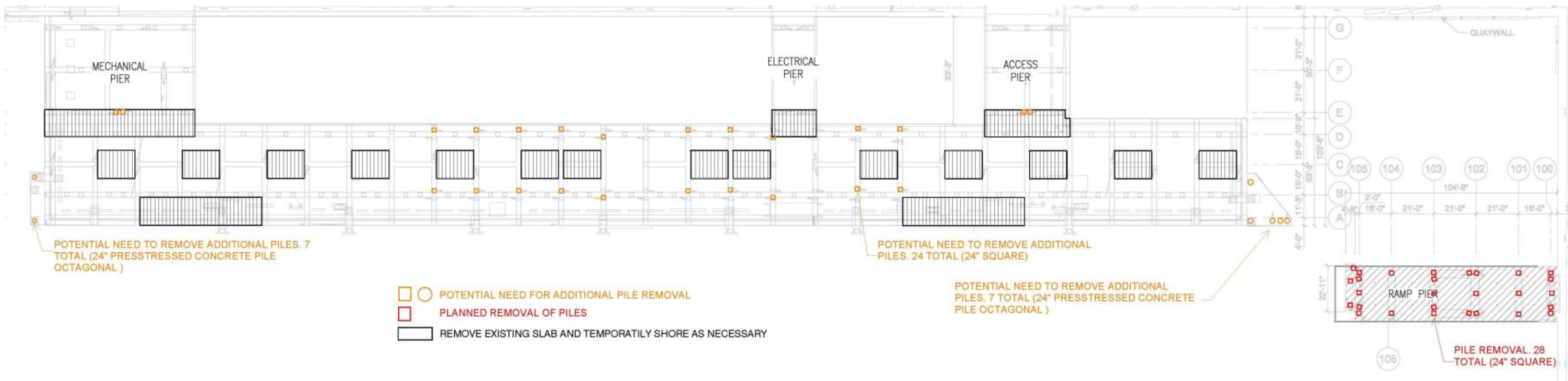


Figure 1-4. Piles to be Potentially Removed as Part of the Project-related Activities.

1.2.2.1.1 Mooring Wharf

Following the relocation of the USS Curtiss and associated hoteling facilities from the south berth of the mooring wharf, typical pier demolition activities would progress bay-ward to landward and from the top down (Navy 2016). First, exterior appurtenances (e.g., utilities) would be removed above and below the pier deck. The concrete pier deck would be saw cut longitudinally and transversely at mid-span of every bent, allowing for removal in large but manageable sections, with weights of less than 50 tons. While the section is rigged to the derrick crane, a hydraulic shearing tool attached to a barge-mounted excavator would be used to cut the piles just below the pile cap. Once freed from the piles, the sections would be set onto a barge. Following the removal of the pier deck, a hydraulic cutter would be lowered over each of the existing piles allowing the pile to be cut at the mudline, removed by the crane, and set onto a barge (personal communication from Alberto Sanchez 2019). A diver may be used to assist in the extraction of piles with this method. A diver may also be used if a hand-held hydraulic saw were needed to cut the piles at the mudline. No fender piles are required to be removed as part of this action.

A total of thirty-one piles would be potentially removed, with twenty-four 24-inch square concrete piles associated with the mooring wharf and seven 24-inch octagonal concrete piles associated with mooring bollards at the east and west ends of the mooring wharf. These piles would be removed over the course of seven days during the IHA time period (see Figure 1-4, and refer to Table 2-1).

1.2.2.1.2 Ramp Pier

The pile-supported vehicle access Ramp Pier at the west end of the wharf—originally installed to support berthing and mooring of the AFDM-14 "Steadfast," would be demolished to allow for installation of a new structure to allow personnel and vehicle access to the FDD. The methods used to remove the Ramp Pier deck and piles would be similar to the methods described for the mooring wharf. This would include the extraction of twenty-eight 24-inch square concrete piles over the course of six days during the IHA time period (see Figure 1-4, and refer to Table 2-1).

1.2.2.2 Pile Installation

Similar to pile extraction activities, pile installation activities for the Project are primarily broken up into separate generalized actions: 1) installation and extraction of 24-inch octagonal concrete piles for a Test Pile Program (TPP); 2) installation of 24-inch octagonal concrete piles at the mooring wharf; and 3) installation of 24-inch octagonal concrete piles associated with the Ramp Pier and Intermediate Support Structure for personnel and vehicle access to the FDD (Figure 1-5). Pile installation will occur via an impact pile driver, high-pressure water jetting, or a combination of both methods.

1.2.2.2.1 Test Pile Program

A total of six 24-inch octagonal concrete test piles would be driven for a TPP at the western end of the mooring wharf (four piles) as well adjacent to the Ramp Pier (two piles; Figure 1-5). The purpose of the TPP is to verify the driving conditions and establish the pile lengths prior to fabrication of the final production piles. These piles would be installed using an impact hammer, re-struck using the same hammer approximately one week later to provide data for production piles, and then removed prior to production pile driving. The TPP piles would be installed and then removed over the course of six days per activity (refer to Table 2-1).

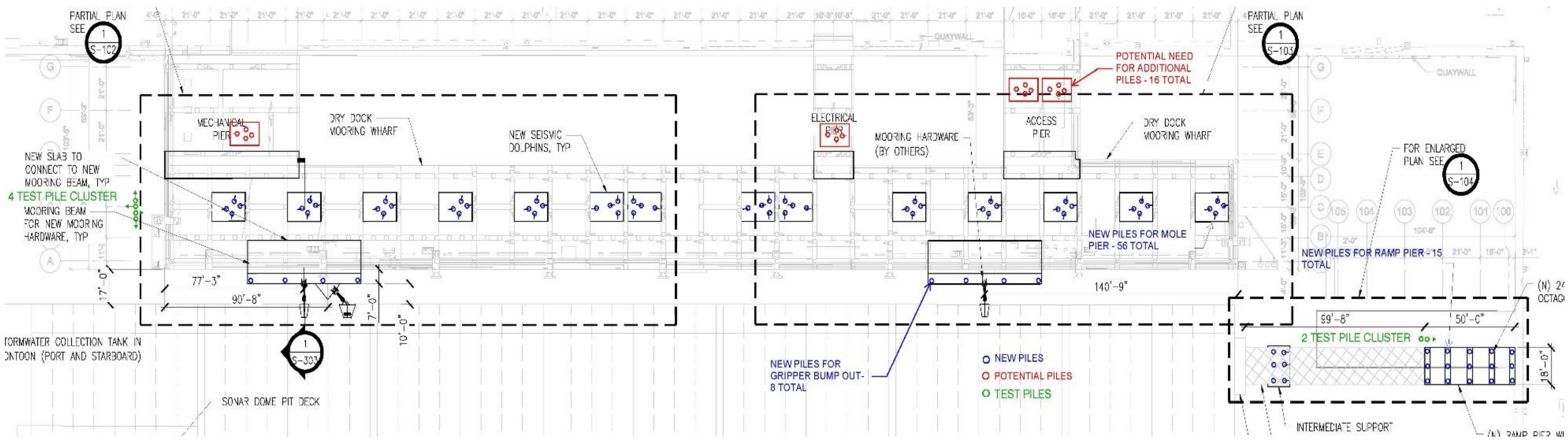


Figure 1-5. Piles to be Installed as Part of the Project-related Activities.

1.2.2.2.2 Mooring Wharf

Once the deck of the mooring wharf has been removed, 14 clusters of four angled (batter) 24-inch octagonal concrete piles will be installed within the existing mooring wharf footprint (see Figure 1-5). Two sets of four 24-inch octagonal concrete piles will also be installed off the southern face of the mooring wharf and will be used to support "bump outs" that will extend out from the existing face of the wharf. Four more clusters of four angled (batter) and vertical (plumb) piles may be installed on the bridges connecting the mooring wharf with the land (indicated by red text in Figure 1-5), but the need for these clusters of piles has not been determined at this point. However, for the purposes of this IHA, these piles will be included in the total number of piles installed. A total of eighty 24-inch octagonal concrete piles would be installed for the mooring wharf over the course of 27 days (see Figure 1-5, and refer to Table 2-1).

1.2.2.2.3 Ramp Pier and Intermediate Support Structure

A new vehicle access bridge will be constructed that will span the distance from the quay wall to the FDD and will consist of a Ramp Pier and an Intermediate Support Structure between the Ramp Pier and the FDD. The space between the pier and the support structure will be spanned by a bridge and then a gangway from the support structure to the FDD. Twenty-one 24-in octagonal concrete pile will be installed to support the Ramp Pier and the Intermediate Support Structure. The 21 piles would be installed over the course of seven days during the IHA time period (see Figure 1-5, and refer to Table 2-1).

1.2.2.3 Floating Dry Dock Placement

The FDD would be procured by Naval Sea Systems Command PMS 325 (refer to Section 1.2, *Proposed Action*) and then barged to NBSD. The FDD would be constructed entirely of steel and have an 18,000-ton vessel-lifting capacity designed to meet the requirements of the Navy's requirements and American Bureau of Shipping Standards. The dimensions for the FDD are 213 m by 50 m (700 ft by 163 ft) with a wing wall height of 13 m (44 ft) above the deck. The FDD would be installed after all in-water and shore-based activities have been completed. This activity is not addressed in the IHA but is included for informational purposes only.

1.3 Best Management Practices, Mitigation, and Minimization Measures

Section 11 describes the general BMPs, mitigation, and minimization measures that may be implemented for all in-water activities. BMPs are routinely used by the Navy during pile installation activities to avoid and minimize potential environmental impacts. Additional minimization measures have been added to protect marine mammals. These measures include performance measures for impact pile driving, and marine mammal monitoring as described in Section 11.

2 DATES, DURATION, AND LOCATION OF ACTIVITIES

The dates and duration of such activity and the specific geographical region where it will occur.

2.1 Dates and Duration of Activities

For this analysis, it is assumed that all in-water work will occur within a 12-month period from 15 March 2024 to 14 March 2025. During that timeframe, both pile extraction and installation would occur on up to 59 days. The duration of pile extraction and installation activities evaluated in the IHA are presented in Table 2-1.

Table 2-1. Proposed Pile Extraction/Installation Activities at the South Berth of the Mole Pier.

Pile Location	*Pile Size/Type*	*Pile Extraction/ Installation Method*	*Piles/ Day*	*Number of Piles*	*Total Estimated Days*
Demolition (Pile Extraction) [1]					
Mooring Wharf	24-inch Square Concrete	-Vibratory Extraction -High-pressure Water Jetting -Hydraulic Pile Clipper -Wire Saw -Underwater Chain Saw -Dead Pull	5	24	5
	24-inch Octagonal Concrete			7	2
Ramp Pier	24-inch Square Concrete			28	6
TPP[2]	24-inch Octagonal Concrete		1	6	6
			Total Piles Removed	**65**	**19**
Construction (Pile Installation) [3]					
TPP[2]	24-inch Octagonal Concrete	-Impact Hammer -High-pressure Water Jetting	1	6	6
Mooring Wharf			3	80	27
Ramp Pier & Intermediate Support Structure				21	7
			Total Piles Installed	**107**	**40**
				Total In-Water Pile Extraction/Installation Days	**59**

Notes:

[1] While other methods of pile extraction are possible, vibratory extraction is the most likely method that will be used to extract piles. No Level A/B take analysis conducted on the other pile extraction methods.

[2] The TPP piles will be installed via an impact hammer prior to the production piles, re-struck for testing approximately one week later, and then extracted prior to the start of production pile installation. Piles will likely be extracted via a vibratory pile remover or dead-pulled.

[3] Impact pile installation is the most likely method that will be used to install piles. High-pressure water jetting may be used either separately from, or at the same time as, impact pile installation.

2.2 Project Area Description

San Diego Bay is a narrow, crescent-shaped natural embayment oriented northwest-southeast with an approximate length of 24 km (15 miles) and a total area of roughly four square kilometers (km^2; 11,000 acres; Port of San Diego [POSD] 2007). The width of the Bay ranges from 0.3 to 5.8 km (0.2 to 3.6 miles), and depths range from 23 m (74 ft) mean lower low water (MLLW) near the tip of Ballast Point to less than 1.2 m (4 ft) at the southern end (Merkel and Associates, Inc. 2009; Figure 2-1). About half of the Bay is less than 4.5 m (15 ft) deep and most of it is less than 15 m (50 ft) deep (Merkel and Associates, Inc. 2009).

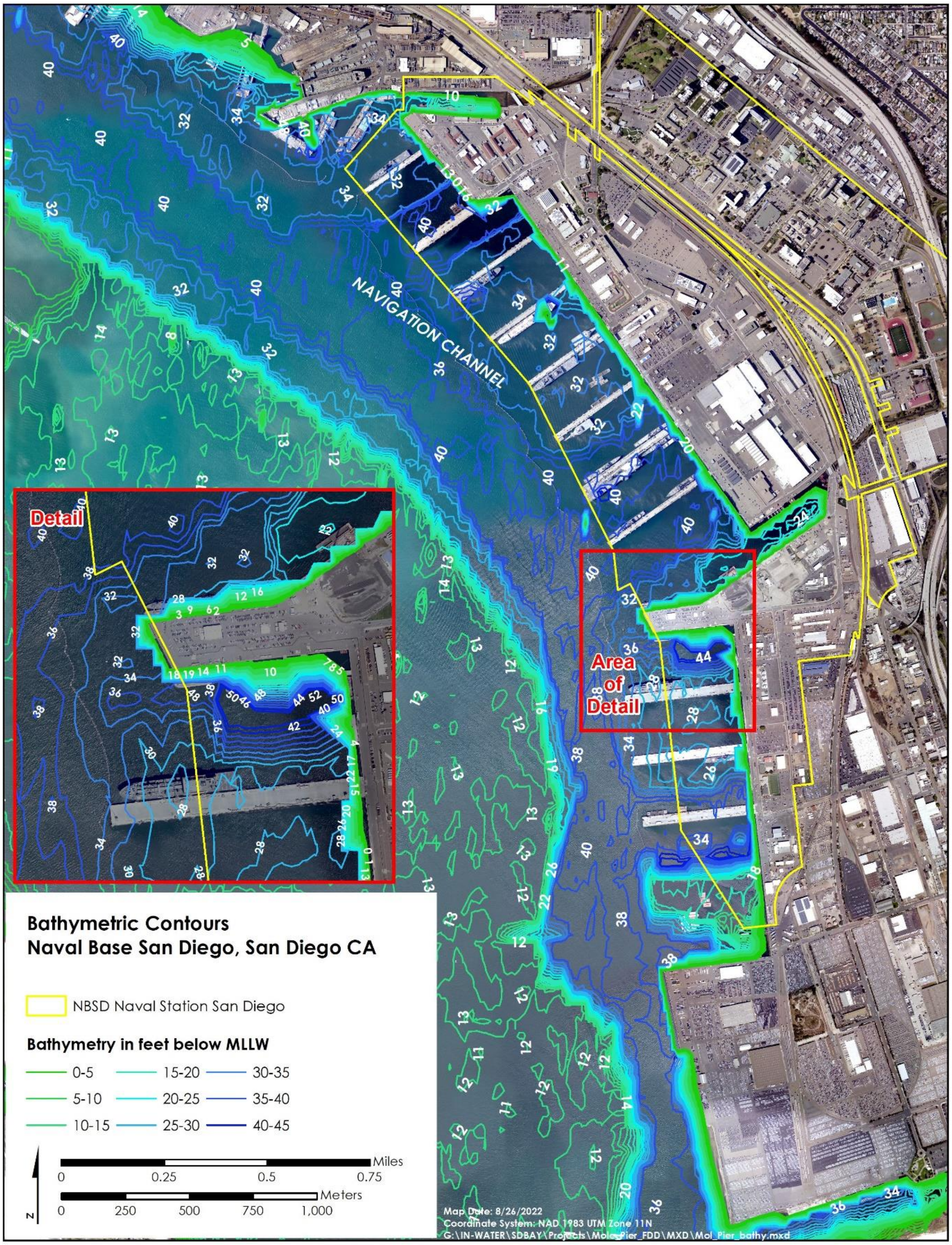
2.2.1 Bathymetric Setting

Bathymetry directly to the south of the Mole Pier has been substantially altered by previously filling and dredging activities, beginning with the construction of the Mole Pier in the early 1980s (see Section 1.1). For example, the sump was originally dredged to a depth of 16.8 m (-55 ft) MLLW at the time of construction to accommodate AFDM 14 "Steadfast," which was previously berthed at the south berth of the Mole Pier and later relocated in 1998. The south berth of the Mole Pier was later modified in 2002 to accommodate berthing and mooring of the USS *Curtiss*, which is currently stationed at the wharf. In preparation for the installation of the FDD, the sediment directly under the FDD would be dredged to depths of approximately 17 m (-56 ft) MLLW.

2.2.2 Circulation, Tides, Temperature, and Salinity

Circulation within San Diego Bay is affected by its crescent shape and narrow Bay mouth, tides, and seasonal salinity and temperature variations (POSD 2007). San Diego Bay can be divided into four regions (see Figure 1-1) based on circulation characteristics:

- North Bay – Marine Region extends from the Bay mouth to the area offshore Downtown San Diego. Tidal action has the greatest influence on circulation in this area, where Bay water is exchanged with sea water over a period of two to three days (POSD 2007).
- North-Central Bay – Thermal Region runs from the North Bay to Glorietta Bay (south of Coronado Island). In the Thermal Region, currents are mainly driven by surface heating. Incoming tides bring cold ocean water from deeper areas, which is then replaced with warm Bay surface water when the tide recedes. These tidal processes lead to strong vertical mixing (POSD 2007).
- South-Central San Diego Bay – The South-Central Seasonally Hypersaline Region (i.e., with higher salt content than seawater) occurs between Glorietta Bay and Sweetwater Marsh. Here, variations in salinity due to warm-weather evaporation at the surface separate the water into upper and lower zones driven by density differences (POSD 2007).
- South Bay – The South Bay Estuarine Region, located south of Sweetwater Marsh, receives occasional freshwater inflows from the Otay and Sweetwater Rivers. Residence time of Bay water in the estuarine region may be greater than 1 month (POSD 2007). Common salinity values for the Bay range from 33.3 to 35.5 practical salinity units for the Bay mouth and the South Bay, respectively (Chadwick et al. 1999).



1 **Figure 2-1. Bathymetric Contours in Waters Adjacent to NBSD.**

San Diego Bay has mixed diurnal/semi-diurnal tides, with the semi-diurnal component being dominant (Largier 1995). The interaction between these two types of tides is such that the higher high tide occurs before the lower low tide, creating the strongest currents on the large ebb tide (Largier 1995). The tidal range (difference between MLLW and mean highest high water) is approximately 1.7 m (5.5 ft; Largier 1995). In general, tidal currents are strongest near the Bay mouth, with maximum velocities of 0.5 to 1 m per second (1.6 to 3.3 ft per second; Largier 1995). Tidal current direction generally follows the center of the channel (Chadwick et al. 1999). Residence time for water in San Diego Bay increases from approximately 5 to 20 days in mid-Bay to over 40 days in the South Bay (Chadwick et al. 1999). During an average tidal cycle, approximately 13 percent (%) of the water in San Diego Bay mixes with ocean water and then moves back into the Bay (POSD 2007). The complete exchange of all the water in San Diego Bay can take between 10 and 100 days, depending on the amplitude of the tidal cycle (POSD 2007). Tidal flushing and mixing are important in maintaining water quality within San Diego Bay. The tidally induced currents regulate salinity, moderate water temperature, and disperse pollutants (POSD 2007).

Temperature and density gradients, both with depth and along a longitudinal cross-section of the Bay, drive tidal exchange of Bay and ocean water beginning in the spring and continuing into fall. The seasonal thermal cycle has an amplitude of about 14 to 16 degrees Fahrenheit (°F) (8 to 9 degrees Celsius [°C]). Maximum water temperatures occur in July and August, and minimums in January and February. In the winter, thermal gradients are absent, with cooler air temperatures and higher winds causing the Bay to be nearly isothermal. During 1993 surveys, the warmest temperature was 84.7°F (29.3°C) in South Bay, and the coolest temperature, 59.2°F (15.1°C), was just north of the Coronado Bridge in January (Lapota et al. 1993). In the early 1970s, the average surface temperature for San Diego Bay was estimated to be 63.3°F (17.4°C; Smith 1972), but recent average temperatures are now in excess of 66°F (18.8°C; National Data Buoy Center 2022) inside of the Bay. Maximum vertical temperature gradients of about 0.3°F/ft (0.5°C/m) occur during the summer (Smith 1972). Typical longitudinal temperature range is about 45 to 50°F (7 to 10°C) (about 0.3 to 0.5°C/km) over the length of the Bay during the summer. Temperature inversions also occur diurnally due to night cooling. Salinities of the Project area resemble those of the nearby open ocean (i.e., 32.8 to 33 parts per thousand [Tierra Data, Inc. 2012a]).

2.2.3 Water Quality

Water quality is commonly assessed by measuring dissolved nutrients, dissolved oxygen, pH, turbidity, chlorophyll *a* (a measure of the amount of phytoplankton present in San Diego Bay), and coliform bacteria (Chadwick et al. 1999). Measured values for dissolved nutrients in the Bay such as phosphate and silicates range from 0.9 to 4 parts per million (ppm) for silicon and 0.02 to 0.3 ppm phosphorus in the winter, to 0.3 to 1.3 ppm for silicates and 0.2 ppm phosphorus in the summer (Chadwick et al. 1999). This variation is the result of inflow of these nutrients with winter runoff, and uptake by phytoplankton growth in the summer (Chadwick et al. 1999). Dissolved oxygen levels range from approximately 4 milliliters per liter (mL/L) during the summer to 8 mL/L during the winter (Chadwick et al. 1999). These oxygen levels are typically at or near atmospheric equilibrium levels. The pH of seawater in San Diego Bay is relatively uniform, ranging from approximately 7.9 to 8.1 mL/L throughout the Bay and the year (Chadwick et al. 1999).

Surface water chemistry is analyzed by the Regional Harbor Monitoring Program using primary and secondary indicators, including total and dissolved levels of copper (primary), and total and dissolved zinc and nickel (secondary). Copper concentrations in San Diego Bay show improvement in comparison with a historical baseline, and average copper concentrations do not exceed the California Toxics Rule (CTR) threshold of 5.8 micrograms per liter (µg/L) total and 4.8 µg/L dissolved. Less than 20% of measurements throughout the Bay still exceed the CTR threshold. Both total and dissolved zinc and nickel concentrations are well below CTR threshold values used for the Regional Harbor Monitoring Program. All other dissolved and total metals have concentrations below their respective acute and chronic CTR thresholds (Amec Foster Wheeler 2016). Polycyclic aromatic hydrocarbon concentrations are also below their respective CTR threshold values (Amec Foster Wheeler 2016).

Turbidity is a measure of water clarity or murkiness and can be caused by suspended sediments transported in runoff or increased algal/bacterial growth (Tierra Data, Inc. 2010). Turbidity can also be created by natural and manmade resuspension of bottom sediments. Increased turbidity reduces the amount of light available for plant growth underwater, so it can affect the ability of San Diego Bay to support living organisms (Tierra Data, Inc. 2010). Turbidity in San Diego Bay varies, depending on the tides, seasons, and location within the Bay (Tierra Data, Inc. 2010).

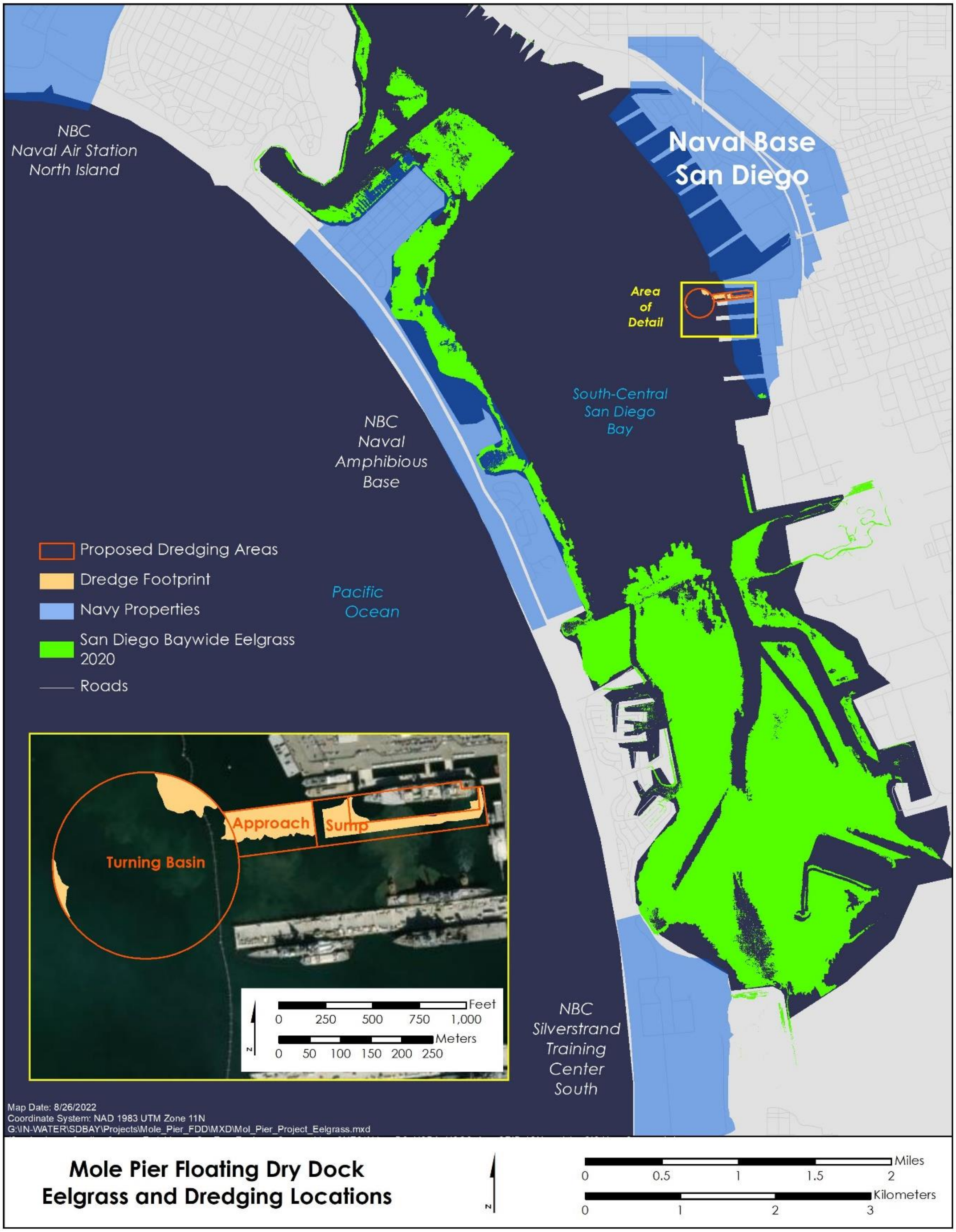
Chlorophyll *a* ranges from 0.2 to 25 µg/L (Chadwick et al. 1999). The highest values were measured in the South Bay in winter, when runoff carries high levels of nutrients into the South Bay. In summer, chlorophyll *a* levels return to background levels of 1 to 2 µg/L. These chlorophyll *a* levels are generally much higher than those found in the adjacent open ocean. Before 1964, when untreated sewage was still being discharged into the San Diego Bay, bacterial counts (fecal coliform) were as high as 82 organisms per milliliter in the South Bay (Chadwick et al. 1999). Since these discharges ended, bacterial counts typically remain below 10 organisms per milliliter except during some winter storms. These levels are below federal limits for water contact, implying that the San Diego Bay is generally safe for recreational use (Chadwick et al. 1999).

Current sources of pollution to San Diego Bay include underground dewatering, industries on the Bay and upstream, marinas and anchorages, U.S. Naval activities, materials used for underwater hull cleaning and vessel antifouling paints, and urban runoff (Chadwick et al. 1999). Additional pollution sources include creosote-treated wood pier pilings, which are a source of polycyclic aromatic hydrocarbons, stormwater runoff from land used for industrial, commercial, and transportation purposes, bilge water discharge, and oil spills (Chadwick et al. 1999). Changes in Navy procedures since the mid-1990s have included replacing approximately half of the pier pilings with plastic, concrete, or untreated wood, and implementing the Bilge Oily Waste Treatment System for treatment of construction and repair wastewater.

Overall, the levels of contamination in the water and sediment in San Diego Bay appear to be lower now than in previous decades, including levels of some metals and polycyclic aromatic hydrocarbons (POSD 2007). However, copper concentrations remain routinely higher than federal and state limits for dissolved copper (POSD 2007).

2.2.4 Substrates and Habitats

Sediments in San Diego Bay are relatively sandy (Naval Facilities Engineering Command, Southwest [NAVFAC SW] and POSD 2013) as tidal currents tend to keep the finer silt and clay fractions in suspension, except in harbors and elsewhere in the lee of structures where water movement is diminished. Much of the shoreline consists of riprap and manmade structures as can be seen in aerial views. The predominant habitats at the Mole Pier site is moderately deep subtidal (3.7 m to 6.1 m [12 to 20 ft] MLLW) at the near-vertical surfaces of artificial substrates present and remaining habitat is deep subtidal (deeper than 6.1 [20 ft] MLLW). Over-water structures, such as the existing mooring wharf, provide substrates for the growth of algae and invertebrates off the bottom and support abundant fish populations (NAVFAC SW and POSD 2013). Eelgrass is not present within the Project area (Figure 2-2).



1 **Figure 2-2. Eelgrass Located within the Vicinity of the Project.**

2.2.5 Vessel Traffic and Ambient Underwater Soundscape

As illustrated by Table 2-2, San Diego Bay is heavily used by commercial, recreational, and military vessels, with an average of 80,966 vessel movements (in or out of the Bay) in 2022. This equates to about 222 vessel transits per day, a majority of which are presumed to occur during daylight hours. The number of transits does not include recreational boaters that use San Diego Bay, estimated to number 200,000 (San Diego Harbor Safety Committee 2020, 2022).

Table 2-2. 2021 Port of San Diego Average Annual Vessel Traffic.

VESSEL TYPE	VESSEL MOVEMENTS (Total Calls by Vessel Type)[1]		
	Subtotal by Vessel Type		Total
	Cargo	Others	
Deep Draft Commercial Vessels (Cargo plus Cruise)[1]			
Cargo Ships[2]: Barge	17		**17**
Bulk	9		**9**
Container Ships	56		**56**
General Cargo	26		**26**
Roll On/Roll Off	49		**49**
Cruise Ships[3]		15	**15**
Excursion Ships[4]		68,000	**68,000**
Commercial Sportfishing[5]		10,094	**10,094**
Military[6]		2,700	**2,700**
Total Annual Movements for All Vessel Types	**157**	**80,809**	**80,966**

Notes:
[1] Tug traffic was not included in the above statistics since inner harbor tug movements alone exceed 7,000 for a typical year; [2] Largest vessel: 1,000 ft length, 106 ft beam, 41 ft draft; [3] Largest vessel: 1,000 ft length, 106 ft beam, 34 ft draft; [4] Largest vessel: 222 ft length, 57 ft beam, 6 ft draft ; [5] Average vessel size: 123 ft length, 32 ft berth, 13 ft draft; [6] Largest vessel: 1,115 ft length, 252 ft beam (flight deck), 39 ft draft
Sources: San Diego Harbor Safety Committee (2020, 2022)

The variety and abundance of ships operating in San Diego Bay contributes to a substantial level of underwater anthropogenic noise. Acoustic monitoring of ship noise in Glacier Bay, Alaska (Kipple and Gabriele 2007), found that root mean square (RMS) sound source levels from a variety of vessel types and sizes was typically within the range of 157 to 180 decibels (dB) referenced to 1 microPascal (re 1 µPa) at 1 m[2]. Ship noise was characterized by a broad frequency range (roughly 0.1 to 35 kilohertz [kHz]), with peak noise at higher frequencies for smaller vessels. Similar broad spectrum (10 Hz to >1 kHz) noise has been reported for a variety of categories of ships (National Research Council [NRC] 2003). Within southern California, in the Santa Barbara Channel, large cargo ships at transit speeds range from 177 to 188 dB re 1 µPa (McKenna 2011). Ship noise in San Diego Bay thus has the potential to mask underwater sound that would otherwise emanate from the Project site to locations farther up the Bay.

In February 2019 researchers collected ambient acoustic data over a three-day period at two locations on NBSD. The first site was a southerly location approximately 200 m (656 ft) south of the end of Pier 13, and the second a more northern location approximately 20 m (66 ft) off the end of Pier 6 (see Figure 1-1 for Pier

[2] Refer to Section 6 for background on acoustics and definitions of metrics.

locations). The ambient noise levels varied at these locations, with median L_{50}[3] levels of 121 dB re 1 µPa and 131 dB re 1 µPa at the Pier 13 and Pier 6 locations, respectively (Dahl and Dall'Osto 2019). Because this data was collected over a relatively short time period, and during one season, an average of the two L_{50} values was used to describe ambient noise values in the south-central San Diego Bay, knowing that some of the time ambient noise levels may be higher or lower than the average of 126 dB re 1 µPa (Dahl and Dall'Osto 2019). Furthermore, because ambient noise levels at the Pier 6 monitoring location were louder than 126 dB re 1 µPa, this is considered as a conservative estimate of the ambient levels around the Project area. Therefore, while the Level B threshold criteria for non-impulsive noise is 120 dB re 1 µPa, noise from non-impulsive sources associated with the Pier 6 project is assumed to become indistinguishable from background noise as it diminishes to 126 dB re 1 µPa with distance from the source.

[3] The L_{50} values represent a statistical descriptor of the sound level exceeded for 50% of the time measurement period.

3 MARINE MAMMAL SPECIES AND NUMBERS

The species and numbers of marine mammals likely to be found within the activity area.

The most frequently observed marine mammal in San Diego Bay is the California sea lion (*Zalophus californianus*), which often rests on buoys and other structures and occurs throughout the North to North-Central Bay. Other species that occur in San Diego Bay include coastal bottlenose dolphin (*Tursiops truncatus*), which is regularly seen in the North Bay; harbor seal (*Phoca vitulina*), which frequently enters the North Bay; and common dolphins (both short-beaked [*Delphinus delphis*] and long-beaked [*Delphinus capensis*]), which are rare visitors in the North Bay. California gray whales (*Eschrichtius robustus*) are also occasionally sighted near the mouth of San Diego Bay during their winter migration (NAVFAC SW and POSD 2013). While common dolphins and gray whales do occur in San Diego Bay, No Level B Take is being requested for these species.

The Project action area for marine mammals is determined by the limits of potential effects, which in this case are defined by acoustic zones of influence (ZOIs; see Section 6.7). Because sound transmission is impeded by natural and manmade barriers on the shore, the ZOI is entirely south of the Coronado Bridge, and does not extend north of the Mole Pier on the east side of the Bay, or north of Naval Amphibious Base Coronado on the west side of the Bay (see Section 6.7).

Due to the dynamic nature of the north and north-central San Diego Bay, with both high use by marine mammals and humans, marine mammal surveys most often occur in the north and north-central San Diego Bay (Merkel and Associates, Inc. 2008; Sorensen and Swope 2010; Graham and Saunders 2014; NAVFAC SW 2018b). Based on these surveys California sea lions are the predominant species observed. For instance, during five years of monitoring efforts associated with the Naval Base Point Loma Fuel Pier Replacement project in north San Diego Bay, a total of 21,643 marine mammals were observed, with 19,091 (88.2%) of those were California sea lions (NAVFAC SW 2019a). However, relative to this Project area, only one dedicated line transect survey (Sorensen and Swope 2010) surveyed an area south of the Coronado Bridge. During the Sorensen and Swope (2010) survey, two sightings of one California sea lion each were reported in the water adjacent to NBSD. As presented in the NBSD Pier 6 Replacement Project's first year's interim report (NAVFAC SW 2022) a clearer picture of marine mammal activity south of the Coronado Bay Bridge was developed during 132 days of observations. This recent monitoring effort found that California sea lions were the most common species observed south of the Coronado Bridge (69.9%), but coastal bottlenose dolphins (29.5%), and to a lesser extent harbor seals (0.6%), were observed as well. The Pier 6 Replacement Project data represents the best available science for an area that is close to the Project area. Thus, impacts to California sea lions, coastal bottlenose dolphins, and harbor seals are evaluated in this IHA relative to the numbers provided in NAVFAC SW (2022). If other marine mammal species are observed, procedures identified in Chapter 13 and in the IHA Monitoring Plan will be implemented. These measures include stopping all in-water pile demolition and/or installation activities if a non-IHA marine mammal enters the Level B ZOI.

3.1 Species Descriptions and Abundances

3.1.1 California Sea Lion

3.1.1.1 Species Description

The California sea lion is now considered to be a full species, separated from the Galapagos sea lion (*Z. wollebaeki*) and the extinct Japanese sea lion (*Z. japonicus*) (Carretta et al. 2019). The breeding areas of the California sea lion are on the Channel Islands, western Baja California, and the Gulf of California. Mitochondrial DNA analysis of California sea lions has identified five genetically distinct geographic populations: (1) Pacific Temperate, (2) Pacific Subtropical, (3) Southern Gulf of California, (4) Central Gulf of California and (5) Northern Gulf of California. The Pacific Temperate population makes up the U.S. stock and includes rookeries within U.S. waters and the Coronado Islands just south of the U.S.-Mexico border.

The California sea lion is sexually dimorphic. Males may reach 454 kilograms (kg; 1,000 pounds) and 2.4 m (8 ft) in length; females grow to 136 kg (300 pounds) and 1.8 m (6 ft) in length. Their color ranges from chocolate brown in males to a lighter, golden brown in females. At around five years of age, males develop a bony bump on top of the skull called a sagittal crest. The crest is visible in the "dog-like" profile of male sea lion heads, and hair around the crest gets lighter with age (Heath 2002).

3.1.1.2 Population Abundance

The entire population cannot be counted because all age and sex classes are never ashore at the same time. In lieu of counting all sea lions, pups are counted when all are ashore, in July during the breeding season, and the number of births is estimated from pup counts (Carretta et al. 2019). The size of the population is then estimated from the number of births and the proportion of pups in the population. Based on these censuses, the U.S. stock has generally increased from the early 1900s, to a current estimate of 257,606, with a minimum estimate of 233,515 (Laake et al. 2018). There are indications that the California sea lion may have reached or is approaching carrying capacity, although more data are needed to confirm that leveling in growth persists (Carretta et al. 2019).

3.1.2 Harbor Seal

3.1.2.1 Species Description

Harbor seals, which are members of the family Phocidae ("true seals"), with two subspecies extant in the Pacific: *P. v. stejnegeri* in the western North Pacific near Japan and *P. v. richardii* in the eastern North Pacific including the west coast of the U.S. Like all true seals, harbor seals have short forelimbs and lack external ear flaps as present in otariids such as the California sea lion. Harbor seals inhabit coastal and estuarine waters and shoreline areas from Baja California to western Alaska. Harbor seals weigh up to 129 kg (285 pounds) and measure up to 1.8 m (6 ft) in length, with males slightly larger than females (NMFS 2022b).

3.1.2.2 Population Abundance

Based on post-breeding counts of individuals at known haul-outs, corrected for the proportion of the population that is out at sea, the population estimate for the California stock of harbor seal is 30,968, and the minimum population size is estimated as 27,348 (Carretta et al. 2019). The population size has increased since the 1980s and fluctuated during the past decade, with the highest counts in 2004, but lower counts in 2009 and 2012 (Carretta et al. 2016).

3.1.3 Coastal Bottlenose Dolphin

3.1.3.1 Species Description

The California coastal stock of coastal bottlenose dolphin is distinct from the offshore population and is resident in the immediate (within 1 km of shore) coastal waters, occurring primarily between Point Conception, California, and San Quintin, Mexico. Coastal bottlenose dolphins have a robust body and a short, thick beak. They range in length from 1.8 to 4.0 m (6 to 13 ft) and weigh from 135 to 635 kg (300 to

1,400 pounds); males are slightly larger than females. They are commonly found in groups of 2 to 15 Individuals and in larger pods offshore. Coastal animals feed on benthic fish and invertebrates (NMFS 2022c).

3.1.3.2 Population Abundance

Based on photographic mark-recapture surveys conducted along the San Diego coast from 2009 to 2011 (Weller et al. 2016), two separate population size estimates were generated from open and closed mark-recapture models. The best open model generated an estimate of 515 (95% confidence interval [CI] = 470–564, coefficient of variation [CV] = 0.05) animals, while the best closed model produced an estimate of 453 (95% CI = 411–524, CV=0.06) animals. These estimates are for marked animals only and do not include an estimated ~40% of animals that are not individually recognizable (Weller et al. 2016). The estimated fraction of unmarked animals is highly uncertain because it is unknown how often unmarked animals are resighted. The new estimates are the largest obtained for this stock, dating back to the 1980s. For comparison with previous estimates of this stock, the closed population estimate of 453 (CV=0.06) animals is used as the best estimate of abundance (Carretta et al. 2017, 2019). In the aforementioned surveys of San Diego Bay, numbers of coastal bottlenose dolphins were highly variable (from 0 to 40).

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4 AFFECTED SPECIES STATUS AND DISTRIBUTION

A description of the status, distribution, and seasonal distribution (when applicable) of the affected species or stocks of marine mammals likely to be affected by such activities.

4.1 California Sea Lion, U.S. Stock

4.1.1 Status and Management

California sea lions are protected under the MMPA and are not listed under the Endangered Species Act (ESA). NMFS has defined one stock for California sea lions (U.S. Stock), with five genetically distinct geographic populations: Pacific Temperate, Pacific Subtropical, Southern Gulf of California, Central Gulf of California, and Northern Gulf of California. The Pacific Temperate population includes rookeries within U.S. waters and the Coronado Islands just south of the U.S.-Mexico border. Animals from the Pacific Temperate population range north into Canadian waters, and movement of animals between U.S. waters and Baja California waters has been documented (Carretta et al. 2019). The U.S. stock is not considered strategic or depleted under the MMPA.

4.1.2 Distribution

More than 95% of the U.S. Stock breeds and gives birth to pups on San Miguel, San Nicolas, and Santa Barbara islands. Some movement has been documented between the U.S. Stock and Western Baja California, Mexico Stock, but rookeries in the U.S. are widely separated from the major rookeries of western Baja California. Smaller numbers of pups are born on San Clemente Island, the Farallon Islands, and Año Nuevo Island (Lowry et al. 1991). The California sea lion is by far the most commonly-sighted pinniped species at sea or on land in the vicinity of San Diego Bay. In California waters, California sea lions represented 97% (381 of 393) of identified pinniped sightings at sea during the 1998–1999 NMFS surveys (Carretta et al. 2000). They were sighted during all seasons and in all areas with survey coverage from nearshore to offshore areas (Carretta et al. 2000). California sea lions, while potentially present at-sea, are most commonly seen hauled out on piers and buoys within and leading into San Diego Bay, (Merkel and Associates, Inc. 2008). In a study of California sea lion reaction to human activity, Holcomb et al. (2009) showed that in general California sea lions are rather resilient to human disturbance.

The distribution and habitat use of California sea lions varies with the sex of the animals and their reproductive phase. Adult males haul out on land to defend territories and breed from mid-to-late May until late July. Individual males remain on territories for 27 to 45 days without going to sea to feed. During August and September, after the mating season, the adult males migrate northward to feeding areas as far away as Washington (Puget Sound) and British Columbia (Lowry et al. 1991). They remain there until spring (March through May), when they migrate back to the breeding colonies. Thus, adult males are present in offshore areas only briefly as they move to and from rookeries. Distribution of immature California sea lions is less well known, but some make northward migrations that are shorter in length than the migrations of adult males (Huber 1991). However, most immature California sea lions are presumed to remain near the rookeries for most of the year. Adult females remain near the rookeries throughout the year. Most births occur from mid-June to mid-July (peak in late June).

Survey data from 1975 to 1978 were analyzed to describe the seasonal shifts in the offshore distribution of California sea lions near the Channel Islands (Bonnell and Ford 1987). The seasonal changes in the center of distribution were attributed to changes in the distribution of the prey species. If California sea lion distribution is determined primarily by prey abundance as influenced by variations in local, seasonal, and interannual oceanographic variation, these same areas might not be the center of California sea lion distribution every year. Melin et al. (2008) showed that foraging female sea lions showed significant variability in individual foraging behavior, and foraged further offshore and at deeper depths during El Niño years as compared to non-El Niño years.

There are limited published at-sea density estimates for pinnipeds within Southern California. At-sea densities likely decrease during warm-water months because females spend more time ashore to give birth and attend their pups. Radio-tagged female California sea lions at San Miguel Island spent approximately 70% of their time at sea during the nonbreeding season (cold-water months) and pups spent an average of 67% of their time ashore during their mother's absence (Melin and DeLong 2000). Different age classes of California sea lions are found in the San Diego region throughout the year (Lowry et al. 1991). Although adult male California sea lions feed in areas north of San Diego, animals of all other ages and sexes spend most, but not all, of their time feeding at sea during winter. During warm-water months, a high proportion of the adult males and females are hauled out at terrestrial sites during much of the period.

The geographic distribution of California sea lions includes a breeding range from Baja California to southern California. During the summer, California sea lions breed on islands from the Gulf of California to the Channel Islands and seldom travel more than about 31 miles (50 km) from the islands (Bonnell et al. 1983). The primary rookeries are located on the California Channel Islands of San Miguel, San Nicolas, Santa Barbara, and San Clemente (Le Boeuf and Bonnell 1980; Bonnell and Dailey 1993). Their distribution shifts to the northwest in fall and to the southeast during winter and spring, probably in response to changes in prey availability (Bonnell and Ford 1987). In the nonbreeding season, adult and subadult males, and juvenile males and females (McHuron et al. 2018) migrate northward along the coast to central and northern California, Oregon, Washington, and Vancouver Island in British Columbia, and return south in the spring.

4.1.3 Site-Specific Occurrence

In San Diego Bay, in general, California sea lions regularly occur on rocks, buoys and other structures, and especially on bait barges, although numbers vary greatly. The interim IHA report for the on-going NBSD Pier 6 Replacement Project recorded 230 individuals over 132 days of monitoring activity (NAVFAC SW 2022). This equates to an average of 1.74 California sea lions observed per day. Rounding to the nearest whole number leads to two (2) individuals per day expected to be in the vicinity of the FDD. As a result, the Navy believes that the monitoring data presented in the interim IHA report for the Pier 6 Replacement Project represent the best available scientific data on numbers of California sea lions that are likely to occur in the Project area.

4.1.4 Behavior and Ecology

Sexual maturity occurs at around 4 to 5 years of age for California sea lions, and the pupping and mating season begins in May and continues through July (Heath 2002). California sea lions are gregarious during the breeding season and social on land during other times. California sea lions' food consists of squid, octopus, and a variety of fishes. While no studies have occurred of their diet in the Bay, studies of food sources have been done in other California coastal areas (Antonelis et al. 1990; Lowry et al. 1990; Melin et al. 1993; Hanni and Long 1995; Henry et al. 1995). Fish species found in the Bay that sea lions most likely feed on include spiny dogfish, jack mackerel, Pacific herring, Pacific sardine, and northern anchovy. They also eat octopus and leopard shark (NAVFAC SW and POSD 2013).

California sea lions show a high tolerance for human activity (Holcomb et al. 2009), modify their foraging in response to spatial and temporal variations in the availability of different prey species (Lowry et al. 1991), and make opportunistic use of almost any available structures as haulouts (NAVFAC SW and POSD 2013).

California sea lions seek a variety of structures, such as rocks, piers, and buoys and low profile docks for hauling out. These behaviors can be destructive to structures due to the weight of the animal and fouling. If California sea lions find an easy food source at tourist spots or fishing piers, their presence can become a nuisance at certain areas in the Bay as they have at marinas in Monterey and San Francisco Bay (Leet et al.1992). Marina operators and commercial and sport fishermen tend to consider them a major nuisance, leading to some human-caused mortality.

4.1.5 Acoustics

On land, California sea lions make incessant, raucous barking sounds with most of the energy at less than 2 kHz (Schusterman et al. 1967). Males vary both the number and rhythm of their barks depending on the social context; the barks appear to control the movements and other behavior patterns of nearby conspecifics (Schusterman 1977). Females produce barks, squeals, belches, and growls in the frequency range of 0.25 to 5 kHz, while pups make bleating sounds at 0.25 to 6 kHz. California sea lions produce two types of underwater sounds: clicks (or short-duration sound pulses) and barks (Schusterman et al. 1966, 1967; Schusterman and Baillet 1969), both of which have most of their energy below 4 kHz (Schusterman et al. 1967). The functional hearing range for California sea lions on land is 50 Hz to 75 kHz (Schusterman 1981) and in-water is 60 Hz to 39 kHz (NMFS 2018).

4.2 Harbor Seal, California Stock

4.2.1 Status and Management

Harbor seals are protected under the MMPA and are not listed as threatened or endangered under the ESA. NMFS has defined five distinct stocks on the U.S. west coast including California, Oregon/Washington Coast, Washington Northern Inland Waters, Southern Puget Sound, and Hood Canal. The Project site is located within the boundaries of the California Stock. The U.S. stock is not considered strategic or depleted under the MMPA (Carretta et al. 2019).

4.2.2 Distribution

Harbor seals are considered abundant throughout most of their range from Baja California to the eastern Alueutian Islands. An unknown number of harbor seals also occur along the west coast of Baja California, at least as far south as Isla Asuncion, which is about 161 km (100 miles) south of Punta Eugenia. Peak numbers of harbor seals haul out on land during late May to early June, which coincides with the peak of their molt. They favor sandy, cobble, and gravel beaches (Stewart and Yochem 1994), with multiple haul-outs identified along the California mainland and Channel Islands (Carretta et al. 2016).

There are limited at-sea density estimates for pinnipeds within southern California. Harbor seals do not make extensive pelagic migrations but do travel 300 to 500 km (186 to 311 miles) on occasion to find food or suitable breeding areas (Carretta et al. 2016). Based on likely foraging strategies, Grigg et al. (2009) reported seasonal shifts in harbor seal movements based on prey availability. When at sea, they remain in the vicinity of haul-out sites and forage close to shore in shallow waters. In relationship to the entire California stock, harbor seals do not have a significant mainland California distribution south of Point Mugu due to beach urbanization and potential disturbance impacts.

4.2.3 Site-Specific Occurrence

Harbor seals are relatively uncommon within San Diego Bay. Similar to California sea lions, harbor seals haul out on rocks, buoys and other structures. The interim IHA annual report for the on-going NBSD Pier 6 Replacement Project recorded two individuals over 132 days of monitoring activity (NAVFAC SW 2022). This equates to an average of 0.02 harbor seals observed per day. Rounding up to the nearest whole number leads to one (1) individual per day expected to be in the vicinity of the FDD. The Navy believes that the monitoring data presented in the interim IHA report for the Pier 6 Replacement Project represent the best available scientific data on numbers of harbor seals that are likely to occur in the Project area.

4.2.4 Behavior and Ecology

Harbor seals prefer sheltered coastal waters and feed on schooling benthic and epibenthic fish species in shallow water (Bonnell and Dailey 1993). While not studied in the Bay, specific prey species have been studied in other California waters (Stewart and Yochem 1985, 1994; Oxman 1993; Henry et al. 1995). Of particular note to San Diego Bay are these potential prey species: specklefin midshipman, plainfin midshipman, jack mackerel, shiner surfperch, yellowfin goby, and English sole. Harbor seals also eat octopus, two species of which are found in the Bay (NAVFAC SW and POSD 2013). Although their ecological niche in the Bay has not been studied, this pinniped is not likely to play a significant role because of their low numbers (NAVFAC SW and POSD 2013). Harbor seals mate at sea and females give birth during the spring and summer although the “pupping season” varies by latitude.

4.2.5 Acoustics

In air, harbor seal males produce a variety of low-frequency (<4 kHz) vocalizations, including snorts, grunts, and growls. Male harbor seals produce communication sounds in the frequency range of 100 to 1,000 Hz (Richardson et al. 1995). Pups make individually unique calls for mother recognition that contain multiple harmonics with main energy below 0.34 kHz (Bigg 1981; Thomson and Richardson 1995). Harbor seals hear nearly as well in air as underwater and had lower thresholds than California sea lions (Kastak and Schusterman 1998). Kastak and Schusterman (1998) reported airborne low frequency (100 Hz) sound detection thresholds at 65.4 dB re 20 µPa for harbor seals. In air, they hear frequencies from 0.25 kHz – 30 kHz and are most sensitive from 6 to 16 kHz (Richardson et al. 1995; Terhune and Turnbull 1995; Wolski et al. 2003).

Adult males also produce underwater sounds during the breeding season that typically range from 0.025 to 4 kHz (duration range: 0.1 second to multiple seconds; Hanggi and Schusterman 1994). Hanggi and Schusterman (1994) found that there is individual variation in the dominant frequency range of sound between different males, and Van Parijs et al. (2003) reported oceanic, regional, population, and site-specific variation that could be vocal dialects. In water, they hear frequencies from 1 to 75 kHz (Southall et al. 2007) and can detect sound levels as weak as 60 to 85 dB re 1 µPa within that band. They are most sensitive at frequencies below 50 kHz; above 60 kHz sensitivity rapidly decreases.

4.3 Coastal Bottlenose Dolphin, California Coastal Stock

4.3.1 Status and Management

Coastal bottlenose dolphins are protected under the MMPA and are not listed as threatened or endangered under the ESA. NMFS has defined two distinct stocks on the U.S. west coast including California Coastal and California/Oregon/Washington Off-Shore. The Project site is located within the boundaries of the California Coastal Stock. The U.S. stock is not considered strategic or depleted under the MMPA (Carretta et al. 2019).

4.3.2 Distribution

The California Coastal stock of bottlenose dolphins occurs at least from Point Conception south into Mexican waters, at least as far south as San Quintin, Mexico. In southern California, animals are found within 500 m (152.4 ft) of the shoreline 99% of the time and within 250 m (820 ft) 90% of the time (Hanson and Defran 1993). Occasionally, during warm-water incursions such as during the 1982–1983 El Niño events, their range extends as far north as Monterey Bay (Wells et al. 1990). Coastal bottlenose dolphins in the Southern California Bight—the coastal waters between Point Conception and just south of the Mexican border—appear to be highly mobile within a narrow coastal zone (Defran et al. 1999), and exhibit little seasonal site fidelity within the Southern California Bight (Defran and Weller 1999) and along the California coast; over 80% of the dolphins identified in Santa Barbara, Monterey, and Ensenada have also been identified off San Diego (Navy 2010).

As seen in the Navy's marine mammal surveys of San Diego Bay (Merkel and Associates 2008; Tierra Data, Inc. 2012b; NAVFAC SW 2014), coastal bottlenose dolphins have occurred sporadically and in highly variable numbers and locations. However, during the Pier 6 Replacement Project (NAVFAC SW 2022), coastal bottlenose dolphin were observed south of the Coronado Bay Bridge during five of the eight months of monitoring effort, with the highest number of individuals observed in January.

4.3.3 Site-Specific Occurrence

Coastal bottlenose dolphins are observed within south central San Diego Bay. The interim IHA report for the on-going NBSD Pier 6 Replacement Project recorded 97 individuals over 132 days of monitoring activity (NAVFAC SW 2022). This equates to an average of 0.73 coastal bottlenose dolphins observed per day. Rounding up to the nearest whole number leads to one (1) individual per day expected to be in the vicinity of the FDD. As a result, the Navy believes that the monitoring data presented in the interim IHA report for the Pier 6 Replacement Project represent the best available scientific data on numbers of coastal bottlenose dolphins that are likely to occur in the Project area.

4.3.4 Behavior and Ecology

The coastal stock utilizes a limited number of fish prey species with up to 74% being various species of surfperch or croakers, a group of non-migratory year-round coastal inhabitants (Defran et al. 1999; Allen et al. 2006). For southern California, common croaker prey species include spotfin croaker, yellowfin croaker, and California corbina, while common surfperch species include barred surfperch and walleye surfperch (Allen et al. 2006). The corbina and barred surfperch are the most common surf zone fish where coastal bottlenose dolphins have been observed foraging (Allen et al. 2006). Defran et al. (1999) postulated that the coastal stock of coastal bottlenose dolphins showed significant movement within their home range (Central California to Mexico) in search of preferred but patchy concentrations of nearshore prey (i.e., croakers and surfperch). Bearzi et al. (2009), in an analysis of coastal bottlenose dolphins in the vicinity of Santa Monica, also concluded that low individual re-sighting rates indicates a large coastal bottlenose dolphin distribution influenced by prey distribution. After finding concentrations of prey, animals may then forage within a more limited spatial extent to take advantage of this local accumulation until such time that prey abundance is reduced; the dolphins then shift location once again to be over larger distances (Defran et al.1999; Bearzi et al. 2009). Specific prey items of coastal bottlenose dolphins along the California coast were studied by Defran et al. (1986). San Diego Bay coastal bottlenose dolphins forage on species such as jack mackerel, Cortez grunt, striped mullet, and black croaker, white sea bass, white croaker, spotted croaker, yellowfin croaker, California corbina, queenfish, Pacific mackerel, Pacific bonito, and sierra (NAVFAC SW and POSD 2013).

4.3.5 Acoustics

Sounds emitted by bottlenose dolphins have been classified into two broad categories: pulsed sounds (including clicks and burst-pulses) and narrow-band continuous sounds (whistles), which usually are frequency modulated. Whistles range in frequency from 0.8 to 24 kHz but can also go much higher. Clicks and whistles have a dominant frequency range of 110 to 130 kHz and a source level of 218 to 228 dB re 1 μPa at 1 m (3.3 ft) (peak to peak levels; Au 1993) and 3.5 to 14.5 kHz with a source level of 125 to 173 dB re 1 μPa at 1 m (3.3 ft), respectively (Ketten 1998). The bottlenose dolphin has a functional high- frequency hearing limit of 160 kHz (Au 1993) and can hear sounds at frequencies as low as 40 to 125 Hz (Turl 1993). Inner ear anatomy of this species has been described (Ketten 1992). Electrophysiological experiments suggest that the bottlenose dolphin brain has a dual analysis system: one specialized for ultrasonic clicks and the other for lower frequency sounds, such as whistles (Schlundt et al. 2000). The audiogram of the bottlenose dolphin shows that the lowest thresholds occurred near 50 kHz at a level around 45 dB re 1 μPa (Nachtigall et al. 2000; Finneran and Houser 2006, 2007). Below the maximum sensitivity, thresholds increased continuously up to a level of 137 dB re 1 μPa at 75 Hz. Above 50 kHz, thresholds increased slowly up to a level of 55 dB re 1 μPa at 100 kHz, then increased rapidly above this to about 135 dB re 1 μPa at 150 kHz. Scientists have reported a range of best sensitivity between 25 and 70 kHz, with peaks in sensitivity occurring at 25 and 50 kHz at levels of 47 and 46 dB re 1 μPa (Nachtigall et al. 2000).

Temporary threshold shifts (TTS) in hearing have been experimentally induced and behavioral responses observed in captive bottlenose dolphins (Ridgway et al. 1997; Schlundt et al. 2000, 2006; Nachtigall et al. 2003, 2004; Finneran et al. 2002, 2005, 2007). Ridgway et al. (1997) observed changes in behavior at the following minimum levels for 1 second tones: 186 dB re 1 μPa at 3 kHz, 181 dB re 1 μPa at 20 kHz, and 178 dB re 1 μPa at 75 kHz. TTS levels were 194 to 201 dB re 1 μPa at 3 kHz, 193 to 196 dB re 1 μPa at 20 kHz, and 192 to 194 dB re 1 μPa at 75 kHz.

Schlundt et al. (2000) exposed bottlenose dolphins to intense tones (0.4, 3, 10, 20, and 75 kHz); the animals demonstrated altered behavior at source levels of 178 to 193 dB re 1 μPa, with TTS after exposures between 192 and 201 dB re 1 μPa at 1 m (3.3 ft) (though one dolphin exhibited TTS after exposure at 182 dB re 1 μPa). Nachtigall et al. (2003) determined threshold for a 7.5 kHz pure tone stimulus. No shifts were observed at 165 or 171 dB re 1 μPa, but when the sound level reached 179 dB re 1 μPa, the animal showed the first sign of TTS. Recovery apparently occurred rapidly, with full recovery apparently within 45 minutes following sound exposure. In another experiment, TTS occurred after 30 minutes of exposure to 160 dB re 1 μPa at 4 to 11 kHz. TTS occurred at test frequencies of 8 to 16 kHz but was negligible or absent at higher frequencies (Nachtigall et al. 2004).

5 HARASSMENT AUTHORIZATION REQUEST

The type of incidental taking authorization that is being requested (i.e., takes by harassment only, takes by harassment, injury and/or death), and the method of incidental taking.

Under Section 101 (a)(5)(D) of the MMPA, the Navy requests an IHA for the take of a small number of marine mammals, by Level B behavioral harassment only, incidental to the extraction and installation of piles related to NBSD Mole Pier FDD Project. The Navy requests an IHA for proposed activities that will be conducted during a one-year period beginning 15 March 2024 through 14 March 2025.

Except with respect to certain activities not pertinent here, the MMPA defines ‘‘harassment’’ as: any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) 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 [Level B harassment] (50 CFR, Part 216, Subpart A, Section 216.3-Definitions). The proposed activities are not anticipated to result in any Level A harassment due to implementation of a buffered Level A ZOI for California sea lions, harbor seals, and coastal bottlenose dolphins during the pile extraction of 24-inch square concrete piles or the pile extraction or installation of 24-inch octagonal concrete piles. The remaining level A ZOIs generated from pile extraction and installation activities are smaller than the 10-m (33-ft) shutdown zone used to reduce physical interaction with Project-related equipment.

5.1 Method of Incidental Taking

This authorization request considers noise from vibratory pile extraction/installation and impact pile installation. While other activities may be used to remove piles, these activities were deemed as the only activities that have the potential to disturb or displace marine mammals or produce a temporary shift in their hearing ability (TTS) resulting in Level B harassment, as defined above.

Based on an analysis of the available data associated with pile extraction, there is small potential for marine mammals to experience permanent threshold shift (PTS) during pile extraction resulting in Level A take. However, Level A ZOIs will be fully monitored to avoid take. To avoid Level A takes, for those activities with Level A ZOIs that are less than 10 m (33 ft; refer to Table 6-6), a buffered shutdown zone out to 10 m (33 ft) would be implemented to halt activities that could potentially injure a marine mammal that is near in-water Project-related activities. For those activities with Level A ZOIs that are greater than 10 m (33 ft; refer to Table 6-6), a buffered shutdown zone out to the next tens of meters would be implemented to reduce the potential for a Level A take. All pile extraction and installation activities will either be delayed from starting or halted if any marine mammals approach the shutdown zone(s) which would include all distances calculated for the Level A zone. No Level A take is anticipated with implementation of these shutdown zones.

In-water pile extraction and installation activities include a range of potential methodologies and sound sources (e.g., pile clippers, underwater chainsaw, diamond wire saw, vibratory pile extractor, and impact hammer). To provide a realistic worst-case scenario, the Navy has estimated takes by assuming pile extraction sound generating activities listed in Table 2-1 will occur on separate days. The total number of in-water workdays is estimated at 59 days. This analysis predicts 236 exposures for all species (see Section 6.8 for estimates of exposures by species) that could be classified as Level B harassment under the MMPA. The Navy’s mitigation procedures, presented in Section 11, include monitoring of mitigation zones during pile extraction activities. The Navy believes that these mitigation measures will be effective in avoiding marine mammal exposures to sound levels that would constitute Level A harassment.

6 NUMBERS AND SPECIES EXPOSED

By age, sex, and reproductive condition (if possible), the number of marine mammals (by species) that may be taken by each type of taking identified in [Section 5], and the number of times such takings by each type of taking are likely to occur.

6.1 Introduction

In-water pile installation/extraction will temporarily increase underwater noise in the vicinity of the Project area. Pile driving can also generate airborne noise that could potentially result in disturbance to marine mammals (pinnipeds) that are hauled out; however, due to the absence of haul-outs in the Project area, the potential for acoustic harassment by airborne noise is considered negligible and is not analyzed.

Research suggests that increased noise may impact marine mammals in several ways and that these impacts depend on many factors. Noise impacts are discussed in more detail in Section 7. Assessing whether a sound may disturb or injure a marine mammal involves understanding the characteristics of the acoustic source and the potential effects that sound may have on the physiology and behavior of that marine mammal. Sound is important for marine mammal communication, navigation, and foraging (NRC 2003, 2005), and understanding the auditory effects from anthropogenic sound on marine mammals has continued to be researched and developed (Southall et al. 2019). Furthermore, many other factors besides the received level of sound may affect an animal's reaction, such as the animal's physical condition, prior experience with the sound, and proximity to the source of the sound.

Several potential pile extraction methods, including use of high-pressure water jetting, hydraulic pile clipper, wire saw, underwater chain saw, or dead pulling are not expected to result in Level A or Level B harassment of marine mammals as defined under the MMPA. Impact pile driving and vibratory pile extraction could result exposure to noise that would cross Level A and Level B marine mammal noise thresholds, as defined in NMFS (2018). The methods for estimating the number and types of exposures are summarized below.

The following methods were used to determine exposure of marine mammals:

- Estimating the area of impact where noise levels exceed acoustic thresholds for marine mammals (Sections 6.7);
- Evaluating the potential presence of marine mammals based on historical occurrence or by site-specific survey as outlined in (Section 6.8); and
- Estimating potential harassment exposures by multiplying the site-specific abundance of marine mammals in the area by their probable duration of exposure during demolition or construction activities (Section 6.8.1).

These three methods are discussed in the sections that follow.

6.2 Fundamentals of Sound

Sound is a physical phenomenon consisting of regular pressure oscillations that travel through a medium, such as air or water. Sound frequency is the rate of oscillation, measured in cycles per second or Hertz (Hz). The amplitude (loudness) of a sound is its pressure, whereas its intensity is proportional to power and is pressure squared. The standard international unit of measurement for pressure is the Pascal, which is a force of 1 Newton exerted over an area of 1 square meter; sound pressures are measured in µPa.

Due to the wide range of pressure and intensity encountered during measurements of sound, a logarithmic scale is used, based on the dB, which, for sound intensity, is 10 times the log10 of the ratio of the measurement to reference value. For sound pressure level (SPL), the amplitude ratio in dB is 20 times the log10 ratio of measurement to reference. Hence each increase of 20 dB in SPL reflects a 10-fold increase in signal amplitude (whether expressed in terms of pressure or particle motion). That is, 20 dB means 10 times the amplitude, 40 dB means 100 times the amplitude, 60 dB means 1,000 times the amplitude, and so on. Because the dB is a relative measure, any value expressed in dB is meaningless without an accompanying reference. In describing underwater sound pressure, the reference amplitude is usually 1 µPa, and is expressed as "dB re 1 µPa." For in-air 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 weighted filter that mimics human sensitivity to amplitude as a function of frequency. This is called A-weighting and the decibel level measured is called the A-weighted sound level (dBA). Methods of frequency weighting that reflect the hearing of marine mammals have been proposed (Southall et al. 2007; Finneran and Jenkins 2012) and are being used in new analyses of Navy testing and training effects, but have not been adopted for pile driving and other non-explosive impulsive sounds (Marine Species Modeling Team 2012). Therefore, for Level B take analyses, underwater sound levels are not weighted and measure the entire frequency range of interest. In the case of marine construction work, the frequency range of interest is 20 Hz to 20 kHz. Level A take analyses use the concept of functional hearing groups (NMFS 2018), which takes into account that different types of marine mammals hear in different frequency ranges, and that different types of pile extraction and/or installation activities transmit sound in different frequency ranges.

Table 6-1 summarizes commonly used terms to describe underwater sounds. Two common descriptors are the instantaneous peak SPL and the root mean square (RMS) SPL. The peak pressure is the instantaneous maximum overpressure, or underpressure, observed during each pulse or sound event and is presented in dB re 1 µPa. The RMS level is the square root of the mean of the squared pressure (= intensity) level as measured over a specified time period. All underwater sound levels throughout the remainder of this application are presented in dB re 1 µPa unless otherwise noted.

Table 6-1. Definitions of Acoustical Terms.

Noise Source	***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 water is 1 microPascal (µPa) and for air is 20 µPa (approximate threshold of human audibility).
Sound Pressure Level, SPL	Sound pressure is the force per unit area, usually expressed in microPascals where 1 Pascal equals 1 Newton exerted over an area of 1 square meter. The SPL is expressed in decibels as 20 times the logarithm to the base 10 of the ratio between the pressure exerted by the sound to a reference sound pressure. SPL is the quantity that is directly measured by a sound level meter.
Frequency, Hz	Frequency is expressed in terms of oscillations, or cycles, per second or hertz (Hz). Typical human hearing ranges from 20 Hz to 20 kilohertz (kHz).

Noise Source	*Definition*
Peak Sound Pressure, dB re 1 µPa	Peak SPL is based on the largest absolute value of the instantaneous sound pressure over the frequency range from 20 Hz to 20 k Hz. This pressure is expressed in this application as dB re 1 µPa (dB RMS).
Root-Mean-Square (RMS), dB re 1µPa	The RMS level is the square root of the mean of the squared pressure level(s) as measured over a specified time period. For pulses, the RMS has been defined as the average of the squared pressures over the time that comprise that portion of waveform containing 90% of the sound energy for one impact pile driving impulse. The unit for RMS is dB re 1µPa and is expressed as dB RMS for pile extraction/installation activities and sound threshold criteria.
Sound Exposure Level (SEL), dB re 1 µPa^2-sec	Sound exposure level is a measure of energy. Specifically, it is the dB level of the time integral of the squared-instantaneous sound pressure, normalized to a 1-sec period. It can be an extremely useful metric for assessing cumulative exposure because it enables sounds of differing duration, to be compared in terms of total energy. The units for SEL are dB re 1 µPa^2-sec.
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 Spectrum, dB over frequency range	The amplitude of sound at various frequencies, usually shown as a graphical plot of the mean square pressure per unit frequency (µPa2 /Hz) over a frequency range (e.g., 10 Hz to 10 kHz in this application).
A-Weighting Sound Level, dBA	The SPL in decibels as measured on a sound level meter using the A- or C-weighting filter network. The A-weighting filter de-emphasizes the low and high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective human reactions to noise.
Ambient Noise Level	The background sound level, which is a composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location. In the case of the Project area, the ambient underwater noise level is 129.6 dB re 1 µPa (NAVFAC SW 2020).

6.3 Description of Noise Sources

Ambient sound is a composite of sounds from multiple sources, including environmental events, biological sources, and anthropogenic activities. Physical noise sources include waves at the surface, precipitation, earthquakes, ice, and atmospheric noise, among other events. Biological sources include marine mammals, fish, and invertebrates. Anthropogenic sounds are produced by vessels (small and large), dredging, aircraft overflights, construction activities, geophysical explorations, commercial and military sonars, and other activities. Known noise levels and frequency ranges associated with anthropogenic sources similar to those that would be used for this Project are summarized in Table 6-2.

In-water construction activities associated with the proposed Project could include the use of high-pressure water jetting, hydraulic pile clipper, wire saw, underwater chain saw, dead pulling, vibratory pile extraction or impact pile driving. The sounds produced by these activities fall into two sound types: impulsive and non-impulsive (defined below). Impact pile driving produces impulsive sounds, while the other sounds sources above produce non-impulsive sounds. The distinction between these two general sound types is important because of their potential to cause physical effects differs, particularly with regard to hearing (Ward 1997).

Impulsive sounds (e.g., explosions, seismic air gun pulses, and impact pile driving), which are referred to as pulsed sounds by Southall et al. (2007, 2019), are brief, broadband, atonal transients (Harris 1998) and occur either as isolated events or are repeated in some succession (Southall et al. 2007, 2019). Impulsive sounds are characterized by a relatively rapid rise from ambient pressure to a maximal pressure value, followed by a decay period that may include a period of diminishing, oscillating maximal and minimal pressures (Southall et al. 2007). Impulsive sounds generally have a greater capacity to induce physical injury compared with sounds that lack these features (Southall et al. 2007, 2019).

Non-impulsive sounds (referred to as non-pulsed in Southall et al. 2007, 2019) can be tonal, broadband, or both. They lack the rapid rise time and can have longer durations than impulsive sounds. Non-impulsive sounds can be either intermittent or continuous. Examples of non-impulsive sounds include vessels, aircraft, and machinery operations such as drilling, dredging, high pressure water jetting, pile clipping, and vibratory pile driving (Southall et al. 2007, 2019). In some environments, the duration of both impulsive and non-impulsive sounds can be extended due to reverberations.

Table 6-2. Representative Levels of Underwater Anthropogenic Noise Sources.

Noise Source	*Frequency Range (Hz)*	*Sound Level*	*References*
Dredging operations	1-500	clamshell/bucket dredge maximum = 124 dB RMS at 150 m; excavator dredge maximum = 148 dB RMS at 60 m (197 ft)	Richardson et al. 1995; Reine et al. 2014; Jones et al. 2015
Small vessels	860–8,000	141–175 dB RMS at 1 m (3.28 ft)	Galli et al. 2003; Matzner and Jones 2011; Sebastianutto et al. 2011
Large ship	20–1,000	176–186 dB re 1 µPa^2-sec at 1 m (3.28 ft) (SEL)	McKenna 2011
Tug docking gravel barge	200–1,000	149 dB at 100 m (328 ft)	Blackwell and Greene 2002

Abbreviations: dB = decibel; Hz = Hertz; m = meter; RMS = root mean square; sec = second; SEL = sound exposure level
dB re 1 µPa = decibels (dB) referenced to (re) 1 micro (µ) Pascal (Pa)

6.4 Sound Exposure Criteria and Thresholds

Under the MMPA, NMFS has defined levels of harassment for marine mammals. Level A harassment is defined as "[a]ny 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 "[a]ny 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."

To date, no studies have been conducted that examine impacts to marine mammals from pile-driving sounds from which empirical noise thresholds have been established. Currently, NMFS uses underwater sound exposure thresholds to determine when an activity could result in impacts to a marine mammal defined as Level A (injury) or Level B (disturbance including behavioral and TTS) harassment (NMFS 2018, 2020). NMFS (2018) developed acoustic threshold levels for determining the onset of PTS in marine mammals in response to underwater impulsive and non-impulsive sound sources (Table 6-3).

Level A harassment is assumed to result in a "stress response." The stress response per se is not considered injury, but refers to an increase in energetic expenditure that results from exposure to the stressor and which is predominantly characterized by either the stimulation of the sympathetic nervous system or the hypothalamic-pituitary-adrenal axis (Reeder and Kramer 2005). The presence and magnitude of a stress response in an animal depends on the animal's life history stage, environmental conditions, reproductive state, and experience with the stressor (Navy 2010).

Behavioral harassment (Level B) is considered to have occurred when marine mammals are exposed to sounds at or above 160 dB re 1µPa for impulse sounds (e.g., impact pile driving) and 120 dB re 1µPa for continuous noise (e.g., pile clipping or cutting), but below injurious thresholds. Level B harassment may or may not result in a stress response. The application of the 120 dB re 1µPa threshold can sometimes be problematic because this threshold level can be either at or below the ambient noise level of certain locations including San Diego Bay. As a result, these levels are considered precautionary (74 FR 41684).

Table 6-3. Injury and Disturbance Threshold Criteria for Underwater Noise.

Marine Mammal Hearing Group	***Underwater Continuous Noise Thresholds (re 1 µPa)***		***Underwater Impulsive Noise Thresholds (re 1 µPa)***	
	Level A Threshold (PTS Onset)	**Level B Threshold (Disturbance)**	**Level A Threshold (PTS Onset)[1]**	**Level B Threshold (Disturbance)**
Low-Frequency Cetaceans[2]	199 dB SEL_{cum}[3]		219 dB Peak[4] 183 dB SEL_{cum}[3]	
Mid-Frequency Cetaceans	198 dB SEL_{cum}[3]		230 dB Peak[4] 185 dB SEL_{cum}[3]	
High-Frequency Cetaceans[2]	173 dB SEL_{cum}[3]	120 dB RMS	202 dB Peak[4] 155 dB SEL_{cum}[3]	160 dB RMS
Phocidae	201 dB SEL_{cum}[3]		218 dB Peak[4] 185 dB SEL_{cum}[3]	
Otariidae	219 dB SEL_{cum}[3]		232 dB Peak[4] 203 dB SEL_{cum}[3]	

Notes:

[1] Dual metric acoustic thresholds for impulsive sounds. Whichever results in the largest isopleth for calculating PTS onset is used in the analysis.

[2] No Low- or High-Frequency cetaceans are anticipated to appear in the Project study area and PTS and TTS thresholds are included here for informational purposes only.

[3] Cumulative SELs are over 24 hours for continuous noise sources, and based on blow count/duration for impulsive noise sources.

[4] Flat weighted or unweighted peak sound pressure within the generalized hearing range.

Abbreviations: µPa = microPascal; dB = decibel; PTS = permanent threshold shift; RMS = root mean square; SEL = sound exposure level.

6.5 Limitations of Existing Noise Criteria

The application of the 120 dB RMS behavioral threshold can sometimes be problematic because this threshold level can be either below the ambient noise level of certain locations. The 120 dB RMS threshold level for non-impulsive noise originated from research conducted by Malme et al. (1984) for California gray whale response to continuous industrial sounds, such as drilling operations.

To date, there is no research or data supporting a response by pinnipeds or odontocetes to non-impulsive sounds from vibratory pile driving as low as the 120 dB RMS threshold. Southall et al. (2007) reviewed studies conducted to document the behavioral responses of harbor seals and northern elephant seals to non-impulsive sounds under various conditions. They concluded that those limited studies suggest that exposures between 90 dB and 140 dB re 1 µPa generally do not appear to induce strong behavioral responses. As discussed in Section 2.2.5, recent measurements recorded in the south-central San Diego Bay resulted in an average ambient underwater noise level of 126 dB RMS (Dahl and Dall'Osto 2019). Therefore, 126 dB RMS is the threshold used for Level B disturbance for non-impulsive underwater sound in this IHA.

6.6 Auditory Masking

Natural and artificial sounds can disrupt behavior through auditory masking or interference with a marine mammal's ability to detect and interpret other relevant sounds, such as communication and echolocation signals (Wartzok et al. 2004). Masking occurs when both the signal and masking sound have similar frequencies and either overlap or occur very close to each other in time. A signal is very likely to be masked if the noise is within a certain "critical bandwidth" around the signal's frequency and its energy level is similar or higher (Holt 2008). Noise within the critical band of a marine mammal signal will show increased interference with detection of the signal as the level of the noise increases (Wartzok et al. 2004). For example, in delphinid subjects, relevant signals needed to be 17 to 20 dB louder than masking noise at frequencies below 1 kHz to be detected and 40 dB greater at approximately 100 kHz (Richardson et al. 1995). Noise at frequencies outside of a signal's critical bandwidth will have little to no effect on the detection of that signal (Wartzok et al. 2004).

Additional factors influencing masking are the temporal structure of the noise and the behavioral and environmental context in which the signal is produced. Continuous noise is more likely to mask signals than intermittent noise of the same amplitude; quiet "gaps" in the intermittent noise allow detection of signals that would not be heard during continuous noise (Brumm and Slabbekoorn 2005). The behavioral function of a vocalization (e.g., contact call, group cohesion vocalization, echolocation click) and the acoustic environment at the time of signaling may both influence the call source level (Holt et al. 2011), which directly affects the chances that a signal will be masked (Nemeth and Brumm 2010). Miksis-Olds and Tyack (2009) showed that manatees modified vocalizations differently during increased noise, depending on whether or not a calf was present.

Masking noise from anthropogenic sources could cause behavioral changes if the masking disrupts communication, echolocation, or other hearing-dependent behaviors. As noted above, noise frequency and amplitude both contribute to the potential for vocalization masking; noise from pile driving typically covers a frequency range of 10 Hz to 1.5 kHz, which is likely to overlap with the frequencies of vocalizations produced by species that may occur in the Project area. Amplitude of noise from both impact and vibratory pile-driving methods is variable and may exceed that of marine mammal vocalizations within an unknown range of each incident pile. Depending on the animal's location and vocalization source level, this range may vary over time.

Based on the frequency overlap between noise produced by both vibratory and impact pile driving (10 Hz to 1.5 kHz), animals that remain in a Project area during pile driving may be vulnerable to masking for the duration of pile driving (typically 2 hours or less, intermittently over the course of a day depending on site and project). Energy levels of vibratory pile driving are less than half that of impact pile driving; therefore, the potential for masking noise would be limited to a small radius around a pile. The likelihood that vibratory pile driving would mask relevant acoustic signals for marine mammals is negligible. In addition, most marine mammal species that may be subject to masking are transitory within the Project areas. The animals most likely to be at risk for vocalization masking are resident sea lions around local haul-out areas. Possible behavioral reactions to vocalization masking include changes to vocal behavior (including cessation of calling), habitat abandonment (short- or long-term), and modifications to the acoustic structure of vocalizations (which may help signalers compensate for masking) (Brumm and Slabbekoorn 2005; Brumm and Zollinger 2011). Given the relatively high source levels for most marine mammal vocalizations, the Navy has estimated that masking events would occur concurrently within the zones of behavioral harassment estimated for vibratory and impact pile driving (see Section 6.7.2) and are therefore taken into account in the exposure analysis.

6.7 Underwater Sound Propagation

Pile driving will generate underwater noise that potentially could result in disturbance to marine mammals swimming by the Project area. Transmission loss (TL) underwater is the decrease in acoustic intensity as an acoustic pressure wave propagates out from a source until the source becomes indistinguishable from ambient sound. Parameters associated with TL vary with frequency, temperature, sea conditions, current, source and receiver depth, water depth, water chemistry, bottom composition and topography. A standard sound propagation model (called "practical spreading loss" [PSL]) was used to estimate the range from pile-driving activity to various expected SPLs at potential Project-related structures by incorporation into a site-specific model (Dall'Osto and Dahl 2019), as well as a generic spreading loss model (NMFS 2018). The generic PSL model follows a geometric propagation loss based on the distance from the driven pile, resulting in a 4.5 dB reduction in sound levels for each doubling of distance from the source. In this model, the SPL at some distance away from the source (e.g., a driven pile) is governed by a measured source level, minus the TL of the energy as it dissipates with distance. The PSL method is generally used to estimate TL where bathymetry varies and empirical measurements are not available. The equation for TL with PSL is:

$$TL = 15 \log_{10} \left(\frac{R_1}{R_2} \right)$$

Where:

TL is the transmission loss in dB,

R_1 is the distance of the modeled SPL from the driven pile, and

R_2 is the distance from the driven pile of the initial measurement.

6.7.1 Modeling Potential Noise Impacts from Pile Extraction and Driving

The degree to which underwater noise propagates away from a noise source is dependent on a variety of factors, most notably by bathymetry and the presence or absence of reflective or absorptive conditions, including the sea surface and sediment type. The two models used to assess the potential distances to regulatory thresholds (Dall'Osto and Dahl 2019; NMFS 2018, 2020) use PSL to evaluate the potential for Level A/B harassment. Dall'Osto and Dahl (2019) developed acoustic models using point sources at three locations (Pier 1, Pier 6 and Pier 13) along the eastern extent of the south-central San Diego Bay on NBSD. Due do the similar bathymetry and location with respect to the channel, the Navy believes that the Pier 13 modeling location, which is roughly 725 m (2,379 ft) to the south of the Project location, represents the best location to approximate the sound propagation profile from a notional source at the Mole Pier mooring wharf FFD location. Key to this profile is the dampening effect of sound due to the western slope of the dredged navigation channel, as well as channelization of sound to the north and south within the channel. While the Pier 13 point is not exactly in the project location, we have used the site-specific model to identify sound propagation in the general project area rather than a generic PSL model, which would not account for environmental variables. We believe that this is the most realistic approach and is based the best available science for the area.

Harbor seals and coastal bottlenose dolphins were not included in the site-specific modeling effort for Level A distance calculations. As a result, the NMFS user spreadsheet (NMFS 2020) was used to determine Level A zones for these species (see Table 6-6; Appendix A). To determine zones for potential Level B harassment, the site-specific model was used for all species because the threshold criteria for Level B impacts are based solely on continuous or impulsive noise source and are not frequency dependent.

6.7.2 Underwater Noise from Pile Driving and Extraction

The intensity of pile driving sound is greatly influenced by factors such as the type of pile, the type of driver, and the physical environment in which the activity takes place. To determine reasonable SPLs from pile driving, studies with similar properties to the proposed Project were evaluated. Table 6-4 presents received SPL at a distance of 10 m (33 ft) from the pile, with RMS and Peak levels relative to 1 µPa and cumulative SELs relative to 1 microPascal squared second (re 1 µPa2-sec) during impact pile driving.

Table 6-4. Underwater Noise Source Levels Modeled for Impact Pile Driving.

Pile Type	*Peak SPL[1] (dB re 1 µPa)*	*RMS SPL (dB re 1 µPa)*	*SEL (dB re 1 μPa^2-sec)*
24-inch Concrete Octagonal	188	176	166

Data Source: CALTRAN (2020; Berth 22 Reconstruction, Port of Oakland).
Note:
[1] All SPLs are unattenuated; single strike SEL are the proxy sources levels presented for impact pile driving and were used to calculate distances to PTS; Source levels for 24-inch concrete square and octagonal piles are assumed to have the same source level.
Abbreviations: dB re 1 µPa = decibels referenced to a pressure of 1 microPascal (measures underwater SPL); dB re 1 μPa^2-sec= decibels referenced to a pressure of 1 microPascal squared per second (measures underwater SEL); RMS = root mean square; SEL = sound exposure level; SPL = sound pressure level.

The source level associated with the non-impulsive (continuous) sound sources is provided in Table 6-5. These sources include a vibratory extractor to assist the extraction of concrete piles. Data from the most similar activities reported in the NAVFAC SW (2022) were used as a proxy for the proposed activities associated with the FDD Project. The sources is assumed to operate for 10 minutes; this is a conservative assumption given that the contractor will be allowed flexibility to combine and use the most efficient methods. For the purpose of generating Level B take estimates, the maximum RMS SPL is the only relevant criterion; peak SPLs and SELs for these types of sources are not usually measured and would only exceed thresholds less than a meter from the source.

Table 6-5. Underwater Noise Source Levels Modeled for Pile Extraction.

Pile Size/Type	*Method*	*RMS SPL[1,2] (dB re 1 μPa)*	*Assumed Duration of Pile Extraction*
24-inch Octagonal Concrete OR 24-inch Square Concrete	Vibratory extraction	162	20:00

Data Source: NAVFAC SW (2022)
Note:
[1] In the absence of information on vibratory extraction of 24-inch square and octagonal concrete piles, source data from 20-inch concrete square piles was used as a proxy source level.
[2] Data were not collected at source (10 m [33 ft]) due to safety concerns. The source value of 162 dB RMS value is based on a calculated source level, assuming practical spreading loss, using the average of the maximum RMS values (161.97 dB RMS) collected at from 49 to 79 m (161 to 259 ft). The Peak SPL and SEL values are not available for the calculated data.
Abbreviations: dB re 1 μPa = decibels referenced to a pressure of 1 microPascal (measures underwater SPL); RMS = root mean square; SPL = sound pressure level.

The representative source levels in Table 6-4 and Table 6-5 were used to estimate the distance to noise levels that exceeded regulatory thresholds. Table 6-6 summarizes the calculated distances to the underwater marine mammal thresholds during pile extraction/driving methods at the Project site. A representative pile location were chosen to model the greatest possible affected areas; typically these locations would be at the seaward end of a pier that extends the farthest into the marine environment. Figure 6-1 illustrates the extent and area of each ZOI for a pile representing the "worst-case" extent of noise propagation (furthest from the shore). Level A ZOIs that are less than 10 m (33 ft; Table 6-6) are not depicted in the figures; However, a 10 m (33 ft) shutdown zone would be implemented for these ZOIs (Table 6-7). It should be noted that if it is determined that smaller piles of the same material are required at the time of construction, the most applicable ZOI areas as presented in Table 6-6 would be referenced for the sake of being conservative.

The extent of the representative ZOIs are depicted in Figure 6-1 using a representative notional pile location near the western end of the mooring wharf. While Dall'Osto and Dahl (2019) utilized a location at Pier 13 (south of the Project location), we feel that the location provides the best approximation of the noise propagation in the Project area. In this case, the land-forms mask noise to the north and east, and the channel reduces sound levels to the west, and "channels" the noise to the south. The channeling is primarily due to the upward slope of the navigation channel, with sound transmission being impeded as the sound travels from deeper water in the navigation channel into shallower water on the western side of San Diego Bay (Dall'Osto and Dahl 2019).

Table 6-6. Calculated Distance(s) to Underwater Noise Thresholds from Pile Extraction/Installation at the Project Site.

Activity Description	Pile Size/Type & Source Levels[1]	Level A ZOIs[2] (m [ft])			Level B ZOIs[2] (m [ft])
		California sea lions	Harbor seals	Coastal bottlenose dolphins	All Species
Vibratory Extraction[3]	24-inch octagonal/square concrete (Production) (162 RMS)	0.0 (0.0)	6.8 (22.3)	1.0 (3.3)	3,525 x 1,055 (11,565 x 3,353)[5]
	24-inch octagonal concrete (TPP)[4] (162 RMS)	0.0 (0.0)	2.3 (7.5)	0.3 (1.0)	
Impact Driving[6]	24-inch octagonal concrete (TPP)[4] (188 Peak, 176 RMS, 166 SEL)	0.0 (0.0)	28.0 (91.9)	1.9 (6.2)	375 (1,230)
	24-inch octagonal concrete (Production) (188 Peak, 176 RMS, 166 SEL)	0.0 (0.0)	58.2 (190.9)	3.9 (12.8)	

Notes:

[1] Sound source levels at 10 m (33 ft) distance. Units for Peak and RMS are dB re 1 µPa. The unit for SEL is dB 1 µPa^2-sec.

[2] Level A distances are based on a site-specific model for California sea lions (Dall'Osto and Dahl 2019) and a generic PSL model (NMFS 2018, 2020) for harbor seals and coastal bottlenose dolphins. No Level A thresholds are crossed for California sea lions based on the site-specific model (Dall'Osto and Dahl 2019). Level B distances are based on the site-specific model (Dall'Osto and Dahl 2019). No Level A take is requested.

[3] Assumes 20 minutes of vibratory pile extraction, Weighting Factor Adjustment of 2.5 kHz, with 5 piles/day for Production, and 1 pile/day for the TPP. While vibratory pile installation is not expected, if it is required to install piles, then monitoring protocols identified for vibratory pile extraction will be implemented.

[4] The TPP Piles will be installed via an impact hammer prior to the production piles, re-struck for testing approximately one week later, and then removed prior to the start of production pile driving.

[5] The distances represent the maximum north/south and east/west distance from the pile being driven. These distances are represented by the green line in Figure 6-1.

[6] Assumes 600 strikes per pile, 0.01 second single-strike duration, Weighting Factor Adjustment of 2.0 kHz, with 3 piles/day for Production, and 1 pile/day for the TPP.

Abbreviations: m = meters; RMS = root mean square; SEL = sound exposure level.

Table 6-7. Distance(s) to Underwater Shutdown Zones for Pile Extraction/Installation at the Project Site.

Activity Description	Pile Size/Type & Source Levels	Shutdown ZOIs (m [ft])		
		California sea lions	Harbor seals	Coastal bottlenose dolphins
Vibratory Extraction	24-inch octagonal/square concrete (Production) (162 RMS)	10 (33)	10 (33)	10 (33)
	24-inch octagonal concrete (TPP) (162 RMS)	10 (33)	10 (33)	10 (33)
Impact Driving	24-inch octagonal concrete (TPP) (188 Peak, 176 RMS, 166 SEL)	10 (33)	30 (98)	10 (33)
	24-inch octagonal concrete (Production) (188 Peak, 176 RMS, 166 SEL)	10 (33)	60 (197)	10 (33)

1 **Figure 6-1. Underwater Sound from Impact Pile Driving Using a Site-Specific Model.**

6.8 Basis for Estimating Take by Harassment

The Navy is seeking authorization for the potential taking of small numbers of California sea lions, harbor seals, and coastal bottlenose dolphins in the Project area because of pile extraction and driving during demolition and construction activities associated with the FDD Project. California sea lions, harbor seals, and coastal bottlenose dolphins are present in San Diego Bay year-round, but as previously discussed, the species are not as common south of the Coronado Bay Bridge (NAVFAC SW 2022). The takes requested are expected to have no more than a minor effect on individual animals and no effect on the sea lion population in general. 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.

Potential exposures that would constitute takes under the MMPA are calculated in Section 6, and based on this analysis, no mortality or serious injuries are anticipated. The thresholds and methodology identified in NMFS (2018) for calculating the distance to the Level A (PTS onset) thresholds are used to determine the distance to the Level A ZOI for each pile installation/extraction activity. If Level A ZOIs are less than 10 m (33 ft), then a minimum 10 m (33 ft) shutdown is required to reduce the likelihood for a physical interaction with Project-related equipment.

Potential Level B takes would likely occur if marine mammals are present within any of the ZOIs identified in Table 6-6. Based on data from NAVFAC SW (2022), sea lions are known to haul out on the security barrier to the west of the Project site. Sea lions, harbor seals, and coastal bottlenose dolphins observed in the area would likely be swimming and/or foraging. As such, potential takes by disturbance will have a negligible short-term effect on individual animals and would not result in population-level impacts.

6.8.1 Description of Take Calculation and Exposure Estimates

While data for presence of marine mammals does exist for the general project area, specifically for the NBSD Pier 6 Replacement project, a density estimate could not be determined based on the available data. As such, using animal density was not considered to be a reasonable approach for calculating potential Level B take. Therefore, to quantitatively assess exposure of marine mammals to noise levels from pile extraction and driving that exceed the NMFS acoustic threshold criteria (NMFS 2018), the potential Level B harassment of marine mammals in the Project area was estimated as follows:

$$\text{Estimate of Level B Exposure} = N \times D$$

Where:

N is the expected average individual marine mammals per day potentially exposed to Project-related noise, and

D is the total days of pile extraction/installation.

California Sea Lions

California sea lions are present in northern San Diego Bay year-round and are by far the most numerous marine mammal in the Bay as reported in the first IHA monitoring period at the Pier 6 Replacement Project. The San Diego Bay population comprises adult females and sub-adult males and females, with adult males being uncommon (Merkel and Associates, Inc. 2008; Navy 2010; Tierra Data, Inc. 2012b; NAVFAC SW 2014, 2022). California sea lions occur year-round in San Diego Bay (NAVFAC SW and POSD 2013). During monitoring efforts associated with Pier 6 Replacement Project (NAVFAC SW 2022), individuals were observed all eight months of monitoring effort, with the highest number of individuals observed during the month of January. The Navy believes that this data provides the best estimate of likelihood of presence in the general Project area for this Project.

Based on the observations presented in the interim report for the Pier 6 Replacement Project (NAVFAC SW 2022), an average of 1.74 California sea lions were observed per day (rounded to 2 per day). This expected daily individual count was used to calculate the Level B take for California sea lions over the expected 59 days of pile extraction activities under the Project. Estimated total Level B take for California sea lions is 118 (Table 6-8).

Potential takes would likely involve sea lions that are loafing on or in the vicinity of structures or moving through the area in route to foraging areas or structures where they haul out. California sea lions that are taken could exhibit behavioral changes such as increased swimming speeds, increased surfacing time, or decreased foraging. Most likely, California sea lions may move away from the sound source and be temporarily displaced from the areas of pile extraction. Minimal reactions were observed from animals that were observed swimming or resting on structures within the Level B ZOIs during exposure to project-related noise (NAVFAC SW 2014, 2015, 2016). As such, potential takes by disturbance would be expected to have a negligible short-term effect on individual California sea lions and would not result in population-level impacts.

Harbor Seals

Based on eight months of monitoring effort for the Pier 6 Replacement Project (NAVFAC SW 2022), harbor seals are infrequent visitors to the area south of the San Diego-Coronado Bridge, with only two individuals observed. These individuals were both observed in January near the Naval Amphibious Base (NAVFAC SW 2022). The Navy believes that this data provides the best estimate of likelihood of presence in the general Project area for this Project.

Based on the observations presented in the interim report for the Pier 6 Replacement Project (NAVFAC SW 2022), an average of 0.02 harbor seals were observed per day (rounded up to 1 per day). This expected daily individual count was used to calculate the Level B take for harbor seals over the expected 59 days of pile extraction activities under the Project. Estimated total Level B take for harbor seals is 59 (Table 6-8).

Potential takes would likely involve harbor seals that are swimming in the vicinity. Harbor seals that are taken could exhibit behavioral changes such as entering the water in response to airborne noise, increased swimming speeds, increased surfacing time, or decreased foraging. Most likely, harbor seals may move away from the sound source and be temporarily displaced from the areas of pile extraction. With the absence of any major rookeries and only a few isolated haul-out areas near or adjacent to the Project site, potential takes by disturbance will have a negligible short-term effect on individual harbor seals and would not result in population-level impacts.

Coastal Bottlenose Dolphins

Coastal bottlenose dolphins occur year-round in San Diego Bay, but during the Pier 6 Replacement Project (NAVFAC SW 2022), individuals were observed during five of the eight months of monitoring effort, with the highest number of individuals observed during the month of January.

Based on the observations presented in the interim report for the Pier 6 Replacement Project (NAVFAC SW 2022), an average of 0.73 coastal bottlenose dolphins were observed per day (rounded up to 1 per day). This expected daily individual count was used to calculate the Level B take for coastal bottlenose dolphins. Estimated total Level B take for coastal bottlenose dolphins is 59 (Table 6-8).

Potential takes could occur if coastal bottlenose dolphins move through the area on foraging trips when pile extraction or installation would occur. Coastal bottlenose dolphins that are taken could exhibit behavioral changes such as increased swimming speeds, increased surfacing time, or decreased foraging. Most likely, coastal bottlenose dolphins may move away from the sound source and be temporarily displaced from the areas of pile extraction. There are no indications that coastal bottlenose dolphins use or regularly occur in the area near the Mole Pier. Hence, any exposure to Project-generated sound is likely to be transient and at relatively large distances, and potential takes by disturbance will have a negligible short-term effect on individual coastal bottlenose dolphins and would not result in population level impacts.

Table 6-8. Summary of Expected Daily Species Presence in the Project Area and Requested Level B Takes.[1]

Species	*Expected Average Individuals Per Day[2]*	*Requested Level B Take*
California sea lion	2	118
Harbor seal	1	59
Coastal bottlenose dolphin	1	59
	TOTAL	**236**

Note:

[1] If the number of takes may be exceeded in any year, NMFS will be notified as early as possible of a potential need to modify the authorized takes.

[2] Individuals per day based on observations during Pier 6 Replacement Project Monitoring interim report (NAVFAC SW 2022).

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7 IMPACTS TO MARINE MAMMAL SPECIES OR STOCKS

The anticipated impact of the activity upon the species or stock of marine mammals

7.1 Potential Effects of Pile Driving on Marine Mammals

7.1.1 Potential Effects Resulting from Underwater Noise

The effects of pile driving on marine mammals are dependent on several factors, including the species, size, and depth of the animal; the depth, intensity, and duration of the pile driving sound; the depth of the water column; the substrate of the habitat; the distance between the pile and the animal; and the sound propagation properties of the environment. Impacts on marine mammals from pile driving activities are expected to result primarily from acoustic pathways. As such, the degree of effect is intrinsically related to the received level and duration of the sound exposure, which are in turn influenced by the distance between the animal and the source. The farther away from the source, the less intense the exposure should be. The substrate and depth of the habitat affect the sound propagation properties of the environment. Shallow environments are typically more structurally complex, which leads to rapid sound attenuation. In addition, substrates that are soft (e.g., sand) will absorb or attenuate the sound more readily than hard substrates (e.g., rock), which may reflect the acoustic wave. Soft porous substrates will also likely require less time to drive the pile, and possibly less forceful equipment, which will ultimately decrease the intensity of the acoustic source (Dahl et al. 2015).

Potential impacts on marine species are expected to be the result of physiological responses to both the type and strength of the acoustic signature (Viada et al. 2008). Behavioral impacts may also occur, though the type and severity of these effects are more difficult to define due to limited studies addressing the behavioral effects of impulsive as well as non-impulsive sounds on marine mammals. Potential effects can range from brief acoustic effects such as behavioral disturbance, tactile perception, physical discomfort, slight injury of the internal organs and temporary to permanent impairment of the auditory system to death of the animal (Yelverton et al. 1973; O'Keefe and Young 1984; Ketten 1995; Navy 2001; Dahl et al. 2015; Finneran 2015; Kastelein et al. 2016, 2018).

7.1.1.1 Physiological Responses

Direct tissue responses to impact/impulsive sound stimulation may range from mechanical vibration or compression with no resulting injury to tissue trauma (injury). Because the ears are the most sensitive organ to pressure, they are the organs most sensitive to injury (Ketten 2000). Sound-related trauma can be lethal or sub-lethal. Lethal impacts are those that result in immediate death or serious debilitation in or near an intense source (Ketten 1995). Sub-lethal damage to the ear from a pressure wave can rupture the tympanum, fracture the ossicles, damage the cochlea, cause hemorrhaging, and leak cerebrospinal fluid into the middle ear (Ketten 2004). Sub-lethal impacts also include hearing loss, which is caused by exposure to perceptible sounds. Moderate injury implies partial hearing loss. Permanent hearing loss (also called PTS) can occur when the hair cells of the ear are damaged by a very loud event, as well as prolonged exposure to noise. Instances of TTS and/or auditory fatigue are well documented in marine mammal literature as being one of the primary avenues of acoustic impact. TTS has been documented in controlled settings using captive marine mammals exposed to strong SELs at various frequencies (Ridgway et al. 1997; Kastak et al. 1999; Finneran et al. 2005, 2015). While injuries to other sensitive organs are possible, they are less likely since pile driving impacts are almost entirely acoustically mediated. Based on the mitigation measures outlined in Chapter 11 and the conservative modeling assumptions discussed in

Chapter 6, California sea lions may be present, but would be expected in very low numbers. Therefore, sea lions that are present during construction may experience auditory effects, but will not cause population-level impacts or affect the continued survival of the species.

7.1.1.2 Behavioral Responses

Behavioral responses to sound are highly variable and context-specific. For each potential behavioral change, the magnitude of the change ultimately determines the severity of the response. A number of factors may influence an animal's response to noise, including its previous experience, its auditory sensitivity, its biological and social status (including age and sex), and its behavioral state and activity at the time of exposure. Habituation occurs when an animal's response to a stimulus wanes with repeated exposure, usually in the absence of unpleasant associated events (Wartzok et al. 2004). Animals are most likely to habituate to sounds that are predictable and unvarying. The opposite process is sensitization, when an unpleasant experience leads to subsequent responses, often in the form of avoidance, at a lower level of exposure.

Behavioral state or differences in individual tolerance levels may affect the type of response as well. For example, animals that are resting may show greater behavioral change in response to disturbing noise levels than animals that are highly motivated to remain in an area for feeding (Richardson et al. 1995; NRC 2003; Wartzok et al. 2004). Indicators of disturbance may include sudden changes in the animal's behavior or avoidance of the affected area. A marine mammal may show signs that it is startled by the noise and/or it may swim away from the sound source and avoid the area. Increased swimming speed, increased surfacing time, and cessation of foraging in the affected area would indicate disturbance or discomfort. Pinnipeds may increase their haul-out time, possibly to avoid in-water disturbance.

Controlled experiments with captive marine mammals showed pronounced behavioral reactions, including avoidance of loud sound sources (Ridgway et al. 1997; Finneran et al. 2003) and an increase in the respiration rate of harbor porpoises (*Phocoena phocoena*) (Kastelein et al. 2013). Observed responses of wild marine mammals to loud pulsed sound sources (typically including seismic guns or acoustic harassment devices and pile driving) have been varied, but these responses often consist of avoidance behavior or other behavioral changes that suggest discomfort (Morton and Symonds 2002; also see reviews in Gordon et al. 2004; Wartzok et al. 2004; and Nowacek et al. 2007). Some studies of acoustic harassment and acoustic deterrence devices have found habituation in resident populations of seals and harbor porpoises (see the review in Southall et al. 2007). Blackwell et al. (2004) found that ringed seals (*Phoca hispida*) exposed to underwater pile-driving sounds in the 153 to 160 dB RMS range tolerated this noise level and did not seem unwilling to dive and did not react strongly to pile-driving activities. Responses of two pinniped species to impact pile driving at the San Francisco-Oakland Bay Bridge East Span Seismic Safety Project were mixed (California Department of Transportation [CALTRANS] 2001; Thorson and Reyff 2006). Harbor seals were observed in the water at distances of approximately 400 to 500 m (1312 ft to 1640 ft) from the pile-driving activity and exhibited no alarm responses, although several showed alert reactions. None of the seals appeared to remain in the area, although they may have been transiting to the haul-out site or feeding areas. One of these harbor seals was even seen to swim to within 150 m (492 ft) of the pile-driving barge during pile driving. Several sea lions, however, were observed at distances of 500 to 1,000 m (1640 ft to 3280 ft) swimming rapidly and porpoising away from pile-driving activities. Both harbor seals and sea lions continued feeding on dense schools of herring that occasionally occurred during pile driving (CALTRANS 2001). Observations at other construction sites (for example, the Navy's Point Loma fuel pier project) indicated that sea lions typically did not respond behaviorally to pile driving (NAVFAC SW 2014, 2015, 2016, 2017a,b, 2018a,b). The reasons for these differences are not known and probably reflect the context of construction activities and the previous experiences of the animals.

Observations of marine mammals on NAVBASE Kitsap at Bangor during the Test Pile Program project concluded that pinniped (harbor seal and California sea lion) foraging behaviors decreased slightly during construction periods involving impact and vibratory pile driving, and both pinnipeds and harbor porpoise were more likely to change direction while traveling during construction (HDR Inc. 2012). Pinnipeds were more likely to dive and sink when closer to pile-driving activity, and a greater variety of other behaviors were observed with increasing distance from pile driving.

During the first year of Explosive Handling Wharf #2 (EHW-2) construction monitoring, only California sea lions and harbor seals were detected within the shutdown and behavioral disturbance zones (Primary Surveys) and outside the waterfront restricted area floating fence (Outside Boat Surveys). The sample size for California sea lions was too small during pile driving to identify any trends in responses to construction (Hart Crowser 2013).

A comprehensive review of acoustic and behavioral responses to noise exposure by Nowacek et al. (2007) concluded that one of the most common behavioral responses is displacement. To assess the significance of displacements, it is necessary to know the areas to which the animals relocate, the quality of that habitat, and the duration of the displacement in the event that they return to the pre-disturbance area. Short-term displacement may not be of great concern unless the disturbance happens repeatedly. Similarly, long-term displacement may not be of concern if adequate replacement habitat is available.

Marine mammals encountering pile-driving operations over a project’s construction time frame would likely avoid affected areas in which they experience noise-related discomfort, limiting their ability to forage or rest there. As described in the section above, individual responses to pile-driving noise are expected to vary. Some individuals may occupy a Project area during pile driving without apparent discomfort, but others may be displaced with undetermined effects. Avoidance of the affected area during pile-driving operations would reduce the likelihood of injury impacts, but would also reduce access to foraging areas. The ZOI is only a small portion of foraging habitat utilized in San Diego Bay in general. Noise-related disturbance may also inhibit some marine mammals from transiting the area. There is a potential for displacement of marine mammals from affected areas due to these behavioral disturbances during the in-water construction season. However, in some areas, habituation may occur, resulting in a decrease in the severity of the response. Since pile driving/extracting activities will only occur during daylight hours, sea lions swimming, foraging, or resting in a Project area at night will not be affected. Effects of pile-driving activities will be experienced by individual sea lions but will not cause population-level impacts or affect the continued survival of the species.

7.2 Conclusions Regarding Impacts to Species or Stocks

Individual marine mammals may be exposed to SPLs during pile extraction operations at NBSD Mole Pier FDD Project may result in Level B Behavioral harassment. Any marine mammals which are taken (harassed), may change their normal behavior patterns (i.e., swimming speed, foraging habits, etc.) or be temporarily displaced from the area of construction. Any takes would likely have only a minor effect on individuals and no effect on the population. The sound generated from all planned pile extraction activities is non-pulsed (e.g., continuous) which is not known to cause injury to marine mammals. While sounds generated during pile installation using impact pile drivers (impulsive noise) may have adverse impacts to marine mammals if they were to get too close to the piles being driven; however, by implementing shutdown procedures for both vibratory extraction and pile installation, no adverse impacts to marine mammals are expected. Nevertheless, some level of impact is unavoidable. The expected level of unavoidable impact (defined as an acoustic or harassment “take”) is described in Section 6. This level of effect is not anticipated to have any detectable adverse impact to any of the studied marine mammal populations recruitment, survival, or recovery.

8 IMPACT ON SUBSISTENCE USE

The anticipated impact of the activity on the availability of the species or stock of marine mammals for subsistence uses.

Potential impacts resulting from the Project will be limited to individual California sea lions, harbor seals, and coastal bottlenose dolphins located in Project ZOIs. No subsistence use of these species occurs in San Diego Bay. Therefore, no impacts on the availability of species or stocks for subsistence use are considered.

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9 IMPACTS TO THE MARINE MAMMAL HABITAT AND THE LIKELIHOOD OF RESTORATION

The anticipated impact of the activity upon the habitat of the marine mammal populations, and the likelihood of restoration of the affected habitat.

The proposed activities at NBSD are expected to have little, if any, effect on the distribution of marine mammals within the Project area. Only small numbers of California sea lions, harbor seals, and coastal bottlenose dolphins are expected to be present during construction. Navigation buoys and a security barrier represent the only known haul-out structures within the Project area. Therefore, the main impact associated with the proposed activity will be temporarily elevated noise levels and the associated direct effects on marine mammals, as discussed in Sections 6 and 7. The most likely impact to habitat will occur from pile driving effects on potential prey (i.e., fish) of these animals and minor impacts to the immediate substrate during installation and extraction of piles.

9.1 Pile Extraction and Installation Effects on Potential Prey (Fish)

Construction activities will produce both pulsed (i.e., impact pile driving) and continuous sounds (i.e., vibratory extracting, high pressure water jetting). Fish react to sounds that are especially strong and/or intermittent low-frequency sounds. Short duration, sharp sounds can cause overt or subtle changes in fish behavior and local distribution. Hastings and Popper (2005; Popper and Hastings 2009) identified several studies that suggest fish may relocate to avoid certain areas of noise energy. Additional studies have documented effects of pile driving (or other types of continuous sounds) on fish although several are based on studies in support of large, multiyear bridge construction projects (Scholik and Yan 2001, 2002; Govoni et al. 2003; Hawkins 2005; Hastings 1990, 2007; Popper et al. 2006; Popper and Hastings 2009). Sound pulses at received levels of 160 dB re 1 µPa may cause subtle changes in fish behavior. SPLs of 180 dB may cause noticeable changes in behavior (Chapman and Hawkins 1969; Pearson et al. 1992; Skalski et al. 1992). Sound pressure levels of sufficient strength have been known to cause injury to fish and fish mortality (Scholik and Yan 2001; Longmuir and Lively 2001). The most likely impact to fish from pile driving activities at the Project Area would be temporary behavioral avoidance of the immediate area. The duration of fish avoidance of this area after pile driving stops is unknown, but a rapid return to normal recruitment, distribution and behavior is anticipated (NAVFAC SW 2014). In general, impacts to marine mammal prey species are expected to be minor and temporary.

9.2 Pile Extraction and Installation Effects on Potential Foraging Habitat

The areas likely impacted by the FDD Project are relatively small compared to the available habitat in San Diego Bay. The Navy's marine mammal surveys (Chollas Creek Quaywall Repairs, unpublished data) and previous monitoring efforts (NAVFAC SW 2022) have documented very few California sea lions within the general area of the Project site. Based on this data, the affected areas are used little, if at all, as foraging habitat. As a result, the extraction and installation of pilings, substrate disturbance, and high levels of activity at the Project site would be inconsequential in terms of effects on marine mammal foraging.

The duration of fish avoidance of this area after pile driving stops is unknown, but a rapid return to normal recruitment, distribution and behavior is anticipated (NAVFAC SW 2014). Any behavioral avoidance by fish of the disturbed area would still leave significantly large areas of fish and marine mammal foraging habitat in other areas of San Diego Bay.

Eelgrass is not present within the Project area. The nearest eelgrass beds are located approximately 2 miles west and 1 mile south of the Project area and thus no impacts to eelgrass would occur.

9.3 Summary of Impacts to Marine Mammal Habitat

Given the short daily duration of noise associated with individual pile extraction/driving, seasonal limitations on the in-water activities that have the greatest potential to disturb marine mammals and their prey, and the relatively small areas being affected, pile driving and extraction activities associated with the Proposed Action are not likely to have a permanent, adverse effect on any Essential Fish Habitat, or population of fish species. Therefore, pile extraction/installation is not likely to have a permanent, adverse effect on California sea lion, harbor seals, or coastal bottlenose dolphin foraging habitat in the Project Area.

10 IMPACTS TO MARINE MAMMALS FROM LOSS OR MODIFICATION OF HABITAT

The anticipated impact of the loss or modification of the habitat on the marine mammal populations involved.

The proposed activities at NBSD are not expected to have any habitat-related effects that could cause significant or long-term consequences for individual California sea lions, harbor seals, coastal bottlenose dolphins, or their respective populations. As previously discussed, these species do not occur in large numbers nor are they expected to use the Project area as frequent foraging habitat. Based on the discussions in Section 9, there will be no impacts to California sea lions, harbor seals, and coastal bottlenose dolphins resulting from loss or modification of marine mammal habitat.

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11 MEANS OF EFFECTING THE LEAST PRACTICABLE ADVERSE IMPACTS – MITIGATION MEASURES

The availability and feasibility (economic and technological) of equipment, methods, and manner of conducting such activity or other means of effecting the least practicable adverse impact upon the affected species or stocks, their habitat, and on their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance.

The potential exposures outlined in Section 6 represent the maximum expected number of marine mammals that could be exposed to acoustic sources reaching Level B harassment levels. The Navy proposes to employ several mitigation measures, discussed below, in an effort to minimize the number of marine mammals potentially affected. NMFS will be notified of any change to the monitoring protocol(s) identified below, or in the corresponding marine mammal monitoring plan.

11.1 Mitigation for Pile Driving Activities

11.1.1 Proposed Measures

1. Marine Mammal Visual Monitoring:
   a. Monitoring shall be conducted by qualified Protected Species Observer (PSOs)[4]. All PSOs will be trained in marine mammal identification and behaviors, and have experience conducting marine mammal monitoring or surveys. Trained PSOs will be placed at the best vantage point(s) practicable (e.g., from a small boat, on shore, or any other suitable location) to monitor for marine mammals and implement shutdown/delay procedures, when applicable, by notifying the construction crew of a need for a work stoppage. The number of PSOs may vary depending on the construction activity and applicable size of the ZOI(s).
   b. Monitoring shall be conducted for all shutdown and Level B ZOIs before, during, and after pile extraction/installation activities. Monitoring will take place from 30 minutes prior to initiation through 30 minutes post-completion of pile extraction/installation activities.
   c. If a marine mammal covered by the IHA is observed inside of the applicable shutdown zone prior to the start of pile extraction/installation, the activity shall not be allowed to start. If an animal is observed inside of the Level B ZOI, the activity shall be allowed to start, but a Level B take will be logged once the activity starts.
   d. If a marine mammal covered by the IHA enters the applicable shutdown zone during the course of pile extraction/installation activities, the activity shall be halted and delayed until either the animal has voluntarily left and been visually confirmed beyond the shutdown zone, or 15 minutes have passed without re-detection of the animal.
   e. If a marine mammal covered by the IHA is observed inside of the Level B ZOI during the course of pile extraction/installation activities, an exposure would be recorded and behaviors documented. Work would be allowed to continue without cessation, unless the animal approaches or enters the Level A shutdown zone, at which point pile extraction/installation shall be halted.

[4] PSOs must meet minimum qualifications identified at https://www.fisheries.noaa.gov/alaska/endangered-species-conservation/guidance-developing-marine-mammal-monitoring-plan

f. If a marine mammal species not covered in the IHA enters the Level B harassment ZOI, pile extraction/installation shall be halted until the individual(s) has left the Level B ZOI of its own volition, or has not been observed for at least one hour. NMFS will be notified immediately with the species, and precautions made during the encounter.

g. In the unlikely event of conditions, such as heavy fog, that prevent the visual detection of marine mammals in the applicable shutdown zone, pile extraction/installation activities will not be initiated. If a non-IHA species is observed inside of the Level B ZOI during conditions with poor visibility, then the Level B ZOI will be considered as the shutdown zone, and the measures identified above will be implemented.

h. If the Level B take of a marine mammal species approaches the authorized take limits specified in the IHA, NMFS will be notified, and appropriate steps will be discussed.

2. Level A and Level B Harassment ZOIs During Pile Extraction/Installation:

   a. During all pile extraction/driving activities with Level A ZOIs less than 10 m (33 ft; see Table 6-6), a 10 m (33 ft) Level A injury prevention (shutdown) zone will be implemented. For those activities with Level A ZOIs larger than 10 m (33 ft), the shutdown ZOIs will be rounded up to the next tens of meters.

   b. If a marine mammal species covered in the IHA enters the applicable shutdown ZOI, pile extraction/installation shall be halted until the individual(s) has left the Level A ZOI of its own volition, or has not been observed for at least 15 minutes.

   c. If a marine mammal species not covered in the IHA enters the Level B harassment ZOI, pile extraction/installation shall be halted until the individual(s) has left the Level B ZOI of its own volition, or has not been observed for at least one hour.

3. Prior to the start of impact pile driving each day, the contractor will implement soft start procedures. Soft start requires contractors to provide an initial set of strikes at reduced energy, followed by a thirty-second waiting period, then two subsequent reduced energy strike sets followed by thirty seconds between each set. A soft start must be implemented at the start of each day’s impact pile driving and at any time following cessation of impact pile driving for a period of thirty minutes or longer.

4. Daylight Pile Extraction/Installation

   a. In-water pile extraction/installation work shall occur only during daylight hours that allow for sighting of marine species within all Project area and defined monitoring zones. Ambient lighting protected conditions will dictate the ability to see marine mammals.
   b. In the Project area, daylight hours will generally be considered as from 30 minutes after sunrise to 30 minutes before sunset. However, the on-site PSO will make a final determination on ambient lighting conditions.

11.2 Mitigation Effectiveness

All PSOs utilized for mitigation activities will be experienced biologists with training in marine mammal detection and behavior. Based on recent monitoring experience at multiple locations around San Diego Bay (NAVFAC SW 2014, 2015, 2016, 2017a,b, 2018a,b, 2022), the Navy expects that visual mitigation will be highly effective because visual detection conditions in San Diego Bay are generally excellent. By its orientation, the Bay is sheltered from large swells and infrequently experiences strong winds; winds are less than 17 knots 98% of the time between November and April (San Diego Harbor Safety Committee

2022). Fog is anticipated on 10 to 20% of the days, typically in late night and early morning hours (San Diego Harbor Safety Committee 2022) and could occasionally limit visibility for marine mammal monitoring. However, PSOs will be positioned in locations which provide the best vantage point(s) for monitoring, such as on nearby piers or on a small boat, and the shutdown and buffer zones cover relatively small and accessible areas of the Bay. As such, proposed mitigation measures are likely to be highly effective.

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12 MINIMIZATION OF ADVERSE EFFECTS ON SUBSISTENCE USE

Where the proposed activity would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses, the applicant must submit either a plan of cooperation or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses. A plan must include the following:

(i) A statement that the applicant has notified and provided the affected subsistence community with a draft plan of cooperation;

(ii) A schedule for meeting with the affected subsistence communities to discuss proposed activities and to resolve potential conflicts regarding any aspects of either the operation or the plan of cooperation;

(iii) A description of what measures the applicant has taken an/or will take to ensure that proposed activities will not interfere with subsistence whaling or sealing; and

(iv) What plans the applicant has to continue to meet with the affected communities, both prior to and while conducting activity, to resolve conflicts and to notify the communities of any changes in the operation.

There is no subsistence use of marine mammal species or stocks in the Project area.

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13 MONITORING AND REPORTING MEASURES

The suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species, the level of taking or impacts on populations of marine mammals that are expected to be present while conducting activities and suggested means of minimizing burdens by coordinating such reporting requirements with other schemes already applicable to persons conducting such activity. Monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s) including migration and other habitat uses, such as feeding.

13.1 Monitoring Plan

The following monitoring measures would be implemented along with the mitigation measures (Section 11) to reduce impacts to marine mammals to the lowest extent practicable during the period of this IHA. A marine mammal monitoring plan will be developed further and submitted to NMFS for approval well in advance of the start of construction during the IHA period. The monitoring plan includes visual observations and will not include acoustic measurements.

13.1.1 Visual Marine Mammal Observations

The Navy will collect sightings data and behavioral responses to construction for marine mammal species observed in the region of activity during the period of construction. All PSOs will be trained in marine mammal identification and behaviors.

13.1.2 Methods of Monitoring

The Navy will monitor the Level A (shutdown) and Level B ZOIs before, during, and after pile-driving activities. Based on NMFS requirements, the Marine Mammal Monitoring Plan will include the following procedures:

- PSOs will be primarily located on boats, docks, and piers at the best vantage point(s) to properly see the entire shutdown zone.
- PSOs will be located at the best vantage point(s) to observe the zones associated with behavioral impact thresholds.
- When there are two or more PSOs, all will be in radio communication with each other to enhance tracking of marine mammals that may be moving through the area to minimize duplicate observation records of the same animal by different PSOs (i.e., a re-sighting).
- One land-/pier-/barge-based PSO (“Command” position) will be stationed with clear view of the Level A shutdown zone(s) and will be responsible for the collection of pile extraction/installation start and stop times, identification of all protected marine species in the vicinity of the pile being extracted/installed, and notifying the contractor if relevant activities must be delayed or stopped due to the presence of protected marine species within the shutdown zones.
- During all observation periods, observers will use binoculars and the naked eye to search continuously for marine mammals.
- Distances to animals will be based on the best estimate of the PSO, relative to known distances to objects in the vicinity of the PSO.
- Bearing to animals will be determined using a compass.

- In-water activities will be curtailed under conditions of fog or poor visibility that might obscure the presence of a marine mammal within the shutdown zone.
- Pre-Activity Monitoring:
  - The shutdown and Level B ZOIs will be monitored for 30 min prior to in-water construction/demolition activities.
- During Activity Monitoring:
  - If a marine mammal is observed entering the Level B ZOI, pile extraction/installation will be completed without cessation. If the animal enters, or directly approaches the applicable shutdown zone, all applicable activities will be halted as soon as it is safe to do so. Pile extraction/installation will only resume once the PSO has determined that the animal has left the shutdown zone of its own volition or has not been re-sighted for a period of 15 minutes. If a non-IHA species is observed, the Level B ZOI will be considered as the shutdown zone, and the time period for ZOI clearance will be extended to one hour.
  - All times when the pile extraction/installation equipment is off, but pile extraction/installation has not completely stopped for the day, will also be monitored.
- Post-Activity Monitoring:
  - Monitoring of the Project area will continue for 30 minutes following the completion of the applicable activities.

13.1.3 Data Collection

NMFS requires that the PSOs use NMFS-approved sighting forms. NMFS requires that a minimum, the following information be collected on the sighting forms

- Date and time that pile extraction or driving begins or ends;
- Construction activities occurring during each observation period;
- Weather parameters identified in the acoustic monitoring (e.g., wind, humidity, temperature);
- Tide state and water currents;
- Visibility;
- Species, numbers, and if possible sex and age class of marine mammals;
- Marine mammal behavior patterns observed, including bearing and direction of travel, and if possible, the correlation to SPLs;
- Distance from pile driving/extracting activities to marine mammals and distance from the marine mammal to the observation point;
- Locations of all marine mammal observations;
- Other human activity in the area.

To the extent practicable, the Navy will record behavioral observations that may make it possible to determine if the same or different individuals are being “taken” as a result of Project activities over the course of a day.

13.2 Reporting

A draft report would be submitted to NMFS within 90 calendar days of the completion of pile driving activities. The results would be summarized in tabular and graphical forms and include summary metrics of data based upon the piles monitored for this IHA period. A final report would be prepared and submitted to the NMFS within 30 days following receipt of comments on the draft report from the NMFS. At a minimum, the report shall include:

- General data:
  - Date and time of activities,
  - Water conditions (e.g., sea-state, tidal state),
  - Weather conditions (e.g., percent cover, visibility).
- Pre- and post-activity observational survey-specific data:
  - Dates and time monitoring was initiated and terminated,
  - Description of any observable marine mammal behavior in the immediate area during monitoring,
- During-activity observational survey-specific data:
  - Description of any observable marine mammal behavior within monitoring zones or in the immediate area surrounding monitoring zones,
  - If possible, correlation to sound levels occurring at the time of this observable behavior,
  - Actions performed to minimize impacts to marine mammals,
  - Times when pile extraction/installation was stopped due to presence of marine mammals within the shutdown zones and the time when pile driving resumed.
- Summary of monitoring results:
  - Summary of the detections of marine mammals, species and numbers observed, sighting rates and distances, and behavioral reactions during pile driving,
  - A refined take estimate based on the number of marine mammals observed during construction.

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14 RESEARCH

Suggested means of learning of, encouraging, and coordinating research opportunities, plans, and activities relating to reducing such incidental taking and evaluating its effects.

The U.S. Navy is one of the world's leading organizations in assessing the effects of human activities the marine environment including marine mammals. From 2004 through 2013, the Navy has funded over $240M specifically for marine mammal research. Navy scientists work cooperatively with other government researchers and scientists, universities, industry, and non-governmental conservation organizations in collecting, evaluating, and modeling information on marine resources. They also develop approaches to ensure that these resources are minimally impacted by existing and future Navy operations. It is imperative that the Navy's research and development (R&D) efforts related to marine mammals are conducted in an open, transparent manner with validated study needs and requirements. The goal of the Navy's R&D program is to enable collection and publication of scientifically valid research as well as development of techniques and tools for Navy, academic, and commercial use. Historically, R&D programs are funded and developed by the Navy's Chief of Naval Operations Energy and Environmental Readiness and Office of Naval Research (ONR), Code 322 Marine Mammals and Biological Oceanography Program. Primary focus of these programs since the 1990s is on understanding the effects of sound on marine mammals, including physiological, behavioral and ecological effects.

ONR's current Marine Mammals and Biology Program thrusts include, but are not limited to: (1) monitoring and detection research; (2) integrated ecosystem research including sensor and tag development; (3) effects of sound on marine life (such as hearing, behavioral response studies, physiology [diving and stress], and the Population Consequences of Acoustic Disturbance model; and (4) models and databases for environmental compliance.

To manage some of the Navy's marine mammal research programmatic elements, in 2011, OPNAV N45 developed a Living Marine Resources (LMR) R&D Program (http://www.lmr.navy.mil/). The goal of the LMR R&D Program is to identify and fill knowledge gaps and to demonstrate, validate, and integrate new processes and technologies to minimize potential effects to marine mammals and other marine resources. Key elements of the LMR program include:

- Providing science-based information to support Navy environmental effects assessments for research, development, acquisition, testing, and evaluation as well as Fleet at-sea training, exercises, maintenance, and support activities.
- Improving knowledge of the status and trends of marine species of concern and the ecosystems of which they are a part.
- Developing the scientific basis for the criteria and thresholds to measure the effects of Navy-generated sound.
- Improving understanding of underwater sound and sound field characterization unique to assessing the biological consequences resulting from underwater sound (as opposed to tactical applications of underwater sound or propagation loss modeling for military communications or tactical applications).
- Developing technologies and methods to monitor and, where possible, mitigate biologically significant consequences to living marine resources resulting from naval activities, emphasizing those consequences that are most likely to be biologically significant.

Other National Department of Defense Funded Initiative - Strategic Environmental Research and Development Program and Environmental Security Technology Certification Program are the Department of Defense's environmental research programs, harnessing the latest science and technology to improve environmental performance, reduce costs, and enhance and sustain mission capabilities. The Programs respond to environmental technology requirements that are common to all of the military Services, complementing the Services' research programs. Both the Strategic Environmental Research and Development Program and Environmental Security Technology Certification Program promote partnerships and collaboration among academia, industry, the military Services, and other Federal agencies. They are independent programs managed from a joint office to coordinate the full spectrum of efforts, from basic and applied research to field demonstration and validation.

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16 REFERENCES

Allen, L.G., D. Pondella II, and M.H. Horn, eds. 2006. The Ecology of Marine Fishes – California and Adjacent Waters. University of California Press, Los Angeles. 660 pp.

Amec Foster Wheeler Environment & Infrastructure, Inc. 2016. 2013 Regional Harbor Monitoring Program Final Report. Prepared for the San Diego Unified Port District. January.

Antonelis, G.A., Jr., B.S. Stewart, and W.F. Perryman. 1990. Foraging characteristics of female northern fur seals (*Callorhinus ursinus*) and California sea lions (*Zalophus californianus*). Canadian Journal of Zoology 68:150-158.

Au, Whitlow W. L. 1993. The Sonar of Dolphins. Springer Science & Business Media. 277 pp.

Bearzi, M., C.A. Saylan, and A. Hwang. 2009. Ecology and comparison of coastal and offshore bottlenose dolphins (*Tursiops truncatus*) in California. Marine and Freshwater Research 60:584-593.

Bigg, M.A. 1981. Harbour seal Phoca vitulina Linnaeus, 1758 and Phoca largha Pallas, 1811. Pages 1-27 IN: S.H. Ridgway and R. Harrison, eds. Handbook of marine mammals, Volume 2: Seals. San Diego: Academic Press.

Blackwell, S.B. and C.R. Greene, Jr. 2002. Acoustic measurements in Cook Inlet, Alaska during August 2001. Greeneridge Report 271-2. Report from Greeneridge Sciences, Inc., Santa Barbara for National Marine Fisheries Service, Anchorage, AK. 43 p.

Blackwell, S.B., J.W. Lawson, and M.T. Williams. 2004. Tolerance by ringed seals (*Phoca hispida*) to impact pipe-driving and construction sounds at an oil production island. Journal of the Acoustical Society of America. 115(5): 2346-2357

Bonnell, M.L. and M.D. Dailey. 1993. Marine mammals. Pages 604-681 in Dailey, M.D., D.J. Reish, and J.W. Anderson, eds. Ecology of the Southern California Bight: A synthesis and interpretation. Berkeley, California: University of California Press.

Bonnell, M.L. and R.G. Ford. 1987. California sea lion distribution: A statistical analysis of aerial transect data. Journal of Wildlife Management 51(1):13-20.

Bonnell, M.L., M.O. Pierson, and G.D. Farrens. 1983. Pinnipeds and sea otters of central and northern California, 1980 - 1983: Status, abundance, and distribution. Volume III, Book 1. OCS Study MMS 84-0044. Los Angeles, California: Minerals Management Service.

Brumm, H., and Slabbekoorn, H. 2005. Acoustic Communication in Noise, In: Slater, P. J. B., Snowdon, C. T. Roper, T. J., Brockmann, H. J., & Naguib, M. Editor(s), Advances in the Study of Behavior, Academic Press, Volume 35, Pages 151–209.

Brumm, H., and Zollinger, S. A. 2011. The evolution of the Lombard effect: 100 years of psychoacoustic research. *Behaviour, 148*(11-13), 1173–1198.

California Department of Transportation (CALTRANS). 2001. Marine Mammal Impact Assessment for the San Francisco- Oakland Bay Bridge Pile Installation Demonstration Project. PIDP EA 012081

_____. 2020. Technical Guidance for Assessment of the Hydroacoustic Effects of Pile Driving on Fish. Available online at: https://dot.ca.gov/-/media/dot-media/programs/environmental-analysis/documents/env/hydroacoustic-manual-a11y.pdf. October 2020.

Carretta, J.V., M.S. Lowry, C.E. Stincomb, M.S. Lynn, and R.E. Cosgrove. 2000. Distribution and abundance of marine mammals at San Clemente Island and surrounding offshore waters:

Results from aerial and ground surveys in 1998 and 1999. NMFS- SWFSC Administrative Report LJ-00-02:1-43.

Carretta, J.V., E.M. Oleson, D.W. Weller, A.R. Lang, K.A. Forney, J. Baker, M.M. Muto, B. Hanson, A.J. Orr, H. Huber, M.S Lowry, J. Barlow, J.E. Moore, D. Lynch, L. Carswell, and R.L. Brownell Jr. 2016. U.S. Pacific Marine Mammal Stock Assessments: 2015. May 2016. NOAA-TMNMFSSWFSC-561.

Carretta, J.V., K.A. Forney, E.M. Oleson, D.W. Weller, A.R. Lang, J. Baker, M.M. Muto, B. Hanson, A.J. Orr, H. Huber, M.S. Lowry, J. Barlow, J.E. Moore, D. Lynch, L. Carswell, and R.L. Brownell Jr. 2017. U.S. Pacific Marine Mammal Stock Assessments 2016. US Department of Commerce. NOAA-TMNMFS-SWFSC-577.

Carretta, J.V., K.A. Forney, E.M. Oleson, D.W.Weller, A.R. Lang, J. Baker, M.M. Muto, B. Hanson, A.J. Orr, H. Huber, M.S. Lowry, J. Barlow, J. E. Moore, D. Lynch, L. Carswell, and R.L Brownell Jr. 2019. U.S. Pacific Marine Mammal Stock Assessments: 2018. US Department of Commerce. NOAA Technical Memorandum NMFS-SWFSC-617.

Chadwick, B., J. Leather, K. Richter, S. Apitz, D. Lapota, D. Duckworth, C. Katz, V. Kirtay, B. Davidson, A. Patterson, P. Wang, S. Curtis, G. Key, S. Steinert, G. Rosen, M. Caballero, J. Groves, G. Koon, A. Valkirs, K. Meyers-Schulte, Ii M. Stallard, S. Clawson, R. Streib Montee, D. Sutton, L. Skinner, J. Germano, and R. Cheng. 1999. Sediment Quality Characterization Naval Station San Diego: Final Summary Report. Technical Report No. 1777. January.

Chapman, C.J. and A.D. Hawkins. 1969. The importance of fish behavior in relation to capture by trawls. *FAO Fisheries Report* 62(3): 717-729.

Chollas Creek Quaywall Repairs. Unpublished data.

Dahl, P.H. and D.R. Dall'Osto. 2019. Ambient Underwater Sound at Naval Base San Diego, San Diego Bay, California. Prepared for Naval Facilities Engineering Command Southwest under contract to Tierra Data, Inc.

Dall'Osto, D.R. and P.H. Dahl. 2019. Hydroacoustic Modeling of Pile Driving for the South-Central Region of San Diego Bay, California. Prepared for Naval Facilities Engineering Command Southwest under contract to Tierra Data, Inc.

Dahl, P.H., de Jong, C.A.F., and Popper, A.N. 2015. The Underwater Sound Field from Impact Pile Driving and Its Potential Effects on Marine Life. *Acoustics Today,* 11(2), 12-25.

Defran, R.H. and D.W. Weller. 1999. Occurrence, distribution, site fidelity, and school size of bottlenose dolphins (*Tursiops truncatus*) off San Diego, California. Marine Mammal Science 15(2):366-380.

Defran, R.H., D.W. Weller, D.L. Kelly, and M.A. Espinosa. 1999. Range characteristics of Pacific coast bottlenose dolphins (*Tursiops truncatus*) in the Southern California Bight. Mar. Mamm. Sci., 15(2):381—393.

Defran, R.H., D.L. Kelley, G.M. Shultz, A.C. Weaver, and M.A. Espinoza. 1986. The occurrence and movements of the bottlenose dolphin in the Southern California Bight. National Marine Fisheries Service Administrative Report LJ-86-36C. National Marine Fisheries Service, La Jolla, CA.

Finneran, J.J. 2015. Noise-induced hearing loss in marine mammals: A review of temporary threshold shift studies from 1996 to 2015. The Journal of the Acoustical Society of America 138, 1702-1726.

Finneran, J.J. and Houser, D.S. 2006. Comparison of in-air evoked potential and underwater behavioral hearing thresholds in four bottlenose dolphins (Tursiops truncatus). Journal of the Acoustical Society of America 119(5):3181-3192.

_____. 2007. Bottlenose dolphin (Tursiops truncatus) steady-state evoked responses to multiple simultaneous sinusoidal amplitude modulated tones. Journal of the Acoustical Society of America 121(3): 1775-1782. March.

Finneran, J.J. and Jenkins, A.K. 2012. Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis. SPAWAR Systems Center Pacific. April.

Finneran, J.J., Carder, D.A., Schlundt, C.E., and Ridgway, S.H. 2005. Temporary threshold shift in bottlenose dolphins (*Tursiops truncatus*) exposed to mid- frequency tones. Journal of the Acoustical Society of America 118:2696–2705.

Finneran, J.J., Dear, R., Carder, D.A., and Ridgway, S.H. 2003. Auditory and behavioral responses of California sea lions (*Zalophus californianus*) to single underwater impulses from an arc-gap transducer. Journal of the Acoustical Society of America. 114(3): 1667-1677.

Finneran, J.J., Schlundt, C.E., Branstetter, B., and Dear, R.L. 2007. "Assessing temporary threshold shift in a bottlenose dolphin (*Tursiops truncatus*) using multiple simultaneous auditory evoked potentials," J. Acoust. Soc. Am. 122, 1249–1264.

Finneran, J.J., Schlundt, C.E., Dear, R., Carder, D.A., and Ridgway, S.H. 2002. Temporary shift in masked hearing thresholds (MTTS) in odontocetes after exposure to single underwater impulses from a seismic watergun. Journal of the Acoustical Society of America. 111: 2929-2940.

Finneran, J.J., Schlundt, C.E., Branstetter, B.K., Trickey, J.S., Bowman, V., and Jenkins, K. 2015. Effects of multiple impulses from a seismic air gun on bottlenose dolphin hearing and behavior. Journal of the Acoustical Society of America 137:1634-1646.

Galli, L., Hurlbutt, B., Jewett, W., Morton, W., Schuster, S., & Van Hilsen, Z. 2003. *Source-level noise in Haro Strait: relevance to orca whales.* Colorado College, Colorado Springs, CO.

Gordon, J., D. Gillespie, J. Potter, A. Frantzis, M.P. Simmonds, R. Swift, and D. Thompson. 2004. A review of the effects of seismic surveys on marine mammals. Marine Technology Society Journal. 37: 16-34.

Govoni, J.J., L.R. Settle, and M.A. West. 2003. Trauma to juvenile pinfish and spot inflicted by submarine detonations. Journal of Aquatic Animal Health 15:111-119.

Graham, S.E. and Saunders, B.P. 2014. Occurrence, Distribution, and Population Estimates of Marine Mammals near Silver Strand Training Complex and San Diego Bay, CA. Prepared for Commander, Pacific Fleet. Submitted to Naval Facilities Engineering Command Southwest. February 2015.

Grigg, E.K., A.P. Klimey, S.G. Allen, D.E. Green, D.L. Elliott-Fisk, and H. Markowitz. 2009. Spatial and seasonal relationships between Pacific harbor seals (*Phoca vitulina richardii*) and their prey at multiple scales. Fisheries Bulletin 107:359-372.

Hanggi, E.B. and R.J. Schusterman. 1994. Underwater acoustic displays and individual variation in male harbour seals, Phoca vitulina. Animal Behaviour 48:1275-1283.

Hanni, K.D. and D.J. Long. 1995. "Food habits of California sea lions at a newly established haul-out in San Francisco Bay". Abstract in Eleventh Biennial Conference on the Biology of Marine Mammals, Dec. 14–18, Orlando, FL.

Hanson, M.T. and R.H. Defran. 1993. The behavior and feeding ecology of the Pacific coast bottlenose dolphin. Aquatic Mammals 19:127-142.

Harris. C.M. 1998. Handbook of acoustical measurements and noise control (3rd Edition). Huntington, NY: Acoustical Society of America.

Hart Crowser. 2013. Naval Base Kitsap-Bangor Explosives Handling Wharf 2: Year 1 Marine Mammal Monitoring Report (2012–2013), Bangor, Washington. Prepared by Hart Crowser. Prepared for NAVFAC, Silverdale, WA. April 2013.

Hastings, M. C. 1990. Effects of Underwater Sound on Fish. Document No. 46254-900206-01IM. Project No. 401775-1600, ATandT Bell Laboratories.

Hastings, M. 2007. Calculation of SEL for Govoni et al. (2003, 2007) and Popper et al. (2007) Studies. Report for Amendment to Project 15218, JandS Working Group, 14 December 2007. 7 pp.

Hastings, M.C., and A.N. Popper. 2005. Effects of Sound on Fish. Report prepared by Jones and Stokes for California Department of Transportation, Contract No. 43A0139, Task Order 1.

Hawkins, A. 2005. Assessing the impact of pile driving upon fish. UC Davis: Road Ecology Center. Retrieved from: http://www.escholarship.org/uc/item/28n858z1

HDR Inc. 2012. Naval Base Kitsap at Bangor Test Pile Program, Bangor, Washington. Final Marine Mammal Monitoring Report. Prepared for Naval Facilities Engineering Northwest, Silverdale, WA. April 2012.

Heath, C. B. 2002. California, Galapagos, and Japanese sea lions– *Zalophus californianus, Z. wollebaeki, and Z. japonicus.* Pages 180 to 186 *in:* Perrin, W. F., B. Würsig, and J. G. M. Thewissen, editors. 2002. Encyclopedia of Marine Mammals. Academic Press.

Henry, A.E., B.S. Stewart, and P.K. Yokem. 1995. Dynamics of dietary overlap between California sea lions and harbor seals near San Nicolas Island, California. Abstract in Eleventh Annual Conference on the Biology of Marine Mammals, Dec. 14–18, Orlando, FL.

Holcomb, K. J.K. Young, and L.R. Gerber. 2009. The influence of human disturbance on California sea lions during the breeding season. Animal Conservation 12:592-598.

Holt, M. 2008. Sound exposure and Southern Resident killer whales (*Orcinus orca*): A review of current knowledge and data gaps. NOAA Technical Memorandum NMFS-NWFSC-89.

Holt, M., Noren, D. P., & Emmons, C. K. 2011. Effects of noise levels and call types on the source levels of killer whale calls. *The Journal of the Acoustical Society of America, 130*(5), 3100–3106.

Huber, H.R. 1991. Changes in the distribution of California sea lions north of the breeding rookeries during the 1982-1983 El Niño. Pages 129-137 *in* F. Trillmich and K.A. Ono, eds. Pinnipeds and El Niño: responses to environmental stress. Springer-Verlag, Berlin.

Jones, D., Marten, K., and Harris, K. 2015. Underwater sound from dredging activities: establishing source levels and modeling the propagation of underwater sound. In: CEDA Dredging Days 2015 – Innovative dredging solutions for ports, Rotterdam.

Kastak, D. and R.J. Schusterman. 1998. Low-frequency amphibious hearing in pinnipeds: methods, measurements, noise, and ecology. Journal of the Acoustical Society of America 103(4):22162228.

Kastak, D., R.J. Schusterman, B.L. Southall and C.J. Reichmuth. 1999. Underwater temporary threshold shift induced by octave-band noise in three species of pinniped. Journal of the Acoustic Society of America. 106(2):1142-1148.

Kastelein, R., van Heerden, D., Gransier, R., and Hoek L. 2013. Behavioral responses of a harbor porpoise (*Phocoena phocoena*) to playbacks of broadband pile driving sounds. *Marine Environmental Research, 92*:206-214.

Kastelein, R.A., Helder-Hoek, L., Covi, J., and Gransier, R. 2016. Pile driving playback sounds and temporary threshold shift in harbor porpoises (*Phocoena phocoena*): Effect of exposure duration. *The Journal of the Acoustical Society of America*, 139, 2842-2851.

Kastelein, R.A., Helder-Hoek, L., Kommeren, A., Covi, J. and Gransier, R. 2018. Effect of pile driving sounds on harbor seal (*Phoca vitulina*) hearing. *The Journal of the Acoustical Society of America*, 143, 3583-3594.

Ketten, D.R. 1992. The marine mammal ear: specializations for aquatic audition and echolocation. Pages 717-750 in D. Webster, R. Fay, and A. Popper, eds. The evolutionary biology of hearing. Springer-Verlag, Berlin.

_____. 1995. Estimates of blast injury and acoustic trauma zones for marine mammals from underwater explosions. Pp. 391-407. In: R.A. Kastelein, J.A. Thomas, and P.E. Nachtigall, eds. Sensory Systems of Aquatic Mammals. Woerden, The Netherlands: De Spil Publishers.

_____. 1998. Marine mammal auditory systems: A summary of audiometric and anatomical data and its implications for underwater acoustic impacts. NOAA Technical Memorandum NMFSSWFSC256: 1-74.

_____. 2000. Cetacean ears. Pp. 43-108. In: W.W.L. Au, A.N. Popper, and R.R. Fay, eds.. Hearing by Whales and Dolphins. New York: Springer-Verlag. Krahn, M.M., M.J. Ford, W.F. Perrin, P.R. Wade, R.P. Angliss, M.B. Hanson, B.L.

_____. 2004. Marine mammal auditory systems: a summary of audiometric and anatomical data and implications for underwater acoustic impacts. Polarforschung 72 (2/3), 79-92.

Kipple, B.M. and C.M. Gabriele. 2007. Underwater noise from skiffs to ships *in* Piatt, J.F. and Gende, S.M., eds, Proceedings of the Fourth Glacier Bay Science Symposium, October 26-28, 2004. U.S. Geological Survey Scientific Investigations Report 2007-5047, p. 172-175.

Laake, J.L., M.S. Lowry, R.L. DeLong, S.R. Melin, and J.V. Carretta. 2018. Population growth and status of California sea lions. The Journal of Wildlife Management; 13 pp.

Lapota, D., D.B. Chadwick, C.N. Katz, A.E. Patterson, B. Davidson, and D. Duckworth. 1993. 1993 fall, winter, spring, and summer seawater characteristics in San Diego Bay: biological, optical, chemical, and physical measurements. Report prepared by Naval Command, Control & Ocean Surveillance Center DIV 522, San Diego, CA for Naval Research Laboratory Remote Sensing Division, Washington, DC.

Largier, J.L. 1995. San Diego Bay Circulation: A Study of the Circulation of Water in San Diego Bay for the Purpose of Assessing, Monitoring and Managing the Transport and Potential Accumulation of Pollutants and Sediment in San Diego Bay. Prepared for California Regional Water Quality Control Board, San Diego Region. July.

Le Boeuf, B. J., and M. L. Bonnell. 1980. Pinnipeds of the California islands: abundance and distribution. Pages 475-493 in D. Power, ed. The California islands. Santa Barbara Mus. Nat. Hist. 787 pp.

Leet, W.S., C.M. Dewees, and C.W. Haugen. 1992. California's living marine resources and their utilization. University of California Sea Grant Extension Publication UCSGEP-92-12. Davis, CA.

Longmuir, C. and T. Lively. 2001. Bubble curtain systems for use during marine pile driving. Report by Fraser River Pile and Dredge Ltd., New Westminster, BC.

Lowry, M.S., C.W. Oliver, C. Macky, and J.B. Wexler. 1990. Food habits of California sea lions *Zalophus californianus* at San Clemente Island, California, 1981-86. Fishery Bulletin 88(3): 509-521.

Lowry, M.S., B.S. Stewart, C.B. Heath, P.K. Yochem, and J.M. Francis. 1991. Seasonal and annual variability in the diet of California sea lions Zalophus californianus at San Nicolas Island, California, 1981-86. Fishery Bulletin 89:331-336.

Malme, C.I., P.R. Miles, C.W. Clark, P.L. Tyack, and J.E. Bird. 1984. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior. Phase II, January 1984 migration. Prepared by Bolt, Beranek, and Newman, Cambridge, MA. Prepared for United States Minerals Management Service, Alaska, OCS Office, Anchorage, AK.

Marine Species Modeling Team. 2012. Determination of Acoustic Effects on Marine Mammals and Sea Turtles for the Hawaii-Southern California Training and Testing Environmental Impact Statement/Overseas Environmental Impact Statement. Naval Undersea Warfare Center Division Newport, Rhode Island. NUWC-NPT Technical Report 12,084. 12 March.

Matzner, S., and Jones, M. E. 2011. Measuring coastal boating noise to assess potential impacts on marine life. *Sea Technology, 52*(7), 41–44.

McHuron, E.A., Block, B.A., and Costa, D.P. 2018. Movements and dive behavior of juvenile California sea lions from Año Nuevo Island. Marine Mammal Science, January 2018, Vol.34(1), pp.238-249.

McKenna, M.F. 2011. Blue whale response to underwater noise from commercial ships. Dissertation. University of California, San Diego. 242 pages.

Melin, S.R., R.L. DeLong, J. R. Thomason, and D.E. Valesquez. 1993. "Foraging behavior of female California sea lions at San Miguel Island, California: winter 1992 and 1993". Abstract in Tenth Biennial Conference on the Biology of Marine Mammals, Nov.11–15, Galveston, TX.

Melin, S.R. and R.L. Delong. 2000. At-sea distribution and diving behavior of California sea lion females from San Miguel Island, California. Pages 407-412 *in* D.R. Browne, K.L. Mitchell, and H.W. Chaney, eds. Proceedings of the Fifth Channel Islands Symposium. OCS Study MMS 99-0038. Minerals Management Service, Camarillo, CA.

Melin, S.R., R.L.Delong, and D.B.Sniff. 2008. The effects of El Niño on the foraging behavior of lactating California sea lions (*Zalophus californianus californianus*) during the non-breeding season. Canadian Journal of Zoology 86:192-206.

Merkel and Associates, Inc. 2008. Marine Mammals Surveys in the Vicinity of the Point Loma Naval Complex, San Diego, California. Final Report. Prepared for NAVFAC SW. September.

_____. 2009. 2008 San Diego Bay Eelgrass Inventory and Bathymetry Update. January.

Miksis-Olds, J. L. and Tyack, P. L. 2009. Manatee (*Trichechus manatus*) vocalization usage in relation to environmental noise levels. *The Journal of the Acoustical Society of America* 125, 1806.

Morton, A.B., and H.K. Symonds. 2002. Displacement of *Orcinus orca* (L.) by high amplitude sound in British Columbia, Canada. *ICES Journal of Marine Science.* 59: 71-80.

Nachtigall, P.E., D.W. Lemonds, and H.L. Roitblat. 2000. Psychoacoustic studies of dolphins and whales. Pages 330-363 in Hearing by Dolphins and Whales. W.W.L. Au, A.N. Popper, and R.R. Fay, eds. Springer-Verlag, New York.

Nachtigall, P.E., J.L. Pawloski, and W.W.L. Au. 2003. Temporary threshold shift and recovery following noise exposure in the Atlantic bottlenose dolphin (Tursiops truncatus). Journal of the Acoustical Society of America 113:3425-3429.

Nachtigall, P.E., A. Supin, J.L. Pawloski, and W.W.L. Au. 2004. Temporary threshold shift after noise exposure in bottlenose dolphin (Tursiops truncatus) measured using evoked auditory potential. Marine Mammal Science 20:673-687.

National Data Buoy Center. 2022. Mean Sea Surface Temperature Data. Station SBC1. Accessed 23 January 2023. Available from: https://www.nodc.noaa.gov/dsdt/cwtg/all_meanT.html.

National Marine Fisheries Service (NMFS). 2005. Endangered Fish and Wildlife; Notice of intent to prepare an environmental impact statement. 70 FR 1871.

_____. 2018. 2018 Revisions to: *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing* (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59, 167 pp.

_____. 2020. Companion User Spreadsheet (December 2020) to: *Technical Guidance for Assessing the* Effects *of Anthropogenic Sound on Marine Mammal Hearing* (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59, 167 pp.

_____. 2022b. Species Directory: Harbor Seal. Available at: https://www.fisheries.noaa.gov/species/harbor-seal Accessed on: 20 June 2022.

_____. 2022c. Species Directory: Common Bottlenose Dolphin. Available at: https://www.fisheries.noaa.gov/species/common-bottlenose-dolphin Accessed on: 20 June 2022.

National Oceanic and Atmospheric Administration (NOAA). 2010. Office of Coast Survey. Chart 18773 San Diego Bay. Edition 41. Available at: http://www.charts.noaa.gov/OnLineViewer/18773.shtm.

National Research Council (NRC). 2003. Ocean Noise and Marine Mammals. National Academies Press, Washington D.C. 192 pp.

_____. 2005. Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects. Washington, D.C.: The National Academies Press.

Naval Facilities Engineering Command, Southwest (NAVFAC SW). 2014. Naval Base Point Loma Fuel Pier Replacement Project: Acoustic, Marine Mammal, Green Sea Turtle, and California Least Tern Monitoring Report. Final, August.

_____. 2015. Naval Base Point Loma Fuel Pier Fleet Logistics Center Replacement Project: Acoustic, Marine Mammal, Green Sea Turtle, and California Least Tern Monitoring Report. Final, June.

_____. 2016. Monitoring Report for Fuel Pier Replacement Project (P-151) Naval Base Point Loma, San Diego, CA (8 October 2015 to 30 April 2016), Including MMPA IHA (Acoustics and Marine

Mammals) and ESA (Pacific Green Sea Turtle, and California Least Tern) Requirements. Final, August 2016.

_____. 2017a. Monitoring Report for Fuel Pier Replacement Project (P-151) Naval Base Point Loma, San Diego, CA (May 2016 to 7 October 2016, Addendum), Including MMPA IHA (Acoustics and Marine Mammals) and ESA (Pacific Green Sea Turtle, and California Least Tern) Requirements. Final, March 2017

_____. 2017b. Monitoring Report for Fuel Pier Replacement Project (P-151) Naval Base Point Loma, San Diego, CA (8 October 2016 to 30 April 2017), Including MMPA IHA (Acoustics and Marine Mammals) and ESA (Pacific Green Sea Turtle, and California Least Tern) Requirements. Final, July 2017.

_____. 2018a. Monitoring Report for Fuel Pier Replacement Project (P-151) Naval Base Point Loma, San Diego, CA (1 May 2017 to 7 October 2017, Addendum), Including MMPA IHA (Acoustics and Marine Mammals) and ESA (Pacific Green Sea Turtle, and California Least Tern) Requirements.

_____. 2018b. Monitoring Report for Fuel Pier Replacement Project (P-151) Naval Base Point Loma, San Diego, CA (8 October 2017 to 25 January 2018), Including MMPA IHA (Acoustics and Marine Mammals) and ESA (Pacific Green Sea Turtle, and California Least Tern) Requirements. Final, March 2018

_____. 2020. Compendium of Underwater and Airborne Sound Data during Pile Installation and In Water Demolition Activities in San Diego Bay, California. Prepared for NAVFAC SW. Prepared by Tierra Data, Inc. October 2020. .

_____. 2022. Acoustic and Marine Protected Species Interim Monitoring Report for the Navy's Pier 6 Replacement Project at Naval Base San Diego, California.

Naval Facilities Engineering Command, Southwest (NAVFAC SW) and Port of San Diego (POSD). 2013. San Diego Bay Integrated Natural Resources Management Plan, Final. San Diego, California. Prepared by Tierra Data Inc., Escondido, California. March.

Nemeth, E., and Brumm, H. 2010. Birds and anthropogenic noise: are urban songs adaptive? *American Naturalist, 176*(4), 465–475.

Nowacek, D.P., L.H. Thorne, D.W. Johnston, and P.L. Tyack. 2007. Responses of cetaceans to anthropogenic noise. *Mammal Review.* 37(2): 81-115.

O'Keeffe, D.J. and G.A. Young. 1984. Handbook on the environmental effects of underwater explosions. Naval Surface Weapons Center, Dahlgren and Silver Spring, NSWC TR 83-240.

Oxman, D.S. 1993. "Seasonal abundance, movements, and food habits of harbor seals in Elkhorn Slough, California". Abstract in Tenth Biennial Conference on the Biology of Marine Mammals, Nov. 11–15, Galveston, TX.

Pearson, W.H., J.R. Skalski, and C.I. Malme. 1992. Effects of sounds from a geophysical survey device on behavior of captive rockfish (*Sebastes* spp.). Canadian Journal of Fisheries and Aquatic Sciences 49: 1343-1356.

Popper, A.N. and M. Hastings. 2009. The effects of human-generated sound on fish. Integrative Zoology 4: 43-52.

Popper, A.N., T.J. Carlson, B.L. Southall, and R.L. Gentry. 2006. Interim Criteria for Injury of Fish Exposed to Pile Driving Operations: A White Paper.

Port of San Diego (POSD). 2007. State of the Bay. January.

Reeder, D.M. and Kramer, K.M. 2005. Stress in free-ranging mammals: Integrating physiology, ecology, and natural history. Journal of Mammalogy 86:225-235.

Reine, K. J., Clarke, D., & Dickerson, C. 2014. Characterization of underwater sounds produced by hydraulic and mechanical dredging operations. *The Journal of the Acoustical Society of America, 135*(6), 3280–3294.

Richardson, W.J., G.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. *Marine mammals and noise*. San Diego, CA: Academic Press. 576 pp.

Ridgway, S.H., D.A. Carder, R.R. Smith, T. Kamolnick, C. E. Schlundt, and W. R. Elsberry. 1997. Behavioral responses and temporary shift in masked hearing threshold of bottlenose dolphins, *Tursiops truncatus*, to 1-second tones of 141 to 201 dB re 1 µPa. Technical Report 1751, Revision 1. San Diego, California: Naval Sea Systems Command.

San Diego Harbor Safety Committee. 2020. San Diego Harbor Safety Plan (Approved July 2020).

_____. 2022. San Diego Harbor Safety Plan (Approved July 2020).

Schlundt, C.E., R.L. Dear, D.A. Carder, and J.J. Finneran. 2006. Growth and recovery of temporary threshold shifts in a dolphin exposed to mid-frequency tones with durations up to 128 s. Journal of the Acoustical Society of America 120:3227A.

Schlundt, C.E., J.J. Finneran, D.A. Carder, and S.H. Ridgway. 2000. Temporary shift in masked hearing thresholds of bottlenose dolphins, *Tursiops truncatus*, and white whale, *Delphinapterus leucas*, after exposure to intense tones. Journal of the Acoustical Society of America 107:3496-3508.

Scholik, A.R., and H.Y. Yan. 2001. Effects of underwater noise on auditory sensitivity of a cyprinid fish. Hearing Research 152:17-24.

_____. 2002. The effects of noise on the auditory sensitivity of the bluegill sunfish, *Lepomis macrochirus*. Comp. Biochemical Physiology A 133:43-52.

Schusterman, R.J. 1977. Temporal patterning in sea lion barking (*Zalophus californianus*). Behavioral Biology, 20:404-408.

Schusterman, R. 1981. Behavioral Capabilities of Seals and Sea Lions: A Review of Their Hearing, Visual, Learning and Diving Skills. The Psychological Record, 31, 125–143.

Schusterman, R.J. and R.F. Balliet. 1969. Underwater barking by male sea lions (*Zalophus californianus*). Nature 222(5199):1179-1181.

Schusterman, R.J., R. Gentry, and J. Schmook. 1966. Underwater vocalization by sea lions: Social and mirror stimuli. Science 154(3748):540-542.

Schusterman, R.J., Gentry, R., and Schmook, J. 1967. Underwater sound production by captive California sea lions. Zoologica, 52:21-2 4.

Sebastianutto, L., M. Picciulin, M. Costantini, and E. Ferrero. 2011. How boat noise affects an ecologically crucial behaviour: the case of territoriality in Gobius cruentatus (Gobiidae). Environmental Biology & Fisheries 92:207-213.

Skalski, J.R., W.H. Pearson, and C.I. Malme. 1992. Effects of sounds from a geophysical survey device on catch-per-unit-effort in a hook-and-line fishery for rockfish (*Sebastes* spp.). *Canadian Journal of Fisheries and Aquatic Sciences* 49: 1357-1365.

Smith, E.L. 1972. Temperature Fluctuations at a Fixed Position in San Diego Bay. Report to the Naval Undersea Research and Development Center, San Diego, CA. July 1972.

Sorensen, K. and Swope, B. 2010. San Diego Bay Marine Mammal Survey Project. Report to Navy Region Southwest, San Diego, CA. Third Survey Report.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene, C.R. Jr., Kastak, D., Ketten, D.K., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A. and Tyack, P.L. 2007. Marine mammal noise exposure criteria: initial scientific recommendations. *Special Issue of Aquatic Mammals*. 33(4): 412-522.

Southall, B.L., Finneran, J.J., Reichmuth, C., P.E. Nachtigall, D.R. Ketten, A.E. Bowles, W.T. Ellison, D.P. Nowacek, and P.L. Tyack. 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. *Aquatic Mammals* 45(2), 125-232, DOI 10.1578/AM.45.2.2019.125.

Stewart, B.S., and P.K. Yochem. 1985. "Feeding habits of harbor seals at San Nicolas Island, California, 1980-1985". Abstract in Sixth Biennial Conference on the Biology of Marine Mammals, Nov. 22–26, Vancouver, BC.

_____. 1994. Ecology of harbor seals in the Southern California Bight. Pages 123-134 in W.L. Halvorson and G.J. Meander, eds. Fourth Channel Islands Symposium: Update on the Status of Resources. Santa Barbara Museum of Natural History.

Terhune, J. and S. Turnbull. 1995. Variation in the psychometric functions and hearing thresholds of a harbour seal. Pages 81-93. IN: R.A. Kastelein, J.A. Thomas, and P.E. Nachtigall, eds. Sensory Systems of Aquatic Mammals. De Spil Publishers, Woerden, Netherlands.

Thomson, D. H. and W. J. Richardson. 1995. Marine mammal sounds. Pages 159-204 in Richardson, W. J., C. R. Greene, Jr., C. I. Malme, and D. H. Thomson, eds. Marine mammals and noise. San Diego: Academic Press.

Thorson, P. and J.A. Reyff. 2006. San Francisco-Oakland Bay Bridge East Span Seismic Safety Project: marine mammal and acoustic monitoring for the marine foundations at piers E2 and T1, January-September 2006. Prepared by SRS Technologies and Illingworth & Rodkin, Inc. for the California Department of Transportation: 51.

Tierra Data, Inc. 2010. Characterizing the Spatial and Temporal Variation in Turbidity and Physical Water Quality Characteristics in San Diego Bay - A Study to Determine a Cost-Efficient Strategy for Longterm Monitoring. A Project for: Environmental Project to Benefit San Diego Bay San Diego Unified Port District Environmental Services Department. Final Report. Available at; http://www.portofsandiego.org/environment/projects-a-progress-reports.html

_____. 2012a. Characterizing the Spatial and Temporal Variation of Key Physical Water Quality Parameters in San Diego Bay: The Importance of Continuous Baseline Data when Evaluating Physical, Biological, and Chemical Processes. Draft Final Report, prepared for Environmental Projects to Benefit San Diego Bay San Diego Unified Port District Environmental Services Department. February.

_____. 2012b. Marine Mammal Surveys, February-April 2012. Unpublished Data. Prepared under contract to NAVFAC SW.

Triton Engineers. 2019. New Dry Dock at National City, Preliminary Engineering Study-Findings, Marine Group Boat Works. Memorandum. September 5.

Turl, C.W. 1993. Low-Frequency Sound Detection by a Bottlenose Dolphin. Journal of Acoustical Society of America. (94)5:3006-3008.

U.S. Navy (Navy). 2001. Shock trial of the WINSTON S. CHURCHILL (DDG 81): final environmental impact statement.

_____. 2010. Incidental Harassment Authorization Application for Navy Training Conducted within the Silver Strand Training Complex Update #3. Submitted to Office of Protected Resources, NMFS, NOAA. 28 December.

_____. 2016. Final Environmental Assessment Pier 8 Replacement Naval Base San Diego. June.

_____. 2018. Dry Dock No. 1 Modifications and Mole Pier Floating Dry Dock Studies. Prepared by GHD COWI Joint Venture for Naval Facilities Engineering Command Southwest. August.

Van Parijs, S.M., P.J. Corkeron, J. Harvey, S.A. Hayes, D.K. Mellinger, P.A. Rouget, P.M. Thompson, M. Wahlberg, and K.M. Kovacs. 2003. Patterns in the vocalizations of male harbor seals. Journal of the Acoustical Society of America 113(6):3403-3410.

Viada, S.T., R.M. Hammer, R. Racca, D. Hannay, M.J. Thompson, B.B. Balcom, and N.W. Phillips. 2008. Review of potential impacts to sea turtles from underwater explosive removal of offshore structures. Environmental Impact Assessment. 28: 267-285.

Ward, W.D. 1997. Effects of high intensity sound. In M.J. Crocker (Ed.) *Encyclopedia of acoustics, Volume III*. (pp 1497-1507). New York: John Wiley and Sons.

Wartzok, D., A.N. Popper, J. Gordon and J. Merrill. 2003/04. Factors affecting the responses of marine mammals to acoustic disturbance. *Marine Technology Society Journal* 37(4):6-15.

Weller, D.W., G.S. Campbell, A. Debich, A.G. Kesaris, and R.H. Defran. 2016. Mark-recapture abundance estimate of California coastal stock bottlenose dolphins: November 2009 to April 2011. NOAA-Technical Memorandum. NOAA-TM-NMFS-SWFSC-563. 18 p.

Wells, R.S., L.J. Hansen, A. Baldridge, T.P. Dohl, D.L. Kelly, and R.H. Defran. 1990. Northward extension of the range of bottlenose dolphins along the California coast. Pages 421-431 in S. Leatherwood and R. R. Reeves, eds. The Bottlenose Dolphin. San Diego Academic Press, San Diego.

Wolski, L.F., R.C. Anderson, A.E. Bowles, and P.K. Yochem. 2003. Measuring hearing in the harbor seal (*Phoca vitulina*): Comparison of behavioral and auditory brainstem response techniques. Journal of the Acoustical Society of America 113(1):629-637.

Yelverton, J.T., D.R. Richmond, E.R. Fletcher, and R.K. Jones. 1973. Safe distances from underwater explosions for mammals and birds. Lovelace Foundation, Albuquerque, DNA 3114T. http://stinet.dtic.mil/cgibin/GetTRDoc?AD=AD766952andLocation=U2anddoc=Get TRDoc.pdf.

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Appendix A
NBSD FLOATING DRY DOCK LEVEL A ZOI CALCULATIONS

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Level A: Vibratory Extraction (Test Pile Program): 24-in Octagonal Concrete Piles Piles

A.1: Vibratory Pile Driving (STATIONARY SOURCE: Non-Impulsive, Continuous)

VERSION 2.2: 2020

KEY

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	NBSD Mole Pier FDD
PROJECT/SOURCE INFORMATION	Vibratory Extraction (Test Pile Program) 24-in Octagonal Concrete Piles 24-in Square Concrete Piles

Please include any assumptions

PROJECT CONTACT	Todd McConchie, NAVFAC SW todd.c.mcconchie.civ@us.navy.mil

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2.5	Default Value

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

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 48), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

STEP 3: SOURCE-SPECIFIC INFORMATION

Sound Pressure Level (L_{rms}), specified at "x" meters (Cell B30)	162
Number of piles within 24-h period	1
Duration to drive a single pile (minutes)	20
Duration of Sound Production within 24-h period (seconds)	1200
10 Log (duration of sound production	30.79
Transmission loss coefficient	15
Distance of sound pressure level (L_{rms}) measurement (meters)	10

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	3.8	0.3	5.7	2.3	0.2

WEIGHTING FUNCTION CALCULATIONS

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

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

Level A: Vibratory Extraction (Production): 24-in Octagonal Concrete Piles & 24-in Square Concrete Piles

A.1: Vibratory Pile Driving (STATIONARY SOURCE: Non-Impulsive, Continuous)

VERSION 2.2: 2020

KEY

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	NBSD Mole Pier FDD
PROJECT/SOURCE INFORMATION	Vibratory Extraction (Production): 24-in Octagonal Concrete Piles 24-in Square Concrete Piles

Please include any assumptions

PROJECT CONTACT	Todd McConchie, NAVFAC SW todd.c.mcconchie.civ@us.navy.mil

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2.5	Default Value

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

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 48), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

STEP 3: SOURCE-SPECIFIC INFORMATION

Sound Pressure Level (L_{rms}), specified at "x" meters (Cell B30)	162
Number of piles within 24-h period	5
Duration to drive a single pile (minutes)	20
Duration of Sound Production within 24-h period (seconds)	6000
10 Log (duration of sound production	37.78
Transmission loss coefficient	15
Distance of sound pressure level (L_{rms}) measurement (meters)	10

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**11.2**	**1.0**	**16.5**	**6.8**	**0.5**

WEIGHTING FUNCTION CALCULATIONS

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

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

Level A: Impact Pile Driving (Test Pile Program): 24-in Octagonal Concrete Piles

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

VERSION 2.2: 2020

KEY

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	NBSD Mole Pier FDD
PROJECT/SOURCE INFORMATION	Impact Pile Driving (Test Pile Program) 24-in Octagonal Concrete Piles

Please include any assumptions

PROJECT CONTACT	Todd McConchie, NAVFAC SW todd.c.mcconchie.civ@us.navy.mil

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2	Default Value

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

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 73), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: METHOD E.1-1 is PREFERRED method when SEL-based source levels are available (because pulse duration is not required). Only use method E.1-2 if SEL-based source l

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT) PREFERRED METHOD (pulse duration not needed)

Unweighted SEL_{cum} (at measured distance) = SEL_{ss} + 10 Log (# strikes)	193.8

SEL_{cum}

Single Strike SEL_{ss} ($L_{E,p,\text{single strike}}$) specified at "x" meters (Cell B32)	166
Number of strikes per pile	600
Number of piles per day	1
Transmission loss coefficient	15
Distance of single strike SEL_{ss} ($L_{E,p,\text{single strike}}$) measurement (meters)	10

PK

$L_{p,0\text{-pk}}$ specified at "x" meters (Cell G29)	188
Distance of $L_{p,0\text{-pk}}$ measurement (meters)*	10
$L_{p,0\text{-pk}}$ Source level	203.0

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	52.3	1.9	62.3	28.0	2.0
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	NA	NA	1.2	NA	NA

"NA": PK source level is ≤ to the threshold for that marine mammal hearing group.

E.1-2: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Sound Pressure Level (L_{rms}), specified at "x" meters (Cell B53)	176
Number of piles per day	1
Strike (pulse) Duration[∆] (seconds)	0.01
Number of strikes per pile	600
Duration of Sound Production (seconds)	6
10 Log (duration of sound production)	7.78
Transmission loss coefficient	15
Distance of sound pressure level (L_{rms}) measurement (meters)	10

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

PK

$L_{p,0\text{-pk}}$ specified at "x" meters (Cell G47)	188
Distance of $L_{p,0\text{-pk}}$ measurement (meters)*	10
$L_{p,0\text{-pk}}$ Source level	203.0

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	11.3	0.4	13.4	6.0	0.4
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	NA	NA	1.2	NA	NA

"NA": PK source level is ≤ to the threshold for that marine mammal hearing group.

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds	
a	1	1.6	1.8	1	2	
b	2	2	2	2	2	
f_1	0.2	8.8	12	1.9	0.94	
f_2	19	110	140	30	25	NOTE: If user de
C	0.13	1.2	1.36	0.75	0.64	they need to ma
Adjustment (-dB)†	-0.01	-19.74	-26.87	-2.08	-1.15	to ensure the bu

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

Level A: Impact Pile Driving (Production): 24-in Octagonal Concrete Piles

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

VERSION 2.2: 2020

KEY

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	NBSD Mole Pier FDD
PROJECT/SOURCE INFORMATION	Impact Pile Driving (Production) 24-in Octagonal Concrete Piles

Please include any assumptions

PROJECT CONTACT	Todd McConchie, NAVFAC SW todd.c.mcconchie.civ@us.navy.mil

STEP 2: WEIGHTING FACTOR ADJUSTMENT

		Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value
Weighting Factor Adjustment (kHz)[¥]	2	Default Value

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

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 73), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

STEP 3: SOURCE-SPECIFIC INFORMATION

NOTE: METHOD E.1-1 is PREFERRED method when SEL-based source levels are available (because pulse duration is not required). Only use method E.1-2 if SEL-based source levels are

E.1-1: METHOD TO CALCULATE PK AND SEL_{cum} (SINGLE STRIKE EQUIVALENT) PREFERRED METHOD (pulse duration not needed)

Unweighted SEL_{cum} (at measured distance) = SEL_{ss} + 10 Log (# strikes)	198.6

SEL_{cum}

Single Strike SEL_{ss} ($L_{E,p, single strike}$) specified at "x" meters (Cell B32)	166
Number of strikes per pile	600
Number of piles per day	3
Transmission loss coefficient	15
Distance of single strike SEL_{ss} ($L_{E,p, single strike}$) measurement (meters)	10

PK

$L_{p,0-pk}$ specified at "x" meters (Cell G29)	188
Distance of $L_{p,0-pk}$ measurement (meters)*	10
$L_{p,0-pk}$ Source level	203.0

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	108.7	3.9	129.5	58.2	4.2
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	NA	NA	1.2	NA	NA

"NA": PK source level is ≤ to the threshold for that marine mammal hearing group.

E.1-2: METHOD TO CALCULATE PK AND SEL_{cum} (USING RMS SPL SOURCE LEVEL)

SEL_{cum}

Sound Pressure Level (L_{rms}), specified at "x" meters (Cell B53)	176
Number of piles per day	3
Strike (pulse) Duration[Δ] (seconds)	0.01
Number of strikes per pile	600
Duration of Sound Production (seconds)	18
10 Log (duration of sound production)	12.55
Transmission loss coefficient	15
Distance of sound pressure level (L_{rms}) measurement (meters)	10

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

PK

$L_{p,0-pk}$ specified at "x" meters (Cell G47)	188
Distance of $L_{p,0-pk}$ measurement (meters)*	10
$L_{p,0-pk}$ Source level	203.0

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

*Impulsive sounds have dual metric thresholds (SELcum & PK). Metric producing largest isopleth should be used.

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	23.4	0.8	27.9	12.5	0.9
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	NA	NA	1.2	NA	NA

"NA": PK source level is ≤ to the threshold for that marine mammal hearing group.

WEIGHTING FUNCTION CALCULATIONS

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

NOTE: If user decided to o[…] they need to make sure to[…] to ensure the built-in calcu[…]

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