INCIDENTAL HARASSMENT AUTHORIZATION APPLICATION
FOR THE NAVY'S EXPLOSIVE HANDLING WHARF #1
PILE REPLACEMENT PROJECT
CONDUCTED AT NAVAL BASE KITSAP AT BANGOR

Submitted to:

Office of Protected Resources,

National Marine Fisheries Service,

National Oceanographic and Atmospheric Administration

Prepared by:

Naval Facilities Engineering Command

For:

Naval Base Kitsap at Bangor and Naval Strategic Systems Program

March 2012

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ACRONYMS AND ABBREVIATIONS

BSS	Beaufort Sea State
°C	Celsius
CA	California
CFR	Code of Federal Regulations
CV	Coefficient of Variation
dB	Decibel
dBA	Decibel with A-weighting filter
DPS	Distinct Population Segment
DO	Dissolved Oxygen
DoN	Department of the Navy
EEZ	Exclusive Economic Zone
EHW-1	Explosive Handling Wharf #1
EHW-2	Explosive Handling Wharf #2
EIS	Environmental Impact Statement
ESA	Endangered Species Act
°F	Fahrenheit
HCDOP	Hood Canal Dissolved Oxygen Program
Hz	Hertz
IHA	Incidental Harassment Authorization
kHz	Kilohertz
kg	Kilogram
km	Kilometer
lbs	Pounds
m	Meter
mg/L	Milligrams per Liter
MHHW	Mean Higher High Water
MMPA	Marine Mammal Protection Act
ms	Millisecond
Navy	United States Navy
NBK	Naval Base Kitsap
NMFS	National Marine Fisheries Service
OR	Oregon
Pa	Pascal
PSU	Practical Salinity Units
RMS	Root Mean Square
SEL	Sound Exposure Level
SPL	Sound Pressure Level
Sq	Square
TL	Transmission Loss
TS	Threshold Shift
TTS	Temporary Threshold Shift
TRIDENT	Trident Fleet Ballistic Missile
U.S.	United States
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
°W	West
WA	Washington
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife

WDOE	Washington Department of Ecology
WSDOT	Washington State Department of Transportation
ZOI	Zone of Influence
μPa	Micropascal

EXECUTIVE SUMMARY

The United States Navy is applying for an Incidental Harassment Authorization under the Marine Mammal Protection Act of 1972, as amended, to complete necessary repairs and maintenance of the Explosive Handling Wharf #1 facility at Naval Base Kitsap at Bangor. These activities are part of a two-year Explosive Handling Wharf #1 Pile Replacement Project that began in August 2011. Activities from August 2011 through July 15, 2012 are covered under a separate Incidental Harassment Authorization.

The proposed action includes construction activities during the second year of the project (July 16, 2012 through July 15, 2013). These activities are the removal of the fragmentation barrier, walkway, and 126 steel and concrete piles. Of the piles requiring removal, ninety-six are 24-inch diameter hollow pre-cast concrete piles, which will be broken and removed or excised down to the mudline using a pneumatic chipping hammer. Additional twenty-nine 12- and 16-inch steel piles will be extracted using a vibratory hammer, direct pull, or they will be cut-off at the mudline. One 24-inch steel fender pile will be cut at the mudline. Also included in the remaining repair work is the construction of new cast-in-place (concrete formwork) pile caps, the installation of a new pre-stressed superstructure, the installation of four sled mounted cathodic protection systems, and the installation of related appurtenances.

The in-water work established by the regulatory agencies (Washington Department of Fish and Wildlife in coordination with the National Marine Fisheries Service and the U.S. Fish and Wildlife Service) to protect juvenile salmon is July 16 through February 15. Therefore, the proposed in-water activities will only occur from July 16, 2012 through February 15, 2013.

Seven species of marine mammals may be present at various times of the year within the waters surrounding Naval Base Kitsap at Bangor: the humpback whale (*Megaptera novaeangliae*), Steller sea lion (*Eumetopias jubatus*), the California sea lion (*Zalophus californianus*), the harbor seal (*Phoca vitulina*), the transient killer whale (*Orcinus orca*), the Dall's porpoise (*Phocoenoides dalli*), and the harbor porpoise (*Phocoena phocoena*). With the exception of the Steller and California sea lion, these species may occur year-round in Hood Canal, though Dall's porpoise and transient killer whales are only rarely sighted. Humpback whale sightings are extremely rare with only one verified sighting. The Steller sea lion is only present from October to mid-April, and the California sea lion is only present from August to early June. While transient killer whales have been observed in Hood Canal occasionally, the Southern Resident killer whale stock (listed under the Federal Endangered Species Act), has not been observed in Hood Canal in over 15 years and was therefore excluded from further analysis. Individuals of the species potentially present during the project's timeline could be exposed to sound pressure levels associated with vibratory pile removal or pneumatic chipping.

The National Marine Fisheries Service has promulgated threshold criteria for assessing potential impacts to marine mammals potentially present from pile installation and removal activities. Vibratory pile extraction and pneumatic chipping produce underwater noise levels at or above the threshold level for continuous noise. The Navy modeled sound propagation from these sources based on empirically measured source levels to estimate the area above the thresholds where marine mammals may be exposed. Predicted exposures of marine mammals within each of the affected areas were calculated using estimated marine mammal densities. The modeling predicted no Level A (injury) harassments would occur from project activities. Level B harassments could occur during vibratory pile extraction and pneumatic chipping from elevated underwater sound levels. Estimated potential exposures for each species potentially present are listed in table below. No incidents of harassment were predicted from airborne sounds or any other construction activities. Conservative assumptions (including marine mammal densities) used to estimate the exposures likely overestimate the potential number of exposures. In addition, mitigation measures are proposed to limit exposure of marine mammals and their prey resources to potential project impacts.

Summary of Estimated Level B Exposures by Species (July 16, 2012 through February 15, 2013)

Species	Potential Exposure To Disturbance Threshold (120dB)
Humpback Whale	0
Steller Sea Lion	62
California Sea Lion	377
Harbor Seal	737
Transient Killer Whale	15
Dall's Porpoise	15
Harbor Porpoise	135
Total	**1,341**

Pursuant to the Marine Mammal Protection Act Section 101(a)(5)(D)[1], the Navy submits this application to the National Marine Fisheries Service for an Incidental Harassment Authorization for the incidental, but not intentional, taking of six marine mammal species during pile removal activities as part of the Explosive Handling Wharf #1 Pile Replacement Project from July 16, 2012 through July 15, 2013. The number of potential exposures requested per species is listed in above table. The taking would be in the form of non-lethal, temporary harassment and is expected to have a negligible impact on individuals and populations of these species. In addition, the taking would not have an unmitigable adverse impact on the availability of these species for subsistence use.

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 Marine Mammal Protection Act. These 14 items are addressed in Sections 1 through 14 of this Incidental Harassment Authorization application.

1 16 U.S.C. § 1371(a)(5); 50 C.F.R. Part 216, Subpart I.

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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

Naval Base Kitsap (NBK) at Bangor, Washington, provides berthing and support services to United States (U.S.) Navy submarines and other fleet assets including the TRIDENT Fleet Ballistic Missile (TRIDENT) program. In 2011 the Navy began a two-year construction project (also called the Pile Replacement Project) to conduct necessary repairs and maintenance on the Explosive Handling Wharf #1 (EHW-1) facility at NBK at Bangor. The wharf is a U-shaped concrete structure built in 1977 for ordnance handling operations in support of the Trident Submarine squadron home ported at NBK at Bangor. EHW-1 consists of two 30-meter (100-feet) access trestles and a main pier deck that measures approximately 215 meters (700 feet) in length. The wharf is supported by both 16-inch and 24-inch hollow octagonal pre-cast concrete piles. Additionally, there are steel and timber fender piles on the outboard and inboard edges of the wharf.

The EHW-1 structural integrity is compromised due to deterioration of the wharf's piling sub-structure. The purpose of the project is to maintain the structure integrity of the wharf and ensure its continued functionality to support the operational requirements of the TRIDENT program. The wharf repair area is highlighted in yellow in Figure 1-1.

Under Section 101 (a)(5)(D) of the Marine Mammal Protection Act (MMPA) of 1972, as amended in 1994, an Incidental Harassment Authorization (IHA) was issued by the National Marine Fisheries Service (NMFS) to the Navy for activities that had the potential to affect small numbers of marine mammals in the waterways adjacent to NBK at Bangor through behavioral harassment incidental to repair activities conducted during the first year of construction (July 16, 2011 through July 15, 2012). With this application, the Navy is requesting an IHA for remaining construction activities that have the potential to affect marine mammals during the second year of construction beginning July 2012. The proposed remaining project activities that could result in behavioral harassment to marine mammals are vibratory removal of steel piles and pneumatic chipping for concrete pile removal. Sections 1.2 and 1.3 describe the proposed activities in detail.

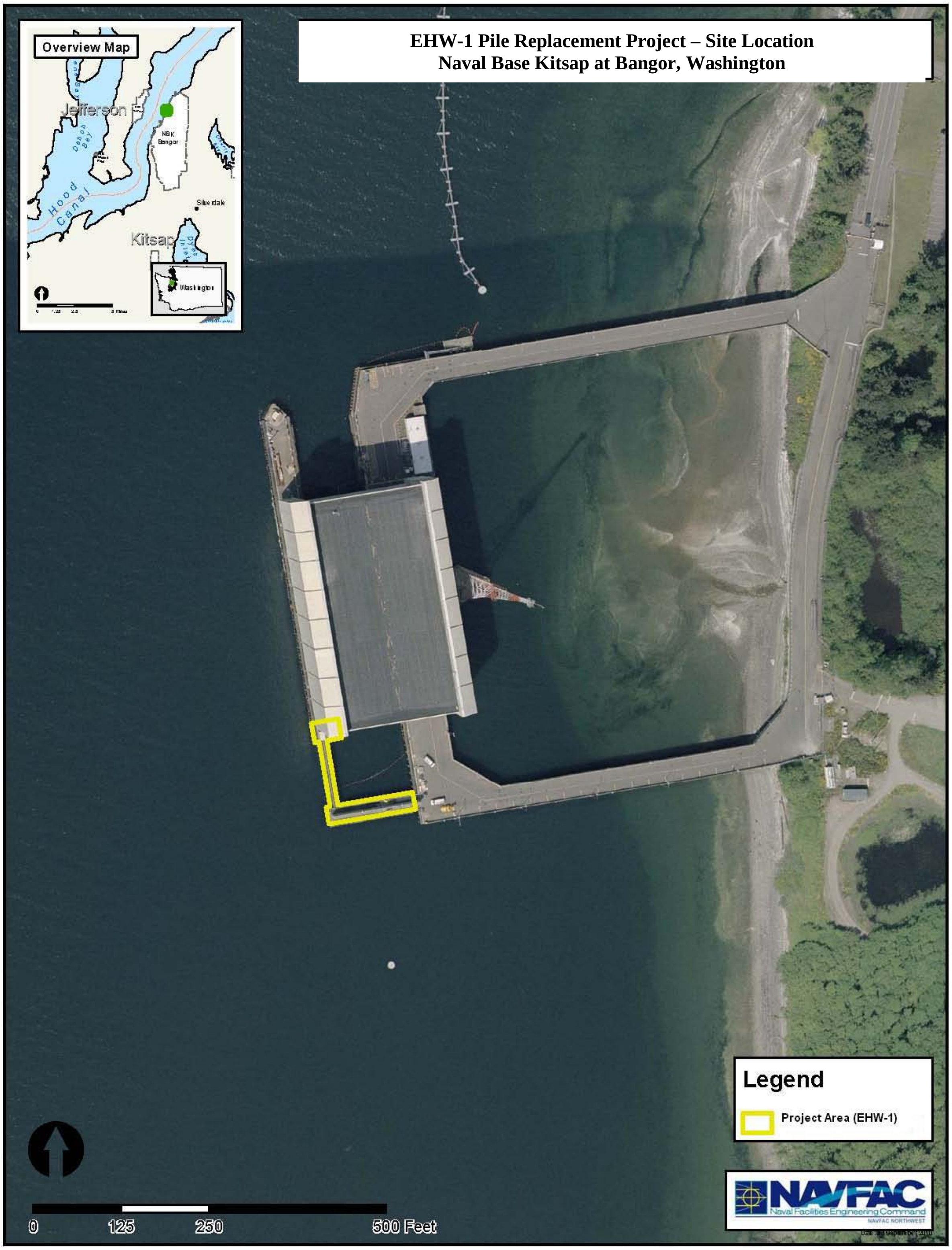


Figure 1-1. Proposed Project Area

1.2 Proposed Action

The proposed action is a two-year project designed to restore the structural integrity of the EHW-1 facility. The entire action was described in the 2011 IHA application submitted for the first year of project construction (July 16, 2011 through July 15, 2012) and the final IHA issued by NMFS (76 FR 30130) for the EHW-1 Pile Replacement Project. The proposed action will occur in the second year of the two-year construction period scheduled to begin July 16, 2012. Table 1-1 provides a description of activities completed under the IHA issued for the 2011/2012 in-water work window (year 1 of construction). Table 1-2 provides a description of remaining activities to be completed under the IHA requested in this application for the 2012/2013 in-water work window (year 2 of construction). Table 1-3 compares pile installation and removal activities completed in the 2011/2012 in-water work window to activities that remain to be completed in the 2012/2013 in-water work window. While impact pile driving was authorized for the project during the first in-water construction season, no impact pile driving was necessary to complete the repairs. Since all pile installation was completed within the first in-water construction season, the Navy does not anticipate requiring the use of an impact hammer for the remainder of the project. The proposed action described here only includes remaining project activities at EHW-1 that were not completed during the first year of construction.

Table 1-1. Construction Activities Completed Under IHA Issued July 2011

Completed Activity
Installation of twelve 30-inch diameter hollow steel pipe piles (approximately 74-122 feet [23-37 meters) long] at the walkway).
Installation of sixteen 30-inch diameter hollow steel pipe piles (approximately 130 feet [40 meters] long at EHW-1 bents 8-10).
Installation of eight 16-inch diameter steel falsework piles.
Removal of two 24-inch diameter steel fender piles at the main wharf and associated fender system components.
Removal of eight 12-inch diameter steel fender piles.
Construction of 6 cast-in-place concrete pile caps (scheduled for early 2012).

Table 1-2. Construction Activities Proposed for IHA Requested for July 2012

Remaining Activity to be Constructed
Removal of one 24-inch diameter steel fender piles at the main wharf and associated fender system components (to be cut-off at mudline).
Removal of twenty-one 12-inch diameter steel fender piles.
Removal of ninety-six 24-inch diameter hollow pre-cast concrete piles to the mud line.
Removal of eight 16-inch diameter steel falsework piles.
Removal of the EHW-1 fragmentation barrier and walkway.
Construction of up to 6 cast-in-place concrete pile caps (if not complete as scheduled for early 2012).
Installation of a pre-stressed concrete superstructure for the walkway.

Installation of four sled mounted passive cathodic protection systems.
Installation/re-installation of related appurtenances.

Table 1-3. Pile Installation/Removal Activities by In-Water Work Window

Activity Status for Each Construction In-Water Work Window (July 16 through February 15)	Piles Installed via Vibratory Driver		Piles Removed via Vibrator Driver/Direct Pull			Piles Removed via Pneumatic Chipping	Total
	16" Steel Falsework	30" Steel	12" Steel Fender	16" Steel Falsework	24" Steel Fender	24" concrete	
Complete 2011/2012	8	28	8	0	2	0	46
Remaining for 2012/2013	0	0	21	8	1	96	126
Project Total	8	28	29	8	3	96	172

Remaining construction activities include the removal of the EHW-1 fragmentation barrier, walkway, and 126 steel and concrete piles (Table 1-2). Of the piles requiring removal, 96 are 24-inch diameter hollow pre-cast concrete piles, which will be removed down to the mudline with a pneumatic chipping hammer or similar device. An additional twenty-one 12-inch steel fender piles and eight 16-inch falsework steel piles will be extracted using a vibratory hammer, direct pull, or, if necessary, cut off at the mudline. One 24-inch steel fender pile will be cut at the mudline because it is too close to the EHW-1 structure to be extracted. Other remaining project elements are the installation of four sled mounted cathodic protection systems, a new pre-stressed superstructure, and related appurtenances. Additionally, if any of the six cast-in-place pile caps scheduled to be constructed early in 2012 (see Table 1-1) are not completed by July 15, 2012, these will also be included in the second year of construction.

In-water project activities will be conducted during the in-water work window that is protective of fish species (July 16 through February 15). Sound propagation data was collected in 2011 through hydroacoustic monitoring during pile installation and removal to support environmental analyses for this year's repair work and other future repair work that may be necessary to maintain the EHW-1 facility. In 2011, pneumatic chipping was not conducted; therefore, hydroacoustic monitoring will be conducted for pneumatic chipping during the 2012/2013 in-water work period covered by the IHA issued for this application. The presence of marine mammals will also be monitored during vibratory pile extraction and pneumatic chipping.

1.3 Description of Pile Removal and Remaining Construction Activities

The remaining construction activities at EHW-1 are described in detail below.

- Removal of piles:
  - One 24-inch steel fender pile,
  - Twenty-one 12-inch diameter steel fender piles,
  - Eight 16-inch diameter steel falsework piles.
  - Ninety-six 24-inch diameter hollow pre-cast concrete piles to the mud line (includes 72 at fragmentation barrier, 4 at walkway, 4 at Bent 8 outboard support, and 8 at Bents 9 and 10).

  The one 24-inch steel will be cut at the mudline because of its close proximity to the EHW-1 structure. A diver with a torch will be used to cut the pile at the mudline. All other steel piles will be removed by direct pull (rigging is attached to a pile and a crane pulls on the piling until it is removed) or extracted with a vibratory hammer. If these methods are not feasible, they will be cut-off at the mudline.

  Concrete piles will be removed with a pneumatic chipping hammer or another tool capable of cutting through concrete. If possible, piles will be first scored by a diver using a small pneumatic hammer. The pile will then moved slightly back and forth to break the pile at the score. Remaining parts of the pile will be chipped away with a pneumatic hammer. If there is not room to move the pile, the entire base of the pile will be chipped away with a pneumatic hammer for removal. A pneumatic chipping hammer is similar to an electric power tool, and performs much like a smaller version of a jackhammer, but uses the energy of compressed air instead of electricity. The pneumatic chipping hammer consists of a steel piston that is reciprocated (moved backward and forward alternately) in a steel barrel by compressed air. On its forward stroke, the piston strikes the end of the chisel. The reciprocating motion of the piston occurs at such a rate that the chisel edge vibrates against the concrete with enough force to fragment or splinter the pile. Rebar strands in the piles will be torched to remove. Concrete debris will be captured as practicable using a debris curtains/sheeting and removed from the project area. Removed piles and/or pile pieces will be placed on a barge for upland disposal.

- Removal of the concrete fragmentation barrier and walkway (Figure 1-2). The walkway is used to get from the Wharf Apron to the Outboard Support. These structures will likely be removed by cutting the concrete into sections using a wire saw, or other equipment, and removed using a crane. The crane will lift the sections from the existing piles and place them on a barge. Concrete pieces will be hauled to a barge for upland disposal.

- Construction of cast-in-place concrete pile caps. The pile caps will be situated on the tops of the steel piles located directly beneath the structure (Figure 1-3) and function as a load transfer mechanism between the superstructure and the piles. Concrete formwork may be located below Mean Higher High Water [MHHW].

- Installation of a pre-stressed concrete superstructure for the walkway. The superstructure is the pre-stressed concrete deck of the wharf found above, or supported by, the caps or sills, including the deck, girders, and stringers. It will be installed using a crane to situate the concrete slab above the piles.

- Installation of four sled mounted passive cathodic protection systems. A passive cathodic protection system is a metallic rod or anode attached to a metal object to protect it from corrosion. A more active metal, which easily oxidizes, corrodes the anode first and protects the primary structure from corrosion damage. At the EHW-1 facility, the passive cathodic protection systems will be banded to the steel piles to prevent the metallic surfaces of the wharf from corroding due to the saline conditions in Hood Canal.

- Installation/re-installation of related appurtenances would follow. Appurtenances are the associated parts of the superstructure that connects the superstructure to the piles. These pieces include all of the components such as bolts, welded metal hangers and fittings, brackets, etc.

Vibratory removal of piles and pneumatic chipping will occur from July 16, 2012 through February 15, 2013. The installation of the concrete pile caps, the concrete superstructure, and sled mounted passive cathodic protection systems will occur out of the water and on the tops of the piles or attached to the wharf's superstructure. The removal of the fragmentation barrier and walkway will occur above the water with Best Management Practices in place to prevent material from entering the water. While sound transmission from these activities could occur and enter the water, this is expected to be minimal. However, to be cautious, these activities will occur in the window of July 16 to February 15 to minimize impacts to listed species, particularly fish.

The Navy will monitor hydroacoustic sound levels associated with pneumatic chipping, as well as the presence and behavior of marine mammals during vibratory pile removal and pneumatic chipping activities. Section 11 provides the details proposed to reduce or mitigate the impacts from proposed project activities.

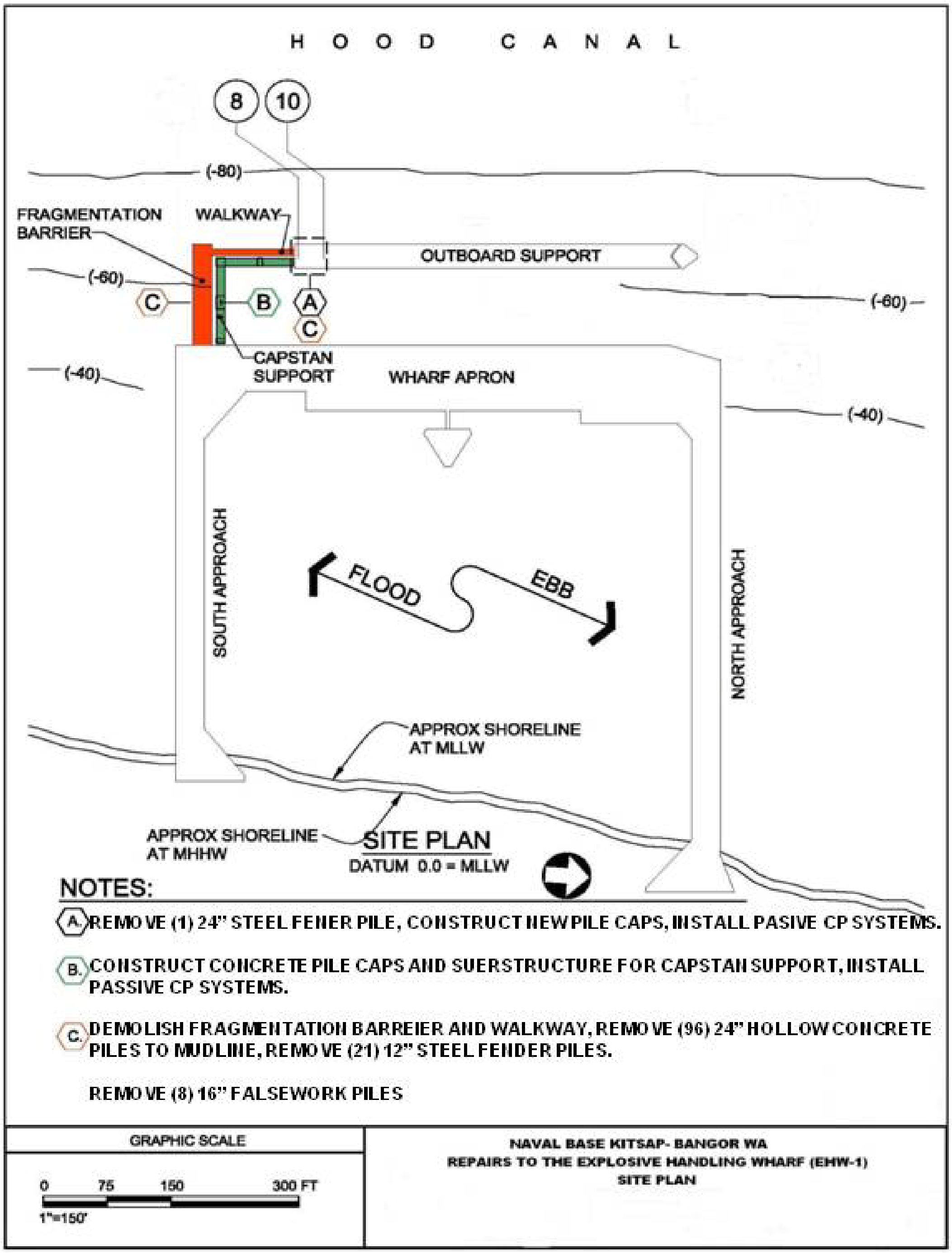


Figure 1-2. Locations of the Proposed Construction Activities

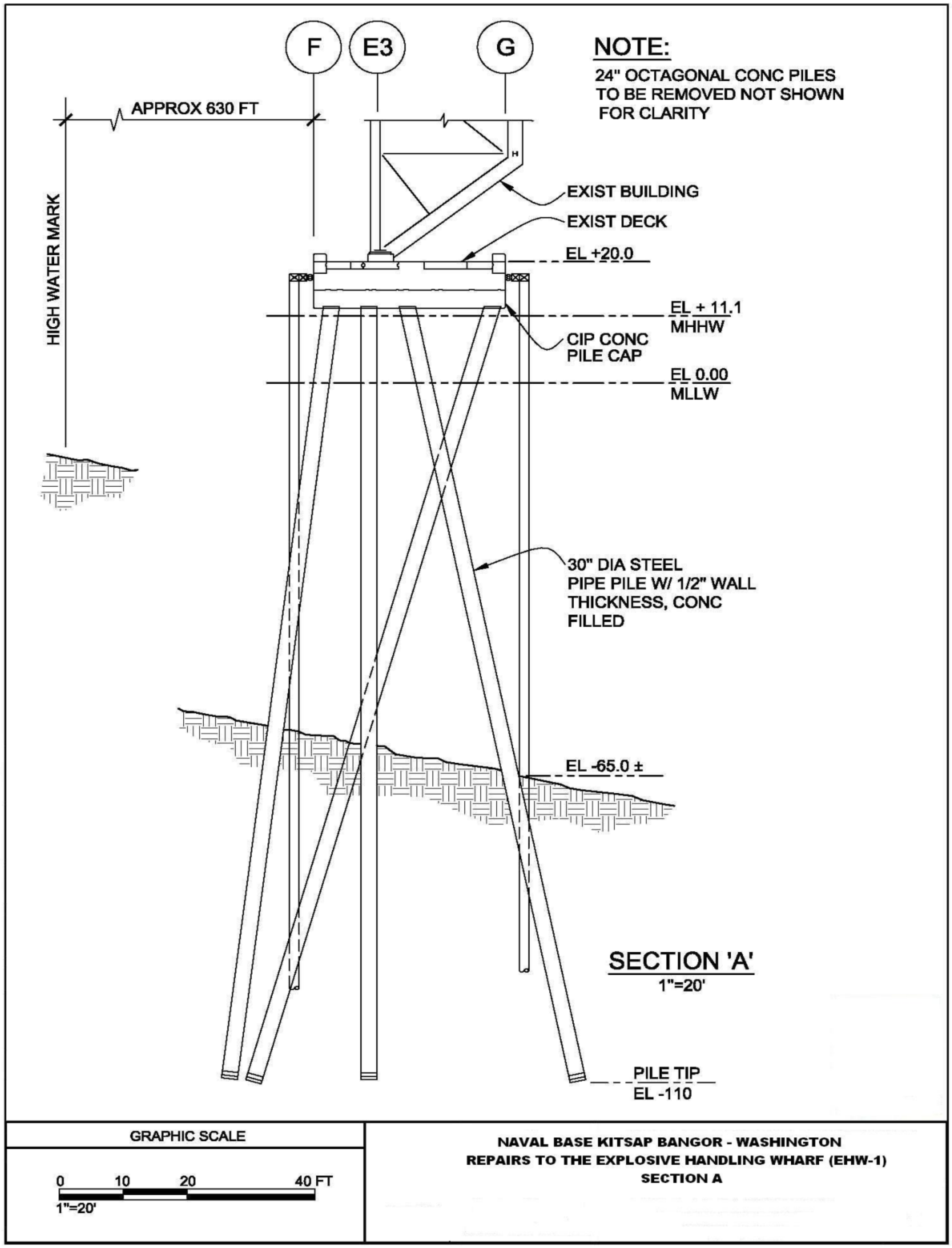


Figure 1-3. Example Repairs to the EHW-1 Facility – Section A

2 LOCATION, DATES AND DURATION OF ACTIVITIES

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

2.1 Region of Activity

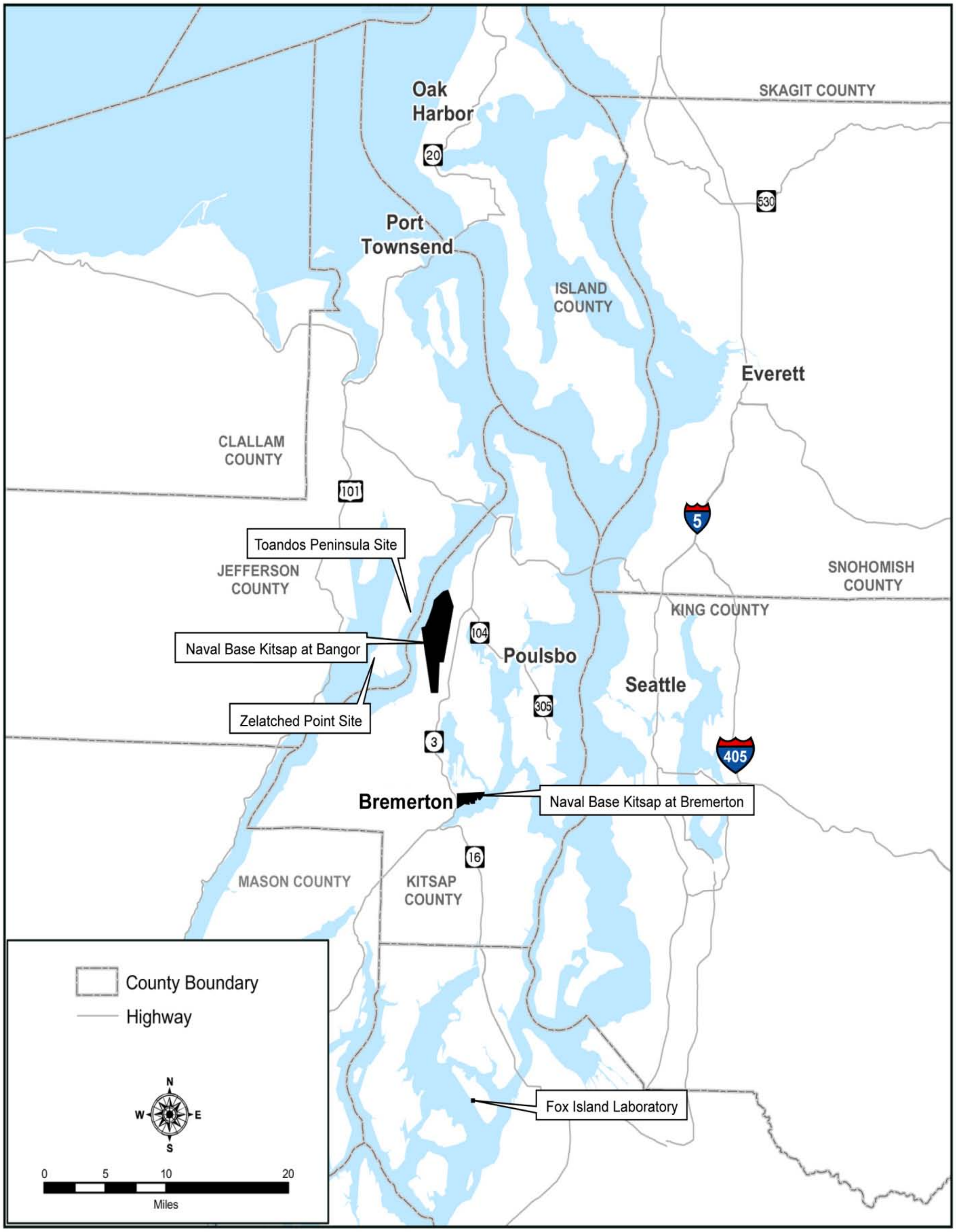
NBK at Bangor is located on the Hood Canal in Kitsap County, approximately 20 miles west of Seattle, Washington (Figure 2-1). EHW-1 is located along the eastern shoreline of Hood Canal. The entirety of NBK at Bangor, including the land areas and adjacent water areas in the Hood Canal, is restricted from general public access (Figure 2-2).

The Hood Canal is a long, narrow fjord-like basin of the western Puget Sound. Throughout its 67-mile length, the width of the canal varies from 1 to 2 miles and exhibits strong depth/elevation gradients and irregular seafloor topography in many areas. Although no official boundaries exist along the waterway, the northeastern section of the canal extending from the mouth of the canal at Admiralty Inlet to the southern tip of Toandos Peninsula is referred to as the northern Hood Canal. The proposed Project Area is located within this region.

2.2 Activity Area Description

2.2.1 Bathymetric Setting

In the northern Hood Canal, water depths in the center of the waterway near Admiralty Inlet vary between 300 to 420 feet. As the canal extends southwestward toward the Olympic Mountain Range and Thorndyke Bay, water depths shoal to approximately 160 feet over a moraine deposit. This deposit forms a sill across the short axis of the canal near Thorndyke Bay, which has an important impact on deep circulation and seawater exchange. The NBK at Bangor waterfront occupies approximately 5 miles of the shoreline within northern Hood Canal (1.7 percent of the entire Hood Canal coastline) and lies just south of the sill feature. Depths of the in-water project site are provided in Figure 2-3. The width of the canal is approximately 1.5 miles at the site, 2.2 miles at the northern end of NBK at Bangor, and constricts to approximately 1.1 miles near the southern end near Hazel Point. The farthest direct line of site from the project site is 8.4 miles to the north and 4.2 miles to the south (see Figure 2-3).



(Source: Navy 2002; ESRI 2000)

Figure 2-1. Map of the Surrounding Vicinity

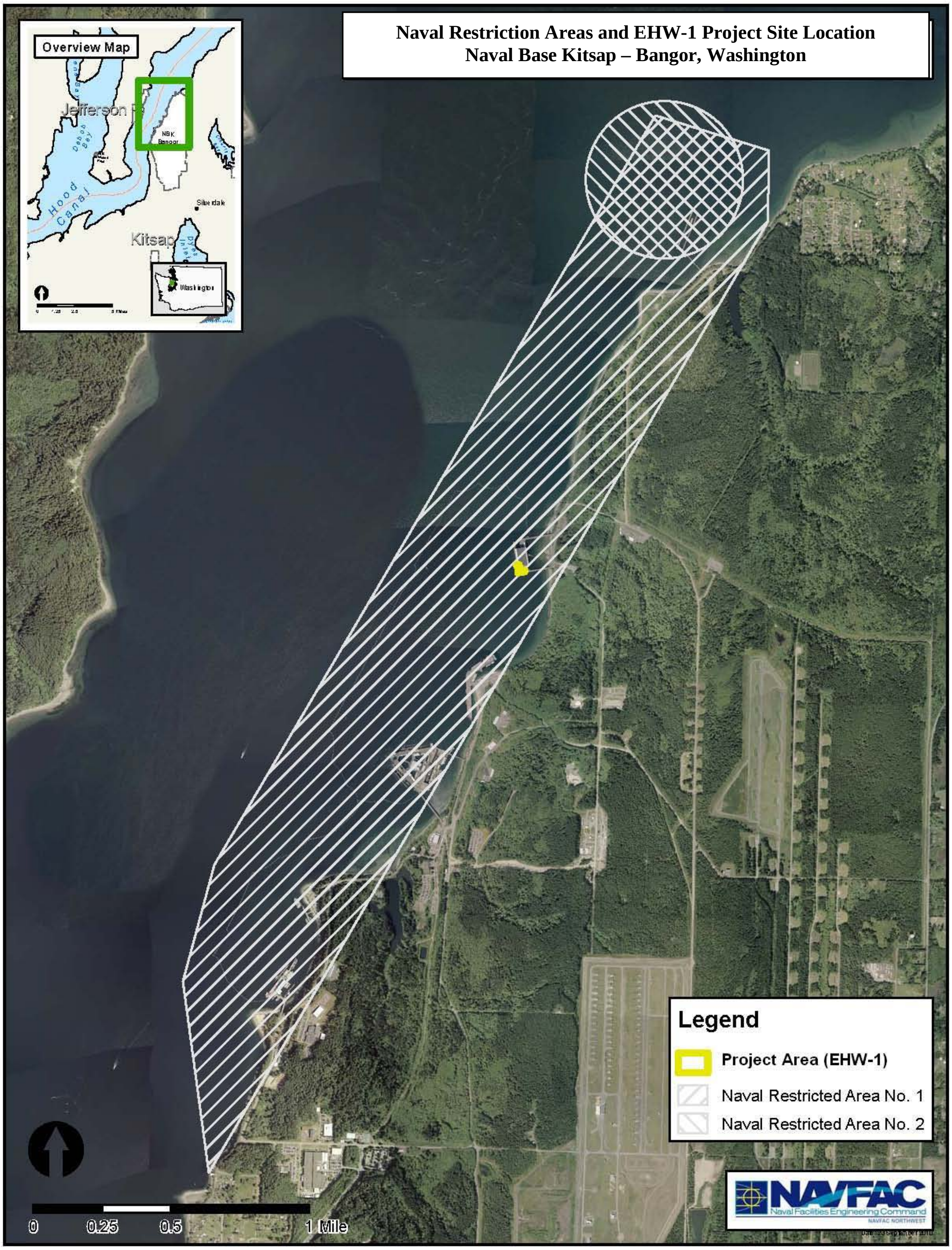


Figure 2-2. Restricted Areas at NBK at Bangor

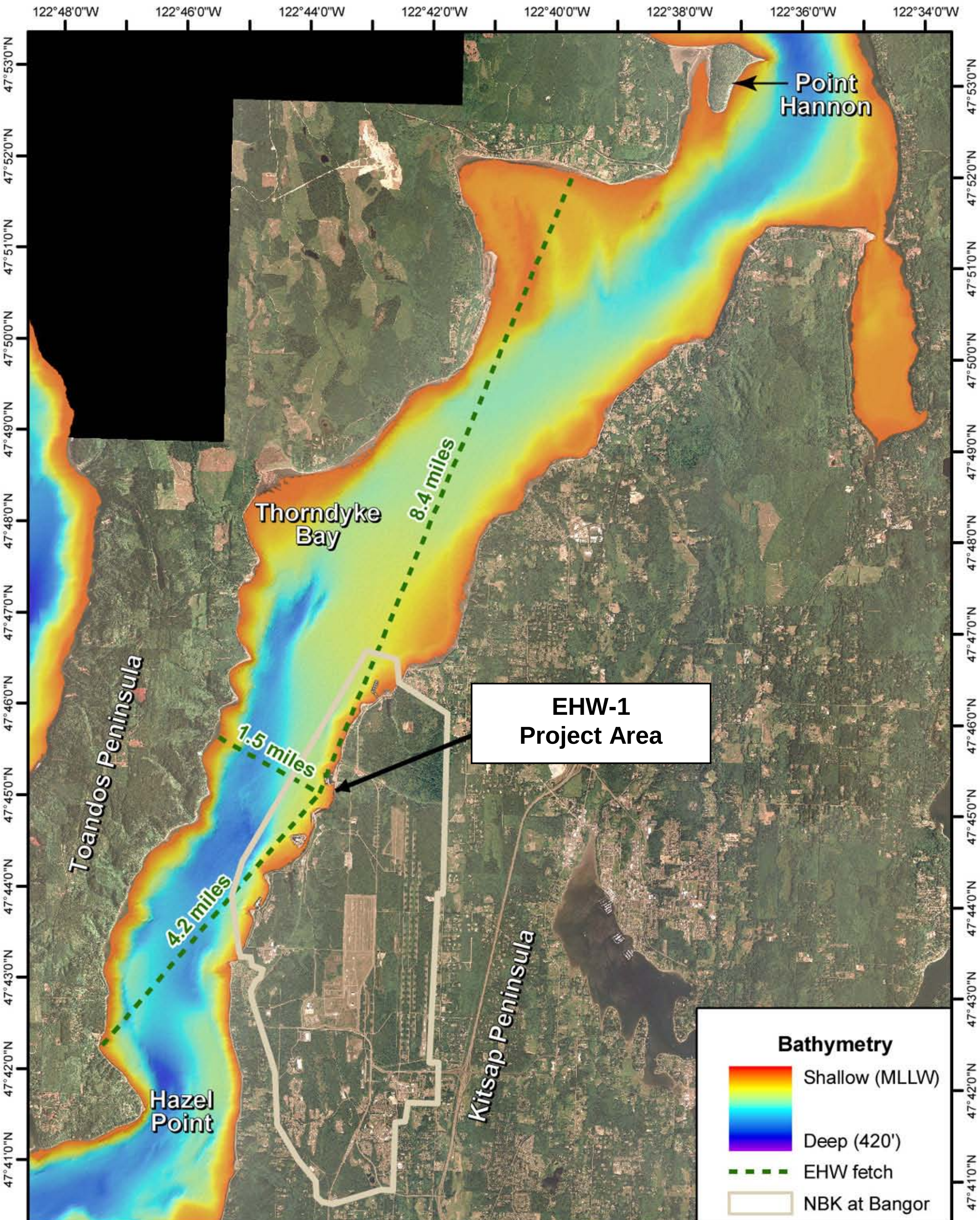


Figure 2-3. EHW Maximum Fetch Diagram

0 1 2
Miles

NOTE:
Coordinate System: WA State Plane (North)
Horizontal Datum: NAD83
Vertical Datum: MHW
Units: feet
DEM provided by University of Washington

2.2.2 Tides

The tides in Hood Canal are mixed, diurnal-semidiurnal with a range directly dependent upon the phase and alignment of the lunar and solar gravitational influences on the regional tides (URS 1994; Morris et al. 2008). The astronomic influences (tides) on water level within Puget Sound and Hood Canal result in one flood and one ebb tidal event with a small to moderate range (1 to 6 feet) and a second flood and second ebb with a larger range (8 to 16 feet) during a 24-hour and 50-minute tidal day. As a result, higher high, lower high, higher low, and lower low water levels are recorded within each tide day.

Since the tides within Hood Canal are mixed diurnal to semi-diurnal, this body of water is subject to one major flushing event per tide day when approximately 1.1326 x 10^9 cubic yards (or 3 percent of the total canal volume) is exchanged over a 6-hour period. Due to the wide range of tidal heights that can occur in this body of water, the actual seawater exchange volume for Hood Canal ranges from 1 percent during a minor tide to 4 percent during a major tide.

Despite considerable tidally driven seawater influx within the basin, some studies have estimated water residence time in the southern and middle portions of Hood Canal can be up to one year due to the natural limitation on seawater exchange (i.e., bathymetry; Warner et al. 2001; Warner 2007). However, at the project site, the majority of the daily volume of seawater exchange flows directly across the NBK at Bangor waterfront area. As a result, the degree of flushing that occurs at the Project Area is relatively high and the characteristics of this seawater more closely track the physical, chemical, and biological conditions of Puget Sound than southern Hood Canal.

2.2.3 Circulation and Currents

Tidal currents and resulting circulation patterns within Hood Canal are complex due to the configuration of the basin, as well as the mixed diurnal-semidiurnal tidal regime. Current measurements obtained from the reaches of northern Hood Canal in the summer of 2007 indicate that tidal phase and range have a significant impact on the velocity of currents associated with the flood and ebb tides (Morris et al. 2008). The larger tidal ranges promote higher velocity currents and increased flushing of the basin, while small to moderate tidal ranges yield a diminished tidal current regime and limit the volume of seawater exchange between Hood Canal and Puget Sound. Seawater entering the canal from Puget Sound during an incoming flood tide tends to be cooler, more saline, and well oxygenated relative to the Hood Canal waters. As a result, the incoming Puget Sound water has a tendency to sink to the bottom of the canal as it flows over the sill and move south during each flood tide, while the lower density Hood Canal water tends to remain in the upper water column.

Current flow (speed and direction) at the Project Area is primarily a function of tidal action based on the phase and range of each tide within the mixed diurnal-semidiurnal regime, and current velocities in the shallower water areas (less than 50 feet) around the Project Area are variable and complex. The magnitude or instantaneous velocity of these fluctuating water column currents range from 0 to 0.88 feet/second within the 30- to 65-foot water depth interval. However, current flow in any one direction is short-lived and inconsistent in magnitude, with relatively few periods of time when sufficient energy (0.7 feet/second) exists to exceed the threshold for re-suspending deposits of unconsolidated material on the seafloor (Boggs 1995). Statistical summaries show that time-averaged net flow is within the 0.07 to 0.10 feet/second range in the upper water column and less than 0.03 feet/second in proximity to the seafloor.

The nearshore current observations at the Project Area and other NBK at Bangor piers and wharves in the summer of 2006 suggest that tidal currents were inconsistent with water level (tide) measurements. Rather than the typical relationship where maximum current corresponds to mid-flood or mid-ebb in the water level record, maximum flow velocities at the Project Area align with water levels at the high and low tide. Furthermore, the direction of nearshore flow often ran counter to expectations in a normal system, with flood tide coinciding with northeastward currents and ebb tide resulting in southwesterly currents (Morris et al. 2008).

2.2.4 Sea State

Apart from larger impacts associated with large-scale changes in weather and ocean circulation in the Pacific Basin, seasonal variability in Hood Canal circulation can occur in the winter when strong meteorological events (e.g., storms, high winds) are more prevalent. Regardless of direction, winds with velocities in excess of 25 knots occur relatively infrequently in the Puget Sound region (Morris et al. 2008). The typically light winds afforded by the surrounding highlands (Olympic and Cascade Mountain Ranges) coupled with the fetch-limited environment of Hood Canal result in relatively calm wind conditions throughout most of the year. However, the northern and middle sections of Hood Canal are oriented in the southwest to northeast direction. Therefore, organized coastal storm events that reach land in the late autumn and winter months, as well as fair weather systems in the spring and summer exhibiting wind speeds in excess of 20 knots, have the capability to generate substantial wind waves due to increased fetch and/or alter normal tidal flow within the basin.

However, the Project Area is afforded some protection by the coastline of both Kitsap and Toandos Peninsulas (see Figure 2-3). Using a maximum fetch of 8.4 miles between the Project Area and the north shore of Thorndyke Bay to the north-northeast, estimates indicate that a 20-knot sustained wind has the capability to generate average wave heights of 1.9 feet (Beaufort Sea State [BSS] of 2) and a 30-knot wind event could produce wave heights of 3.1 feet (BSS = 3) (CERC 1984). The maximum fetch to the southwest is one-half that to the northeast (4.2 miles), which could yield average waves of 1.3 feet in height (BSS = 2) in a 20-knot wind and 1.9 feet (BSS =2) in a 30 knot wind. Maximum wave heights in these weather conditions could be 67 percent higher than average estimates reported above. Thus, a weather event capable of generating waves with an average height of 3.1 feet (BSS = 3) could also yield waves with maximum heights of 5.1 feet (BSS = 4) (CERC 1984).

2.2.5 Water Temperature

Water temperatures in the Strait of Juan de Fuca and Puget Sound typically range from 44 to 46 degrees Fahrenheit (°F) throughout the winter months (mid-December through mid-March). Surface waters slowly warm throughout the spring and summer due to increased solar heating, reaching temperatures of 50°F in mid-May or early June to a maximum temperature of 54°F during the month of August. Beginning in September, water temperatures begin to decrease over time, falling 6 to 8°F over the next 3 months due to decreasing levels of solar radiation. Occasionally, anomalies in this pattern of heating and cooling are detected in the data record, but are often short (1 to 2 weeks). Monthly mean water temperatures along the NBK at Bangor waterfront are summarized in Table 2-1. Nearshore, areas (water depths range from 1-60 m) are susceptible to greater temperature variations due to seasonal fluxes in solar radiation input.

Table 2-1. Monthly Mean Surface Water Temperatures (°C/°F)

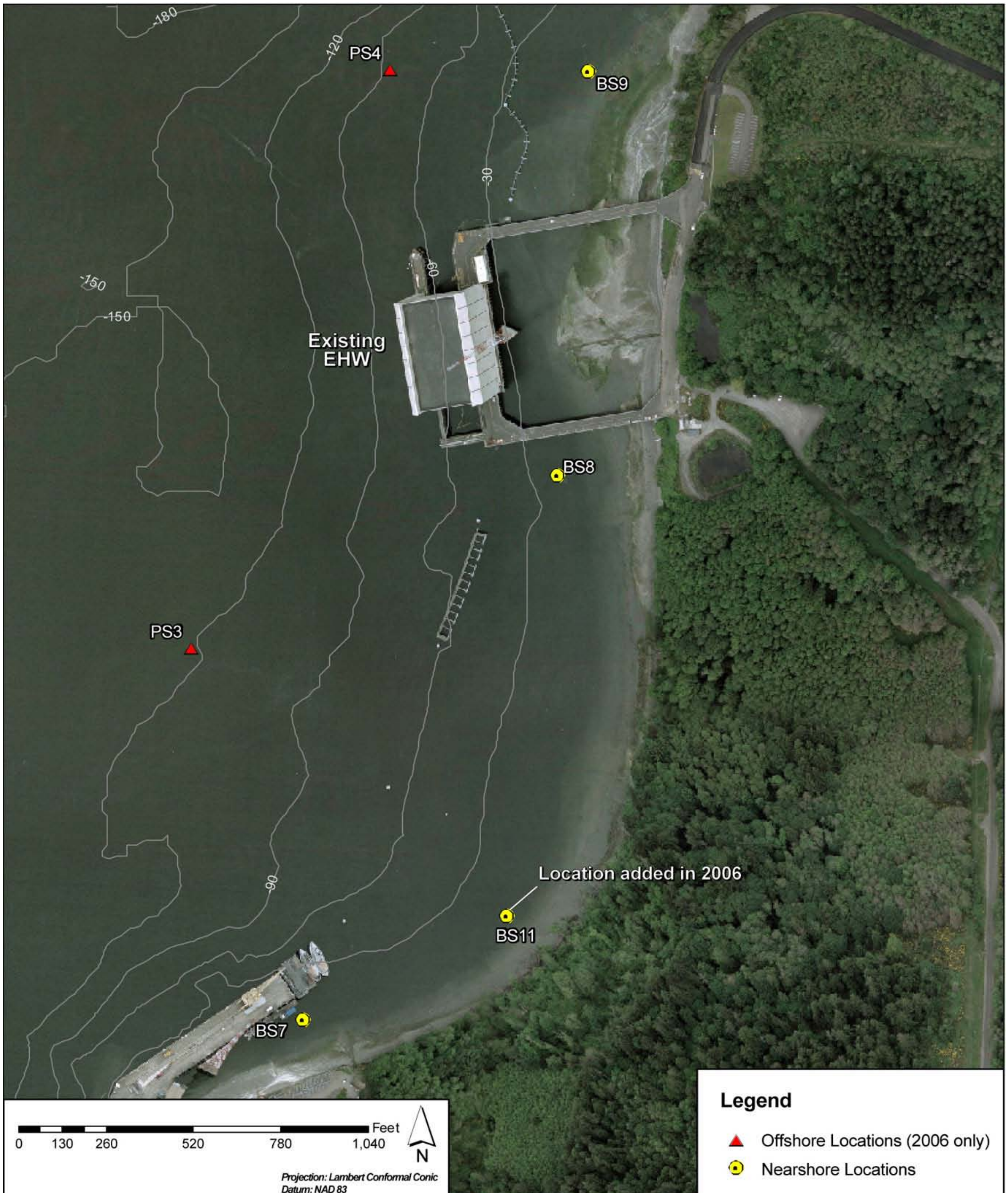
SAMPLING MONTH (2005, 2006)[1]	NEARSHORE TEMPERATURE	OFFSHORE TEMPERATURE
July 2005	14.3°C (57.8°F)	11.6°C (52.9°F)
August 2005	13.8°C (56.8°F)	13.5°C (56.3°F)
September 2005	14.9°C (58.8°F)	11.6°C (52.9°F)
January 2006	8.2°C (46.8°F)	---
February 2006	8.1°C (46.6°F)	---
March 2006	8.5°C (47.3°F)	8.3°C (46.9°F)
April 2006	9.6°C (49.3°F)	9.3°C (48.7°F)
May 2006	10.9°C (51.6°F)	11.0°C (51.8°F)
June 2006	13.2°C (55.8°F)	---

Source: Phillips et al. 2009.
Data are from 13 nearshore and 4 offshore stations along the Naval Base Kitsap at Bangor waterfront. Those stations near the project site are shown in Figure 2–4.
--- No data were collected at this depth during this sampling month

2.2.6 Dissolved Oxygen

Concentrations of dissolved oxygen (DO) in extraordinary quality marine surface waters should exceed 7.0 mg/L of DO, allowing for only 0.2 mg/L reductions in the natural condition by human-caused activities (Washington Administrative Code 173-201A). According to the WDOE Marine Water Quality Report for 1998 to 2000, fish are negatively affected by DO concentrations of less than 4.5 mg/L (Newton et al. 2002). Data from WDOE's Marine Water Quality Monitoring Program for 1998 to 2000 and the Hood Canal Dissolved Oxygen Program (HCDOP) for 2002 to 2004 show that Hood Canal is particularly susceptible to low DO levels (Newton et al. 2002; HCDOP 2005). The 2008 Clean Water Act Section 303(d) list, the most recent list approved by the U.S. Environmental Protection Agency (USEPA), includes five segments within northern Hood Canal impaired by low DO levels (WDOE 2009). Two of these segments are located along the NBK at Bangor waterfront. The low DO for both of those segments is believed to be due to or influenced by human actions (WDOE 2009). However, these stations are offshore in deep water and would not necessarily be representative of nearshore conditions at the NBK at Bangor waterfront.

Although some waters along the NBK at Bangor waterfront are on the 303(d) list, mean DO measurements during July 2005 through June 2006 indicate that nearshore stations at the NBK at Bangor waterfront consistently met extraordinary quality standards for DO. From July 2005 through June 2006 and January 2007 through April 2008, DO levels met the extraordinary standard for surface waters (0 to 20 feet in depth) year round and for deep water (66 to 197 feet in depth) most of the year (deeper waters can drop to only a fair standard for DO in late summer). In late summer-early fall, DO levels in the action area drop from typical ranges of approximately 6 to 10 mg/L to a range of 4.7 to 9.1 mg/L (Phillips et al. 2009). The variation in mean DO measurements for deeper waters (66 to 197 feet in depth) near the project site was consistent with DO patterns within the rest of Hood Canal. During the late summer and early fall period (July through September 2005), mean DO measurements met fair to excellent quality standards.



Source: Phillips et al. 2009

Figure 2-4. Water Quality Monitoring Stations for 2005 and 2006

At 66 to 197 feet in depth, these measurements are on the upper range of low DO conditions measured historically throughout Hood Canal during the late summer and fall periods (Warner 2007). Mean DO measurements at 66 to 197 feet in depth from March through May 2006 met Extraordinary Quality standards.

2.2.7 Stratification and Salinity

The waters of Hood Canal surrounding the Project Area are stratified, with less saline, warmer water overlying colder, more saline bottom waters. The salinity of the upper water layer is sensitive to the amount of freshwater input and may become more diluted during heavy precipitation (URS 1994). Variances due to seasonal changes (such as freshwater input, wind-induced mixing, and solar heating) are common (URS 1994).

Freshwater input into Hood Canal comes from creeks, rivers, groundwater (including artesian wells [deep underground aquifer]), and stormwater outfalls. The freshwater inputs affect the salinity in Hood Canal. Artesian wells also contribute to freshwater inputs, with estimated flows of 2,000 to 2,500 gallons per minute (WDOE 1981). Overland flow from much of the western portion of NBK at Bangor is routed to Hood Canal through a series of stormwater outfalls. Saltwater and freshwater mixing zones exist at the mouths of each of these streams and outfalls (URS 1994).

During water quality surveys from 2005 through 2008, average surface water salinity levels along the NBK at Bangor waterfront ranged from 24 to 34 practical salinity units (PSU) (Phillips et al. 2009) Salinity measurements with depth reflected a stratified water column, with less saline surface water overlying cooler saline water at depth. The transition between the lower salinity surface waters and higher salinity subsurface waters occurred at a depth of about 33 feet (Phillips et al. 2009). The lowest surface water salinity (18.47 PSU) was measured in February 2007 when freshwater (low salinity) input may have been high due to winter storms and runoff (Hafner and Dolan 2009). The range of salinity along the NBK at Bangor waterfront is typical for marine waters in Puget Sound (Newton et al. 1998, 2002).

2.2.8 Sediments

Existing sediment information is based on results from sampling near the Project Area during 2007 (Hammermeister and Hafner 2009); sampling locations are shown in Figure 2-5. Sediment quality at the project site is generally good; levels of contaminants meet applicable state standards. Marine sediments are composed of gravelly sands with some cobbles in the intertidal zone, transitioning to silty sands in the subtidal zone (Hammermeister and Hafner 2009).

Subsurface coring studies conducted in 1994 found the presence of glacial till approximately 6 feet below mud line in the intertidal zone, increasing to over 10 feet in the subtidal zone (URS 1994). The composition of sediment samples from the Project Area ranged from 65 to 100 percent for sand, less than 1 to 7 percent for gravel, 2 to 32 percent silt, and 2 to 11 percent clay.

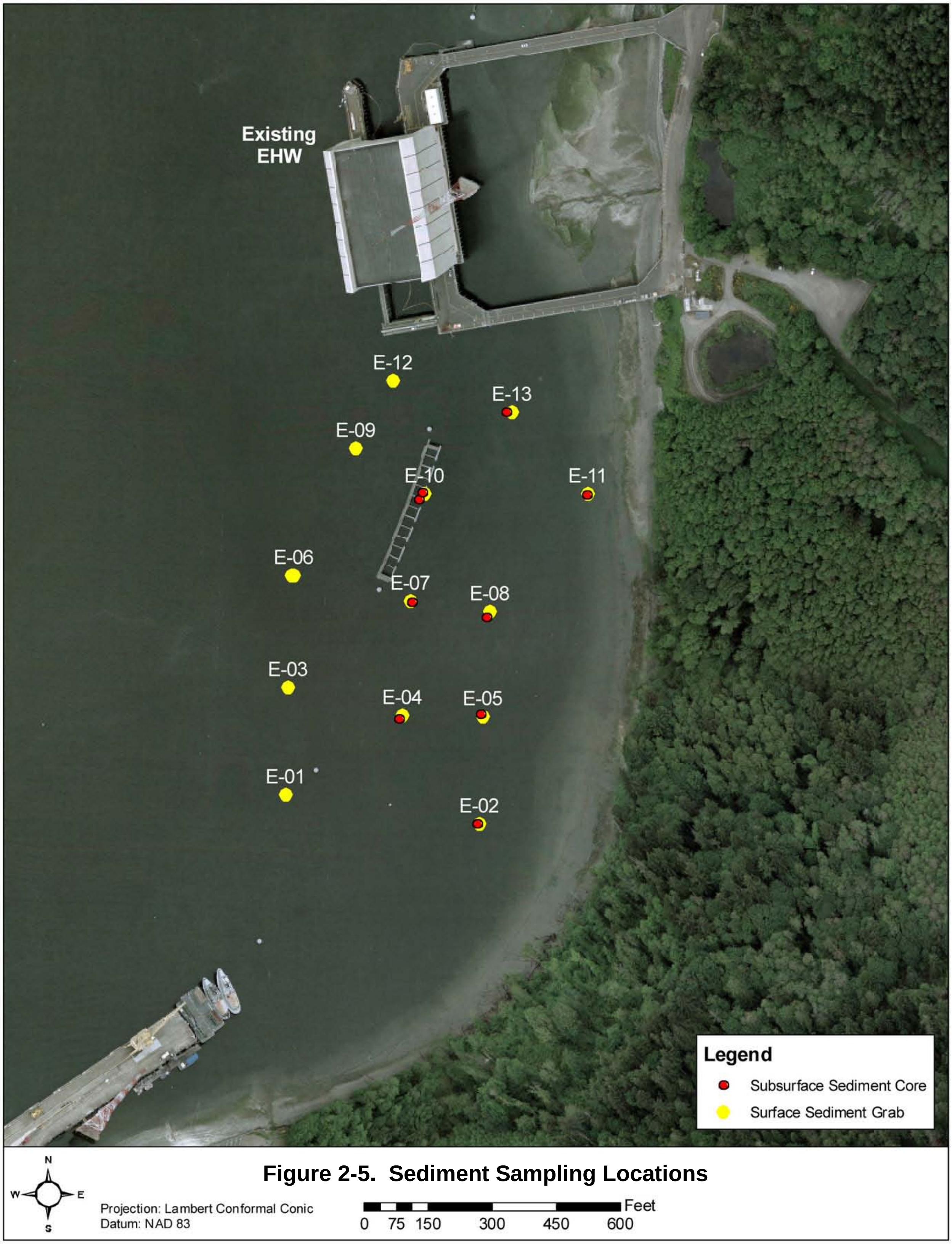


Figure 2-5. Sediment Sampling Locations

2.2.9 Ambient Underwater Soundscape

Underwater ambient noise at the Project Area is widely variable over time due to a number of natural and anthropogenic sources. A number of sources of underwater sound exist near the Project Area. Sources of naturally caused underwater noise include wind, waves, precipitation, and biological sources (such as shrimp, fish, and cetaceans). Noise derived from biological organisms can be absent or dominant over narrow and broad frequency ranges. Precipitation can contribute up to 35 dB to the existing sound level, and increases in wind speed of 5 to 10 knots can cause a 5 dB increase in ambient ocean noise across most frequencies (Urick 1983). The highest noise levels occur in nearshore areas where the sound of surf can increase underwater noise levels by 20 dB or more within 200 yards from the surf zone in the 200 Hz to 2 kHz regime (Wilson et al. 1985). In addition, wakes from boat traffic causes breaking waves in the surf zone.

There is also human-generated noise from ship or boat traffic and other mechanical sources (Urick 1983). Small powerboats generate peak narrow band sound pressure levels of 150 to 165 dB re 1µPa at 3 feet in the 350 to 1,200 Hz region, with mean sound pressure levels of 148 dB re 1µPa at 3 feet (Barlett and Wilson 2002). Fishing vessels can generate peak spectral densities of 140 dB re 1µPa at 3 feet in the 250 to 1,000 Hz regime (Hildebrand 2007). Underwater sound from human activities includes ship traffic noise, use of sonar and echo sounders in commercial fishing to locate fish schools, industrial ship noise, and recreational boat use. Ship and small boat noise comes from propellers and other on-board rotating equipment. Other sources of underwater noise at industrial waterfronts could come from cranes, generators, and other types of mechanized equipment on wharves or the adjacent shoreline.

Near the project site, average broadband ambient sound levels were measured at 114 dB re 1µPa between 100 Hz and 20 kHz (Slater 2009). Peak spectral noise from industrial activity was noted below the 300 Hz frequency, with maximum levels of 110 dB re 1µPa noted in the 125 Hz band. In the 300 Hz to 5 kHz range, average levels ranged between 83 and 99 dB re 1µPa. Wind-driven wave noise dominated the background sound environment at approximately 5 kHz and above, and ambient sound levels flattened above 10 kHz. The primary source of noise was due to industrial activity along the waterfront (such as at EHW-1, Marginal Wharf, and Delta Pier), small boat traffic, and wind-driven wave noise. No substantial precipitation was noted during the study period, although this noise would be undoubtedly present during seasonal periods.

Carlson et al. (2005) measured the underwater baseline noise at Hood Canal Bridge and found that underwater noise levels ranged from 115 to 135 dB re 1µPa. The Washington State Department of Transportation (WSDOT) summarized underwater noise at ferry terminals with no construction activity as ranging from 80 to 90 dB at the Everett Home Port, 145 dB at Mukilteo ferry terminal, and 131 to 136 dB (peak levels) at Friday Harbor (WSDOT 2007), which demonstrates the range over which localized anthropogenic noise can vary by specific locations and time periods. Average underwater broadband noise levels measured at the Project Area, inclusive of existing human activities but in the absence of construction activities, fell within the minimum and maximum range of measurements taken at similar environments within Puget Sound. For the purposes of further noise analyses, the average background underwater noise levels at the Project Area were considered to be 114 decibels (dB) re 1µPa between 100 hertz (Hz) and 20 kilohertz (kHz).

2.3 Dates of Construction

The proposed action will occur during the second year of the two-year construction period that began in August 2011. An incidental harassment IHA was issued for one year (July 16, 2011 through July 15, 2012) and covered activities in the in-water work window between July 16, 2011 and February 15, 2012. This application requests an IHA to cover remaining project work, which will occur in the second year of construction scheduled to begin July 16, 2012. In-water work can be performed between July 16th and February 15th of each year. This in-water timeframe restriction was determined in consultation with NMFS Northwest Region and USWFS under the Endangered Species Act (ESA) to protect fish populations.

2.4 Duration of Activities

No work will begin on the proposed action until all required permits and approvals are in place. The remaining work will occur over a one-year construction window scheduled to begin in July 2012. All in-water construction, including vibratory pile extraction and pneumatic chipping, will be limited to July 16 through February 15, 2013 a potential duration of 215 days.

The contractor estimates that steel pile extraction will occur at an average rate of two piles per day. Steel piles will be extracted using a vibratory hammer, direct pull, or they will be cut at the mud line. Extraction is anticipated to take approximately 30 minutes per pile. Concrete piles will be removed using a pneumatic chipping hammer or other similar concrete demolition tool. It is estimated that concrete pile removal could occur at a rate of five piles per day maximum, but removal will more likely occur at a rate of 3 piles per day. Concrete piles are expected to take a maximum of 2 hours of chipping per pile, or potentially 6 hours per day. Therefore, while 215 days of in-water work time is proposes for vibratory extraction or pneumatic chipping, only a fraction of the total work time per day will actually be spent conducting these activities. An average workday is approximately 8 to 9 hours, depending on the month. While its anticipated that only one hour of vibratory pile extraction will be needed per day for steel piles, or 6 hours of pneumatic chipping will be needed for concrete piles, to account for deviations from the estimated times for pile removal, the Navy modeled the potential impact as if the entire day could be spent conducting vibratory pile removal or pneumatic chipping.

Based on the proposed action, the total duration for vibratory steel pile removal is estimated to be 15 days (29 steel piles at an average of 2 per day). The total time for concrete pile removal using a pneumatic chipping hammer would be 32 days (96 piles at an average of 3 per day).

3 MARINE MAMMAL SPECIES AND NUMBERS

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

Six marine mammal species, three cetaceans and three pinnipeds, have been historically documented in the waters near NBK at Bangor in Hood Canal. These include the transient killer whale, Dall's porpoise, harbor porpoise, Steller sea lion, California sea lion, and the harbor seal. In addition, one humpback whale was recently documented in Hood Canal over a period of several weeks. While the Southern Resident killer whale is resident to the inland waters of Washington State and British Columbia, it has not been observed in the Hood Canal in over 15 years, and therefore was excluded from further analysis. The Steller sea lion and humpback whale are listed under the ESA. The U.S. Eastern stock/Distinct Population Segment (DPS) of Steller sea lion is listed at threatened. The humpback whale is listed as endangered. All marine mammal species are protected under the MMPA. Section 3 summarizes the population status and abundance of these species, while Section 4 contains detailed life history information. Table 3-1 lists the marine mammal species that occur near NBK at Bangor and their estimated densities within the Project Area.

Table 3-1. Marine Mammals Historically Sighted in Hood Canal near NBK at Bangor

Species	Stock(s) Abundance [1]	Season(s) of Occurrence	Relative Occurrence [a]	Density (Individuals/ sq km [b]) Within In-water Work Season [c]
Humpback Whale *Megaptera novaeangliae* CA/OR/WA stock	2,043[3] (CV=0.10)	Year-round in Puget Sound	Extemely rare	0.003
Steller sea lion *Eumetopias jubatus* Eastern U.S. stock/DPS	58,334–72,223 [2]	October – mid-April	Common	0.028
California sea lion *Zalophus californianus* U.S. stock	238,000 [3]	August – early June	Common	0.63
Harbor seal *Phoca vitulina* WA inland waters stock	14,612 [3] (CV=0.15)	Year-round; resident species in Hood Canal	Common	1.3
Killer whale *Orcinus orca* West Coast transient stock	354[2, d]	Year-round	Rarely	0.04
Dall's porpoise *Phocoenoides dalli* CA/OR/WA stock	42,000 [3] (CV=0.33	Year-round	Rarely	0.01
Harbor porpoise *Phocoena phocoena* WA inland waters stock	10,682[3] (CV=0.38)	Year-round	Occasionally present	0.250

Sources: 1. NMFS marine mammal stock assessment reports at: http://www.nmfs.noaa.gov/pr/sars/species.htm; 2. Allen and Angliss 2011; 3. Carretta et al. 2011.

a. Common: Consistently present either year-round (harbor seal) or during non-breeding season (California sea lion and Steller sea lion); occasionally present: Documented at irregular intervals; rarely present: sporadic sightings, not occurring on a yearly basis; extremely rare: generally no sightings over multiple years or decades.

b. See density calculations in Section 6.7.
c. In-water work season is the period from July 16– February 15.
d. Combined catalog counts for West Coast stock.
CA = California; CV = coefficient of variation; OR = Oregon; WA = Washington

The harbor seal is an abundant year-round resident of Hood Canal. The cetacean species (humpback whale, killer whale, Dall's porpoise, and harbor porpoise), although either extremely rare or rarely or occasionally present, may be encountered in any season (Table 3–1). The two sea lion species have seasonal peaks of abundance in Hood Canal. The Steller sea lion use of Hood Canal extends from October to April. The Steller sea lion appears consistently during those times in small numbers (maximum number observed was 6 individuals). California sea lions observed on NBK at Bangor are adult and sub-adult males from the California breeding population that spend the non-breeding season in the Pacific Northwest. The species has been observed at haul-out locations on NBK at Bangor from August to early June.

3.1 ESA-Listed Marine Mammals

3.1.1 Humpback Whale

Species Description

The humpback whale is a large baleen whale with a worldwide distribution in all ocean basins, although it is less common in Arctic waters (Angliss and Outlaw 2005). In the summer, most humpback whales are found in high latitude or highly biologically productive feeding grounds. In the winter, they are congregate in subtropical or tropical waters for mating.

The stock structure of humpback whales is defined based on feeding areas because distinct populations have a high degree of fidelity to specific feeding areas. Carretta et al. (2011) described distinct feeding populations in the eastern Pacific, and the waters off northern Washington may be an area of mixing between the California (CA)/Oregon (OR)/Washington (WA) stock and southern British Columbia/Alaska stock or whales in northern Washington and southern British Columbia may be a distinct feeding population and a separate stock.

Population Abundance

Humpback whales are increasing in abundance in much of their range, including the CA/OR/WA stock (NMFS 2012). Carretta et al. (2011) reported the best estimate for the CA/OR/WA stock is 2,043 (coefficient of variation = 0.10) based on mark-recapture estimated by Calambokidis et al. (2009). However, this estimate excludes some whales in Washington. Population trends from mark-recapture estimates have shown an overall long-term increase of approximately 7.5 percent per year for the California/Oregon Washington stock (Calambokidis 2009).

3.1.2 Steller Sea Lion

Species Description

Steller sea lions are the largest members of the Otariid (eared seal) family. Steller sea lions show marked sexual dimorphism, in which adult males are noticeably larger and have distinct coloration patterns from females. Males average approximately 1,500 pounds and 10 feet in length; females average about 700 pounds and 8 feet in length. Adult females have a tawny to silver-colored pelt. Males are characterized by dark, dense fur around their necks that appears like a mane and light tawny coloring over the rest of their body (NMFS 2008a).

Population Abundance

The eastern DPS of Steller sea lions includes the species distribution east of 144°W longitude (Loughlin 1997), including southeast Alaska, Canada, Washington, Oregon, and California (62 FR 30772). The eastern stock was estimated by NMFS in the *Recovery Plan for the Steller Sea Lion* to number between 45,000 to 51,000 animals (NMFS 2008a). This stock has been increasing approximately 3 percent per year over the entire range since the late 1970s (NMFS 2008a; Pitcher et al. 2007). The most recent population estimate for the Eastern stock ranges from 58,334 to 72,223 (Allen and Angliss 2011).

The Eastern stock is stable or increasing throughout the northern portion of its range (Southeast Alaska and British Columbia) and stable or increasing slowly in the central portion of its range (Oregon through northern California) (Angliss and Outlaw 2008; Olesiuk 2008). Steller sea lion numbers in southern and central California have declined from historic numbers, but they have been relatively stable since 1980. Although the population size has increased overall, the status of this stock relative to its optimum sustainable population is unknown (Angliss and Outlaw 2008).

Steller sea lions occupy major winter haul-out sites on the coast of Vancouver Island in the Strait of Juan de Fuca and the Georgia Basin (Bigg 1985; Olesiuk 2008); the closest breeding rookery to the project area is at Carmanah Point near the western entrance to the Strait of Juan de Fuca. In Washington inland waters, up to 10 animals have been observed at Toliva Shoals in south Puget Sound (Jeffries et al. 2000), and up to six individuals have been observed on NBK at Bangor (Bhuthimethee 2008, personal communication; Navy 2010).

3.2 Non-ESA Listed Marine Mammals

3.2.1 California Sea Lion

Species Description

California sea lions are also members of the Otarrid family. The species *Zalophus californianus* includes three subspecies: *Z. c. wollebaeki* (on the Galapagos Islands), *Z. c. japonicus* (in Japan, but now thought to be extinct), and *Z. c. californianus* (found from southern Mexico to southwestern Canada; referred to here as the California sea lion) (Carretta et al. 2007).

The California sea lion is sexually dimorphic. Males may reach 1,000 pounds and 8 feet in length; females grow to 300 pounds and 6 feet in length. Their color ranges from chocolate brown in males to a lighter, golden brown in females. At around 5 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.

Population Abundance

The U.S. stock of California sea lions may occur in the marine waters nearby NBK at Bangor. The estimated stock is 238,000 and the minimum population size of this stock is 141,842 individuals (Carretta et al. 2007). These numbers are from counts during the 2001 breeding season of animals that were ashore at the four major rookeries in southern California and at haulout sites north to the Oregon/California border. Sea lions that were at-sea or hauled out at other locations were not counted (Carretta et al. 2007). An estimated 3,000 to 5,000 California sea lions migrate to Washington and British Columbia waters during the non-breeding season from September to May (Jeffries et al. 2000). Peak numbers of up to 1,000 sea lions occur in Puget Sound (including Hood Canal) during this period (Jeffries et al. 2000).

3.2.2 Harbor Seal

Species Description

Harbor seals, which are members of the family Phocidae ("true seals"), inhabit coastal and estuarine waters and shoreline areas from Baja California to western Alaska. For management purposes, differences in mean pupping date (i.e., birthing) (Temte 1986), movement patterns (Jeffries 1985; Brown 1988), pollutant loads (Calambokidis et al. 1985) and fishery interactions have led to the recognition of three separate harbor seal stocks along the west coast of the continental U.S. (Boveng 1988). The three distinct stocks are: 1) inland waters of Washington State (including Hood Canal, Puget Sound, and the Strait of Juan de Fuca out to Cape Flattery), 2) outer coast of Oregon and Washington, and 3) California (Carretta et al. 2007). The inland waters of Washington state stock is the only stock that is expected to occur within the Study Area.

The average weight for adult seals is about 180 pounds and males are slightly larger than females. Male harbor seals weight up to 245 lbs and measure approximately 5 feet in length. The basic color of harbor seals' coat is gray and mottled but highly variable, from dark with light color rings or spots to light with dark markings (NMFS 2008c).

Population Abundance

Estimated population numbers for the inland waters of Washington, including the Hood Canal, Puget Sound, and the Strait of Juan de Fuca out to Cape Flattery, are 14,612 (CV = 0.15) individuals (Carretta et al. 2007). Harbor seals are the only species of marine mammals that is consistently abundant and considered resident in the Hood Canal (Jeffries et al. 2003). The population of harbor seals in Hood Canal is a closed population, meaning they do not have much movement outside of Hood Canal (London 2006). The abundance of harbor seals in Hood Canal has stabilized, and the population may have reached its carrying capacity in the mid-1990s with an approximate abundance of 1,000 harbor seals (Jeffries et al. 2003).

3.2.3 Killer Whale

Species Description

Killer whales are members of the Delphinid family and are the most widely distributed cetacean (e.g. whales, dolphins, and porpoises) species in the world. Killer whales have a distinctive color pattern, with black dorsal (top) and white ventral (bottom) portions. They also have a conspicuous white patch above and behind the eye and a highly variable gray or white saddle area behind the dorsal fin. The species shows considerable sexual dimorphism. Adult males develop larger pectoral flippers, dorsal fins, tail flukes, and girths than females. Male adult killer whales can reach up to 32 feet in length and weight nearly 22,000 lbs (10,000 kg); females reach 28 feet in length and weigh up to 16,500 lbs (7,500 kg).

Based on appearance, feeding habits, vocalizations, social structure, and distribution and movement patterns there are three forms or ecotypes of killer whales (Wiles 2004; NMFS 2005). The three distinct ecotypes of killer whales recognized in the North Pacific Ocean are: 1) resident, 2) transient, and 3) offshore. The resident and transient populations have been divided further into different subpopulations based mainly on genetic analyses and distribution; not enough is known about the offshore whales to divide them into subpopulations (Wiles 2004).

Within the transient ecotype, association data (Ford et al. 1994, Ford and Ellis 1999, Matkin et al. 1999), acoustic data (Saulitis 1993, Ford and Ellis 1999) and genetic data (Hoelzel et al. 1998, 2002; Barrett-Lennard 2000) confirms that three communities of transient whales exist and represent three discrete populations: 1) Gulf of Alaska, Aleutian Islands, and Bering Sea transients, 2) AT1 transients, and 3) West Coast transients. Among the genetically distinct assemblages of transient killer whales in the northeastern Pacific, only the West Coast transient stock, which occurs from southern California to southeastern Alaska, may occur in the Project Area.

Population Abundance

The West Coast transient stock includes animals that occur in California, Oregon, Washington, British Columbia, and southeastern Alaska. Analysis of photographic data resulted in the following minimum counts for West Coast transient stock. In British Columbia and southeastern Alaska, 219 transients have been catalogued (Ford and Ellis 1999, Dahlheim et al. 1997). Off the coast of California, 105 transients have been identified (Black et al. 1997), 10 of which match photos of whales in other catalogs and the remaining 95 were linked by association. An additional 14 whales in southeastern Alaska and 16 whales off the coast of California have been provisionally classified as transient by association. Combined, these counts give a minimum number of 354 (219 + 95+10+14+16) individuals belonging to the West Coast transient stock (Allen and Angliss 2011). A recent mark-recapture estimate for the West Coast transient population, excluding whales from California, resulted in an estimate of 243 (95% probability interval = 180-339) in 2006 (DFO 2009). This estimate applies to the population of West Coast transient whales that occur in southeastern Alaska, British Columbia, and northern Washington (Allen and Angliss 2011). However, the number in Washington waters at any one time is probably fewer than 20 individuals (Wiles 2004).

3.2.4 Dall's Porpoise

Species Description

Dall's porpoises are members of the Phocoenid (porpoise) family and are common in the North Pacific Ocean. They can reach a maximum length of just under 8 feet and weight up to 480 lbs. Males are slightly larger and thicker than females, which reach lengths of just under 7 feet long. The body of Dall's porpoises is a very dark gray or black in coloration with variable contrasting white "thoracic" panels and white "frosting" on the dorsal fin and tail that distinguish them from other cetacean species. These markings and colorations vary with geographic region and life stage, with adults having patterns that are more distinct.

The distribution of Dall's porpoise through its range is highly variable between years and appears to be affected by oceanographic conditions (Forney 1997; Forney and Barlow 1998). The stock structure of eastern North Pacific Dall's porpoise is not known. For MMPA stock assessment reports, Dall's porpoises within the Pacific U.S. Exclusive Economic Zone (EEZ), i.e., a distance of 200 nautical miles out from the U.S. Pacific coast, are divided into two discrete, noncontiguous areas: (1) waters off California, Oregon, and Washington; and (2) those in Alaskan waters (Carretta et al. 2008). Individuals from the California/Oregon/Washington stock occur within the project area.

Population Abundance

The NMFS population estimate for the California/Oregon/Washington stock is the geometric mean of estimates from 2005 (Forney 2007) and 2008 (Barlow 2010), or 42,000 (CV=0.33) animals (Carretta et al. 2011). Additional numbers of Dall's porpoise occur in the inland waters of Washington state, but the most recent estimate obtained in 1996 (900 animals; CV=0.40) (Calambokidis et al. 1997) is not included in the overall estimate of abundance for this stock due to the need for more up-to-date information.

3.2.5 Harbor Porpoise

Species Description

Harbor porpoises belong to the Phocoenid (porpoise) family and are found extensively along the Pacific U.S. coast. Harbor porpoises are small with males reaching average lengths of approximately 5 feet; Females are slightly larger with average length of 5.5 feet. The average adult harbor porpoise weights between 135 and 170 lbs. Harbor porpoises have a dark grey coloration on their backs with white bellies and throats. They have a dark grey chin patch and intermediate shades of grey along their sides.

Recent preliminary genetic analyses of samples ranging from Monterey, California to Vancouver Island, British Columbia indicate that there is small-scale subdivision within the U.S./Vancouver Island, British Columbia portion of this range (Chivers et al. 2002). These genetically distinguishable groupings are not geographically distinct by latitude, but results suggest a low mixing rate and limited movement of harbor porpoise along the west coast of North America. Survey data found significant differences in harbor porpoise mean densities between coastal Oregon/Washington waters and inland Washington/British Columbia waters (Calambokidis et al. 1993), although a specific stock boundary line cannot be identified based upon biological or genetic differences. Since harbor porpoise movements and rates of intermixing within the eastern North Pacific are restricted, and there was a significant decline in harbor porpoise sightings within southern Puget Sound from the 1940s until recently (Calambokidis 2010, personal communication), NMFS conservatively recognizes two stocks in Washington waters: the Oregon/Washington Coast stock and the Washington Inland Waters stock (Carretta et al. 2011). Individuals from the Washington Inland Waters stock are expected to occur in the project area.

Harbor porpoise sightings have increased in Puget Sound and northern Hood Canal in recent years and are now considered to occur year-round in these waters (Calambokidis 2010, personal communication). This may represent a return to historical conditions, when harbor porpoises were considered one of the most common cetaceans in Puget Sound (Scheffer and Slipp 1948).

Population Abundance

Aerial surveys of the inland waters of Washington and southern British Columbia were conducted during August of 2002 and 2003 (J. Laake, unpublished data in Carretta et al. 2011). These aerial surveys included the Strait of Juan de Fuca, San Juan Islands, Gulf Islands, and Strait of Georgia, which includes waters inhabited by the Washington Inland Waters stock of harbor porpoise as well as harbor porpoises from British Columbia. An average of the 2002 and

2003 estimates of abundance in U.S. waters resulted in an uncorrected abundance of 3,123 (CV=0.10) harbor porpoises in Washington inland waters (J. Laake, unpublished data in Carretta et al. 2011). When corrected for availability and perception bias, using a correction factor of 3.42 (1/g(0); g(0)=0.292, CV=0.366) (Laake et al. 1997), the estimated abundance for the Washington Inland Waters stock of harbor porpoise is 10,682 (CV=0.38) animals (Carretta et al. 2011).

3.3 Marine Mammal Modeling Parameters

3.3.1 Spatial Distribution and Project-Area Survey Efforts

Density assumes that marine mammals are uniformly distributed within a given area, although this is rarely the case. Marine mammals are usually clumped in areas of greater importance, for example, areas of high prey abundance, safe calving or haul-out, areas with lower predation risk, etc. Available data on marine mammal populations in Hood Canal are sparse, with the exception of surveys of harbor seal haul-outs (Jeffries et al. 2000) and recent surveys on NBK at Bangor (Agness and Tannenbaum 2009; Tannenbaum et al. 2009, 2011; Navy 2010; Navy 2011a, in prep.), some of which covered a very limited area.

Beginning in April 2008, Navy personnel have recorded sightings of marine mammals including California sea lion, Steller sea lion, and harbor seal at known sea lion haul-outs along the Bangor waterfront on NBK, including Delta Pier, Marginal Wharf, Service Pier, K/B Dock, and the nearshore pontoons of the floating security fence. Sightings of marine mammals within the waters adjoining these locations were also recorded. Sightings were attempted during a typical workweek (i.e., Monday through Friday), but inclement weather, holidays, or security constraints often precluded surveys. These sightings took place frequently (average 14 per month) although without a formal protocol. During the surveys, staff visited each of the above-mentioned locations and recorded observations of marine mammals on data collection forms, noting date, time, location, number, and species of marine mammals (by location), and other relevant notes. Surveys were conducted using binoculars and the naked eye from shoreline locations or the piers/wharves themselves. Data were compiled for the period from April 2008 through October 2011 for analysis in this IHA.

Boat-based opportunistic sightings along portions of the Bangor waterfront on NBK during the course of beach seine fish surveys during the spring/summer of 2007 detected two marine mammal species (harbor seal and California sea lion) (Agness and Tannenbaum 2009). In these surveys, seals and sea lions were noted in a field notebook, as well as date, time, location, number of individuals, species, and other relevant notes. Boat-based protocol marine wildlife surveys conducted during July through September 2008 (12 surveys) and November through May 2009/2010 (12 surveys) (Tannenbaum et al. 2009, 2011) detected four marine mammal species (harbor seal, California sea lion, harbor porpoise, and Dall's porpoise). These protocol surveys operated along pre-determined transects parallel to the shoreline from the nearshore out to approximately 1,800 feet from shoreline, at a spacing of 100 yards, and covered the entire Bangor waterfront on NBK (approximately 3.9 sq km) at a speed of 5 knots or less. Two observers recorded sightings of marine mammals both in the water and hauled out, including date, time, species, number of individuals, age (juvenile, adult), behavior (swimming, diving, hauled out, avoidance dive), and haul-out location. Positions of marine mammals were obtained by recording distance and bearing to the animal with a rangefinder and compass, noting the concurrent location of the boat with GPS, and, subsequently, analyzing these data with the coordinate geometry application available in ArcInfo to produce coordinates of the locations of all animals detected.

Recently, as part of a Test Pile Program, marine mammal monitoring was conducted on construction days for mitigation. In addition, on days where no pile driving activities occurred due to construction delays, security restrictions, or other factors, the Navy conducted vessel-based line transect surveys in Hood Canal and Dabob Bay to collect additional density data for species present in Hood Canal. The primary impetus for these surveys was observational data during construction monitoring, which indicated an unexpected abundance of harbor porpoise within Hood Canal. The surveys in Hood Canal, conducted in September and October, detected four marine mammal species (Steller sea lion, harbor seal, California sea lion, and harbor porpoise). The surveys operated along pre-determined transects that followed a double saw-tooth pattern to achieve uniform coverage of the entire Bangor waterfront. The vessel traveled at a speed of approximately 5 knots when transiting along the transect lines. Two observers recorded sightings of marine mammals both in the water and hauled out, including the date, time, species, number of individuals, and behavior (swimming, diving, etc.). Positions of marine mammals were obtained by recording the distance and bearing to the animal(s), noting the concurrent location of the boat with GPS, and subsequently analyzing these data with the coordinate geometry application available in ArcInfo to produce coordinates of the locations of all animals detected. Distance sampling methodologies were used to estimate densities of animals for the data. Due to the recent execution of these surveys, not all data have been processed. Due to the unexpected abundance of harbor porpoises encountered during the Test Pile Program, data for this species were processed first and are available for inclusion in this IHA application. All other species data may be included in subsequent environmental compliance documents once all post processing is complete.

The cetacean species and the harbor seal appear to range throughout Hood Canal; therefore, the analysis in this IHA application assumes that harbor seal, transient killer whale, harbor porpoise, and Dall's porpoise are uniformly distributed in the project area. The remaining species that occur in the project area, Steller sea lion and California sea lion, do not appear to utilize most of Hood Canal. As described in Sections 4.1.1, Steller Sea Lion, and 4.2.1, California Sea Lion, these species appear attracted to the manmade haul-out opportunities along the waterfront on NBK at Bangor and forage in the nearby waters. They have been seen leaving the piers and swimming south of the base towards the large river mouth areas on the west side of Hood Canal. The California sea lion was not reported during aerial surveys of Hood Canal (Jeffries et al. 2000), and the Steller sea lion has only been documented on NBK at Bangor (although NMFS [1997b] stated that the species is present in Hood Canal without providing numbers, locations, or sighting dates). Therefore, it is assumed in this IHA application that sea lion species are either hauled out on NBK at Bangor or are transiting or foraging from this area northward, and density calculations utilize the project impact area defined as the maximum area in which underwater noise disturbance would affect pinnipeds (see Section 6.5, Distance to Sound Thresholds, for discussion of density calculations).

3.3.2 Submergence

Cetaceans spend their entire lives in the water and spend most of their time (>90% for most species) entirely submerged below the surface. When at the surface, cetacean bodies are almost entirely below the water's surface, with only the blowhole exposed to allow breathing. This makes cetaceans difficult to locate visually and exposes them to underwater noise, both natural and anthropogenic, essentially 100% of the time because their ears are nearly always below the water's surface.

Seals and sea lions (pinnipeds) spend significant amounts of time out of the water during breeding, molting, and hauling out periods. Seals and sea lions have been sighted hauling out on structures along the NBK at Bangor waterfront. In the water, pinnipeds spend varying amounts of time underwater. California sea lions are known to rest at the surface in large groups for long amounts of time. When not actively diving, pinnipeds at the surface often orient their bodies vertically in the water column and often hold their heads above the water surface. Consequently, pinnipeds may not be exposed to underwater sounds to the same extent as cetaceans.

For the purpose of assessing impacts from underwater sound at NBK at Bangor, the Navy assumed that that all three cetacean species and two pinniped species that may be found in the vicinity of NBK at Bangor (Steller sea lion, California sea lion, killer whale, Dall's porpoise, and harbor porpoise) spend 100% of the time underwater. This approach could be considered conservative because sea lions spend a portion of their time hauled out and therefore are expected to be exposed to less sound than is estimated by this approach. The harbor seal was the only species for which detailed information regarding the percentage of time spent underwater, in-water but at the surface, and hauled out was available (Jeffries et al. 2003, Huber et al. 2001). The application of these results to exposure calculations for harbor seals in this IHA application is described in detail in Section 6.7.3.

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4 STATUS AND DISTRIBUTION OF MARINE MAMMAL SPECIES OR STOCKS THAT COULD POTENTIALLY BE AFFECTED

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.

There are seven marine mammal species within the marine waters adjacent to NBK at Bangor with confirmed or historic occurrence in the Project Area. Only two of these species, the humpback whale and Steller sea lion, are listed as threatened or endangered under the ESA.

4.1 ESA-Listed Marine Mammals

4.1.1 Humpback Whale (*Megaptera novaeangliae*)

Status and Management

Humpback whales were listed as endangered under the Endangered Species Preservation Act of 1966 (35 FR 1222) due to commercial whaling. This protection was transferred to the ESA in 1973. For the MMPA stock assessment reports, the CA/ OR/WA Stock is defined to include humpback whales that feed off the west coast of the continental U.S. Because the species is listed as endangered under the ESA, the CA/OR/WA stock is automatically listed as "depleted" and "strategic" under the MMPA. The recovery plan for humpback whales was finalized in November 1991 (NMFS 1991).

Critical habitat has not been designated for this species.

Distribution

Humpback whales were one of the most common large cetaceans in the inland waters of Washington in the early 1900s (Scheffer and Slipp 1948). Humpback whale sightings were infrequent in Puget Sound and the Georgia Basin through the late 1990s, and prior to 2003 the presence of only three individual humpback whales was confirmed (Falcone et al. 2005). However, in 2003 and 2004, 13 individuals were sighted in the inland waters of Washington, mainly during the fall (Falcone et al. 2005). Records available for April 2001 to February 2012 include observations in the Strait of Juan de Fuca, the Gulf Islands and the vicinity of Victoria, British Columbia, Admiralty Inlet, the San Juan Islands, Hood Canal, and Puget Sound (Orca Network 2012). For the areas listed above, Orca Network records shows humpback whale presence in one of the areas listed above in all months from May through November in 2009; in all months but January, March, April , May, and August in 2010; and from March through November in 2011.

In Hood Canal, humpback whale sightings occurred several times beginning on January 27, 2012 (Orca Network 2012). Review of the sightings information indicates the sightings are of one individual (Calambokidis pers. comm. 2012). The most recent sighting reported was on February 17, 2012. It is currently unknown if this individual has left Hood Canal. Prior to these sightings, there have been no confirmed reports of humpback whales entering Hood Canal (Calambokidis pers. comm.. 2012). No other reports of humpback whales in the Hood Canal were found in the Orca Network database, the scientific literature, or agency reports. Construction of the Hood Canal Bridge occurred in 1961 and could have contributed to the lack of historical sightings (Calambokidis pers. comm. 2010). Only a few records of humpback whales near Hood Canal (but north of the Hood Canal Bridge) are in the Orca Network database. Two were from the northern tip of Kitsap Penisnsula (Foulwater Bluff/point No Point) and a few others from Port Madison Bay in Puget Sound.

Behavior and Ecology

In the summer, most humpback whales are found in high latitude feeding grounds eating crustaceans, plankton, and small fish. During the summer months they spend the majority of their time building up blubber to live off off in the winter. Humpback whales can consume up to 1,360 kg of food per day (NMFS 2012). In the winter, they congregate in subtropical or tropical waters for mating. The CA/OR/WA stock winters in coastal Central America and Mexico, and the stock migrates to areas ranging from the coast of California to southern British Columbia in summer and fall (NMFS 2012).

Acoustics

Humpback whales, like all baleen whales, are considered low-frequency cetaceans (Southall et al. 2007). Functional hearing for low-frequency cetaceans is estimated to range from 7 Hz to 22 kHz (Southall et al. 2007).

4.1.2 Steller Sea Lion (*Eumetopias jubatus*), Eastern U.S. Stock

Status and Management

The Steller sea lion was originally listed as threatened under the ESA in 1990. In 1997, the NMFS reclassified Steller sea lions as two subpopulations, listing the Western Stock as endangered under the ESA, and maintaining threatened status for the Eastern stock (NMFS 1997). There is a final revised species recovery plan that addresses both stocks (NMFS 2008a).

Critical habitat has been designated for the Steller sea lion (NMFS 1993). Critical habitat includes so-called "aquatic zones" that extend 3,000 feet (1 km) seaward in state and federally managed waters from the baseline or base point of each major rookery in Oregon and California (NMFS 2008a). Three major rookery sites in Oregon (Rogue Reef, Pyramid Rock; and Long Brown Rock and Seal Rock on Orford Reef at Cape Blanco) and three rookery sites in California (Ano Nuevo I; Southeast Farallon I; and Sugarloaf Island and Cape Mendocino) are designated critical habitat (NMFS 1993). There is no designated critical habitat for the species in Washington.

Distribution

Steller sea lions are found along the coasts of Washington, Oregon, and northern California where they occur at breeding rookeries and numerous haulout locations along the coastline (Jeffries et al. 2000; Scordino 2006). From breeding rookeries in northern California (St. George Reef) and southern Oregon (Rogue Reef), male Steller sea lions often disperse widely outside of the breeding season (Scordino 2006). Based on mark recapture sighting studies, males migrate back into these Oregon and California locations from winter-feeding areas in Washington, British Columbia, and Alaska (Scordino 2006).

In Washington, Steller sea lions use haulout sites primarily along the outer coast from the Columbia River to Cape Flattery, as well as along the Vancouver Island side of the Strait of Juan de Fuca (Jeffries et al. 2000). Numbers vary seasonally in Washington with peak numbers present during the fall and winter months (Jeffries et al. 2000). Steller Sea lions are occasionally present in the Puget Sound at the Toliva Shoals haul-out site in south Puget Sound (Jeffries et al. 2000) and a rock 3 miles south of Marrowstone Island (NMFS 2010). At NBK at Bangor, Steller sea lions were observed hauled out on submarines at Delta Pier on several occasions from 2008 through 2011 during fall through spring months October through April) (Bhuthimethee 2008, personal communication; Navy in prep.). Steller sea lions likely occupy habitats in Hood Canal similar to those of the California sea lion and harbor seal, which include marine water habitats for foraging and manmade structures for haul out.

Behavior and Ecology

Steller sea lions are gregarious animals that often travel or haul out in large groups of up to 45 individuals (Keple 2002). At sea, groups usually consist of female and subadult males; adult males are usually solitary while at sea (Loughlin 2002). In the Pacific Northwest, breeding rookeries are located in British Columbia, Oregon, and northern California. Steller sea lions form large rookeries during late spring when adult males arrive and establish territories (Pitcher and Calkins 1981). Large males aggressively defend territories while non-breeding males remain at peripheral sites or haul-outs. Females arrive soon after and give birth. Most births occur from mid-May through mid-July, and breeding takes place shortly thereafter. Most pups are weaned within a year. Non-breeding individuals may not return to rookeries during the breeding season but remain at other coastal haul-outs (Scordino 2006).

Steller sea lions are opportunistic predators, feeding primarily on fish and cephalopods, and their diet varies geographically and seasonally (Bigg 1985; Merrick et al. 1997; Bredesen et al. 2006; Guénette et al. 2006). Foraging habitat is primarily shallow, nearshore and continental shelf waters; freshwater rivers; and deep waters (Reeves et al. 2008; Scordino 2010). Their prey in inland Washington waters is not well documented, but their expected prey, based on studies in British Columbia and Alaska, would include schooling fish such as herring, hake, sand lance, salmon, flounder, rockfish, squid, and octopus (Bigg 1985; Merrick and Loughlin 1997). Foraging habitats in Hood Canal would likely include nearshore and deeper waters.

Acoustics

Like all pinnipeds, the Steller sea lion is amphibious; while all foraging activity takes place in the water, breeding behavior is carried out on land in coastal rookeries (Mulsow and Reichmuth 2008, in prep). On land, territorial male Steller sea lions regularly use loud, relatively low-frequency calls/roars to establish breeding territories (Schusterman et al. 1970; Loughlin et al 1987). The calls of females range from 0.03 to 3 kHz, with peak frequencies from 0.15 to 1 kHz; typical duration is 1.0 to 1.5 sec (Campbell et al. 2002). Mulsow and Reichmuth (2008) measured the unmasked aerial hearing sensitivity of one male Steller sea lion. The range of best hearing sensitivity was between 5 and 14.1 kHz (Mulsow and Reichmuth 2008). Maximum sensitivity was found at 10 kHz, where the subject had a mean threshold of 7 dB re 20 μPa.

Testing of the underwater hearing of two Steller sea lions found the hearing threshold of the male was significantly different from that of the female. The range of best hearing for the male was from 1 to 16 kHz, with maximum sensitivity (77 dB re 1 μPa-m) at 1 kHz. The range of best hearing for the female was from 16 to above 25 kHz, with maximum sensitivity (73 dB re 1 μPa-m) at 25 kHz. However, because of the small number of animals tested, the findings could not be attributed to individual differences in sensitivity or sexual dimorphism (Kastelein et al. 2005).

4.2 Non-ESA Listed Marine Mammals

4.2.1 California Sea Lion (*Zalophus californianus*), U.S. Stock

Distribution

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).

The non-breeding distribution extends from Baja California north to Alaska for males, and encompasses the waters of California and Baja California for females (Reeves et al. 2008; Maniscalco et al. 2004).In the non-breeding season, an estimated 3,000 to 5,000 adult and sub-adult males migrate northward along the coast to central and northern California, Oregon, Washington, and Vancouver Island from September to May (Jeffries et al. 2000) and return south the following spring (Mate 1975; Bonnell et al. 1983). Along their migration, they are occasionally sighted hundreds of miles (kilometers) offshore (Jefferson et al. 1993). Females and juveniles tend to stay closer to the rookeries (Bonnell et al. 1983).

Peak abundance in the Puget Sound is September to May. Although there are no regular California sea lion haulouts within the Hood Canal (Jeffries et al. 2000), they often haul out at several opportune areas. They are known to utilize man-made structures such as piers, jetties, offshore buoys, and oil platforms (Riedman 1990). California sea lions in the Puget Sound haul out on log booms and U.S. Navy submarines, and are often seen rafted off river mouths (Jeffries et al. 2000; DoN 2001). As many as 40 California sea lions have been observed hauled at NBK at Bangor on manmade structures – submarines, the floating security fence, and barges (Agness and Tannenbaum 2009a; Tannenbaum et al 2009a; Walters 2009, personal communication). California sea lions have also been observed swimming in the Hood Canal near the Project Area on several occasions and likely forage in both nearshore marine and inland marine deeper waters (Navy 2001).

Behavior and Ecology

California sea lions are gregarious during the breeding season and social at haul-out sites during other times. They prefer to breed on sandy, remote beaches (Le Boeuf 2002) near productive upwelling zones where prey is easily available to lactating females (Heath 2002). Females give birth in May and June, and mating follows. During the most recent aerial survey population counts for California sea lion within the inland waters of Washington State, no regular haul-outs were documented to exist within the Hood Canal (Jeffries et al. 2000). However, recent anecdotal information, such as observations by Navy personnel at the waterfront on NBK, has documented that they haul out opportunistically at areas within Hood Canal. Within their geographic range, California sea lions have been known to utilize manmade structures such as piers, jetties, offshore buoys, oil platforms, and navigational buoys (Riedman 1990; Jeffries et al. 2000). Dedicated surveys on NBK at Bangor have reported as many as 58 California sea lions hauled out daily from late August through early June on manmade structures (submarines, buoys, pontoons of the floating security fence, and barges) on NBK at Bangor (Agness and Tannenbaum 2009; Tannenbaum et al. 2009; Navy 2010) (see detailed discussion in Section 6.6.2). Most documented haul-outs of California sea lions along NBK at Bangor have been on submarines docked at Delta Pier and on pontoons of the security fence in that vicinity, located approximately one mile south of the EHW-1 project site. California sea lions were also observed swimming in Hood Canal near the EHW-1 project site on several occasions (Tannenbaum et al. 2009; Navy 2010) and likely forage in both nearshore marine and inland marine deeper water habitats in the vicinity.

California sea lions feed on a wide variety of prey, including many species of fish and squid (Everitt et al. 1981; Roffe and Mate 1984; Antonelis et al. 1990; Lowry et al. 1991). In the Puget Sound region, they feed primarily on fish such as hake, walleye pollock, herring, and spiny dogfish (Calambokidis and Baird 1994). In some locations where sea lions and salmon runs exist, California sea lions also feed on returning adult and out-migrating juvenile salmonids (London 2006). Sexual maturity occurs at around four to five years of age for California sea lions (Heath 2002). California sea lions are gregarious during the breeding season and social on land during other times.

<u>*Acoustics*</u>

On land, California sea lions make 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). All underwater sounds have most of their energy below 4 kHz (Schusterman et al. 1967).

The range of maximal hearing sensitivity underwater is between 1 and 28 kHz (Schusterman et al. 1972). Functional underwater high frequency hearing limits are between 35 and 40 kHz, with peak sensitivities from 15 to 30 kHz (Schusterman et al. 1972). The California sea lion shows relatively poor hearing at frequencies below 1 kHz (Kastak and Schusterman 1998). Peak hearing sensitivities in air are shifted to lower frequencies; the effective upper hearing limit is approximately 36 kHz (Schusterman 1974). The best range of sound detection is from 2 to 16 kHz (Schusterman 1974). Kastak and Schusterman (2002) determined that hearing sensitivity generally worsens with depth—hearing thresholds were lower in shallow water, except at the highest frequency tested (35 kHz), where this trend was reversed. Octave band noise levels of 65 to 70 dB above the animal's threshold produced an average TTS of 4.9 dB in the California sea lion (Kastak et al. 1999). Center frequencies were 1,000 hertz (Hz) for corresponding threshold testing at 1000 Hz and 2,000 Hz for threshold testing at 2,000 Hz; the duration of exposure was 20 minutes.

4.2.2 Harbor Seal (*Phoca vitulina*), WA Inland Waters Stock

<u>*Distribution*</u>

The geographic distribution of harbor seals includes the U.S. west coast from Baja California north to British Columbia and coastal Alaska, including southeast Alaska, the Aleutian Islands, the Bering Sea, and the Pribilof Islands (Carretta et al. 2007b). The harbor seal is the only pinniped species that breeds in inland Washington waters, including Hood Canal, and is consistently abundant and widespread (Jeffries et al. 2003). The population of harbor seals in Hood Canal is a closed population, meaning they do not have much movement outside of Hood Canal (London 2006). The abundance of harbor seals in Hood Canal has stabilized, and the population may have reached carrying capacity in the mid-1990s (approximate abundance in Hood Canal is 1,000 harbor seals) (Jeffries et al. 2003). The mean population size in 1999 for harbor seals in all inland waters of Washington was estimated from 9,550 to 14,612 harbor seals (Jeffries et al. 2003). Thus, up to 10 percent of the Puget Sound harbor seal population occurs in Hood Canal. The abundance of harbor seals in Hood Canal may have been influenced by the recent occurrences of transient killer whales in Hood Canal, which feed on harbor seals; however, no change in abundance was detected in subsequent survey efforts (Jeffries et al. 2003; London 2006).

Harbor seals have been observed swimming in the waters along NBK at Bangor in every month of surveys conducted from 2007 to 2010 (Agness and Tannenbaum 2009; Tannenbaum et al. 2009, 2011). Harbor seals use all marine habitats: the intertidal zone and manmade structures are used for haul-out sites, and subtidal nearshore marine, inland marine deeper water habitats, and the lower reaches of rivers are used for foraging (Reeves et al. 2008). Along the Bangor waterfront on NBK, harbor seals have not been observed hauling out in the intertidal zone but have been observed hauled out on manmade structures such as the floating security fences, wave screen at Carderock Pier, buoys, barges, marine vessels, and logs (Agness and Tannenbaum 2009; Tannenbaum et al. 2009, 2011). A few of the documented occurrences of harbor seals opportunistically hauling out along the Bangor waterfront were on pontoons of the security fence close to Delta Pier, which is about one mile south of the EHW-1 project site. The main dedicated haul-out locations for harbor seals in Hood Canal (Figure 4–1) are located on river delta and tidal exposed areas at Quilcene, Dosewallips, Duckabush, Hamma Hamma, and Skokomish River mouths, with the closest haul-out area 10 miles southwest of NBK at Bangor at the Dosewallips River mouth (London 2006).

Behavior and Ecology

Although generally solitary in the water, harbor seals come ashore at communal haul-out sites for resting, thermoregulation, birthing, and nursing pups. Major haul-out sites are relatively consistent from year to year. Haul-out areas can include intertidal and subtidal rock outcrops, mudflats, sandbars, sandy beaches, peat banks in salt marshes, and manmade structures such as log booms, docks, and recreational floats (Wilson 1978; Prescott 1982; Gilbert and Guldager 1998; Jeffries et al. 2000). Harbor seals mate at sea and females in most areas give birth during the spring and summer, although the "pupping season" varies considerably in the Pacific Northwest. The Hood Canal population has the latest pupping season in the region: pupping typically extends from mid-July through December (Ferrero and Fowler 1992). Suckling harbor seal pups spend as much as 40 percent of their time in the water (Bowen et al. 1999). On August 5, 2011, a harbor seal gave birth on the wave screen dock at Carderock Pier, several miles south of the EHW-1 project site. This was the first documented birth at NBK at Bangor. Harbor seal pups were regularly seen near the EHW-1 during the Test Pile Program and during EHW-1 repairs in 2011.

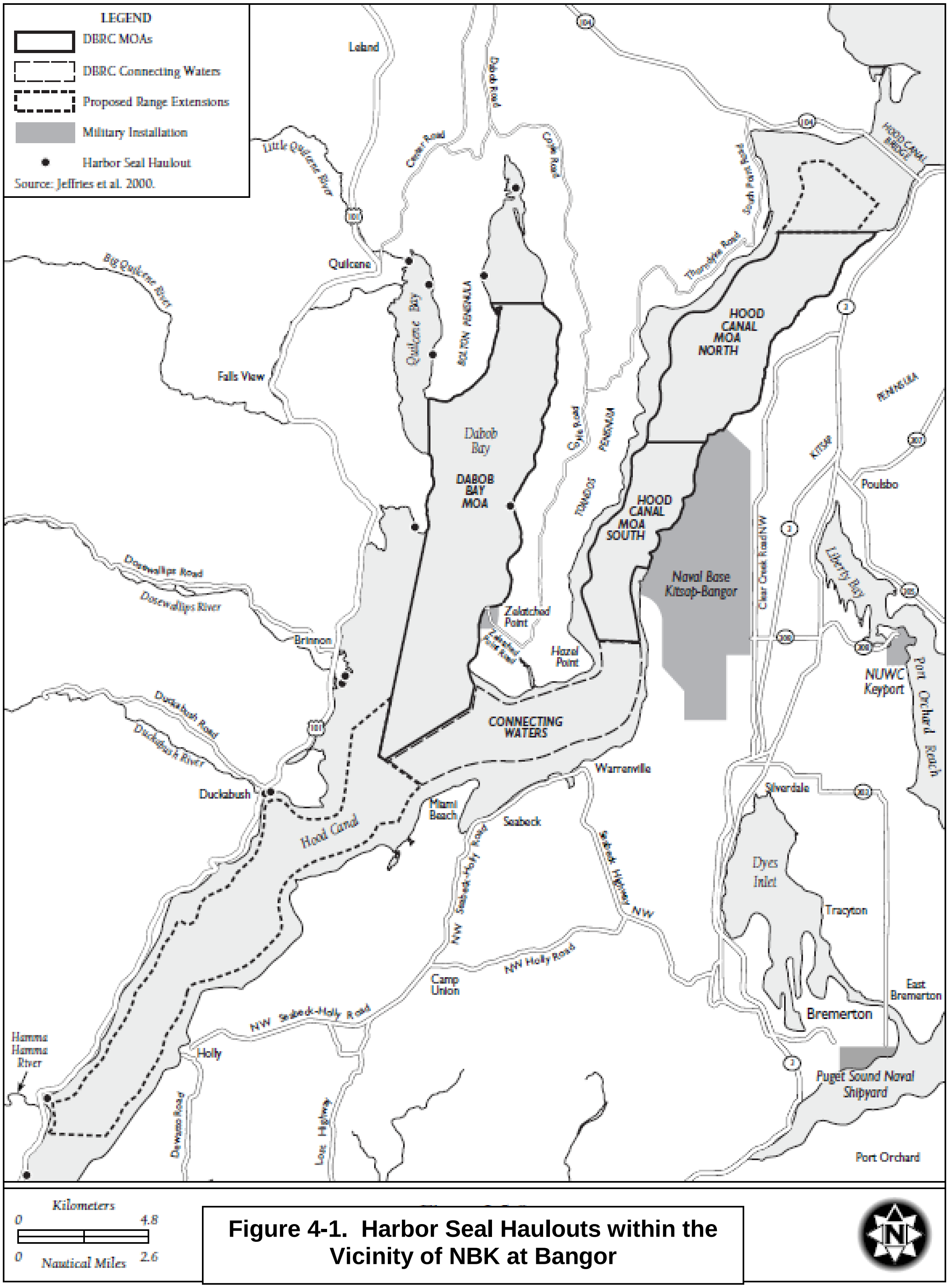

Figure 4-1. Harbor Seal Haulouts within the Vicinity of NBK at Bangor

Harbor seals are opportunistic feeders that adjust their patterns to take advantage of locally and seasonally abundant prey (Payne and Selzer 1989; Baird 2001; Bjørge 2002). Diet consists of fish and invertebrates (Bigg 1981; Roffe and Mate 1984; Orr et al. 2004). In the Puget Sound region, the diet is diverse but primarily consists of Pacific hake, walleye pollock, and Pacific herring (Lance and Jeffries 2006, 2007; London 2006; Luxa 2008). In some locations harbor seals feed on returning adult and out-migrating juvenile salmonids (London et al. 2002; Lance and Jeffries 2006, 2007; London 2006; Scordino 2010). Harbor seals in Hood Canal feed on returning adult salmon, including threatened summer-run chum salmon (London et al. 2002); the other top prey species found in Hood Canal harbor seal scats were Pacific hake and Pacific herring (London 2006). Telemetry studies in the San Juan Islands showed no consistent diurnal or nocturnal pattern for foraging behavior (Suryan and Harvey 1998), and observations in Hood Canal at river mouths indicated that feeding on fish occurred during both day and night, and was most influenced by tidal stage (London 2006).

<u>Acoustics</u>

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 0.35 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 1995, Terhune & 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 s to multiple seconds; Hanggi and Schusterman 1994). Hanggi and Schusteman (1994) found that there is individual variation in the dominant frequency range of sounds 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.

4.2.3 Killer whale (*Orcinus orca*), West Coast Transient Stock

<u>Distribution</u>

The geographical range of transient killer whales includes the northeast Pacific, with preference for coastal waters of southern Alaska and British Columbia (Krahn et al. 2002). Transient killer whales in the eastern North Pacific spend most of their time along the outer coast, but visit Hood Canal and the Puget Sound in search of harbor seals, sea lions, and other prey. Transient occurrence in inland waters appears to peak during August and September (Morton 1990; Baird and Dill 1995, Ford and Ellis 1999) which is the peak time for harbor seal pupping, weaning, and post-weaning (Baird and Dill 1995). In 2003 and 2005, small groups of transient killer whales (11 and 6 individuals, respectively) visited Hood Canal to feed on harbor seals and remained in the area for significant periods of time (59 and 172 days, respectively) between the months of January and July.

Behavior and Ecology

Transient killer whales show great variability in habitat use, with some groups spending most of their time foraging in shallow waters close to shore while others hunt almost entirely in open water (Felleman et al. 1991; Baird and Dill 1995; Matkin and Saulitis 1997). West Coast transient killer whales feed on marine mammals and some seabirds, and do not consume fish (Morton 1990; Baird and Dill 1996; Ford et al. 1998, 2005; Ford and Ellis 1999). While present in Hood Canal in 2003 and 2005, transient killer whales preyed on harbor seals in the subtidal zone of the nearshore marine and inland marine deeper water habitats (London 2006). Other observations of foraging transient killer whales indicate they prefer to forage on pinnipeds in shallow, protected waters (Heimlich-Boran 1988; Saulitis et al. 2000). Transient killer whales travel in small matrilineal groups, but they typically contain 6 or fewer animals and their social organization generally is more fluid than the resident killer whale (Morton 1990; Ford and Ellis 1999). Differences in social organization may be adaptations to differences in feeding specializations (Ford and Ellis 1999; Baird and Whitehead 2000). There is no information on the reproductive behavior of transient killer whales in this area.

Acoustics

Killer whales produce several types of underwater sounds, including: (1) clicks used for echolocation, (2) highly variable whistles produced while whales socialize, and (3) pulsed signals generated at high repetition rates (Ford 1987). Both behavioral and auditory brainstem response measurements indicate killer whales can hear in a frequency range of 1 to 100 kHz and are most sensitive at 20 kHz. This is one of the lowest maximum-sensitivity frequencies known among toothed whales (Szymanski et al. 1999).

Killer whales are "mid-frequency" cetaceans, their echolocation signals use a frequency range somewhat lower than other odontocetes such as Dall's porpoise and harbor porpoise. Source levels of echolocation signals range between 195 and 224 dB re 1μPa-m peak-to-peak, with dominant frequencies ranging from 20 to 60 kHz (Au et al. 2004). Social signals generally use a lower frequency range. Whistles range from 1.5 to 18 kHz (dominant frequency range 6 to 12 kHz) (Richardson et al. 1995). Pulsed sounds have frequencies ranging from 0.5 to 25 kHz (dominant frequency range: 1 to 6 kHz) (Ford 1987; Richardson et al. 1995). Source levels associated with social sounds have been calculated to range between 131 and 168 dB re 1μPa-m and vary with vocalization type (Veirs 2004). The most abundant and characteristic sound type produced by killer whales is pulsed signals, which are highly repetitive and fall into distinctive structural categories (Ford 1987). These are referred to as discrete calls, and one of their potential functions may be to help whales maintain contact while they are out of sight of each other (Ford and Ellis 1999).

The discrete call repertoire of Pacific Northwest transients is smaller than the repertoire of resident whales, with only four to six calls, none of which is used by resident whales. Every transient group shares at least two discrete calls, and most have all calls in common (Ford and Ellis 1999), although some regional differences exist. The lack of a well-developed dialect system in transients (compared to residents) may result from the fluidity of their social structure (Ford and Ellis 1999). Moreover, transients are far quieter than residents when foraging, suggesting that transients must remain relatively silent to avoid alerting their prey because other marine mammals are highly sensitive to sounds in the frequency range of transients' sonar clicks (Barrett-Lennard et al. 1996).

4.2.4 Dall's Porpoise (*Phocoenoides dalli*), CA/OR/WA Stock

Distribution

The Dall's porpoise is found from northern Baja California, Mexico, north to the northern Bering Sea and south to southern Japan (Jefferson et al. 1993). The species is only common between 32°N and 62°N in the eastern North Pacific (Morejohn 1979; Houck and Jefferson 1999). North-south movements in California, Oregon, and Washington have been suggested. Dall's porpoises shift their distribution southward during cooler-water periods (Forney and Barlow 1998). Norris and Prescott (1961) reported finding Dall's porpoise in southern California waters only in the winter, generally when the water temperature was less than 15°C. Seasonal movements have also been noted off Oregon and Washington, where higher densities of Dall's porpoises were sighted offshore in winter and spring and inshore in summer and fall (Green et al. 1992).

In Washington, they are most abundant in offshore waters. They are year-round residents in Washington (Green et al. 1992), but their distribution is highly variable between years likely due to changes in oceanographic conditions (Forney and Barlow 1998). Dall's porpoise are observed throughout the year in the Puget Sound north of Seattle (Osborne et al. 1998) and are seen occasionally in southern Puget Sound. Dall's porpoises may also occasionally occur in Hood Canal (Jeffries 2006, personal communication). Nearshore habitats used by Dall's porpoise could include the marine habitats found in the inland marine waters of the Hood Canal. A Dall's porpoise was observed in the deeper water at NBK at Bangor in summer 2008 (Tannenbaum et al. 2009).

Behavior and Ecology

Groups of Dall's porpoises generally include fewer than 10 individuals and are fluid, probably aggregating for feeding (Jefferson 1990 and 1991, Houck and Jefferson 1999). Dall's porpoises become sexually mature at 3.5 to 8 years of age (Houck and Jefferson 1999) and give birth to a single calf after 10-12 months. Breeding and calving typically occurs in the spring and summer (Angell and Balcomb 1982). In the North Pacific, there is a strong summer calving peak from early June through August (Ferrero and Walker 1999), and a smaller peak in March (Jefferson 1989). Resident Dall's porpoise breed in Puget Sound from August to September.

Dall's porpoises can be opportunistic feeders but primarily consume schooling forage fish. They are known to eat squid, crustaceans, and fishes such as eelpout, herring, Pollock, whiting, and sand lance (Walker et al. 1998).

Acoustics

Like the harbor porpoise, Dall's porpoise is a "high-frequency" cetacean; that is, its auditory range includes very high frequencies (estimated auditory bandwidth for this category is 200 Hz to 180 kHz) (Southall et al. 2007). Only short duration pulsed sounds have been recorded for Dall's porpoise (Houck and Jefferson 1999); this species apparently does not whistle often (Richardson et al. 1995). Dall's porpoises produce short duration (50 to 1,500 μs), high-frequency narrow band clicks, with peak energies that range from 120 to 160 kHz (Jefferson 1988; Hatakeyama and Soeda 1990). There is little published data on the hearing abilities of this species.

4.2.5 Harbor Porpoise (*Phocoena phocoena*), WA Inland Waters Stock

Distribution

Harbor porpoises are generally found in cool temperature to subarctic waters over the continental shelf in both the North Atlantic and North Pacific (Read 1999). This species is seldom found in waters warmer than 17°C (Gaskin et al. 1993) or south of Point Conception (Barlow and Hanan 1995). Harbor porpoises can be found year-round primarily in the shallow coastal waters including harbors, bays, and river mouths (Green et al. 1992). Along the Pacific coast, harbor porpoises occur from Monterey Bay, California, to the Aleutian Islands and west to Japan (Reeves et al. 2008). Harbor porpoises are known to occur in Puget Sound year-round (Osmek et al. 1996, 1998; Carretta et al. 2007b); indeed, harbor porpoise observations in Puget Sound including northern Hood Canal have increased in recent years (Calambokidis 2010, personal communication). A harbor porpoise was seen in deeper water on NBK at Bangor during 2010 field observations (Tannenbaum et al. 2011). Based on observations during line transect surveys conducted to date as part of the Test Pile Program, harbor porpoises have been seen commonly during surveys with the number of individuals sighted in the deeper waters of the Hood Canal ranging from 0 to 11 individuals, with an average of approximately 6 animals sighted per day (Navy, in prep.).

Behavior and Ecology

Harbor porpoises are usually seen in small groups of 2 to 5 animals. Little is known about their social behavior. Studies of harbor porpoises in the Gulf of Maine showed that they mature at an earlier age, reproduce more frequently, and live for shorter periods than other toothed whales (Read and Hohn 1995). Females reach sexual maturity at 3 to 4 years and may give birth every year for several years in a row. Calves are born in late spring (Read 1990; Read and Hohn 1995). Dall's and harbor porpoises appear to hybridize relatively frequently in the Puget Sound area (Willis et al. 2004).

Harbor porpoises can be opportunistic foragers but primarily consume schooling forage fish (Osmek et al. 1996; Bowen and Siniff 1999; Reeves et al. 2008). Along the coast of Washington, harbor porpoises primarily feed on Pacific herring (C*lupea pallasii*), market squid, and smelts (Gearin et al. 1994).

Acoustics

The harbor porpoise, like killer whales and Dall's porpoise, uses high-frequency sounds for echolocation, and lower frequency signals for social interactions (Southall et al. 2007). Harbor porpoise vocalizations include clicks and pulses with peak energy at frequencies from 120 to 140 kHz (Tyack and Clark 2000; Hansen et al. 2008). Electrophysiological tests of the hearing range of harbor porpoises showed that the high frequency range may be as great as 130 kHz (Bibikov 1992). Popov et al. (1986) found evidence for two frequency ranges of best sensitivity: 20 to 30 kHz and 120 to 130 kHz. More recent psycho-acoustic studies found the range of best hearing to be 16 to 140 kHz, with a reduced sensitivity around 64 kHz (Kastelein et al. 2002). Maximum sensitivity occurs between 100 and 140 kHz (Kastelein et al. 2002). Peak echolocation frequencies were in the range of 120 to 130 kHz (Bibikov 1992; Kastelein et al. 2002), which corresponds to their maximum hearing sensitivity range (100 to 140 kHz) (Kastelein et al. 2002).

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5 HARASSMENT AUTHORIZATION REQUESTED

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 small numbers of marine mammals, by Level B behavioral harassment only, incidental to conducting pile removal operations associated with the EHW-1 Pile Replacement Project at NBK at Bangor, Washington. The Navy requests an IHA for incidental take of marine mammals described within this application for one year commencing in July 2012 (or the issuance date, whichever is later). All proposed in-water activities are anticipated to be completed by February 15, 2013 within the timeframe of the requested IHA. 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 C.F.R, Part 216, Subpart A, Section 216.3-Definitions).*

Level A is the more severe form of harassment because it may result in injury, whereas Level B only results in disturbance without the potential for injury (Norberg pers. comm. 2007a).

5.1 Take Authorization Request

Under Section 101 (a)(5)(D) of the MMPA, the Navy requests an IHA from NMFS for: Level B take (behavioral harassment) of small numbers of marine mammals described within this application because of in-water pile removal activities. The Navy requests the IHA to begin coverage on July 16, 2012.

The exposure assessment methodology in this IHA application attempts to quantify potential exposures to marine mammals resulting from pile removal. Section 6 presents a detailed description of the acoustic exposure assessment methodology. Results from this approach overestimate exposures because all animals are assumed to be available to be exposed 100% of the time, and the formulas used to estimate transmission loss used idealized parameters, which are unrealistic in nature. Modeling was conducted for the work window from July 16 through February 15.

The analysis for the Pile Replacement Project predicts 1,341 potential exposures (see Section 6 for estimates of exposures by species from pile removal that could be classified as Level B harassment as defined under MMPA). The Navy's mitigation procedures, presented in Section 11, include monitoring of mitigation zones prior to the initiation of vibratory steel pile extraction or pneumatic chipping of concrete piles, the use of a shutdown zone to prevent injury, and in-situ hydroacoustic recordings of pneumatic chipping. These mitigation measures decrease the likelihood that marine mammals will be exposed to sound pressure levels that would cause Level B harassment, though the amount of that decrease cannot be quantified.

The Navy does not anticipate that 1,341 actual harassment incidents will result from the remaining activities in the Pile Replacement Project. However, to allow for scientific uncertainty regarding the exact mechanisms of the physical and behavioral effects, and as a conservative approach, the Navy is requesting authorization for take (Level B harassment) of 1,341 marine mammals over the course of one year in this IHA application.

5.2 Method of Incidental Taking

Construction activities associated with the Pile Replacement Project as outlined in Sections 1 and 2 have the potential to disturb or displace small numbers of marine mammals. Specifically, only underwater sounds generated from pile removal activities that produce underwater noise above the 120 dB rms threshold level for continuous noise (vibratory pile extraction and pneumatic chipping) may result in "take" in the form of Level B harassment (behavioral disturbance). Level B harassment is not anticipated from airborne sounds generated during pile removal or during other construction activities. Level A harassment is not anticipated to result from any of the construction activities. Specifically, vibratory hammers used for extraction and pneumatic chipping hammers are not expected to cause injury to marine mammals due to the relatively low source levels (<190 dB rms), and both activities will either not start or be halted if marine mammals approach the shutdown zone. No impact pile driving will occur. See Section 11 for more details on mitigation measures.

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

The NMFS application for IHAs requires applicants to determine the number of marine mammals that are expected to be incidentally harassed by an action and the nature of the harassment (Level A or Level B). Section 5 defines MMPA Level A and Level B and Section 6 below presents how these definitions were relied on to develop the quantitative acoustic analysis methodologies used to assess the potential for the proposed action to affect marine mammals.

The project construction and operation as outlined in Sections 1 and 2 have the potential to take marine mammals by harassment only, primarily through noise produced by in-water vibratory pile extraction and pneumatic chipping of concrete piles. Other activities are not expected to result in take as defined under the MMPA.

In-water pile installation/extraction activities would temporarily increase the local underwater and airborne noise environment near the Project Area. Research suggests that increased noise may affect marine mammals in several ways and depends on many factors. This will be discussed in more detail in Section 7. The following text provides a background on underwater sound, description of noise sources in the Project Area, applicable noise criteria, and the basis for the calculation of take by Level B harassment. Level A harassment of cetaceans and pinnipeds for this project is not expected to occur; therefore, Level A harassment is not discussed in this application.

6.2 Fundamentals of Sound

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water. Sound is generally characterized by several factors, including frequency and intensity. Frequency describes the sound's pitch and is measured in hertz (Hz), while intensity describes the sound's loudness. Due to the wide range of pressure and intensity encountered during measurements of sound, a logarithmic scale is used. In acoustics, the word "level" denotes a sound measurement in dBs. A decibel (dB) expresses the logarithmic strength of a signal relative to a reference. Because the decibel is a logarithmic measure, each increase of 20 dB reflects a ten-fold increase in signal amplitude (whether expressed in terms of pressure or particle motion), i.e., 20 dB means ten times the amplitude, 40 dB means one hundred times the amplitude, 60 dB means one thousand times the amplitude, and so on. Because the decibel is a relative measure, any value expressed in decibels is meaningless without an accompanying reference. In describing underwater sound pressure, the reference amplitude is usually 1 microPascal (μPa, or 10^{-6} Pascals), 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 weighting system that reflects that human hearing is less sensitive at low frequencies and extremely high frequencies than at mid-range frequencies. This is called A-weighting, and the decibel level measured is called the A-weighted sound level (dBA). A filtering method that reflects hearing of marine mammals has not yet been developed. Therefore, 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 10 to 10,000 Hz.

Table 6-1 summarizes commonly used terms to describe underwater sounds. Two common descriptors are the peak sound pressure level (SPL) and the root mean square (rms) SPL (dB rms) during the pulse or over a defined averaging period. The peak pressure is the maximum absolute value of the instantaneous pressure observed during each pulse or sound event and is presented in Pascals (Pa) or dB referenced to a pressure of one microPascal (dB re 1 µPa). The rms level is the square root of the energy divided by a defined 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

Term	Definition
Decibel, dB	A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference pressure for 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 (or 20 micro Newtons per square meter), where 1 Pascal is the pressure resulting from a force of 1 Newton exerted over an area of 1 square meter. The sound pressure level is expressed in decibels as 20 times the logarithm to the base 10 of the ratio between the pressures exerted by the sound to a reference sound pressure. Sound pressure level 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. Cycles per second are commonly referred to as hertz (Hz). Typical human hearing ranges from 20 Hz to 20,000 Hz.
Peak Sound Pressure (unweighted), dB re 1 µPa	Peak sound pressure level is based on the largest absolute value of the instantaneous sound pressure over the frequency range from 20 Hz to 20,000 Hz. This pressure is expressed in this application as dB re 1 µPa.
Root-Mean-Square (rms), dB re 1 µPa	The rms level is the square root of the energy divided by a defined 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 percent of the sound energy for one impact pile driving impulse.[2]
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-second 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.
Waveforms, µPa over time	A graphical plot illustrating the time history of positive and negative sound pressure of individual pile strikes shown as a plot of µPa over time (i.e., seconds).
Frequency Spectra, dB over frequency range	A graphical plot illustrating the 6 to 12 Hz band-center frequency sound pressure over a frequency range (e.g., 10 to 5,000 Hz in this application).
A-Weighting Sound Level, dBA	The sound pressure level 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.

[2] Underwater sound measurement results obtained by Illingworth & Rodkin (2001) for the Pile Installation Demonstration Project in San Francisco Bay indicated that most impact pile driving impulses occurred over a 50 to 100 millisecond (ms) period. Most of the energy was contained in the first 30 to 50 ms. Analyses of that underwater acoustic data for various pile strikes at various distances demonstrated that the acoustic signal measured using the standard "impulse exponential time-weighting" on the sound level meter (35-ms rise time) correlated to the rms level measured over the duration of the pulse.

6.3 Description of Noise Sources

Underwater sound levels are comprised of multiple sources, including physical noise, biological noise, and anthropogenic noise. Physical noise includes waves at the surface, earthquakes, ice, and atmospheric noise. Biological noise includes sounds produced by marine mammals, fish, and invertebrates. Anthropogenic noise consists of vessels (small and large), dredging, aircraft over flights, and construction noise. 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. Details of each of the sources are described in the following text.

Table 6-2. Representative Noise Levels of Anthropogenic Sources

Noise Source	Frequency Range (Hz)	Underwater Noise Level (dB re 1 μPa)	Reference
Small vessels	250 – 1,000	151 dB rms at 1 meter (m)	Richardson et al. 1995
Tug docking gravel barge	200 – 1,000	149 dB rms at 100 m	Blackwell and Greene 2002
Vibratory driving of 30-inch Steel Pipe pile	10 – 1,500	~168 dB rms at 10m	WSDOT 2010a, 2010b
Impact driving of 30-inch Steel Pipe pile	10 – 1,500	~193 dB rms at 10m	WSDOT 2005, 2008; Caltrans 2007; Reyff 2005

In-water construction activities associated with the Project would include the use of a vibratory pile driver and a pneumatic chipping hammer. The sounds produced by construction equipment fall into one of two sound types: pulsed and non-pulsed (defined below). Impact pile driving produces pulsed sounds, while vibratory pile driving and pneumatic chippers produce non-pulsed (or continuous) sounds. The distinction between these two general sound types is important because they have differing potential to cause physical effects, particularly with regard to hearing (e.g. Ward 1997 as cited in Southall et al. 2007).

Pulsed sounds (e.g. explosions, gunshots, sonic booms, seismic air gun pulses, and impact pile driving) are brief, broadband, atonal transients (ANSI 1986; Harris 1998) and occur as isolated events or repeated in some succession (Southall et al. 2007). Pulsed sounds are all 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). Pulsed sounds generally have an increased capacity to induce physical injury as compared with sounds that lack these features (Southall et al. 2007).

Non-pulse (intermittent or continuous sounds) can be tonal, broadband, or both (Southall et al. 2007). Some of these non-pulse sounds can be transient signals of short duration but without the essential properties of pulses (e.g. rapid rise time) (Southall et al. 2007). Examples of non-pulse sounds include vessels, aircraft, machinery operations such as drilling or dredging, vibratory pile driving, pneumatic chipping, and active sonar systems (Southall et al. 2007). The duration of such sounds, as received at a distance, can be greatly extended in highly reverberant environments (Southall et al. 2007).

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

Since 1997, NMFS has used generic sound exposure thresholds to determine when an activity in the ocean that produces sound might result in impacts to a marine mammal such that a take by harassment might occur (NMFS 2005b). To date, no studies have been conducted that examine impacts to marine mammal from pile driving sounds from which empirical noise thresholds have been established. Current NMFS practice regarding exposure of marine mammals to sounds is that cetaceans and pinnipeds exposed to impulsive sounds of 180 and 190 dB rms or above, respectively, are considered to have been taken by Level A (i.e., injurious) harassment.

Behavioral harassment (Level B) is considered to have occurred when marine mammals are exposed to sounds at or above 160 dB rms for impulse sounds (e.g., impact pile driving) and 120dB rms for continuous noise (e.g., vibratory pile driving, pneumatic chipping), but below injurious thresholds. The current Level A (injury) and Level B (disturbance) thresholds are provided in Table 6-3.

Table 6-3. Injury and Disturbance Thresholds for Underwater and Airborne Sounds

Marine Mammals	Airborne Marine Construction (re 20 µPa)	Underwater Continuous Sound (Vibratory Pile Extraction/ Chipping Hammer[1]) (re 1 µPa)	
	Disturbance Guideline Threshold (Haulout)[2]	Level A Injury Threshold	Level B Disturbance Threshold
Cetaceans (whales, dolphins, porpoises)	N/A	180 dB rms	120 dB rms
Pinnipeds (seals, sea lions, walrus; except harbor seal)	100 dB rms (unweighted)	190 dB rms	120 dB rms
Harbor seal	90 dB rms (unweighted)	190 dB rms	120 dB rms

[1] Specific criterion for pneumatic chipping hammers does not exist. These tools produce continuous sounds similar to vibratory pile driving and therefore use the same criteria for the analysis of effects.
[2] Sound level at which pinniped haulout disturbance has been documented. Not an official threshold, but used as a guideline.
dB = decibel; N/A = not applicable; rms = root mean square

6.4.1 Limitations of Existing Noise Criteria

The application of the 120 dBrms threshold can sometimes be problematic because this threshold level can be either at or below the ambient noise level of certain locations. As a result, this threshold level is subject to ongoing discussion (74 FR 41684). NMFS is developing new science-based thresholds to improve and replace the current generic exposure level thresholds, but the criteria have not been finalized (Southall et al. 2007). The 120 dB rms threshold level for continuous noise originated from research conducted by Malme et al. (1984, 1988) for California gray whale response to continuous industrial sounds such as drilling operations. The 120 dB *continuous* sound threshold should not be confused with the 120 dB *pulsed* sound criterion established for migrating bowhead whales in the Arctic as a result of research in the Beaufort Sea (Richardson et al. 1995; Miller et al. 1999).

To date, there is no research or data supporting a response by pinnipeds or odontocetes to continuous sounds from vibratory pile driving as low as the 120 dB rms threshold. Southall et al. (2007) reviewed studies conducted to document behavioral responses of harbor seals and northern elephant seals to continuous sounds under various conditions, and concluded that those limited studies suggest that exposures between 90 and 140 dB re 1 μPa rms generally do not appear to induce strong behavioral responses.

6.4.2 Ambient Noise

Ambient noise by definition is background noise and it has not single source or point (Richardson et al. 1995). Ambient noise varies with location, season, time of day, and frequency. Ambient noise is continuous, but with much variability on time scales ranging from less than one second to one year (Richardson et al. 1995). Ambient underwater noise is widely variable over time due to a number of natural and anthropogenic sources. Sources of naturally occurring underwater noise include wind, waves, precipitation, and biological noise (such as shrimp, fish, and cetaceans). There is also human generated noise from ship or boat traffic and other mechanical means (Urick 1983). Other sources of underwater noise at industrial waterfronts could come from cranes, generators, and other types of mechanized equipment on wharves or the adjacent shoreline.

Near the Project Area, the average broadband ambient underwater noise levels were measured at 114 dB re 1µPa between 100 Hz and 20 kHz (Slater 2009). Peak spectral noise from industrial activity was noted below the 300 Hz frequency, with maximum levels of 110 dB re 1µPa noted in the 125 Hz band. In the 300 Hz to 5 kHz range, average levels ranged between 83 and 99 dB re 1µPa. Wind-driven wave noise dominated the background noise environment at approximately 5 kHz and above, and ambient noise levels flattened above 10 kHz.

Airborne noise levels at NBK at Bangor vary based on location but are estimated to average around 65 dBA (A-weighted decibels) in the residential and office park areas, with traffic noise ranging from 60 to 80 dBA during daytime hours (Cavanaugh and Tocci 1998). The highest levels of airborne noise are produced along the waterfront and at the ordnance handling areas where estimated noise levels range from 70 to 90 dBA and may peak at 99 dBA for short durations. These higher noise levels are produced by a combination of sound sources including heavy trucks, forklifts, cranes, marine vessels, mechanized tools and equipment, and other sound-generating industrial/military activities. All references to noise relate to noise in the air as opposed to underwater noise, and noise measurements are not corrected for distance unless specifically indicated.

6.5 Distance to Sound Thresholds

6.5.1 Underwater Sound Propagation Formula

Pile installation/removal activities would generate underwater noise that could potentially result in disturbance to marine mammals swimming by the project area. Transmission loss underwater is the decrease in acoustic intensity as an acoustic pressure wave propagates out from a source. Transmission loss parameters vary with frequency, temperature, sea conditions, current, source and receiver depth, water depth, water chemistry, and bottom composition and topography. A practical sound propagation modeling technique was used to estimate the range from the pile driving activity to various expected sound pressure levels in the water. This model follows a geometric propagation loss based on the distance from the driven pile, resulting in a 4.5 dB reduction in level for each doubling of distance from the source. In this model, the sound pressure level at some distance away from the source (e.g., driven pile) is governed by a measured source level, minus the transmission loss of the energy as it dissipates with distance. The formula for underwater transmission loss is:

$$TL = 15 * \log_{10}(R_1/R_2),$$

Where: TL = Transmission loss
R_1 = the distance of the modeled sound pressure level from the driven pile, and
R_2 = the distance from the driven pile of the initial measurement.

The degree to which underwater noise propagates away from a noise source is dependent on a variety of factors, most notably by the water bathymetry and presence or absence of reflective or absorptive conditions including in-water structures and sediments. In a perfectly unobstructed (free-field) environment not limited by depth or water surface, noise follows the spherical spreading law, resulting in a 6 dB reduction in noise level for each doubling of distance from the source [20*log(range)]. Cylindrical spreading occurs in an environment wherein noise propagation is bounded by the water surface and sea bottom. In this case, a 3 dB reduction in noise level is observed for each doubling of distance from the source [10*log(range)].
The propagation environment along the Bangor waterfront on NBK is neither free-field nor cylindrical; as the receiver moves away from the shoreline, the water increases in depth, resulting in an expected propagation environment that would lie between spherical and cylindrical spreading loss conditions. Since no empirical propagation loss studies had been conducted along the Bangor waterfront on NBK to measure the propagation environment, a practical spreading loss model was adopted to approximate the environment for noise propagation between the cylindrical and spherical methods. The practical spreading loss method uses a 4.5 dB reduction in noise level for each doubling of distance from the source [15*log(range)], and has been accepted by NMFS and U.S. Fish and Wildlife Service (USFWS).

6.5.2 Underwater Noise from Pile Driving

The intensity of pile driving sounds, is greatly influenced by factors such as the type of piles, hammers, and the physical environment in which the activity takes place. In order to determine reasonable sound pressure levels and their associated affects to marine mammals that are likely to result from pile removal at NBK at Bangor, studies with similar properties to the proposed action were evaluated. Sound levels associated with vibratory pile removal are the same as those during vibratory installation (Caltrans 2007) and have been taken into consideration in the modeling analysis. A lack of empirical data exists regarding the acoustic output of chipping hammers. As a result, acoustic information for similar types of concrete breaking instruments, such as jackhammers, concrete saws, etc. was also consulted. Additionally, NMFS' recent opinion in the Port of Anchorage LOA (NMFS 2009, 74 FR 35136) provided guidance with our acoustic assessment. For instance, NMFS noted that "chipping hammers operate at 19 percent of the energy that is required for a vibratory pile driving hammer". Overall, studies which met the following parameters were considered:

1. Pile materials: Installation - steel pipe piles (30" diameter); Removal – steel pipe piles (12 – 24" diameter); Removal – concrete piles (24" diameter)
2. Hammer machinery: Installation (steel)- vibratory and impact hammer, Removal (steel) – vibratory hammer; Removal (concrete)- pneumatic chipping and/or jackhammer
3. Physical environment - shallow depth (<100 feet [30 m]).

The tables below detail representative pile driving sound pressure levels that have been recorded from similar construction activities in recent years. Due to the similarity of these actions and the Navy's proposed action, they represent reasonable sound pressure levels which could be anticipated and these values were used in the acoustic modeling and analysis. Table 6-4 represents SPLs that may be expected during the removal of the 12 to 24-inch steel pipe piles. Table 6-5 represents SPLs that may be expected during the removal of the 24-inch concrete pilings with a pneumatic chipping hammer.

Table 6-4. Underwater Sound Pressure Levels Expected During Steel Pile Removal Based on Similar In-situ Monitored Construction Activities

Project & Location	Pile Size &Type	Installation Method	Water Depth	Measured Sound Pressure Levels
Unknown, CA[1]	24-inch Steel Pipe Pile	Vibratory	~15 m	165 dB re 1 µPa (rms) at 10 m

Sources: [1]Caltrans, 2007;

Table 6-5. Underwater Sound Pressure Levels Expected During Concrete Pile Removal Based on Similar In-situ Monitored Construction Activities

Project & Location	Pile Size &Type	Installation Method	Water Depth	Measured Sound Pressure Levels
United Kingdom[1]	Unknown size[2], Concrete	Jackhammer	?	161 dB re 1 µPa (rms) at 1 m

Sources: [1]Nedwell & Howell, 2004
[2] This is the only underwater reading available for the use of a jackhammer/pneumatic chipping tool. The size of the pile was not recorded. Since these tools operate to chip portions of concrete from the pile, its sound output may not be tied to the size of the pile itself as impact and vibratory pile drivers are. Therefore, this data was found to be representative for this project.

Calculated distances to and the total area encompassed by the marine mammal noise thresholds are provided in Tables 6-6 and 6-7.

Table 6-6. Calculated Distance(s) to and the Area(s) Encompassed by the Underwater Marine Mammal Noise Thresholds During Vibratory Steel Pile Removal

Species	Continuous Noise Threshold	Distance in (m) [1]	Distance in (km)	Area in (km^2)
Pinnipeds	Vibratory Extraction Injury (190 dB rms)	0	0.000	0.000
Cetaceans	Vibratory Extraction Injury (180 dB rms)	1	0.001	0.000003
All Marine Mammals	Vibratory Extraction Disturbance (120 dB rms)	10,000[2]	10.0[2]	314.159[2]

All sound levels expressed in dB re 1 µPa rms.
dB = decibel; rms = root-mean-square; µPa = microPascal
Practical spreading loss (15 log, or 4.5 dB per doubling of distanced) used for calculations.
[1]Sound pressure levels used for calculations were: 165 dB rms re1 µPa @ 10m for vibratory.
[2]Range calculated is greater than what would be realistic. Hood Canal average width at site is 2.4 km, and is fetch limited from N to S at 20.3 km.

Table 6-7. Calculated Distance(s) to and the Area(s) Encompassed by the Underwater Marine Mammal Noise Thresholds During Concrete Pile Removal

Species	Threshold[1]	Distance in (m) [2]	Distance in (km)	Area in (km^2)
Pinnipeds	Chipping Hammer Injury (190 dB rms)	0	0.000	0.000
Cetaceans	Chipping Hammer Injury (180 dB rms)	0	0.000	0.000
All Marine Mammals	Chipping Hammer Disturbance (120 dB rms)	542[3]	0.542[3]	0.929[3]

All sound levels expressed in dB re 1 µPa rms.
dB = decibel; rms = root-mean-square; µPa = microPascal
Practical spreading loss (15 log, or 4.5 dB per doubling of distanced) used for calculations.
[1] Specific criterion for pneumatic chipping hammers does not exist. These tools produce continuous sound similar to vibratory pile driving and therefore use the same criteria for the analysis of effects.
[2] Sound pressure levels used for calculations were: 161 dB re1 µPa @ 1m for jackhammer
[3] Range calculated is greater than what would be realistic. Hood Canal average width at site is 2.4 km, and is fetch limited from N to S at 20.3 km.

The calculated results presented in Tables 6-6 and 6-7 assume a field free of obstruction, which is unrealistic, however, because Hood Canal does not represent open water conditions (free field) and therefore, sounds would attenuate as they encountered land masses or bends in the canal. As a result, some of the distances and areas of impact calculated cannot actually be attained at the project area. The actual distances to the behavioral disturbance thresholds for vibratory pile extraction and pneumatic chipping may be shorter than those calculated due to the irregular contour of the waterfront, the narrowness of the canal, and the maximum fetch (furthest distance sound waves travel without obstruction [i.e. line of site]) at the project area. Tables 6-8 and 6-9 depict the actual areas encompassed by the marine mammal thresholds. Figures 6-1 and 6-2 depict the areas of each underwater sound threshold that are predicted to occur at the project area due to pile removal for marine mammals (cetaceans and pinnipeds) during each stage of the Pile Replacement project.

Table 6-8. Actual Area(s) Encompassed by the Underwater Marine Mammal Noise Thresholds During Steel Pile Removal

Species	Threshold	Distance in (m)	Distance in (km)	Predicted Area in (km^2)	Actual Area in (km^2)
Pinnipeds	Vibratory Driving Injury (190 dB rms)	0	0.000	0.000	0.000
Cetaceans	Vibratory Driving Injury (180 dB rms)	1	0.001	0.000003	0.000
All Marine Mammals	Vibratory Driving Disturbance (120 dB rms)	10,000	10.0	314.159	35.870

Table 6-9. Actual Area(s) Encompassed by the Underwater Marine Mammal Noise Thresholds During Concrete Pile Removal

Species	Threshold	Distance in (m)	Distance in (km)	Predicted Area in (km^2)	Actual Area in (km^2)
Pinnipeds	Chipping Hammer Injury (190 dB rms)	0	0.000	0.000	0.000
Cetaceans	Chipping Hammer Injury (180 dB rms)	0	0.000	0.000	0.000
All Marine Mammals	Chipping Hammer Disturbance (120 dB rms)	542	0.542	0.929	0.608

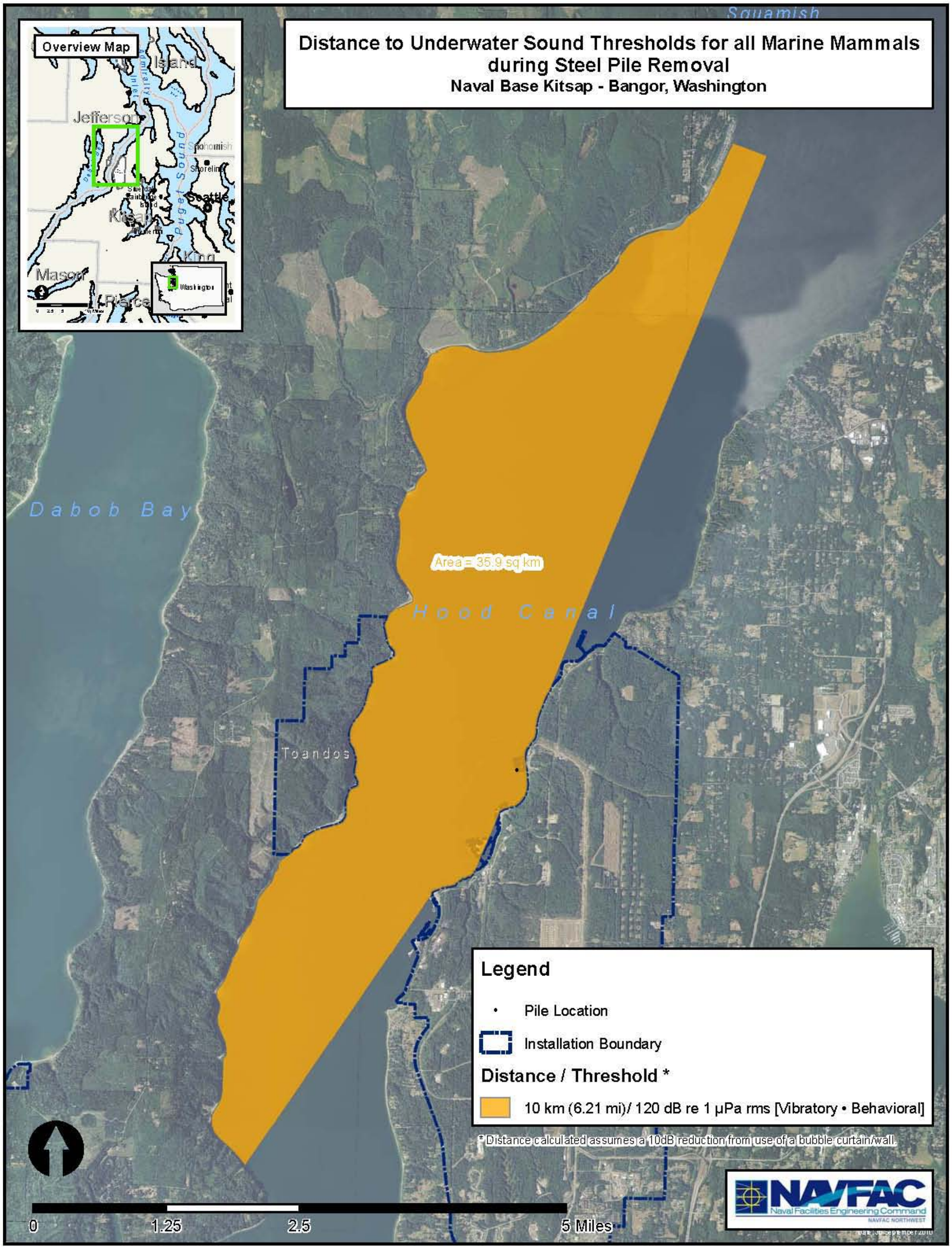

Figure 6-1. Distance(s) (m) to Underwater Sound Thresholds for all Marine Mammals from Vibratory Steel Pile Removal

Figure 6-2. Distance(s) (m) to Underwater Sound Thresholds for all Marine Mammals from a Chipping Hammer During Concrete Pile Removal

6.5.3 Airborne Sound Propagation Formula

Pile driving can generate airborne noise that could potentially result in disturbance to marine mammals (pinnipeds) which are hauled out or at the water's surface. As a result, the Navy analyzed the potential for pinnipeds hauled out or swimming at the surface near the NBK at Bangor to be exposed to airborne sound pressure levels that could result in Level B behavioral harassment. The appropriate airborne noise thresholds for behavioral disturbance for all pinnipeds, except harbor seals is 100 dB re 20 µPa rms (unweighted) and for harbor seals is 90 dB re 20 µPa rms (unweighted) (see Table 6-3). Construction noise behaves as point-source, and thus propagates in a spherical manner, with a 6 dB decrease in sound pressure level over water ("hard-site" condition) per doubling of distance (WSDOT 2010c). A spherical spreading loss model, assuming average atmospheric conditions, was used to estimate the distance to the 100 dB and 90 dBRMS re 20 µPa (unweighted) airborne thresholds. The formula for calculating spherical spreading loss is:

$$TL = 20 * \log_{10}(R1/R2),$$

Where: TL = Transmission loss
R1 = the distance of the modeled sound pressure level from the source, and
R2 = the distance from the source of the initial measurement.

6.5.4 Airborne Sound from Pile Driving

The intensity of pile driving sounds is greatly influenced by factors such as the type of piles, hammers, and the physical environment in which the activity takes place. In order to determine reasonable airborne sound pressure levels and their associated affects on marine mammals that are likely to result from pile driving at NBK at Bangor, studies with similar properties to the proposed action were evaluated. Studies which met the following parameters were considered:

1. Pile materials: Installation - steel pipe piles (24-42" diameter); Removal – steel pipe piles (12 – 30" diameter); Removal – concrete piles (24" diameter)
2. Hammer machinery: Installation (steel)- vibratory and impact hammer, Removal (steel) – vibratory hammer; Removal (concrete)- pneumatic chipping and/or jackhammer
3. Physical environment - shallow depth (<100 feet [30 m]).

The tables below detail representative airborne pile driving sound pressure levels that have been recorded from similar construction activities in recent years. Due to the similarity of these actions and the Navy's proposed action, they represent reasonable sound pressure levels which could be anticipated and these values were used in the acoustic modeling and analysis. Table 6-10 represents SPLs that may be expected during the removal of the 12 to 24-inch steel pipe piles. Table 6-11 represents SPLs that may be expected during the removal of the 24-inch concrete pilings with a pneumatic chipping hammer.

Table 6-10. Airborne Sound Pressure Levels Expected During Steel Pile Removal from Similar In-situ Monitored Construction Activities

Project & Location	Pile Size &Type	Removal Method	Water Depth	Measured Sound Pressure Levels
Wahkiakum Ferry Terminal[1]	18- inch Steel Pipe	Vibratory	~3-4 m (10-12 feet)	87.5 dB re 20 µPa (rms) at 50 feet
Keystone Ferry Terminal, WA[1]	30- inch Steel Pipe	Vibratory	~9 m (30 feet)	98 dB re 20 µPa (rms) at 36 feet
			Average	92 dB re 20 µPa (rms) at 50 feet

Sources**:** [1]WSDOT, 2010d

Table 6-11. Airborne Sound Pressure Levels Expected During Concrete Pile Removal from Similar In-situ Monitored Construction Activities

Project & Location	Pile Size &Type	Removal Method	Water Depth	Measured Sound Pressure Levels
Unknown[1]	Unknown[2], Concrete	Chipping Hammer	?	92 dB re 20 µPa (rms) at 10 m

Sources**:** [1]Cheremisinoff, 1996;
[2] This is the only underwater reading available for the use of a jackhammer/pneumatic chipping tool. The size of the pile was not recorded. Since these tools operate to chip portions of concrete from the pile, its sound output may not be tied to the size of the pile as are impact and vibratory pile drivers. Therefore, this data was considered representative for this project.

The distances to the airborne thresholds were calculated with the airborne transmission loss formula presented in section 6.5.3. All calculated distances to and the total area encompassed by the marine mammal noise thresholds are provided in Tables 6-12 and 6-13. All airborne distances are less than those calculated for underwater sound thresholds. All construction noise associated with the Project would not extend beyond the buffer zone that would be established to protect seals and sea lions. Figures 6-3 through 6-6 depict the actual distances for each airborne pinniped sound threshold that is predicted to occur due to pile removal.

Table 6-12. Calculated Distances (m) to and the Area(s) Encompassed by the Marine Mammal Noise Thresholds In-Air from Vibratory Steel Pile Removal

Species	Threshold	Airborne Behavioral Disturbance		
		Distance (m)	Distance (km)	Area (km^2)
Pinnipeds (except harbor seal)	100 dB rms (vibratory disturbance)	7 m (23 feet)	0.007	0.00015
Harbor seal	90 dB rms (vibratory disturbance)	20 m (66 feet)	0.020	0.00126

All sound pressure levels are reported re 20 µPa rms (unweighted)

Table 6-13. Calculated Distances (m) to and the Area(s) Encompassed by the Marine Mammal Noise Thresholds In-Air from Pneumatic Chipping During Concrete Pile Removal

Species	Threshold	Airborne Behavioral Disturbance		
		Distance (m)	Distance (km)	Area (km^2)
Pinnipeds (except harbor seal)	100 dB rms (vibratory disturbance)	4 m (13 feet)	0.004	0.00005
Harbor seal	90 dB rms (vibratory disturbance)	13 m (43 feet)	0.013	0.0005

All sound pressure levels are reported re 20 µPa rms (unweighted)

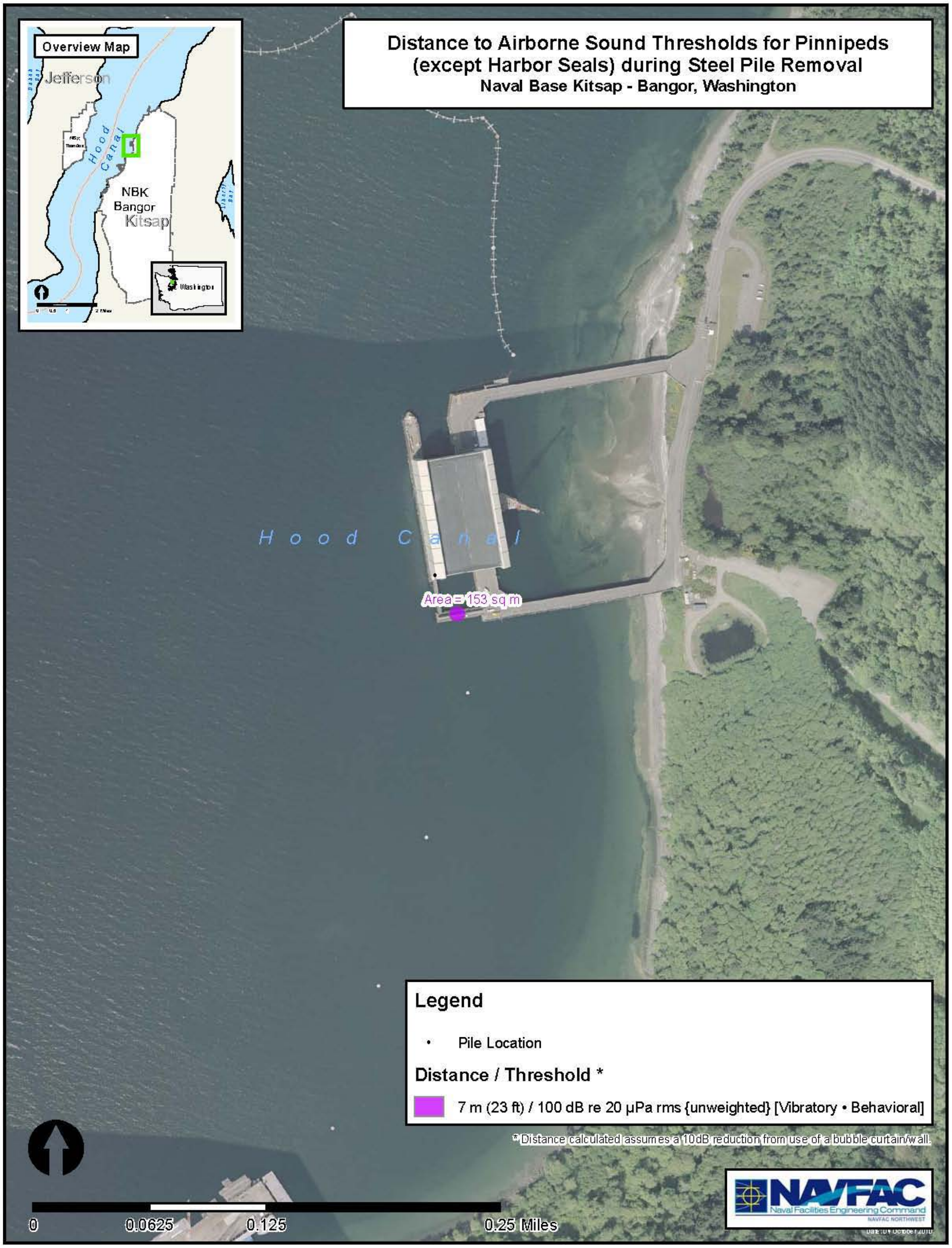

Figure 6-3. Distance(s) (m) to Airborne Sound Thresholds for Pinnipeds (except Harbor Seals) from Vibratory Steel Pile Extraction

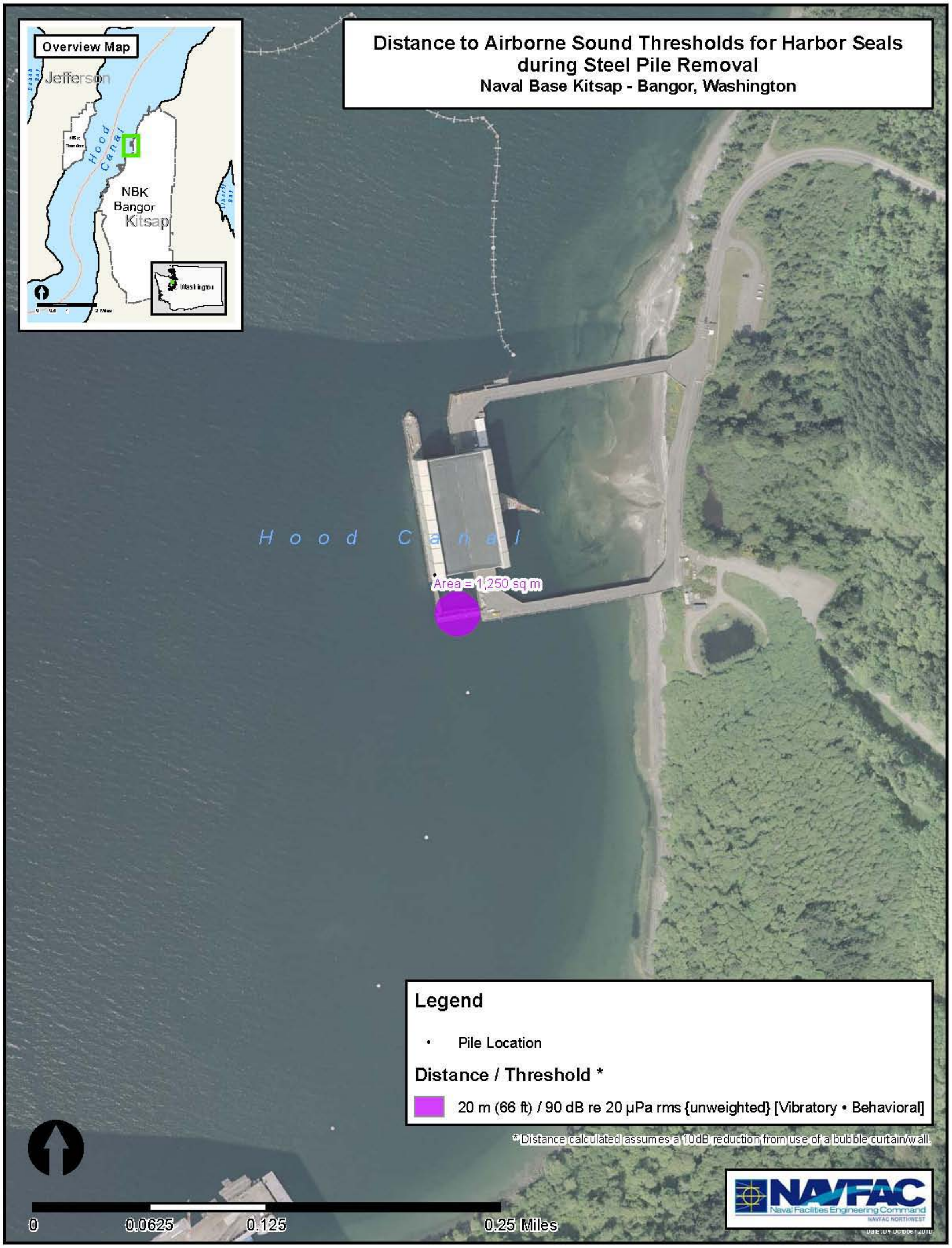

Figure 6-4. Distance(s) (m) to Airborne Sound Thresholds for Harbor Seals from Vibratory Steel Pile Extraction

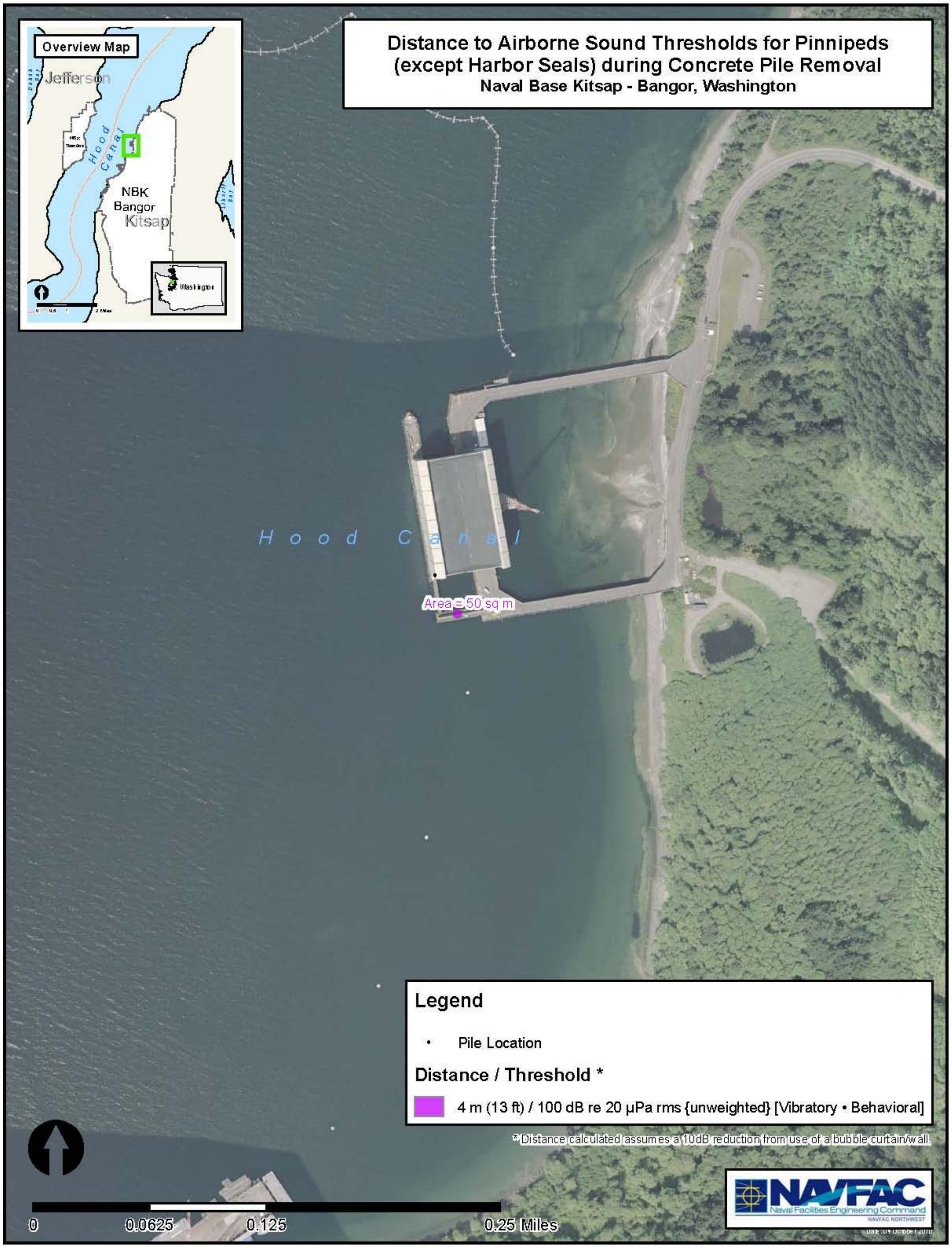

Figure 6-5. Distance(s) (m) to Airborne Sound Thresholds for Pinnipeds (except Harbor Seals) from a Chipping Hammer During Concrete Pile Removal

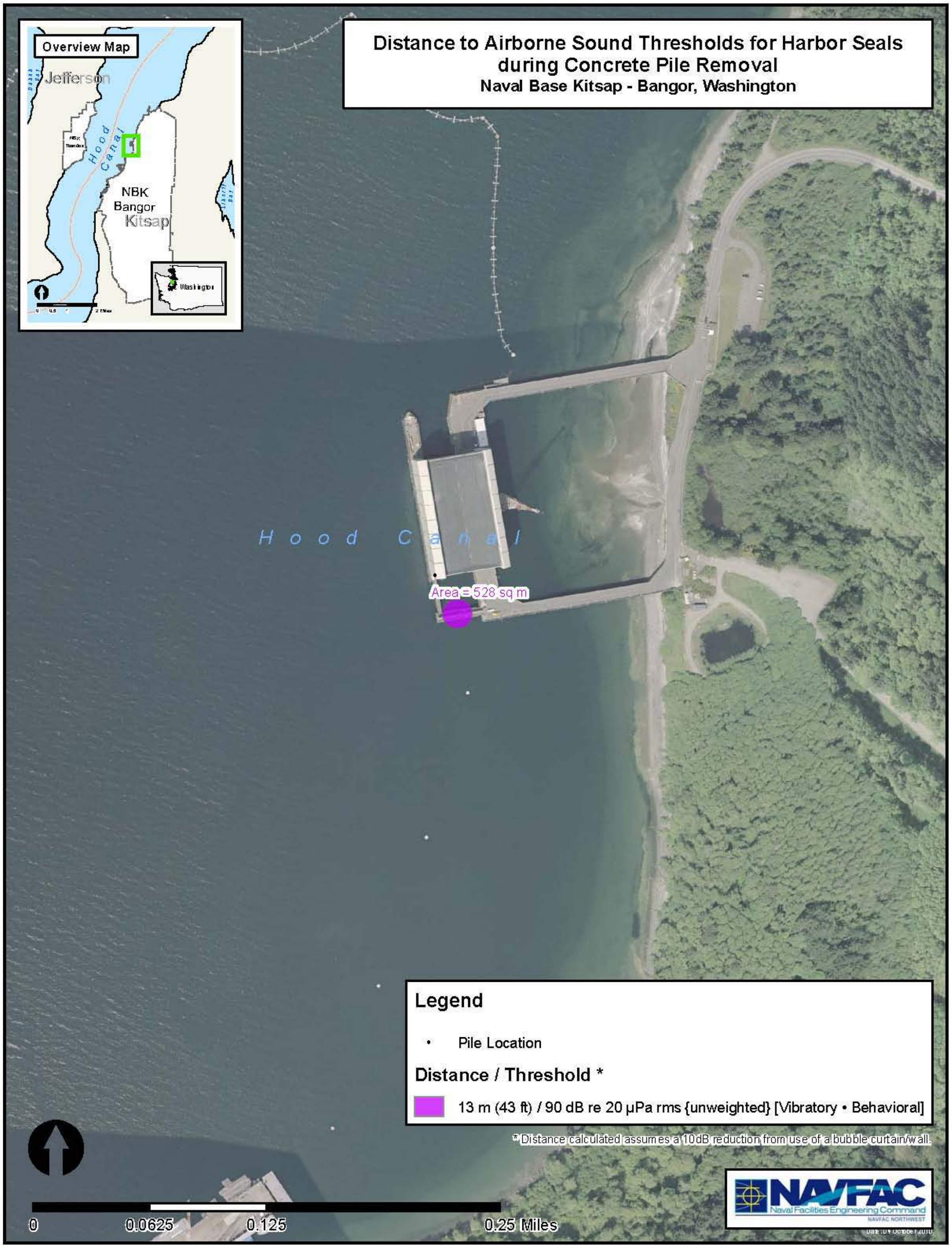

Figure 6-6. Distance(s) (m) to Airborne Sound Thresholds for Harbor Seals from a Chipping Hammer During Concrete Pile Removal

6.5.5 Auditory Masking

Natural and artificial sounds can disrupt behavior by auditory masking or interfering with a marine mammal's ability to hear other relevant sounds such as communication and echolocation signals (Wartzok et al. 2003, 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. Noise can only mask a signal if it is within a certain "critical band" 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. 2003, 2004). In delphinid subjects, for example, relevant signals needed to be 17 to 20 dB louder than masking noise at frequencies below 1 kHz in order to be detected and 40 dB greater at approximately 100 kHz (Richardson et al. 1995).

If the masking sound is manmade, it could be potentially harassing (as defined by the MMPA) if it disrupts hearing-dependent behavior such as communications or echolocation. The most intense underwater sounds in the remainder of the proposed action are those produced by vibratory pile extraction and pneumatic chipping. No impact pile driving is proposed for the remaining project activities proposed to be covered in this IHA application.

Vibratory pile driving produces frequencies from 1.25 to 2 kHz, which would be at the lower range of audible sound for most marine mammals that may occur in the project area. Given the energy level of vibratory pile driving is less than half that of impact pile driving, the potential for masking noise would be limited to a very small radius around the given pile. The likelihood that vibratory pile driving would mask relevant acoustic signals for marine mammals is negligible. Any masking event that could possibly rise to Level B harassment under the MMPA would occur concurrently within the zones of behavioral harassment estimated for vibratory pile extraction and pneumatic chipping (see Section 6.5.2, Underwater Noise from Pile Driving) and which are taken into account in the exposure analysis (see Section 6.7, Description of Exposure Calculation). Therefore, masking effects are not considered as separately contributing to exposure estimates in this IHA application.

6.6 Basis for Estimating Harassment Exposures

The Navy analyzed the potential for taking of small numbers of Steller sea lions, California sea lions, harbor seals, transient killer whales, Dall's porpoises, and harbor porpoises in the Hood Canal as a result of pile removal during construction activities associated with the Pile Replacement Project in the in-water work window from July 16, 2012 through February 15, 2013. The exposures requested are expected to have no more than a minor effect on individual animals and no effect on the populations of these species. Any effects experienced by individual marine mammals are anticipated to be limited to short-term disturbance of normal behavior or temporary displacement of animals near the source of the noise.

6.6.1 Humpback Whale

One humpback whale has been documented in Hood Canal. This individual was originally sighted in January 2012 and is potentially still present at the time of this document submission. Although known to be historically abundant in the inland waters of Washington, no other documentation of humpback whales in Hood Canal is available. Their presence has likely not occurred in several decades.

With the absence of any regular occurrence adjacent to the project site and 15 days estimated for vibratory extraction expected with short durations per day and with the marine mammal monitoring proposed in this application, the likelihood of exposure is discountable.

The extent of noise from pneumatic chipping is not expected to extend beyond the floating security fence. Humpback whales would not be expected within the floating security fence; therefore, no exposures are would be expected due to pneumatic chipping.

6.6.2 Steller Sea Lion

Steller sea lions were first documented in Hood Canal in 2008 while hauled out along the Bangor waterfront on NBK (Bhuthimethee 2008, personal communication; Navy 2010), and they are seasonally present. Beginning in April 2008, Navy personnel have recorded sightings of marine mammals at known haul-outs along the Bangor waterfront on NBK. Steller sea lions have been sighted on the submarines docked at Delta Pier North and Delta Pier South, and on the nearshore pontoons of the floating security fence (Navy 2010). These surveys have taken place frequently (average 14 per month) although without a formal protocol and only include known haul-outs. Steller sea lions were first observed on NBK at Bangor hauled out on a submarine at Delta Pier in November 2008. An independent observation reported four Steller sea lions at the same location on a different day in November 2008 (Bhuthimethee 2008, personal communication). On both occasions California sea lions were also present, allowing the informants to confirm their identifications based on discrepancies in size and other physical characteristics. Boat-based opportunistic sightings along portions of the Bangor waterfront on NBK during the course of fish surveys during spring/summer of 2007 did not detect any Steller sea lions (Figure 7–24 in Agness and Tannenbaum 2009), nor did boat-based protocol marine wildlife surveys conducted during summer/fall 2008 and winter/spring 2009/2010 (Tannenbaum et al. 2009, 2011).

Data provided by Navy personnel since April 2008 have continued to document sightings of Steller sea lions at Delta Pier from November through April (Table 6–14). Steller sea lions have only been observed hauled out on submarines docked at Delta Pier. Delta Pier and other docks on NBK at Bangor are not accessible to pinnipeds, although the smaller California sea lions are able to haul out on pontoons that support the floating security barrier. One to two animals are typically seen hauled out with California sea lions; the maximum Steller sea lion group size seen at any given time was six individuals in November 2009. The time period from November through April coincides with the time when Steller sea lions are frequently observed in Puget Sound. Only adult and sub-adult males are likely to be present in the project area during this time; female Steller sea lions have not been observed in the project area. Since there are no known breeding rookeries near the project site, Steller sea lion pups are not expected to be present. By May, most Steller sea lions have left inland waters and returned to their rookeries to mate. Occasionally, sub-adult individuals (immature or pre-breeding animals) will remain in Puget Sound over the summer. However, on NBK at Bangor, Steller sea lions have only been observed from November through April and not during the summer months. Recent observational data from daily surveys available from the Test Pile Program noted the presence of Steller sea lions along NBK at Bangor in October for the first time. Steller sea lions arrived on October 8th and were seen during surveys every day of the remaining 12 days of the project. Up to four individuals were sighted either hauled out at the submarines docked at Delta Pier or swimming in the waters just adjacent to the base. These sightings were incorporated into the data in Table 6-14 used to estimate the density of Steller sea lions for the month of October.

Table 6-14. Steller Sea Lions (SSL) Observed on NBK at Bangor, April 2008 - October 2011

	Number of Surveys with SSL present	Number of Surveys	Frequency of SSL presence at survey sites[1]	Monthly Average of Maximum Number Observed	Density (animals/sq km)[2]
January	4	25	0.16	1.0	0.024
February	1	28	0.04	0.5	0.012
March	4	28	0.14	1.0	0.024
April	5	38	0.13	1.3	0.031
May	0	44	0.00	0.0	0
June	0	44	0.00	0.0	0
July	0	31	0.00	0.0	0
August	0	29	0.00	0.0	0
September	0	26	0.00	0.0	0
October	12	38	0.32	1.3	0.031
November	3	22	0.14	5.0	0.12
December	5	24	0.21	1.5	0.036
Totals	**31**	**377**	**Average: 0.095**	**Average Within In-Water Work Season: 1.16**	**Within In-Water Work Season: 0.028**

1. Frequency is the number of surveys with Steller sea lions present/number of surveys conducted.
2. For consistency, density estimates were derived from the Explosive Handling Wharf #2 (EHW-2) IHA application. The EHW-2 project is located adjacent to EHW-1. The EHW-2 application was submitted to NMFS December 2011. Density was calculated as the monthly average of the maximum number of individuals present during Navy surveys at known haulouts divided by the area defined by the 120 dB behavioral harassment isopleths for vibratory pile installation (41.4 sq km). The 41.4 sq km area used in the calculation is slightly larger than the 120 dB behavioral harassment isopleths (35.9 sq km) used in this application for vibratory extraction. However, because both projects would occur in the same location within Hood Canal, the Navy believes the densities should be consistent for both projects. Furthermore, differences in the size of the area used in the density calculation were minor (Steller sea lion densities estimated with the 35.9 sq km area are 0.032).

Based on observations in recent years on NBK at Bangor, Steller sea lions may be seasonally present in the project area (October through April) and overlap with the in-water construction period (mid-July through mid-February). Steller sea lions hauled out on submarines at Delta Pier would be beyond the areas encompassed by the airborne noise behavioral harassment threshold (Figure 6–3 and 6-5). They are unlikely to be affected by construction activities except potentially when vibratory pile extraction or pneumatic chipping is under way. Exposure to noise from vibratory extraction or pneumatic chipping would likely involve sea lions that are moving through the area en route to Delta Pier or during the return trip to Puget Sound. Steller sea lions that are exposed to elevated noise levels could exhibit behavioral changes such as increased swimming speed, increased surfacing time, or decreased foraging. Pile removal would occur only during daylight hours, and therefore would not affect nocturnal movements of Steller sea lions in the water. Most likely, Steller sea lions affected by elevated underwater or airborne noise would move away from the sound source and be temporarily displaced from the affected areas. Given the absence of any rookeries, only one haul-out area near the project site (i.e., submarines docked at Delta Pier), and infrequent attendance by a small number of individuals at this site, potential disturbance exposures will have a negligible effect on individual Steller sea lions and would not result in population-level impacts.

6.6.3 California Sea Lion

California sea lions are present in Hood Canal during much of the year with the exception of mid-June and July (Table 6–15). California sea lions occur regularly near the project site from September through mid-June, as determined by Navy waterfront surveys conducted from April 2008 through June 2010 (Navy 2010). A California sea lion was observed arriving on the NBK at Bangor waterfront for the first time in August in 2011 (Navy, in prep.).

Table 6-15. California Sea Lions (CSL) Observed on NBK at Bangor, April 2008 - October 2011

	Number of Surveys with CSL present	Number of Surveys	Frequency of CSL presence at survey sites[1]	Monthly Average of Maximum Number Observed	Density (animals/sq km)[2]
January	15	25	0.60	24.0	0.58
February	24	28	0.86	31.0	0.75
March	26	28	0.93	38.5	0.93
April	27	38	0.71	36.3	0.88
May	32	44	0.73	25.0	0.6
June	7	44	0.16	5.3	0.13
July	0	31	0.00	0.0	0.0
August	1	29	0.03	0.5	0.0
September	9	26	0.35	22.0	0.53
October	22	26	0.85	45.5	1.1
November	22	22	1.00	54.0	1.3
December	14	24	0.58	32.5	0.79
Totals	**199**	**365**	**Average: 0.55**	**Average Within In-Water Work Season: 26.2**	**Within In-Water Work Season: 0.63**

1. Frequency is the number of surveys with California sea lions present/number of surveys conducted.
2. For consistency, density estimates were derived from the EHW-2 IHA application. The EHW-2 project is located adjacent to EHW-1. The EHW-2 application was submitted to NMFS December 2011. Density was calculated as the monthly average of the maximum number of individuals present during Navy surveys at known haulouts divided by the area defined by the 120 dB behavioral harassment isopleths for vibratory pile installation (41.4 sq km). The 41.4 sq km area used in the calculation is slightly larger than the 120 dB behavioral harassment isopleths (35.9 sq km) used in this application for vibratory extraction. However, because both projects would occur in the same location within Hood Canal, the Navy believes the densities should be consistent for both projects. Furthermore, differences in the size of the area used in the density calculation were minor (California sea lion densities estimated with the 35.9 sq km area are 0.73).

The largest number of California sea lions hauled out along the Bangor waterfront on NBK was 58 in a November survey. During the in-water construction period (mid-July to mid-February) the largest daily attendance averaged for each month ranged from 24 individuals to 54 individuals. The likelihood of California sea lions being present on NBK at Bangor is greatest from October through May, when the frequency of attendance in surveys was at least 0.58. Attendance along the Bangor waterfront on NBK in November surveys (2008/2009) was 100 percent. Additionally, five navigational buoys near the entrance to Hood Canal were documented as potential haul-outs, each capable of supporting three adult California sea lions (Jeffries et al. 2000).

Breeding rookeries are in California; therefore, pups are not expected to be present in Hood Canal (NMFS 2008b). Female California sea lions are rarely observed north of the California/ Oregon border; therefore, only adult and sub-adult males are expected to be exposed to project impacts.

California sea lions would typically be present in the project area during a portion (early September through mid-February) of the in-water construction period (mid-July through mid-February). When vibratory pile extraction or pneumatic chipping is under way, exposure to construction activity would likely involve sea lions that are moving through the area en route to a haul-out site at Delta Pier or during the return trip to Puget Sound. 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 affected by elevated underwater or airborne noise would move away from the sound source and be temporarily displaced from the areas of pile extraction or pneumatic chipping. With the absence of any rookeries and only a few isolated haul-out areas near the project site, potential takes by disturbance will have a negligible short-term effect on individual California sea lions and would not result in population-level impacts.

6.6.4 Harbor Seal

Harbor seals are the most abundant marine mammal in Hood Canal, where they can occur anywhere in Hood Canal waters year-round. Jeffries et al. (2003) assessed the harbor seal population in Hood Canal in 1999 and estimated 1,088 harbor seals in 1999 and counted 711 harbor seals hauled out. This abundance was adjusted using a correction factor of 1.53 to account for seals in the water and not counted to provide a population estimate of 1,088 harbor seals in the Hood Canal. The Navy detected harbor seals during marine mammal boat surveys of the waterfront area from July to September 2008 (Tannenbaum et al. 2009) and November to May 2010 (Tannenbaum et al. 2011), as described in Section 3.3.1. Harbor seals were sighted during every survey and were found in all marine habitats including nearshore waters and deeper water, and hauled out on manmade objects such as piers and buoys. From 3 to 5 individuals were detected in most boat surveys, which encompassed the entire Bangor waterfront on NBK out to a distance of at least 1,800 feet from shore. Although there are no known pupping sites near the project site, one pup was observed on a waterfront pier. Therefore, some harbor seal neonates could be expected to be present during pile extraction and pneumatic chipping. Otherwise, during most of the year, all age and sex classes could occur in the project area throughout the period of construction activity.

Potential exposures would likely involve seals that are present in the area on foraging trips when pile extraction or pneumatic chipping would occur. Harbor seals that are taken could exhibit behavioral changes such as 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 removal.

With the absence of any breeding rookeries and only a few small haul-out sites (primarily buoys and pontoons of the floating security barrier) near the project site, and the small number of individuals that frequent the project area, potential disturbance exposures will have a minor short-term effect on individual harbor seals and would not result in population-level impacts.

6.6.5 Transient Killer Whales

Transient killer whales are uncommon visitors to Hood Canal. Transients may be present in the Hood Canal anytime during the year and traverse as far as the project site. Resident killer whales have not been observed in Hood Canal, but transient pods were observed in Hood Canal for lengthy periods of time in 2003 (January-March) and 2005 (February-June), feeding on harbor seals (London 2006).

Potential exposures would likely involve transient killer whales that are moving through the area on foraging trips when pile extraction would occur. Killer whales that are taken could exhibit behavioral changes such as increased swimming speeds, increased surfacing time, or decreased foraging. Most likely, killer whales may move away from the sound source and be temporarily displaced from affected areas. With the absence of any regular occurrence adjacent to the project site and 15 days estimated for vibratory extraction expected with short durations per day, the likelihood of exposure is small and, potential takes by disturbance will have a negligible short-term effect on individual killer whales and would not result in population-level impacts.

The extent of noise from pneumatic chipping is not expected to extend beyond the floating security fence. Transient killer whales would not be expected within the floating security fence; therefore, no exposures are expected due to pneumatic chipping.

6.6.6 Dall's Porpoise

Dall's porpoises may be present anywhere in Hood Canal year-round, although their use of inland Washington waters centers on the Strait of Juan de Fuca. The Navy conducted marine mammal boat surveys of the waterfront area from July to September 2008 (Tannenbaum et al. 2009) and from November to May 2010 (Tannenbaum et al. 2011), as described in Section 3.3.1. During one of these surveys one Dall's porpoise was sighted in August in the deeper waters off Carlson Spit. During line transect surveys conducted in the Hood Canal in September and October 2011, as part of the Test Pile Program, no Dall's porpoises were sighted (Navy, in prep.).

Potential exposures would likely involve Dall's porpoise that are moving through the area on foraging trips when vibratory pile extraction would occur. Dall's porpoise that are taken could exhibit behavioral changes such as increased swimming speeds, increased surfacing time, or decreased foraging. Most likely, Dall's porpoise may move away from the sound source and be temporarily displaced from the areas of pile driving. With the absence of any regular occurrence adjacent to the project site and approximately 15 days of vibratory extraction expected with short durations per day, the likelihood of exposure is small and potential takes by disturbance will have a negligible short-term effect on individual Dall's porpoise and would not result in population-level impacts.

The extent of noise from pneumatic chipping noise is not expected to extend beyond the floating security fence. Dall's porpoises would not be expected within the floating security fence; therefore, no exposures are expected due to pneumatic chipping.

6.6.7 Harbor Porpoise

Harbor porpoises may be present anywhere in Hood Canal year-round. The Navy conducted nearshore marine mammal boat surveys of the Bangor waterfront area from July to September 2008 (Tannenbaum et al. 2009) and from November to May 2010 (Tannenbaum et al. 2011), as described in Section 3.3.1. During one of these surveys a harbor porpoise was sighted in May in the deeper waters within the WRA near the existing EHW. Overall, these nearshore surveys indicated a low occurrence of harbor porpoise within the waters adjacent to the base. However, recent marine mammal surveys conducted during the Test Pile Program indicate that the abundance of harbor porpoises within Hood Canal near NBK at Bangor is much more robust than anticipated from existing surveys and anecdotal evidence. During these surveys, while harbor porpoise presence in the immediate vicinity of the base (i.e., within 1 km) remained low, harbor porpoises were frequently sighted within several kilometers of the base, mostly to the north or south of the project area, but occasionally directly across from the proposed EHW-1 project site on the far side of Toandos Peninsula. Based on observations during track line transect surveys conducted from September through October 2011, harbor porpoises have been seen commonly during surveys with the number of individuals sighted in the deeper water of Hood Canal ranging from 0 to 11 individuals, with an average of approximately 6 animals sighted per day (Navy, in prep.).

Potential exposures could occur if harbor porpoises move through the area on foraging trips when vibratory pile extraction would occur. Harbor porpoises that are taken could exhibit behavioral changes such as increased swimming speeds, increased surfacing time, or decreased foraging. Most likely, harbor porpoises may move away from the sound source and be temporarily displaced from the areas of pile driving. Since their occurrence immediately adjacent to the project site remains low, exposures would likely be at very low sound pressure levels. With approximately 15 days of vibratory extraction expected with short durations per day, the likelihood of exposure is small and, if exposure occurs it would be brief as animals are traversing the area. Therefore, potential takes by disturbance will have a negligible short-term effect on individual harbor porpoises.

Additionally, because of the abundance of these animals in Hood Canal and other inland waters and the proportion of harbor porpoises that may experience effects relative to the entire stock, the proposed action would not result in population-level impacts

The extent of noise from pneumatic chipping noise is not expected to extend beyond the floating security fence. Harbor porpoises would not be expected within the floating security fence; therefore, no takes are expected due to pneumatic chipping.

6.7 Description of Exposure Calculation

Exposure calculations for California sea lions and Steller sea lions in the following sections are based on the Navy's marine mammal survey efforts described in detail in Section 3.3.1. Exposure calculations for the other marine mammals reported in this IHA are based in part on the Navy's boat surveys, described in Section 3.3.1, as well as the literature. A formula was developed for calculating exposures due to impact pile driving and applied to each group-specific noise impact threshold.

The formula is founded on the following assumptions:

- Each species population is at least as large as any previously documented highest population estimate.
- Each species would be present in the project area during construction at the start of each day, based on observed patterns of occurrence in the absence of construction.

- Vibratory pile extraction or pneumatic chipping could potentially occur every day of the in-water work window; however, no more than a few hours of vibratory pile extraction (1 hour) or pneumatic chipping (6 hours) are estimated to occur per day. The total number of days for steel pile vibratory extraction is estimated to be 15 (29 piles at an average of 2 per day). The total number of days utilizing a pneumatic chipping hammer during concrete pile removal is estimated to be 32 days (96 piles at an average of 3 per day).
- An individual can only be taken once per method of removal during a 24 hour period.

The density calculation for marine mammals depends on the known or likely range of the species in Hood Canal, and is discussed in greater detail in the following species-specific sections. For harbor seals and the cetacean species, the range is known or assumed to encompass all of Hood Canal. For California sea lions and Steller sea lions, the range is assumed to encompass a smaller area around the project area (see Section 6.7.1, Steller Sea Lion, and Section 6.7.2, California Sea Lion, for details).

The calculation for marine mammal exposures is estimated by:

Exposure estimate = (n * ZOI) * X days of total activity,

Where:

n = density estimate used for each species/season
X = number of days of pile vibratory extraction or pneumatic chipping, estimated based on the total number of piles and the average number of piles that the contractor can remove per day.
ZOI[3] = noise threshold zone of influence (ZOI) impact area[4]

The ZOI impact area is the estimated range of impact to the noise criteria. The formula for determining the area of a circle (π* *radius*^{2}) was used to calculate the ZOI around each pile, for each threshold. The distances specified in Tables 6–8 and 6–9 were used to calculate the overwater areas that would be encompassed within the threshold distances for injury or disturbance harassment. As described in Section 6.5.2 with regard to the distances, the ZOIs for each threshold are not spherical and would be truncated by land masses, such as points of land along the Bangor shoreline on NBK and the Toandos Peninsula on the opposite shoreline, which would dissipate sound pressure waves (WSDOT 2010c).

The exposure assessment methodology is an estimate of the numbers of individuals exposed to the effects of pile removal activities exceeding NMFS established thresholds. Of significant note in these exposure estimates, additional mitigation methods (i.e. visual monitoring and the use of shutdown zones) were not quantified within the assessment and successful implementation of this mitigation is not reflected in exposure estimates. Results from acoustic impact exposure

3 Zone of Influence (ZOI) is the area encompassed by all locations where the sound pressure levels equal or exceed the threshold being evaluated.

4 The product of N*ZOI was rounded to the nearest whole number before multiplying by the number of pile driving days. If the product of N*ZOI rounds to zero, the number of exposures calculated was zero regardless of the number of pile driving days.

assessments should be regarded as conservative estimates that are strongly influenced by limited marine mammal population data. While the numbers generated from the pile removal exposure calculations provide conservative overestimates of marine mammal exposures, the short duration and limited geographic extent of Pile Replacement Project would further limit actual exposures.

6.7.1 Humpback Whale

Humpback whales are extremely rare in Hood Canal with only one confirmed record. Based on this data, the density for humpback whales in the Hood Canal is 0.003/km^2 (1 individual divided by the area of the Hood Canal [291 km^2]). A seasonal use trend in Hood Canal was not possible to discern from one occurrence. However, humpback whales occur intermittently in all months in other Washington inland waters; therefore, we assumed that humpback whales could occur year-round. Exposures were calculated using the formula presented in Section 6.7. Table 6-16 depicts the number of acoustic harassments and is estimated at zero from vibratory pile extraction and pneumatic chipping . With the absence of any regular occurrence adjacent to the project site and 15 days estimated for vibratory extraction expected with short durations per day and with the marine mammal monitoring proposed in this application, the Navy believes the likelihood of exposure is discountable.

Table 6-16. Number Potential Exposures of Humpback Whales within Various Acoustic Threshold Zones

Season	Density of Humpback Whales [1] (sq km)	Activity	Underwater
			Behavioral Harassment Threshold (120 dB_{RMS})
Mid-July – Mid-February	0.003	Vibratory Steel Pile Extraction	0[2]
		Pneumatic Chipping	0[3]
		Total	0

1. Density was calculated as one (the maximum number of individuals present at a given time) (Calambokidis 2012) divided by the area of Hood Canal.
2. Density (0.003 humpback whales/sq km)*ZOI for behavioral harassment (35.9 sq km) results in a daily abundance of 0 humpback whales in the ZOI. Zero multiplied by 15 potential days of pile extraction equals 0 estimated exposures to behavioral harassment.
3. Density (0.003 humpback whales/sq km)*ZOI for behavioral harassment (0.6 sq km) results in a daily abundance of 0 humpback whales in the ZOI. Zero multiplied by 32 potential days of pneumatic chipping equals 0 estimated exposures to behavioral harassment. In addition, the ZOI for pneumatic chipping occurs within the floating security fence. Cetacean species are not documented or expected to occur within the floating security fence.

6.7.2 Steller Sea Lion

Steller sea lions may be present in Washington inland waters but have only been detected in Hood Canal during the period from October to April, primarily during the course of the Navy's monitoring of California sea lions at haul-out sites along the Bangor waterfront on NBK, as described in detail in Section 3.3.1.

The Navy determined a reasonable area that Steller sea lions could be expected to utilize in the project area while swimming and foraging, based on available literature, in order to calculate in-water density for sound exposure modeling. Foraging trips of satellite-tracked adult western stock Steller sea lions in Alaska averaged 17 ± 5 km during summer, and 133 ± 60 km in winter (Merrick and Loughlin 1997). Eastern stock Steller sea lions were concentrated within 1 to 13 km (mean 7.0 km) of rookeries off the coast of California during summer and were observed 7 to 59 km offshore (mean 28.2 km) in autumn (Bonnell et al. 1983). Foraging ranges of young-of-the-year animals in Alaska averaged 30 km (Merrick and Laughlin 1997). Winter foraging ranges for adult male eastern stock Steller sea lions in Washington inland waters have not been reported, but can reasonably be expected to be as great as distances reported for females and immatures. Given these distances, the Navy concluded that it was reasonable to expect that Steller sea lions could travel 30 to 130 km when foraging in inland waters. Because this project will co-occur with the Explosive Handling Wharf #2 (EHW-2) project, for purposes of the analysis, we assumed the largest project action area as defined by both projects. The largest area is the calculated distance from EHW-2 pile installation locations to the behavioral harassment threshold (120 dB sound pressure level) or the greatest line-of-sight distance (13.8 km) that underwater sound waves could travel from pile driving locations unimpeded by land masses. The affected area was determined to be 41.4 sq km. This area is slightly larger than the 35.9 sq km area calculated for EHW-1 pile removal activities (35.9 sq km, see Table 6–8). However, this area will be encompassed in the larger area used in the analysis. The Navy believes that it is reasonable to expect that Steller sea lions would forage within this area, given their reported foraging distances. Moreover, it is assumed that any sea lions swimming within this area would be potentially subject to exposure to elevated pile extraction noise from the EHW-1 construction site. Because they are seasonally present in the project area, the density calculation for Steller sea lions uses the average of the monthly maximum number of individuals present during surveys rather than the maximum number (6) ever observed (Navy 2010) (Table 6–14). The average of the monthly maximum number present during the in-water work window is 1.16 animal (Table 6–14). The calculated density of Steller sea lions is 0.028 animal per sq km (see Section 6.6.1). Exposures were calculated using this density in the formula described in Section 6.7.

With regard to the range of this species in Hood Canal and the project area, it is assumed that the opportunity to haul out on submarines docked at Delta Pier is a primary attractant for Steller sea lions in Hood Canal. Their haul-out site, submarines docked at Delta Pier (approximately 1 km from the EHW-1), is within the underwater distance threshold for behavioral harassment due to vibratory pile extraction (10 km), but not within the underwater disturbance threshold for pneumatic chipping (0.54 km) or airborne disturbance thresholds for either activity (7 meters and 4 meters, respectively, for sea lions). It is assumed that animals swimming to and from the submarines may be exposed to disturbing noise levels primarily resulting from vibratory pile extraction because the submarines are within the zone above the 120 dB threshold.

Exposures to underwater and airborne pile driving noise were calculated using the formula in Section 6.7. Based on the exposure calculation, an average of 1 individual Steller sea lion per day may experience elevated noise levels that would qualify as harassment while present during the in-water work period for steel vibratory pile extraction and none are expected to experience elevated noise levels that would qualify as harassment while present during pneumatic chipping during concrete pile removal. The density analysis assumes an even distribution of animals. However, in reality Steller sea lion distribution within the project area is patchy with their occurrence concentrated near Delta Pier in groups of 1-4 individuals. As a result, it is more likely that more than one exposure would occur in a day. To ensure the Navy has adequate coverage, the Navy increased the number of takes requested to 2 exposures per day of pile extraction and 1 exposure per day of pneumatic chipping, for a total of 62 exposures. Therefore, the total number of Steller sea lion exposures is estimated to be 62 due to behavioral harassment. Table 6–17 depicts the number of acoustic harassments that are estimated from pile extraction both underwater and in-air.

Table 6-17. Number of Potential Exposures of Steller Sea Lions within Various Acoustic Threshold Zones

Season	Density of Steller Sea Lions (sq km)	Activity	Underwater	Airborne
			Behavioral Harassment Threshold (120 dBRMS)	Behavioral Harassment Threshold (100 dBRMS)
Mid-July – Mid-February	0.028	Vibratory Steel Pile Extraction	30[1]	0
		Pneumatic Chipping	32[2]	0
		Total	62	0

1. Density (0.028 sea lion/sq km)*ZOI for behavioral harassment (35.9 sq km) results in a daily abundance of 1 Steller sea lion in the ZOI. One multiplied by 15 potential days of pile extraction equals 15 estimated exposures to behavioral harassment. The density calculation assumes an even distribution of Steller sea lions. However, in reality their distribution is patchy with their occurrence concentrated near Delta Pier in groups of 1-4 individuals. As a result, it is more likely that more than one exposure would occur in a day. To ensure the Navy has adequate coverage, the Navy increased the number of takes requested to 2 exposures per day for pile extraction, for a total of 30 exposures.
2. Density (0.028 sea lion/sq km)*ZOI for behavioral harassment (0.6 sq km) results in a daily abundance of 0 Steller sea lion in the ZOI. Zero multiplied by 32 potential days of pneumatic chipping equals 0 estimated exposures to behavioral harassment. The density calculation assumes an even distribution of Steller sea lions. However, in reality their distribution is patchy with their occurrence concentrated near Delta Pier in groups of 1-4 individuals. As a result, it is more likely that more than zero exposures would occur in a day. To ensure the Navy has adequate coverage, the Navy increased the number of takes requested to 1 exposure per day for pneumatic chipping, for a total of 32 exposures.

Steller sea lions that are exposed to acoustic harassment could exhibit behavioral reactions. Disturbance from underwater noise impacts is not expected to be significant at the population level because it is estimated that only a small number of Steller sea lions may be affected by acoustic harassment.

6.7.3 California Sea Lion

No regular haul-outs were documented during aerial survey population counts of California sea lions within Hood Canal (Jeffries et al. 2000). However, the Navy's observations of animals hauled out on vessels and manmade structures on NBK at Bangor indicate that California sea lions are present in Hood Canal during much of the year with the exception of mid-June through (Table 6–15). The Navy has conducted waterfront surveys beginning in April 2008, and results were compiled through June 2010 for the analysis in this IHA (Navy 2010), as described in Section 3.3.1. These surveys, which are summarized in Table 6–15, represent the best available data for California sea lion abundance within Hood Canal.

Table 6–15 reports the frequency of California sea lion presence at survey sites and the monthly average of the maximum number of California sea lions observed during the Navy's surveys. During the in-water construction period (mid-July to mid-February), the largest daily attendance averaged for each month ranged from 24 individuals to 54 individuals. The largest monthly average (54 animals) was recorded in November, as was the largest daily count (58). The likelihood of California sea lions being present on NBK at Bangor was greatest from October through May, when the frequency of attendance in surveys was at least 0.58. Attendance along the Bangor waterfront on NBK in November surveys (2008 and 2009) was 100 percent.

The Navy determined a reasonable area that this population could be expected to utilize while swimming and foraging, based on available literature on California sea lions, in order to calculate in-water density for sound exposure modeling. Costa et al. (2007) found that foraging adult females (n = 32) in California traveled an average of 66.3 + 11 km from their rookery. Wintering males from the Columbia River (n = 14) traveled a maximum of 70 km from shore (Wright et al. 2010). Additional data from 12 adult males from mixed stocks in Washington had a maximum travel speed of 99 km (62 miles) per day (Wright et al. 2010). Given these distances, the Navy concluded that it was reasonable to expect that California sea lions could travel between 55 and 100 km when foraging. Since these were straight-line distances, the area encompassed would be smaller. Because this project will co-occur with the EHW-2 project, for purposes of the analysis, we assumed the largest project action area as defined by both projects. The largest area was defined as the calculated distance from EHW-2 pile installation locations to the behavioral harassment threshold (120 dB sound pressure level) or the greatest line-of-sight distance (13.8 km) that underwater sound waves could travel from pile driving locations unimpeded by land masses. The affected area was determined to be 41.4 sq km. This area is slightly larger than the 35.9 sq km area calculated for EHW-1 pile removal activities (35.9 sq km, see Table 6–8). The Navy believes that it is reasonable to expect that California sea lions would forage within this area, given their reported foraging distances. Moreover, it is assumed that any sea lions swimming within this area would be potentially subject to exposure to elevated vibratory pile extraction noise from the EHW-1 construction site. The density used in the sound exposure analysis was calculated using the monthly average of the maximum number of California sea lions on NBK at Bangor (26.2 individuals) (Table 6–15). The calculated density of California sea lions is 0.63 animal per sq km (see Section 6.6.2). Exposures were calculated using this density in the formula described in Section 6.7.

With regard to the range of this species in Hood Canal and the project area, it is assumed that the opportunity to haul out on submarines docked at Delta Pier is a primary attractant for California sea lions in Hood Canal. Their haul-out sites, submarines docked at Delta Pier and nearby pontoons of the security fence in this area (approximately 1 mile from the proposed EHW-1 location), are within the underwater distance threshold for behavioral harassment due to vibratory pile extraction (10 km), but not within the underwater disturbance threshold for pneumatic chipping (0.54 km) or airborne disturbance thresholds for either activity (7 meters and 4 meters, respectively, for sea lions). It is assumed that animals swimming to and from the submarines may be exposed to disturbing noise levels primarily resulting from vibratory pile extraction (approximately 35.9 sq km).

Exposures to underwater and airborne pile driving noise were calculated using the formula in Section 6.7. Based on the density analysis (Section 6.6.2), an average of 23 individual California sea lions may experience sound pressure levels from pile extraction and none are expected to experience elevated noise levels that would qualify as harassment while present during pneumatic chipping during concrete pile removal. The density analysis assumes an even distribution of animals. However, in reality California sea lion distribution within the project area is patchy with their occurrence concentrated near Delta Pier in groups of several too many individuals. As a result, it is more likely that some exposure would occur in a day. To ensure the Navy has adequate coverage, the Navy increased the number of takes requested to 1 exposure per day for pneumatic chipping, for a total of 32 exposures. The total number of exposures to be covered by the requested IHA is estimated to be 377 individuals due to behavioral harassment from vibratory pile extraction and pneumatic chipping. Table 6–18 depicts the number of acoustic harassments that are estimated from vibratory pile extraction and pneumatic chipping both underwater and in-air.

Table 6-18. Number of Potential Exposures of California Sea Lions within Various Acoustic Threshold Zones

Season	Density of California Sea Lions (sq km)	Activity	Underwater	Airborne
			Behavioral Harassment Threshold (120 dBRMS)	Behavioral Harassment Threshold (100 dBRMS)
Mid-July – Mid-February	0.63	Vibratory Steel Pile Extraction	345[1]	0
		Pneumatic Chipping	32[2]	0
		Total	377	0

1. Density (0.63 sea lion/sq km)*ZOI for behavioral harassment (35.9 sq km) results in a daily abundance of 23 California sea lions in the ZOI. 23 multiplied by 15 potential days of pile extraction equals 345 estimated exposures to behavioral harassment.
2. Density (0.63 sea lion/sq km)*ZOI for behavioral harassment (0.6 sq km) results in a daily abundance of 0 California sea lions in the ZOI. 0 multiplied by 32 potential days of pneumatic chipping equals 0 estimated exposures to behavioral harassment. The density calculation assumes an even distribution of California sea lions. However, in reality their distribution is patchy with their occurrence concentrated near Delta Pier in groups of several to many individuals. As a result, it is more likely that more than zero exposures would occur in a day. To ensure the Navy has adequate coverage, the Navy increased the number of takes requested to 1 exposure per day for pneumatic chipping, for a total of 32 exposures.

California sea lions that experience exposure to elevated noise levels could exhibit behavioral reactions. Disturbance from underwater noise impacts is not expected to be significant because it is estimated that only a small number of California sea lions may be affected by acoustic harassment. Disturbance from underwater noise impacts is not expected to be significant at the population level because it is estimated that only a small number of California sea lions may be affected by acoustic harassment.

6.7.4 Harbor Seal

Harbor seals are the most abundant marine mammal in Hood Canal, where they can occur anywhere in Hood Canal waters year-round. Jeffries et al. (2003) conducted aerial surveys of the harbor seal population in Hood Canal in 1999 for the Washington Department of Fish and Wildlife and reported 711 harbor seals hauled out. The authors adjusted this abundance with a correction factor of 1.53 to account for seals in the water, which were not counted, and estimated that there were 1,088 harbor seals in Hood Canal. The correction factor (1.53) was based on the proportion of time seals spend on land versus in the water over the course of a day, and was derived by dividing one by the percentage of time harbor seals spent on land. These data came from tags (VHF transmitters) applied to harbor seals at six areas (Grays Harbor, Tillamook Bay, Umpqua River, Gertrude Island, Protection/Smith Islands, and boundary Bay, BC) within two different harbor seal stocks (the coastal stock and the inland waters of WA stock) over four survey years. The Hood Canal population is part of the inland waters stock, and while not specifically sampled, Jeffries et al. (2003) found the VHF data to be broadly applicable to the entire stock. The tagging research in 1991 and 1992 conducted by Huber et al. (2001) and Jeffries et al. (2003) used the same methods for the 1999 and 2000 survey years. These surveys indicated that approximately 35 percent of harbor seals are in the water versus hauled out on a daily basis (Huber et al. 2001; Jeffries et al. 2003).

In order to estimate the underwater exposures from pile driving operations, the Navy determined the proportion of the Hood Canal population that could be in the water and susceptible to exposure on a daily basis. Jeffries et al. (2003) applied the correction factor on an annual basis, thereby assuming that the proportion of harbor seals on land versus in-water was consistent on a daily basis for the entire year. Similarly, the Navy assumed that the proportion of the population susceptible to exposure to underwater sound on a daily basis was 35 percent of the total population (35 percent of 1,088 animals, or approximately 381 individuals). The Navy recognizes that over the course of the day, while the proportion of animals in the water may not vary significantly, different individuals may enter and exit the water. However, fine-scale data on harbor seal movements within the project area on time durations of less than a day are not available.

Exposures to underwater and airborne pile removal noise were calculated using a density derived from the number of harbor seals that are present in the water at any one time (35 percent of 1,088 animals, or approximately 381 individuals), divided by the area of Hood Canal (291 sq km, or 112 square miles) (Huber et al. 2001; Jeffries et al. 2003). The density of harbor seals calculated in this manner (1.3 animals/sq km) is corroborated by results of the Navy's marine mammal boat surveys on NBK at Bangor in 2008 and 2009/10, in which an average of 5 individual harbor seals was observed in the 3.9 sq km survey area (density = 1.3 animals/sq km) (Tannenbaum et al. 2009, 2011). Exposures to underwater noise were calculated with the formula in Section 6.7.

In order to analyze the potential for harbor seals to be disturbed by airborne noise associated with pile extraction and pneumatic chipping, the Navy looked at the likelihood for harbor seals in the project area to be hauled out and/or swimming with their heads out of the water. While Huber et al (2001) indicated that harbor seals typically spend 65 percent of their time hauled out, the Navy's waterfront surveys and boat surveys (Agness and Tannenbaum 2009; Tannenbaum et al. 2009, 2011; Navy 2010) found that it is rare for harbor seals to haul out along the Bangor waterfront on NBK. Harbor seals occasionally haul out on pontoons of the floating security fence, buoys, and barges within the Waterfront Restricted Area but have not been observed on submarines. Documented use of these structures is outside of the ZOI for airborne noise resulting from vibratory extraction or pneumatic chipping. An observation of harbor seals hauled out on a log on the shoreline approximately 1,460 feet due south of EHW-1 represents the closest documented haul-out site. The log in question is no longer present. Harbor seals' ideal haul-out locations include intertidal or sub-tidal rock outcrops, sandbars, sandy beaches, peat banks in salt marshes, and manmade structures such as log booms, docks, and floats (Wilson 1978; Prescott 1982; Schneider and Payne 1983; Gilbert and Guldager 1998; Jeffries et al. 2000). Although in-water sightings of harbor seals are common in the project area, no haul-out locations fall within the calculated airborne acoustic noise ZOIs (20 meters and 13 meters, respectively). The only structures within the airborne ZOI (Figure 6–2) are the EHW-1 wharf, which is elevated more than 16 feet above MHHW and thus inaccessible to pinnipeds. The shoreline zone near this structure is beyond the airborne ZOIs.

Therefore, on NBK at Bangor, harbor seals would primarily be exposed to airborne noise effects as they swim or rest in the water with their heads above the surface. Based on the diving cycle of tagged harbor seals near the San Juan Islands, we estimate that seals are on the surface approximately 16.4 percent of their total in-water duration (Suryan and Harvey 1998). Therefore, by multiplying the percentage of time spent at the surface (16.4%) by the total in-water population of harbor seals at any one time (~381 individuals), the number of harbor seals with the potential to experience airborne impacts (~63 individuals) can be obtained. Airborne exposures were calculated (see Section 6.7 for formula) using a density derived from the number of harbor seals available at the surface (~63 individuals), divided by the area of Hood Canal (291 sq km)(density in air = 0.2 animals/sq km). Additionally, marine mammal observers will be monitoring the shutdown and buffer zones (see Section 11 for a detailed discussion of mitigation measures) for the presence of marine mammals, and will alert work crews when to begin or stop work due to presence of seals in or near the shutdown and buffer zones, reducing the potential for acoustic harassment. Based on the exposure analysis, no harbor seals are anticipated to experience airborne sound pressure levels that would qualify as harassment.

Table 6–19 depicts the number of acoustic harassments that are estimated from vibratory pile extraction and pneumatic chipping. Based on the density analysis, up to 737 individual harbor seals may experience sound pressure levels on a given day that would qualify as behavioral harassment). Harbor seals that are exposed to acoustic harassment could exhibit behavioral reactions.

Table 6-19. Number of Potential Exposures of Harbor Seals within Various Acoustic Threshold Zones

Season	Density of Harbor Seals [1] (sq km)	Activity	Underwater	Airborne
			Behavioral Harassment Threshold (120 dBRMS)	Behavioral Harassment Threshold (90 dBRMS) [4]
Mid-July – Mid-February	1.3	Vibratory Steel Pile Extraction	705[2]	0
		Pneumatic Chipping	32[3]	0
		Total	737	0

1. Density was calculated as the number of individuals present in the water (not hauled out) in Hood Canal at any given time (Huber et al. 2001).
2. Density (1.3 harbor seals/sq km)*ZOI for behavioral harassment (35.9 sq km) results in a daily abundance of 47 harbor seals in the ZOI. 47 multiplied by 15 potential days of pile extraction equals 705 estimated exposures to behavioral harassment.

3. Density (1.3 harbor seals/sq km)*ZOI for behavioral harassment (0.6 sq km) results in a daily abundance of 1 harbor seal in the ZOI. 0ne multiplied by 32 potential days of pneumatic chipping equals 32 estimated exposures to behavioral harassment.
4. Harbor seal densities (0.2/sq km) exposed to airborne noise were calculated using the percentage (16.4%) of animals in the water but on the surface (Suryan and Harvey 1998).

6.7.5 Killer Whale

Transient killer whales are uncommon visitors to Hood Canal. In 2003 and 2005, small groups of transient killer whales (6 to 11 individuals per event) visited Hood Canal to feed on harbor seals and remained in the area for significant periods of time (59 to 172 days) between the months of January and July (London 2006). These whales used the entire expanse of Hood Canal for feeding. Subsequent aerial surveys suggest that there has not been a sharp decline in the local seal population from these sustained feeding events (London 2006). Based on this data, the density for transient killer whales in the Hood Canal for January to June is $0.038/km^2$ (11 individuals divided by the area of the Hood Canal [291 km^2]). A seasonal use trend from the limited data in Hood Canal was not possible to discern from the occurrences in 2003 and 2005. In addition, transient killer whales occur intermittently in other Washington inland waters year-round; therefore, we assumed that transient killer whales could occur year-round, the density estimate from the January to June sightings was used for the exposure calculations. Exposures were calculated using the formula presented in Section 6.7. Table 6-19 depicts the number of acoustic harassments that are estimated from vibratory pile extraction and pneumatic chipping.

Killer whales that are taken could exhibit behavioral changes. Disturbance from underwater noise impacts is not expected to be significant because it is estimated that only a small number of killer whales may be affected by acoustic harassment from vibratory pile extraction.

Table 6-20. Number Potential Exposures of Killer Whales within Various Acoustic Threshold Zones

Season	Density of Transient Killer Whales [1] (sq km)	Activity	Underwater
			Behavioral Harassment Threshold (120 dB$_{RMS}$)
Mid-July – Mid-February	0.04	Vibratory Steel Pile Extraction	15[2]
		Pneumatic Chipping	0[3]
		Total	15

1. Density was calculated as the maximum number of individuals present at a given time during two visits in 2003 and 2005 (London 2006) divided by the area of Hood Canal.
2. Density (0.04 killer whales/sq km)*ZOI for behavioral harassment (35.9 sq km) results in a daily abundance of 1 killer whale in the ZOI. 1 multiplied by 15 potential days of pile extraction equals 15 estimated exposures to behavioral harassment.
3. Density (0.04 killer whales/sq km)*ZOI for behavioral harassment (0.6 sq km) results in a daily abundance of 0 killer whale in the ZOI. Zero multiplied by 32 potential days of pneumatic chipping equals 0 estimated exposures to behavioral harassment. In addition, the ZOI for pneumatic chipping occurs within the floating security fence. Cetacean species are not documented or expected to occur within the floating security fence.

Based on the density analysis above, up to 1 individual killer whale per day may experience sound pressure levels that would qualify as harassment. The total number of exposures is estimated to be 15 due to behavioral harassment caused by vibratory pile extraction or pneumatic chipping as described in Table 6–20. Killer whales that are exposed to acoustic harassment could exhibit behavioral changes. Disturbance from underwater noise impacts is not expected to be significant at the population level because it is estimated that only a small number of killer whales may be affected by acoustic harassment.

6.7.6 Dall's Porpoise

Dall's porpoise may be present in Hood Canal year-round and are assumed to use the entire area. The Navy conducted boat surveys of the waterfront area from July to September 2008 (Tannenbaum et al. 2009) and November 2009 to May 2010 (Tannenbaum et al. 2011). During one of the surveys a single Dall's porpoise was sighted in August 2009 in the deeper waters off Carlson Spit. In the absence of an abundance estimate for the entire Hood Canal, density was derived from the waterfront surveys using the number of individuals seen divided by total area of survey effort (18 surveys with approximately 3.9 km2 [1.5 sq mi] of effort per survey, using strip transect surveys). Exposures were calculated using the formula in Section 6.7. Table 6–21 depicts the number of acoustic harassments that are estimated from underwater vibratory extraction of steel pile and pneumatic chipping.

Table 6-21. Number of Potential Exposures of Dall's Porpoise within Various Acoustic Threshold Zones

Season	Density of Dall's Porpoise [1] (sq km)	Activity	Underwater
			Behavioral Harassment Threshold (120 dB$_{RMS}$)
Mid-July – Mid-February	0.01	Vibratory Steel Pile Extraction	15[2]
		Pneumatic Chipping	0[3]
		Total	15

1. Density was calculated as the number of individuals observed in 18 surveys of the 3.9 sq km Bangor waterfront area on NBK (Tannenbaum et al. 2009, 2011).
2. Density (0.01 Dall's porpoise/sq km)*ZOI for behavioral harassment (35.9 sq km) results in a daily abundance of 0 Dall's porpoise in the ZOI. 0 multiplied by 15 potential days of pile extraction equals 0 estimated exposures to behavioral harassment. Dall's porpoise are rarely present in Hood Canal and only one was observed in 18 full surveys of the waters off NBK at Bangor. Since this individual was observed in deeper offshore waters encompassed by the vibratory pile extraction behavioral harassment zone (120 dB threshold), it is possible that an animal may be exposed to behavioral harassment due to pile extraction. Therefore, the Navy believes that additional disturbance exposures may occur. The Navy is requesting take for 1 Dall's porpoise per day during

pile extraction, for a total of 15 behavioral harassment exposures due to pile driving over the course of the project.

3. Density (0.01 Dall's porpoise/sq km)*ZOI for behavioral harassment (0.6 sq km) results in a daily abundance of 0 Dall's porpoise in the ZOI. Zero multiplied by 32 potential days of pneumatic chipping equals 0 estimated exposures to behavioral harassment. Dall's porpoise are rarely present in Hood Canal and only one was observed in 18 full surveys of the waters off NBK at Bangor. Since this individual was observed in deeper offshore waters not encompassed by the pneumatic chipping behavioral harassment zone (120 dB threshold), it is not likely that an animal may be exposed to behavioral harassment due to pneumatic chipping. In addition, the ZOI for pneumatic chipping occurs within the floating security fence. Cetacean species are not documented or expected to occur within the floating security fence.

Based on the density analysis above, zero exposures were calculated for Dall's porpoise for underwater pile extraction noise. However, the Navy requests behavioral harassment (Level B) takes due to pile extraction noise based on possible exposure of 1 Dall's porpoise per day during the 15 days of pile extraction estimated (Table 6–21). Dall's porpoises exposed to acoustic harassment could exhibit behavioral changes. Disturbance from underwater noise impacts is not expected to be significant at the population level because it is estimated that only a small number of Dall's porpoises may be affected.

6.7.7 Harbor Porpoise

Harbor porpoises may be present in Hood Canal year-round and are assumed to use the entire area. The Navy conducted vessel-based line transect surveys in the Hood Canal during the Test Pile Program (Navy, in prep.). Over the course of the surveys, the total track line length was 259.01 kilometers. Sightings of harbor porpoises during these surveys were used to generate a density for Hood Canal. Based on guidance from other line transect surveys conducted for harbor porpoises using similar monitoring parameters (i.e., boat speed, number of observers, etc.) (Barlow 1988; Calambokidis et al. 1993; Carretta et al. 2001), the Navy determined the effective strip width for the surveys to be one kilometer, or a perpendicular distance of 500 meters from the transect to the left or right of the vessel. The effective strip width was set at the distance at which the detection probability for harbor porpoises was equivalent to one, which assumes that all individuals on a transect are detected. Only sightings occurring within the effective strip width were used in the density calculation. By multiplying the track line length of the surveys by the effective strip width, the total area surveyed during the surveys was 259.01 sq. km. Thirty five individual harbor porpoises were sighted within this area, resulting in a density of 0.135 animals per sq.km. To account for availability bias [g(0)] or the animals which are unavailable to be detected because they are submerged, the Navy utilized a g(0) value of 0.54, derived from other similar line transect surveys (Barlow 1988; Calambokidis et al. 1993; Carretta et al. 2001). This resulted in a density of 0.250 harbor porpoises per sq. km. Exposures were calculated using the formula in Section 6.7. Table 6–22 depicts the number of acoustic harassments that are estimated from underwater pile removal.

Table 6-22. Number of Potential Exposures of Harbor Porpoise within Various Acoustic Threshold Zones

Season	Density of Harbor Porpoise [1] (sq km)	Activity	Underwater
			Behavioral Harassment Threshold (120 dB RMS)
Mid-July – Mid-February	0.250	Vibratory Steel Pile Extraction	135[2]
		Pneumatic Chipping	0[3]
		Total	135

1. Density was calculated as the number of individuals observed in 2011 Test Pile Program surveys covering 259.01 sq km, corrected for detectability g(0) (Navy, in prep.).
2. Density (0.250 harbor porpoise/sq km)*ZOI for behavioral harassment (35.9 sq km) results in a daily abundance of 9 harbor porpoise in the ZOI. Nine multiplied by 15 potential days of pile extraction equals 135 estimated exposures from behavioral harassment.
3. Density (0.250 harbor porpoise/sq km)*ZOI for behavioral harassment (0.6 sq km) results in a daily abundance of 0 harbor porpoise in the ZOI. Zero multiplied by 32 potential days of pneumatic chipping equals 0 estimated exposures from behavioral harassment. In addition, the ZOI for pneumatic chipping occurs within the floating security fence. Cetacean species are not documented or expected to occur within the floating security fence.

Based on the density analysis above, up to 9 individual harbor porpoises may experience sound pressure levels on a given day that would qualify as harassment. The total number of exposures is calculated to be 135 due to behavioral harassment (Table 6–22). Harbor porpoises that are exposed to acoustic harassment could exhibit behavioral changes. Disturbance from underwater noise impacts is not expected to be significant at the population level because it is estimated that only a small number of harbor porpoises may be affected by acoustic harassment relative to the size of the entire stock.

6.8 Effects of Other Construction Activities

Several non-pile construction activities will also occur at the project area as part of the proposed action. Among them are the removal of the fragmentation barrier and walkway and the installation of cast-in-place concrete pile caps, passive cathodic protection systems, and the new pre-stressed wharf superstructure and related appurtenances. All of these construction activities will occur out of the water/above the water's surface and will be installed on the tops of the piles or attached to the wharf's superstructure. Each of these activities could involve the generation of low levels of noise from the operation of associated installation machinery (i.e. concrete cutting saw, bolt gun, welder, etc.). While no empirical data exists for these construction activities they are expected to be significantly lower than those estimated for pile installation and removal using an impact/vibratory pile driver or pneumatic chipping hammer. As a result, airborne disturbance is not anticipated for any marine mammal species. It's possible that sound could be transmitted from these activities along the piles' length and enter the water. However, since these activities will be occurring at the top of the pile or on the superstructure, tens of feet above the water, sounds transmitted into the water would be significantly reduced. As a result, underwater acoustic impacts from these construction operations are expected to be minimal and are unlikely to result in harassment of any marine mammal species. Therefore, the Navy is not requesting any additional takes from construction activities other than vibratory steel pile extraction or pneumatic chipping of concrete piles.

6.9 Summary

The total numbers of exposures the Navy is requesting for the marine mammals species that may occur within the Project Area are presented in Table 6-23. All exposure will be Level B disturbance takes from noise levels exceeding the 120 dB rms underwater threshold for continuous noise from vibratory pile extraction or pneumatic chipping. No additional exposures are requested for exposure to airborne noise levels because these will be encompassed in the larger ZOI being monitored.

Table 6-23. Summary of Potential Exposures for All Species During the EHW-1 Pile Replacement Project's Timeframe (July 16 through February 15)

Species	Underwater	Airborne	
	Vibratory Disturbance Threshold (120dB)	Vibratory Disturbance Threshold (100dB)	Vibratory Disturbance Threshold (90dB)
Humpback Whale	0	N/A	N/A
Steller Sea Lion	62	0	N/A
California Sea Lion	377	0	N/A
Harbor Seal	737	N/A	0
Transient Killer Whale	15	N/A	N/A
Dall's Porpoise	15	N/A	N/A
Harbor Porpoise	135	N/A	N/A
Total	**1,341**	**0**	**0**

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 Underwater Noise Effects

The effects of pile removal on marine mammals are dependent on several factors, including the size, type, and depth of both the animal; the depth, intensity, and duration of the sound; the depth of the water column; the substrate of the habitat; the standoff distance between the pile and the animal; and the sound propagation properties of the environment. Impacts to marine mammals from pile removal 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 further 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 which are soft (i.e. sand) will absorb or attenuate the sound more readily than hard substrates (rock) which may reflect the acoustic wave. Soft porous substrates would also likely require less time to drive the pile, and possibly less forceful equipment, which would ultimately decrease the intensity of the acoustic source.

Impacts to marine species from pile removal are not expected to be the result of physiological responses to both the type and strength of the acoustic signature (Viada et al. 2008). Behavioral impacts are also expected, though the type and severity of these effects are more difficult to define due to limited studies addressing the behavioral effects of continuous sounds on marine mammals. Potential effects from continuous sound sources are expected to be temporary behavioral disturbance.

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 impacts include hearing loss, which is caused by exposure to perceptible sounds. Severe damage from a pressure wave to the ear can include rupture of the tympanum, fracture of the ossicles, damage to the cochlea, hemorrhage, and cerebrospinal fluid leakage into the middle ear (NMFS 2008b). Moderate injury implies partial hearing loss. Permanent hearing loss can occur when the hair cells are damaged by one very loud event, as well as prolonged exposure to noise. Instances of temporary threshold shifts (TTS) and/or auditory fatigue are well documented in marine mammal literature as being one of the primary avenues of acoustic impact. Temporary loss of hearing sensitivity (TTS) has been documented in controlled settings using captive marine mammals exposed to strong sound exposure levels at various frequencies (Ridgway et al. 1997; Kastak et al. 1999; Finneran et al. 2005), but it has not been documented in wild marine mammals exposed to pile driving. While injuries to other sensitive organs are possible, they are less likely since pile driving impacts are almost entirely acoustically mediated, versus explosive sounds which also include a shock wave which can result in damage.

No physiological responses are expected from pile removal operations (including the use of a pneumatic chipping hammer) occurring during the EHW-1 Pile Replacement Project within the Project Area because vibratory pile extraction does not generate peak sound pressure levels that are high enough to be associated with physiological damage. Both vibratory pile extraction and pneumatic chipping of concrete piles do not have source levels over the injury thresholds provided by NMFS (see Section 6.4). Additionally, the Navy will have trained biologists monitoring a shutdown zone to ensure no marine mammals are injured.

Behavioral Responses

An individual's behavioral response to sound is 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. 2003, 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. 2003/2004). 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.

The type and severity of behavioral effects are difficult to define due to limited studies addressing the behavioral effects of sounds on marine mammals. Controlled experiments with captive marine mammals showed pronounced behavioral reactions, including avoidance of loud sound sources (Ridgway et al. 1997; Finneran et al. 2003). Observed responses of wild marine mammals to loud pulsed sound sources (typically seismic guns or acoustic harassment devices, and also including pile driving) have been varied but often consist of avoidance behavior or other behavioral changes suggesting discomfort (Morton and Symonds 2002; also see reviews in Gordon et al. 2004; Wartzok et al. 2003/2004; 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 review in Southall et al. 2007). Blackwell et al. (2004) found that ringed seals exposed to underwater pile driving sounds in the 153–160 dBRMS range tolerated this noise level and did not seem unwilling to dive. One individual was as close as 63 meters from the pile driving. Responses of two pinniped species to impact pile driving at the San Francisco-Oakland Bay Bridge East Span Seismic Safety Project were mixed (CALTRANS 2001, 2006, 2010). Harbor seals were observed in the water at distances of approximately 400 to 500 meters from the pile driving activity and exhibited no alarm responses, although several showed alert reactions, and none of the seals appeared to remain in the area. One of these harbor seals was even seen to swim to within 150 meters of the pile driving barge during pile driving. Several sea lions, however, were observed at distances of 500 to 1,000 meters swimming rapidly and porpoising away from pile driving activities. The reasons for these differences are not known, although Kastak and Schusterman (1998) reported that sea lions are more sensitive than harbor seals to underwater noise at low frequencies.

Studies of marine mammal responses to continuous noise, such as vibratory pile installation proposed in this application, are limited. Marine mammal monitoring during two lengthy construction seasons at the Port of Anchorage marine terminal found no response by marine mammals swimming within the threshold distances to noise impacts from construction activities including pile driving (both impact hammer and vibratory driving) (Integrated Concepts & Research Corporation 2009). Most marine mammals observed were beluga whales, harbor seals, harbor porpoises, and small numbers of Steller sea lions were observed in smaller numbers. Background noise levels at this port are typically at 125 dB.

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.

Vibratory pile extraction and the use of a pneumatic chipping hammer could result in temporary, short term changes in an animal's typical behavior and/or avoidance of the affected area. A marine mammal may show signs that it is startled by the noise and/or may swim further away from the sound source and avoid the area. Other potential behavioral changes could include increased swimming speed, increased surfacing time, and decreased foraging in the affected area. Since vibratory pile extraction or pneumatic chipping will occur for only a few hours a day, over a short period of time, permanent displacement is unlikely. In addition, since pile removal would only occur during daylight hours, marine mammals transiting the project area or foraging or resting in the project area at night would not be affected. Any potential impacts from pile extraction or pneumatic chipping activities could be experienced by individual marine mammals, but would not cause population level impacts, or affect the long-term fitness of a species.

7.1.2 Airborne Noise Effects

Marine mammals that occur in the project area could be exposed to airborne sounds associated with pile removal that have the potential to cause harassment, depending on their distance from activities. Airborne noise would have less impact on cetaceans than pinnipeds because noise from atmospheric sources does not transmit well underwater (Richardson et al. 1995); thus airborne noise would only be an issue for hauled-out pinnipeds in the Project Area. Most likely, airborne sound would cause behavioral responses similar to those discussed above in relation to underwater noise. For instance, anthropogenic sound could cause hauled out pinnipeds to exhibit changes in their normal behavior, such as reduction in vocalizations, or cause them to temporarily abandon their habitat and move further from the source. Studies by Blackwell et al. (2004) and Moulton et al. (2005) indicate a tolerance or lack of response to unweighted airborne sounds as high as 112 dB peak and 96 dB rms. Based on these observations marine mammals could exhibit temporary behavioral reactions to airborne noise, however, exposure is not likely to result in population level impacts. Despite taking into consideration all known and incidental haulout locations nearby the Project Area, the exposure modeling indicated that no pinniped species would be exposed to airborne noise levels at sound pressure levels that would constitute Level B behavioral harassment during vibratory pile extraction or chipping (see Section 6 for modeling results). Injury or Level A harassment is not expected to occur from airborne noise. In conclusion, this is a negligible impact.

7.2 Conclusions Regarding Impacts to Species or Stocks

Individual marine mammals may be exposed to sound pressure levels during vibratory steel pile extraction or pneumatic chipping of concrete piles, which may result in Level B Behavioral harassment. Any marine mammals that are taken (harassed) may change their normal behavior patterns (e.g., 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 vibratory pile extraction or pneumatic chipping is non-pulsed (e.g., continuous) which is not known to cause injury to marine mammals. Monitoring a 10 meter radius around vibratory pile extraction or pneumatic chipping is likely to avoid most potential adverse underwater impacts to marine mammals. Nevertheless, some level of impact is unavoidable. The expected level of unavoidable impact (defined as an acoustic or harassment "take") is described in Sections 6 and 7. This level of effect is not anticipated to have any detectable adverse impact on population recruitment, survival or recovery (i.e., no more than a negligible adverse effect).

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.

8.1 Subsistence Harvests by Northwest Treaty Indian Tribes

Historically, Pacific Northwest treaty Indian tribes were known to utilize (hunt) several species of marine mammals including, but not limited to: harbor seals, Steller sea lions, northern fur seals, gray whales, and humpback whales (Norberg pers. comm. 2007b). Several Pacific Northwest treaty Indian tribes have promulgated[5] tribal regulations allowing tribal members to exercise treaty rights for subsistence harvest of California sea lions and harbor seals (Carretta et al. 2007). There are no known active ceremonial and/or subsistence hunts for marine mammals in Hood Canal, Puget Sound, or the San Juan Islands (Norberg pers. comm. 2007b). Carretta et al. (2007) estimated annual subsistence takes of zero to two California sea lions. No data are available for the number of annual harbor seal subsistence takes (Carretta et al. 2011).

8.2 Summary

Potential impacts resulting from the Proposed Action will be limited to individuals of marine mammal species located in the marine waters near NBK at Bangor and will be limited to Level B harassment. Therefore, no impacts on the availability of species or stocks for subsistence use were found.

5 To make known by open declaration; publish; proclaim formally or put into operation (a law, decree of a court, etc.).

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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 NBK at Bangor would have potential short-term impacts to food sources such as forage fish, but would not result in any permanent impacts on habitats used by marine mammals. There are no rookeries or major haul-out sites within 10 km, foraging hotspots, or other ocean bottom structure of significant biological importance to marine mammals that may be present in the marine waters near the Project Area. The primary potential impact of concern 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 marine mammal habitat occurs from temporary noise disturbance to marine mammal prey (i.e., fish) nearby and minor impacts to the immediate substrate during removal of piles.

9.1 Pile Driving Effects on Potential Prey (Fish)

Construction activities will produce elevated noise levels from vibratory pile driving and pneumatic chipping. Fish react to sounds which 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, 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 file, 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). Because vibratory pile driving and pneumatic chipping do not create pulsed or sharp waveforms, the most likely impact to fish from pile removal activities at the project area would be temporary behavioral disturbance or avoidance of the area during these activities. The duration of fish avoidance of this area after pile removal stops is unknown, but a rapid return to normal recruitment, distribution and behavior is anticipated. In general, impacts to marine mammal prey species are expected to be minor and temporary due to the short-time frame for the project.

9.2 Pile Driving Effects on Potential Foraging Habitat

In addition, the area likely impacted by the EHW-1 Pile Replacement Project is relatively small compared to the available habitat in the Hood Canal. Potentially a small area surrounding a pile may have decreased foraging value as each pile is removed. Avoidance by potential prey (i.e. fish) of the immediate area due to the temporary loss of this foraging habitat is also possible. The duration of fish avoidance of this area after pile removal stops is unknown, but a rapid return to normal recruitment, distribution and behavior is anticipated. Any behavioral avoidance by fish of the disturbed area would still leave significantly large areas of fish and marine mammal foraging habitat in the Hood Canal and nearby vicinity.

9.3 Summary of Impacts to Marine Mammal Habitat

Given the short daily duration of noise associated with pile removal, the short duration of the entire Pile Replacement Project, and the relatively small area being affected, in-water activities associated with the proposed action are not likely to have a permanent, adverse effect on any marine habitat or population of fish species.

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 NBK at Bangor are not expected to have any habitat-related effects that could cause significant or long-term consequences for individual marine mammals or their populations, since all activities will be temporary and all piles removed are within the existing footprint of the current EHW-1 facility. Based on the discussions in Section 9, there will be no impacts to marine mammals 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 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 a number of mitigation measures, discussed below, in an effort to minimize the number of marine mammals potentially affected.

11.1 Mitigation for Pile Driving Activities

The modeling results for ZOIs discussed in Section 6 were used to develop mitigation measures for pile removal activities. Underwater SPLs for either activity are not anticipated to equal or exceed the Level A (injury) Harassment criteria for marine mammals (180 dB isopleths for cetaceans; 190 dB isopleths for pinnipeds). While the ZOIs vary between the different types of removal methodologies, the Navy is proposing to establish mitigation zones for the ZOI for vibratory pile extraction and pneumatic chipping.

1. Shutdown and Buffer Zone (*Pile removal via a vibratory driver or chipping hammer*)

    - During pile removal with a vibratory driver or chipping hammer, the shutdown zone shall include all areas where the underwater SPLs are anticipated to equal the Level A (injury) harassment criteria for marine mammals (180 dB isopleths for cetaceans; 190 dB isopleths for pinnipeds). However, modeling does not predict a zone of influence for these activities because their anticipated SPLs are below the Level A criteria for injury. To be conservative, a 10 meter (33 feet) shutdown zone shall be established and monitored to prevent injury to marine mammal species from their physical interaction with construction equipment during in-water activities.
    - During pile removal with a vibratory driver or chipping hammer, the buffer zone shall include all areas where underwater or airborne SPLs are anticipated to equal or exceed the Level B (disturbance) harassment criteria for marine mammals (underwater: 120 dB rms isopleths; airborne: 90 dB rms isopleths for harbor seals or 100 dB rms isopleths for pinnipeds other than harbor seals). However, because the ZOI for vibratory pile extraction is approximately 35.9 sq. km (Figure 6.1), the size of this area would make effective monitoring impractical. As a result the Navy proposes to monitor a buffer zone within the floating security fence equivalent to where pneumatic chipping noise levels are estimated to be at or above (120 dB re 1µPa) (Figure 6-2) for all pile removal activities.
    - The shutdown and buffer zone(s) will be monitored throughout the time required to extract a pile with a vibratory driver or a pneumatic chipper. If a marine mammal enters the buffer zone, an exposure would be recorded and behaviors

documented. However, that pile would be completed without cessation, unless the animal approaches or enters the shutdown zone, at which point all pile removal activities will be halted.

- Under certain construction circumstances where initiating the shutdown and clearance procedures (which could include a delay of 15 minutes or more) would result in an imminent concern for human safety, the shutdown provision may be waived. The Navy is working with NMFS Headquarters to clarify situations or criteria in which such as scenario may occur.

2. Shutdown Zone (*In-water construction activities not involving a vibratory driver or chipping hammer*)

   - During in-water construction activities not involving a vibratory driver or chipping hammer, but having the potential to affect marine mammals, in order to prevent injury from physical interaction with construction equipment, a shutdown zone of 10 meters (33 feet) will be monitored to ensure marine mammals are not present within this zone.
   - These activities could include, but are not limited to: (1) the movement of a barge to the pile location, or (2) the removal of a pile from the water column/substrate via a crane (i.e. "dead pull").

3. Visual Monitoring

   A marine mammal monitoring plan will be finalized prior to the commencement of pile removal activities; however, at a minimum it will include the following:

   - Visual monitoring will be conducted by qualified, trained marine mammal observers (hereafter "observer"). An observer is a biologist with prior training and experience conducting marine mammal monitoring or surveys, and who has the ability to identify marine mammal species and describe relevant behaviors that may occur in proximity to in-water construction activities. A trained observer will be placed from the best vantage point(s) practicable (e.g. from a small boat, the pile driving barge, or any other suitable location) to monitor for marine mammals and implement shut-down or delay procedures when applicable by calling for the shut-down to the driver or hammer operator.
   - Prior to the start of vibratory pile extraction or pneumatic chipping, the shutdown zone will be monitored for 15 minutes to ensure that the shutdown zone is clear of marine mammals. Pile removal will only commence once observers have declared the shutdown zone clear of marine mammals; Animals will be allowed to remain in the buffer zone and their behavior will be monitored and documented to the extent practicable.
   - During vibratory extraction and pneumatic chipping, visual monitoring will be conducted before, during, and after pile extraction activities. Visual monitoring will occur from 15 minutes prior to initiation through 30 minutes post-completion of pile removal activities. Pile removal activities include the time to remove a single pile or series of piles, as long as the time elapsed between uses of the pile removal equipment is no more than 30 minutes.

- During in-water construction activities that do not involve the use of a vibratory driver or chipping hammer, as defined above (Section 11.1 #2), monitoring will be conducted within the shutdown zone to preclude marine mammal injury from physical interaction with construction equipment. Monitoring will take place from 15 minutes prior to initiation until the action is complete.
- If a marine mammals approaches or enters the shutdown zone(s) during the course of pile removal operations or other in-water construction activities, these activities will 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.

4. Acoustic Measurements – Acoustic measurements will be taken to empirically verify the noise levels from pneumatic chipping. A subset of piles will be monitored, and at a minimum, measurements will be taken at 10 meters from the pneumatic chipper. For further detail regarding acoustic monitoring, see Section 13.
5. Timing Restrictions - To minimize the number of fish exposed to underwater noise and other disturbance, in-water work will only be conducted during the in-water work window (from July 16 through February 15) for Puget Sound Marine Area 13 as outlined in WAC-220-110-271, when juvenile ESA-listed salmonids are least likely to be present. The initial months (July through September) of the timing window overlap with times when Steller sea lions are not expected to be present within the study area.
6. Soft Start - The use of a soft-start procedure is believed to provide additional protection to marine mammals by providing a warning and/or giving marine mammals a chance to leave the area prior to the hammer operating at full capacity. Soft-start techniques for vibratory pile extraction will be used, as follows[6]:

   "*The soft-start requires contractors to initiate noise from vibratory hammers for 15 seconds at reduced energy followed by a 30-second waiting period. This procedure should be repeated two additional times.*"

7. Daylight Construction – Pile extraction using a vibratory driver or pneumatic chipping hammer and all other in-water construction activities will occur from July 16 through February 15 during daylight hours (sunrise to sunset[7]). Non in-water construction activities could occur between 7:00 AM and 10:00 PM during any time of the year.

[6] The sequence of the soft-start procedures includes a minor deviation from those typically requested by the NMFS which utilize a longer waiting period (one minute vs. 30 seconds). The Navy requested to change the waiting period because observational data during the Test Pile Program and EHW-1 repairs indicated a one minute wait period may be too long. Longer breaks between the sounds may be interpreted by the animals as a transient sound, and may not serve the intended purpose to provide an indication that louder sounds are about to begin. The Navy consulted with NMFS regarding using a shorter waiting period (i.e. 30 seconds) and the Service found the Navy's reasoning to be valid and accepted the requested modification.

[7] Sunrise and sunset are to be determined based on the National Oceanic and Atmospheric Administration data which can be found at http://www.srrb.noaa.gov/highlights/sunrise/sunrise.html.

11.2 Mitigation Effectiveness

All observers utilized for mitigation activities will be experienced biologists with training in marine mammal detection and behavior. Due to their specialized training the Navy expects that visual mitigation will be highly effective. Trained observers have specific knowledge of marine mammal physiology, behavior, and life-history which may improve their ability to detect individuals or help determine if observed animals are exhibiting behavioral reactions to construction activities.

The Puget Sound region, including the Hood Canal, only infrequently experience winds with velocities in excess of 25 knots (Morris et al. 2008). The typically light winds afforded by the surrounding highlands coupled with the fetch limited environment of the Hood Canal result in relatively calm wind and sea conditions throughout most of the year. The EHW-1 Pile Replacement project site has a maximum fetch of 8.4 miles to the north, and 4.2 miles to the south, resulting in maximum wave heights of from 2.85-5.1 feet (BSS between 2-4), even in extreme conditions (30 knot winds) (CERC 1984). Visual detection conditions are considered optimal in BSS conditions of 3 or less, which align with the conditions that should be expected for the Pile Replacement Project at NBK at Bangor.

The observers will be positioned in locations which provide the best vantage point(s) for monitoring. This will probably be an elevated position as they provide a better range of viewing angles. In addition, the shutdown zone has a small radius to monitor which should improve detectability.

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.

Subsistence use is the traditional exploitation of marine mammals by native peoples for their own consumption. Based on the discussions in Section 8, there are no adverse effects on the availability of species or stocks for subsistence use.

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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 will be implemented along with the mitigation measures (Section 11) in order to reduce impacts to marine mammals to the lowest extent practicable. A marine mammal monitoring plan will be developed further and submitted to NMFS for approval prior to the start of construction. The monitoring plan will include the following components: acoustic measurements and visual observations.

13.1.1 Acoustic Measurements

The Navy will conduct acoustic monitoring for pneumatic chipping of concrete piles to determine the actual distances to the 120 dB re 1μPa rms isopleths for behavioral harassment relative to background levels. The monitoring plan will address underwater and airborne sounds measurements from pneumatic chipping. Underwater sound levels were measured at the project site in 2011 in the absence of construction activities to determine background sound levels and; therefore, will not be recorded again during this work window. The background levels were recorded over the frequency range from 10 Hz to 20 kHz.

At a minimum, the methodology includes:

- Acoustic monitoring will be conducted on a minimum of 5 concrete piles.
- For underwater recordings, a stationary hydrophone system with the ability to measure SPLs will be placed in accordance with NMFS most recent guidance for collection of source levels.
- For airborne recordings, reference recordings will be attempted at approximately 50 feet (15.2 meters) from the source via a stationary hydrophone. However, other distances may be utilized to obtain better data if the signal cannot be isolated clearly due to other sound sources (i.e., barges or generators).
- Each hydrophone (underwater) and microphone (airborne) will be calibrated prior to the start of the action and will be checked at the beginning of each day of monitoring activity. Other hydrophones will be placed at other distances and/or depths as necessary to determine the distance to the thresholds for marine mammals.
- Environmental data will be collected including but not limited to: wind speed and direction, wave height, water depth, precipitation, and type and location of in-water construction activities, as well other factors that could contribute to influencing the airborne and underwater sound levels (e.g. aircraft, boats, etc.);

- The construction contractor will supply the Navy and other relevant monitoring personnel with the substrate composition, hammer model and size, hammer energy settings and any changes to those settings during the piles being monitored.
- For acoustically monitored piles, post-analysis of the sound level signals will include the average, minimum, and maximum RMS value for each pile monitored during removal. A frequency spectrum will also be provided for the pneumatic chipping signal.

13.1.2 Visual Marine Mammal Observations

Marine mammal observers will collect sighting data and behavioral responses to construction activities for marine mammal species observed in the region of activity during the period of construction. All observers will be experienced biologists trained in marine mammal identification and behaviors, as described in Section 11.1, #3. NMFS requires that the observers have no other construction related tasks while conducting monitoring.

13.1.3 Methods of Monitoring

The Navy will monitor the shut down zone and buffer zone before, during, and after vibratory pile extraction or pneumatic chipping. Based on NMFS requirements, the Marine Mammal Monitoring Plan will include the following procedures for vibratory pile or pneumatic chipping pile extraction and other in-water construction activities not involving a vibratory driver or chipping hammer:

- Observers would be located at the best vantage point(s) in order to properly see the entire shut down zone and safety zone. This may require the use of a small boat to monitor certain areas while also monitoring from one or more land based vantage points. At least one observer would be assigned to monitor the shutdown zone.
- During all observation periods, observers would use binoculars and the naked eye to search continuously for marine mammals.
- If the shut down zone is obscured by fog or poor lighting conditions, vibratory pile extraction or pneumatic chipping would not be initiated until the shut down zone is visible.
- The shut down and buffer zones around the pile will be monitored for the presence of marine mammals before, during, and after any vibratory pile extraction or pneumatic chipping.
- Pre-Activity Monitoring:
    - The shut down and buffer zones will be monitored for 15 minutes prior to initiating pneumatic chipping, the soft start for vibratory pile extraction, or other in-water construction activities not involving a vibratory driver or chipping hammer (i.e. dead pull, etc.). If a marine mammal(s) is present within the shut down zone prior to start of these activities or during the soft start, the start of pile removal would be delayed until the animal(s) leave the shut down zone. Pile removal would resume only after the observer has determined, through visual observation or by waiting approximately 15 minutes, the animal(s) has moved outside the shut down zone.

- During Activity Monitoring:
    - The shutdown and buffer zones will also be monitored throughout the time required to remove a pile or complete other in-water construction activities. If a marine mammal is observed entering the buffer zone, an exposure would be recorded and behaviors documented. However, that pile segment or other in-water construction activities would be completed without cessation, unless the animal enters or approaches the shut down zone, at which point all pile removal activities will be halted. However, the shut down provision may be waived in situations where shut down would create an imminent concern for human safety (see Section 11.1). Pile removal or other in-water construction activities can only resume once the animal has left the shutdown zone of its own volition or has not been re-sighted for a period of 15 minutes.
- Post-Activity Monitoring: Monitoring of the shutdown and buffer zones would continue for 30 minutes following the completion of pile removal.
- The individuals that implement the monitoring protocol will assess its effectiveness using an adaptive approach. Monitoring biologists will use their best professional judgment throughout implementation and will seek improvements to these methods when deemed appropriate. Any modifications to protocol will be coordinated between the U.S. Navy and NMFS.

13.1.4 Data Collection

NMFS requires that a minimum, the following information be collected on the sighting forms:

- Date and time that pile removal begins or ends;
- Construction activities occurring during each observation period;
- Weather parameters identified in the acoustic monitoring (e.g. percent cover, visibility);
- Water conditions (e.g. sea state, tidal state [incoming, outgoing, slack, low, and high]);
- 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 sound pressure levels;
- Distance from pile removal 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.

Additionally, based on recent discussions with NMFS Headquarters, they request that the Navy record behavioral observations such that, if possible, the Navy can attempt to determine whether animals can be (or are) "taken" by more than one sound source in a day's operations. For instance, the Navy has agreed to: "Note in behavioral observations, to the extent practicable, if an animal has remained in the area during construction activities. Therefore, it may be possible to identify if the same animal or a different individuals are being taken."

13.2 Reporting

A draft report will be submitted to NMFS within 90 work days of the completion of acoustic measurements and marine mammal monitoring. The results will be summarized in graphical form and include summary statistics and time histories of sound values for each monitored pile. 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).
- Specific pile removal data for acoustically monitored piles:
    - Description of the pile removal activities being conducted.
        - Size and type of piles.
        - The machinery used for removal.
    - The vibratory driver force or chipping hammer setting used to extract the piles.
- Specific acoustic monitoring information:
    - A description of the monitoring equipment.
    - The distance between hydrophone(s) and pile.
    - The depth of the hydrophone(s).
    - The physical characteristics of the bottom substrate from which the piles were extracted (if possible).
    - The RMS range and mean for each acoustically monitored pile.
    - The results of the underwater measurements, including the frequency spectrum and RMS SPL's for acoustically monitored piles.
- Pre-activity observational survey-specific data:
    - Dates and time survey is initiated and terminated.
    - Description of any observable marine mammal behavior in the immediate area during monitoring.
    - If possible, the correlation to underwater sound levels occurring at the time of the observable behavior.
    - Actions performed to minimize impacts to marine mammals.
- 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, the correlation to underwater or airborne sound levels occurring at the time of this observable behavior.
    - Actions performed to minimize impacts to marine mammals.
    - Times when pile extraction is stopped due to presence of marine mammals within the shutdown zones and time when pile driving resumes.
- Post-activity observational survey-specific data:
    - Results, which include the detections of marine mammals, species and numbers observed, sighting rates and distances, behavioral reactions within and outside of safety zones.
    - A refined take estimate based on the number of marine mammals observed during the course of 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.

To minimize the likelihood that impacts will occur to the species, stocks and subsistence use of marine mammals, all construction activities will be conducted in accordance with all federal, state, and local regulations and minimization measures proposed by the Navy will be implemented to protect marine mammals. The Navy will coordinate all activities with the relevant federal and state agencies. These include, but are not limited to: the NMFS, USFWS, U.S. Coast Guard, Federal Energy Regulatory Commission, U.S. Army Corps of Engineers, and the Washington Department of Fish and Wildlife. The Navy will share field data and behavioral observations on all marine mammals that occur in the project area. Draft results of each monitoring effort will be provided to NMFS in a summary report within 60 days of the conclusion of monitoring. This information could be made available to regional, state and federal resource agencies, scientists, professors, and other interested private parties upon written request to NMFS.

Additionally the Navy provides a significant amount of funding and support for marine research. The Navy provided $26 million in Fiscal Year 2008 and $22 million in Fiscal Year 2009 to universities, research institutions, federal laboratories, private companies, and independent researchers around the world to study marine mammals. Over the past five years, the Navy has funded over $100 million in marine mammal research, with several projects ongoing in Washington.

The Navy sponsors 70% of all U.S. research concerning the effects of human-generated sound on marine mammals and 50% of such research conducted worldwide. Major topics of Navy-supported research include the following:

- Gaining a better understanding of marine species distribution and important habitat areas,
- Developing methods to detect and monitor marine species before and during training,
- Understanding the effects of sound on marine mammals, and
- Developing tools to model and estimate potential effects of sound.

The Navy has sponsored several workshops to evaluate the current state of knowledge and potential for future acoustic monitoring of marine mammals. The workshops brought together acoustic experts and marine biologists from the Navy and other research organizations to present data and information on current acoustic monitoring research efforts and to evaluate the potential for incorporating similar technology and methods in Navy activities. The Navy supports research efforts on acoustic monitoring and will continue to investigate the feasibility of passive acoustics as a potential monitoring tool. Overall, the Navy will continue to research and contribute to university/external research to improve the state of the science regarding marine species biology and acoustic effects. These efforts include monitoring programs; data sharing with NMFS from research and development efforts; and future research as described previously.

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