Port of Alaska Modernization Program South Floating Dock Project:

Application for a Marine Mammal Protection Act Incidental Harassment Authorization

Prepared for the

Port of Alaska

2000 Anchorage Port Road
Anchorage, Alaska 99501

May 12, 2021

CH2M, Inc.
Anchorage, Alaska

HDR, Inc.
Anchorage, Alaska

This page intentionally left blank.

List of Preparers

Heather Spore: HDR Environmental Scientist

Brett Carrothers: HDR Wildlife Biologist

Leslie Curran: HDR Wildlife Biologist

Suzann Speckman, PhD: HDR Alaska Marine Science Program Lead

Nathan Jones: HDR Senior Biologist

James Reyff: Illingworth & Rodkin Senior Consultant

Recommended Citation:

Port of Alaska. 2021. Port of Alaska Modernization Program, South Floating Dock Project: Application for a Marine Mammal Protection Act Incidental Harassment Authorization. Prepared by HDR, Inc., Anchorage, AK; and Illingworth & Rodkin, Petaluma, CA; for the Port of Alaska under contract to CH2M.

*This page intentionally le*ft blank.

Contents

Tables

Figures

Appendices

Acronyms and Abbreviations

ADF&G	Alaska Department of Fish and Game
CIMMC	Cook Inlet Marine Mammal Council
dB	Decibels
dBA	A-weighted Decibels
DPS	Distinct Population Segment
EFH	Essential Fish Habitat
ESA	Endangered Species Act
FR	*Federal Register*
HF	High Frequency
Hz	Hertz
ICRC	Integrated Concepts and Research Corporation
IHA	Incidental Harassment Authorization
JBER	Joint Base Elmendorf-Richardson
KABATA	Knik Arm Bridge and Toll Authority
kHz	Kilohertz
km^2	Square Kilometers
LF	Low Frequency
L_{pk}	Peak Sound Level
μPa	MicroPascals
m^2	square meter
MF	Mid-frequency
mi^2	Square Miles
MMO	Marine Mammal Observer
MMPA	Marine Mammal Protection Act
MTRP	Marine Terminal Redevelopment Project
NOAA	National Oceanic and Atmospheric Administration
NMFS	National Marine Fisheries Service
NPFMC	North Pacific Fishery Management Council
OSP	Optimum Sustainable Population
OW	Otariid in Water
PAMP	Port of Alaska Modernization Program
PCE	Primary Constituent Element
PCT	Petroleum and Cement Terminal

POA	Port of Alaska
PSO	Protected Species Observer
PTS	Permanent Threshold Shift
PW	Phocid in Water
rms	Root Mean Square
SEL	Sound Exposure Level
SEL_{cum}	Cumulative Sound Exposure Level
SFD	South Floating Dock
SPL	Sound Pressure Level
SSL	Sound Source Level
SSV	Sound Source Verification
TL	Transmission Loss
TL_c	Transmission Loss Coefficient
TPP	Test Pile Program
TTS	Temporary Threshold Shift
USACE	U.S. Army Corps of Engineers

1 Description of Specified Activity

1.1 Introduction

The Port of Alaska (POA), located on Knik Arm in upper Cook Inlet (Figure 1-1), provides critical infrastructure for the citizens of Anchorage and a majority of the citizens of Alaska. The existing marine-side infrastructure and support facilities at the POA are in need of replacement because of their structural condition. To address these deficiencies, the POA is modernizing its marine terminals through the Port of Alaska Modernization Program (PAMP). Plans for modernization include replacing deteriorated pile-supported infrastructure with new pile-supported infrastructure. One of the first priorities of the PAMP is to replace the existing Petroleum Oil Lubricants Terminal (commonly referred to as POL 1) with a new structure that exceeds current seismic standards. For the new Petroleum and Cement Terminal (PCT) Project to advance, the existing South Floating Dock (SFD)—a small, multipurpose, floating dock constructed in 2004—will be required to be relocated south of the PCT near the southern portion of the South Backlands Stabilization project. The existing location of the SFD will not allow docking operations at the SFD once the PCT is constructed due to proximity of one of the PCT mooring dolphins.

The National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) regulations governing the issuance of Incidental Harassment Authorizations (IHAs) and Letters of Authorization permitting the incidental take of marine mammals under certain circumstances are codified in 50 Code of Federal Regulations Part 216, Subpart I (Sections 216.101–216.108). The Marine Mammal Protection Act (MMPA) defines “take” to mean “to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal” (16 United States Code Chapter 31, Section 1362(13)). Section 216.104 sets out 14 specific items that must be addressed in requests for rulemaking and renewal of regulations pursuant to Section 101(a)(5) of the MMPA. Those 14 items are addressed in this application for an IHA. The POA requests authorization for the take of small numbers of marine mammals, by Level A and Level B harassment, incidental to construction of the SFD near its existing port facility in Anchorage, Alaska.

1.2 Project Purpose and Need

The purpose of the SFD is to provide staging, mooring, and docking of small vessels, such as first responder (e.g., Anchorage Fire Department, U.S. Coast Guard) rescue craft, small work skiffs, and occasionally tug boats, in an area close to the daily operations at the Port. Upper Cook Inlet near Anchorage exhibits the largest tide range in the U.S. and one of the largest tide ranges in the world, with an average daily difference between high and low tide of 26.2 feet and an extreme difference of up to 41 feet (NOAA 2015). The ability of first responders to conduct response operations during low tide stages requires access to the SFD (Figure 1-2), as the waterline is inaccessible for vessels at the Anchorage public boat launch at Ship Creek during low-tide stages (Figure 1-3). The planned relocation of the SFD south of the new PCT structure also will provide continuous access to the water, and relocation is needed to continue to provide timely, safe access for rescue personnel and vessels in the northern portion of Cook Inlet. The existing location of the SFD will not allow docking operations at the SFD once the PCT is constructed due to proximity of one of the PCT mooring dolphins.

Relocation of the SFD will include the removal of the existing structure, including the float and gangway, and installation of 12 permanent 36-inch steel piles: 10 plumb and 2 battered. Construction of the SFD will also require up to six temporary 24- or 36-inch plumb template piles. This relatively small project with a small number of piles provides critical support for the safety and security of Anchorage, and it is anticipated that the project’s brief duration and limited amount of pile installation and removal will have minimal effects on the area’s marine mammal populations.

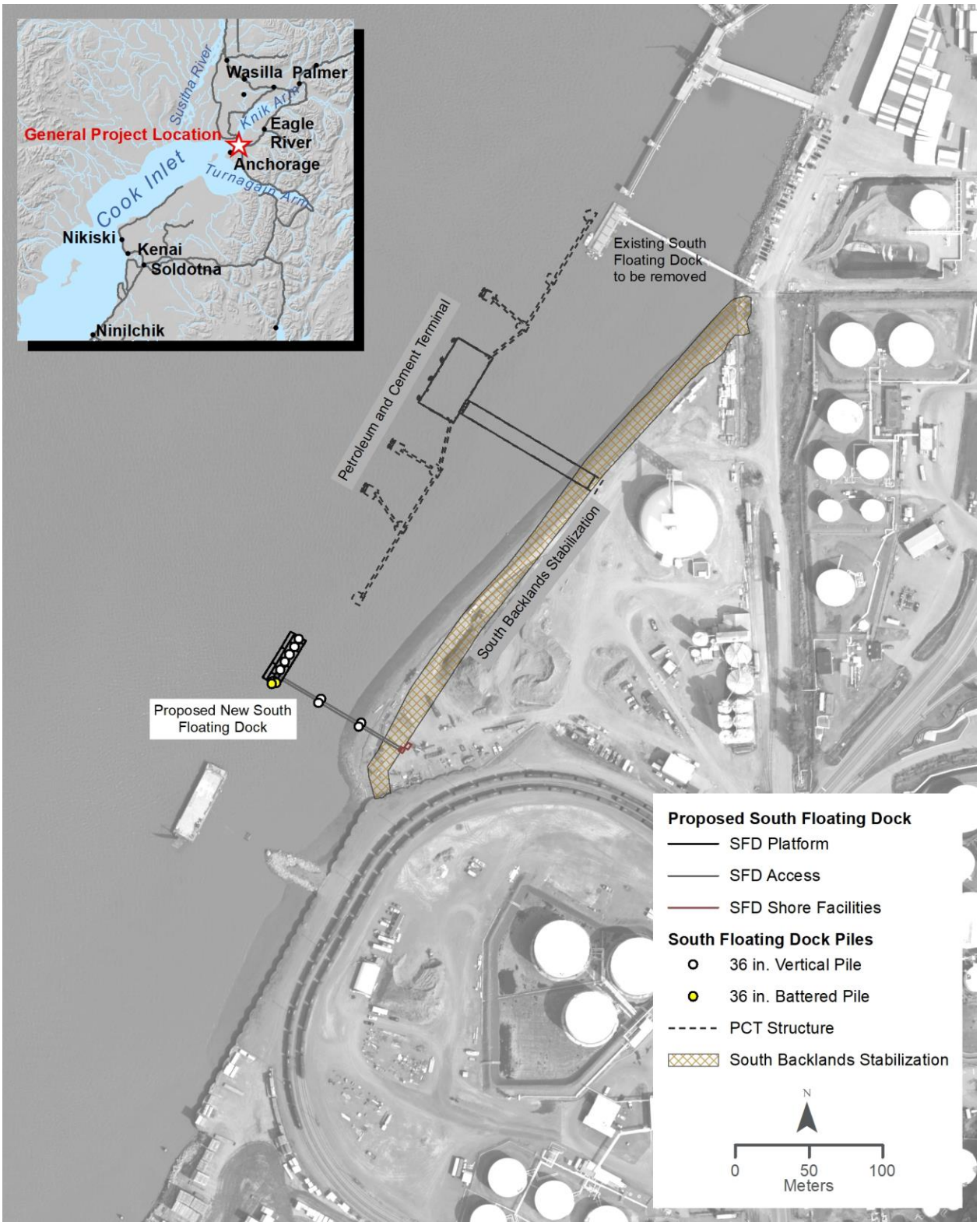

Figure 1-1. Overview of South Floating Dock

Figure 1-2. Cross-sectional View of the Current Location of the SFD Showing that the Dock Face Remains Watered and Available for Use at Low Tide Levels

Figure 1-3. View of the Anchorage Public Boat Dock by Ship Creek Showing that the Dock is Dry and Unavailable for Use at Low Tide Levels

1.3 Project Summary

In-water pile installation and removal associated with SFD removal and construction is anticipated to take place between April and November 2021. Construction dates may change because of unexpected project delays, ongoing construction activities in other areas of the POA, timing of ice-out and spring breakup, and other factors. The project design and construction methods have been modified to achieve the least practicable adverse impact on marine mammals, particularly in regards to minimizing the required number of temporary piles. Use of a bubble curtain during installation of permanent and installation and removal of temporary plumb piles will reduce propagation of sound in the water. Use of an unconfined bubble curtain is proposed instead of a confined bubble curtain in order to reduce the need for templates that would be required to stabilize a confined bubble curtain, substantially reducing the required number of temporary template piles by approximately 14 piles. The reduced number of template piles minimizes the estimated total days and hours of pile installation and removal associated with construction, which in turn reduces the overall estimated marine mammal exposures.

The following project description represents the planned approach for construction of the SFD. Actual field conditions may require minor adjustments to this construction approach to address issues that may arise due to constructability, safety, or encountering an erratic in the soil profile.

All pile installation and removal will take place from a floating work barge and crane. A marine-based operation is required because of the extreme tidal range, which precludes use of a land-based crane in the absence of a temporary support trestle. The floating work barge will require sufficient water depth for support; therefore, opportunities to install piles when the project site is dewatered will be limited. It is anticipated that piles will be installed in water.

Twelve 36-inch permanent steel piles will be required to construct the new SFD: four piles for the gangway and eight for the floating dock. Two of the permanent piles located at the south corner of the floating dock will be battered piles due to lateral ice flow conditions. Two of the permanent 36-inch gangway piles at Bent B, the bent closest to shore, may be installed when the area is de-watered, but will likely be installed in water. Temporary template piles may be required to assist with permanent pile placement and would consist of up to six 24- or 36-inch steel pipe piles: four for the gangway and two for the float. To allow for flexibility in construction, temporary piles may be all of one size or a combination of 24- and 36-inch steel pipe piles.

All permanent and temporary piles will be installed with a vibratory hammer to the greatest extent possible. Each pile is estimated to require approximately 45 minutes of vibratory installation time, based on an analysis of PCT Phase 1 data. Vibratory hammer installation will be the preferred method; however, an impact hammer may be used if a pile encounters refusal and cannot be advanced to the necessary tip elevation with the vibratory hammer. Refusal criteria for a vibratory hammer is defined by the hammer manufacturer, and is described as the pile not advancing one foot within 30 seconds of vibratory hammer operation at full speed. Three piles have deeper embedment depth than others, and therefore may reach refusal before the specificed minimum tip elevation. In such a situation, an impact hammer would be needed to drive these piles to their required depth. A small number of total piles, estimated at approximately 25 percent or up to 5 piles, may reach refusal before the tip elevation is reached, requiring up to 20 minutes of impact installation each at 1 pile per day. It is estimated that each of these piles could require up to 1,000 strikes, which was the mean number of strikes measured for 48-inch production piles during the PCT Phase 1 construction sound source verification (SSV) study (I&R 2021). It is likely that the number of strikes will be less due to the smaller pile sizes associated with SFD. To be precautious, 1,000 strikes were used to calculate Level A zone sizes (see Section 6.4.1). It is assumed that if a pile does require impact installation, the vibratory installation time would be reduced by a commensurate amount (i.e., 15 minutes of impact installation would replace 15 minutes of vibratory installation), and the overall duration of installation would remain the same.

Temporary template piles will be removed with a vibratory hammer. Based on an analysis of PCT Phase 1 data, each temporary pile will require approximately 75 minutes of vibratory hammer removal. Knik Arm soils have demonstrated a strong set up and resistance condition on temporary piles due to dense clay composition, making removal lengthier and more difficult than installation. This duration is approximately two-thirds of the duration required for vibratory removal of 36-inch temporary trestle piles during PCT Phase 1 construction. Temporary piles for the SFD will be in place for only approximately 3 weeks and will not be load-bearing, in contrast to the piles used for the PCT temporary trestle that were in place for approximately five months and subject to loads from the construction crane. It is therefore estimated that the temporary SFD piles will require less time for removal than PCT piles at approximately two-thirds duration.

An unconfined bubble curtain noise attenuation system will be used to mitigate noise propagation during vibratory installation and potential impact installation of 10 permanent plumb piles and 6 temporary plumb piles, and vibratory removal of 6 temporary piles. Pile installation or removal in the dry, which is a completely de-watered state, is unlikely but if it occurs, will be conducted without a bubble curtain (POA 2020). Since an unconfined bubble curtain system will not be used for battered piles, the unattenuated Level A and Level B harassment zones for that pile size will be implemented as described in Section 6.4.

All of the existing SFD float and gangway piles will remain in place; a vibratory hammer will not be required for their removal.

It is estimated that construction will require 21 hours and 9 to 24 non-consecutive days for in-water pile installation and removal (Table 1-1). The number of days may shift as scheduling, production rates, or other factors vary.

Table 1-1. Pile Details and Estimated Effort Required for Pile Installation and Removal

Pipe Pile Diameter	Feature	Number of Plumb Piles	Number of Battered Piles	Vibratory Installation Duration per Pile (minutes)	Vibratory Removal Duration per Pile (minutes)	Potential Impact Strikes per Pile, if Needed (up to 5 piles)	Production Rate (piles/day)		Days of Installation	Days of Removal
							Installation	Removal		
36-inch	Floating Dock	6	2	45	n/a	1,000	1–3	n/a	4–12	n/a
	Gangway	4	0		n/a	1,000	1–3	n/a		n/a
24- or 36-inch	Temporary Template Piles	6	0	45	75	1,000	1–2	1–3	3–6	2–6
Project Totals		**16**	**2**	**13.5 hours**	**7.5 hours**		**--**	**--**	**7–18**	**2–6**

1.4 Applicable Permits/Authorizations

The following permits/authorizations are applicable to in-water work addressed by this application:

- U.S. Army Corps of Engineers (USACE) Section 10 of the Rivers and Harbors Act of 1899
- Section 401 of the Clean Water Act
- Endangered Species Act (ESA) Section 7 Consultation
- Marine Mammal Protection Act (MMPA)
- Magnuson-Stevens Fishery Conservation and Management Act

This page intentionally left blank.

2 Dates, Durations, and Geographic Region

2.1 Dates and Durations

2.1.1 Dates

The POA requests an IHA that is valid for 1 year, from 01 April 2021 through 31 March 2022.

2.1.2 Durations

The number of days of SFD in-water pile installation and removal is estimated at up to 24 non-consecutive days (Table 1-1) and is anticipated to occur between April and November 2021. These dates are estimates and may shift as contracting details, starting dates, ice-free conditions, production rates, and other factors vary. Construction dates also may change because of unexpected project delays and ongoing construction activities in other areas of the POA.

2.2 Geographic Region

The following sections describe the overall geographical region of the SFD Project site, comprised of the physical, acoustical, and biological environments. Aspects of the biological environment considered include Essential Fish Habitat (EFH), fish, and invertebrates.

The Municipality of Anchorage is located in the lower reaches of Knik Arm of upper Cook Inlet (Figure 2-1). The POA sits on the industrial waterfront of Anchorage, just south of Cairn Point and north of Ship Creek (Latitude 61° 15’ N, Longitude 149° 52’ W; Seward Meridian). Knik Arm and Turnagain Arm are the two branches of upper Cook Inlet, and Anchorage is located where the two arms join (Figure 2-1).

2.2.1 Physical Environment

Cook Inlet is a large tidal estuary that exchanges waters at its mouth with the Gulf of Alaska. The inlet is roughly 20,000 square kilometers (km^2; 7,700 square miles [mi^2]) in area, with approximately 1,350 linear kilometers (840 miles) of coastline (Rugh et al. 2000) and an average depth of approximately 100 meters (330 feet). Cook Inlet is generally divided into upper and lower regions by the East and West Forelands. Freshwater input to Cook Inlet comes from snowmelt and rivers, many of which are glacially fed and carry high sediment loads. Currents throughout Cook Inlet are strong and tidally periodic, with average velocities ranging from 3 to 6 knots (Sharma and Burrell 1970). Extensive tidal mudflats occur throughout Cook Inlet, especially in the upper reaches, and are exposed at low tides.

Cook Inlet is a seismically active region susceptible to earthquakes and has some of the highest tides in North America (NOAA 2015) that drive surface circulation. Cook Inlet contains substantial quantities of mineral resources, including coal, oil, and natural gas. During winter, sea, beach, and river ice are dominant physical forces within Cook Inlet. In upper Cook Inlet, sea ice generally forms in October to November, and continues to develop through February or March (Moore et al. 2000).

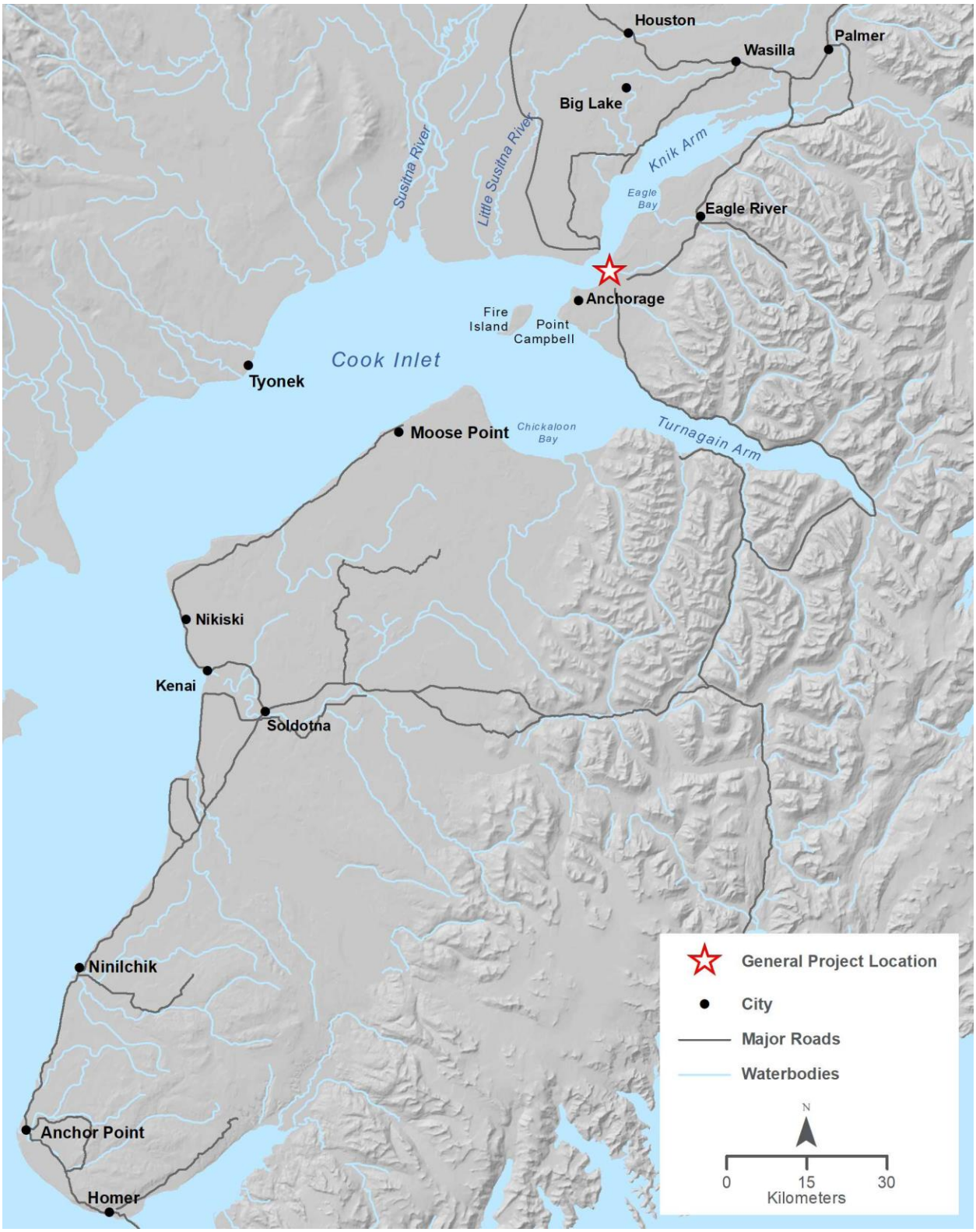

Figure 2-1. Overview of Knik Arm and Upper Cook Inlet

Northern Cook Inlet bifurcates into Knik Arm to the north and Turnagain Arm to the east (Figure 2-1). Knik Arm is generally considered to begin at Point Woronzof, 7.4 kilometers (4.6 miles) southwest of the POA. From Point Woronzof, Knik Arm extends about 48 kilometers (30 miles) in a north-northeasterly direction to the mouths of the Matanuska and Knik rivers. At Cairn Point, just northeast of the POA, Knik Arm narrows to about 2.4 kilometers (1.5 miles) before widening to as much as 8 kilometers (5 miles) at the tidal flats northwest of Eagle Bay at the mouth of Eagle River.

Knik Arm comprises narrow channels flanked by large tidal flats composed of sand, mud, or gravel, depending upon location. Approximately 60 percent of Knik Arm is exposed at Mean Lower Low Water. The intertidal (tidally influenced) areas of Knik Arm are mudflats, both vegetated and unvegetated, which consist primarily of fine, silt-sized glacial flour. Freshwater sources often are glacially born waters, which carry high suspended sediment loads, as well as a variety of metals such as zinc, barium, mercury, and cadmium. Surface waters in Cook Inlet typically carry high silt and sediment loads, particularly during summer, making Knik Arm an extremely silty, turbid waterbody with low visibility through the water column. The Matanuska and Knik rivers contribute the majority of fresh water and suspended sediment into Knik Arm during summer. Smaller rivers and creeks also enter along the sides of Knik Arm (USDOT and Port of Anchorage 2008).

Tides in Cook Inlet are semidiurnal, with two unequal high and low tides per tidal day (tidal day = 24 hours, 50 minutes). Due to Knik Arm's predominantly shallow depths and narrow widths, tides near Anchorage are greater than those in the main body of Cook Inlet. The tides at the POA have a mean range of about 8.0 meters (26 feet), and the maximum water level has been measured at more than 12.5 meters (41 feet) at the Anchorage station (NOAA 2015). Maximum current speeds in Knik Arm, observed during spring ebb tide, exceed 7 knots (12 feet/second). These tides result in strong currents in alternating directions through Knik Arm and a well-mixed water column. The navigation harbor at the POA is a dredged basin in the natural tidal flat. Sediment loads in upper Cook Inlet can be high; spring thaws occur, and accompanying river discharges introduce considerable amounts of sediment into the system (Ebersole and Raad 2004). Natural sedimentation processes act to continuously infill the dredged basin each spring and summer.

The POA's boundaries currently occupy an area of approximately 129 acres. Other commercial and industrial activities related to secured maritime operations are located near the POA on Alaska Railroad Corporation property immediately south of the POA, on approximately 111 acres at a similar elevation. The PCT footprint spans approximately 0.87 acre and is approximately 0.74 kilometer (0.46 mile) north of Ship Creek, a location of concentrated marine mammal activity during seasonal runs of several salmon species. Ship Creek serves as an important recreational fishing resource and is stocked twice each summer. Ship Creek flows into Knik Arm through the Municipality of Anchorage industrial area. Joint Base Elmendorf-Richardson (JBER) is located east of the POA, approximately 30.5 meters (100 feet) higher in elevation. The U.S. Army Defense Fuel Support Point-Anchorage site is located east of the POA, south of JBER, and north of Alaska Railroad Corporation property. The perpendicular distance to the west bank directly across Knik Arm from the POA is approximately 4.2 kilometers (2.6 miles). The distance from the POA (east side) to nearby Port MacKenzie (west side) is approximately 4.9 kilometers (3.0 miles).

2.2.2 Acoustical Environment

The physical characteristics of Knik Arm contribute to elevated ambient sound levels due to noise produced by winds and tides (Section 2.2.1). The lower range of broadband (10 to 10,000 Hertz [Hz]) background sound levels obtained during underwater measurements at Port MacKenzie, located across Knik Arm from the POA, ranged from 115 decibels (dB) to 133 dB referenced to 1 microPascal (dB re 1 µPa; Blackwell 2005). All underwater sound levels in this application are referenced to 1 µPa. Background sound levels measured during the 2007 test pile study for the POA's Marine Terminal Redevelopment Project (MTRP) site ranged from 105 to 135 dB (URS 2007). The ambient background sound pressure levels (SPLs) obtained in that study were highly variable, with most SPL recordings

exceeding 120 dB. Background sound levels measured in 2008 at the MTRP site ranged from 120 to 150 dB (Scientific Fishery Systems, Inc. 2009). These measurements included industrial sounds from maritime operations, but ongoing USACE maintenance dredging and pile driving from construction were not underway at the time of the study.

Ambient sound levels were measured at the POA from the PAMP 2016 Test Pile Program (TPP), when ambient sound recordings were measured at two locations during a 3-day break in pile installation. Median ambient noise levels, measured at a location just offshore of the POA SFD and at a second location about 1 kilometer offshore, were 117.0 and 122.2 dB, respectively (POA 2016a). The two IHAs for Phase 1 and Phase 2 of the 2020 PCT issued by NMFS in April 2020 (85 *Federal Register* [FR] 19294) used 122.2 dB as ambient noise. A recent SSV study conducted in 2020 at the PCT did not directly measure ambient noise but did not indicate that ambient noise levels were significantly different from 122.2 dB (James Reyff, pers. comm., 26 August 2020).

2.2.3 Biological Environment

2.2.3.1 Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act defines EFH as "waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The Act notes that:

> *…for the purpose of interpreting the definition of EFH, "waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities, "necessary" means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species full life cycle.*

The North Pacific Fishery Management Council (NPFMC) identifies estuarine and marine waters in the vicinity of the POA as EFH for Chinook (*Oncorhynchus tshawytscha*), chum (*O. keta*), coho (*O. kisutch*), sockeye (*O. nerka*), and pink salmon (*O. gorbuscha*) (NPFMC 2012). Marine EFH for salmon in Alaska includes all estuarine and marine areas utilized by Pacific salmon of Alaska origin, extending from the influence of tidewater and tidally submerged habitats to the limits of the U.S. Exclusive Economic Zone (NPFMC 2016).

Eulachon (*Thaleichthys pacificus*), longfin smelt (*Spirinchus thaleichthys*), and low numbers of Pacific cod (*Gadus macrocephalus*), walleye pollock (*Theragra chalcogramma*), Pacific herring (*Clupea pallasii*), and Pacific staghorn (*Leptocottus armatusspecies*) have also recently been captured in upper Cook Inlet (Houghton et al. 2005; NOAA 2016). While these species are managed by the fishery management plan for groundfish in the Gulf of Alaska, waters in the vicinity of the POA are not identified as EFH for these species (NPFMC 2016; Matt Eagleton, pers. comm., 01 January 2016). In addition, streams, lakes, ponds, wetlands, and other water bodies that support Pacific salmon, as identified by the Alaska Department of Fish and Game (ADF&G) *Anadromous Waters Catalog* (Johnson and Blossom 2018), are considered freshwater EFH for Pacific salmon. Details of EFH and the life stages of these species can be found in the *Anchorage Port Modernization Program Essential Fish Habitat Technical Memorandum – APMP Petroleum and Cement Terminal Project* (POA 2017a).

2.2.3.2 Fish

All fish species in Knik Arm are important to the diets of marine mammals, and many are important to recreational sport fishing as catch or prey. The seasonal fish resources in upper Cook Inlet are generally characterized by the spring to fall availability of migratory eulachon, out-migrating salmon smolt, and returning adult salmon, with variable species abundance and distribution throughout summer (Moore et al. 2000). Survey data indicate that Knik Arm, including in the vicinity of the POA, provides migration,

rearing, and foraging habitat to a wide diversity of marine and anadromous fish (FHWA and DOT&PF 1983; Houghton et al. 2005). NMFS determined that Chinook, sockeye, chum, and coho salmon; Pacific eulachon; Pacific cod; walleye pollock; saffron cod (*Eleginus gracilis*); and yellowfin sole (*Limanda aspera*) are primary prey species that are essential to the conservation of the Cook Inlet beluga whale (NMFS 2016).

Biologists captured a total of 19 fish species in Knik Arm during nearshore beach seine and mid-channel surface tow net surveys in 2004 and 2005 (Houghton et al. 2005). Juvenile salmon (five species combined), three-spine stickleback (*Gasterosteus aculeatus*), saffron cod, and eulachon were among the most abundant species captured (Houghton et al. 2005).

Coho salmon was the most abundant juvenile salmon species in April; abundance increased to a peak in July before declining, with smaller numbers present in the nearshore Knik Arm through November (Houghton et al. 2005). Coho, and to a lesser degree sockeye salmon, had the largest and longest presence in Knik Arm of the juvenile salmonids. Juvenile pink and chum salmon had the shortest residency time in Knik Arm compared to other salmon species. Relatively small numbers of juvenile pink and chum salmon were captured in April; numbers peaked in May and June before declining sharply (Houghton et al. 2005). Juvenile Chinook salmon were captured in April; numbers increased to a peak in June and declined in August, with few present through October 2004. Juvenile Chinook salmon captured from between Cairn Point and Point Woronzof were primarily of William Jack Hernandez Sport Fish Hatchery origin (Houghton et al. 2005). Few sockeye were observed in Knik Arm before May, but sockeye were abundant from June through August, before declining in September and October (Houghton et al. 2005).

Tow net surveys confirmed the presence of substantial numbers of juvenile salmon throughout the open waters of Knik Arm (Houghton et al. 2005). Juvenile pink and chum salmon were more abundant in mid-channel tow net sampling than nearshore beach seining, which suggests that they may not have a strong association with shorelines in Knik Arm. Higher catches of juvenile coho and Chinook salmon in beach seines, as compared to tow net survey catches, suggest a closer association with shoreline habitat in Knik Arm. The numbers of juvenile sockeye salmon captured during tow net surveys as compared to beach seine hauls did not differ substantially (Houghton et al. 2005).

Based on the spring 1983 and 2004–2005 sampling efforts, Houghton et al. (2005) suggested the species most likely to contribute to beluga whale diets in Knik Arm include:

- April: Eulachon, saffron cod
- May: Eulachon, Chinook salmon, saffron cod
- June: Chinook salmon, saffron cod (questionable)
- July: Pink, chum, sockeye, and coho salmon
- August: Coho salmon, saffron cod
- September: Saffron cod, longfin smelt
- October: Saffron cod, longfin smelt
- November: Saffron cod

2.2.3.3 Zooplankton and Invertebrates

Fish and benthos sampling were conducted around the POA and north to Eagle Bay from July through November 2004, and from April through September 2005 (Houghton et al. 2005). These studies concluded that the area around the POA supports low benthic primary productivity, except for small patches of macroalgae (rockweed and annual green algae), which were present on occasional boulders and riprap and in tidal marshes. Plankton samples included three species of copepods, four species of amphipods, one species of mysid, and several additional classes, orders, and families of freshwater invertebrates. The zooplankton samples were generally characterized by eight primary taxonomic groups including *Crangon* shrimp (spp.), copepods, amphipods, mysids, fish and larval fish, isopods, terrestrial invertebrates, and a marine polychaete (*N. limnicola)*. Overall, the most abundant group captured was larval fish (55 percent of total catch), followed by amphipods (10.7 percent), mysids (10.1 percent), copepods (9.1 percent), and *Crangon* spp. (2.3 percent). In general, zooplankton abundance was low, while crustaceans of sizes larger than could be consumed by juvenile salmon were abundant (Houghton et al. 2005).

This page intentionally left blank.

3 Species and Abundance of Marine Mammals

Marine mammals most likely to be observed within the upper Cook Inlet project area include harbor seals (*Phoca vitulina*), beluga whales (*Delphinapterus leucas*), and harbor porpoises (*Phocoena*; NMFS 2003; Table 3-1). Species that may be encountered infrequently or rarely within the project area are killer whales (*Orcinus orca*), humpback whales (*Megaptera novaeangliae*), and Steller sea lions (*Eumetopias jubatus*; Table 3-1). Marine mammals occurring in Cook Inlet that are not expected to be observed in the project area include gray whale (*Eschrichtius robustus*), minke whale (*Balaenoptera acutorostrata*), and Dall's porpoise (*Phocoenoides dalli*). Data from the Alaska Marine Mammal Stranding Network database (NMFS unpublished data) provide additional support for the determination that these species rarely occur in upper Cook Inlet. Since 2011, only three humpback whales, one minke whale, and one Dall's porpoise have been documented as stranded in the portion of Cook Inlet north of Point Possession. All were dead upon discovery; it is unknown if they were alive upon their entry into upper Cook Inlet or drifted into the area with the tides. No gray whales were reported as stranded in upper Cook Inlet during this time period. However, one live gray whale was observed on 24 May 2020 during PCT Phase 1 construction monitoring (61N Environmental 2021). For comparison, 23 beluga whale strandings were documented in upper Cook Inlet during the same time period, from a population that is currently about 279 individuals. One dead beluga whale calf was discovered in a state of advanced decomposition in the North End (North Expansion) area of the Port on 18 May 2020 during routine marine mammal observations associated with PCT Phase 1 construction. NMFS was contacted immediately to report the discovery, and a report documenting the location and details of the animal was submitted to NMFS within 24 hours. The beluga whale calf had clearly been dead for many weeks and its death was not attributed to POA activities. With very few exceptions, minke whales, gray whales, and Dall's porpoises do not occur in upper Cook Inlet, and therefore take of these species is not requested in this application.

Except for the beluga whale and harbor seal, very small proportions of the populations of the four other species occur in upper Cook Inlet near the SFD Project site. This IHA application assesses the potential impacts of the project on the following six species, which are discussed more fully in Section 4:

- Harbor seal
- Steller sea lion
- Harbor porpoise
- Killer whale
- Beluga whale
- Humpback whale

Table 3-1. Marine Mammals in or near the Project Area

Species or DPS	Abundance (Population/Stock)	MMPA Designation	ESA Listing	Occurrence in Project Area
Harbor seal	28,411 (Cook Inlet/Shelikof Strait)	None	None	Common
Western DPS Steller sea lion	52,932 (Western DPS)	Depleted & Strategic	Endangered	Rare
Harbor porpoise	31,046 (Gulf of Alaska)	Strategic	None	Occasional
Killer whale (Orca)	2,347 (Eastern North Pacific Alaska Resident)	None	None	Rare
	587 (Gulf of Alaska, Aleutian Islands, & Bering Sea Transient)	None	None	
Cook Inlet beluga whale	279[a] (Cook Inlet)	Depleted & Strategic	Endangered	Common
Humpback whale	11,398 (Hawaii DPS)	Depleted & Strategic	None	Rare
	3,264 (Mexico DPS)	Depleted & Strategic	Threatened	
	1,059 (Western North Pacific DPS)	Depleted & Strategic	Endangered	

[a] N_{best} = 279. The 95 percent probability range is 250–317 whales (Shelden and Wade 2019).

Source: Humpback whale population estimates: Wade et al. 2016. All other population estimates: Muto et al. 2020a and Muto et al. 2020b.

Note: DPS = Distinct Population Segment; ESA = Endangered Species Act; MMPA = Marine Mammal Protection Act.

4 Affected Species Status and Distribution

4.1 Harbor Seal

4.1.1 Status and Distribution

Harbor seals inhabit waters all along the western coast of the United States, British Columbia, and north through Alaskan waters to the Pribilof Islands and Cape Newenham. There are 12 recognized stocks of harbor seals in Alaska. Harbor seals in the project area are members of the Cook Inlet/Shelikof stock; no other stock is present within the project area. Distribution of the Cook Inlet/Shelikof stock extends from Unimak Island, in the Aleutian Islands archipelago, north through all of upper and lower Cook Inlet (Muto et al. 2020a).

The current abundance estimate for the Cook Inlet/Shelikof stock is based on aerial survey data from 1998 through 2018 and is estimated at 28,411 individuals, with a negative population growth trend of minus 111 seals per year (Muto et al. 2020a). The estimated average annual subsistence harvest of the Cook Inlet/Shelikof stock between 2004 and 2008 was 233 individuals (Muto et al. 2020a). Harbor seals are not listed under the ESA or designated as depleted or strategic under the MMPA, but like all marine mammals, they are protected under the MMPA.

4.1.2 Foraging Ecology

Harbor seals forage in marine, estuarine, and occasionally freshwater habitat. They are opportunistic feeders that adjust their local distribution to take advantage of locally and seasonally abundant prey (*as cited in* Payne and Selzer 1989; Baird 2001; Bjørge 2002). In Cook Inlet, harbor seals have been documented in higher concentrations near steelhead, Chinook, and salmon spawning streams during summer and may target more offshore prey species during winter (Boveng et al. 2012). Researchers have found that they complete both shallow and deep dives during hunting, depending on the availability of prey (Tollit et al. 1997).

Harbor seals are non-migratory, hauling out on rocks, reefs, beaches, and drifting glacial ice (Muto et al. 2018). Their movements are influenced by tides, weather, season, food availability, and reproduction, as well as individual sex and age class (Lowry et al. 2001; Small et al. 2003; Boveng et al. 2012).

4.1.3 Presence in Cook Inlet

Harbor seals inhabit the coastal and estuarine waters of Cook Inlet, and are observed in both upper and lower Cook Inlet throughout most of the year (Boveng et al. 2012; Shelden et al. 2013). Recent research on satellite-tagged harbor seals observed several movement patterns within Cook Inlet (Boveng et al. 2012). In fall, a portion of the harbor seals appeared to move out of Cook Inlet and into Shelikof Strait, northern Kodiak Island, and coastal habitats of the Alaska Peninsula. The western coast of Cook Inlet had higher usage by harbor seals than eastern coast habitats, and seals captured in lower Cook Inlet generally exhibited site fidelity by remaining south of the Forelands in lower Cook Inlet after release (Boveng et al. 2012).

The presence of harbor seals in upper Cook Inlet is seasonal. Harbor seals are commonly observed along the Susitna River and other tributaries within upper Cook Inlet during eulachon and salmon migrations (NMFS 2003). The major haulout sites for harbor seals are in lower Cook Inlet; however, there are a few in upper Cook Inlet, including near the Little and Big Susitna rivers, Beluga River, Theodore River, and Ivan River (Barbara Mahoney, pers. comm., 16 November 2020; Montgomery et al. 2007). During beluga whale aerial surveys of upper Cook Inlet from 1993 to 2012, harbor seals were observed 24 to 96 kilometers (15 to 60 miles) south-southwest of Anchorage at the Chickaloon, Little Susitna, Susitna, Ivan, McArthur, and Beluga rivers (Shelden et al. 2013).

4.1.4 Presence in Project Area

Harbor seals are commonly observed within the project area, particularly foraging near the mouth of Ship Creek (Cornick et al. 2011; Shelden et al. 2013; 61N Environmental 2021). During annual marine mammal surveys conducted by NMFS since 1994, harbor seals have been observed in Knik Arm and in the vicinity of the POA (Shelden et al. 2013) but are not known to haul out within the project area.

Harbor seals have been observed during construction monitoring at the POA from 2005 through 2011, and in 2016; data were unpublished for years 2005 through 2007 (Table 4-1; Prevel-Ramos et al. 2006; Markowitz and McGuire 2007; Cornick and Saxon-Kendall 2008, 2009; Cornick et al. 2010, 2011). Harbor seals were observed in groups of one to seven individuals (Cornick et al. 2011; Cornick and Seagars 2016). Harbor seals were also observed near the POA from 27 April through 30 September 2020 during the PCT Phase 1 construction monitoring (61N Environmental 2021). Sighting rates of harbor seals have been highly variable, and sighting rates may have increased during MTRP monitoring between 2005 and 2020 (Table 4-1). It is unknown whether any potential increase was due to local population increases or habituation to ongoing construction activities. It is possible that increased sighting rates are correlated with increased monitoring efforts, especially in 2020, when the number of observers and monitoring stations increased to 11 and 4, respectively.

Table 4-1. Summary of Harbor Seals Previously Documented at the POA

Year	Monitoring Effort			Total # of Sightings	Total # of Harbor Seals Observed	Survey
	Time Frame	# of Days	# of Hours			
2005	August 2–Nov. 28	51	374	NA	NA	POA: Scientific Monitoring
2006	April 26–Nov. 3	95	564	NA	NA	POA: Scientific Monitoring
2007	Oct. 9–Nov. 20	28	139	NA	NA	POA: Scientific Monitoring
2008	June 24–Nov. 14	86	612	2	2	POA: Scientific Monitoring
2008	July 24–Nov. 26	108	607[a]	1	1	POA: Construction Monitoring
2009	May 4–Nov. 18	86	783	1	1	POA: Scientific Monitoring
2009	March 28–Dec. 14	214	3,322[a]	NA	34[b]	POA: Construction Monitoring
2010	June 29–Nov. 19	87	600	0	0	POA: Scientific Monitoring
2010	July 21–Nov. 20	106	862[a]	13	13	POA: Construction Monitoring
2011	June 28–Nov. 15	104	1,202	32	57	POA: Scientific Monitoring
2011	July 17–Sept. 27	16	NA	2	2	POA: Construction Monitoring
2016	May 3–June 21	19	83.5	28	28	TPP: Marine Mammal Monitoring
2020	April 27–Nov. 24	128	1,238.9	321	340	POA: Construction Monitoring

[a] Intermittent in-water pile-driving hours.

[b] Additionally, three unidentified pinnipeds were documented.

Source: Prevel-Ramos et al. 2006; Markowitz and McGuire 2007; Cornick and Saxon-Kendall 2008, 2009; Cornick et al. 2010, 2011; Cornick and Pinney 2011; ICRC 2009, 2010, 2011, 2012; Cornick and Seagars 2016; 61N Environmental 2021.

Notes: NA = Not available; the information was not provided in the reports. Reports for monitoring in 2005, 2006, and 2007 do not indicate whether or not harbor seals were sighted. The 2009 construction monitoring report does not indicate the total number of sightings, only the total number of harbor seals observed. POA = Port of Alaska; TPP = Test Pile Program.

During the 2020 PCT Phase 1 construction monitoring, harbor seals were regularly observed in the vicinity of the POA with frequent observations near the mouth of Ship Creek, southeast of the SFD

location. Harbor seals were observed almost daily during construction, with 54 individuals documented in July, 66 documented in August, and 44 sighted in September (61N Environmental 2021). Preliminary observation data indicate that the most common behavior of harbor seals documented during the 2020 PCT Phase 1 construction is described as "looking and sinking," with that behavior documented throughout all hours of observation.

4.1.5 Acoustics

Harbor seals respond to underwater sounds from approximately 1 to 180 kilohertz (kHz), with a functional high-frequency limit around 60 kHz and peak sensitivity at about 32 kHz (Kastak and Schusterman 1995). Hearing ability in the air is greatly reduced (by 25 to 30 dB); harbor seals respond to sounds from 1 to 22.5 kHz, with a peak sensitivity of 12 kHz (Kastak and Schusterman 1995). NMFS (2018a) defines harbor seals' hearing range as between 50 Hz and 86 kHz.

4.2 Steller Sea Lion

4.2.1 Status and Distribution

Two Distinct Population Segments (DPSs) of Steller sea lion occur in Alaska: the western DPS and the eastern DPS. The western DPS includes animals that occur west of Cape Suckling, Alaska, and therefore includes individuals within the project area. The western DPS was listed under the ESA as threatened in 1990, and its continued population decline resulted in a change in listing status to endangered in 1997. Since 2000, studies indicate that the population east of Samalga Pass (i.e., east of the Aleutian Islands) has increased and is potentially stable (Muto et al. 2020b). For the region that encompasses Cook Inlet (Central Gulf of Alaska), the annual trend in counts (annual rates of change) of western DPS Steller sea lions is 4.16 for non-pups (adults and juveniles) and 3.01 for pups for the period 2002 through 2018 (Sweeney et al. 2016; Muto et al. 2020b). The most recent abundance estimate for the western DPS is 12,581 pups and 40,351 non-pups, totaling 52,932 individuals (Muto et al. 2020b).

4.2.2 Foraging Ecology

Steller sea lions feed on seasonally abundant prey throughout the year, predominately on species that aggregate in schools or for spawning. They adjust their distribution based on the availability of prey species. Principal prey include eulachon, walleye pollock, capelin, mackerel, Pacific salmon, Pacific cod, flatfishes, rockfishes, Pacific herring, sand lance, skates, squid, and octopus (Womble and Sigler 2006; Womble et al. 2009).

4.2.3 Presence in Cook Inlet

It is rare for Steller sea lions to be observed in upper Cook Inlet. Steller sea lions have not been documented in upper Cook Inlet during beluga whale aerial surveys conducted annually in June from 1994 through 2012 and in 2014 (Shelden et al. 2013, 2015).

4.2.4 Presence in Project Area

Steller sea lions have been observed near the POA in June 2009 (ICRC 2009), May 2016 (Cornick and Seagars 2016), June 2019, and 2020 (61N Environmental 2021). In 2009, there were three Steller sea lion sightings that were believed to have been the same individual (ICRC 2009). In 2016, Steller sea lions were observed on 2 separate days. On 02 May 2016, one individual was sighted. On 25 May 2016, there were five Steller Sea lion sightings within a 50-minute period, and these sightings occurred in areas relatively close to one another (Cornick and Seagars 2016). Given the proximity in time and space, it is believed these five sightings were of the same individual sea lion. In 2019, one Steller sea lion was observed in June at the POA during transitional dredging (Port of Alaska, Final Marine Mammal

Observation Report, POA-2003-0502 M-13 Knik Arm). Six Steller sea lions were observed near the POA from 27 April through 24 November 2020 during Phase 1 PCT construction monitoring (61N Environmental 2021). All sightings occurred during summer, when the sea lions were likely attracted to ongoing salmon runs. However, considering the many hours of observations that have taken place in the area, the documented occurrence of Steller sea lions in the project area is rare.

4.2.5 Acoustics

The hearing capabilities of Steller sea lions are fairly similar to the hearing ranges of California sea lions, with slight variations in males and females (Kastelein et al. 2005; Mulsow and Reichmuth 2008). Kastelein et al. (2005) documented that the best hearing range for Steller sea lions is 1 to 16 kHz, but they are capable of detecting sounds between 60 Hz and 39 kHz (NMFS 2018a).

4.3 Harbor Porpoise

4.3.1 Status and Distribution

In Alaska, harbor porpoises are divided into three stocks: the Bering Sea stock, the Southeast Alaska stock, and the Gulf of Alaska stock. The Gulf of Alaska stock, which includes individuals in Cook Inlet, is currently estimated at 31,046 individuals (Muto et al. 2020a). Dahlheim et al. (2000) estimated abundance and density of harbor porpoises in Cook Inlet from surveys conducted in the early 1990s. The estimated density of animals in Cook Inlet was 7.2 per 1,000 km^2, with an abundance estimate of 136 (Dahlheim et al. 2000), indicating that only a small number use Cook Inlet. Hobbs and Waite (2010) estimated a harbor porpoise density in Cook Inlet of 13 per 1,000 km^2 from aerial beluga whale surveys in the late 1990s. Neither of these surveys included coastlines, which are used heavily by harbor porpoises (Shelden et al. 2014).

4.3.2 Foraging Ecology

Harbor porpoises can be opportunistic foragers but consume primarily schooling forage fish (Bowen and Siniff 1999). Harbor porpoises feed primarily on Pacific herring, squid, and smelts (North Pacific Universities 2015).

4.3.3 Presence in Cook Inlet

Harbor porpoises occur in both upper and lower Cook Inlet, and there has been an increase in harbor porpoise sightings in upper Cook Inlet over the past 2 decades (Shelden et al. 2014). Small numbers of harbor porpoises have been consistently reported in upper Cook Inlet between April and October. The highest monthly counts include 17 harbor porpoises reported between spring and fall 2006 (Prevel-Ramos et al. 2008), 14 in spring 2007 (Brueggeman et al. 2007), 12 in fall 2007 (Brueggeman et al. 2008a), and 129 between spring and fall 2007 (Prevel-Ramos et al. 2008). These observations occurred between Granite Point (near Tyonek) and the Susitna River. The number of porpoises counted more than once was unknown, indicating that the actual numbers are likely smaller than reported. The overall increase in the number of harbor porpoise sightings in upper Cook Inlet is unknown, although it may be an artifact from increased studies and marine mammal monitoring programs in upper Cook Inlet. It is also possible that the reduction in the Cook Inlet beluga whale range has opened up previously occupied beluga whale range to harbor porpoises (Shelden et al. 2014).

Harbor porpoises have been detected during passive acoustic monitoring efforts throughout Cook Inlet, with detections especially prevalent in lower Cook Inlet. In 2009, harbor porpoises were documented by using passive acoustic monitoring in upper Cook Inlet at the Beluga River and Cairn Point (Small 2009, 2010).

4.3.4 Presence in Project Area

Harbor porpoises have been observed within Knik Arm during monitoring efforts since 2005. During POA construction from 2005 through 2011 and in 2016, harbor porpoises were reported in 2009, 2010, and 2011 (Prevel-Ramos et al. 2006; Markowitz and McGuire 2007; Cornick and Saxon-Kendall 2008, 2009; Cornick et al. 2010, 2011; Cornick and Seagars 2016; Table 4-2). In 2009, a total of 20 harbor porpoises were observed during construction monitoring, with sightings in June, July, August, October, and November. Harbor porpoises were observed twice in 2010, once in July and again in August. In 2011, POA monitoring efforts documented harbor porpoises five times, with a total of six individuals, in August, October, and November at the POA (Cornick et al. 2011). During other monitoring efforts conducted in Knik Arm, there were four sightings of harbor porpoises in 2005 (Shelden et al. 2014), and a single harbor porpoise was observed within the vicinity of the POA in October 2007 (URS 2008; Table 4-2). A total of 18 harbor porpoises were observed near the POA from 27 April through 24 November 2020 during the Phase 1 PCT construction monitoring (61N Environmental 2021).

Table 4-2. Summary of Harbor Porpoise Sightings near the POA

Year	Monitoring Effort			Total # of Sightings	Total # of Animals	Survey
	Time Frame	# of Days	# of Hours			
2005	April–May	NA	NA	4	NA	Beluga Whale Habitat Use
2005	August 2–Nov. 28	51	374	NA	NA	MTRP: Scientific Monitoring
2006	April 26–Nov. 3	95	564	NA	NA	MTRP: Scientific Monitoring
2007	Oct. 9–Nov. 20	28	139	NA	NA	MTRP: Scientific Monitoring
2007	October	NA	NA	1	1	URS
2008	June 24–Nov. 14	86	612	0	0	MTRP: Scientific Monitoring
2008	July 24–Nov. 26	108	607[a]	0	0	MTRP: Construction Monitoring
2009	May 4–Nov. 18	86	783	0	0	MTRP: Scientific Monitoring
2009	March 28–Dec. 14	214	3,322[a]	NA	20	MTRP: Construction Monitoring
2010	June 29–Nov. 19	87	600	0	0	MTRP: Scientific Monitoring
2010	July 21–Nov. 20	106	862[a]	2	2	MTRP: Construction Monitoring
2011	June 28–Nov. 15	104	1,202	5	6	MTRP: Scientific Monitoring
2011	July 17–Sept. 27	16	NA	0	0	MTRP: Construction Monitoring
2016	May 3–June 21	19	85.3	0	0	TPP: Construction Monitoring
2020	April 27–Nov. 24	128	1,238.9	15	18	POA: Construction Monitoring

[a] Intermittent in-water pile-driving hours.

Source: Prevel-Ramos et al. 2006; Markowitz and McGuire 2007; URS 2008; Cornick and Saxon-Kendall 2008, 2009; Cornick et al. 2010, 2011; ICRC 2009, 2010, 2011, 2012; Cornick and Pinney 2011; Shelden et al. 2014; Cornick and Seagars 2016; 61N Environmental 2021.

Notes: MTRP = Marine Terminal Redevelopment Project; NA = not available (the information was not provided in the reports). Reports for monitoring in 2005, 2006, and 2007 do not indicate whether or not harbor porpoises were sighted. The 2009 construction monitoring report does not indicate the total number of sightings, only the total number of harbor porpoises observed. POA = Port of Alaska; TPP = Test Pile Program.

4.3.5 Acoustics

The harbor porpoise has the highest upper-frequency limit of all odontocetes investigated. Kastelein et al. (2002) found that the range of best hearing was from 16 to 140 kHz, with a reduced sensitivity around 64 kHz. Maximum sensitivity (about 33 dB re 1 µPa) occurred between 100 and 140 kHz. This maximum sensitivity range corresponds with the peak frequency of echolocation pulses produced by harbor porpoises (120–130 kHz; NMFS 2018a).

4.4 Killer Whale

4.4.1 Status and Distribution

There are three distinct ecotypes of killer whale in the northeastern Pacific Ocean: resident, transient, and offshore killer whales. There are two stocks that have the potential to be in the project area: the Eastern North Pacific Alaska Residents and the Gulf of Alaska, Aleutian Islands, and Bering Sea Transients. Both ecotypes overlap in the same geographic area; however, they maintain social and reproductive isolation and feed on different prey species. The population of the Eastern North Pacific Alaska Resident stock of killer whales contains an estimated 2,347 animals and the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock of killer whales is estimated to contain 587 animals (Muto et al. 2020a). Killer whales are rare in Cook Inlet, and most individuals are observed in lower Cook Inlet (Shelden et al. 2013).

4.4.2 Foraging Ecology

Resident killer whales are primarily fish-eaters, while transients consume marine mammals. In Cook Inlet, transient killer whales are known to feed on beluga whales, and resident killer whales are known to feed on anadromous fish (Shelden et al. 2003).

4.4.3 Presence in Cook Inlet

Killer whales are rare in upper Cook Inlet, and the availability of prey species largely determines the likeliest times for killer whales to be in the area. Killer whales have been sighted in lower Cook Inlet 17 times, with a total of 70 animals between 1993 and 2012 during beluga whale aerial surveys (Shelden et al. 2013); no killer whales were observed in upper Cook Inlet. Surveys over 20 years by Shelden et al. (2003) documented an increase in beluga whale sightings and strandings in upper Cook Inlet, beginning in the early 1990s. Several of these sightings and strandings reported killer whale predation on beluga whales. The pod sizes of killer whales preying on beluga whales ranged from 1 to 6 individuals (Shelden et al. 2003). Passive acoustic monitoring efforts throughout Cook Inlet documented killer whales at the Beluga River, Kenai River, and Homer Spit, although they were not encountered within Knik Arm. These detections were likely resident (fish-eating) killer whales. Transient killer whales (marine-mammal eating) likely have not been detected due to their propensity to move quietly through waters to track prey (Small 2010; Lammers et al. 2013).

4.4.4 Presence in Project Area

No killer whales were spotted in the vicinity of the POA during surveys by Funk et al. (2005), Ireland et al. (2005), or Brueggeman et al. (2007, 2008a, 2008b). Killer whales have also not been documented during any POA construction or scientific monitoring from 2005 to 2011 or during 2016 (Prevel-Ramos et al. 2006; Markowitz and McGuire 2007; Cornick and Saxon-Kendall 2008; ICRC 2009, 2010, 2011, 2012; Cornick et al. 2010, 2011; Cornick and Pinney 2011; Cornick and Seagars 2016). Few killer whales, if any, are expected to approach or be in the vicinity of the project area during construction of the PCT. No killer whales were observed from April through November 2020 during Phase 1 PCT construction monitoring (61N Environmental 2021).

4.4.5 Acoustics

The hearing of killer whales is well developed. Szymanski et al. (1999) found that they responded to tones between 1 and 120 kHz, and their most sensitive range was between 18 and 42 kHz. Their greatest sensitivity was at 20 kHz, which is lower than the most sensitive range of many other odontocetes, but it matches peak spectral energy reported for killer whale echolocation clicks.

4.5 Beluga Whale

4.5.1 Status and Distribution

Beluga whales appear seasonally throughout much of Alaska, except in the Southeast region and the Aleutian Islands. Five stocks are recognized in Alaska: the Beaufort Sea stock, eastern Chukchi Sea stock, eastern Bering Sea stock, Bristol Bay stock, and Cook Inlet stock (Muto et al. 2020b). The Cook Inlet stock is the most isolated of the five stocks, since it is separated from the others by the Alaska Peninsula and resides year-round in Cook Inlet (Laidre et al. 2000). Included in the Cook Inlet stock under the MMPA is a small group of beluga whales, fewer than 20 individuals, that is regularly observed in Yakutat Bay. This small group of individuals is reproductively separated from individuals in Cook Inlet and is not known to enter Cook Inlet (Muto et al. 2020b); therefore, the Yakutat Bay beluga whales are not discussed further in this IHA application. Only the Cook Inlet stock inhabits the project area.

The ADF&G conducted a survey of beluga whales in August 1979 and estimated 1,293 individuals (Calkins 1989). Although this survey did not include all of upper Cook Inlet, the area where almost all beluga whales are currently found during summer, it is the most complete survey of Cook Inlet prior to 1994 and incorporated a correction factor for beluga whales missed during the survey. Therefore, the ADF&G summary (Calkins 1989) provides the best available estimate for the historical beluga whale abundance in Cook Inlet. For management purposes, NMFS has determined that the carrying capacity of Cook Inlet is 1,300 beluga whales (65 FR 34590) based on Calkins (1989).

No systematic population estimates for Cook Inlet beluga whales were conducted prior to 1994. NMFS began comprehensive, systematic aerial surveys of beluga whales in Cook Inlet in 1994. Unlike previous efforts, these surveys included the upper, middle, and lower inlet. These surveys documented a decline in abundance of nearly 50 percent between 1994 and 1998, from an estimate of 653 to 347 whales (Rugh et al. 2000). In response to this decline, NMFS initiated a status review on the Cook Inlet beluga whale stock pursuant to the MMPA and the ESA in 1998 (63 FR 64228). Annual abundance surveys were conducted each June from 1999 through 2012. In 2013, NMFS changed the survey to a biennial schedule because a detailed analysis determined that there would be no decrease in the assessment quality if the number of surveying years was reduced (Hobbs 2013). The surveys between 1999 and 2016 indicated that the population continued to decline at an annual rate of 0.4 percent (Shelden et al. 2015, 2017; Muto et al. 2020b). However, Shelden and Wade (2019) analyzed time-series abundance data from 2010 to 2018 using a fully Bayesian method developed by Boyd et al. (2019) that incorporates uncertainty in correction factors. This new analysis shows that from 2008 to 2010, the Cook Inlet beluga whale population was declining at an annual rate of 2.3 percent (Shelden and Wade 2019). The most recent surveys using this new methodology were conducted in 2018 and produced an abundance estimate of 279 beluga whales (Table 4-3; Shelden and Wade 2019). The 95 percent probability range is 250 to 317 whales (Shelden and Wade 2019).

Table 4-3. Annual Cook Inlet Beluga Whale Abundance Estimates

1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2014	2016	2018
367	435	386	313	357	366	278	302	375	375	321	340	284	312	340	328	279

Source: Hobbs et al. 2000, 2011, 2012; Rugh et al. 2003, 2004a, 2004b, 2005a, 2005b, 2005c, 2006a, 2006b, 2007; Hobbs and Shelden 2008; Allen and Angliss 2010, 2011; Shelden et al. 2013, 2015, 2017; Shelden and Wade 2019; Boyd et al. 2019.

Note: Abundance surveys were not completed in 2013, 2015, 2017, 2019, and 2020.

In 1999, NMFS received petitions to list the Cook Inlet beluga whale stock as an endangered species under the ESA (64 FR 17347). However, NMFS determined that the population decline was due to overharvest by Alaska Native subsistence hunters and, because the Native harvest was regulated in 1999, listing this stock under the ESA was not warranted at the time (65 FR 38778). The Cook Inlet beluga whale stock was designated as depleted under the MMPA in 2000, indicating that the size of the stock was below its Optimum Sustainable Population (OSP) level (65 FR 34590). The population has remained below its OSP since the designation but would be considered recovered once the population estimate rises above the OSP.

NMFS announced initiation of another Cook Inlet beluga whale status review under the ESA in 2006 (71 FR 14836) and received another petition to list the Cook Inlet beluga whale under the ESA (71 FR 44614). NMFS issued a decision on the status review on 20 April 2007, concluding that the Cook Inlet beluga whale is a DPS that is in danger of extinction throughout its range. Subsequently, NMFS issued a proposed rule to list the Cook Inlet beluga whale as an endangered species (72 FR 19821). On 17 October 2008, NMFS announced the listing of the population as endangered under the ESA (73 FR 62919). In 2010, a Recovery Team, consisting of a Science Panel and Stakeholder Panel, began meeting to develop a Recovery Plan for the Cook Inlet beluga whale. The Draft Recovery Plan was published in the *Federal Register* on 15 May 2015 and the Final Recovery Plan was published in the *Federal Register* on 05 January 2017.

4.5.2 Critical Habitat

On 11 April 2011, NMFS designated two areas of critical habitat for beluga whales in Cook Inlet (76 FR 20180). The designation includes 7,800 km^2 (3,013 mi^2) of marine and estuarine habitat within Cook Inlet, encompassing approximately 1,909 km^2 (738 mi^2) in Area 1 and 5,891 km^2 (2,275 mi^2) in Area 2 (Figure 4-1). From spring through fall, Area 1 critical habitat has the highest concentration of beluga whales due to its important foraging and calving habitat. Area 2 critical habitat has a lower concentration of beluga whales in spring and summer but is used by beluga whales in fall and winter. Critical habitat does not include two areas of military usage: the Eagle River Flats Range on Fort Richardson and military lands of JBER between Mean Higher High Water and Mean High Water. Additionally, the POA, adjacent navigation channel, and turning basin were excluded from critical habitat designation due to national security reasons (76 FR 20180).

The designation identified the following Primary Constituent Elements (PCEs), essential features important to the conservation of the Cook Inlet beluga whale:

(1) Intertidal and subtidal waters of Cook Inlet with depths of less than 30 feet (Mean Lower Low Water) and within 5 miles of high- and medium-flow anadromous fish streams

(2) Primary prey species, including four of the five species of Pacific salmon (chum, sockeye, Chinook, and coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole

(3) The absence of toxins or other agents of a type or amount harmful to beluga whales

(4) Unrestricted passage within or between the critical habitat areas

(5) The absence of in-water noise at levels resulting in the abandonment of habitat by Cook Inlet beluga whales

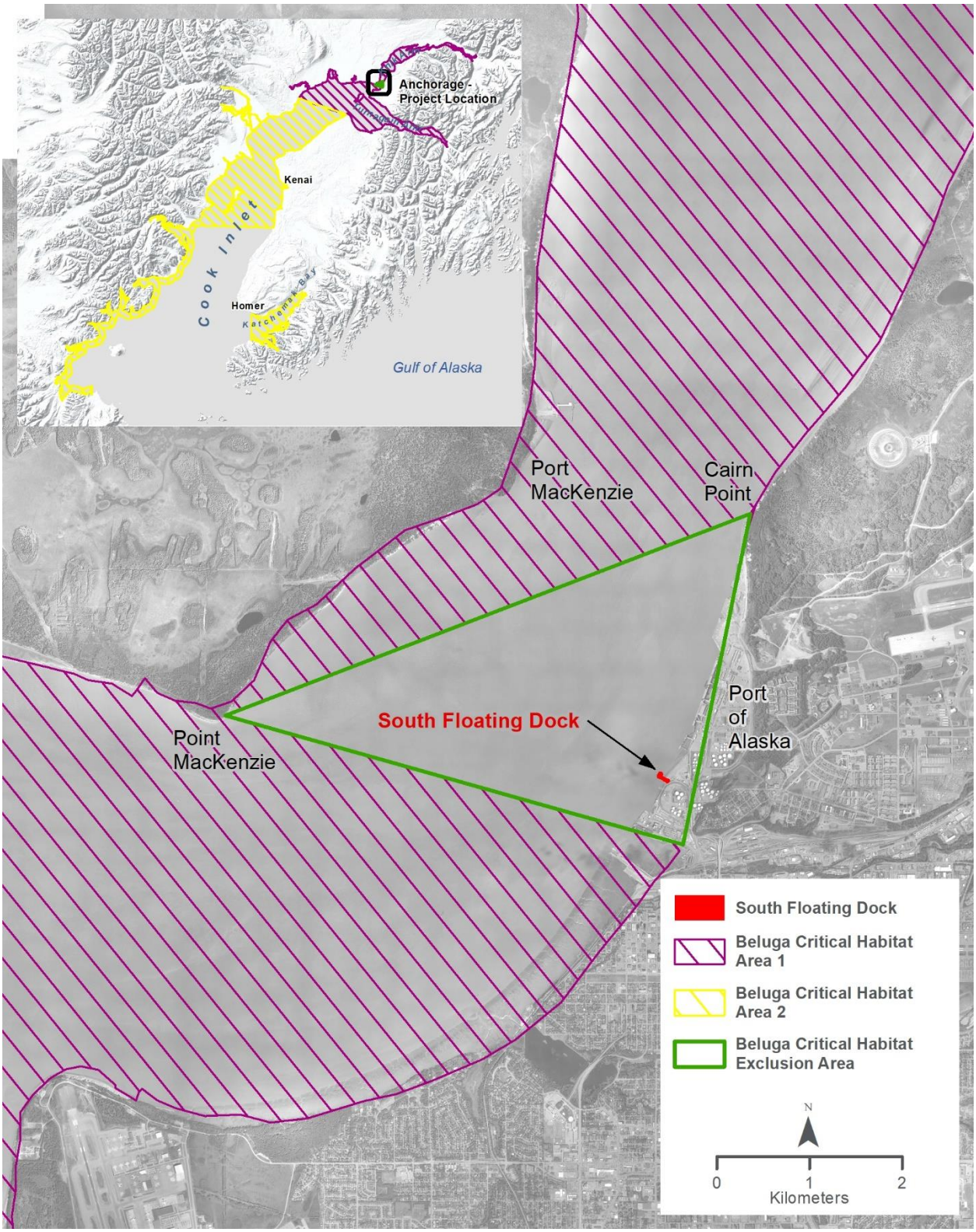

Figure 4-1. Cook Inlet Beluga Whale Critical Habitat and Exclusion Zone at POA

4.5.3 Foraging Ecology

Cook Inlet beluga whales feed on a wide variety of prey species, particularly those that are seasonally abundant. In spring, the preferred prey species are eulachon and cod. Other fish and invertebrate species found in the stomachs of beluga whales include porifera, polychaetes, mysids, amphipods, shrimp, crabs, and marine worms. Some of the species may be found in beluga whale stomachs from secondary ingestion because species such as cod feed on polychaetes, shrimp, amphipods, and mysids, as well as other fish (e.g., walleye pollock and flatfish) and invertebrates (Quakenbush et al. 2015).

From late spring through summer, most beluga whale stomachs sampled contained Pacific salmon, which corresponded to the timing of fish runs in the area. Anadromous smolt and adult fish aggregate at river mouths and adjacent intertidal mudflats (Calkins 1989). All five Pacific salmon species (i.e., Chinook, pink, coho, sockeye, and chum) spawn in rivers throughout Cook Inlet (Moulton 1997; Moore et al. 2000). Salmon, overall, represent the highest percent frequency of occurrence of prey species in Cook Inlet beluga whale stomachs. This suggests that their spring feeding in upper Cook Inlet, principally on fat-rich fish such as salmon and eulachon, is important to the energetics of these animals (NMFS 2016).

In fall, as anadromous fish runs begin to decline, beluga whales return to consume fish species (cod and bottom fish) found in nearshore bays and estuaries. Stomach samples from Cook Inlet beluga whales are not available for winter (December through March), although dive data from beluga whales tagged with satellite transmitters suggest that they feed in deeper waters during winter (Hobbs et al. 2005), possibly on such prey species as flatfish, cod, sculpin, and pollock.

4.5.1 Distribution in Cook Inlet

4.5.1.1 Spring and Summer

During spring and summer, beluga whales generally aggregate near the warmer waters of river mouths where prey availability is high and predator occurrence is low (Moore et al. 2000). In particular, beluga whale groups are seen in the Susitna River Delta, the Beluga River and along the shore to the Little Susitna River, Knik Arm, and along the shores of Chickaloon Bay. Small groups have been recorded farther south in Kachemak Bay, Redoubt Bay (Big River), and Trading Bay (McArthur River) prior to 1996, but rarely thereafter. Since the mid-1990s, most beluga whales (96 to 100 percent) aggregate in shallow areas near river mouths in upper Cook Inlet, and they are rarely sighted in the central or southern portions of Cook Inlet during summer (Hobbs et al. 2008). Important calving grounds are located near the river mouths of upper Cook Inlet, and peak calving occurs between July and October (McGuire et al. 2016).

4.5.1.2 Fall and Winter

Data from tagged whales (14 tags between July and March 2000 through 2003) show that beluga whales continue to use upper Cook Inlet intensively between summer and late autumn (Hobbs et al. 2005). Beluga whales tagged with satellite transmitters continue to use Knik Arm, Turnagain Arm, and Chickaloon Bay as late as October, but some range into lower Cook Inlet to Chinitna Bay, Tuxedni Bay, and Trading Bay (McArthur River) in fall (Hobbs et al. 2005; Goetz et al. 2012a). From September through November, beluga whales move between Knik Arm, Turnagain Arm, and Chickaloon Bay (Hobbs et al. 2005; Goetz et al. 2012b). By December, beluga whales are distributed throughout the upper to mid-inlet. From January into March, they move as far south as Kalgin Island and slightly beyond in central offshore waters. Beluga whales make occasional excursions into Knik Arm and Turnagain Arm in February and March in spite of ice cover (Hobbs et al. 2005). Although tagged beluga whales move widely around Cook Inlet throughout the year, there is no indication of seasonal migration in and out of Cook Inlet (Hobbs et al. 2005). Data from NMFS aerial surveys, opportunistic sighting reports, and corrected satellite-tagged beluga whales confirm that they are more widely dispersed throughout Cook

Inlet during winter (November–April), with animals found between Kalgin Island and Point Possession. Generally fewer observations of beluga whales are reported from the Anchorage and Knik Arm area from November through April (76 FR 20180; Rugh et al. 2000, 2004a).

4.5.2 Presence in Project Area

Knik Arm is one of three areas in upper Cook Inlet where beluga whales are concentrated during spring, summer, and early fall (Section 4.5.1). Most beluga whales observed in or near the POA are transiting between upper Knik Arm and other portions of Cook Inlet, and the POA itself is not considered high-quality foraging habitat. Beluga whales tend to follow their anadromous prey and travel in and out of Knik Arm with the tides. Use of Knik Arm is concentrated between August and October and is highest in September. Use of Knik Arm is lowest in winter (December through February) and remains low in spring and early summer (March–July; Rugh et al. 2000, 2004a, 2005a, 2006a, 2007; Funk et al. 2005; U.S. Army Garrison Fort Richardson 2009; Hobbs et al. 2011, 2012).

Goetz et al. (2012a) used distribution and group size data collected during annual aerial surveys between 1994 and 2008 to develop a predictive habitat model. This predictive model maps beluga whale density from 0 to 1.12 whales per square kilometer in Cook Inlet. The highest predicted densities of beluga whales are in Knik Arm, near the mouth of the Susitna River, and in Chickaloon Bay. The model suggests that the density of beluga whales at the mouth of Knik Arm, near the POA, ranges between approximately 0.013 and 0.062 whales per square kilometer. The distribution presented by Goetz et al. (2012a) is generally consistent with beluga whale distribution documented in upper Cook Inlet throughout ice-free months (NMFS 2016).

Several marine mammal monitoring programs and studies have been conducted at or near the POA during the last 15 years. These studies, summarized below, offer some of the best available information on the abundance of beluga whales in the project area.

4.5.2.1 2020 Phase 1 PCT Construction Monitoring

A marine mammal monitoring program was implemented during construction of Phase 1 of the PCT in 2020. Marine mammal monitoring occurred during 128 non-consecutive days, with a total of 1,238.9 hours of monitoring from 27 April to 24 November 2020 (61N Environmental 2021). To date, a total of 987 individual beluga whales across 245 groups have been sighted during Phase 1 PCT construction monitoring (Table 4-4).

Table 4-4. Beluga Whales Observed in the POA Area during PCT Phase 1 Monitoring, 2020

Month	Hours	Whales (Individuals)	Whales (Groups)	Average Group Size
April	40.5	33	11	3.0
May	301.4	168	35	4.8
June	318.1	114	33	3.5
July	192.5	25	12	2.1
August	151.2	274	56	4.9
September	85.6	276	73	3.8
October	17.6	0	0	0
November	132.0	97	25	3.9
Totals	**1,238.9**	**987**	**245**	

The monitoring effort and data collection were conducted at four locations: (1) the Anchorage Public Boat Dock by Ship Creek, (2) the Anchorage Downtown Viewpoint near Point Woronzof, (3) the PCT construction site, and (4) the North End (North Expansion) at the north end of the POA, near Cairn Point. Marine mammal sighting data from April to September indicate that beluga whales swim into the

clearance zone and linger there for periods of time ranging from a few minutes to a few hours. Beluga whales are most often seen traveling at a slow or moderate pace through the monitoring zone, either from the north near Cairn Point or from the south or milling at the mouth of Ship Creek. Groups of beluga whales have also been observed swimming north and south in front of the PCT construction site after in-water work was shut down and did not exhibit avoidance behaviors. Beluga sightings in June were concentrated on the west side of Knik Arm from the Little Susitna River delta to Port MacKenzie. From July through September, beluga whales were most often seen milling and traveling on the east side of Knik Arm from Point Woronzof to Cairn Point.

4.5.2.2 2016 Test Pile Program Monitoring

In 2016, a marine mammal monitoring program was implemented during the TPP. Marine mammal monitoring was conducted during 19 non-consecutive days, with a total of 85.3 hours of monitoring observation from 03 May through 21 June 2016 (Cornick and Seagars 2016).

The monitoring effort and data collection were conducted at three locations: (1) the Anchorage Public Boat Dock by Ship Creek, (2) the North End, which is located just above shore level at the north end of the POA, and (3) a roving observer with primary responsibility for the mandatory 100-meter shutdown zone and areas immediately adjacent to the PAMP 2016 TPP in-water activity that were not observable from other stations under all scenarios (Cornick and Seagars 2016).

4.5.2.3 POA Monitoring 2005 to 2011

The POA conducted NMFS-approved monitoring programs for beluga whales and other marine mammals focused at the POA from 2005 to 2011 (Table 4-5). Data on beluga whale sighting rates, groupings, behavior, and movements indicate that the POA is a relatively low-use area, in that beluga whales do not linger in the area but pass through en route to other locations. They are observed most often in fall, with numbers peaking in late August to early October (Funk et al. 2005). Although groups with calves have been observed entering the POA area, data do not suggest that the area is an important nursery.

Although the POA scientific monitoring studies indicate that beluga whales are generally passing through the area, it is also used as foraging habitat by whales traveling between lower and upper Knik Arm. Individuals and groups of beluga whales have been observed passing through the area each year during monitoring efforts (Table 4-5). Diving and traveling are common behaviors, with many instances of confirmed feeding. Sighting rates at the POA ranged from 0.05 to 0.4 whales per hour (Prevel-Ramos et al. 2006; Markowitz and McGuire 2007; Cornick and Saxon-Kendall 2008; Cornick et al. 2011) as compared to 3 to 5 whales per hour at Eklutna, 20 to 30 whales per hour at Birchwood, and 3 to 8 whales per hour at Cairn Point (Funk et al. 2005), indicating that these areas are of higher use than the POA. In 2009, the mean sighting duration for 54 groups of beluga whales was 11.4 minutes (± 1.8 minutes), with a range of 1 to 61 minutes (Cornick et al. 2010). In 2011, the mean sighting duration for 62 groups of beluga whales was 16.4 minutes (± 3.5 minutes), with a range of 1 to 144 minutes. There were two observations that had long sighting durations of 144 minutes and 90 minutes; the remaining 60 observations had sighting durations of less than 64 minutes (Cornick et al. 2011).

Table 4-5. Beluga Whales Observed in the POA Area during Monitoring Programs

Year	Dates of Monitoring Effort	Monitoring Effort		Total Number of Groups[a] Sighted	Total Number of Beluga Whales	Monitoring Type
		# of Days	# of Hours			
2005	August 2–Nov. 28	51	374	21	157	MTRP: Scientific Monitoring
2006	April 26–Nov. 3	95	564	25	82	MTRP: Scientific Monitoring
2007	Oct. 9–Nov. 20	28	139	14	61	MTRP: Scientific Monitoring
2008	June 24–Nov. 14	86	612	74	283	MTRP: Scientific Monitoring
	July 24–Dec. 2	108	607[b]	59	431	MTRP: Construction Monitoring
2009	May 4–Nov. 18	86	783	54	166	MTRP: Scientific Monitoring
	March 28–Dec. 14	214	3,322[b]	NA	1,221	MTRP: Construction Monitoring
2010	June 29–Nov. 19	87	600	42	115	MTRP: Scientific Monitoring
	July 21–Nov. 20	106	862[b]	103	731	MTRP: Construction Monitoring
2011	June 28–Nov. 15	104	1,202	62	290	MTRP: Scientific Monitoring
	July 17–Sept. 27	16	NA	5	48	MTRP: Construction Monitoring
2016	May 3–June 21	19	85.3	9	10	TPP: Construction Monitoring
2019	May 8–Sept. 17	133	NA	66	797	POA: Construction Monitoring
2020	April 27–Nov. 24	128	1,238.9	245	987	POA: Construction Monitoring

[a] Group can be one or more individuals.

[b] Intermittent in-water pile-driving hours.

Source: Prevel-Ramos et al. 2006; Markowitz and McGuire 2007; Cornick and Saxon-Kendall 2008, 2009; Cornick and Pinney 2011; Cornick et al. 2010, 2011; ICRC 2009, 2010, 2011, 2012; Cornick and Seagars 2016; POA, Final Marine Mammal Observation Report, POA-2003-0502 M-13 Knik Arm; 61N Environmental 2021.

Notes: MTRP = Marine Terminal Redevelopment Project; NA = not available; the information was not provided in the report. The 2009 construction monitoring report does not indicate the total number of sightings, only the total number of beluga whales observed. POA = Port of Alaska; TPP = Test Pile Program.

Data collected annually during monitoring efforts demonstrated that few beluga whales were observed in July and early August; numbers of sightings increased in mid-August, with the highest numbers observed in late August to mid-September. In all years, beluga whales have been observed to enter the project area while construction activities were taking place, including pile installation and dredging. No apparent behavioral changes or reactions to in-water construction activities (e.g., displacement or abandonment of feeding behavior) were observed by either the construction workers or the scientific observers (Cornick et al. 2011).

4.5.2.4 Knik Arm Bridge and Toll Authority Baseline Study, 2004–2005

To assist in the evaluation of the potential impact of a proposed bridge crossing of Knik Arm north of Cairn Point, Knik Arm Bridge and Toll Authority (KABATA) initiated a study to collect baseline environmental data on beluga whale activity and the ecology of Knik Arm (Funk et al. 2005). Boat and land-based observations were conducted in Knik Arm from July 2004 through July 2005. Land-based observations were conducted from nine stations along the shore of Knik Arm. The three primary stations were located at Cairn Point, Point Woronzof, and Birchwood. The majority of beluga whales were observed north of Cairn Point. Temporal use of Knik Arm by beluga whales was related to tide height,

with most whale sightings at Cairn Point occurring at low tide. During the study period, most beluga whales using Knik Arm stayed in the upper portion of Knik Arm north of Cairn Point. Approximately 90 percent of observations occurred during the months of August through November, and only during this time were whales consistently sighted in Knik Arm. The relatively low number of sightings in Knik Arm throughout the rest of the year suggested that the whales were using other portions of Cook Inlet. In addition, relatively few beluga whales were sighted in spring and early to mid-summer. Beluga whales predominantly frequented Eagle Bay (mouth of Eagle River), Eklutna, and the stretch of coastline in between, particularly when they were present in high numbers (Funk et al. 2005).

4.5.2.5 Cook Inlet Beluga Whale Photo-ID Project

Beluga whales have persistent distinct natural markings that can be used to identify individuals. The Cook Inlet beluga whale photo-ID project has surveyed beluga whales in several areas throughout Cook Inlet. Knik Arm and the Susitna River Delta have been surveyed annually since 2005 (McGuire et al. 2013a). These annual surveys have indicated that beluga whales with calves and newborns use Knik Arm and Eagle Bay seasonally (McGuire et al. 2013b). In 2011, McGuire et al. (2013b) documented that 78 percent of the 307 beluga whales identified in Cook Inlet traveled to the Eagle Bay area. These data provide evidence that most, if not all, of the population visit this area at least once in their lifetime. Groups containing calves or neonates are more likely to be seen in Knik Arm, Eagle Bay, and the Susitna River Delta than other areas studied in upper Cook Inlet during the photo-ID project (McGuire et al. 2011, 2016).

4.5.3 Acoustics

In terms of hearing abilities, beluga whales are one of the most studied odontocetes because they are a common marine mammal in public aquariums around the world. Although they are known to hear a wide range of frequencies, their greatest sensitivity is around 10 to 100 kHz (Richardson et al. 1995), well above sounds produced by most industrial activities (less than 100 Hz or 0.1 kHz) recorded in Cook Inlet. Average hearing thresholds for captive beluga whales have been measured at 65 and 120.6 dB re 1 µPa at frequencies of 8 kHz and 125 Hz, respectively (Awbrey et al. 1988). Masked hearing thresholds were measured at approximately 120 dB re 1 µPa for a captive beluga whale at three frequencies between 1.2 and 2.4 kHz (Finneran et al. 2002). Beluga whales do have some limited hearing ability down to approximately 35 Hz, where their hearing threshold is about 140 dB re 1 µPa (Richardson et al. 1995). Their thresholds for pulsed sounds are higher, depending on the specific durations and other characteristics of the pulses (Johnson 1991).

4.6 Humpback Whale

4.6.1 Status and Distribution

Humpback whales worldwide were designated as endangered under the Endangered Species Conservation Act in 1970 and were listed under the ESA at its inception in 1973. However, on 08 September 2016, NMFS published a final decision that changed the status of humpback whales under the ESA (81 FR 62259), effective 11 October 2016. The decision recognized the existence of 14 DPSs based on distinct breeding areas in tropical and temperate waters. Five of the 14 DPSs were classified under the ESA (4 endangered and 1 threatened), while the other 9 DPSs were delisted. No critical habitat was designated for any of the 5 listed DPSs.

The most comprehensive photo-identification data available suggest that approximately 89 percent of all humpback whales in the Gulf of Alaska are members of the Hawaii DPS, 11 percent are from the Mexico DPS, and less than 1 percent are from the western North Pacific DPS (Wade et al. 2016). The Hawaii DPS is not listed under the ESA, the Mexico DPS is listed as threatened, and the Western North Pacific DPS is listed as endangered. Members of different DPSs are known to intermix in feeding

grounds; therefore, all waters off the coast of Alaska should be considered to have ESA-listed humpback whales.

The DPSs of humpback whales that were identified through the ESA listing process are not equivalent to existing MMPA stocks, and the stock delineations of humpback whales under the MMPA are currently under review. Until this review is complete, NMFS considers humpback whales in the Gulf of Alaska to be comprised primarily of whales belonging to the Central North Pacific stock, with a small proportion of animals belonging to the Western North Pacific Stock (Muto et al. 2020a). Both stocks are designated strategic and depleted under the MMPA (Muto et al. 2020a). The current estimates of humpback whale population sizes are 10,103 for the Central North Pacific stock and 1,107 for the Western North Pacific stock (Muto et al. 2020a).

Humpback whales experienced large population declines due to commercial whaling operations in the early twentieth century. Barlow (2003) estimated the population of humpback whales at approximately 1,200 animals in 1966. The population in the North Pacific grew to between 6,000 and 8,000 by the mid-1990s. Current threats to humpback whales include vessel strikes, releases of chemicals or hydrocarbons into the marine environment, climate change, and commercial fishing operations (Muto et al. 2020a).

4.6.2 Foraging Ecology

Humpback whales target aggregations of krill (Euphausiidae; Nemoto 1957) and small schooling fish including herring (Krieger and Wing 1984), capelin (Witteveen et al. 2008), sand lance (Hazen et al. 2009), and juvenile salmon (Chenoweth et al. 2017). In Alaska waters, the species composition of prey taken by humpback whales varies, likely due to prey availability and individual preference (Witteveen et al. 2011).

4.6.3 Presence in Cook Inlet

Humpback whales are encountered regularly in lower Cook Inlet and occasionally in mid-Cook Inlet; however, sightings are rare in upper Cook Inlet. During aerial surveys conducted in summers between 2005 and 2012, Shelden et al. (2013) reported dozens of sightings in lower Cook Inlet, a handful of sightings in the vicinity of Anchor Point and in lower Cook Inlet, and no sightings north of 60° N latitude (approximately the latitude of the town of Ninilchik). Vessel-based observers participating in the Apache Corporation's 2014 survey operations recorded three humpback whale sightings near Moose Point in upper Cook Inlet and two sightings near Anchor Point, while aerial and land-based observers recorded no humpback whale sightings, including in the upper Inlet (Lomac-MacNair et al. 2014). Observers monitoring waters between Point Campbell and Fire Island during summer and fall 2011 and spring and summer 2012 recorded no humpback whale sightings (Brueggeman et al. 2013). Monitoring of Turnagain Arm during ice-free months between 2006 and 2014 yielded one humpback whale sighting (McGuire, unpublished data; cited in LGL and DOWL 2015).

4.6.4 Presence in Project Area

There have been few sightings of humpback whales in the vicinity of the project area. Humpback whales were not documented during POA construction or scientific monitoring from 2005 to 2011 or during 2016 (Prevel-Ramos et al. 2006; Markowitz and McGuire 2007; Cornick and Saxon-Kendall 2008, 2009; Cornick et al. 2010, 2011; ICRC 2009, 2010, 2011, 2012; Cornick and Pinney 2011; Cornick and Seagars 2016). Observers monitoring the Ship Creek Small Boat Launch from 23 August to 11 September 2017 recorded two sightings, each of a single humpback whale, which was presumed to be the same individual (POA 2017b). One other humpback whale sighting has been recorded for the immediate vicinity of the project area. This event involved a stranded whale that was sighted near a number of locations in upper Cook Inlet before washing ashore at Kincaid Park in 2017; it is unclear as to whether the humpback whale was alive or deceased upon entering Cook Inlet waters. No humpback whales were

observed from April through November 2020 during Phase 1 PCT construction monitoring (61N Environmental 2021).

4.6.5 Acoustics

There are no directly measured data for humpback whale hearing sensitivity. Recordings of vocalizations indicate that humpback whales produce sounds at frequencies between 20 Hz and 2 kHz (Thompson et al. 1986; Darling 2015). Au et al. (2006) recorded humpback vocalizations with harmonics up to 24 kHz. The hearing range of low-frequency cetaceans, including the humpback whale, is estimated at 7 Hz to 35 kHz (NMFS 2018a).

5 Type of Incidental Take Authorization Requested

5.1 Incidental Harassment Authorization

Under Section 101 (a)(5)(D) of the MMPA, the POA requests authorization for the take of small numbers of marine mammals, by Level A and Level B harassment, incidental to pile installation and removal associated with construction of the SFD Project in Anchorage, Alaska. The POA requests an IHA that is valid for 1 year, from 01 April 2021 through 31 March 2022.

5.2 Take Authorization Request

The exposure assessment methodology used in this IHA application quantifies potential noise exposures of marine mammals resulting from pile installation and removal in the marine environment (see Section 6). Results from this approach tend to overestimate exposures because all animals are assumed to be available to be exposed 100 percent of the time, and the formulas used to estimate transmission loss (TL) use idealized parameters. Additionally, this approach assumes that all exposed individuals are harassed, contributing to overestimation of "take."

The analysis for the construction of the SFD Project predicts a total of 69 potential marine mammal exposures (see Section 6 for estimates of exposures by species) to pile installation and removal over the course of the project that could be classified as Level B harassment as defined under the MMPA. The POA's mitigation measures for construction of the SFD Project, described in Section 11, include monitoring of harassment zones to avoid and minimize take during pile installation and removal, and the planned use of a bubble curtain on all vertical piles. These mitigation measures decrease the likelihood that marine mammals will be exposed to sound pressure levels that would cause Level A and Level B harassment, although the amount of that decrease cannot be quantified.

The POA does not expect that 69 harassment incidents will result from construction of the SFD Project. However, to allow for uncertainty regarding the exact mechanisms of the physical and behavioral effects, the POA is requesting authorization for take of 4 marine mammals by Level A harassment and 65 marine mammals by Level B harassment in this IHA application.

5.3 Method of Incidental Taking

Pile installation and removal associated with construction of the SFD Project, as outlined in Section 1, have the potential to disturb or displace small numbers of marine mammals. Specifically, the proposed action may result in "take" in the form of Level B harassment from underwater noise generated from pile installation and removal. See Section 11 for more details on the impact reduction and mitigation measures proposed.

*This page intentionally left b*lank.

6 Take Estimates for Marine Mammals

The NMFS application process for IHAs requires applicants to determine the number of marine mammals by species that are expected to be incidentally harassed by an action, and the nature of the harassment (Level A or Level B). The SFD Project, as outlined in Section 1, has the potential to incidentally take marine mammals by harassment through exposure to sound associated with in-water pile installation and removal.

6.1 Underwater Sound Descriptors

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium such as air or water. Sound is generally characterized by several variables, including frequency and intensity. Frequency describes the sound's pitch and is measured in Hertz (Hz), while intensity describes the sound's loudness and is measured in decibels (dB). Decibels are measured using a logarithmic scale.

The method commonly used to quantify in-air sounds consists of evaluating all frequencies of a sound according to a weighting system reflecting 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 to reflect in-air hearing of marine mammals such as hauled-out pinnipeds has not been developed for regulatory purposes.

Underwater sounds are described by a number of terms that are commonly used and specific to this field of study (Table 6-1). Two common descriptors are the root-mean-square SPL (dB rms) during the pulse or over a defined averaging period, and sound exposure level (SEL). The rms level is the square root of the energy divided by a defined time period and referenced to a pressure of 1 microPascal (dB re 1 µPa). Unless otherwise indicated, in-water sound levels throughout this report are presented in dB re 1 µPa.

Spreading loss in marine waters is generally between 10 dB (cylindrical spreading) and 20 dB (spherical spreading), typically referred to as 10 log and 20 log, respectively. Cylindrical spreading occurs when sound energy spreads outward in a cylindrical fashion bounded by the bottom sediment and water surface, such as shallow water, resulting in a 3-dB reduction in noise level per doubling of distance. Spherical spreading occurs when the source encounters little to no refraction or reflection from boundaries (e.g., bottom, surface), such as in deep water, resulting in a 6-dB reduction in noise level per doubling of distance.

Table 6-1. Definitions of Some Common 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 µPa (or 20 microNewtons per square meter [m^2]), where 1 Pascal is the pressure resulting from a force of 1 Newton exerted over an area of 1 m^2. The sound pressure level is expressed in decibels as 20 times the logarithm to the base 10 of the ratio between the pressure exerted by the sound to a reference sound pressure. 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 to 20,000 Hz.

Table 6-1. Definitions of Some Common Acoustical Terms

Term	Definition
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 comprises that portion of waveform containing 90 percent of the sound energy for one impact pile-driving impulse.
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.
Sound Exposure Level (SEL), dB re 1 μPa^2-s	Proportionally equivalent to the time integral of the pressure squared in terms of dB re 1 μPa^2-s over the duration of the impulse. Similar to the unweighted SEL standardized in in-air acoustics to study noise from single events.
Cumulative SEL (SEL_{cum})	Measure of the total energy received during pile installation and removal, defined here as occurring within a single day.
Transmission Loss (TL)	Underwater TL is the decrease in acoustic intensity as an acoustic pressure wave propagates out from a source. TL parameters vary with frequency, temperature, sea conditions, current, source and receiver depth, water chemistry, and bottom composition and topography.

6.2 Applicable Noise Criteria

The MMPA defines Level A harassment as “any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild.” The MMPA defines Level B harassment 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.”

NMFS recently published updated Technical Guidance (NMFS 2018a) that is currently used to assess effects of exposure to underwater anthropogenic sound on the hearing of marine mammals.

The Technical Guidance identifies the received levels, or thresholds, above which individual marine mammals are predicted to experience permanent changes (e.g., a permanent threshold shift [PTS]) in their hearing sensitivity from incidental exposure to underwater anthropogenic sound sources (NMFS 2018a). NMFS considers the Technical Guidance to represent the best available scientific information and, on this basis, suggests that these thresholds and weighting functions be used to assess the potential for PTS in marine mammals, which equates to Level A harassment under the MMPA. The models used to derive the acoustic thresholds for onset of PTS incorporate marine mammal auditory weighting functions in recognition of the variability found among marine mammal species in their hearing sensitivity. The auditory weighting functions are defined for five functional hearing groups: low-frequency (LF), mid-frequency (MF), and high-frequency (HF) cetaceans; and otariid in water (OW) and phocid in water (PW) pinnipeds (Table 6-2). Additionally, the models used to derive the PTS onset acoustic thresholds incorporate a time component in the form of a cumulative sound exposure level (SEL_{cum}) for both impulsive and non-impulsive sound, and a sound pressure level component by using peak sound level (L_{pk}) for impulsive sounds (NMFS 2018a).

Table 6-2. Marine Mammal Functional Hearing Groups and Representatives of Each Group that are Found near the Port of Alaska

	Functional Hearing Group	Species	Generalized Hearing Range
Cetaceans	LF cetaceans	Humpback whales	7 Hz to 35 kHz
	MF cetaceans	Beluga whales, killer whales	150 Hz to 160 kHz
	HF cetaceans	Harbor porpoises	275 Hz to 160 kHz
Pinnipeds	PW pinnipeds underwater	Harbor seals	50 Hz to 86 kHz
	OW pinnipeds underwater	Steller sea lions	60 Hz to 39 kHz

Source: NMFS 2018a

Notes: LF = low frequency; MF = mid-frequency; HF = high frequency; PW = phocid in water; OW = otariid in water; Hz = Hertz; kHz = kilohertz.

NMFS continues to use its interim criteria to assess Level B harassment levels. Under the interim guidance, Level B harassment by impulsive sounds, such as impact pile installation, occurs with exposure to an SPL of 160 dB rms for all marine mammals. Level B harassment by non-impulsive sounds, such as vibratory pile installation and removal, occurs with exposure to an SPL of 120 dB rms for all marine mammals unless empirical data exist to justify a higher threshold, which will be 122.2 dB for this project (see Section 6.3.1).

This application uses the Technical Guidance acoustic thresholds to calculate Level A harassment isopleths and the NMFS interim criteria to calculate Level B harassment isopleths (Table 6-3). The NMFS Companion User Spreadsheet (Version 2.0, 2018), provided by NMFS for use with the Technical Guidance (NMFS 2018a), was used as a basis to predict zones where the onset of a PTS in marine mammal hearing could occur. Since the onset of PTS based on SEL_{cum} is computed as farther from the pile than it would be using peak sound pressure computations, the onset of PTS is based on SEL computations; therefore, the onset of PTS based on peak sound levels is not provided in this assessment. Estimation of acoustic thresholds was conducted for conditions both with and without a sound-attenuating bubble curtain (Section 6.3.2.2).

Table 6-3. Summary of PTS Onset Acoustic Thresholds for Assessing Level A Harassment, and Acoustic Criteria for Assessing Level B Harassment, of Marine Mammals from Exposure to Noise from Impulsive (Pulsed) and Non-impulsive (Continuous) Underwater Sound Sources

Species Group	PTS Onset Acoustic Thresholds (Received Level)			
	Hearing Group	Impulsive (Pulsed or Intermittent)		Non-impulsive (Continuous)
Level A Harassment				
Cetaceans	LF	$L_{pk,flat}$	219 dB	$L_{E, LF, 24h}$: 199 dB
		$L_{E, LF, 24h}$	183 dB	
	MF	$L_{pk,flat}$	230 dB	$L_{E, MF, 24h}$: 198 dB
		$L_{E, MF, 24h}$	185 dB	
	HF	$L_{pk,flat}$	202 dB	$L_{E, HF, 24h}$: 173 dB
		$L_{E, HF, 24h}$	155 dB	

Table 6-3. Summary of PTS Onset Acoustic Thresholds for Assessing Level A Harassment, and Acoustic Criteria for Assessing Level B Harassment, of Marine Mammals from Exposure to Noise from Impulsive (Pulsed) and Non-impulsive (Continuous) Underwater Sound Sources

Species Group	PTS Onset Acoustic Thresholds (Received Level)			
	Hearing Group	Impulsive (Pulsed or Intermittent)		Non-impulsive (Continuous)
Pinnipeds	PW phocids underwater	$L_{pk,flat}$	218 dB	$L_{E, PW, 24h}$: 201 dB
		$L_{E, PW, 24h}$	185 dB	
	OW otariids underwater	$L_{pk,flat}$	232 dB	$L_{E, OW, 24h}$: 219 dB
		$L_{E, OW, 24h}$	203 dB	
Level B Harassment				
Cetaceans	LF	160 dB rms		120 dB rms or ambient level
	MF			
	HF			
Pinnipeds	PW pinnipeds			
	OW pinnipeds			

Source: NMFS 2018a

Note: PTS = permanent threshold shift; $L_{pk,flat}$ = peak sound pressure level (unweighted); $L_{E,24h}$ = sound exposure level, cumulative 24 hours; LF = low-frequency; MF = mid-frequency; HF = high-frequency; PW = phocid in water; OW = otariid in water; dB = decibels; rms = root mean square.

6.3 Description of Noise Sources

For the purposes of this IHA application, the sound field in Knik Arm is the existing ambient sound plus additional construction noise from the SFD Project. Pile installation and removal are anticipated to produce the highest in-water sound pressure levels (Section 6.3.2). A number of project activities will take place above marine waters (including welding, cutting, wiring, and setting of a prefabricated gangway and ramp), and no in-water noise is anticipated in association with their installation. Vessel noise will be generated by tugs and barges; however, noise from project vessels is not anticipated to have more than a negligible effect on beluga whales or other marine mammals.

6.3.1 Ambient Noise

Ambient noise is background noise that is comprised of many sources from multiple locations (Richardson et al. 1995). Ambient noise can vary with location, time of day, tide, weather, season, and frequency on scales ranging from 1 second to 1 year (Richardson et al. 1995). Ambient underwater noise levels in the project area are both variable and relatively high, primarily because of extreme tidal activity, elevated sediment loads in the water column, periodic high winds, the seasonal presence of ice, and anthropogenic activities. Sources of anthropogenic noise in the project area consist of dredging operations, boats, ships, oil and gas operations, construction noise, and aircraft overflights from JBER, all of which contribute to the high underwater noise levels in upper Cook Inlet (e.g., Blackwell and Greene 2002; KABATA 2011). These levels are consistent with other measurements conducted in Cook Inlet by Blackwell (2005).

Ambient levels were most recently measured near the POA in 2016 at two locations, one within the POA and one about 1 kilometer offshore of the POA, during a 3-day break in pile installation during the POA TPP (Austin et al. 2016). The median values of the background sound pressure levels from continuous 60-second sample averages were 117.0 dB at the nearshore location within the POA and 122.2 dB at the offshore location (POA 2016a). During the measurements, some typical sound signals were noted, such

as noise from current flow and the passage of vessels. Throughout the data set, the offshore levels were consistently higher than those closer to the POA by 3 to 5 dB. Although different sound metrics were measured, the median levels are thought to be the most appropriate characterization of the nominal ambient conditions. A diurnal pattern to the ambient sound data was not apparent. More recently, NMFS accepted 122.2 dB as the ambient noise level for Phase 1 of the POA PCT Project (85 FR 19294). Based on these measurements, and the application of 122.2 dB for another POA project, the ambient noise level of 122.2 dB will be used for the SFD Project. Ambient noise levels were not measured as part of the acoustic monitoring program in June 2020 (I&R 2021).

6.3.2 Pile Installation and Removal

The primary sound-generating activities associated with construction of the SFD Project will be vibratory hammer installation and removal of permanent and temporary steel pipe piles, and potentially a short duration of impact hammering.

6.3.2.1 Source Sound Levels

In 2016, the POA assessed sound levels produced by impact and vibratory installation of 48-inch piles in the POA environment as part of the POA TPP. No 24- or 36-inch piles were installed during the TPP, and no measurements of sound levels produced by vibratory installation of unattenuated (without a bubble curtain) 24- or 36-inch piles were collected during the PCT SSV study in June 2020 (I&R 2021). The sound pressure levels used in this assessment for attenuated (installed with a bubble curtain) piles are based on acoustic data collected during the 2020 PCT SSV study; however, in the absence of project-specific empirical data, sound source levels (SSLs) from U.S. Navy (2015) were used for unattenuated piles. Selected levels were cross checked with the individual pile driving events reported in the 2020 PCT SSV and found to be in agreement.

U.S. Navy (2015) data were selected as proxies for pile installation in the POA environment because piles were installed at similar depths and in a similar marine environment. In 2013, sound levels for vibratory installation of unattenuated 36-inch piles were measured for the Naval Base Kitsap at Bangor EHW-2 Project (U.S. Navy 2015), and these were applied to the SFD Project for unattenuated battered piles. In the absence of site-specific transmission loss data, the TL coefficient for vibratory installation of the two battered unattenuated 36-inch piles is the NMFS default 15log. U.S. Navy data (2015) indicate a 10-meter sound level of 161 dB for vibratory installation of unattenuated 24-inch piles. The TL coefficient is the NMFS default 15log.

Sound levels for installation of 36-inch piles with a vibratory hammer and bubble curtain were measured in June 2020 (I&R 2021) during PCT construction, and it is assumed that sound levels will be similar for the SFD (Table 6-4). It is also assumed that sound levels during pile installation and removal are similar.

During the PCT SSV study, data were also collected for vibratory installation of 24-inch piles with a bubble curtain. Sample sizes were sufficient to separate data into two categories, template piles and trestle piles, with corresponding differences in sound levels and TL (I&R 2021). Differences are attributed to different drive times and hammer sizes, among other potential factors. The PCT temporary trestle piles were driven for 4.5 to 11.8 minutes using an APE 300-6 vibratory hammer, while the PCT template piles were driven much longer at 19.2 to 25.6 minutes using the smaller APE 200-6 vibratory hammer (I&R 2021).

In the PCT Final IHA for Phase 2 of that project (85 FR 19294), the POA proposed, and NMFS applied, a TL coefficient of 16.85 dB SEL for assessing potential for Level A harassment from impact pile driving and a TL coefficient of 18.35 dB rms when assessing potential for Level B harassment from impact pile driving based on Austin et al. (2016) measurements recorded during the TPP on 48-inch piles. Higher TL rates in Knik Arm are supported by additional studies, such as by Širović and Kendall (2009), who reported a TL of 16.4 dB during impact hammer driving during passive acoustic monitoring of the POA Marine

Terminal Redevelopment Project, and by Blackwell (2005), who reported TLs ranging from 16 to 18 dB SEL and 21.8 dB rms for impact and vibratory installation of 36-inch piles, respectively, during modifications made to the Port MacKenzie dock. After review of the draft *Federal Register* notice provided by NMFS, and given the variability and previous data suggesting higher TL rates, the POA has applied a practical spreading loss model (15log) to calculate ensonified areas (Table 6-4). The 15 TL coefficient also falls within the range of TL coefficients reported in I&R (2021) for PCT Phase 1.

Measurements of source level at 10 meters collected during impact installation of 48-inch piles with a bubble curtain during the PCT Phase 1 construction SSV study were compared with measurements collected without a bubble curtain during impact installation of 48-inch piles during the 2016 Test Pile Program. Efficacy of the 2020 bubble curtain during impact pile installation ranged from 9 to 11 dB for peak, rms, and SEL single strike for this comparison (I&R 2021; see Table 6-20 in the report). However, to be conservative, and in consideration of the effect that local currents may have on the distribution of bubbles and thus the effectiveness of an unconfined bubble curtain system, a conservative 7 dB reduction was applied to the U.S. Navy (2015) unattenuated SSLs (Table 6-4) for attenuated 24-inch and 36-inch piles during impact pile driving (Table 6-4). These SSLs are consistent with SSLs previously authorized by NMFS for POA impact pile driving of 24-inch and 36-inch piles (e.g., PCT Final IHAs [85 FR 19294]).

The POA will be conducting additional hydroacoustic monitoring in 2021 during Phase 2 of PCT construction as part of the PAMP. When the data and resulting analyses are available, NMFS and the POA will consider those data, and modifications may be made to SFD calculations, including source levels and transmission loss, if appropriate.

Table 6-4. Estimates of Unweighted Underwater Sound Levels Generated during Vibratory and Impact Pile Installation

Method and Pile Type	Unweighted Sound Level at 10 Meters							TL Coefficient
	Unattenuated Without Bubble Curtain				Attenuated With Bubble Curtain			
Vibratory Hammer	**dB rms**				**dB rms**			
24-inch steel	161[a,b]				158.5[b] (template piles)			15.0[c]
36-inch steel	166[a]				161.4[b]			15.0[c]
Impact Hammer	**dB rms**	**dB SEL**	**dB peak**	**TL Coefficient**	**dB rms**	**dB SEL**	**dB peak**	**TL Coefficient**
24-inch steel	193[a]	181[a]	210[a]	15.0[c] (rms) 15.0[c] (SEL)	186[a]	174[a]	203[a]	15.0[c] (rms) 15.0[c] (SEL) 15.0[c] (rms) 15.0[c] (SEL)
36-inch steel	194[a]	184[a]	211[a]	15.0[c] (rms) 15.0[c] (SEL)	187[a]	177[a]	204[a]	15.0[c] (rms) 15.0[c] (SEL) 15.0[c] (rms) 15.0[c] (SEL)

[a] U.S. Navy 2015
[b] I&R 2021
[c] NMFS default value (Practical Spreading Loss)

Note: dB = decibels; rms = root mean square; TL = transmission loss; SEL = sound exposure level

6.3.2.2 In-Air Noise Levels

To assess potential exposure of hauled-out pinnipeds to in-air noise, NMFS uses disturbance criteria for Level B harassment of 90 dB rms re 20 µPa for harbor seals, and 100 dB rms re 20 µPa for all other types of pinnipeds, including Steller sea lions. Note that all in-air sound discussed in this document is referenced to 20 µPa, unless otherwise noted. Impact installation of 36-inch steel pipe piles is anticipated to be among the highest SPLs resulting from project construction. In-air noise levels from impact installation of 36-inch steel piles were measured during the Naval Base Kitsap at Bangor EHW-2 Project (U.S. Navy 2015). In-air noise levels during impact installation were 109 dB (unweighted) re 20 µPa as measured at 15 meters (50 feet). Therefore, it is assumed that 109 dBA would be the highest anticipated in-air sound level at 15 meters for the SFD.

No pinniped haulouts are known to occur near the POA, and the nearest identified harbor seal haulout is located more than 20 kilometers from the SFD Project in the Little Susitna River delta (see Section 4.1.3). Therefore, it is unlikely that harbor seals or Steller sea lions will be impacted by in-air noise from pile installation or removal.

6.4 Distances to Sound Thresholds and Areas

6.4.1 In-water Noise

Sound propagation and the distances to the sound isopleths at which a marine mammal exposed to those values would potentially experience a PTS based on the Technical Guidance (Level A isopleths) were estimated using the User Spreadsheet developed by NMFS (NMFS 2018a). The NMFS User Spreadsheet computes the distances to isopleths for the different functional hearing groups based on an unweighted sound level with corresponding distance. The model applies simple Weighting Factor Adjustments for the five functional hearing groups and incorporates a duty cycle to account for the number of pile strikes (NMFS 2018a).

The simple spreading loss to account for sound propagation and the distances to the sound isopleths defined by NMFS for onset of PTS and Level B harassment of marine mammals were estimated based on the following:

$$TL = TL_c \log10 (R/D)$$

Where

- TL is the difference between the reference SSL dB rms and the Level B threshold dB (122.2 dB for vibratory);
- TL_c is the transmission loss coefficient;
- R is the estimated distance to where the sound level is equal to the Level B harassment threshold (122.2 dB for vibratory sound); and
- D is the distance at which the SSL was measured.

The estimated distance to the onset of PTS and Level B harassment isopleths can be calculated by rearranging the terms in the above equation to the following:

$$R = D\ 10^{(TL/TL_c)}$$

For estimated distances to the onset of PTS, the SSL is based on the accumulated SEL (SEL_{cum}) over time, which is computed based on the following for vibratory pile driving:

$$SEL_{cum} = SEL + 10Log_{10} (seconds)$$

This model was used to predict distances to underwater sound levels generated by vibratory pile installation and removal as part of the SFD Project (Table 6-5). Figure 6-1 shows example Level A isopleths for vibratory installation of up to three 36-inch piles per day with a bubble curtain. Level A zones for attenuated vibratory hammer installation and removal were calculated using 45 minutes for installation and 75 minutes for removal of temporary piles. All combinations of functional hearing group, pile size, number of piles per day, and use of a bubble curtain are smaller than the 100-meter shutdown zone that will be implemented by the POA during pile installation and removal (Table 6-5; Figure 6-1). Figure 6-2 shows Level A harassment isopleths for attenuated impact installation of 24- and 36-inch piles.

Figure 6-3 shows Level B harassment isopleths for attenuated and unattenuated vibratory installation of 24- and 36- inch piles. Figure 6-4 shows Level B harassment isopleths for attenuated impact installation of 24- and 36-inch piles.

Table 6-5. Distances to the Level A and B Harassment Isopleths for Installation and Removal of 24- and 36-inch Piles

Pile Size	Hammer Type	Attenuation	Piles per Day	Level A Harassment Zone (m)					Level A Areas (km^2)	Level B Harassment Zone (m)
				Cetaceans			Pinnipeds		All Hearing Groups	
				LF	MF	HF	PW	OW		
24-inch Template, Plumb	Vibratory (Installation)	**Bubble Curtain**	1	4	1	6	3	1	<0.01	**2,631**
			2	**7**	**1**	**9**	**4**	**1**		
		Unattenuated	1	6	1	9	4	1		3,861
	Vibratory (Removal)	**Bubble Curtain**	1	6	1	8	4	1		**2,631**
			3	**12**	**1**	**17**	**7**	**1**		
		Unattenuated	1	8	1	12	5	1		3,861
36-inch Template, Plumb	Vibratory (Installation)	**Bubble Curtain**	1	6	1	9	4	1		**4,106**
			2	**10**	**1**	**15**	**6**	**1**		
		Unattenuated	1	13	2	18	8	1		8,318
	Vibratory (Removal)	**Bubble Curtain**	1	9	1	13	6	1		**4,106**
			3	**18**	**2**	**26**	**11**	**1**		
		Unattenuated	1	18	2	26	11	1		8,318
36-inch Gangway and Float, Plumb (Installation Only)	Vibratory	**Bubble Curtain**	1	6	1	9	4	1		**4,106**
			3	**13**	**1**	**19**	**8**	**1**		
36-inch Float, Battered (Installation Only)	Vibratory	**Unattenuated**	**1**	**13**	**2**	**18**	**8**	**1**		**8,318**
24-inch Template, Plumb	Impact	**Bubble Curtain**	**1**	**251**	**9**	**299**	**135**	**10**	**<0.19**	**542**
		Unattenuated	1	735	27	876	394	29	<1.34	1,585
	Impact	**Bubble Curtain**	**1**	**398**	**14**	**474**	**213**	**16**	**<0.76**	**631**

36-inch Gangway, Float and Template	Unattenuated	1	1,165	42	1,387	624	46	<3.14	1,848

Note: m = meters; km^2 = square kilometers; LF = low-frequency; MF = mid-frequency; HF = high-frequency; PW = phocid in water; OW = otariid in water. Bold text reflects the most likely construction scenario.

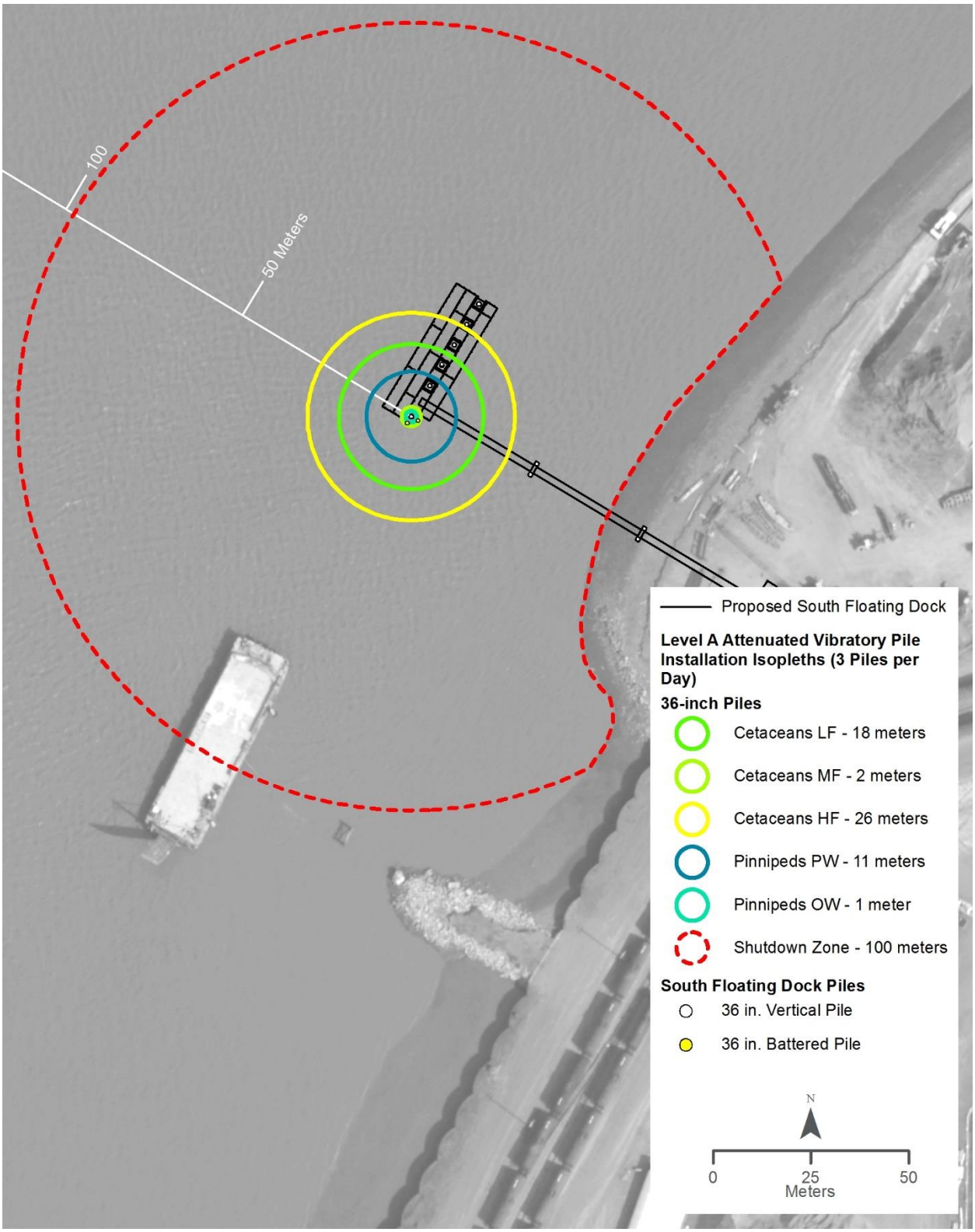

Figure 6-1. Level A Harassment Isopleths for Attenuated Vibratory Installation of 36-inch Piles

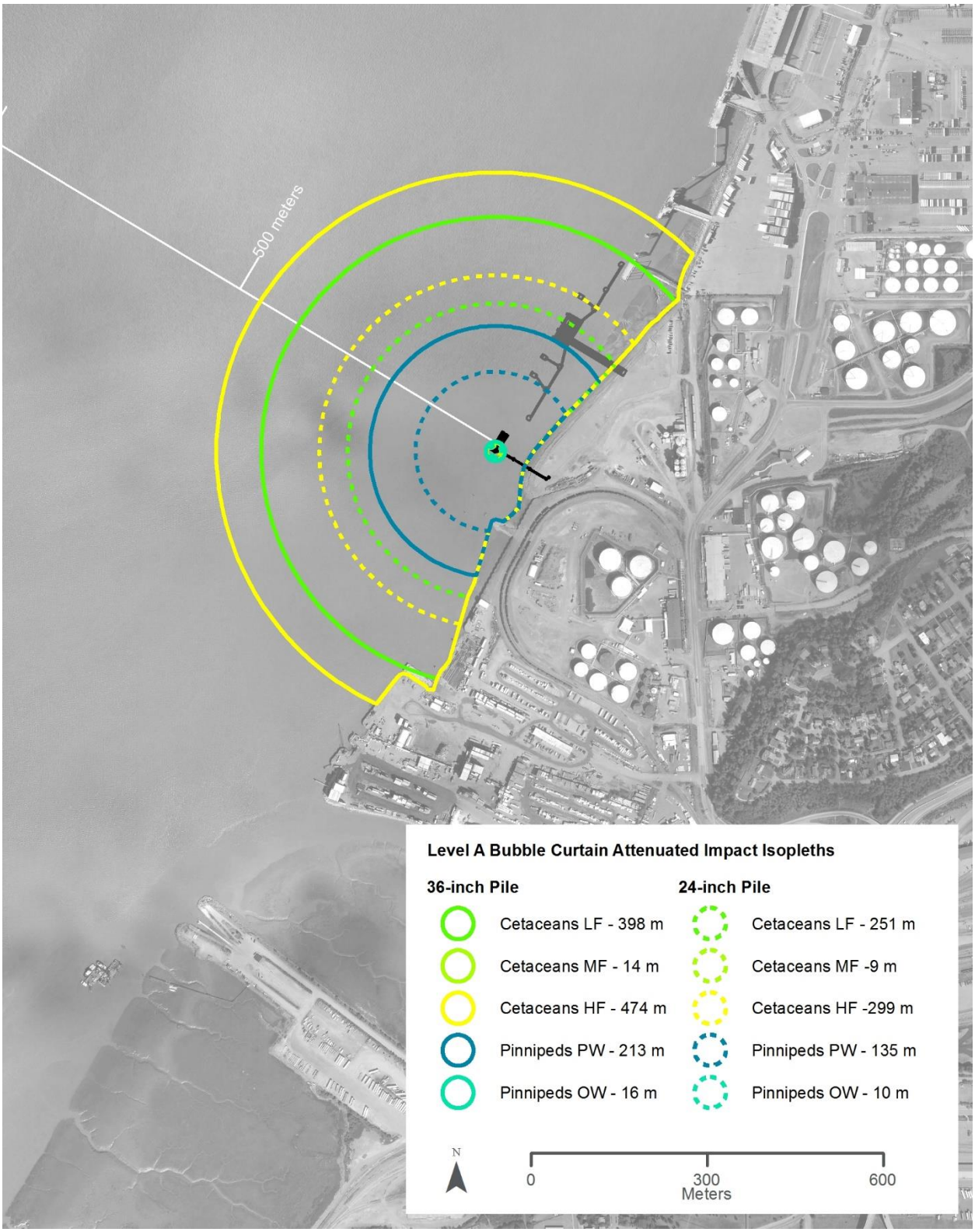

Figure 6-2. Level A Harassment Isopleths for Attenuated Impact Hammer Installation of 24- and 36-inch Piles

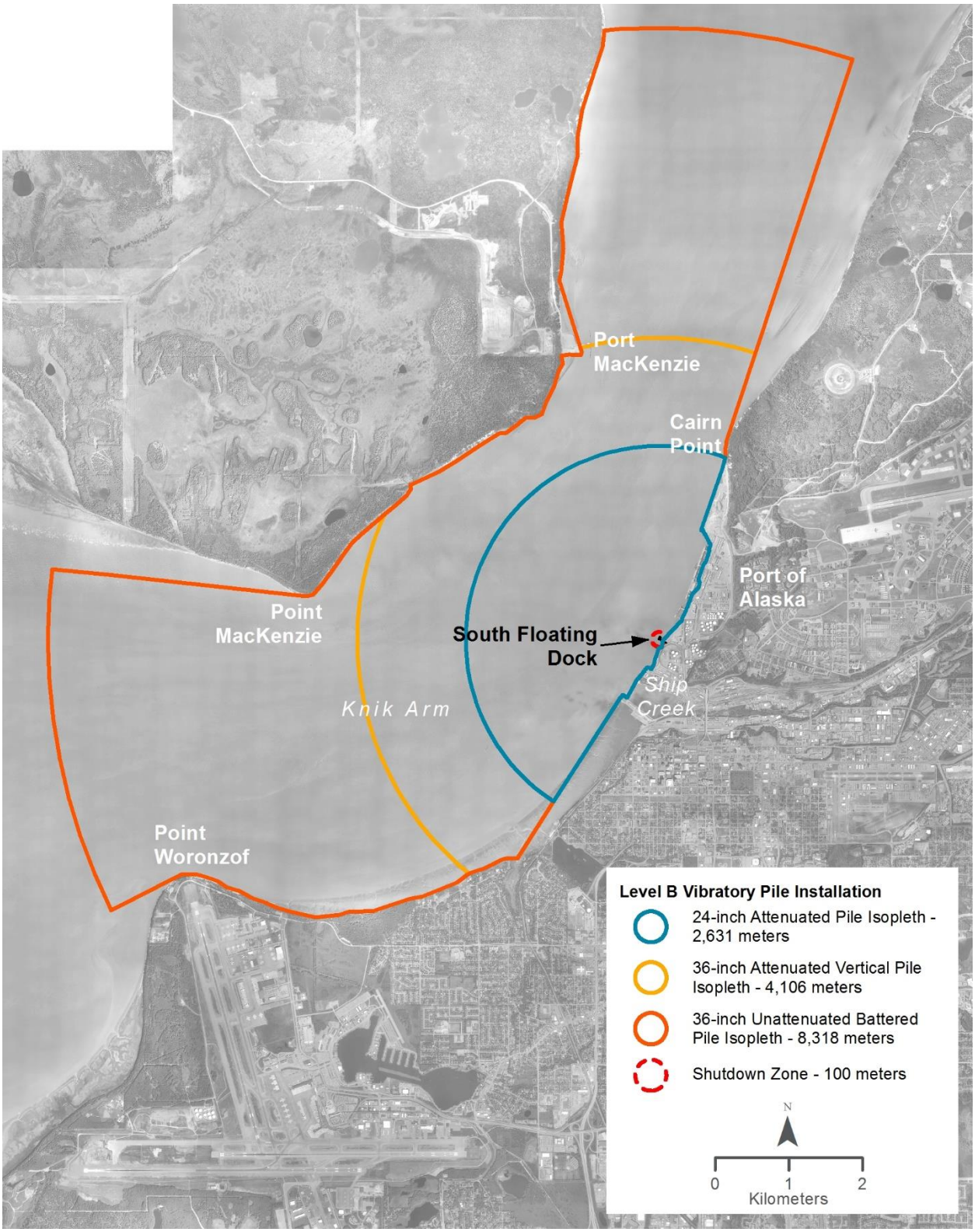

Figure 6-3. Level B Harassment Isopleths for Attenuated and Unattenuated Vibratory Installation of 24- and 36-inch Piles

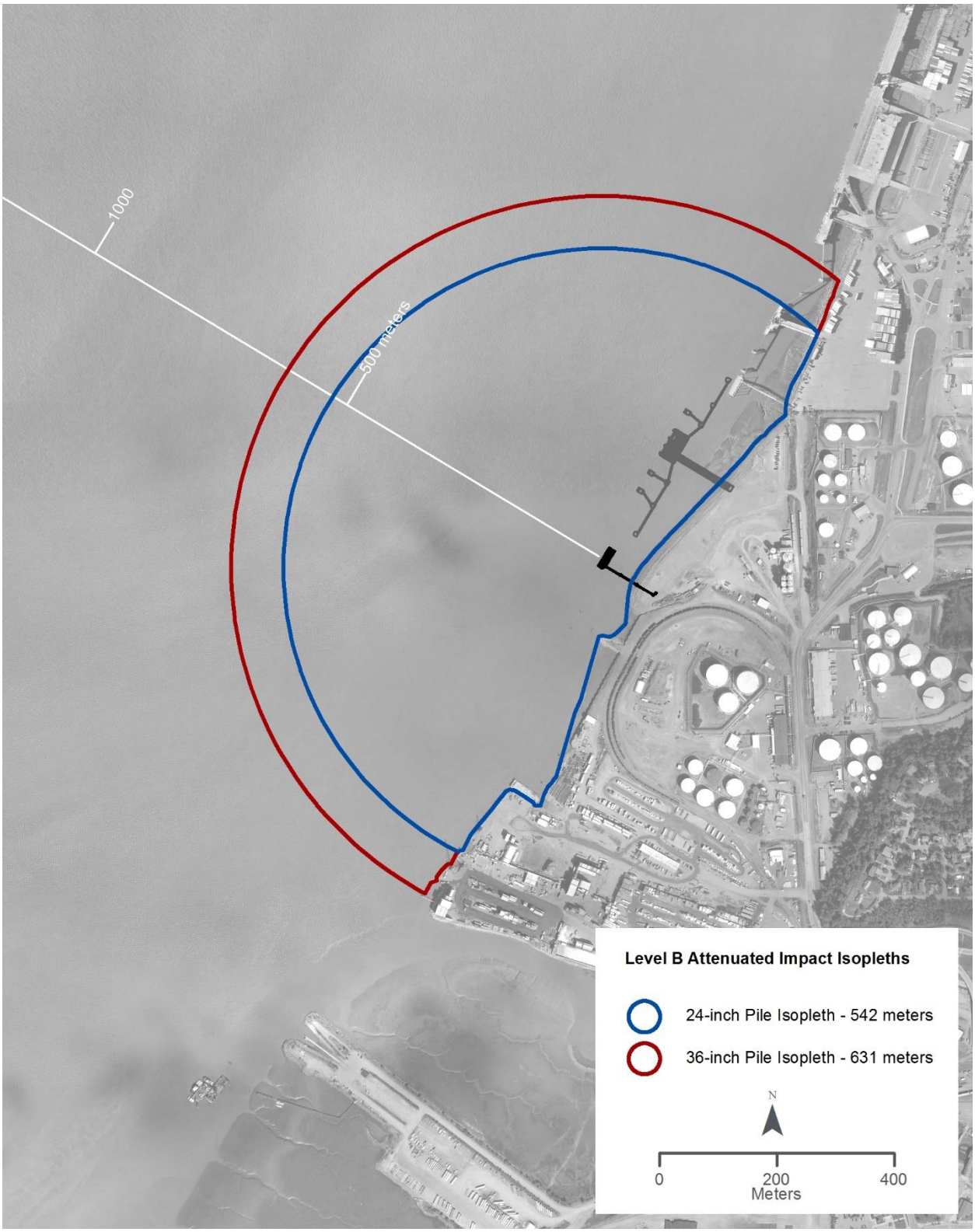

Figure 6-4. Level B Harassment Isopleths for Attenuated Impact Installation of 24- and 36-inch Piles

6.4.2 In-air Noise

The spherical spreading model with sound transmission loss of 6.0 dB per doubling distance for a hard surface ($D = D_o * 10$ [(Construction Noise – Ambient Sound Level in dBA)/α]; WSDOT 2018) was used to estimate noise threshold distances from the mean source levels. In the model,

D = the distance from the noise source

D_o = the reference measurement distance (15 meters [50 feet] in this case)

α = 20 for hard ground or water, which assumes a 6 dBA reduction per doubling distance

The distance to the in-air sound level threshold for impact installation of 36-inch steel piles is 43 meters for all pinnipeds except harbor seals, and 136 meters for harbor seals (Table 6-6).

Table 6-6. Distances from Impact Installation where In-air Sound will Attenuate to NMFS Threshold for Level B Harassment

Method, Pile Type	Harbor Seals (90 dB)	Other Pinnipeds (100 dB)
Impact Installation		
36-inch piles	136 m	43 m

Note: dB = decibels; m = meters.

The estimates for distances that in-air noise could travel and exceed the harassment threshold for in-air disturbance fall far short of the distance to the nearest known pinniped haulout (24 to 96 kilometers [15 to 60 miles] south-southwest of Anchorage for harbor seals; Section 4.1.3). Therefore, in-air noise is not considered further for SFD construction, and no incidental take of marine mammals from in-air sound is requested.

6.5 Estimated Numbers Exposed to Noise

6.5.1 Harbor Seal

No known harbor seal haulout or pupping sites occur in the vicinity of the POA; therefore, exposure of harbor seals to in-air noise is not considered in this application, and no take for in-air exposure is requested. Harbor seals are not known to reside in the project area, but they are seen regularly near the mouth of Ship Creek when salmon are running, from July through September. With the exception of newborn pups, all ages and sexes of harbor seals could occur in the project area during construction of the SFD. Any harassment of harbor seals during pile installation would involve a limited number of individuals that may potentially swim through the project area or linger near Ship Creek. Harbor seals that are disturbed by noise may alter their behavior (e.g., modify foraging patterns) and be temporarily displaced from the project area.

Marine mammal monitoring data were used to examine hourly sighting rates for harbor seals in the project area (Table 4-1). Sighting rates of harbor seals were highly variable and appeared to have increased during monitoring between 2005 and 2020 (Table 4-1). It is unknown whether any potential increase was due to local population increases or habituation to ongoing construction activities. The highest individual hourly sighting rate recorded for a previous year was used to quantify take of harbor seals for pile installation associated with the SFD. This occurred in 2020 during Phase 1 PCT construction, when harbor seals were observed from May through September. A total of 340 harbor seals were observed over 1,238.9 hours of monitoring, at a rate of 0.27 harbor seals per hour. The maximum monthly sighting rate occurred in September and was 0.51 harbor seals per hour. Based on these data, it is estimated that approximately 1 harbor seal may be observed near the project per hour of hammer use. During the 21 hours of anticipated pile installation and removal (Table 1-1), it is estimated that up

to 21 harbor seals will be potentially exposed to in-water noise levels exceeding the Level B harassment thresholds for pile installation and removal during SFD construction.

All efforts will be taken to shut down prior to a harbor seal entering the 100-meter shutdown zone (Section 11) and prior to a harbor seal entering the Level A harassment zones for impact installation. However, harbor seals often are curious of onshore activities, and previous monitoring suggests that this species may mill at the mouth of Ship Creek. It is important to note that the mouth of Ship Creek is about 700 meters from the southern end of the SFD, and is therefore outside the Level A zones for harbor seals during both unattenuated and attenuated (with a bubble curtain) vibratory and impact pile installation and removal. However, given the potential difficulty of detecting harbor seals and their consistent use of the area, Level A take for a small number of harbor seals is requested. Given that 30 harbor seals (8.6 percent of all harbor seals) and unidentified pinnipeds were detected within 624 meters, the largest Level A harassment zone for SFD, two harbor seals (8.6 percent of 21 exposures rounded up) could be exposed to Level A harassment levels and 19 harbor seals could be exposed to Level B harassment levels during PCT Phase 1 construction monitoring (61 North Environmental 2021).

Exposure is anticipated to be further minimized because pile installation/removal will occur intermittently (Table 1-1) over the short construction period. Few harbor seals are expected to approach the project area, and this small number of potential exposures is anticipated to have no measurable effect on the population as a whole.

6.5.2 Steller Sea Lion

Steller sea lions are anticipated to be encountered in low numbers, if at all, within the project area (Section 4.2.4). Three sightings of what was likely a single individual occurred in the project area in 2009, two sightings occurred in 2016, one occurred in 2019, and six were observed from April through September 2020. Based on observations in 2016, it is anticipated that an exposure rate of two individuals every 19 days during SFD pile installation and removal. Based on this rate, it is anticipated that up to two exposures of Steller sea lions could occur during the 24 days of SFD pile installation and removal.

All efforts will be taken to shut down prior to a sea lion entering the 100-meter shutdown zone (Section 11) and prior to a sea lion entering the Level A harassment zone. However, sea lions are known to travel at high speeds, in rapidly changing directions, and have the potential to be counted multiple times. It is possible that, despite all precautions, sea lions could enter the Level A harassment zone before a shutdown could be fully implemented. During SFD construction, it is anticipated that four sea lions could potentially be exposed to harassment over the course of SFD pile installation and removal. Therefore, the POA requests Level B harassment take of two Steller sea lions and Level A harassment take of two Steller sea lions, for a total of four exposures.

6.5.3 Harbor Porpoise

Monitoring data recorded for the MTRP and TPP were used to evaluate daily sighting rates for harbor porpoises in the project area (Table 4-2). During most years of monitoring, no harbor porpoises were observed. However, there has been an increase in harbor porpoise sightings in upper Cook Inlet over the past 2 decades (Shelden et al. 2014). The highest individual sighting rate for any recorded year during pile installation and removal associated with the PCT was an average of 0.09 harbor porpoise per day during 2009 construction monitoring, but this value does not account for increases in population size or range extensions. Therefore, it is assumed that 1 harbor porpoise could be observed every 2 days. It is estimated that approximately 12 harbor porpoises (24 days/1 harbor porpoise every 2 days = 12 harbor porpoises) could be exposed to harassment over the course of SFD pile installation and removal. This precautionary approach also covers the possibility that larger groups of harbor porpoises could occur less frequently.

All efforts will be taken to shut down prior to a harbor porpoise entering the Level A harassment zone or 100-meter shutdown zone (Section 11). During vibratory installation of battered, unattenuated 36-inch piles, the Level A harassment isopleth for high-frequency cetaceans (e.g., harbor porpoises) may extend up to 38 meters, but will generally be smaller (Table 6-5). The Level A harassment zone for impact installation of attenuated 36-inch piles may extend up to 987 meters (Table 6-5). Few harbor porpoises are expected to approach the project area and are likely to be sighted prior to entering the Level A harassment zone. Therefore, no Level A take of harbor porpoises is anticipated or requested.

With in-water pile installation and removal occurring intermittently over the construction period, the potential for exposure within the Level B harassment isopleths is anticipated to be low. Few harbor porpoises are expected to approach the project area, and the small number of requested takes (12 harbor porpoise) is expected to have a negligible effect on individual animals and no measurable effect on the population as a whole.

6.5.4 Killer Whale

Numbers of resident and transient killer whales in upper Cook Inlet are small in comparison with their overall population sizes. Few, if any, killer whales are expected to approach the project area. No killer whales were sighted during previous monitoring programs for the Knik Arm Crossing and POA construction projects, including the 2016 TPP (Prevel-Ramos et al. 2006; Markowitz and McGuire 2007; Cornick and Saxon-Kendall 2008, 2009; Cornick et al. 2010, 2011; ICRC 2009, 2010, 2011, 2012; Cornick and Pinney 2011; Cornick and Seagars 2016). The infrequent sightings of killer whales that are reported in upper Cook Inlet tend to occur when their primary prey (anadromous fish for resident killer whales and beluga whales for transient killer whales) are also in the area (Shelden et al. 2003). Previous sightings of transient killer whales have documented pod sizes in upper Cook Inlet between one and six individuals (Shelden et al. 2003).

The potential for exposure of killer whales within the Level B harassment isopleths is anticipated to be extremely low. Level B take is conservatively estimated at no more than one small pod (six individuals; Section 4.4.3) for the duration of pile installation and removal. Few killer whales are expected to approach the project area, and this small potential exposure is expected to have a negligible effect on an individual animal and no effect on killer whale populations as a whole. No Level A take for killer whales is anticipated or requested under this authorization, considering the proposed 100-meter shutdown zone. This small number of potential exposures is anticipated to have no measurable effect on individuals or the population as a whole.

6.5.5 Beluga Whale

Potential exposure of beluga whales to elevated sound levels from pile installation and removal was calculated following the method outlined in the PCT Final IHA (85 FR 19294), which was based on data published in Kendall and Cornick (2016) and from April through November 2020 of Phase 1 construction of the PCT (61N Environmental 2021). Monitoring data from the 2016 TPP (Cornick and Seagers 2016) were not included in the analysis because of limited hours observed and seasonal coverage. Hourly sighting rates for beluga whales for each calendar month were calculated using documented hours of observation and beluga whale sightings from April through November for 2005 through 2009 (Kendall and Cornick 2016) and using data for May through November 2020 (61N Environmental 2021). The hours of effort and numbers of whales observed during past construction monitoring programs were used to produce a sighting rate (beluga whales/hour) per month (Table 6-7). As described in Section 2, SFD construction could occur between April and November 2021. Pile installation and removal are anticipated to require 21 hours of in-water work over 24 non-consecutive days. Due to the uncertainty in construction timing, a precautionary approach was taken and it is assumed that all pile installation and removal will occur in August, the month with the highest calculated sighting rate (Table 6-7). The sighting rate of 0.94 whale per hour was used to calculate potential beluga whale exposures (21 hours of

pile installation and removal multiplied by 0.94 beluga whale/hour). Using this method, it is anticipated that 20 beluga whales (rounded up from 19.75) could be exposed to noise at the Level B harassment level during pile installation and removal. However, to more accurately estimate potential beluga whale exposures, the ratio of authorized exposures compared to realized exposures at the POA from 2008 through 2012 and in 2020 was examined, as recommended by NMFS for the PCT Final IHA (85 FR 19294). The highest percentage of recorded takes across all years was 59 percent. Applying this adjustment to account for potential exposures of beluga whales that would be avoided by shutting down, it was estimated that 12 beluga whales (20 whales * 0.59 = 11.8 whales; 12 rounded up) may be exposed to Level B harassment during pile installation and removal.

However, large groups of beluga whales have been seen swimming through the POA vicinity during POA monitoring efforts. For example, during Phase 1 of the PCT, the mean group size was 4.34 whales; however, 52 percent of observations were of groups greater than the mean group size, with 5 percent of those 119 groups being larger than 12 individuals (61 North Environmental 2021). To ensure that a large group of beluga whales would not result in using the majority or all of the take in one or two sightings, the exposure estimate calculated from sighting rates was buffered by adding the estimated size of a notional large group of beluga whales. The 95th percentile is commonly used in statistics to evaluate risk. Therefore, to determine the most appropriate size of a large group, the 95th percentile of group size of beluga whales observed during Kendall and Cornick (2015) and 2020 Phase 1 PCT construction monitoring (61 North Environmental 2021) was calculated; the same data were used to derive hourly sighting rates. In this case, the 95th percentile provides a conservative value that reduces the risk of taking a large group of beluga whales and exceeding authorized take levels. The 95th percentile of group size for the Kendall and Cornick (2015) and the PCT Phase 1 monitoring data (61 North Environmental 2021) is 12.0. This means that, of the 422 documented beluga whale groups in these data sets, 95 percent consisted of fewer than 12.0 whales; 5 percent of the groups consisted of more than 12.0. Considering large group size, 24 takes (accounting for the 12 takes previously estimated using sighting rates plus a group size of 12) of beluga whales incidental to pile driving for the SFD are requested. Incorporation of large groups into the beluga whale exposure estimate is intended to reduce risk of the unintentional take of a larger number of beluga whales.

No Level A take of beluga whales is anticipated or requested. This small number of potential exposures is anticipated to have no measurable effect on individuals or the population as a whole.

Table 6-7. Summary of Beluga Whale Sighting Data from April through November 2005–2009 and May through November 2020

Month	Total Hours	Total Groups	Total Whales	Whales/Hour
April	52.50	13	35	0.67
May	457.40	53	208	0.45
June	597.77	37	122	0.20
July	552.67	14	27	0.05
August	577.30	120	543	0.94
September	533.03	124	445	0.83
October	450.70	9	22	0.05
November	346.63	52	272	0.78

6.5.6 Humpback Whale

Sightings of humpback whales in the project area are rare, and the potential risk of exposure of a humpback whale to sounds exceeding the Level B harassment threshold is low. Few, if any, humpback whales are expected to approach the project area. However, based on two sightings in 2017 of what was

likely a single individual at the Anchorage Public Boat Dock at Ship Creek (ABR Inc. 2017) south of the project area, it is anticipated that exposure of up to two individuals for the duration of SFD pile installation and removal. This could include sighting of a cow-calf pair or multiple sightings of single humpback whales. This small potential exposure is expected to have a negligible effect on an individual animal and no effect on humpback whale populations as a whole. No Level A take for humpback whales is anticipated or requested under this authorization.

6.6 All Marine Mammal Takes Requested

Table 6-8 provides a summary of all marine mammal exposures requested for the SFD Project. The analysis of pile installation and removal associated with the SFD Project predicts potential exposures of marine mammals to noise from vibratory pile installation and removal that could be classified as Level A and Level B harassment under the MMPA (Table 6-5). No Level A take is requested for harbor porpoises, killer whales, beluga whales, or humpback whales.

Table 6-8. Summary of All Marine Mammal Exposures Requested by Species

Species	Level A Exposures	Level B Exposures	Species Total	Stock/DPS	Abundance	Percent of Population[a]
Harbor seal	2	19	**21**	Gulf of Alaska	28,411	0.07
Steller sea lion	2	2	**4**	Western DPS	52,932	<0.01
Harbor porpoise	0	12	**12**	Cook Inlet / Shelikof Strait	31,046	0.04
Killer whale	0	6	**6**	Resident	2,347	0.26[b] or
				Transient	587	1.02[b]
Beluga whale	0	24	**24**	Cook Inlet	279	8.6
Humpback whale	0	2	**2**	Hawaii DPS	11,398	0.02[b] or
				Mexico DPS	3,264	0.06[b] or
				W N Pacific DPS	1,059	0.19[b]
Total	4	65	**69**			

[a] Population estimates used in calculations are presented in Section 4.

[b] These percentages assume that all potential exposures come from each stock; thus, each percentage should be adjusted down if multiple stocks are actually affected.

Note: DPS = distinct population segment; W N = Western North.

7 Description of Potential Impacts to Marine Mammals

Marine mammals use hearing and sound transmission to perform vital life functions. Sound (hearing, vocalization, and echolocation) serves four primary functions for marine mammals: (1) providing information about their environment, (2) communication, (3) prey detection, and (4) predator detection. The distances to which pile installation noise from the construction of the SFD Project are audible will depend upon source levels, frequency, ambient noise levels, propagation characteristics of the environment, and sensitivity of the receptors (Richardson et al. 1995). In-water pile installation and removal will temporarily increase the local underwater and in-air noise environment in the vicinity of the construction of the SFD Project.

Research suggests that increased noise may impact marine mammals in several ways (e.g., behaviorally and physiologically). The effects of pile installation and removal on marine mammals are dependent on several factors, including the size, type, and depth of the animal; the depth, intensity, and duration of the pile-driving sound; the depth of the water column; the substrate of the habitat; the distance between the pile and the animal; and the sound propagation properties of the environment.

7.1 Zones of Noise Influence

The effects of sounds from pile installation on marine mammals might include one or more of the following: tolerance, masking of natural sounds, behavioral disturbance, temporary or permanent hearing impairment, and non-auditory physical effects (Richardson et al. 1995). In assessing potential effects of noise, Richardson et al. (1995) have suggested four criteria for defining zones of influence. These zones are described below from greatest influence to least:

Zone of hearing loss, discomfort, or injury – the area within which the received sound level is potentially high enough to cause discomfort or tissue damage to auditory or other systems. This includes PTS (loss in hearing at specific frequencies or deafness). Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to strong underwater sound include stress, neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage.

Zone of masking – the area within which the noise may interfere with detection of other sounds, including communication calls, prey sounds, or other environmental sounds.

Zone of responsiveness – the area within which the animal reacts behaviorally or physiologically. The behavioral responses of marine mammals to sound are dependent upon a number of factors, including (1) acoustic characteristics of the noise source of interest, (2) physical and behavioral state of the animals at the time of exposure, (3) ambient acoustic and ecological characteristics of the environment, and (4) context of the sound (e.g., whether it sounds similar to a predator; Richardson et al. 1995; Southall et al. 2007). However, temporary behavioral effects are often simply evidence that an animal has heard a sound and may not indicate lasting consequence for exposed individuals (Southall et al. 2007).

Zone of audibility – the area within which the marine mammal might hear the noise. Marine mammals as a group have functional hearing ranges of 7 Hz to 180 kHz, with best thresholds near 40 dB (Ketten 1998; Southall et al. 2007; NMFS 2018a). Hearing capabilities of the species included in this application are discussed in Section 4. There are no applicable criteria for the zone of audibility due to difficulties in human ability to determine the audibility of a particular

noise for a particular species. The audibility zone does not fall in the sound range of a "take" as defined by NMFS and is not discussed below.

7.2 Assessment of Acoustic Impacts

The exposure to noise from pile installation and removal could result in behavioral and mild physiological changes in marine mammals. Some age and sex classes are more sensitive to noise disturbance, and such disturbance may be more detrimental to young animals (e.g., National Research Council 2003). David (2006) suggested that pile installation operations should be avoided when bottlenose dolphins (*Tursiops truncatus*) are calving, since lactating females and young calves are likely to be particularly vulnerable to such sound. Distinct mating periods, calving dates, and calving areas for the Cook Inlet beluga whale are not well documented; however, calves are present during summer (Huntington 2000; Hobbs et al. 2005). Monitoring and mitigation measures will be implemented during construction of the SFD Project to minimize the number of takes by Level B disturbance caused by in-water pile installation, including use of shutdowns when beluga whales approach the proposed Level B harassment zone. There is a small chance that a few individual calves may be exposed to noise from pile installation and removal; however, the overall impacts to the population are expected to be negligible.

7.2.1 Zone of Hearing Loss, Discomfort, or Injury

Strong sounds can cause temporary or permanent reduction in hearing sensitivity. No studies have determined levels that cause PTS in beluga whales. Laboratory experiments investigating temporary threshold shift (TTS) onset for beluga whales have been conducted. Finneran et al. (2000) exposed a trained captive beluga whale to a single pulse from an explosion simulator. No TTS threshold shifts were observed at the highest received SELs (179 dB re 1 μPa^2-s; approximately 199 dB rms); amplitudes at frequencies below 1 kHz were not produced accurately to represent predictions for the explosions. Finneran et al. (2002) repeated the study using seismic water guns with a single acoustic pulse. Masked hearing TTSs were 7 and 6 dB at 0.4 and 30 kHz, respectively, after exposure to intense single pulses (186 dB SEL; 208 dB rms). Schlundt et al. (2000) demonstrated temporary shifts in masked hearing thresholds for beluga whales occurring generally between 192 and 201 dB rms (192 to 201 dB SEL) after exposure to intense, non-pulse, 1-second tones at 3, 10, and 20 kHz. TTS onset occurred at mean SEL of 195 dB rms (195 dB SEL). Popov et al. (2013) conducted studies of TTS in a captive male and a captive female beluga whale. The fatiguing noise had a 0.5-octave bandwidth, with center frequencies ranging from 11.2 to 90 kHz, a level of 165 dB re 1 µPa, and exposure lasting 1 to 30 minutes. The highest TTS with the longest recovery duration was produced by noises of lower frequencies (11.2 and 22.5 kHz) and appeared at a test frequency of +0.5 octave. At higher noise frequencies (45 and 90 kHz), the TTS decreased. The TTS effect gradually increased with prolonged exposures ranging from 1 to 30 minutes. In a variety of exposure and recording conditions, TTS in the female subject was higher and longer than in the male subject, further illustrating that inter-individual difference must be taken into consideration when possible impacts to hearing are assessed. Popov et al. (2013) measured a TTS onset of 158 dB maximum accumulated sound exposure level (SEL_{cum}) from a female beluga whale.

Kastelein et al. (2013a) determined that the hearing threshold was lower when a harbor porpoise was exposed to multiple strike sounds than when it was exposed to only a single strike sound. Using a psychophysical technique, a harbor porpoise's hearing thresholds were obtained for series of five pile-driving sounds (inter-pulse interval 1.2 to 1.3 seconds) recorded at 100 and 800 meters from the pile-driving site and played back in a pool. The 50 percent detection threshold SELs for the first sound of the series (no masking) were 72 (100 meters) and 74 (800 meters) dB re 1 μPa^2-s. Multiple sounds in succession (series) caused a 5-dB decrease in hearing threshold.

During in-air auditory threshold testing, Kastak and Schusterman (1996) inadvertently exposed a harbor seal to broadband construction noise for 6 days, averaging 6 to 7 hours of intermittent exposure per

day. When the harbor seal was tested immediately upon cessation of the noise, a TTS of 8 dB at 100 Hz was evident. Following 1 week of recovery, the subject's hearing threshold was within 2 dB of its original level. Pure-tone sound detection thresholds were obtained in water for a harbor seal before and immediately following exposure to octave-band noise (Kastak et al. 1999). Test frequencies ranged from 100 Hz to 2 kHz, and octave-band exposure levels were approximately 60 to 75 dB source level. The subject was trained to dive into a noise field and remain stationed underwater during a noise-exposure period that lasted a total of 20 to 22 minutes. Following exposure, the harbor seal showed threshold shifts averaging 4.8 dB. The average threshold shift relative to baseline thresholds following noise exposure was 4.8 dB, and the average shift following the recovery period was 20.8 dB (Kastak et al. 1999).

Noise may affect physiology and developmental, stress, reproductive, or immune functions. Norman (2011) reviewed environmental and anthropogenic stressors for Cook Inlet beluga whales. Lyamin et al. (2011) determined that the heart rate of a beluga whale increases in response to noise, depending on the frequency and intensity. Acceleration of heart rate in the beluga whale is the first component of the "acoustic startle response." Romano et al. (2004) demonstrated that captive beluga whales exposed to high-level impulsive sounds (i.e., seismic airgun and/or single pure tones up to 201 dB rms) resembling sonar pings showed increased stress hormone levels of norepinephrine, epinephrine, and dopamine when TTS was reached. Thomas et al. (1990) exposed beluga whales to playbacks of an oil-drilling platform in operation ("Sedco 708," 40 Hz–20 kHz; source level 153 dB). Ambient SPL at ambient conditions in the pool before playbacks was 106 dB and 134 to 137 dB during playbacks at the monitoring hydrophone across the pool. All cell and platelet counts and 21 different blood chemicals, including epinephrine and norepinephrine, were within normal limits throughout baseline and playback periods, and stress response hormone levels did not increase immediately after playbacks. The difference between the Romano et al. (2004) and Thomas et al. (1990) studies could be the differences in the type of sound (oil drilling versus simulated underwater explosion), the intensity and duration of the sound, the individual's response, and the surrounding circumstances of the individual's environment (Romano et al. 2004). The construction sounds in the Thomas et al. (1990) study would be more similar to those of pile installation than those in the study investigating stress response to water guns and pure tones. Therefore, no more than short-term, low-hormone stress responses, if any, of beluga whales or other marine mammals are expected as a result of exposure to pile installation.

Some species of odontocetes may have the ability to dampen hearing sensitivity in expectation of loud noise. Dampening has been observed in captive bottlenose dolphins (Nachtigall et al. 2016a), false killer whales (Nachtigall and Supin 2013), beluga whales (Nachtigall et al. 2015), and, to a lesser degree, harbor porpoises (Nachtigall et al. 2016b). When animals were given a series of warning pips in advance of a louder noise, hearing threshold shifted. For false killer whales, bottlenose dolphins, and beluga whales, the magnitudes, durations, and timing of both threshold shift and recovery in relation to the warning and loud sounds indicated a conditioned dampening response rather than noise-induced threshold shift (Nachtigall and Supin 2013; Nachtigall et al. 2015, 2016a). For harbor porpoises, data suggested that both a conditioned response and a noise-induced threshold shift contributed to the observed threshold shifts (Nachtigall et al. 2016b).

7.2.2 Zone of Masking

Pile-installation operations could result in minor masking through overlapping frequencies of the marine mammal signals or by increasing sound levels such that animals are unable to detect important signals over the increased noise. A passive acoustic study in the vicinity of the MTRP during its 2009 construction season measured noise to be less than 10 kHz, with one exception of impact pile installation, which extended to 20 kHz (Širović and Kendall 2009). Impact pile installation is less likely to mask beluga whale vocalizations than vibratory pile installation, because the frequency bandwidth from vibratory methods is within the range of whistles and noisy vocalizations (up to 10 kHz; Kendall 2010).

Beluga whale whistles have dominant frequencies in the 2 to 6 kHz range; other beluga whale call types include sounds at mean frequencies ranging upward from 1 kHz (Sjare and Smith 1986a, 1986b). The acoustic data from 2009 did not include any vocalizations other than echolocation clicks, indicating that beluga whales in the area may be focused on foraging as opposed to social behaviors (Saxon-Kendall et al. 2013). In response to loud noise, beluga whales may shift the frequency of their echolocation clicks to prevent masking by anthropogenic noise (Tyack 2000). Beluga whale echolocation has peak frequencies from 40 to 120 kHz and broadband source levels of up to 219 dB at 1 meter (Au et al. 1985). Killer whales produce whistles between 1.5 and 18 kHz, and pulsed calls between 500 Hz and 25 kHz (Ford and Fischer 1983 *as cited in* Richardson et al. 1995). Harbor porpoises produce acoustic signals in a very broad frequency range, from less than 100 Hz to 160 kHz (Verboom and Kastelein 2004). The echolocation clicks produced by the aforementioned marine mammals are far above the frequency range of the sounds produced by vibratory pile driving and other construction sounds (e.g., dredging and gravel fill). Harbor seals produce social calls at 500 to 3,500 Hz and clicks from 8 to 150 kHz (reviewed in Richardson et al. 1995).

Increased noise levels could also result in minor masking of some marine mammal signals. Blackwell (2005) and URS (2007) reported that background noise at the POA (physical environment and maritime operations) contributed more to received levels than did pile installation at distances greater than 1,300 meters from the source. Therefore, beluga whales and other marine mammals in the POA area have likely become habituated to increased noise levels.

Implementation of the proposed mitigation measures will reduce impacts on marine mammals (Section 11), with any minor masking occurring close to the sound source, if it at all. The area of the SFD Project construction activities is a small area of ensonification relative to the width and size of Knik Arm, further reducing any effects on marine mammals. Beluga whales are able to adjust vocalization amplitude and frequency in response to increased noise levels (Scheifele et al. 2005). However, the energetic costs of adjusting vocalizations in response to increased noise levels is poorly understood, and it is uncertain how this will affect individual animals. As a result of the intermittent nature of pile installation and removal at the SFD Project area, the likelihood of in-water pile-installation and removal operations masking beluga whale social calls or echolocation clicks is low.

7.2.3 Zone of Responsiveness

Responses from marine mammals in the presence of pile-installation and removal activities might include a reduction of acoustic activity, a reduction in the number of individuals in the area, and avoidance of the area (e.g., Brandt et al. 2011; Tougaard et al. 2012; Dähne et al. 2013). Of these, temporary avoidance of the noise-impacted area is the most common response of marine mammals. Avoidance responses may be initially strong if the marine mammals move rapidly away from the source or weak if animal movement is deflected only slightly away from the source. Noise from pile installation/removal could potentially displace marine mammals from the immediate area of the activity. However, marine mammals will likely return after completion of pile-driving activities, as demonstrated by a variety of studies about temporary displacement of marine mammals by industrial activity (reviewed in Richardson et al. 1995).

Beluga whales in Cook Inlet have continued to utilize the habitat in the POA vicinity and Knik Arm, despite it being heavily disturbed from maritime operations, maintenance dredging, and aircraft. Cook Inlet beluga whales did not abandon the area of the POA or Knik Arm during the 2016 TPP or the MTRP (Kendall 2010; Cornick and Seagars 2016). Cook Inlet beluga whales were continually observed in the MTRP area, even in the presence of pile installation (Section 7.2.4). However, sightings of beluga whales may have increased along the western shoreline of Knik Arm during the MTRP in 2008–2009, relative to pre-construction sightings from 2005 to 2007, indicating possible avoidance of the activity at the MTRP site (Kendall 2010). Sonobuoy data collected near the MTRP site in 2009 indicated fewer beluga echolocation clicks per hour during construction activities than when no construction was being

performed; however, this difference was not statistically significant (Saxon-Kendall et al. 2013). Any masking event that could possibly rise to Level B harassment under the MMPA will occur concurrently within the zones of behavioral harassment already estimated for impact pile installation and removal, and have already been taken into account in the exposure analysis.

The presence of beluga whales in 2008 through 2011 during marine mammal monitoring for the MTRP followed a pattern similar to what has been observed prior to commencement of pile installation at the POA, including similar behaviors (diving and feeding) and peak abundance in late August and September, suggesting that pile-driving activities have not affected overall beluga whale behavior. Implementation of the mitigation measures during the MTRP reduced impacts on individual beluga whales to a short-term, temporary disturbance (i.e., Level B takes). Beluga whales have been observed during the same time period (peaking in September and October) in the POA area despite the presence of in-water construction and other maritime activities (Prevel-Ramos et al. 2006; Cornick and Saxon-Kendall 2008, 2009; Kendall 2010; Cornick et al. 2011; Cornick and Pinney 2011). There is no evidence to suggest that pile-installation operations at the POA affected beluga whale use of Knik Arm as a whole, as evidenced by the consistency of timing, location, and numbers of beluga whales (including calves; Prevel-Ramos et al. 2006; Markowitz and McGuire 2007; Cornick and Saxon-Kendall 2008, 2009; Kendall 2010; Cornick and Pinney 2011; Cornick et al. 2011). Further, monitoring data conducted during PCT Phase 1 construction in 2020 indicated that traveling, milling, and diving were the primary beluga whale behaviors observed (61N Environmental 2021). Beluga whales frequently approached and transited through the project site after pile installation or removal was shut down, often lingering for extended periods of time (61N Environmental 2021). These reports indicate that beluga whales are primarily transiting through the POA area while opportunistically foraging, and that project construction, harbor dredging, and other maritime activities are not blocking this transit. Therefore, impacts on the Cook Inlet beluga whale population from the proposed SFD Project in-water construction activities are expected to be negligible.

To estimate the discomfort threshold of pile-installation sounds on a harbor porpoise, Kastelein et al. (2013a) exposed a captive individual to playbacks (46 strikes/minute) at five SPLs (6 dB steps: 130 to 154 dB re 1 μPa). At and above a received broadband SPL of 136 dB re 1 μPa (zero-peak SPL: 151 dB re 1 μPa; t90: 126 milliseconds; SEL of a single strike: 127 dB re 1 μPa^2-s), the porpoise's respiration rate increased in response to the pile-installation sounds. At higher levels, the individual also jumped out of the water more often (Kastelein et al. 2013b). The effects of pile-driving noise were studied by Tougaard et al. (2003) during the construction of the offshore wind farms at Horns Reef (North Sea) and Nysted (Baltic). At Horns Reef, the acoustic activity of harbor porpoises decreased shortly after each pile-driving event and went back to baseline conditions after 3 to 4 hours. However, harbor porpoises in Cook Inlet are currently exposed to a variety of industrial sounds and return to upper Cook Inlet each year, suggesting a level of habituation.

There are no studies that have focused on the effects of pile-driving noise on killer whales. However, since killer whales are rarely sighted near the POA, it is unlikely that killer whales will be exposed to pile-driving noise that masks acoustic communication.

A study by Kastelein et al. (2013c) showed that the hearing threshold for harbor seals exposed to playbacks of pile installation noise was lower when the animals were exposed to multiple strike sounds than it would be if they were exposed to a single strike sound. The harbor seal's unmasked hearing threshold level for pile installation sounds was found to be many orders of magnitude (approximately 130 dB) lower than the level measured at a distance of 800 meters from an offshore pile installation location. Kastelein et al. (2013c) noted that this suggests that pile-driving sounds are audible to harbor seals at distances on the order of hundreds of kilometers from pile-driving sites, depending on the actual propagation conditions and the masking of the sounds by ambient noise. Kastak et al. (1999) reported that pinniped behavior was often altered during experiments to assess TTS, reflected in hauling

out, aggression directed at the apparatus and at the trainer, and refusal to station at the apparatus during noise exposure. Kastak et al. (1999) noted that these altered behaviors in the form of increased levels of aggression and/or avoidance of a location at which food had been received prior to noise exposure should be considered in the context of free-ranging seals that might respond similarly to uncomfortable noise exposures.

It is important to understand that there is variation among individual animals in behavioral reactions to sounds. For example, during in-water pile driving at Hood Canal, Washington, during fall 2011, harbor seals (particularly juveniles) appeared to be attracted to pile-driving activities, and often moved toward the construction area when pile driving was initiated (Ampela et al. 2014).

7.2.4 Habituation and Desensitization

Repeated or sustained disruption of important behaviors (such as feeding, resting, traveling, and socializing) is more likely to have a demonstrable impact than a single exposure (Southall et al. 2007). However, it is possible that marine mammals exposed to repetitious construction sounds will become habituated, desensitized, and tolerant after initial exposure to these sounds, as demonstrated by beluga whale tolerance of larger vessels in industrialized areas such as the St. Lawrence River and Beaufort Sea (reviewed by Richardson et al. 1995). Cook Inlet beluga whales are familiar with, and likely habituated to, the presence of large and small vessels. Beluga whales are frequently sighted in and around the POA, the Port MacKenzie Dock, and the small boat launch adjacent to the outlet of Ship Creek (Blackwell and Greene 2002; Funk et al. 2005; Ireland et al. 2005; NMFS 2008a). For example, Cook Inlet beluga whales did not appear to be bothered by the sounds from a passing cargo freight ship (Blackwell and Greene 2002).

Although the POA area is a highly industrialized area supporting a large amount of ship traffic, beluga whales are present almost year-round. Despite increased shipping traffic and upkeep operations (e.g., dredging), beluga whales continue to utilize waters within and surrounding the POA area, interacting with tugs and cargo freight ships (Markowitz and McGuire 2007; NMFS 2008a). During the POA monitoring studies, animals were consistently found in higher densities in the nearshore area (6 km^2) around the POA area throughout April to October each year where vessel presence was highest. Cook Inlet beluga whales were continually observed in the MTRP area, even in the presence of pile installation activity. In comparing pre- and post-pile-driving observations, Kendall (2010) reported a decrease in sighting duration of beluga whales; the increase in travel and the increased sightings near Port MacKenzie may indicate avoidance behavior by beluga whales in the area around the MTRP. It should be noted that Cornick et al. (2011) remarked that, during 2011 monitoring, beluga whales in the area of the MTRP appeared to have returned to similar habitat use, behavior, and group structure patterns that were in place prior to 2010, which may have been related to the reduced occurrence of pile driving and other in-water construction activities.

Carstensen et al. (2006) and Brandt et al. (2011) observed a decrease in harbor porpoises in the presence of pile-driving activity during the construction of offshore wind turbines near Denmark. Harbor porpoises returned to the construction area between pile-driving events; however, the return time occasionally took several days (Carstensen et al. 2006). Brandt et al. (2011) observed the reduction of harbor porpoise activity and density at the construction area over the entire period during which pile driving took place (5 months), also documenting increased use of areas 20 kilometers away from the construction site.

These studies indicate that beluga whales have become desensitized and habituated to the present level of human-caused disturbance. Therefore, it is anticipated that beluga whales will become habituated to pile installation and removal noise. Cook Inlet beluga whales have demonstrated a tolerance to ship traffic around the POA. Animals will be exposed to greater than current background noise levels from pile installation and removal; however, background sound levels in Knik Arm are already high due to

strong currents, eddies, recreational vessel traffic, U.S. Coast Guard patrols, dredging, and commercial and military shipping traffic entering and leaving the POA (Blackwell and Greene 2002; Blackwell 2005; URS 2007; KABATA 2011). Based upon the already-elevated background noise around the POA area and a beluga whale's ability to compensate for masking, it can be reasonably expected that beluga whales will become habituated to pile installation as they have to vessel traffic. It is expected that the frequency and intensity of behavioral reactions, if present, will decrease when habituation occurs.

7.3 Assessment of Impacts on Cook Inlet Beluga Whale Stock

Anthropogenic noise is ranked as one of three threats of "high relative concern" to the recovery of Cook Inlet beluga whales (NMFS 2016). As discussed above, anthropogenic noise can affect beluga whale communication, behavior, and echolocation, and can alter the distribution or abundance of prey resources. Chronic exposure to anthropogenic noise may decrease survival and reproduction, with population-level consequences. However, the magnitude of this impact on Cook Inlet beluga whales and the potential for increasing exposure enough to result in population-level effects is currently unknown. In order to address whether noise is limiting the recovery of the Cook Inlet beluga whale population, Tollit et al. (2016) developed an interim-population consequences-of-disturbance model. This model builds on the concept that species perceive human disturbance as a threat, which results in behavioral and physiological responses that adversely affect individual health (Tollit et al. 2016). Currently, there are limited empirical data to explain how and to what extent anthropogenic noise in Cook Inlet results in changes to beluga whale behavior, reproduction, or individual survival. To fill this data gap, Tollit et al. (2016) convened a workshop in April 2016 in which expert knowledge was gathered and incorporated in the interim population consequences of disturbance model. The model was then used to assess population-level impacts from a hypothetical pile-installation project with different levels of beluga whale exposure over multiple years. Under all scenarios, the effect of anthropogenic noise disturbance on vital rates was so small that it was considered unlikely to result in population-level effects (Tollit et al. 2016).

7.4 Conclusions Regarding Impacts to Species or Stocks

Individual marine mammals may be exposed to SPLs during pile installation and removal associated with the SFD Project that may exceed Level B harassment. In addition, small numbers of harbor seals, Steller sea lions, and harbor porpoises may be exposed to Level A harassment. Marine mammals that are "taken" (i.e., harassed) may change their normal behavior patterns (e.g., swimming speed or foraging habits) or be temporarily displaced from the area of pile installation or removal. Any "takes" will likely have only a minor effect on individuals due to the short-term, temporary nature of the noise and the project. No measurable effect on Cook Inlet beluga whale, harbor seal, Steller sea lion, killer whale, harbor porpoise, or humpback whale populations is anticipated. Implementation of mitigation measures proposed in Section 11 is likely to avoid most potential adverse underwater impacts to marine mammals from pile installation or removal. Nevertheless, some level of impact is unavoidable. The expected level of unavoidable impact (defined as an acoustic or harassment "take") is described in Section 6.

This page intentionally left blank.

8 Description of Potential Impacts to Subsistence Uses

While no significant subsistence activity currently occurs within or near the POA, Alaska Natives have traditionally harvested subsistence resources, including marine mammals, in upper Cook Inlet for millennia. Beluga whales are more than a food source; they are important to the cultural and spiritual practices of Cook Inlet Native communities (NMFS 2008b). Dena'ina Athabascans, currently living in the communities of Eklutna, Knik, Tyonek, and elsewhere, occupied settlements in Cook Inlet for the last 1,500 years and have been the primary traditional users of this area into the present.

NMFS estimated that 65 whales per year (range 21–123) were killed between 1994 and 1998, including those successfully harvested and those struck and lost. NMFS concluded that this number was high enough to account for the estimated 14 percent annual decline in population during this time (Hobbs et al. 2008); however, given the difficulty of estimating the number of whales struck and lost during the hunts, actual mortality may have been higher. During this same period, population abundance surveys indicated a population decline of 47 percent, although the reason for this decline should not be associated solely with subsistence hunting and likely began well before 1994 (Rugh et al. 2000).

In 1999, a moratorium was enacted (Public Law 106-31) prohibiting the subsistence harvest of Cook Inlet beluga whales except through a cooperative agreement between NMFS and the affected Alaska Native organizations. NMFS began working cooperatively with the Cook Inlet Marine Mammal Council (CIMMC), a group of tribes that traditionally hunted Cook Inlet beluga whales, to establish sustainable harvests. CIMMC voluntarily curtailed its harvests in 1999. In 2000, NMFS designated the Cook Inlet stock of beluga whales as depleted under the MMPA (65 FR 34590). NMFS and CIMMC signed *Co-Management of the Cook Inlet Stock of Beluga Whales* agreements in 2000, 2001, 2002, 2003, 2005, and 2006. Beluga whale harvests between 1999 and 2006 resulted in the strike and harvest of five whales, including one whale each in 2001, 2002, and 2003, and two whales in 2005 (NMFS 2008b). No hunt occurred in 2004 due to higher than normal mortality of beluga whales in 2003, and the Native Village of Tyonek agreed to not hunt in 2007. Since 2008, NMFS has examined how many beluga whales could be harvested during 5-year intervals based on estimates of population size and growth rate and determined that no harvests would occur between 2008 and 2012 and between 2013 and 2017 (see NMFS 2008b for equations). The CIMMC was disbanded by unanimous vote of the CIMMC member Tribes' representatives in June 2012, and a replacement group of Tribal members has not been formed to date. There has been no subsistence harvest of beluga whales since 2005 (NMFS 2016).

Harvests of harbor seals for traditional and subsistence uses by Native peoples are low in upper Cook Inlet. ADF&G (2018) has collected harvest data for harbor seals in Tyonek for the following years: 1996 (two seals harvested), 1997 (two seals harvested), 1998 (no seals harvested), 2000 (no seals harvested), 2001 (no seals harvested), 2002 (three seals harvested), 2003 (five seals harvested), 2004 (no seals harvested), 2005 (no seals harvested), 2006 (four seals harvested), 2007 (no seals harvested), 2008 (nine seals harvested), and 2013 (six seals harvested). ADF&G conducted more comprehensive harvest studies in 1983, when marine mammal harvests included no seals and one beluga whale (Fall et al. 1983), and in 2005, when marine mammal harvests included two beluga whales (Stanek et al. 2007).

Residents of the Native Village of Tyonek are the primary subsistence users in the upper Cook Inlet area. As project activities will take place within the immediate vicinity of the POA, no activities will occur in or near Tyonek's identified traditional subsistence hunting areas. As the harvest of marine mammals in upper Cook Inlet is historically a small portion of the total subsistence harvest, and the number of marine mammals using upper Cook Inlet is proportionately small, the number of marine mammals harvested in upper Cook Inlet is expected to remain low. As the proposed project will likely result in

temporary disturbances to small numbers of marine mammals during construction, the project will not impact the availability of these other marine mammal species for subsistence uses.

9 Description of Potential Impacts to Marine Mammal Habitat

9.1 Effects of Project Activities on Marine Mammal Habitat

Habitat is the locality or environment that is essential for an animal's survival, where it feeds, rests, travels, socializes, breeds, and raises its young. For cetaceans, these are in-water areas, whereas for pinnipeds, habitat also includes haulout sites or rookeries. In addition to physical locations, habitat also includes the prey upon which a marine mammal feeds.

The Cook Inlet beluga whale is the only marine mammal species in the project area with critical habitat designated in Cook Inlet. The area around the POA (Figure 4-1) was excluded from the critical habitat designation for national security reasons (76 FR 20180). However, there is potential for effects on critical habitat beyond the exclusion zone; these are discussed in Section 4.5.2. Section 7 consultation under the ESA requires an analysis of potential effects on critical habitat; therefore, the Biological Assessment being prepared for the SFD Project will provide detailed information on potential effects to designated critical habitat for the Cook Inlet beluga whale.

The SFD Project will be located in an area that has been highly modified by industrial activity, including annual dredging. The project area experiences high levels of vessel traffic and relatively high underwater and in-air noise levels. The project area is not considered to be high-quality habitat for marine mammals or marine mammal prey, such as fish. The most likely impact to marine mammal habitat would be the displacement of marine mammal prey at and near the POA and minor impacts to the immediate substrate during installation and removal of piles during the SFD Project. Long-term effects of any prey displacements are not expected to affect the overall fitness of individual marine mammals or adversely affect marine mammal populations; effects would be minor and would terminate after cessation of SFD Project construction.

Although excluded from the critical habitat designation for Cook Inlet beluga whales under the ESA, the POA provides habitat for beluga whales and their prey. Direct impacts such as substrate modification from pile installation or indirect impacts to prey species could occur in this area. Additionally, underwater noise from pile installation and removal will be perceptible in designated critical habitat beyond the critical habitat exclusion zone.

Beluga whales use shallow, nearshore submarine channels to concentrate prey and, occasionally, to seek refuge from killer whales (NMFS 2016). The significance of these channels to successful foraging is an important factor in the designation of shallow intertidal and subtidal waters of Cook Inlet as the first PCE of the critical habitat. Pile installation may alter the substrate and bathymetry in the immediate area around the pile; however, all pile installation and removal will occur within the exclusion zone. Although the exclusion zone contains beluga whale habitat, the areas that will be affected by pile installation and removal are already highly modified by structures and POA activities, and are poor-quality marine mammal habitat.

Level A harassment zones for vibratory installation and removal will be entirely within the POA's critical habitat exclusion zone, for both 24- and 36-inch piles with or without use of a bubble curtain (Figure 6-1). Level A harassment zones for impact installation with a bubble curtain will be within the POA's critical habitat exclusion zone (Figure 6-2). Vibratory Level B zones for 24- and 36-inch piles extend to the western shore of Knik Arm (Figure 6-3). However, pile installation and removal are intermittent activities, and hammer use will occur for an estimated 21 hours over 24 non-consecutive days. There will be many hours each day when waters along the western shore of Knik Arm are not ensonified,

permitting beluga whales and other marine mammals to transit through the project area—and between areas of critical habitat—without being exposed to noise levels that exceed the Level B harassment criteria. Furthermore, the monitoring program protocol requires clearing of the entire area between the inbound and outbound lines of beluga whales before in-water pile installation or removal may begin, providing additional assurance that transit through the project area by beluga whales will not be affected (see Section 11 for details). This condition of unrestricted passage within or between critical habitat areas is a PCE of Cook Inlet beluga whale critical habitat as designated (76 FR 20180).

9.2 Effects of Project Activities on Marine Mammal Prey

As noted in Section 4, Cook Inlet beluga whales, harbor seals, harbor porpoises, Steller sea lions, killer whales, and humpback whales can be found in or may use the area. This section presents information on prey preferences for marine mammal species in the area and possible effects of the SFD Project construction on those prey items.

The diets of Cook Inlet beluga whales in Knik Arm can be generalized based on a comparison of fishes found in stomach analyses of beluga whales and fish species observed in Knik Arm (Houghton et al. 2005). Cook Inlet beluga whales appear to feed on a wide variety of prey species, focusing on species that are seasonally abundant. Common prey species in Knik Arm include salmon, eulachon, and Pacific cod (Houghton et al. 2005; Rodrigues et al. 2006, 2007; Quakenbush et al. 2015). There are anecdotal reports of Cook Inlet beluga whales feeding on Pacific herring, Pacific tomcod, lingcod (*Ophiodon elongatus*), steelhead trout (*Oncorhynchus mykiss)*, flatfishes, and humpback whitefish (*Coregonus oidschian)* (Huntington 2000; NMFS 2008a).

Harbor seals are opportunistic feeders whose diet varies with season and location. The preferred diet of the harbor seal in the Gulf of Alaska consists of pollock, octopus, Pacific capelin (*Mallotus villosus*), eulachon, and Pacific herring (Sease 1992). Other prey species include cod, flat fishes, shrimp, salmon, and squid (Hoover 1988). Harbor seals in lower Cook Inlet move in response to local steelhead trout and salmon runs (Montgomery et al. 2007) and have been documented feeding on salmon in proximity to beluga whales in upper Cook Inlet (Easley-Appleyard et al. 2011). Harbor porpoises forage on prey similar to that of Cook Inlet beluga whales (Shelden et al. 2014): primarily Pacific herring, other schooling fish, and cephalopods (Leatherwood et al. 1982). Killer whales feed on either fish or other marine mammals, depending on ecotype (resident versus transient, respectively). Occasional occurrences of killer whales in Knik Arm are typically of the transient ecotype (Shelden et al. 2003); transients feed on beluga whales and other marine mammals, such as harbor seals and harbor porpoises.

Fish species in Knik Arm that are prey for marine mammals could be affected by noise from in-water pile installation. Although data on fish populations in upper Cook Inlet are limited, studies indicate that a wide variety of fish species, including five species of Pacific salmon, saffron cod, and forage fish, including eulachon and longfin smelt, are present in the vicinity of the POA. Marine waters surrounding the POA provide habitat for migrating, rearing, and foraging (Moulton 1997; Houghton et al. 2005). In general, fish perceive underwater sounds in the frequency range of 50 to 2,000 Hz, with peak sensitivities below 800 Hz (Popper and Hastings 2009).

Especially strong or intermittent sounds may elicit changes in fish behavior and local distribution and could potentially harm fish. High underwater SPLs (such as those occurring during impact hammer pile installation) are documented to alter behavior, cause hearing loss, and injure or kill individual fish by causing serious internal injury (Hastings and Popper 2005). Results of laboratory studies of juvenile Chinook salmon suggested that mild injuries resulting from pile-driving exposure are unlikely to affect the survival of the exposed animals, at least in a laboratory environment (Casper et al. 2012). However, as noted by Popper et al. (2014), even recoverable injuries could reduce fitness and lead indirectly to mortality in free-ranging fish. More difficult to assess is the disturbance of the natural behavior of fish or

the masking of communication and orientation signals due to exposure to lower noise levels (Hastings and Popper 2005). No data are available on TTS or masking for fish exposed to pile driving, nor are there data on behavioral responses (Popper et al. 2014). Masking may occur for the duration that fish are exposed to pile driving, and, as noted by Popper et al. (2014), it is not possible to say how long behavioral effects, if any, would continue following impact hammer operation.

Regulations for impact hammer pile installation currently utilize a dual interim criteria approach for onset of physiological effects to fish (Fisheries Hydroacoustic Working Group 2008; Woodbury and Stadler 2008; Stadler and Woodbury 2009). The acoustic criterion identifies peak SPL and accumulated sound SEL noise thresholds (re 1 µPa) for injury to fish exposed to underwater noise from impact hammer pile installation as follows:

- Peak SPL is 206 dB (single strike) for any fish size;
- Accumulated SEL is 187 dB for fish weighing 2 grams or more; and
- Accumulated SEL is 183 dB for fish weighing less than 2 grams.

Adults and juveniles of five Pacific salmon species, eulachon, longfin smelt, saffron cod, and other species use habitat throughout Knik Arm during the timeframe in which vibratory pile installation is anticipated to occur. All permanent and temporary piles will be installed with a vibratory hammer to the greatest extent possible; however, the SFD Project may include pile installation with an impact hammer for approximately 25 percent of piles. However, the duration of impact installation of each pile would be brief (approximately 20 minutes) and, therefore, fish are unlikely to be exposed to injury-producing noise. Currently, there are no criteria to evaluate underwater noise impacts to fish from a vibratory hammer. However, since vibratory hammers do not produce impulsive noise, and SSLs are generally much lower than those produced from an impact hammer (see Table 6-4), it is not expected that the SFD Project will have any impact on local fish species.

In general, the nearer the animal is to the source, the greater the likelihood of high energy and a resultant effect (such as mild, moderate, or mortal injury). Small fish such as juvenile salmon may be the most susceptible to injury or mortality from noise associated the peak SPL for a single strike because of their small body mass (Yelverton et al. 1975), entrainment within swift currents, and distribution throughout Knik Arm from May to August (Houghton et al. 2005). However, the strong currents within Knik Arm limit the potential for juvenile salmon to occupy habitat in proximity to impact hammer operation for extended periods.

During the MTRP, the effects of impact and vibratory installation of 30-inch steel sheet piles at the POA on 133 caged juvenile coho salmon in Knik Arm were studied (Hart Crowser Incorporated et al. 2009; Houghton et al. 2010). Maximum peak SPLs observed ranged from 177 to 195 dB re 1 µPa, and accumulated SELs ranged from 174.8 to 190.6 dB re 1 µPa. Acute or delayed mortalities, or behavioral abnormalities were not observed in any of the coho salmon. Furthermore, results indicated that the pile driving had no adverse effect on feeding ability or the ability of the fish to respond normally to threatening stimuli (Hart Crowser Incorporated et al. 2009; Houghton et al. 2010). In light of studies (Hart Crowser Incorporated et al. 2009; Houghton et al. 2010) of fish in cages exposed to pile driving that showed no physical trauma to fish exposed to levels significantly above a SEL_{cum} of 187 dB (Popper et al. 2013), Popper et al. (2014) re-examined the SEL_{cum} threshold and published interim sound exposure guidelines for fish from pile installation (Table 9-1).

The SFD Project is not anticipated to substantially impede migration of adult or juvenile salmon, or adversely affect the health and survival of the affected species at the population level. Affected fish would represent only a portion of the food available to marine mammals in the area. Once pile installation and removal has ceased and construction of the SFD is complete, habitat quality is expected to return to pre-SFD Project conditions. The only exception is habitat lost due to the presence of piles;

however, this amount of habitat is minimal compared to the available habitat in adjacent Knik Arm waters. Fish are expected to move into and use adjacent available areas.

Table 9-1. Interim Sound Exposure Guidelines for Exposure of Fish to Impact Pile Installation Noise

Type of Animal	Mortality and Potential Mortal Injury	Recoverable Injury	TTS	Masking	Behavior
Fish: no swim bladder (particle motion detection)[a]	Mortality and potential mortal injury	>216 dB SEL_{cum} or >213 dB peak	>>186 dB SEL_{cum}	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder is not involved in hearing (particle motion detection)[b]	210 dB SEL_{cum} or >207 dB peak	203 dB SEL_{cum} or >207 dB peak	>186 dB SEL_{cum}	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder involved in hearing (primarily pressure detection)[c]	207 dB SEL_{cum} or >207 dB peak	203 dB SEL_{cum} or >207 dB peak	186 dB SEL_{cum}	(N) High (I) High (F) Moderate	(N) High (I) High (F) Moderate
Eggs and larvae	>210 dB SEL_{cum} or >207 dB peak	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low
Fish: no swim bladder (particle motion detection)[a]	Mortality and potential mortal injury	>216 dB SEL_{cum} or >213 dB peak	>>186 dB SEL_{cum}	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low

[a] Eulachon, flounder.

[b] Salmon.

[c] Pacific cod.

Source: Popper et al. 2014.

Notes: TTS = temporary threshold shift; dB = decibels; SEL_{cum} = cumulative sound exposure level. Peak and rms sound pressure levels are reported in dB re 1 µPa; SEL is reported in dB re 1 $\mu Pa^2 \cdot s$. All criteria are presented as sound pressure even for fish without swim bladders, since no data for particle motion exist. Relative risk (high, moderate, low) is given for animals at three distances defined in relative terms as near (N), intermediate (I), and far (F) from the pile-driving source. While it would not be appropriate to ascribe particular distances to effects because of the many variables in making such decisions, “near” might be considered to be in the tens of meters from the source, “intermediate” in the hundreds of meters, and “far” in the thousands of meters. The *relative* risk of an effect is then rated as being “high,” “moderate,” or “low” with respect to source distance and animal type. No assumptions are made about source or received levels because there are insufficient data to quantify what these distances might be. However, in general, the nearer the animal is to the source, the higher the likelihood of high energy and a resultant effect.

10 Description of Potential Impacts from Loss or Modification of Habitat to Marine Mammals

Descriptions of the potential impacts on habitat from construction of the SFD are discussed in Section 9. The effects from construction of the SFD on marine mammal habitat are expected to be temporary and minor (Section 9.1). An extremely small amount of low-quality marine habitat will be replaced by steel pilings, such that the permanent impacts to marine habitat are discountable. The greatest impact on marine mammals associated with the SFD Project will be a temporary loss of habitat because of elevated noise levels. Displacement of marine mammals by noise will not be permanent, and there will be no long-term effects to their habitat. Pile installation and removal will occur only for a relatively small portion of each day and for up to 24 days (Section 2.1), allowing ample recovery period should displacement or modification of behavior occur. The SFD Project is not expected to result in any habitat-related effects that could cause significant or long-term consequences for individual marine mammals or their populations, since installation and removal of piles will be temporary and intermittent.

This page intentionally left blank.

11 Avoidance and Minimization Measures

The POA is committed to minimizing the impacts of its activities through implementation of avoidance and minimization measures summarized in this section to eliminate the potential for injury and to minimize disturbance harassment of marine mammals. The avoidance and minimization measures presented below are (1) components of the proposed action and (2) requirements of contractors during construction of the SFD. To mitigate potential impacts on marine mammals, the mitigation described in the Final PCT IHAs (85 FR 19294) will be implemented.

11.1 Noise Attenuation

An unconfined bubble curtain noise attenuation system will be used to mitigate noise propagation during vibratory installation and potential impact installation of 10 permanent plumb piles and 6 temporary piles, and vibratory removal of 6 temporary piles. Piles that are driven at a location that is de-watered, when no water is present at the pile, will not use a bubble curtain and marine mammal harassment zones will not be monitored. Since a bubble curtain sound attenuation system will not be used for the two battered piles, the unattenuated Level A and Level B harassment zones for that pile size will be implemented (Table 6-5).

In a bubble curtain system, the air is released through a series of vertically distributed bubble rings that create a cloud of bubbles that act to impede and scatter sound, lowering the sound velocity. A compressor provides a continuous supply of compressed air, which is distributed among the layered bubble rings. Air is released from small holes in the bubble rings to create a curtain of air bubbles surrounding the pile. The curtain of air bubbles floating to the surface inhibits the transmission of pile installation sounds into the surrounding water column. The design of the bubble curtain will be determined by the Construction Contractor based on factors such as water depth, current velocities, and pile sizes. The use of a bubble curtain during pile installation will reduce the zones of ensonification, ultimately reducing impacts from noise on marine mammals. A modified version of the bubble curtain design used during the 2020 SSV study conducted during PCT construction will be employed during the SFD Project. The updated design will include an unconfined bubble curtain system.

11.2 Monitoring and Reporting

Marine mammal monitoring will be conducted at the POA at all times when in-water pile installation or removal is taking place (SFD Marine Mammal Monitoring and Mitigation Plan 2020; Appendix A). The POA, through its Construction Contractor, will collect data on sightings of marine mammals and any behavioral responses to in-water pile installation associated with the SFD Project. All Marine Mammal Observers (MMOs; sometimes called Protected Species Observers or PSOs) will be trained in marine mammal identification and behaviors. The MMOs will monitor for marine mammals within all applicable harassment zones for pile installation and removal, depending on the pile size (24- or 36-inch pile) and hammer type (vibratory or impact) occurring at the time of monitoring. The largest harassment zone is for the unattenuated vibratory hammer used on the two battered 36-inch piles, extending to 8.3 kilometers (Table 6-5). Previous work done at the POA for PCT Phase 1 was successful in monitoring harassment zones and shutting down to avoid and minimize take by stationing 11 MMOs at four different locations in the vicinity of the POA (61N Environmental 2021). The marine mammal monitoring and mitigation program that is planned for SFD construction will be the same as for Phase 1 construction of the PCT. Eleven MMOs for the SFD Project will be stationed at Anchorage Downtown Viewpoint near Point Woronzof, the Anchorage Public Boat Dock at Ship Creek, the SFD Project site, and the north end of the POA property.

The POA will receive a daily monitoring summary from its Construction Contractor that will include a summary of marine mammal sightings and an electronic copy of all data recorded. Due to the short duration needed to complete this work, the POA will provide one monitoring report to USACE and NMFS within 30 days of completion of the marine mammal monitoring. The summary report will include information on the monitoring efforts, a summary of environmental conditions, details of marine mammal sightings, in-water activities before and after each sighting, and a summary of project shutdowns.

11.3 Mitigation Measures

Additional mitigation measures include the following, modeled after the stipulations outlined in the Final IHAs for Phase 1 and Phase 2 PCT construction (85 FR 19294):

- For in-water construction involving heavy machinery activities other than pile driving (e.g., use of barge-mounted excavators), if a marine mammal comes within 10 meters, the POA will cease operations and reduce vessel speed to the minimum level required to maintain steerage and safe working conditions.
- The two permanent, battered 36-inch floating dock piles will not be installed in August or September to minimize impacts during months with the highest numbers of beluga whale sightings.
- MMOs will begin observing for marine mammals within the Level A and Level B harassment zones for at least 30 minutes before “soft start” or in-water pile installation or removal begins. A ‘‘soft start’’ technique will be used at the beginning of impact pile installation each day to allow any marine mammal that may be in the immediate area to leave before pile installation reaches full energy. Soft starts will not be used for vibratory pile installation and removal. When the impact hammer is used, operators will provide an initial set of three strikes from the impact hammer at reduced energy, followed by a 30-second waiting period, then two subsequent three-strike sets.
- The POA will conduct briefings for construction supervisors and crews, the monitoring team, and POA staff prior to the start of all pile installation and removal, and when new personnel join the work in order to explain responsibilities, communication procedures, the marine mammal monitoring protocol, and operational procedures.
- The POA will employ MMOs per the Marine Mammal Monitoring Plan (Appendix A).
- Marine mammal monitoring will take place from 30 minutes prior to initiation of pile installation and removal through 30 minutes post-completion of pile installation and removal. The pre-clearance zone must be fully visible for 30 minutes before the zone can be considered clear. Pile driving will commence when observers have declared the shutdown zone clear of marine mammals or the mitigation measures developed specifically for beluga whales (below) are satisfied. In the event of a delay or shutdown of activity, marine mammal behavior will be monitored and documented until the marine mammals leave the shutdown zone of their own volition, at which point pile installation or removal will begin.
- On a given day, if MMO monitoring ceases but pile driving is scheduled to resume, MMOs will follow the pre-pile-driving monitoring protocol as described in the bullet above, including a 30-minute clearance scan.
- If a marine mammal is entering or is observed within an established Level A zone or shutdown zone, pile installation and removal will be halted or delayed. Pile driving will not commence or resume until either the animal has voluntarily left and been visually confirmed 100 meters beyond the shutdown zone and on a path away from such zone, or 15 minutes (non-beluga whales) or 30 minutes (beluga whales) have passed without subsequent detections.

- If a species for which authorization has not been granted, or a species for which authorization has been granted but the authorized takes are met, is observed approaching or within the Level B zone, pile installation and removal will shut down immediately. Pile driving will not resume until the animal has been confirmed to have left the area or the 30 minutes have elapsed.
- Pile Installation and Removal Delay and Shutdown Protocol for Cook Inlet beluga whales (but not other species of marine mammals) include the following:
  - Prior to the onset of pile installation or removal, should a beluga whale(s) be observed within the in-bound or out-bound clearance zone (Figure 11-1), pile driving or removal will be delayed. Pile driving will not commence until the animal has voluntarily traveled at least 100 meters beyond the Level B harassment zone (Table 6-5) and is on a path away from such zone, or the whale has not been re-sighted within 30 minutes.
  - If pile installation or removal has commenced, and a beluga whale(s) is observed within or likely to enter the Level B harassment zone, pile installation or removal will be delayed. Pile driving will not commence until the animal has voluntarily traveled at least 100 meters beyond the Level B harassment zone (Table 6-5) and is on a path away from such zone, or the whale has not been re-sighted within 30 minutes.
  - If during installation and removal of piles, MMOs can no longer effectively monitor the entirety of the Cook Inlet beluga whale Level B shutdown zones (Table 6-5) due to environmental conditions (e.g., fog, rain, wind), pile driving will continue only until the current segment of pile is driven; no additional sections of pile or additional piles may be driven until conditions improve such that the monitoring zone can be effectively monitored. If the Level B harassment zone cannot be monitored for more than 15 minutes, the entire Level B harassment zone will be cleared again for 30 minutes prior to pile driving.
- The POA will not operate two vibratory hammers simultaneously. It is unlikely that an impact hammer and vibratory hammer or two impact hammers could operate simultaneously, but this cannot be ruled out.
- The POA will employ an unconfined bubble curtain system during installation and removal of plumb (vertical) 24- and 36-inch piles with a vibratory or impact hammer.
- It is possible that a small number of piles could be installed or removed when the pile location is de-watered. Piles that are driven at a location that is de-watered, when no water is present at the pile, will not use a bubble curtain.
- When piles are installed or removed in water without a bubble curtain because the pile orientation is battered, the unattenuated Level A and Level B harassment zones for that pile size will be implemented (Table 6-5).
- The bubble curtain will be operated in a manner consistent with the following performance standards:
  - An unconfined bubble curtain is composed of an air compressor(s), supply lines to deliver the air, distribution manifolds or headers, perforated aeration pipe, and a frame. The frame facilitates transport and placement of the system, keeps the aeration pipes stable, and provides ballast to counteract the buoyancy of the aeration pipes in operation.
  - The aeration pipe system will consist of multiple layers of perforated pipe rings, stacked vertically in accordance with the following:

Water depth (meters)	Number of Layers
0 to less than 5	2
5 to less than 10	4
10 to less than 15	7
15 to less than 20	10
20 to less than 25	13

- The pipes in all layers will be arranged in a geometric pattern that will allow for the pile being driven to be completely enclosed by bubbles for the full depth of the water column and with a radial dimension such that the rings are no more than 0.5 meter from the outside surface of the pile.
- The lowest layer of perforated aeration pipe will be designed to ensure contact with the substrate without burial and will accommodate sloped conditions.
- Air holes will be 1.6 millimeters (1/16 inch) in diameter and will be spaced approximately 20 millimeters (3/4 inch) apart. Air holes with this size and spacing will be placed in four adjacent rows along the pipe to provide uniform bubble flux.
- The system will provide a bubble flux of 3 cubic meters per minute per linear meter of pipe in each layer (32.91 cubic feet per minute per linear foot of pipe in each layer). The total volume of air per layer is the product of the bubble flux and the circumference of the ring using the formula: Vt= 3.0 m^3/min/m * Circumference of the aeration ring in meters or Vt= 32.91 ft^3/min/ft * Circumference of the aeration ring in feet.
- Meters must be provided as follows:
  - Pressure meters must be installed at all inlets to aeration pipelines and at points of lowest pressure in each branch of the aeration pipeline.
  - Flow meters must be installed in the main line at each compressor and at each branch of the aeration pipelines at each inlet. In applications where the feed line from the compressor is continuous from the compressor to the aeration pipe inlet, the flow meter at the compressor can be eliminated.
  - Flow meters must be installed according to the manufacturer’s recommendation based on either laminar flow or non-laminar flow.

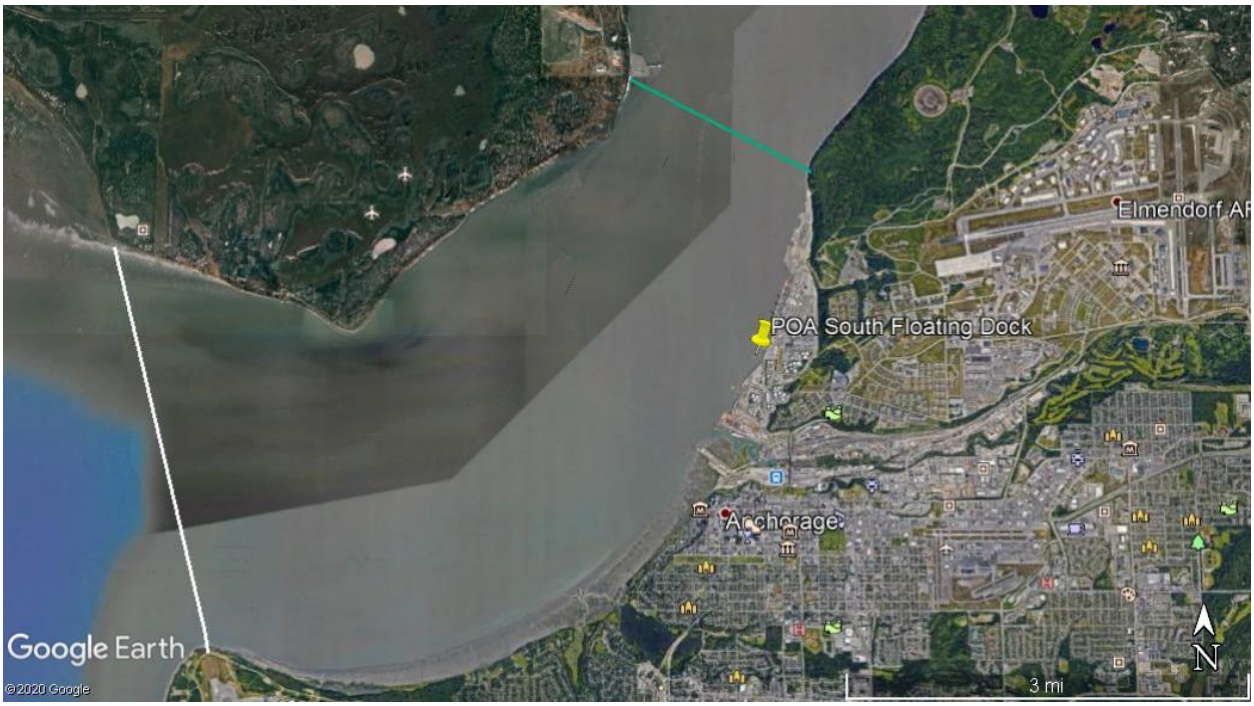

Figure 11-1. **Beluga Whale Inbound (white) and Outbound (green) Clearance Zones**

This page intentionally left blank.

12 Measures to Reduce Impacts to Subsistence Users

SFD Project construction will occur in or near a traditional subsistence hunting area and could affect the availability of marine mammals for subsistence uses. Therefore, the POA will communicate with representative Native subsistence users and Tribal members to identify and explain the measures that have been taken or will be taken to minimize any adverse effects of SFD Project construction on the availability of marine mammals for subsistence uses.

The POA will adhere to the following procedures during Tribal consultation regarding marine mammal subsistence use within the project area:

(1) Send letters to the Kenaitze, Tyonek, Knik, Eklutna, Ninilchik, Seldovia, Salamatof, and Chickaloon tribes informing them of the project (i.e., timing, location, and features). Include a map of the project area; identify potential impacts to marine mammals and mitigation efforts, if needed, to avoid or minimize impacts; and inquire about possible marine mammal subsistence concerns they have.

(2) Follow up with a phone call to the environmental departments of the eight Tribal entities to ensure that they received the letter, understand the project, and have a chance to ask questions. Inquire about any concerns they might have about potential impacts to subsistence hunting of marine mammals.

(3) Document all communication between the POA and Tribes.

(4) If any Tribes express concerns regarding project impacts to subsistence hunting of marine mammals, propose a Plan of Cooperation between the POA and the concerned Tribe(s).

The project features and activities, in combination with a number of actions to be taken by the POA during project implementation, should avoid or mitigate any potential adverse effects on the availability of marine mammals for subsistence uses. Furthermore, although construction will occur within the traditional area for hunting marine mammals, the project area is not currently used for subsistence activities. In-water pile installation and removal will follow mitigation procedures to minimize effects on the behavior of marine mammals, and impacts will be temporary.

If desired, regional subsistence representatives may support project marine mammal biologists during the monitoring program by assisting with collection of marine mammal observations and may request copies of marine mammal monitoring reports.

It is anticipated that the SFD Project location, relatively small number of piles, small size of the affected area, mitigation measures, and input from Tribal entities will result in project construction having no effect on subsistence use of marine mammals.

This page intentionally left blank.

13 Marine Mammal Monitoring and Reporting

The POA will implement a marine mammal monitoring and mitigation strategy intended to avoid and minimize impacts to marine mammals (see Appendix A). The marine mammal monitoring and mitigation program that is planned for SFD construction will be the same as for Phase 1 and Phase 2 construction of the PCT. The POA will collect electronic data on marine mammal sightings and any behavioral responses to in-water pile installation or removal for species observed during pile installation and removal associated with the SFD Project. Four MMO teams will work concurrently to provide full coverage for marine mammal monitoring in rotating shifts during in-water pile installation and removal. All MMOs will be trained in marine mammal identification and behaviors. Field experience and/or training may be substituted for a biological degree. NMFS will review submitted MMO CVs and indicate approval as warranted. Approval must be granted by NMFS within 7 days; if no notice is received from NMFS, it will be considered tacit approval.

Eleven MMOs for the SFD Project will be stationed at the Anchorage Downtown Viewpoint near Point Woronzof, the Anchorage Public Boat Dock at Ship Creek, the SFD Project site, and the north end of POA property. MMOs will have no other construction-related tasks or responsibilities while conducting monitoring for marine mammals. Observations will be carried out using combinations of equipment that include 7 by 50 binoculars, 20x/40x tripod mounted binoculars, 25 by 150 “big eye” tripod mounted binoculars (North End, Ship Creek, and Woronzof), and theodolites.

Trained MMOs will be responsible for monitoring the 100-meter shutdown zone, the Level A harassment zones, and the Level B harassment zones, as well as effectively documenting Level A and Level B take. They will also (1) report on the frequency at which marine mammals are present in the project area, (2) report on behavior and group composition near the POA, (3) record all construction activities, and (4) report on observed reactions (changes in behavior or movement) of marine mammals during each sighting. Observers will monitor for marine mammals during all in-water pile installation and removal associated with the SFD Project. Observers will work in collaboration with the POA to immediately communicate the presence of marine mammals prior to or during pile installation or removal.

A report that includes electronic data collected and summarized from all monitoring locations will be submitted to NMFS within 90 days of the completion of the marine mammal monitoring.

The marine mammal monitoring approach will be described in further detail in the Marine Mammal Monitoring and Mitigation Plan (Appendix A).

This page intentionally left blank.

14 Suggested Means of Coordination

To minimize the likelihood that impacts will occur to the species, stocks, and subsistence use of marine mammals, pile installation, and removal associated with the SFD Project will be conducted in accordance with all federal, state, and local regulations. To further minimize potential impacts from the SFD Project, the POA will continue to cooperate with NMFS and other appropriate federal agencies (i.e., U.S. Fish and Wildlife Service, U.S. Coast Guard, U.S. Environmental Protection Agency, and USACE), JBER, and the State of Alaska. Potential impacts to subsistence use of marine mammals will be minimized through ongoing cooperation with Alaska Native leadership in Cook Inlet communities, as discussed in Section 12.

The POA will cooperate with other marine mammal monitoring and research programs taking place in Cook Inlet to coordinate research opportunities when feasible. The POA will also assess mitigation measures that can be implemented to eliminate or minimize any impacts from these activities. The POA will make its field data and behavioral observations of marine mammals that occur in the project area during the construction of the SFD available to NMFS. Results of monitoring efforts from the construction of the SFD will be provided to NMFS in a summary report within 30 days of the conclusion of monitoring. This information could be made available to regional, state, and federal resource agencies, universities, and other interested private parties upon written request to NMFS.

This page intentionally left blank.

15 References

61N (61 North) Environmental. 2021. Petroleum and Cement Terminal Construction Marine Mammal Monitoring Final Report. Prepared for Pacific Pile and Marine, Port of Alaska, and NMFS. Prepared February 2021.

ABR, Inc. 2017. *Protected Species Monitoring Report, 2017 Ship Creek Boat Launch Repairs Project, Anchorage, Alaska*. Prepared for R&M Consultants and Port of Anchorage. 06 November 2017.

ADF&G (Alaska Department of Fish & Game). 2018. Community Subsistence Information System (CSIS), Harvest by Community: Tyonek. Available online at http://www.adfg.alaska.gov/sb/CSIS/index.cfm?ADFG=harvInfo.harvest

Allen, B.M., and R.P. Angliss. 2010. *Alaska marine mammal stock assessments, 2009*. NOAA Technical Memorandum NMFS-AFSC-233. National Marine Fisheries Service, Seattle, WA.

———. 2011. *Alaska marine mammal stock assessments, 2010*. NOAA Technical Memorandum NMFS-AFSC-234. National Marine Fisheries Service, Seattle, WA.

Ampela, K., A. Balla-Holden, C. Bacon, D. Fertl, J. Latusek-Nabholz, T. McConchie, D. Spontak, and N. Stadille. 2014. Effects of pile driving on marine mammal behavior in Puget Sound, Washington, USA. Page 11 in Abstracts, ESOMM - 2014 5th International Meeting on the Effects of Sound in the Ocean on Marine Mammals, 7–12 September 2014, Amsterdam, The Netherlands.

Au, W.W.L., D.A. Carder, R.H. Penner, and B.L. Scronce. 1985. Demonstration of adaptation in beluga whale echolocation signals. *Journal of the Acoustical Society of America* 77(2):726–730.

Au, W.W.L., A.A. Pack, M.O. Lammers, L.M. Herman, M.H. Deakos, and K. Andrews. 2006. Acoustic properties of humpback whale songs. *Journal of the Acoustical Society of America* 120(2): 1103–1110.

Austin, M., S. Denes, J. MacDonnell, and G. Warner. 2016. *Hydroacoustic Monitoring Report, Anchorage Port Modernization Project Test Pile Program*. Prepared by JASCO under contract of Kiewit Infrastructure West Co. for the Port of Anchorage.

Awbrey, F.T., J.A. Thomas, and R.A. Kastelein. 1988. Low-frequency underwater hearing sensitivity in belugas, *Delphinapterus leucas*. *Journal of the Acoustical Society of America* 84:2273–2275.

Baird, R.W. 2001. Status of harbour seals, *Phoca vitulina*, in Canada. *Canadian Field-Naturalist* 115(4):663–675.

Barlow, J. 2003. Preliminary estimates of the abundance of cetaceans along the U.S. west coast: 1991–2001. Southwest Fisheries Science Center Administrative Report LJ_03_03. Available from SWFSC, La Jolla. CA.

Bjørge, A. 2002. How persistent are marine mammal habitats in an ocean of variability? Pages 63–91 in P.G.H. Evans, and J.A. Raga, eds. *Marine mammals: Biology and conservation*. Kluwer Academic/Plenum Publishers, New York, NY.

Blackwell, S.B. 2005. Underwater measurements of pile-driving sounds during the Port MacKenzie dock modifications, 13–16 August 2004. Rep. from Greeneridge Sciences, Inc., Goleta, CA, and LGL Alaska Research Associates, Inc., Anchorage, AK, in association with HDR Alaska, Inc., Anchorage, AK, for Knik Arm Bridge and Toll Authority (KABATA), Anchorage, AK, Department of Transportation and Public Facilities, Anchorage, Alaska, and Federal Highway Administration, Juneau, AK.

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

Boveng, P.L., J.M. London, and J.M. Ver Hoef. 2012. Distribution and abundance of harbor seals in Cook Inlet, Alaska. Task III: Movements, marine habitat use, diving behavior, and population structure, 2004–2006. Final Report. BOEM Report 2012-065. Bureau of Ocean Energy Management, Alaska Outer Continental Shelf Region, Anchorage, AK.

Bowen, W.D., and D.B. Siniff. 1999. Distribution, population biology, and feeding ecology of marine mammals. Pages 423–484 in J.E. Reynolds and S.A. Rommel, eds. *Biology of marine mammals*. Smithsonian Institution Press, Washington, DC.

Boyd, C., R.C. Hobbs, A.E. Punt, K.E. W. Shelden, C.L. Sims, and P.R. Wade. 2019. Bayesian estimation of group sizes for a coastal cetacean using aerial survey data. *Marine Mammal Science* 35(4):1322–1346. doi: 10/1111/mms.12592

Brandt, M.J., A. Diederichs, K. Betke, and G. Nehls. 2011. Responses of harbour porpoises to pile driving at the Horns Rev II offshore wind farm in the Danish North Sea. *Marine Ecology Progress Series* 421:205–216.

Brueggeman, J.J., D. Lenz, and M. Wahl. 2013. Beluga whale and other marine mammal occurrence in upper Cook Inlet between Point Campbell and Fire Island, Alaska August–November 2011 and April–July 2012. Prepared by Jay Brueggeman of Canyon Creek Consulting LLC and Drew Lenz and Melanie Wahl of 61 North Consulting LLC for Cook Inlet Regional Corporation, Anchorage, AK.

Brueggeman, J.J., M. Smultea, H. Goldstein, S. McFarland, and D.J. Blatchford. 2007. *2007 spring marine mammal monitoring program for the ConocoPhillips Beluga River seismic operations in Cook Inlet Alaska: 90-day report*. Prepared for ConocoPhillips Alaska, Inc., Anchorage, AK, by Canyon Creek Consulting, Seattle, WA.

Brueggeman, J.J., M. Smultea, K. Lomac-MacNair, D.J. Blatchford, and R. Dimmick. 2008a. *2007 fall marine mammal monitoring program for the Union Oil Company of California Granite Point seismic operations in Cook Inlet Alaska: 90-day report*. Prepared for Union Oil Company of California by Canyon Creek Consulting, Seattle, WA.

Brueggeman, J.J., M. Smultea, K. Lomac-MacNair, and D.J. Blatchford. 2008b. *2007 fall marine mammal monitoring program for the Marathon Oil Company North Ninilchik seismic operations in Cook Inlet Alaska: 90-day report*. Prepared for Marathon Oil Company by Canyon Creek Consulting, Seattle, WA.

Calkins, D.G. 1989. Status of beluga whales in Cook Inlet. Pages 109–112 *in* L.E. Jarvela, and L.K. Thorsteinson (eds.). *Gulf of Alaska, Cook Inlet, and North Aleutian Basin Information Update Meeting. Anchorage, Alaska, Feb. 7–8, 1989*. USDOC, NOAA, OCSEAP, Anchorage, AK.

Carstensen, J., O.D. Henriksen, and J. Teilman. 2006. Impacts of offshore wind farm construction on harbor porpoises: acoustic monitoring of echolocation activity using porpoise detectors (T-PODs). *Marine Ecology Progress Series* 321:295–308.

Casper, B.M., A.N. Popper, F. Matthews, T.J. Carlson, and M.B. Halvorsen. 2012. Recovery of barotrauma injuries in Chinook salmon, *Oncorhynchus tshawytscha* from exposure to pile driving sound. *PLoS ONE* 7(6): e39593. doi:39510.31371/journal.pone.0039593.

Chenoweth, E.M., J.M. Straley, M.V. McPhee, S. Atkinson, and S. Reifenstuhl. 2017. Humpback whales feed on hatchery-released juvenile salmon. *Royal Society Open Science* 4(7):170180.

Cornick, L.A., and L. Pinney. 2011. *Distribution, habitat use and behavior of Cook Inlet beluga whales and other marine mammals at the Port of Anchorage Marine Terminal Redevelopment Project June – November 2010: Scientific Marine Mammal Monitoring Program 2010 Annual Report*. Prepared for U.S. Department of Transportation, Maritime Administration, Washington, DC; Port of Anchorage, Anchorage, AK; and Integrated Concepts & Research Corporation (ICRC), Anchorage, AK by Alaska Pacific University, Anchorage, AK.

Cornick, L.A., and L. Saxon-Kendall. 2008. *Distribution, habitat use, and behavior of Cook Inlet beluga whales in Knik Arm, Fall 2007. Final annual report for 2007.* Prepared by Alaska Pacific University, Anchorage, AK, for Integrated Concepts & Research Corporation (ICRC), Anchorage, AK.

———. 2009. *Distribution, habitat use and behavior of Cook Inlet beluga whales and other marine mammals at the Port of Anchorage Marine Terminal Redevelopment Project June–November, 2008: Scientific marine mammal monitoring report for 2008.* Prepared by Alaska Pacific University, Anchorage, AK, for U.S. Department of Transportation Maritime Administration, Washington, DC, and Port of Anchorage, Anchorage, AK, and Integrated Concepts and Research Corporation (ICRC), Anchorage, AK.

Cornick, L.A., L. Saxon Saxon-Kendall, and L. Pinney. 2010. *Distribution, habitat use and behavior of Cook Inlet beluga whales and other marine mammals at the Port of Anchorage Marine Terminal Redevelopment Project May – November, 2009: Scientific Marine Mammal Monitoring Program 2009 annual report*. Prepared by Alaska Pacific University, Anchorage, AK for U.S. Department of Transportation, Maritime Administration, Washington, DC, Port of Anchorage, Anchorage, AK, and Integrated Concepts & Research Corporation (ICRC), Anchorage, AK.

Cornick, L.A., S. Love, L. Pinney, C. Smith, and Z. Zartler. 2011. *Distribution, habitat use and behavior of Cook Inlet beluga whales and other marine mammals at the Port of Anchorage Marine Terminal Redevelopment Project June - November 2011: Scientific Marine Mammal Monitoring Program 2011 Annual Report*. Prepared for U.S. Department of Transportation, Maritime Administration, Washington, DC; Port of Anchorage, Anchorage, AK; and Integrated Concepts and Research Corporation (ICRC), Anchorage, AK by Alaska Pacific University, Anchorage, AK.

Cornick, L.A., and D.J. Seagers. 2016. *Final Report: Anchorage Port Modernization Project Test Pile Program Marine Mammal Observing Program*. Technical report by AECOM for Kiewit. 31 July 2016.

Dahlheim, M., A. York, R. Towell, J. Waite, and J. Breiwick. 2000. Harbor porpoise (*Phocoena phocoena*) abundance in Alaska: Bristol Bay to Southeast Alaska, 1991–1993. *Marine Mammal Science* 16:28–45.

Dähne, M., A. Gilles, K. Lucke, V. Peschko, S. Adler, K. Krügel, J. Sundermeyer, and U. Sieber. 2013. Effects of pile-driving on harbour porpoises (*Phocoena phocoena*) at the first offshore wind farm in Germany. *Environmental Research Letters* 8:025002.

Darling, J.D. 2015. Low frequency, ca. 40 Hz, pulse trains recorded in the humpback whale assembly in Hawaii. *Journal of the Acoustical Society of America* 138(5): doi: 10.1121/1.4935070

David, J.A. 2006. Likely sensitivity of bottlenose dolphins to pile-driving noise. *Water and Environment Journal* 20:48–54.

Eagleton, M. 2016. Personal communication between Matt Eagleton (NMFS) and Erin Cunningham (HDR) regarding EFH designations in the SBS Project area and throughout Cook Inlet, 01 September 2016.

Easley-Appleyard, B., L. Pinney, L. Polasek, J. Prewitt, T. McGuire. 2011. *Alaska SeaLife Center Cook Inlet beluga whale remote monitoring pilot study May – August 2011*. Alaska SeaLife Center partnered with LGL Alaska Research Associates.

Ebersole, B., and L. Raad. 2004. Tidal circulation modeling study to support the Port of Anchorage expansion. Appendix E: Hydrodynamics *In* Port of Anchorage Marine Terminal Redevelopment Environmental Assessment.

Fall, J.A., D.J. Foster, and R.T. Stanek. 1983. *The use of fish and wildlife resources in Tyonek, Alaska*. Technical Paper 105. Alaska Department of Fish and Game (ADF&G), Division of Subsistence. Available online at http://www.adfg.alaska.gov/TechPap/tp105.pdf.

FHWA (Federal Highway Administration) and DOT&PF (Alaska Department of Transportation and Public Facilities). 1983. Knik Arm Crossing. Marine Biological Studies Technical Memorandum No. 15. Prepared by Dames & Moore, Anchorage, AK.

Finneran, J.J., C.E. Schlundt, D.A. Carder, J.A. Clark, J.A. Young, J.B. Gaspin, and S.H. Ridgway. 2000. Auditory and behavioral responses of bottlenose dolphins (*Tursiops truncatus*) and a beluga whale (*Delphinapterus leucas*) to impulsive sounds resembling distant signatures of underwater explosions. *Journal of the Acoustical Society of America* 108:417–431.

Finneran, J.J., C.E. Schlundt, R. Dear, D.A. Carder, and S.H. Ridgway. 2002. Temporary shift in masked hearing thresholds in odontocetes after exposure to single underwater impulses from a seismic watergun. *Journal of the Acoustical Society of America* 111(6):2929–2940.

Fisheries Hydroacoustic Working Group. 2008. Memorandum, agreement in principle for guidelines for injury to fish from pile driving activities, NOAA's Fisheries Northwest and Southwest Regions, U.S. Fish and Wildlife Service Regions 1 and 8, California/Washington/Oregon Departments of Transportation, California Department of Fish and Game, and U.S. Federal Highway Administration. 12 June 2008. Available online at http://www.wsdot.wa.gov/NR/rdonlyres/4019ED62-B403-489C-AF05-5F4713D663C9/0/BA_InterimCriteriaAgree.pdf. Accessed 04 December 2014

Funk, D.W., T.M. Markowitz, and R. Rodrigues (eds.) 2005. *Baseline studies of beluga whale habitat use in Knik Arm, Upper Cook Inlet, Alaska, July 2004–July 2005*. Prepared by LGL Alaska Research Associates, Inc., Anchorage, AK, in association with HDR Alaska, Inc., Anchorage, AK, for Knik Arm Bridge and Toll Authority (KABATA), Anchorage, AK, Department of Transportation and Public Facilities, Anchorage, AK, and Federal Highway Administration, Juneau, AK.

Goetz, K.T., R.A. Montgomery, J.M. Ver Hoef, R.C. Hobbs, and D.S. Johnson. 2012a. Identifying essential summer habitat of the endangered beluga whale *Delphinapterus leucas* in Cook Inlet, Alaska. *Endangered Species Research* 16:135–147.

Goetz, K.T., P.W. Robinson, R.C. Hobbs, K.L. Laidre, L.A. Huckstadt, and K.E.W. Shelden. 2012b. Movement and dive behavior of beluga whales in Cook Inlet, Alaska. AFSC Processed Rep. 2012-03. Alaska Fisheries Science Center, NOAA, NMFS, Seattle, WA.

Hart Crowser Incorporated, Pentec Environmental, and Illingworth & Rodkin, Inc. 2009. *Acoustic monitoring and* in-situ *exposures of juvenile coho salmon to pile-driving noise at the Port of Anchorage Marine Terminal Redevelopment Project, Knik Arm, Anchorage, Alaska*. Report Number 12684-03. Prepared for URS Corporation, Integrated Concepts & Research Corporation (ICRC), and Port of Anchorage.

Hastings, M.C., and A.N. Popper. 2005. Effects of sound on fish. Technical report for Jones and Stokes to California Department of Transportation.

Hazen, E.L., A.S. Friedlaender, M.A. Thompson, C.R. Ware, M.T. Weinrich, P.N. Halpin, and D.N. Wiley. 2009. Fine-scale prey aggregations and foraging ecology of humpback whales *Megaptera novaeangliae*. *Marine Ecology Progress Series* 395:75–89.

Hobbs, R.C. 2013. Detecting changes in population trends for Cook Inlet beluga whales (*Delphinapterus leucas*) using alternative schedules for aerial surveys. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-AFSC- 252.

Hobbs, R.C., K.L. Laidre, D.J. Vos, B.A. Mahoney, and M. Eagleton. 2005. Movements and area use of belugas, *Delphinapterus leucas*, in a subarctic Alaskan estuary. *Arctic* 58(4):331–340.

Hobbs, R.C., D.J. Rugh, and D.P. DeMaster. 2000. Abundance of belugas, *Delphinapterus leucas*, in Cook Inlet, Alaska, 1994–2000. *Marine Fisheries Review* 62:37–45.

Hobbs, R.C., and K.E.W. Shelden. 2008. *Supplemental status review and extinction assessment of Cook Inlet belugas (*Delphinapterus leucas*)*. AFSC Processed Report 2008-08. Alaska Fisheries Science Center, National Marine Fisheries Service, Seattle, WA.

Hobbs, R.C., K.E.W. Shelden, D.J. Rugh, and S.A. Norman. 2008. *2008 Status review and extinction risk assessment of Cook Inlet belugas (*Delphinapterus leucas*)*. AFSC Processed Report 2008-02. National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA. Available online at http://www.nmfs.noaa.gov/pr/pdfs/statusreviews/belugawhale_cookinlet.pdf.

Hobbs, R.C., K.E.W. Shelden, D.J. Rugh, C.L. Sims, and J.M. Waite. 2015. Estimated abundance and trend in aerial counts of beluga whales, *Delphinapterus leucas*, in Cook Inlet, Alaska, 1994–2012. *Mar. Fish. Rev.* 77(1):11–31. DOI: dx.doi.org/10.7755/MFR.77.1.2.

Hobbs, R.C., C.L. Sims, and K.E.W. Shelden. 2011. *Estimated abundance of belugas in Cook Inlet, Alaska, from aerial surveys conducted in June 2011*. NMFS, NMML Unpublished Report.

———. 2012. *Estimated abundance of belugas in Cook Inlet, Alaska, from aerial surveys conducted in June 2012*. NMFS, NMML Unpublished Report.

Hobbs, R.C., P.R. Wade, and K.E.W. Shelden. 2016. Viability of a small, geographically-isolated population of beluga whales, *Delphinapterus leucas*: Effects of hunting, predation, and mortality events in Cook Inlet, Alaska. *Marine Fisheries Review* 77:59–88. DOI: dx.doi.org/10.7755/MFR.77.2.4.

Hobbs, R.C., and J.M. Waite. 2010. Abundance of harbor porpoise (*Phocoena phocoena*) in three Alaskan regions, corrected for observer errors due to perception bias and species misidentification, and corrected for animals submerged from view. *Fishery Bulletin* 108:251–267.

Hoover, A.A. 1988. Harbor seal--*Phoca vitulina*. Pages 135–157 in J.W. Lentfer, ed. *Selected marine mammals of Alaska: Species accounts with research and management recommendations*. Marine Mammal Commission, Washington, DC.

Houghton, J., J. Starkes, M. Chambers, and D. Ormerod. 2005. *Marine fish and benthos studies in Knik Arm, Anchorage, Alaska*. Prepared by Pentec Environmental, Edmonds, Washington, for the Knik Arm Bridge and Toll Authority (KABATA) and HDR Alaska, Inc., Anchorage, AK.

Houghton, J.P., J.E. Starkes, J.P. Stutes, M.A. Havey, J.A. Reyff, and D.E. Erikson. 2010. Acoustic monitoring and in-situ exposures of juvenile coho salmon to pile driving noise at the Port of Anchorage Marine Terminal Redevelopment Project, Knik Arm, Alaska. Page 63 in Abstracts, Alaska Marine Science Symposium, 18–22 January 2010, Anchorage, AK.

Huntington, H.P. 2000. Traditional knowledge of the ecology of belugas, *Delphinapterus leucas*, in Cook Inlet, Alaska. *Marine Fisheries Review* 62(3):134–140.

I&R (Illingworth & Rodkin). 2021. 2020 Hydroacoustic Monitoring Report, Port of Alaska Modernization Program Petroleum and Cement Terminal Phase January 2021. Prepared for the POA, Anchorage, AK, by Illingworth & Rodkin, Cotati, CA.

ICRC (Integrated Concepts & Research Corporation). 2009. *Marine mammal monitoring final report 15 July 2008 through 14 July 2009. Construction and scientific marine mammal monitoring Associated with the Port of Anchorage Marine Terminal Redevelopment Project, in accordance with the 15 July 2008 National Marine Fisheries Service Incidental Harassment Authorization*. Prepared for Maritime Administration, Washington, DC; Port of Anchorage, Anchorage, AK, by Integrated Concepts & Research Corporation (ICRC), Anchorage, AK.

———. 2010. *2009 Annual marine mammal monitoring report. Construction and scientific marine mammal monitoring Associated with the Port of Anchorage Marine Terminal Redevelopment Project, in accordance with the USACE 404/10 Permit and the NMFS 2009 Letter of Authorization*. Prepared for U.S. Department of Transportation, Maritime Administration, Washington, DC; Port of Anchorage, Anchorage, AK, by Integrated Concepts & Research Corporation (ICRC), Anchorage, AK.

———. 2011. *2010 Annual marine mammal monitoring report. Construction and Scientific Marine Mammal Monitoring Associated with the Port of Anchorage Marine Terminal Redevelopment Project, in accordance with the USACE 404/10 Permit and the NMFS 2010-2011 Letter of Authorization*. Prepared U.S. Department of Transportation, Maritime Administration, Washington, DC; Port of Anchorage, Anchorage, AK, by Integrated Concepts & Research Corporation (ICRC), Anchorage, AK.

———. 2012. *2011 Annual marine mammal monitoring report. Construction and Scientific Marine Mammal Monitoring Associated with the Port of Anchorage Marine Terminal Redevelopment Project, in accordance with the Letter of Authorization issued by the National Marine Fisheries for July 15, 2011 through July 14, 2012*. Prepared for the U.S. Department of Transportation, Maritime Administration, Washington, DC; Port of Anchorage, Anchorage, AK, by Integrated Concepts & Research Corporation (ICRC), Anchorage, AK.

Ireland, D.S., D.W. Funk, T.M. Markowitz, and C.C. Kaplan. 2005. *Beluga whale distribution and behavior in Eagle Bay and the Sixmile area of upper Cook Inlet, Alaska, in September and October 2005*. Rep. from LGL Alaska Research Associates, Inc., Anchorage, Alaska, in association with HDR Alaska, Inc., Anchorage, AK, for the Knik Arm Bridge and Toll Authority (KABATA), Anchorage, AK, Department of Transportation and Public Facilities, Anchorage, AK, and Federal Highway Administration, Juneau, AK.

Johnson, C.S. 1991. Hearing thresholds for periodic 60-kHz tone pulses in the beluga whale. *Journal of the Acoustical Society of America* 89:2996–3001.

Johnson, J., and B. Blossom. 2018. Catalog of waters important for spawning, rearing, or migration of anadromous fishes – Southcentral Region, Effective June 1, 2018, Alaska Department of Fish and Game, Special Publication No. 18-04, Anchorage, AK.

KABATA (Knik Arm Bridge and Toll Authority). 2011. *Ambient noise measurements near the proposed Knik Arm Crossing site during May and July 2010*. Prepared by HDR Alaska, Inc., Anchorage, AK.

Kastak, D., and R.J. Schusterman. 1995. Aerial and underwater hearing thresholds for 100 Hz pure tones in two pinniped species. In R.A. Kastelein, J.A. Thomas, and P.E. Nachtigall (Editors), Sensory systems of aquatic mammals. De Spil Publishing, Woerden, Netherlands.

———. 1996. Temporary threshold shift in a harbor seal (*Phoca vitulina*). *Journal of the Acoustical Society of America* 100(3):1905–1908.

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

Kastelein, R.A., P. Bunshoek, and D. Haan. 2002. Audiogram of a harbor porpoise (*Phocoena phocoena*) measured with narrow-band frequency-modulated signals. *Journal of the Acoustical Society of America* 112(1): 10.1121/1.1480835

Kastelein, R.A., L. Hoek, R. Gransier, and C.A.F. de Jong. 2013a. Hearing thresholds of a harbor porpoise (*Phocoena phocoena*) for playbacks of multiple pile driving strike sounds. *Journal of the Acoustical Society of America* 134:2301-2306.

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

Kastelein, R.A., L. Hoek, R. Gransier, C.A.F. de Jong, and N. Jennings. 2013c. Hearing thresholds of two harbor seals (*Phoca vitulina*) for playbacks of multiple pile driving strike sounds. *Journal of the Acoustical Society of America* 134:2307-2312.

Kastelein, R.A., R. van Schie, W.C. Verboom, and D. de Haan, 2005. Underwater hearing sensitivity of a male and a female Steller sea lion (*Eumetopias jubatus*). *Journal of the Acoustical Society of America* 118:1820–1829.

Kendall, L.S. 2010. *Construction impacts on the Cook Inlet beluga whale (*Delphinapterus leucas*) at the Port of Anchorage Marine Terminal Redevelopment Project*. Master's thesis, Alaska Pacific University.

Kendall, L.S. and L.A. Cornick. 2016. Behavior and distribution of Cook Inlet beluga whales, *Delphinapterus leucas*, before and during pile driving activity. *Marine Fisheries Review* 77:106-114.

Ketten, D.R. 1998. Marine mammal auditory systems: A summary of audiometric and anatomical data and its implications for underwater acoustic impacts. NOAA Technical Memorandum NMFS-SWFSC-256:1–74.

Krieger, K.J., and B.L. Wing. 1984. Hydroacoustic surveys and identification of humpback whale forage in Glacier Bay, Stephens Passage, and Frederick Sound, southeastern Alaska, summer 1983. U.S. Department of Commerce, NOAA Technical Memo NMFS/ NWC-66.

Laidre, K.L., K.E.W. Shelden, D.J. Rugh, and B.A. Mahoney. 2000. Beluga, *Delphinapterus leucas*, distribution and survey effort in the Gulf of Alaska. *Marine Fisheries Review* 62:27–36.

Lammers, M.O., M. Castellote, R.J. Small, S. Atkinson, J. Jenniges, A. Rosinski, J.N. Oswald, and C. Garner. 2013. Passive acoustic monitoring of Cook Inlet beluga whales (*Delphinapterus leucas*). *Journal of the Acoustical Society of America* 134:2497-2504.

Leatherwood, S., R.R. Reeves, W.F. Perrin, and W.E. Evans. 1982*. Whales, dolphins, and porpoises of the eastern North Pacific and adjacent Arctic waters: A guide to their identification*. NOAA Technical Report NMFS Circular 444. National Marine Fisheries Service, Rockville, MD.

LGL Alaska Research Associates, Inc., and DOWL. 2015. Biological Assessment of the Cook Inlet Beluga Whale (*Delphinapterus leucas*) for the Seward Highway MP 105-107 Windy Corner Project, Municipality of Anchorage, Upper Cook Inlet, Alaska. Prepared for State of Alaska Department of Transportation and Public Facilities, Central Region.

Lomac-MacNair, K., M.A. Smultea, and G. Campbell. 2014. Draft NMFS 90-Day Report for Marine Mammal Monitoring and Mitigation during Apache's Cook Inlet 2014 Seismic Survey, 2 April – 27

June 2014. Prepared for Apache Alaska Corporation, Anchorage AK. Prepared by Smultea Environmental Sciences (SES), Preston, WA.

Lowry, L.F., K.J. Frost, J.M. Ver Hoef, and R.A. DeLong. 2001. Movements of satellite-tagged subadult and adult harbor seals in Prince William Sound, Alaska. *Marine Mammal Science* 17:835-861.

Lyamin, O.I., S.M. Korneva, V.V. Rozhnov, and L.M. Mukhametov. 2011. Cardiorespiratory changes in beluga in response to acoustic noise. *Doklady Biological Sciences* 440:275–278.

Mahoney, B. 2020. Personal communication between Barbara Mahoney, NMFS, other NMFS analysts, and POA PCT project team regarding harbor seal haulouts in upper Cook Inlet, 16 November 2020.

Markowitz, T.M., and T.L. McGuire (eds.) 2007. *Temporal-spatial distribution, movements and behavior of beluga whales near the Port of Anchorage, Alaska*. Prepared by LGL Alaska Research Associates, Inc., Anchorage, AK, for Integrated Concepts and Research Corporation (ICRC), Anchorage, AK.

McGuire, T., M. Blees, and M. Bourdon. 2011. *Photo-identification of beluga whales in Upper Cook Inlet, Alaska. Final report of field activities and belugas resighted in 2009*. Prepared by LGL Alaska Research Associates, Inc., Anchorage, AK, for National Fish and Wildlife Foundation, Chevron, and ConocoPhillips Alaska, Inc.

McGuire, T., A. Stephens, and M. Bourdon. 2013a. *Photo-identification of beluga whales in Upper Cook Inlet, Alaska. Final report of field activities in 2011 and 2012 and belugas re-sighted in 2011.* Prepared by LGL Alaska Research Associates, Inc., Anchorage, AK, for National Fish and Wildlife Foundation and ConocoPhillips Alaska, Inc.

McGuire, T., A. Stephens, L. Bisson, and M. Bourdon. 2013b. *Photo-identification of beluga whales in Eagle Bay, Knik Arm, Upper Cook Inlet, Alaska. Final report of field activities and belugas identified in 2011.* Prepared by LGL Alaska Research Associates, Inc., Anchorage, AK, for Department of Defense, U.S. Air Force, JBER, and the Alaska Department of Fish and Game.

McGuire, T., A. Stephens, and B. Goetz. 2016. The Susitna river delta as a calving ground: Evidence from observation of a Cook Inlet beluga birth and the 2005–2015 seasonal and geographic patterns of neonate occurrence in upper Cook Inlet. Poster presented at Alaska Marine Science Symposium.

Montgomery, R.A., J.M. Ver Hoef, and P.L Boveng. 2007. Spatial modeling of haul-out site use by harbor seals in Cook Inlet, Alaska. *Marine Ecology Progress Series* 341:257–264.

Moore, S.E., K.E.W. Shelden, L.L. Litzky, B.A. Mahoney, and D.J. Rugh. 2000. Beluga, *Delphinapterus leucas*, habitat associations in Cook Inlet, Alaska. *Marine Fisheries Review* 62:60–80.

Moulton, L.L. 1997. Marine residence, growth, and feeding by juvenile salmon in northern Cook Inlet, Alaska. *Alaska Fishery Research Bulletin* 4:154–177.

Mulsow, J., and C. Reichmuth. 2008. Aerial hearing sensitivity in a Steller sea lion. Page 157 in S. Heimlich and D.K. Mellinger, ed. Abstracts, Second International Conference on Acoustic Communication by Animals, 12–15 August 2008, Corvallis, OR.

Muto, M.M., V.T. Helker, R.P. Angliss, B.A. Allen, P.L. Boveng, J.M. Breiwick, M.F. Cameron, P.J. Clapham, S.P. Dahle, M.E. Dahlheim, B.S. Fadely, M.C. Ferguson, L.W. Fritz, R.C. Hobbs, Y.V. Ivashchenko, A.S. Kennedy, J.M. London, S.A. Mizroch, R.R. Ream, E.L. Richmond, K.E.W. Shelden, R.G. Towell, P.R. Wade, J.M. Waite, and A.N. Zerbini. 2018. *Alaska Marine Mammal Stock Assessments, 2017*. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-AFSC-378, doi:10.7289/V5/TM-AFSC-378. Available online at https://www.afsc.noaa.gov/publications/AFSC-TM/NOAA-TM-AFSC-378.pdf.

Muto, M.M., V.T. Helker, B.J. Delean, R.P. Angliss, P.L. Boveng, J.M. Breiwick, B.M. Brost, M.F. Cameron, P.J. Clapham, S.P. Dahle, M.E. Dahlheim, B.S. Fadely, M.C. Ferguson, L.W. Fritz, R.C. Hobbs, Y.V. Ivashchenko, A.S. Kennedy, J.M. London, S.A. Mizroch, R.R. Ream, E.L. Richmond, K.E.W. Shelden, K.L. Sweeney, R.G. Towell, P.R. Wade, J.M. Waite, and A.N. Zerbini. 2020a. Alaska marine mammal stock assessments, 2019. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-AFSC-404.

Muto, M.M., V.T. Helker, B.J. Delean, N.C. Young, J.C. Freed, R.P. Angliss, P.L. Boveng, J.M. Breiwick, B.M. Brost, M.F. Cameron, P.J. Clapham, J.L. Crance, S.P. Dahle, M.E. Dahlheim, B.S. Fadely, M.C. Ferguson, L.W. Fritz, K.T. Goetz, R.C. Hobbs, Y.V. Ivashchenko, A.S. Kennedy, J.M. London, S.A. Mizroch, R.R. Ream, E.L. Richmond, K.E.W. Shelden, K.L. Sweeney, R.G. Towell, P.R. Wade, J.M. Waite, and A.N. Zerbini. 2020b. Draft Alaska marine mammal stock assessments, 2020. U.S. Department of Commerce, NOAA Tech. Memo. Available online at https://s3.amazonaws.com/media.fisheries.noaa.gov/2020-12/Draft%202020%20Alaska-marine%20mammal%20stock%20assessment%20reports.pdf?null

Nachtigall, P.E., and A.Y. Supin. 2013. A false killer whale reduces its hearing sensitivity when a loud sound is preceded by a warning. *Journal of Experimental Biology* 216:3062–3070.

Nachtigall, P.E., A.Y. Supin, J.A. Estaban, and A.F. Pacini. 2015. Learning and extinction of conditioned hearing sensation change in the beluga whale (*Delphinapterus leucas*). *Journal of Comparative Physiology A* 202: 105–113.

Nachtigall, P.E., A.Y. Supin, J.A. Estaban, and A.F. Pacini. 2016a. Learning and extinction of conditioned hearing sensation change in the beluga whale (*Delphinapterus leucas*). *Journal of Comparative Physiology* A 202(2):105–113.

Nachtigall, P.E., A.Y. Supin, A.F. Pacini, and K.A. Kastelein. 2016b. Conditioned hearing sensitivity change in the harbor porpoise (*Phocoena phocoena*). *Journal of the Acoustical Society of America* 140:960.

Nemoto, T. 1957. Foods of the baleen whales of the northern Pacific. *Scientific Reports of the Whale Research Institute* 12(1957):33–89.

NMFS (National Marine Fisheries Service). 2003. *Subsistence Harvest Management of Cook Inlet Beluga Whales - Final Environmental Impact Statement*. Available online at http://alaskafisheries.noaa.gov/protectedresources/whales/beluga/eis2003/final.pdf.

———. 2008a. *Conservation plan for the Cook Inlet beluga whale* (Delphinapterus leucas). National Marine Fisheries Service, Juneau, AK.

———. 2008b. Cook Inlet Beluga Whale Subsistence Harvest Final Supplemental Environmental Impact Statement. Available online at http://alaskafisheries.noaa.gov/protectedresources/whales/beluga/seis/seis0608.pdf.

———. 2009. Biological Opinion for the Marine Terminal Redevelopment Project for the Port of Anchorage. National Marine Fisheries Service, Alaska Region. 13 July 2009.

———. 2016. Recovery Plan for the Cook Inlet Beluga Whale (*Delphinapterus leucas*). National Marine Fisheries Service, Alaska Regional Office, Protected Resources Division, Juneau, AK.

———. 2018a. *2018 Revisions to: Technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing (Version 2.0): Underwater thresholds for onset of permanent and temporary threshold shifts*. U.S. Department of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59.

———. 2018b. Endangered Species Act Section 7(a)(2) Letter of Concurrence, Port of Alaska, Fender Pile Replacement and Repair, Knik Arm. NMFS PCTS #AKR-2018-9778. 11 July 2018.

———. 2018c. Endangered Species Act Section 7(a)(2) Letter of Concurrence, Port of Alaska, Petroleum and Cement Terminal, Knik Arm. NMFS PCTS #AKR-2018-9830. 13 December 2018.

NOAA (National Oceanic and Atmospheric Administration). 2015. Tidal Datums, Anchorage, AK, Station ID: 9455920, NOAA Tides & Currents. Available online at http://tidesandcurrents.noaa.gov/noaatidepredictions/NOAATidesFacade.jsp?Stationid=9455920. Anchorage, AK&type=Datums. Accessed 02 January 2015.

———. 2016. Nearshore Fish Atlas of Alaska. Available online at https://alaskafisheries.noaa.gov/mapping/szflex/index.html?T=FA@L=B.

Norman, S.A. 2011. *Nonlethal anthropogenic and environmental stressors in Cook Inlet beluga whales (*Delphinapterus leucas*)*. Report prepared for NOAA Fisheries, National Marine Fisheries Service, Anchorage, AK under NMFS contract no. HA133F-10-SE-3639.

North Pacific Universities (North Pacific Universities Marine Mammal Research Consortium). 2015. Harbor Porpoise Biology. Available online at http://www.marinemammal.org/biology/harbor-porpoise/. Accessed 08 January 2015.

NPFMC (North Pacific Fishery Management Council). 2012. Fishery Management Plan for the Salmon Fisheries in the EEZ off Alaska. National Marine Fisheries Service Alaska Region, State of Alaska Department of Fish and Game. June 2012.

———. 2016. Fishery Management Plan for Groundfish of the Gulf of Alaska. National Marine Fisheries Service Alaska Region, State of Alaska Department of Fish and Game. November 2016.

NRC (National Research Council). 2003. Ocean Noise and Marine Mammals. National Academy Press, Washington, DC.

Payne, P.M., and L.A. Selzer. 1989. The distribution, abundance and selected prey of the harbor seal, *Phoca vitulina concolor*, in southern New England. *Marine Mammal Science* 5(2):173–192.

POA (Port of Alaska). 2016a. Anchorage Port Modernization Program Test Pile Program Report of Findings. Prepared by HDR, Inc., Anchorage, AK, for the Port of Anchorage [now Port of Alaska] under contract to CH2M.

———. 2016b. Anchorage Port Modernization Program In-air Noise and Ground-borne Vibration Analysis Monitoring Report. Prepared by HDR, Inc., Anchorage, AK, for the Port of Anchorage under contract to CH2M.

———. 2017a. *Anchorage Port Modernization Program Essential Fish Habitat Technical Memorandum – APMP Petroleum and Cement Terminal Project.* Prepared by HDR, Inc., Anchorage, AK, for the Port of Anchorage under contract to CH2M.

———. 2017b. Anchorage Port Modernization Program, Petroleum and Cement Terminal: Application for a Marine Mammal Protection Act Incidental Harassment Authorization. Prepared by HDR, Inc., Anchorage, AK; and Illingworth & Rodkin, Petaluma, CA; for the Port of Anchorage under contract to CH2M.

———. 2020. PCT Project Addendum to Marine Mammal Mitigation and Monitoring Plan. NMFS Supporting Materials. Available online at https://www.fisheries.noaa.gov/action/incidental-take-authorization-port-alaska-petroleum-and-cement-terminal-pct-anchorage-alaska. Accessed 03 December 2020.

Popov, V.V., A.Y. Supin, V.V. Rozhnov, D.I. Nechaev, E.V. Sysuyeva, V.O. Klishin, M.G. Pletenko, and M.B. Tarakanov. 2013. Hearing threshold shifts and recovery after noise exposure in beluga whales, *Delphinapterus leucas*. *Journal of Experimental Biology* 216:1, 581–587, 596.

Popper, A.N., and M.C. Hastings. 2009. The effects of anthropogenic sources of sound on fishes. *Journal of Fish Biology* 75:455–489.

Popper, A.N., M.B. Halvorsen, B.M. Casper, and T.J. Carlson. 2013. *Effects of pile sounds on non-auditory tissues of fish*. OCS Study BOEM 2012-105. Bureau of Ocean Energy Management, Herndon, VA.

Popper, A.N., A.D. Hawkins, R.R. Fay, D.A. Mann, S. Bartol, T.J. Carlson, S. Coombs, W.T. Ellison, R.L. Gentry, M.B. Halvorsen, S. Løkkeborg, P.H. Rogers, B.L. Southall, D.G. Zeddies, and W.N. Tavolga. 2014. *Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. ASA S3/SC1.4 TR-2014*. ASA Press and Springer, NY.

Prevel-Ramos, A.P., T.M. Markowitz, D.W. Funk, and M.R. Link. 2006. *Monitoring beluga whales at the Port of Anchorage: Pre-expansion observations, August-November 2005*. Prepared by LGL Alaska Research Associates, Inc., Anchorage, AK, for Integrated Concepts and Research Corporation (ICRC), the Port of Anchorage, AK, and the Department of Transportation Maritime Administration.

Prevel-Ramos, A. M., M. J. Nemeth, and A. M. Baker. 2008. *Marine mammal monitoring at Ladd Landing in Upper Cook Inlet, Alaska, from July through October 2007.* Prepared by LGL Alaska Research Associates, Inc., Anchorage, AK for DRven Corporation, Anchorage, AK.

Quakenbush, L.T., R.S. Suydam, A.L. Bryan, L.F. Lowry, K.J. Frost, and B.A. Mahoney. 2015. Diet of beluga whales *Delphinapterus leucas*, in Alaska from Stomach Contacts, March–November.

Reyff, J. 2020. Personal communication between James Reyff, I&R, and Heather Spore (HDR) regarding ambient noise levels near the Port of Alaska, 26 August 2020.

Richardson, W.J., C.R. Greene, C.I. Malme, and D.H. Thomson. 1995. Marine Mammals and Noise. Academic Press, Inc., San Diego, CA.

Rodrigues, R., M. Nemeth, T. Markowitz, and D. Funk, eds. 2006. *Review of literature on fish species and beluga whales in Cook Inlet, Alaska*. Final report. Prepared by LGL Alaska Research Associates, Inc., Anchorage, for DRven Corporation, AK.

Rodrigues, R., M. Nemeth, T. Markowitz, C. Lyons, and D. Funk, eds. 2007. *Review of literature on marine fish and mammals in Cook Inlet, Alaska*. Final report. Prepared by LGL Alaska Research Associates, Inc., Anchorage, for DRven Corporation, AK.

Romano, T.A., M.J. Keogh, C. Kelly, P. Feng, L. Berk, C.E. Schlundt, D.A. Carder, and J.J. Finneran. 2004. Anthropogenic sound and marine mammal health: Measures of the nervous and immune systems before and after intense sound exposure. *Canadian Journal of Fisheries and Aquatic Sciences* 61:1124–1134.

Rugh, D.J., K.E.W. Shelden, and B.A. Mahoney. 2000. Distribution of belugas, *Delphinapterus leucas*, in Cook Inlet, Alaska, during June/July, 1993–2000. *Marine Fisheries Review* 62:6–21.

Rugh, D.J., B.A. Mahoney, C.L. Sims, B.K. Smith, and R.C. Hobbs. 2003. *Aerial surveys of belugas in Cook Inlet, Alaska, June 2003*. Unpubl. NMFS report. Available online at http://www.fakr.noaa.gov/protectedresources/whales/beluga/ surveyrpt2003.pdf.

Rugh, D.J., B.A. Mahoney, and B. K. Smith. 2004a. *Aerial surveys of beluga whales in Cook Inlet, Alaska, between June 2001 and June 2002*. NOAA Technical Memorandum NMFS-AFSC-145. National Marine Fisheries Service, Seattle, WA.

Rugh, D.J., B.A. Mahoney, C.L. Sims, B.A. Mahoney, B.K. Smith, and R.C. Hobbs. 2004b. *Aerial surveys of belugas in Cook Inlet, Alaska, June 2004*. Unpubl. NMFS report. Available online at https://www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-145.pdf.

Rugh, D.J., K.E.W. Shelden, C.L. Sims, B.A. Mahoney, B.K. Smith, L.K. Litzky, and R.C. Hobbs. 2005a. *Aerial surveys of belugas in Cook Inlet, Alaska, June 2001, 2002, 2003, and 2004*. NOAA Technical Memorandum NMFS-AFSC-149. National Marine Fisheries Service, Seattle, WA.

Rugh, D. J., K.T. Goetz, and B.A. Mahoney. 2005b. *Aerial surveys of belugas in Cook Inlet, Alaska, August 2005*. Unpubl. NMFS report. Available online at https://alaskafisheries.noaa.gov/sites/default/files/cib_as_aug2005.pdf.

Rugh, D. J., K. T. Goetz, B. A. Mahoney, B. K. Smith, and T. A. Ruszkowski. 2005c. *Aerial surveys of belugas in Cook Inlet, Alaska, June 2005*. Unpubl. NMFS report.

Rugh, D.J., K.T. Goetz, C.L. Sims, and B.K. Smith. 2006a. *Aerial surveys of belugas in Cook Inlet, Alaska, August 2006*. Unpubl. NMFS report. Available online at https://alaskafisheries.noaa.gov/sites/default/files/cib_as_aug2006.pdf

Rugh, D.J., K.T. Goetz, C.L. Sims, K.W. Shelden, O.V. Shpak, B.A. Mahoney, B.K. Smith. 2006b. *Aerial surveys of belugas in Cook Inlet, Alaska, June 2006*. Unpubl. NMFS report.

Rugh, D.J., K.T. Goetz, J.A. Mocklin, B.A. Mahoney, and B.K. Smith. 2007. *Aerial surveys of belugas in Cook Inlet, Alaska, June 2007*. Unpubl. NMFS report.

Saxon-Kendall, L., A. Širović, and E.H. Roth. 2013. Effects of construction noise on the Cook Inlet Beluga Whale (*Delphinapterus leucas*) vocal behavior. *Canadian Acoustics* 41(3):3–13.

Scheifele, P.M., S. Andrew, R.A. Cooper, M. Darre, F.E. Musiek, and L. Max. 2005. Indication of a Lombard vocal response in the St. Lawrence River beluga. *Journal of the Acoustical Society of America* 117:1486–1492.

Schlundt, C.E., J.J. Finneran, D.A. Carder, and S.H. Ridgway. 2000. Temporary shift in masked hearing thresholds (MTTS) of bottlenose dolphins and white whales after exposure to intense tones. *Journal of the Acoustical Society of America* 107:3496–3508.

Scientific Fishery Systems, Inc. 2009. *2008 Underwater Noise Survey During Construction Pile Driving*. Prepared by Scientific Fishery Systems under contract to Integrated Concepts and Research Corporation (ICRC), Anchorage, AK, for the Port of Anchorage, Marine Terminal Development Project. Unpublished report.

Sease, J.L. 1992. *Status review - harbor seals (*Phoca vitulina*) in Alaska*. AFSC Processed Report 92-15. Alaska Fisheries Science Center, National Marine Fisheries Service, Seattle, WA.

Sharma, G.D., and D.C. Burrell. 1970. Sedimentary Environment and Sediments of Cook Inlet, Alaska. *American Association of Petroleum Geologists* 54(4, 9):647–654.

Shelden, K.E.W., B.A. Agler, J.J. Brueggeman, L.A. Cornick, S.G. Speckman, and A. Prevel-Ramos. 2014. Harbor porpoise, *Phocoena phocoena vomerina*, in Cook Inlet, Alaska. *Marine Fisheries Review* 76:22–50.

Shelden, K.E.W., R.C. Hobbs, C.L. Sims, L. Vate Brattström, J.A. Mocklin, C. Boyd, and B.A. Mahoney. 2017. Aerial surveys, abundance, and distribution of beluga whales (*Delphinapterus leucas*) in Cook Inlet, Alaska, June 2016. AFSC Processed Rep. 2017-09. Alaska Fisheries Science Center, NOAA, NMFS, Seattle WA. Available online at http://www.afsc.noaa.gov/Publications/ProcRpt/PR2017-09.pdf

Shelden, K.E.W., D.J. Rugh, K.T. Goetz, C.L. Sims, L. Vate Brattström, J.A. Mocklin, B.A. Mahoney, B.K. Smith, and R.C. Hobbs. 2013. *Aerial surveys of beluga whales,* Delphinapterus leucas*, in Cook Inlet, Alaska, June 2005 to 2012*. NOAA Technical Memorandum NMFS-AFSC-263. National Marine Fisheries Service, Seattle, WA.

Shelden, K.E.W., D.J. Rugh, B.A. Mahoney, and M.E. Dahlheim. 2003. Killer whale predation on belugas in Cook Inlet, Alaska: Implications for a depleted population. *Marine Mammal Science* 19(3):529–544.

Shelden, K.E.W., C.L. Sims, L.V. Brattstrom, K.T. Goetz, and R.C. Hobbs. 2015. Aerial surveys of beluga whales (*Delphinapterus leucas*) in Cook Inlet, Alaska, June 2014. AFSC Processed Rep. 2015-03. Alaska Fisheries Science Center, NOAA, NMFS, Seattle, WA.

Shelden, K.E.W. and P.R. Wade (editors). 2019. Aerial surveys, distribution, abundance, and trend of belugas (*Delphinapterus leucas*) in Cook Inlet, Alaska, June 2018. AFSC Processed Rep. 2019-09. Alaska Fisheries Science Center, NOAA, NMFS, Seattle WA.

Širović, A., and L.S. Kendall. 2009. *Passive acoustic monitoring of Cook Inlet beluga whales: Analysis report, Port of Anchorage Marine Terminal Redevelopment Project*. Prepared for U.S. Department of Transportation, Maritime Administration, Washington, DC; Port of Anchorage, Anchorage, AK; and Integrated Concepts and Research Corporation (ICRC), Anchorage, AK.

Sjare, B., and T.G. Smith. 1986a. The relationship between vocalizations and behavioral activity of white whales, *Delphinapterus leucas*. *Canadian Journal of Zoology* 64:2824–2831.

———. 1986b. The vocal repertoire of white whales, *Delphinapterus leucas*, summering in Cunningham Inlet, Northwest Territories. *Canadian Journal of Zoology* 64:407-415.

Small, R.J. 2009. *Acoustic monitoring of beluga whales and noise in Cook Inlet: Semi-annual performance report. 1 October 2009 through 31 March 2010*. Prepared by Alaska Department of Fish and Game for National Marine Fisheries Service. Available online at https://alaskafisheries.noaa.gov/sites/default/files/cib_acoustics-1009-0310_adfg.pdf.

———. 2010. *Acoustic monitoring of beluga whales and noise in Cook Inlet: Final report*. Prepared by Alaska Department of Fish and Game for National Marine Fisheries Service. Available online at https://alaskafisheries.noaa.gov/protectedresources/whales/beluga/acoustics/cib_acoustics-1007-0910.pdf.

Small, R.J., G.W. Pendleton, and K.W. Pitcher. 2003. Trends in abundance of Alaska harbor seals, 1983–2001. *Marine Mammal Science* 19:344–362.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. *Aquatic Mammals* 33(4):411–497.

Stadler, J.H., and D.P. Woodbury. 2009. *Assessing the effects to fishes from pile driving: Application of new hydroacoustic guidelines*. Report presented at Inter-Noise 2009, 23–26 August 2009, Ottawa, Canada.

Stanek, R.T., D.L. Holden, and C. Wassillie. 2007. *Harvest and uses of wild resources in Tyonek and Beluga Alaska*. Technical Paper 321. Alaska Department of Fish and Game, Division of Subsistence, Juneau, AK. Available online at http://www.subsistence.adfg.state.ak.us/techpap/TP321.pdf.

Sweeney, K., L. Fritz, R. Towell, and T. Gelatt. 2016. Results of Steller sea lion surveys in Alaska, June–July 2016. Memorandum to D. DeMaster, J. Bengtson, J. Balsiger, J. Kurland, and L. Rotterman, 05 December 2016. Available from Marine Mammal Laboratory, AFSC, NMFS, Seattle, WA.

Szymanski, M.D., D.E. Bain, K. Kiehl, S. Pennington, S. Wong, and K.R. Henry. 1999. Killer whale (*Orcinus orca*) hearing: Auditory brainstem response and behavioral audiograms. *Journal of the Acoustical Society of America* 106:1134–1141.

Thomas, J.A., R.A. Kastelein, and F.T. Awbrey. 1990. Behavior and blood catecholamines of captive belugas during playbacks of noise from an oil drilling platform. *Zoo Biology* 9:393–402.

Thompson, P.O., W.C. Cummings, and S.J. Ha. 1986. Sounds, source levels, and associated behavior of humpback whales, Southeast Alaska. *Journal of the Acoustical Society of America* 80(3):735–740.

Tollit, D.J., S.P.R. Greenstreet, and P.M. Thompson. 1997. Prey selection by harbor seals (*Phoca vitulina*) in relation to variations in prey abundance. *Canadian Journal of Zoology* 75:1508–1518.

Tollit, D., J. Harwood, C. Booth, L. Thomas, L. New, and J. Wood. 2016. Cook Inlet beluga whale PCoD expert elicitation workshop report. Prepared by SMRU Consulting North America. SMRUC-NA-NOAA915. 29 September 2016.

Tougaard, J., J. Carstensen, O.D. Henriksen, H. Skov, and J. Teilmann. 2003. *Short-term effects of the construction of wind turbines on harbour porpoises at Horns Reef*. Technical report to TechWise A/S. HME/362-02662, Hedeselskabet, Roskilde.

Tougaard, J., L.A. Kyhn, M. Amundin, D. Wennerberg, and C. Bordin. 2012. Behavioral reactions of harbor porpoise to pile-driving noise. Pages 277–280 in A.N. Popper and A. Hawkins, eds. *The effects of noise on aquatic life*. Springer, New York, NY.

Tyack, P.L. 2000. Functional aspects of cetacean communication. Pages 270–307 *in* J. Mann, R.C. Connor, P.L. Tyack and H. Whitehead, eds. *Cetacean societies: Field studies of dolphins and whales.* University of Chicago Press, Chicago, IL.

URS Corporation (URS). 2007. Port of Anchorage Marine Terminal Development Project underwater noise survey test pile driving program, Anchorage, Alaska. Report prepared for Integrated Concepts and Research Corporation (ICRC), Anchorage, AK.

———. 2008. *Application for 2008 Incidental Harassment Authorization for construction activities associated with the Port of Anchorage Marine Terminal Redevelopment Project*. Prepared for U.S. Department of Transportation, Maritime Administration, Washington, DC; Port of Anchorage, Anchorage, AK; and Integrated Concepts & Research Corporation (ICRC), Anchorage, AK.

U.S. Army Garrison Fort Richardson. 2009. *Biological Assessment of the Cook Inlet beluga whale (*Delphinapterus leucas*) for the resumption of year-round firing in Eagle River Flats Impact Area.* U.S. Department of Army, Fort Richardson, AK. Available online at https://alaskafisheries.noaa.gov/protectedresources/whales/beluga/development/ftrichardson/ba_erf1210.pdf.

USDOT (U.S. Department of Transportation) and POA (Port of Anchorage). 2008. *Rulemaking and letters of authorization application for construction activities associated with the Port of Anchorage Marine Terminal Redevelopment Project, July 15, 2009 – July 15, 2014*. Prepared by Integrated Concepts & Research Corporation (ICRC), Anchorage, AK.

U.S. Navy. 2015. Proxy source sound levels and potential bubble curtain attenuation for acoustic modeling of nearshore marine pile driving at Navy installations in Puget Sound. Prepared by Michael Slater, Naval Surface Warfare Center, Carderock Division, and Sharon Rainsberry, Naval Facilities Engineering Command Northwest. Revised January 2015.

Verboom, W.C., and R. Kastelein. 2004. Structure of harbor porpoise (*Phocoena phocoena*) acoustic signals with high repetition rates. In J.A. Thomas, W.E. Pritchett, C. Moss, and M. Vater (eds), Echolocation in bats and dolphins, pages 40–42. University of Chicago Press, Chicago, IL.

Wade, P.R., T.J. Quinn II, J. Barlow, C.S. Baker, A.M. Burdin, J. Calambokidis, P.J. Clapham, E. Falcone, J.K.B. Ford, C.M. Gabriele, R. Leduc, D.K. Mattila, L. Rojas-Bracho, J. Straley, B.L. Taylor, J. Urbán R., D. Weller, B.H. Witteveen, and M. Yamaguchi. 2016. Estimates of abundance and migratory destination for North Pacific humpback whales in both summer feeding areas and winter mating

and calving areas. Paper SC/66b/IA21 submitted to the Scientific Committee of the International Whaling Commission, June 2016, Bled, Slovenia.

Witteveen, B.H., R.J. Foy, K.M. Wynne, and Y. Tremblay. 2008. Investigation of foraging habits and prey preference of humpback whales (*Megaptera novaeangliae*) near Kodiak Island, Alaska using acoustic tags and concurrent fish surveys. *Marine Mammal Science* 24:516–534.

Witteveen, B.H., G.A. Worthy, K. Wynne, and R.J. Foy. 2011. Modeling the diet of humpback whales: An approach using stable carbon and nitrogen isotope ratios in a Bayesian mixing model. *Marine Mammal Science* 28:233–250.

Womble, J.N., and M.F. Sigler. 2006. Temporal variation in Steller sea lion diet at a seasonal haul-out in southeast Alaska. Pages 141–154 *in* A.W. Trites, S.K. Atkinson, D.P. DeMaster, L.W. Fritz, T.S. Gelatt, L.D. Rea, and K.M. Wynne (eds.). *Sea Lions of the World*. Alaska Sea Grant College Program, Fairbanks, AK.

Womble, J.N., M.F. Sigler, and M.F. Willson. 2009. Linking seasonal distribution patterns with prey availability in a central-place forager, the SSL. *Journal of Biogeography* 36(3):439–451.

Woodbury, D., and J. Stadler. 2008. A proposed method to assess physical injury to fishes from underwater sound produced during pile driving. *Bioacoustics* 17:289–291.

WSDOT (Washington State Department of Transportation). 2018. *Biological Assessment Preparation for Transportation Projects - Advanced Training Manual Version August-2018*. *Chapter 7.0 Construction Noise Impact Assessment.* Available online at http://www.wsdot.wa.gov/sites/default/files/2018/01/18/Env-FW-BA_ManualCH07.pdf

Yelverton, J.T., D.R. Richmond, W. Hicks, K. Saunders, and E.R. Fletcher. 1975. *The relationship between fish size and their response to underwater blast.* Report DNA 3677T. Defense Nuclear Agency, Washington, DC.

This page intentionally left blank.

Appendix A

Marine Mammal Monitoring and Mitigation Plan

This page intentionally left blank.