US Army Corp
of Engineers
Alaska District

Environmental Assessment and
Finding of No Significant Impact

August 2008

Anchorage Harbor Dredging & Disposal
Anchorage, Alaska

FINDING OF NO SIGNIFICANT IMPACT (FONSI)

In accordance with the National Environmental Policy Act of 1969, as amended, the U.S. Army Corps of Engineers, Alaska District, has assessed the environmental effects of the following action:

Anchorage Harbor Dredging and Disposal
Anchorage, Alaska

The proposed action increases the dredging volume and frequency of dredging in Anchorage Harbor. Dredged material disposal will be at the existing open water disposal site. Construction of the expanded port facilities requires up to 5.6 million cubic yards of dredging during this transitional period. After such time, the dredging should drop to maintenance levels between 2 and 2.5 million cubic yards of dredged material annually. Dredging will occur from mid-May through November to maintain water depth (-35 feet mean lower low water) appropriate for navigation in Anchorage Harbor and to -45 feet mean lower low water for the authorized expansion project). Two to four barge trips (occasionally five trips) each containing approximately 1,500 cubic yards of dredged material will be made per day to the disposal area during the dredging season. Dredging footprints have changed as described in the EA to accommodate the port expansion project. The disposal site is the same, but expanded to allow for both deeper water areas and ability to maneuver from belugas if necessary.

The proposed dredging and disposal activity will not produce significant environmental effects. No threatened or endangered species, critical habitat, marine mammals, wetlands, or cultural resources will be adversely impacted by the project. Essential fish habitat will not be substantially altered. These determinations have been coordinated with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and the State Historic Preservation Office.

The action is consistent with the State coastal management program to the maximum extent practicable. The accompanying environmental assessment supports the conclusion that the project does not constitute a major Federal action significantly affecting the quality of the human environment. Therefore, an environmental impact statement is not necessary to perform the maintenance dredging and dredge material disposal at Anchorage Harbor.

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Kevin Wilson
Colonel, Corps of Engineers
District Engineer

Date

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1.0 PURPOSE AND NEED

1.1 INTRODUCTION

The Port of Anchorage (POA) is being expanded to accommodate more and larger vessels and the materials carried by those vessels. This action, led by Maritime Administration (MARAD), will rebuild and enlarge docking; loading/unloading equipment and facilities; working space to handle fuels, freight and other materials; and transportation serving the port. Ship access to the existing port is maintained by a Corps of Engineers operations and maintenance program that annually dredges up to 2 million cubic yards of sediment along the docks and approaches to the docks. That dredging program will be expanded to deepen and enlarge mooring and maneuvering areas to serve the expanded port facilities.

The port expansion program has been known by various names that address the entire action and segments of the action. In Congressional language, the expansion is the Port of Anchorage intermodal marine facility. In other documents, it is the Port Intermodal Expansion Project, and the most extensive part of the action is called the Marine Terminal Redevelopment. Less formally, the action generally is called the Anchorage Port Expansion.

The Municipality of Anchorage and the Federal government are partners in the port expansion. Congress has authorized construction of the port expansion and has appropriated initial construction funds. The lead Federal agency for the port expansion is MARAD, an agency of the U.S. Department of Transportation. MARAD prepared and released an environmental assessment (EA) for the Federal action. The MARAD EA identified the need for the action, described alternative actions, and discussed the affected environment and potential effects of the action on that environment. MARAD signed a finding of no significant impact (FONSI) on March 9, 2005.

The MARAD FONSI selected an alternative for implementation and documented the Federal decision to expand the Anchorage marine terminal facilities.

The alternative selected in the FONSI included provisions for dredging to support construction and for periodic dredging to maintain project depths. The EA and FONSI were ambiguous, however, regarding where dredged material would be placed if it could not be used in construction. While MARAD made the Federal decision to expand the port, Congress specifically directed the US Army Corps of Engineers to dredge the port to support the MARAD action as part of the Corps ongoing operations and maintenance program at Anchorage Harbor. The specific Congressional language (in Section 118 of P.L. 108-447) is as follows:

(a) ANCHORAGE HARBOR.—

(1) HARBOR DEPTH.—The project for navigation improvements, Cook Inlet, Alaska (Anchorage Harbor, Alaska), authorized by section 101 of the River and Harbor Act of 1958 (72 Stat. 299) and modified by section 199 of the Water Resources Development Act of 1976 (90 Stat. 2944), is further modified to direct the Secretary of

the Army to construct a harbor depth of minus 45 feet mean lower low water for a length of 10,860 feet at the modified Port of Anchorage intermodal marine facility at each phase of facility modification as such phases are completed and thereafter as the entire project is completed.

(3) TRANSITIONAL DREDGING.—Before completion of the project modification described in paragraph (1), the Secretary may conduct dredging to a depth of at least minus 35 feet mean lower low water in such locations as will allow maintenance of navigation and vessel access to the Port of Anchorage intermodal marine facility during modification of such facility. Such work shall be carried out by the Secretary in accordance with section 101 of the River and Harbor Act of 1958.

(5) MAINTENANCE.—Federal maintenance shall continue for the existing project until the modified intermodal marine facility is completed. Federal maintenance of the modified project shall be in accordance with section 101 of the River and Harbor Act of 1958; except that the project shall be maintained at a depth of minus 45 feet mean lower low water for 10,860 feet referred to in paragraph (1).

1.2 PURPOSE OF THE ACTION

The purpose of the Corps action is two-fold. First, the Corps is making provisions for future maintenance dredging at the POA. The Corps maintains navigation depths for the POA and other ports across Alaska as a part of the agency's mission. The Corps has been maintaining Anchorage Harbor since 1965. Maintaining navigation depths is necessary for commercial and military operations at the Port of Anchorage. The POA serves 90 percent of the population of Alaska, handles 75 percent of goods shipped to Alaska, and is a strategic military and commercial seaport. Maintaining navigation at the port is essential to Alaska.

The amount dredged to maintain the POA varies from year to year, with a maximum of about 2.1 million cubic yards dredged in 2004. The sedimentation rate at POA has increased in the last decade for reasons that are not fully understood. Table 1 shows dredging quantities since 1989. The site used for dredged material disposal now has been large enough for all the material dredged each year, but changes in local conditions could reduce capacity of that site. This EA addresses the need for a larger disposal site to allow for that possibility.

Table 1. Dredged Quantities 1989 through 2007

Year	*Volume (cubic yards)*	*Year*	*Volume (cubic yards)*
1989	200,284	1999	438,800
1990	290,686	2000	1,458,236
1991	221,863	2001	451,431
1992	227,559	2002	763,268
1993	229,358	2003	844,968
1994	251,968	2004	2,076,961
1995	244,530	2005	1,792,515
1996	197,322	2006	1,833,520
1997	196,162	2007	1,442,332
1998	356,000		

The second purpose of the Corps of Engineers (Corps) action is to provide dredging support for MARAD's POA expansion in compliance with Section 118 of P.L. 108-447. The MARAD 2005 EA fully describes the purpose and need for POA expansion. This Corps EA addresses MARAD's dredging requirements and addresses, in more detail, alternatives to meet those requirements.

1.3 SCOPE OF THE ACTION

The Congressional language and the MARAD decision together define the scope of this Corps EA to dredge the POA. This EA addresses dredging activities to support the MARAD Anchorage port expansion and future dredging to maintain project depths at the port. It does not address the broader scope of Anchorage port expansion or the decisions already made by MARAD in their 2005 FONSI. This Corps EA does not alter any decision made in that FONSI nor does it expand the scope of the MARAD project. This EA is intended to provide additional detail regarding Corps of Engineers construction and maintenance dredging activities previously described in general in the MARAD EA.

1.4 ISSUES AND CONCERNS

Issues and concerns related to POA expansion are well-developed in the MARAD EA and FONSI and in the comments from the agencies and public related to that action. Identified issues and concerns include those related to dredging and disposal of dredged material. The U.S. Fish and Wildlife Service Coordination Act report (Appendix A) also identifies issues and concerns developed during review of the MARAD project and refined to specifically address dredging and disposal. Principal concerns are related to potential effects of dredging turbidity, suspended solids, noise, and potential mechanical damage to fish, beluga whales, and other organisms. This Corps EA focuses on those resources and the potential effects of the proposed action to those resources. It also provides information to address issues of regional, state, and national concern and to respond to specific legal and policy requirements.

1.5 DESCRIPTION OF THE PROJECT AREA

The Port of Anchorage (POA) is in south-central Alaska at the upper end of Cook Inlet. It is adjacent to downtown Anchorage on the southeastern shoreline of Knik Arm at latitude 61º 13.3’ N, longitude 149º 54.6’ W (figures 1 and 2). Anchorage, the state's largest city and center of transportation, is at the inlet's northeast end, between Knik and Turnagain Arms. Nearly half the state’s population resides in Anchorage. A shipping channel connects POA to lower Cook Inlet and the Gulf of Alaska.

Cook Inlet is a large estuary on the south-central coast of Alaska, bordered on three sides by rugged mountains, tidal flats, marshlands, and rolling lowlands. Figure 1 shows the inlet and the topographic features that surround it. The inlet is approximately 200 miles long, from the upper ends of Knik Arm and Turnagain Arm in the north to the southern tip of the Kenai Peninsula. Both Knik Arm and Turnagain Arm, at the northern extreme of Cook Inlet near Anchorage, are more than 37 miles from their confluence to the limits of their tidelands.

The majority of fresh water that enters upper Cook Inlet is from three rivers at its northern end. The Matanuska, Susitna, and Knik rivers contribute nearly 70 percent of the fresh water discharged annually into the inlet (Gatto, 1976). These glacier-fed rivers carry a heavy sediment load into Cook Inlet, particularly during summer. Rivers entering Turnagain Arm discharge nearly 3 million tons of sediment annually, while the rivers entering Knik Arm discharge about 20 million tons (Gatto, 1976). This sediment continues to fill the upper inlet. The finest material in this sediment is carried into the southern inlet and some of it is goes out into the Gulf of Alaska.

Upper Cook Inlet above the East and West forelands is a shallow basin, with depths generally less than 65 feet. Knik Arm averages about 50 feet in depth for about half its length and then rapidly shoals to a tidal flat. Turnagain Arm shoals within the first 10 miles to a large tidal flat cut by many tidal channels.

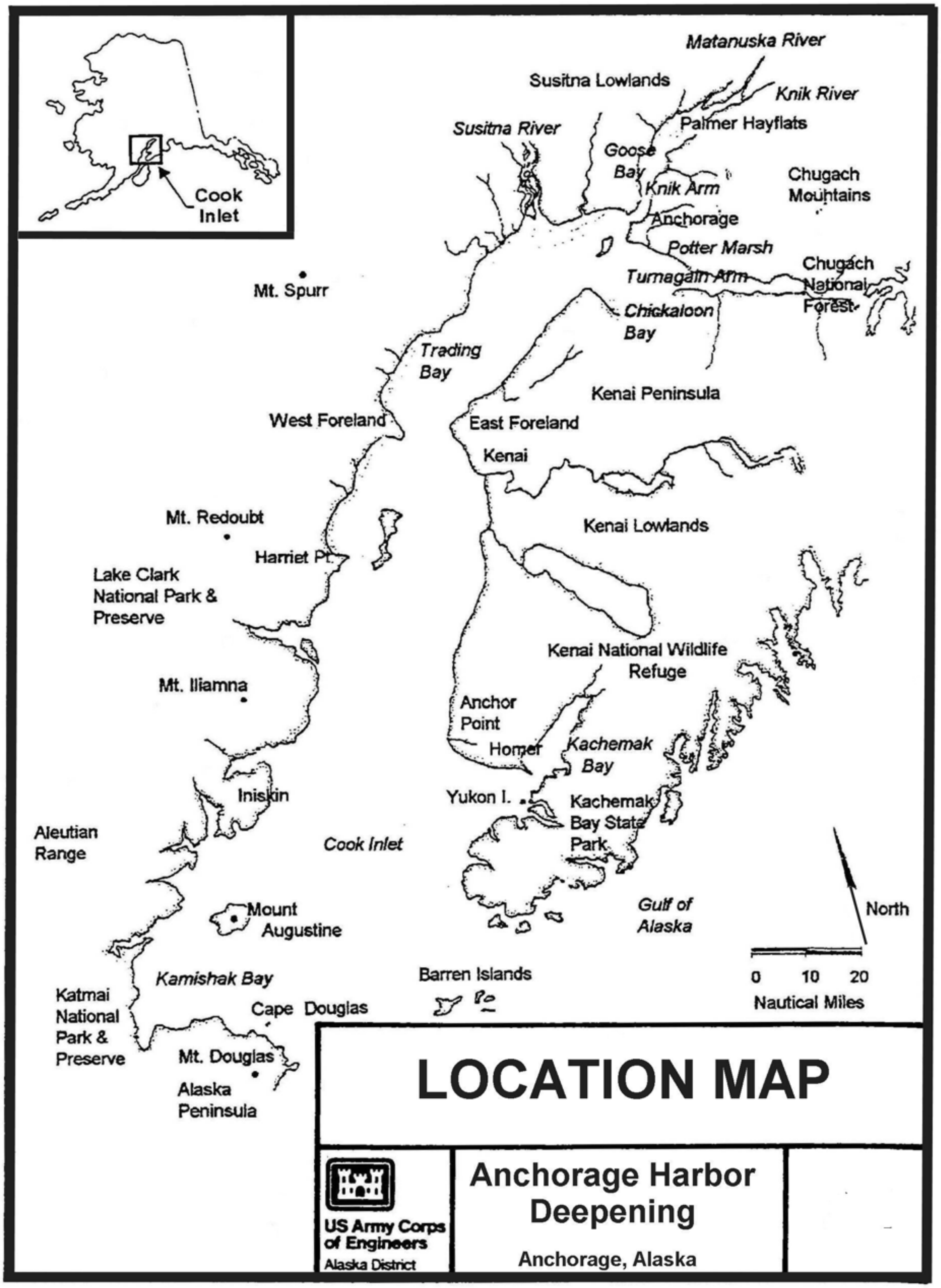

Figure 1. Location Map

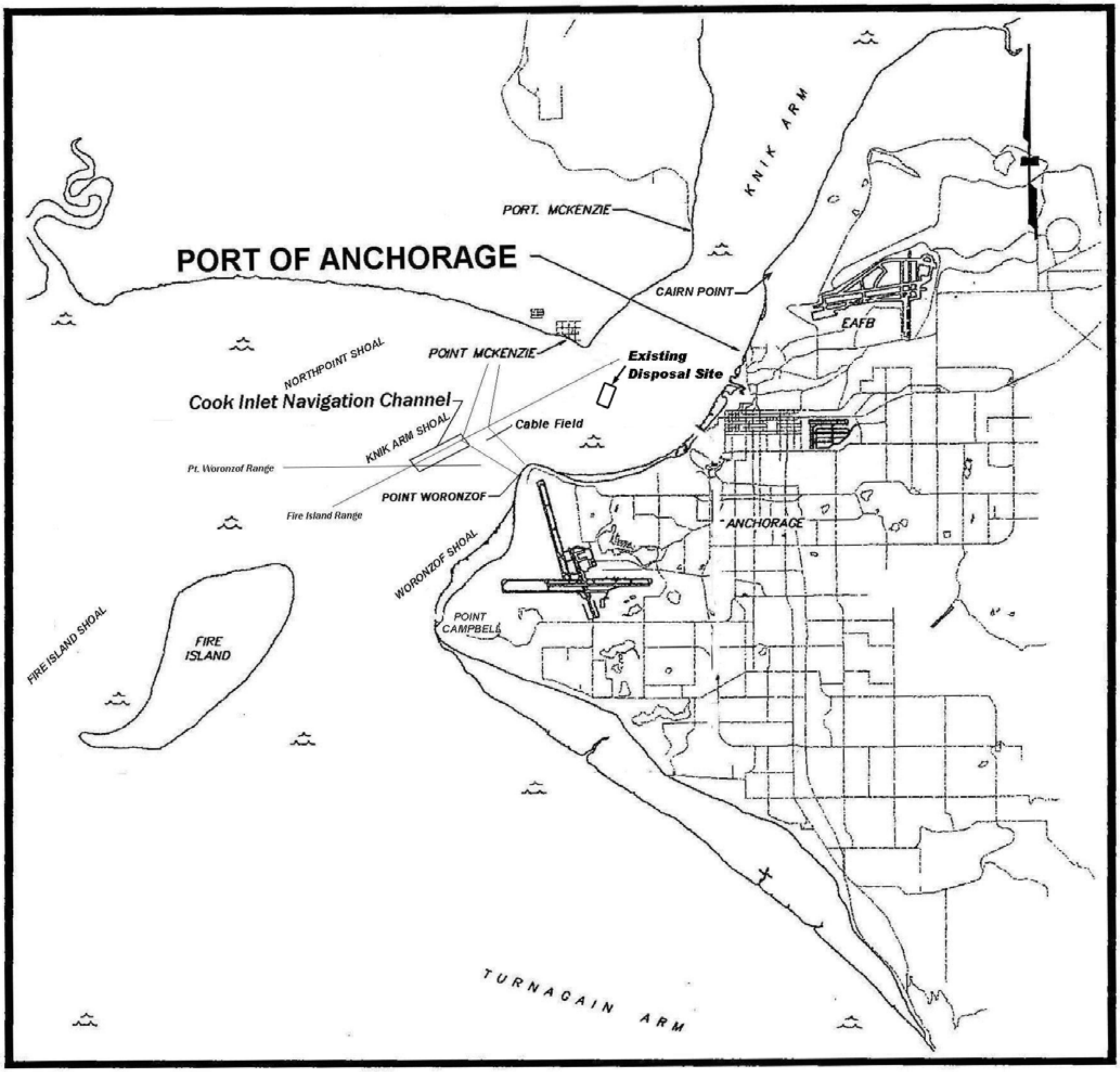

Figure 2. Vicinity Map

The Cook Inlet area is in a transition zone between Alaska's maritime and interior climates. The lower inlet has a more maritime climate, with cooler summers and milder winters than in the upper reaches of the inlet. A comparison of temperatures between two cities located at opposite ends of the inlet demonstrates the differing climates. Anchorage, at the head of the inlet, has an average winter temperature of -9 °C and a summer average of 13 °C, while Homer, near the southern end of the inlet, averages -7 °C in winter and 10 °C in the summer.

The mean daily tide range is about 30 feet at Anchorage. The tides are two unequal high tides and two unequal low tides per tidal day. A tidal (lunar) day is 24 hours and 50 minutes. The greatest tides are in the spring, with high and low tides exceeding the mean by more than 5 feet.

Currents in the upper inlet are classified as reversing currents because the flow changes to the opposite direction and is briefly near zero velocity at each high and low tide. Extreme tides can cause currents in upper Cook Inlet to exceed 4 knots in some areas. Each tidal cycle in the upper inlet creates strong turbulence and vertical mixing, so water properties tend to be more uniform from the surface to the bottom in most areas.

The upper inlet is so shallow that wave heights seldom exceed 10 feet. Knik Arm waves are further constrained east of Fire Island by limited fetch. Strong tidal currents in Cook Inlet can oppose wind-generated waves. This can make waves steeper and more chaotic, a dangerous condition for small boats.

1.6 CURRENT OPERATIONS

The current operations and maintenance plan at Anchorage Harbor authorizes the Corps to dredge to -35 feet mean lower low water. The footprint dredged at Anchorage Harbor fluctuates annually, varying from 95 acres in 1999 to 117 acres in 2004. Over the last 9 years the average size of the dredged footprint has been about 100 acres. Volumes of material dredged are reported in table 1. Dredging is conducted by one or more dredges and is from mid-May through November. Two to four barge trips per day (occasionally five trips) each transport about 1,500 cubic yards of material from each dredge to the disposal site. The current dredging footprint is displayed in red in figure 3. The current disposal site is shown in figure 4.

2.0 ALTERNATIVES

2.1 ALTERNATIVES

The MARAD EA considered a range of alternatives for POA expansion, and the resulting FONSI specified the alternative to be constructed. The alternatives considered in this Corps EA are limited to those directly associated with dredging and with the disposal of that dredged material. The Corps has the option of supporting the alternative selected by MARAD or of selecting the No Action alternative. If the Corps elects to support the MARAD action, the Corps will be responsible for determining dredging methods, timing, and disposal sites.

2.2 NO ACTION ALTERANTIVE

The No Action alternative would allow the Corps to continue to dredge as required to maintain the existing port, but would not allow the Corps to dredge previously undredged material for expansion or to conduct maintenance dredging to support navigation at the expanded port. MARAD would be required to abandon the expansion, substantially alter the scope of the project to use the existing maintenance dredging footprint and quantities, or dredge the additional area themselves.

2.3 PROPOSED ACTION

2.3.1 Maintenance and Expansion Dredging

Section 118 of P.L. 108-447 directed the Secretary of the Army, acting through the Chief of Engineers, to deepen Anchorage Harbor to a depth of -45 feet MLLW for a distance of 10,860 feet to support the expanded Port of Anchorage. The plan shown in figure 3 reflects both plan and profile views. The plan view indicates the project in several stages; the existing port, the port as it will appear during port expansion, and the port as it will appear after port expansion.

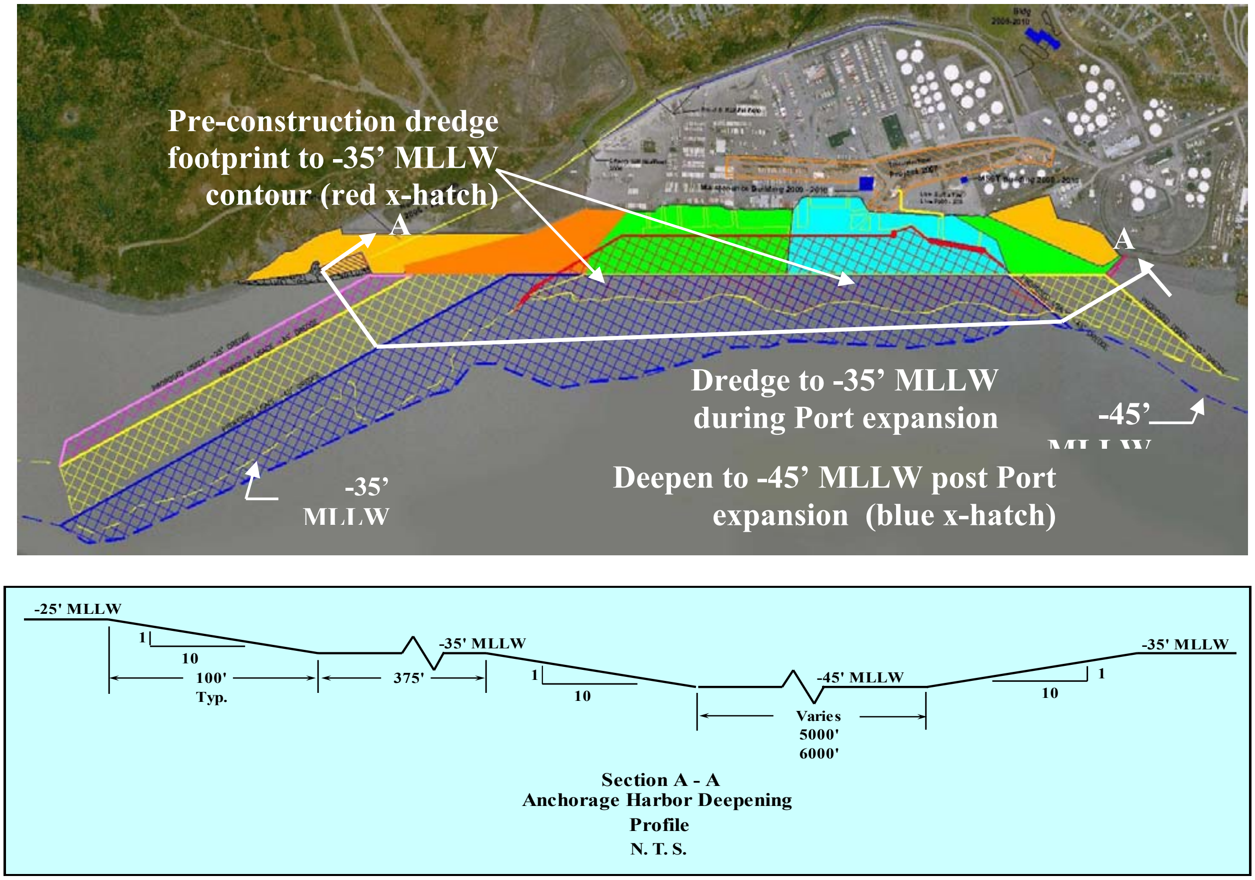

Figure 3. The Anchorage Port Expansion project area (solid blocks), the present and proposed future dredged footprint (hatched blocks), and cross section profile of Corps of Engineers new dredging depths.

The existing maintenance dredging is generally in the area delineated by the red cross-hatching. This dredging extends seaward to the -35-foot MLLW contour, shown by the yellow dashed line. The actual location of the -35 foot MLLW contour is changed by dredging, currents, and tidal action.

The “during expansion” dredged area is depicted by the magenta (-25 feet MLLW) and yellow (-35 feet MLLW) areas. During expansion, the area at the north (left) end would be deepened out to the -35 feet MLLW (yellow) contour. Dredging new material to construct the deeper harbor on the north end could begin as early as the 2009 dredging season (May through October) to accommodate new container service at the Port’s new facility (orange area). New dredging at the south end could begin as early as the 2011 dredging season. Annual maintenance dredging of the new and existing areas would continue during the port expansion.

The post-expansion deepening of the harbor is shown by the blue cross-hatched area. Dredging would deepen the harbor in this area to -45 feet MLLW. It would deepen part of the area previously deepened to -35 feet MLLW so that container vessels with deeper operating drafts could use POA. This area could be dredged as early as 2012.

The profile in figure 3 shows the design configuration of the future (i.e., post-expansion) harbor bottom. The central area would be deepened to -45 feet MLLW in a fan shape, which would vary between 5,000 and 6,000 feet across. Transitional slopes are designed with a 1 vertical on 10 horizontal ratio, which indicates a transitional slope of approximately 100 feet. The transition slopes would be cut like stair steps which would slump or erode into a more uniform slope. The figure depicts the expected configuration after the currents and slumping have smoothed the cut bottom.

Table 2 shows the volume of material dredged in recent years and expected to be dredged each year until 2015 for both construction and dredging

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Table 2. Actual and Estimated Dredged Quantities 2004 through 2015

* = Actual Quantity

Year	Maintenance	Virgin	Maintenance	Total
2004	2,077,000*	0	0	2,077,000*
2005	1,793,000*	0	0	1,793,000*
2006	1,834,000*	0	0	1,834,000*
2007	1,442,000*	0	0	2,000,000
2008	2,000,000	0	0	2,000,000
2009	3,000,000	1,463,000	1,131,000	5,594,000
2010	1,500,000	0	2,284,000	3,784,000
2011	1,500,000	553,000	3,633,000	5,686,000
2012	0	0	2,377,000	2,377,000
2013	0	0	2,250,000	2,250,000
2014	0	0	2,150,000	2,150,000
2015	0	0	2,100,000	2,100,000

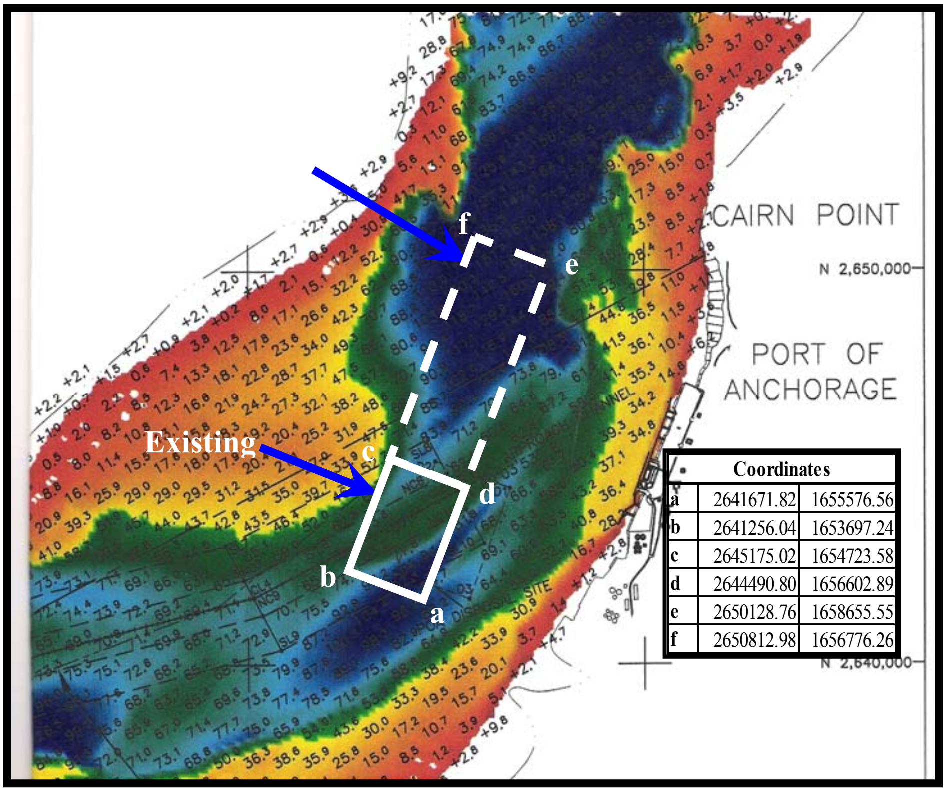

Figure 4. Current Disposal Site with Proposed Expansion

2.3.2 Dredged Material Disposal

The Corps has for many years dredged to maintain POA and has discharged the dredged material into a nearby disposal site (figure 4). The site is in relatively deep water where tidal currents are relatively strong and where the discharged material is rapidly suspended and dispersed into the already turbid waters of upper Cook Inlet. The millions of yards of material discharged into that site have not caused any discernable accumulation at the disposal site or on the inlet bottom around the site. The existing disposal site might be sufficient for construction and future maintenance dredging, but this is uncertain. The previously undredged material that will be dredged for POA expansion will be more cohesive than material dredged for maintenance and will contain unknown quantities of rock of various sizes. Some of this material may slowly disperse, and some will not disperse at all. Deposition in the present disposal site could eventually raise the bottom enough to affect navigation. Enlarging the disposal site would allow the Corps more latitude to spread dredged material over a larger area and so ensure that discharged material would not accumulate excessively in one location. This would avoid potential effects to navigation and changes in bottom configuration that could affect water movement.

The No Action alternative would use the present disposal site for future dredging at POA. The proposed action would expand the disposal site as shown in figure 4.

Other disposal options were examined. Some of the dredged material might be used for POA construction, but it is not suitable for most construction needs there or elsewhere within a reasonable transportation distance. It is not needed in Cook Inlet for environmental restoration or other beneficial use. The material could be placed in an on-land disposal site, but transportation costs would be prohibitive and there does not appear to be a viable beneficial use for the material. Handling costs, storage problems, potential for salt contamination and conflict with future use plans prevent the material from being used to backfill gravel pits that are providing material for POA expansion. Dredged material could be transported to a more distant disposal site in Cook Inlet, but there is no reason to believe that any other site would have less potential for impact. Any other site farther from the dredge location would increase noise, emissions, and fuel expenditure with no apparent potential for environmental gain.

2.3.3 Dredging Methodology

Many different types of dredges are used in marine construction, but most can be classified as mechanical or hydraulic. Mechanical dredges bite or scrape bottom material into a bucket or other container, lift it to the surface, and transfer it to a disposal site or into a barge, scow, or other large container for transportation to a disposal site. Mechanical dredges may be backhoes and excavators that are also used for dry land excavation, but may be special purpose clamshell, hydraulic, scraper, or other types of dredges specifically constructed for high capacity work in marine environments. Figure 5 is a sketch of a typical clamshell dredge, which is a type of mechanical dredge often used in Alaska. Bucket sizes vary widely and may range from less than 5 to about 30 cubic yards. Mechanical dredges are generally relatively fast to set up; most can move into position, lower spuds to hold them into position, and begin dredging fairly quickly. They are generally employed for relatively small jobs, for dredging close to docks, breakwaters, and other structures, and where more precise boundaries must be maintained. Some types of mechanical dredges also can excavate rocks and other material that cannot be dredged by a hydraulic dredge.

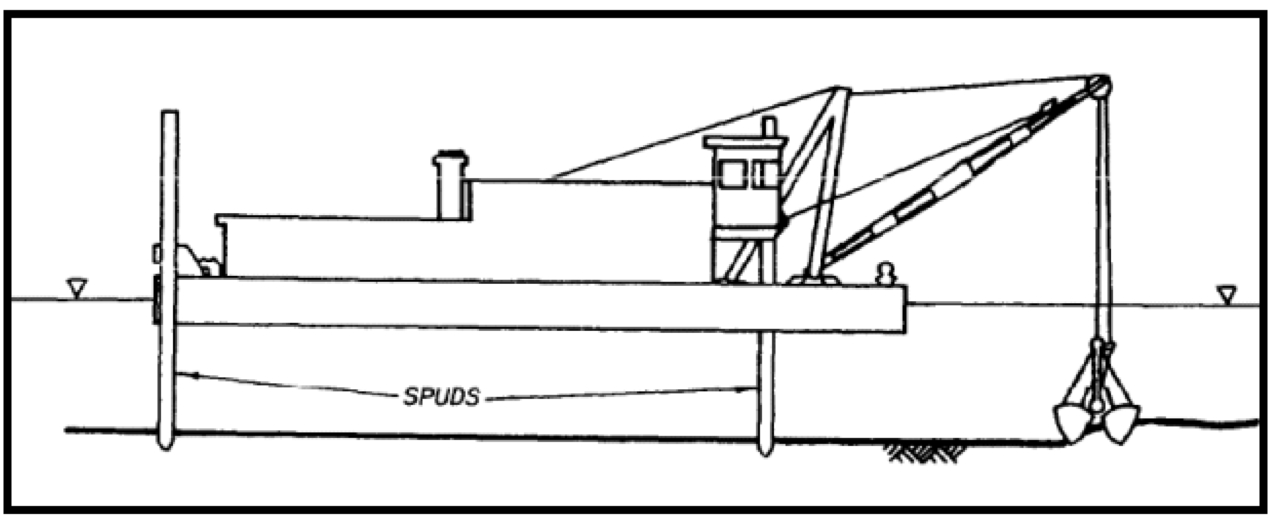

Figure 5. Clamshell Schematic.

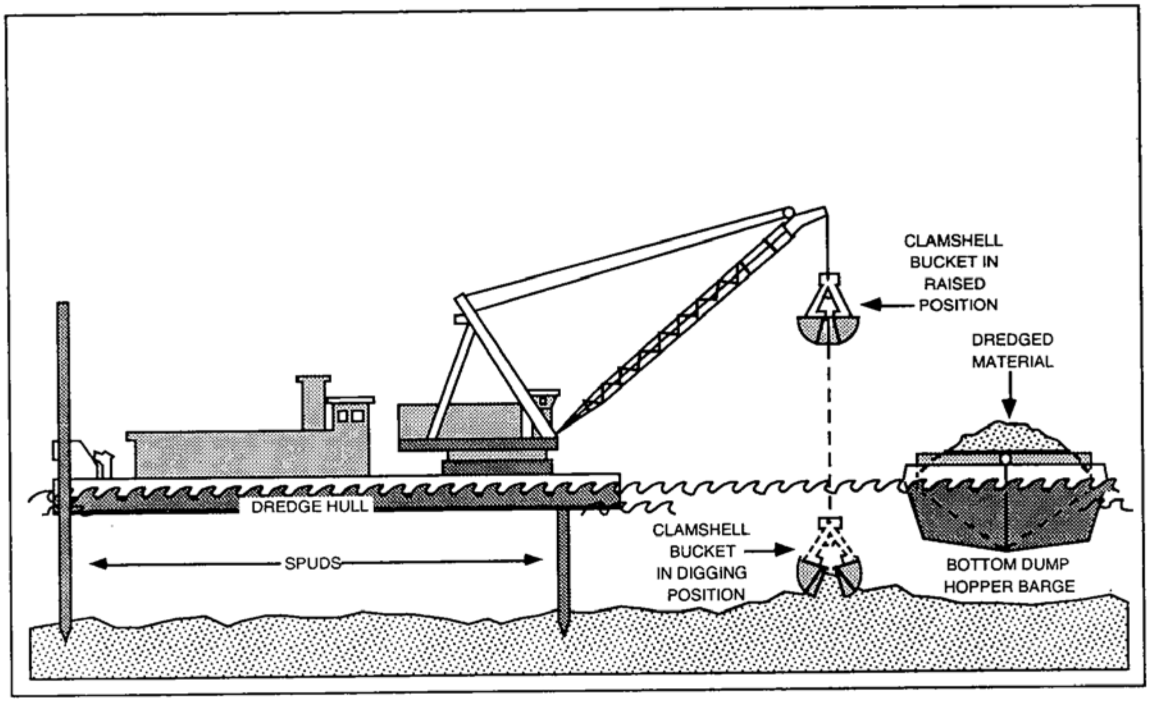

Figure 6. Clamshell and Hopper Barge

A hydraulic excavator dredge is a large power shovel mounted to a barge. It is one type of mechanical dredge used for hard, compact bottom material as may be encountered at POA, but dredging depth is limited by reach of the mechanical arm.

Hydraulic dredges suck material from the bottom, through a pipe or pipeline, and deposit it directly into a disposal site or into a hopper or barge for transportation to a disposal site. Most use water jets or a mechanical cutter head to break up bottom material so it can be sucked into and through the pipeline.

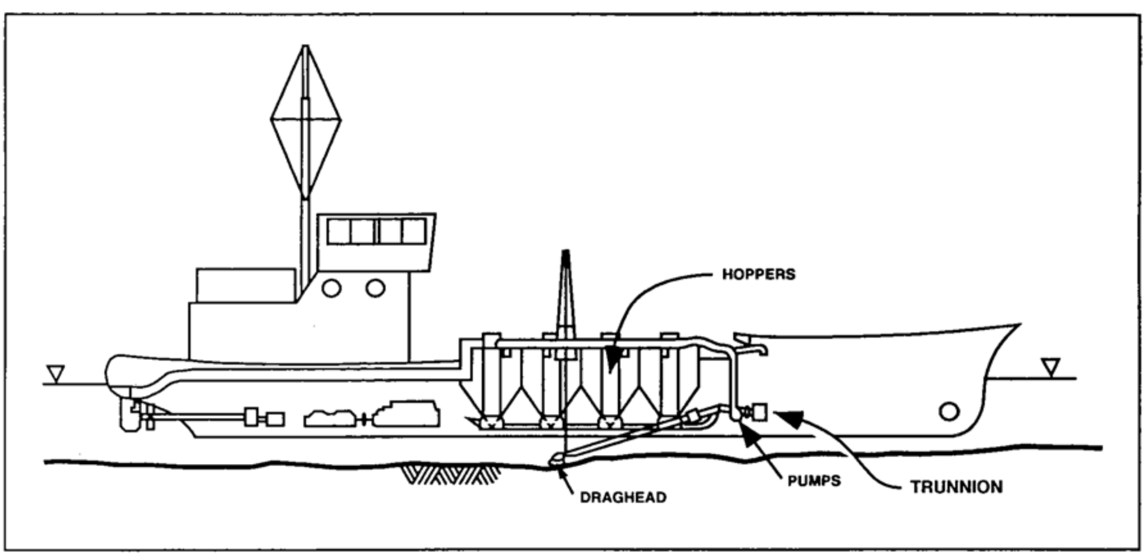

Figure 7. Typical hydraulic dredge schematic.

Hydraulic dredges can be much faster and more efficient than mechanical dredges, but may not be able to excavate rocks, debris, or hard, compacted bottom material. They also are typically not as precise in depth or along boundaries as mechanical dredges. Hydraulic dredges typically are best suited for dredging in open areas away from marine structures.

Dredging jobs often involve close, more precision work around docks and other structures, and larger volume dredging in more open areas. At POA, and in many other harbors, dredging contractors typically use both mechanical and hydraulic dredges for the same project. Contractors know the capabilities of their dredges and usually are allowed to choose among the various types of mechanical and hydraulic dredges they may have available for each project.

Dredged material sometimes can be deposited directly into a disposal site, but generally must be transported, either in a barge or hopper or through a pipeline. Mechanically dredged material generally is placed into a hopper built into the dredging vessel, or into a barge moored to or held close to the dredge. Hopper dredges are filled, stop dredging, and travel under their own power to the disposal site, then return to begin dredging again. Other dredges remain in place, shifting as necessary to dredge, but load into barges that tugs push or tow to the disposal site. At the disposal site, the hopper or barge bottom-dumps the dredged material.

Hydraulic dredges transport dredged material and entrained water to a hopper on the dredge, into a barge, or through a pipeline directly to a disposal site. Material excavated by hydraulic dredges typically is entrained in more than 80 percent water. When that slurry of water and dredged material is emptied into a hopper or barge, the heavier entrained material is allowed to settle and the water on top is decanted out. That excess water is removed through a weir and out through the bottom of the vessel to avoid creating a surface plume.

The hydraulically dredged material also can be pumped as a slurry directly into a pipeline and to a disposal site. Disposal pipelines allow a hydraulic dredge to operate almost continuously and can be extremely efficient. The pipelines typically are floated on the surface and may be several miles long if auxiliary pumps are used. The pipeline generally is set up to discharge the dredged material slurry well beneath the surface. Pipeline disposal typically is used for larger jobs where efficient operations can repay the time and expense of shipping, setting up, and operating the disposal pipeline. Pipelines operate best where currents and waves are limited and where the floating pipeline does not unduly impede navigation. Pipeline disposal typically is not used at POA, but could be employed for POA expansion.

The proposed action would allow the dredging contractor to select dredging equipment and methods, but would require discharge of dredged material at least 10 feet beneath the surface to minimize surface plume.

2.3.4 Best Management Practices and Monitoring

Each Corps of Engineers dredging project employs standard industry best management practices and requires contractors to provide quality control to ensure that water quality standards and pollution control requirements are met. Those practices are, and will continue to be implemented for all future Corps dredging for POA.

Scoping for the proposed action identified two specific areas of concern related to dredging at POA. One was that noise generated by dredging could adversely affect beluga whales that were very close to operations where they could be exposed to more sound energy than they are accustomed to from port operations. In consultation with concerned conservation groups, the Corps adopted a whale watch for belugas and other cetaceans during dredging and disposal operations. The Corps Beluga Monitoring Program requires the pilot of the vessel to monitor the presence of belugas on the daily QC report. The pilot is briefed at the beginning of the dredging season by a District biologist on the identification of belugas, their general behaviors in the area and reporting requirements. The reporting requirements include a recording of the numbers of adults and juveniles present or not present, distance from the dredge as measured from buoys, any sudden course changes, reactions to dredging and disposal, directional movements and any other behaviors on a daily basis and compile those observations into a report to be submitted to NMFS on a monthly basis. A copy of this monthly report is furnished to the District Office.

If beluga whales are present within the boundaries of the dredging operation, the Corps stops dredging until the whales disperse. Similarly, if beluga whales are in the vicinity of the disposal site, the barge moves to a site more distant from the whales. The Corps will continue this method of operations for the duration of the project, unless modified to be more restrictive.

The other concern, expressed in the U.S. Fish and Wildlife Coordination Act report (appendix A), was that increased sediment concentrations and turbidity at the surface could adversely affect the ability of juvenile fish, particularly salmon juveniles, to feed on surface and near-surface invertebrates.

Two actions would be adopted to mitigate those potential effects: (1) dredging contractors would be required to discharge excess water and to dispose dredged material well beneath the surface to avoid increasing surface turbidity, and (2) surface water parameters would be monitored at and down-current from dredging and disposal activities to determine whether surface turbidity increases during dredging. If those activities increased surface turbidity, the Corps would consult with resource agencies to determine whether additional data related to near-surface feeding should be collected or operations should be modified to protect juvenile fish in the project area.

3.0 AFFECTED ENVIRONMENT

3.1 PHYSICAL RESOURCES

3.1.1 Air Quality

POA is approximately one-half mile north of downtown Anchorage. Overall, Anchorage enjoys very clean air, with an Air Quality Index rating of "good" on 92 percent of monitored days in 2007 (EPA 2007). The city maintains levels of regulated pollutants within the National Ambient Air Quality Standards (NAAQS) established under the Clean Air Act. The air quality standards include concentration limits on the "criteria pollutants" carbon monoxide (CO), ozone, sulfur dioxide, nitrogen oxides, lead, and particulate matter.

Anchorage has historically experienced elevated CO concentrations during the winter, when cold temperatures and the nearby mountains can result in temperature inversions that trap pollutants close to the ground. As in most urban areas, carbon monoxide emissions are generated primarily by vehicles, with cars and trucks accounting for around three-quarters of the annual CO emissions in Anchorage (ADEC 2004). A large part of metropolitan Anchorage was designated a "non-attainment" area for CO in November 1990. The Port of Anchorage is not within the boundaries of this non-attainment area, but is within a half-mile of its northwest corner.
The city was re-designated from "non-attainment" to "maintenance" status for CO in July 2004, largely through a program of vehicle inspection and emission control. The state maintenance plan specifies measures the state will take to maintain compliance with air quality standards. The EPA requires a demonstration of maintenance for 10 years following re-designation.

3.1.2 Noise

Noise Transmitted Underwater. Project-related underwater noise can be produced by equipment used for dredging, filling, and associated noise from vessels involved with dredging. Ambient noise is background noise that masks sounds of interest. For example, noise produced from ice, tides, and currents would be present in recordings aimed at measuring the noise from a tug boat operated at a port. Similarly, if one were measuring noise produced by beluga whales near a port, the sounds from other marine mammals, tides, currents, ships, tugs and other sources would be considered ambient noise. For underwater environments, ambient noise could include noise produced by tidal action, currents, wind, rain, floating ice, and waves. Human-caused (anthropogenic) underwater noise can be generated from operation of vessels, sonar, aircraft over-flights, seismic surveys, oil and gas platforms, dredging, shore based activities, and other events. There is no single "source" of ambient noise; instead the sources are continually changing in their contribution to the background level. Ambient noise can change from season to season, day to day, and when anthropogenic sources are present, the noise levels can change from minute to minute.

Ambient noise is important in discussions of sounds and their effects because ambient noise is an important reference point for measuring sounds and because sounds are considered to have diminished to the point that they can no longer be detected by recording instruments when they are reduced to (attenuate to) background or ambient levels.

Because sound moves differently through air than it does through water, it is measured differently in each medium. Water is denser than air, and sound travels about 5 times faster in water than air. The higher density of water is also the reason why sound may go farther underwater than in air. Sound pressure levels (SPLs) in air and water are referenced differently due to different pressures in the two mediums. While intensity is reported in decibels, the instruments used to measure underwater noise actually sense pressure. Noise traveling through air is typically measured in decibels (dB) relative to a reference pressure of 20 micro-pascals (μPa), whereas noise traveling through water is measured in dB relative to a much lower reference pressure of 1 μPa. These reference pressures are standards adopted among acoustic researchers (Richardson *et al.* 1995). Because the reference pressures that apply to the mediums are not the same, it is inappropriate to make direct comparisons between measurements taken in air and water.

Levels of sounds (in either air or water) are measured on a logarithmic instead of a linear scale. This means, for example, that a sound measured at 80 dB is 10 times more powerful than a sound measured at 70 dB, and a sound measured at 90 dB is 100 times more powerful than the sound that was measured at 70 dB. But, at the same time, the 90 dB sound is only 10 times more powerful than the 80 dB sound.

A very important, yet frequently overlooked component of sound is the spectrum over which it occurs. While the term 145 dB re 1 μPa gives an indication of the intensity of an underwater sound, it does not indicate how that intensity is distributed across the band of potential frequencies. A frequency is the rate at which a repetitive event occurs and is measured in hertz (cycles per second). If all of the energy for a measured sound is concentrated at a single frequency then it is called a tone. Underwater industrial noises typically span a range of frequencies due to the nature of the source; an engine emits a range of frequencies because of its multiple internal components and a ship emits even more frequencies produced by engines, generators, propellers and other onboard sources. Sometimes these sounds are measured and presented relative to a broadband range of frequencies. This is common for ambient noise since there are various spectral components due to the wide range of sources. Sounds can also be analyzed to one-third octave band levels. Sound levels are often reported in one-third octave bands because it is the effective filter bandwidth (i.e. levels which can be distinguished) detectable by humans and some animals. A complete description of octave and one-third octave bands is provided in Richardson *et al.* (1995).

When attempting to interpret the meaning of any reported sound level it is critical to understand the bandwidth over which the level was measured. Sounds are sometimes discussed with reference to their spectral composition. In this case, for example, a sound may be described as having a dominant tone at 50 Hz where most of the sound energy is concentrated but there may also be prominent components of the sound between 1000 and 1200 Hz.

Underwater noise data is often measured to determine potential effects to fish, diving birds, and marine mammals. The sensitivity of organisms to underwater noise varies with frequency. The response of an animal is likely to depend on the presence and levels of sound in the range of frequencies to which it is sensitive (Richardson *et al.* 1995). Given this rationale, sounds may be measured at 95 dB re 1 μPa at a frequency of 100 Hz, but the threshold level for a sound to be audible to certain animals may be 130 dB. In that instance, the 95 dB re 1 μPa sound source at a frequency of 100 Hz would not be detectable to the animal. Similarly, a dog whistle blown at a high dB level is not detectable to humans because it is at a higher frequency than we can detect.

The following sections and figures related to underwater noise (ambient, ships and tugs, and aircraft) have been adapted from Blackwell and Greene (2002), sometimes verbatim. The section on dredging noise was adapted from Dickerson *et al.* (2001). It is uncommon for a project to have such a wealth of recent and applicable underwater noise data, so it was utilized extensively in this document. Both documents are cited and are available on the internet.

Natural Sources of Ambient Noise. Underwater noise was measured at five locations in Cook Inlet and Knik Arm in 2001 to document naturally occurring underwater sounds. Some sites selected are known to harbor beluga whales at certain times of the year (recording locations are shown as red inverted triangles in figure 8). Those locations were not in the immediate vicinity of industrial activities and are more representative of "natural" ambient sound levels in the study area.

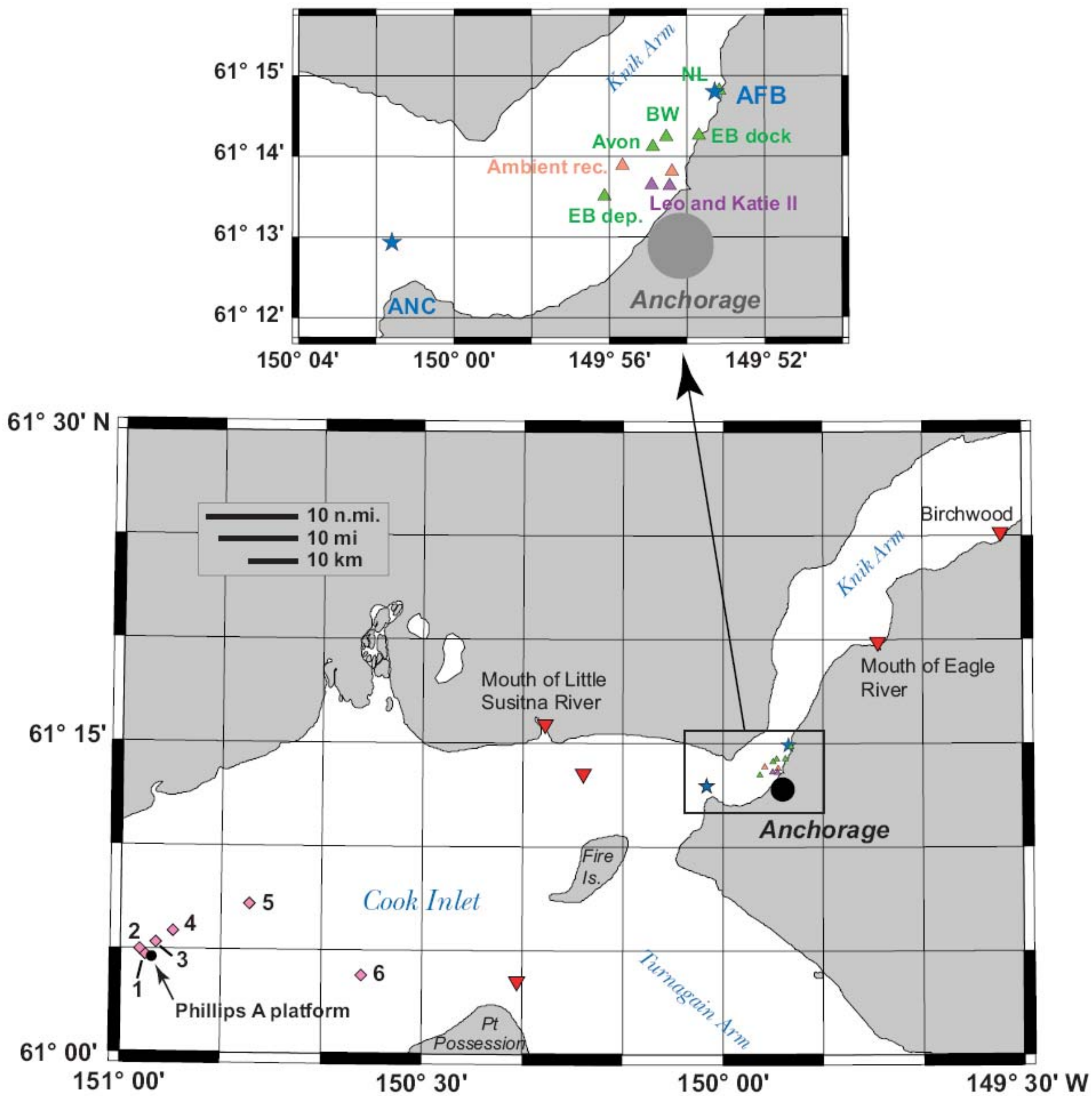

Figure 8. Map of Cook Inlet, Alaska, showing recording locations from 21-24 August 2001.

Locations marked in the figure 8 inset show where over flights were recorded seaward of Stevens (Anchorage) International Airport (ANC) and Elmendorf Air Force Base (AFB) (blue stars); recording stations 1-6 for measurement of the Phillips A platform (pink diamonds); vessels in Anchorage harbor (purple, green, and orange triangles); and ambient sound level recordings (red inverted triangles). NL = *Northern Lights*, EB = *Emerald Bulker*, BW = Boston Whaler. Locations of the Phillips A platform and the small vessel (Avon and Boston Whaler) recording sites are presented on the figure, but are not discussed in this report (Source: Blackwell and Greene, 2002).

Underwater broadband (10 - 20,000 Hz) SPLs are presented in figure 9 for the locations shown in figure 8. In addition, three ambient levels from the general area are shown for comparison. They include ambient levels at the Anchorage airport and Elmendorf AFB locations (recorded while no airplanes were landing or taking off; blue stars in figure 8), and the Anchorage harbor ambient recordings.

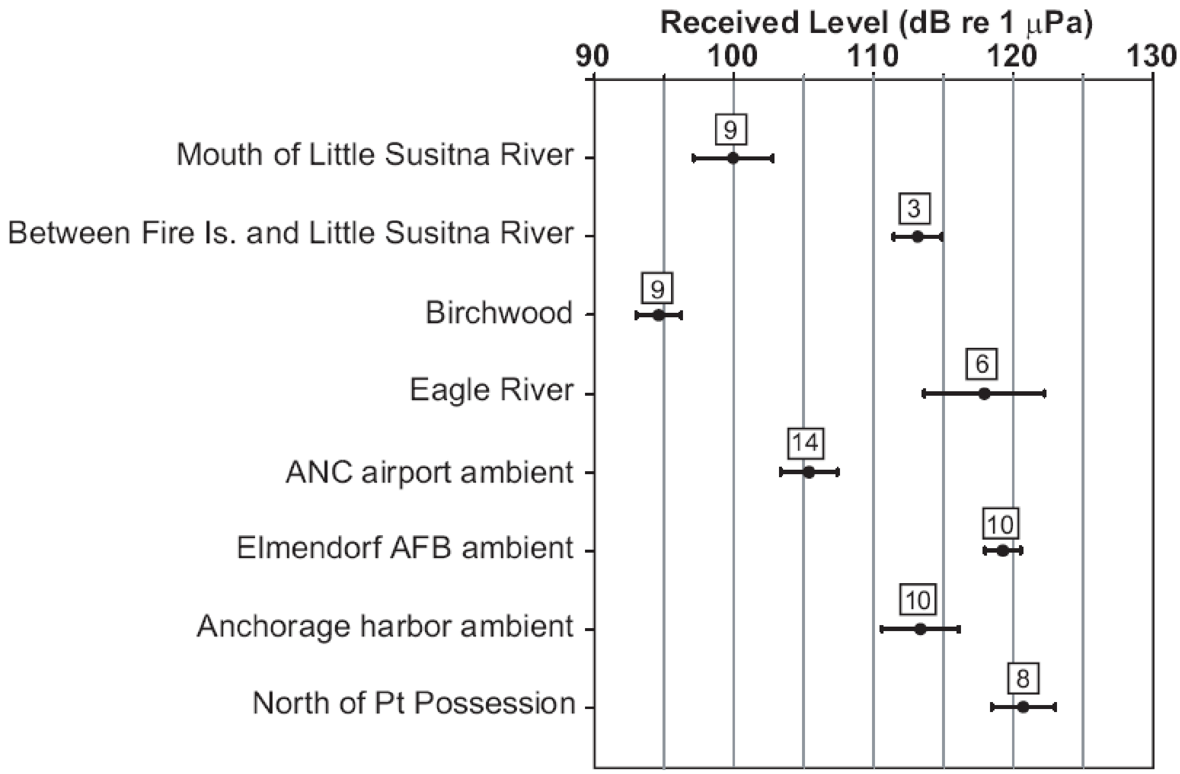

Figure 9. Broadband (10 - 20,000 Hz) levels of ambient underwater sound at eight locations in Cook Inlet and Knik Arm, with varying levels of proximity to industrial activities (see text for details). Values shown are meanş one standard deviation. The number of 8.5-second samples used for each mean is indicated above the mean. (Source: Blackwell and Greene, 2002)

The mean ambient underwater broadband levels shown in figure 9 span a fairly wide range, from 95 to 120 dB re 1 μPa. The variation within each recording, however, was generally small. The two quietest locations (Little Susitna River and Birchwood) were in areas removed from the proximity of industrial activity, but so was the loudest (N of Point Possession), where elevated broadband levels were attributed to the incoming tide. Broadband levels for the location between Fire Island and Little Susitna River were probably artificially inflated as there was a fair amount of wave slap noise on the recording vessel. It is not surprising that the recording location seaward of Stevens (Anchorage) International Airport was the quietest of the "industrial" locations, as it is somewhat removed from Anchorage itself and the harbor. The ambient POA recording was from farther off shore than the Elmendorf AFB ambient (which was also in the harbor area); this could explain the lower values.

Underwater narrowband spectra are shown in figure 10 for three contrasting locations: Birchwood, northeast of Anchorage up the Knik Arm (figure 10A, pink line), the POA area (figure 10A, black line), and the location north of Point Possession (figure 10B, green line). Birchwood was the quietest location (see figure 9) and also the only one at which beluga whale noise was heard. The whales produced a variety of whistles and noisy vocalizations, which contributed to the peaks in sound levels between 200 Hz and somewhat over 1 kHz that are shown in figure 10A The sounds heard on the Anchorage harbor recording included a variety of noises of the type that can be expected in an area with construction, boat traffic, loading and offloading of vessels. Sound levels are higher at all frequencies and include two prominent peaks at 30-40 Hz and 60 Hz. These can be linked to power generation and industrial activities in general. The location north of Point Possession had the highest broadband level of all the locations shown in figure 9 and reached 124 dB re 1 μPa. During that recording, the tide was coming in and the sounds it generated predominated in the recording and were audible by the field crew in air and underwater. The lack of prominent tones over most of the frequency range (i.e., atonality of the sound source) and “bell” shape at higher frequencies (500 - 20,000 Hz) is characteristic of this type of sound. The source of the peaks at 21, 29 and 38 Hz is not known.

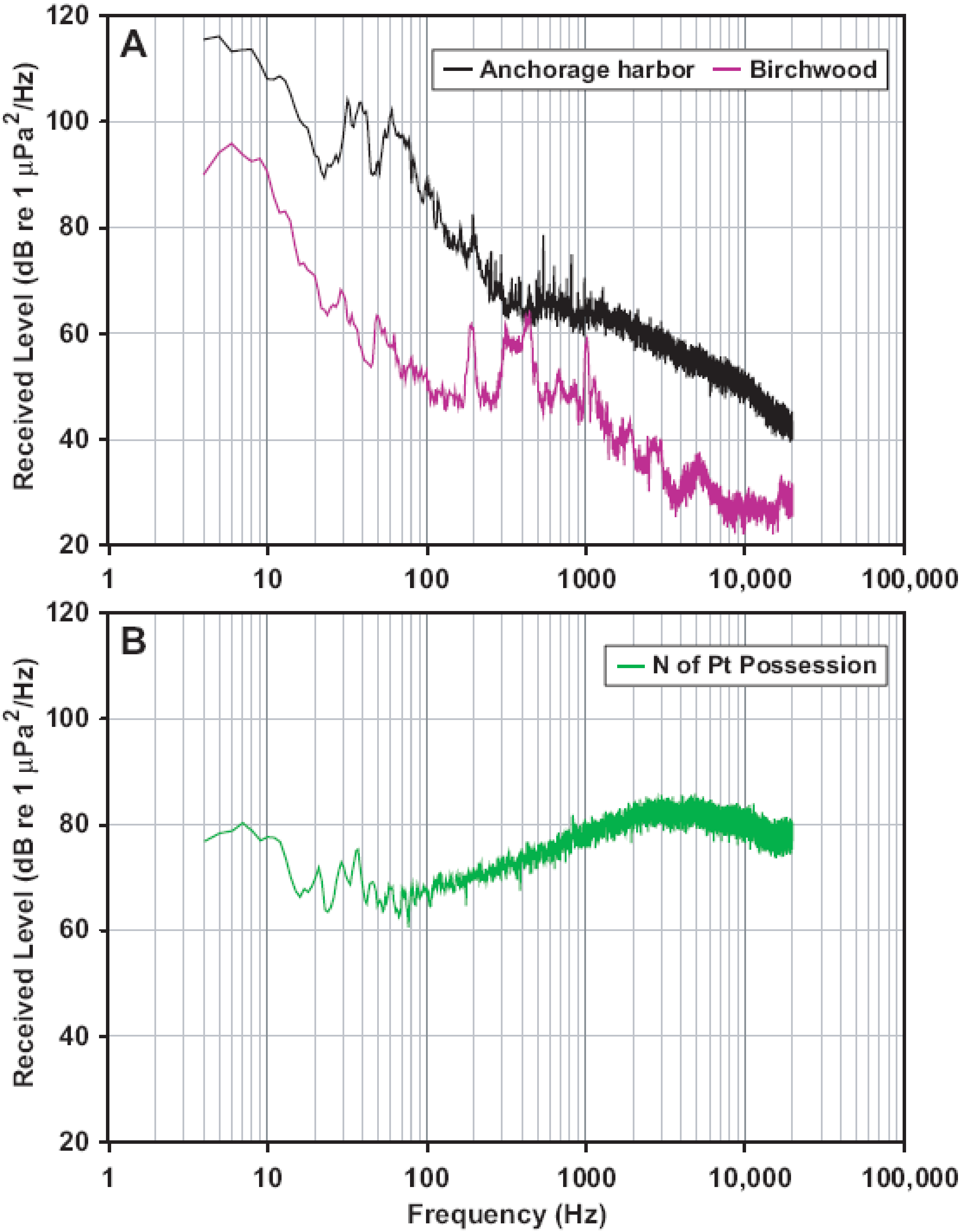

Figure 10. Narrowband underwater spectra (4 to 20,000 Hz) from typical 8.5-s samples. (*A*) Anchorage harbor (24 Aug 2001) and Birchwood (23 Aug 2001); (*B*) North of Point Possession (22 Aug). (Source: Blackwell and Greene, 2002)

A comparison of the narrowband spectra from the Birchwood and POA (see figure. 10A) shows roughly a 20 dB increase in sound pressure levels across all frequencies at the "industrial" site. In addition, there are several peaks at low frequencies (<100 Hz) and a smooth decrease with frequency above 1 kHz. This is fairly typical of most industrial noise as well as oceanic traffic, which primarily affects frequencies below 1 kHz. The recording north of Point Possession yielded some of the highest broadband levels, up to 25 dB above the quietest station (Birchwood, see figure 9). The narrowband spectrum plot (figure 10B) shows an unusual presence of higher frequencies, specifically 1 to 10 kHz. For example, the received level for the one-third octave band centered at 5 kHz was about 16 dB higher than the POA recording and 40 dB higher than the Birchwood recording. Blackwell and Greene (2002) report that this source is likely due to rolling gravel being moved by tidal action.

Industrial Sources of Underwater Noise

<u>Ships and Tugs.</u> The sounds produced by small and large vessels in Anchorage Harbor were recorded seven times on 21, 23 and 24 August 2001. Recordings were opportunistic, except for those involving the Boston Whaler and Avon inflatable boat. Recording locations are all shown on the insert of figure 8 as green and purple triangles. Recorded sound sources included:

● the cargo-freight ship *Northern Lights* while docked in the harbor during loading or unloading

● the cargo-bulk carrier *Emerald Bulker* while being held at the dock by two tugs immediately preceding its departure, and then during its departure from Anchorage harbor.

● the tug *Leo* while pushing the gravel barge *Katie II* towards a dock, and then while maneuvering and holding the barge against the dock

Broadband (10 - 20,000 Hz) underwater SPLs as a function of distance to the presumed sound source are shown in figure 8A for all the larger vessels. The highest SPL recorded was 149 dB re 1 µPa, about 100 meters from the tug *Leo* while it was holding or maneuvering the gravel barge *Katie II* against a dock.

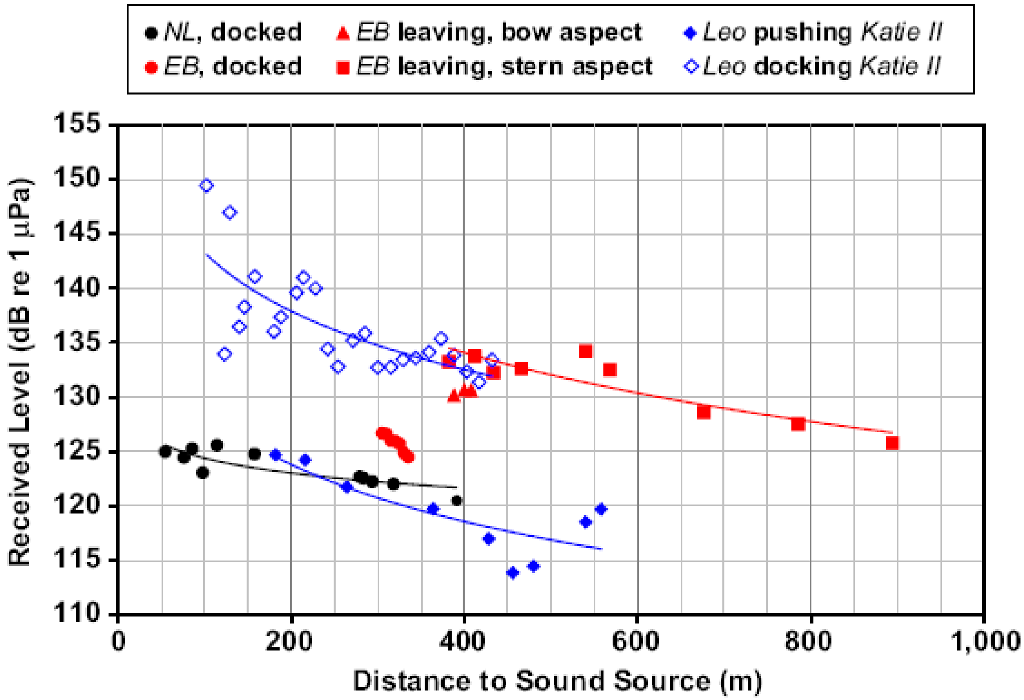

Figure 11. Broadband (10 - 20,000 Hz) underwater SPLs as a function of distance to sound source for various large vessels operating in Anchorage Harbor. *NL* = *Northern Lights*, *EB* = *Emerald Bulker*. (Source: Blackwell and Greene, 2002)

Most of the sound energy from the recording of the tug *Leo* pushing the gravel barge *Katie II* is in the band 100 - 2000 Hz. A large peak at 50 Hz was recorded and tones were detected at numerous multiples of 25 Hz up to 426 Hz. It is likely that the tug was the source of the 25-Hz tone, which could have been a blade-turning rate. The dip in received levels for frequencies below about 400 Hz, and especially below 150 Hz, is indicative of the rapid attenuation of those frequencies in very shallow water - the water depth during the recording was only about 7 meters. The levels rise for frequencies below 100 Hz as "ground waves" contribute to the received levels. The highest recorded broadband level underwater in this study was 149 dB re 1 µPa, obtained 102 m from the tug *Leo* while docking a gravel barge.

Source levels cannot be computed reliably from far-field measurements, but a large ship such as the *Emerald Bulker* will likely produce broadband source levels on the order of 180 dB re 1 µPa-m (i.e., at 1 meter) while cruising, as suggested by the data in figure 11. Source levels of that magnitude are not uncommon for large ships such as container ships, supertankers, and icebreakers (Richardson *et al.* 1995).

<u>Dredging Noise.</u> The POA is dredged for maintenance every summer and early fall. The proposed project would involve continued maintenance dredging and also would dredge an additional area as the dock face is expanded seaward. Dredging is not a new addition to the noise environment at the POA. Rather, it will continue for the foreseeable future

for maintenance and expand temporarily for a few years during the port expansion. Researchers at the U.S. Army Engineer Research and Development Center in Vicksburg, Mississippi measured underwater noise from a bucket (clamshell) dredge in Cook Inlet near the POA in September 1999 and August 2001. Their results are summarized below and are available in detail in Dickerson, Reine, and Clarke, 2001. During this study, the greatest sound levels were produced by the clamshell striking the sea bottom. These sounds ranged from approximately 95 to 122 db re 1 µPa, levels that are near ambient conditions for most up upper Cook Inlet. It should be noted that this study only measured underwater sounds associated with a dredge (i.e. bottom contact, bucket digging, bucket closing, winch up, and barge loading. Sounds produced by the tug needed to move the dump barge or the barge on which the dredge was stationed was not recorded.

Based on data provided above for tugs, it is reasonable to conclude that the tug would create the strongest sound source during the dredging operation where clamshell dredges are involved. The majority of underwater sounds produced by bucket dredging operations occur in relatively low frequency ranges, primarily 20 to 1,000 Hz.

As is typical, noise levels decreased with increasing distance from the source. Sound pressure levels diminished from 15 to 30 dB re 1 µPa at 150-m and 5,500-meter distances, respectively. In this study dredge sounds were audible at 5,500 meters, whereas at 7,000 meters, only the most intense event, that of the bucket striking the bottom, remained faintly audible.

The apparent maximum detection distance of 7 km observed in this study is much lower that reported for the Beaufort Sea and is probably influenced in large part by bottom composition and concentrations of suspended sediment. Much greater detection distances for dredge noise above ambient were reported by Greene (1987, 1985), who measured broad-band (20-1,000 Hz) noise emitted by a hydraulic cutter head-pipeline (cutter-suction transfer) dredge at ranges extending to 25 km in the Beaufort Sea. Also in the Beaufort Sea, Miles, Malme, and Richardson (1987) and Miles et al. (1986) recorded sounds produced by a bucket dredge, noting most intense sounds in the 1/3 octave at 250Hz, ranging from 150 to 162 dB re 1 µPa-m.

Unlike the Beaufort Sea, Cook Inlet waters near the POA have extremely high suspended sediment loads. High prevailing suspended sediment concentrations may have a pronounced sound-scattering effect, thereby reducing sound detection distances rapidly compared with sounds emitted from sources in clear oceanic waters. For example, Richards, Heathershaw, and Thorne (1996) reported that concentrations on the order of 20 mg/L could cause an attenuation of 3 dB over a path length of 100 meters at 100 kHz. Although sediment concentrations were not measured when the bucket dredge noise was measured in 1999 and 2000, suspended sediment concentrations were measured near POA in 2006 and 2007 (USACE, unpublished data). In September and October 2006 suspended sediment concentrations ranged from approximately 1,000 to 2,500 mg/L; concentrations that are more than ten times greater than those reported to cause an attenuation of 3 dB over a path length of 100 meters at 100 kHz. Thus, site-specific conditions should be an important consideration in evaluating dredging-related underwater noise at POA.

Miles, Malme, and Richardson (1987) and Miles et al. (1986) reported that the loudest sounds measured in their study were produced during the winching of the loaded bucket up through the water column. In contrast, the winching events recorded by Dickerson, Reine, and Clarke (2001) were relatively weak in terms of acoustic energy compared with that of the bucket striking the bottom. This variability indicates that the condition of the dredge plant greatly affects the character of the sounds produced. Poorly maintained or lubricated mechanical gear can potentially generate very intense sounds. The character of bucket dredging sounds also appears to be greatly influenced by the granulometry of the sediments being dredged; i.e., a bucket impacting coarse sands and gravels, as exemplified by the dredge *Viking* performing deepening work in coarse sand and gravel, produced very different, less intense sounds from those of the dredge *Crystal Gayle* performing maintenance work in unconsolidated mud. Miles, Malme, and Richardson (1987) and Miles et al. (1986) also noted that the noise from the tug and barge used to transfer the dredged material was stronger than that produced by the clamshell dredge.

Pipeline dredge noise was measured in the Beaufort Sea on two separate dredges and produced sounds of 135-140 dB re 1 μPa-m (20-1000 Hz) at a range of 0.5 km from the source. A hopper dredge in the same area produced approximately 150 dB re 1 μPa-m at the same frequency range and distance. In the Beaufort Sea, these broadband sounds were detectable to about 25 km, although some strong tones were likely to be detectable at greater distances. Low frequency sounds predominated in recording of pipeline and hopper dredges (Richardson *et al.* 1995). As previously stated, sound level attenuation rates are greater with increased concentrations of suspended sediment. Therefore, sounds produced from hopper and pipeline dredges would likely travel much shorter distances.

<u>Aircraft Noise.</u> Though aircraft noise is not influenced by the dredging project and the port expansion, it is presented here with the intent of providing a complete and realistic description of the sound environment at the port.

During transmission of sound from air to water, a large amount of the acoustic energy is reflected by the water surface. In the case of an overhead sound source, such as an aircraft, most (but not all) of the sound at angles greater than 13 degrees from the vertical is reflected and does not penetrate the water (the area of maximum transmission under an aircraft can therefore be visualized as a 26 degree cone with the aircraft at the apex). This is particularly true if the conditions are calm, the water is deep or the water is shallow but with a non-reflective bottom (Richardson *et al.* 1995). When waves are present, they provide suitable angles for additional transmission, but only above certain frequencies (Lubard and Hurdle 1976). Water depth and bottom conditions (i.e., whether the bottom is reflective to sound or not) also have an important influence on the propagation of aircraft sound underwater.

Broadband levels recorded underwater all fell in the range of 110 to 125 dB re 1 μPa for the commercial aircraft when measured offshore from the Stevens (Anchorage) International Airport and up to 135 dB re 1 μPa for one F-15 military jet measured offshore from Elmendorf Air Force Base during August 2001. "Ambient" broadband levels, recorded in the same locations while no over flights were taking place, were higher for Elmendorf Air Force Base (119 dB re 1 μPa) than for Anchorage International Airport (105 dB re 1 μPa).

Other Sources of Underwater Noise. In an acoustic study conducted at POA in October 2007, hydrophones were used to measure sound propagation during both impact and vibratory pile driving (Federal Register, March 2008). For impact pile-driving, the most conservative measurement showed that at 19 meters the received level was 177 dB re 1 μPa (root mean square (rms) ranging from 100–15,000 Hz. For vibratory pile-driving, the most conservative measurement showed that at 20m the received level was 162 dB ranging from 400 2,500 Hz. These measurements were used to estimate the distances at which animals might be exposed to received levels that could lead to injury or behavioral harassment. Impact pile driving produces much more energy (*i.e.*, is louder) than vibratory pile driving due to the nature of the operations. However, low frequency sound travels poorly in shallow water, so transmission of these sounds in Knik Arm is expected to be confined to relatively short ranges. Sounds generated from pile driving, dredging, and other construction activities will be detectable underwater and/or in air some distance away from the area of activity. Audible distance, or received levels (RLs) will depend on the nature of the sound source, ambient noise conditions, and the sensitivity of the receptor to the sound (Richardson *et al.*, 1995).

3.1.3 Water Quality

The waters of Knik Arm are brackish, with salinities ranging from 10 to 12 practical salinity units (PSU, equivalent to grams of dissolved solids per kilogram of seawater) at Fire Island (Gatto 1976) and 4 to 6 PSU north of Cairn Point. Water temperatures range from freezing (about 31°F) to 63°F or more (in surface pockets observed during the summer months). Measurements of suspended sediment at several locations near the river mouths tend to be similar, showing concentrations of up to 1,000 mg/L between water surface and depths of 15 feet, then increasing to more than 4,000 mg/L at greater depths (Smith et al. 2005). The average natural turbidity of Upper Cook Inlet and Knik Arm typically ranges from 400 to 600 nephelometric turbidity units (NTU's). The turbulent nature of the system mixes the water and maintains relatively high dissolved oxygen concentrations through the entire water column.

At the mouths of the streams and rivers that flow into Knik Arm, fresh water interacts with the sea water to create an identifiable zone. Since the sea water is more dense, the fresh water will float on top until it is mixed by tides and currents, creating a freshwater lens that is sometimes less turbid than the sea water. The lenses extend relatively short distances out from the river mouths and in the direction of the current and may provide important fish habitat.

The significant streams flowing into the Knik Arm near the POA include Ship Creek, Chester Creek, Campbell Creek, Fish Creek, and Little Campbell Creek. All these streams flow through urban areas and are identified as CWA Section 303(d) impaired water bodies (ADEC 2008).

Ship Creek is the closest stream to the POA. It is a nonglacial stream that originates at Ship Lake in the Chugach Mountains. Water is diverted from Ship Creek at several locations as it flows through Fort Richardson, Elmendorf AFB, and Anchorage before it discharges into Cook Inlet about a mile south of POA. Chester Creek, Campbell Creek and Little Campbell Creek pass through other highly urbanized watersheds before discharging farther south of Ship Creek.

Annual maintenance dredging and disposal activities at POA generally begin in mid May, shortly after the ice is out of the inlet, and continue into November. The sediments dredged by existing annual maintenance operations and the sediment that would be dredged from the proposed dredging footprint have been evaluated to determine the presence of contaminants (USACE 2008). Samples were collected and tested for volatile and semi-volatile organic compounds, total recoverable petroleum hydrocarbons, PCBs, pesticides, cadmium, mercury, selenium, silver, arsenic, barium, chromium, and lead. Contaminant concentrations in the samples were below screening levels (State of Washington, Department of Ecology, Sediment Management Standards Minimum Clean-up Levels-Chemical Criteria) and have been determined to be suitable for in-water discharge. Although the sediment does not contain significant contaminant concentrations, dredging and disposal activities create localized increases in suspended sediment concentrations and turbidity and slightly lower dissolved oxygen concentrations at the dredging and disposal sites.

Dredged material is transported to the disposal site by tug and barge and discharged in increments of approximately 1,500 cubic yards. Mixing zones are not necessary due to the naturally high suspended sediment load in the receiving waters and the similarity of the dredged material with the material comprising the natural sediment load. Tides and currents affect the extent and magnitude of the water quality impacts but observable impacts in the upper water column are generally limited to an area within several hundred feet downstream of the dredging or disposal activity.

3.1.4 Water Circulation Patterns and Sedimentation

The USACE dredges sediment every year to maintain the -35-foot MLLW authorized federal depth in the approach channel and in the berthing areas of POA. Dredged starts in the spring along the existing dock and then outward for approximately 1,100 feet, to a depth of -40 feet MLLW. Dredged material is disposed of approximately 3,000 feet away from the dock face, in approximately 70 feet of water. The dredged material is very cohesive and when released from the barge is deposited in a large mass at the disposal site. A large percentage reaches the bottom.

The deposited dredged material is dispersed through Knik Arm by the strong tidal currents. Contractor surveys of the area and bathymetric measurements conducted every year show material has not remained at the disposal site. The volumes of material that have been dredged from the POA since 1989 are shown in table 1 in section 2.3.1.

3.2 CULTURAL RESOURCES

This project will dredge material from the seabed and dispose the material farther off shore in deeper water. Initial data review identified a sunken anomaly that eventually was determined to be concrete connected with rebar. The Corps determined that the feature is not an historic property, and the State Historic Preservation Officer concurred (Appendix B). No other resources of potentially historic value were identified in the areas proposed for dredging or dredged material disposal.

3.3 BIOLOGICAL RESOURCES

3.3.1 Vegetation

Grasses, sedges, and other vascular plants in the estuarine POA area do not survive at elevations much below the upper tidal range. Arrow grass, silverweed, and salt grass are reported growing on upper mud beaches (Pentec 2005) along with clumps of vegetation eroded from adjacent shorelines. Macrophytes (seaweed) assemblages are sparse in the muddy intertidal zone of Knik Arm, but some types of seaweed, including green algae (*Enteromorpha linza, E. intestinalis, E. prolifera*) and rockweed (*Fucus gradneri*) are reported on hard substrates of the rockier shores of western Knik Arm within a few miles of the Port of Anchorage (Pentec 2005, Nemeth et al. 2007). Hard substrates are uncommon near the Port of Anchorage except for man-made structures and debris, and attached seaweed is rare. Nowhere in Knik Arm has living, attached seaweed been reported at depths below the intertidal zone. The highly turbid waters of Knik Arm would keep sunlight from reaching seaweed, so they could not manufacture food through photosynthesis and could not survive.

Marine phytoplankton (unattached algae) are present throughout Cook Inlet. Phytoplankton in upper Cook Inlet are primarily diatoms (Pentec 2005). Diatoms are single-cell algae that are particularly well adapted to surviving in turbid waters and other difficult environments. They are among the most adaptive of the algae's. Some are capable of surviving transition from fresh to salt water, and rivers can be a source of diatoms in estuaries. As could be expected in very turbid waters, none of the studies conducted in Knik Arm have reported substantial phytoplankton biomass. Phytoplankton would have the greatest chance of survival and reproduction near the surface, where they can absorb sunlight for photosynthesis.

3.3.2 Marine Invertebrates

Marine invertebrates include forms like polychaete worms that burrow into the bottom, snails and bottom-dwelling crustaceans that live on the top of the seafloor, and the many forms of sea life in the water column like shrimp, smaller crustaceans, and the sub-adults forms of bottom-living species. Diversity of marine invertebrates in Kink Arm is extremely limited. Pentec (2005) summarizing extensive studies between 1982 and 2004 for a Knik Arm bridge, identified fewer than a dozen species of marine invertebrates from both the bottom and the water column. The collections also were unusual because most of the same species were collected both from the bottom and from the water column.

The Pentec report suggested that severe scouring, mixing, and sediment transport may carry normally bottom-dwelling polychaete worms, mysid and crangonid shrimp, and amphipods up into the water column. Densities of these small organisms were about the same in most places sampled, which also indicates an unusual degree of mixing. The only notable stratification in the deeper waters was by one species of amphipod that was unusually abundant just beneath the surface in pockets and lenses of water with less suspended sand and silt than most Knik Arm water.

Knik Arm has often been described as a "sterile" environment, almost devoid of fish and invertebrates except for anadromous fish moving through the Arm to and from spawning habitat. The Knik Arm studies did not find as many invertebrates as might be found in central and southern Cook Inlet, but did find more invertebrate numbers than might have been expected. Collections in a net towed through two transects in deeper water near the Corps' historically used dredged material disposal site collected an average of about 250 invertebrates per tow. They were mostly small, almost clear, crustaceans. Many of the little amphipods that made up most of the collection were so small that, if given time, they could crawl through the ¼ - inch mesh of the net bag.

Kink Arm collection data suggest that in the spring, summer, and autumn periods when invertebrates were collected, the numbers of invertebrates present in Knik Arm are low for marine waters and the diversity is extremely low. There are, however, invertebrates that could be prey for birds and fish. The most promising habitat for predators that might feed on the little amphipods is in the small pockets of surface water with comparatively little sediment where sight-feeding birds and fish might be able to locate them.

While marine invertebrates are relatively limited in availability to predators, terrestrial insects are apparently relatively abundant on the surface of Kink Arm waters. Aphids, dipterans (flies, mosquitoes, midges, and associated flying insects), and other insects are predominant terrestrial insects.

Table 3. Marine Invertebrates in Knik Arm Collections

Common Name	Species Name
California Bay shrimp	Crangon franciscorum
Blacktail Bay shrimp	Crangon nigricauda
Bay Shrimp	Crangon spp.
Baltic macoma (Clam)	Macoma baltica
Gammarid amphipod	Lagunogammarus setosus
Aquatic sow bug	Saduria entomon
Mysid shrimp	Mysis litoralis
Opossum shrimp	Neomysis mercedis
Mysid shrimp	Neomysis rayii
Gammarid amphipod	Onisimus spp.
Nereid polychaete worm	Neanthes limnicola

3.3.3 Fish

Five species of Pacific salmon and two species of smelt migrate through Knik Arm to and from spawning habitat. Recent studies by Pentec (2005) reported other species that are occasionally or seasonally present, including herring larvae drifting in the water column as plankton. Table 4 lists the species identified in Knik Arm by those studies.

The USFWS Coordination Act Report for this proposed action (AppendixA) summarizes the findings of those studies. Knik Arm has long been identified as habitat for migrating anadromous fish, but only more recently have biologists shown that juvenile salmon can survive and grow in Upper Cook Inlet including Knik Arm (Moulton 1997, Pentec 2005) at rates that may not be too different from those in Prince William Sound.

Juvenile salmon were not substantially more abundant close to shore in Knik Arm, which is somewhat unusual. Pentec (2005) attributed this to the cover provided by the turbid water, which protected them from predators. The same source also noted that juveniles did not school in Knik Arm, presumably because they did not need the protection from predation or because they could not see each other well enough to maintain a cohesive school.

All the juvenile salmon reported in Knik Arm literature were collected within 10 feet of the water surface. Seasonal abundance matched well with times when juvenile salmon typically migrate out from their home streams and occupy nearby marine waters. Collections in Knik Arm and nearby waters show that pink and chum salmon juveniles, which out-migrate in their first year, are seasonally abundant, but move rapidly through the area, presumably to clearer waters farther south in Cook Inlet and eventually the Pacific Ocean. The juveniles of those species are not particularly well-adapted to feeding on surface prey and are too small too eat most of the available marine invertebrates, so they need to get to waters where food is available farther south in Cook Inlet. Chinook, sockeye, and coho salmon, however are adapted to feed on surface prey and apparently survive and grow well in the waters around Anchorage, including Knik Arm. The most common food organisms in their stomachs were terrestrial insects, particularly aphids and dipterans. They also consumed other insects, herring larvae, polychaete worms, and a variety of other invertebrates. Those juvenile salmon were collected from the time they out-migrated into Knik Arm until well into the autumn. They were reported to be well fed and growing.

Adult salmon returning to spawning streams in the Knik Arm drainage may be in Upper Cook Inlet and Knik Arm for days or weeks before entering their spawning streams. Pentec (2005) reported that adults tended to remain close to shore, often in less than 2 feet of water. They suggested this near-shore orientation was to avoid beluga whales, which prey on adult salmon.

The most common fish in Knik Arm collections were sticklebacks. Both three-spined and nine-spine were collected, but three-spined stickleacks were far more numerous. These small and extremely hardy little fish are abundant in the fresh and brackish marshes around Knik Arm and may do well in estuarine waters. They, like the juvenile salmon, were widely distributed in both near-shore and deeper waters.

Pacific herring were present both as adults in the spring and as juveniles throughout the seasons sampled. They were most abundant as small larvae, drifting as plankton with the tide and currents. They were not abundant as larger juveniles. No important habitat was identified.

Two smelt species were seasonally abundant. Eulachon return to the area to each spring to spawn in coastal beaches and longfin smelt return to spawn in the autumn. Both migrate through the general project area but the only identified important habitats are the coastal streams and nearby beaches. Bering cisco are whitefish that generally are associated with coastal waters with less than marine salinity.

Several species of marine fishes move into near-shore or estuarine waters when conditions are favorable. Among them are saffron cod, Pacific tom cod, ringtail snailfish, Pacific staghorn sculpin, starry flounder, walleye pollack, and snake prickleback that were occasionally collected in Knik Arm or nearby waters. Most were collected in relatively small numbers and were most abundant during the winter or at least were most abundant in collections after sediment loads had begun to drop in early autumn. Saffron cod was the most abundant of these fish. They were reported to be in spawning condition and well-fed.

Dolly Varden and rainbow trout can be freshwater fish or can be anadromous. Since they were not collected in any abundance, they probably were passing through Knik Arm to or from freshwater habitat.

Table 4. Fish in Knik Arm Collections

Common Name	Species Name
Pink salmon	Oncorhynchus gorbuscha
Chum salmon	Oncorhynchus keta
Coho salmon	Oncorhynchus kisutch
Chinook salmon	Oncorhynchus tshawytscha
Sockeye salmon	Oncorhynchus nerka
Rainbow trout	Oncorhynchus mykiss
Dolly Varden	Salvelinus malma
Saffron cod	Eleginus gracilis
Longfin smelt	Spirinchus thaleichthys
Threespine stickleback	Gasterostreus aculeatus
Ninespine stickleback	Pungitius pungitius
Bering cisco	Coregonus laurettae
Pacific herring	Clupea pallasii
Ringtail snailfish	Liparis rutteri
Pacific Staghorn sculpin	Leptocottus armatus
Starry flounder	Platichthys stellatus
Eulachon	Thaleichthys pacificus
Pacific Tom cod	Microgadus proximus
Walleye pollock	Theragra chalcogramma
Snake prickleback	Lumpenus sagitta
Unidentified flatfish	
Unidentified larval fish	

3.3.4 Birds

Bird habitat involved with the dredging and disposal activities is aquatic. Corps activities would be offshore in water that has suspended sediment concentrations as high as 2400 mg/L in the summer and early fall when dredging and disposal would take place.

Corps biologists surveyed the intertidal and shallow subtidal habitat from the Anchorage boat launch ramp (i.e. about 300 meters south of the mouth of Ship Creek) from one to four times per month from spring through late fall in 2006. The survey area extended from the boat ramp to approximately one-half mile south. One sector which covered approximately the lowest 300 feet of intertidal habitat and the nearest 300 feet of subtidal aquatic habitat (both distances measured horizontally) was routinely surveyed during this period, although depending on the tide level the entire sector was sometimes completely submerged or nearly completely exposed. Bird activity observed in this survey sector provides insight into the near shore bird habitat near POA. Other than a single observation of 78 Canada geese, most birds observed were mew gulls (36 total in 10 surveys), followed by Bonaparte's gulls (13 in 10 surveys), and followed by lesser numbers of herring gulls, mallards, arctic terns and a single western sandpiper. Many of the gulls counted were flying and the Canada geese and mallards were foraging on either the exposed mudflats or at the tide line.

The area that would be dredged is not intertidal so the most likely birds in the project area would be gulls that are either flying or resting. Given the water depth and high suspended sediment loads it is unlikely that ducks or geese would be found in the project area in appreciable numbers on a regular basis.

3.3.5 Marine Mammals

Seventeen species of marine mammals are reported at least occasionally in Cook Inlet, but only harbor seal (*Phoca vitulina*) and beluga whale (*Delphinapterus leucas*) are commonly observed in Upper Cook Inlet (NOAA Fisheries 2003a, Sheldon *et al.* 2003, NMML 2004).

Beluga Whale. In western U.S. waters, beluga whales comprise five distinct stocks: Beaufort Sea, Eastern Chukchi Sea, Eastern Bering Sea, Bristol Bay, and Cook Inlet (Angliss and Outlaw, 2006). Belugas in upper Cook Inlet are of the Cook Inlet stock. This population stays in Cook Inlet and is geographically separated from others (Hobbs *et al.*, 2006).

The Cook Inlet beluga's range is believed to be largely confined to Cook Inlet with a high occurrence of animals in the upper Inlet and Knik Arm during the spring, summer, and fall seasons. These whales demonstrate site fidelity to regular summer concentration areas (Seaman *et al.*, 1985), typically near river mouths and associated shallow, warm, low-salinity waters (Moore *et al.*, 2000).

Fourteen belugas were satellite-tagged in upper Cook Inlet and Knik Arm between late July and early September 2000–2002. The tags provided location and movement data through the autumn and winter and into May. During summer and autumn, belugas were concentrated in river and bays in Upper Cook Inlet, traveling back and forth between Knik Arm, Chickaloon Bay, and upper Turnagain Arm, although some also spent time offshore. When in those areas, belugas often remained in one area for many weeks followed by rapid movement to another area. Those movements often were between distinct bays or river mouths (moving either to the east or to the west of Fire Island, past Pt. Woronzof and the Port of Anchorage). One beluga tracked in 2001 moved back and forth between those three bodies of water seven times in three months. Area use in August was the most limited of all months. Approximately 50 to 75 percent of the recorded August locations were in Knik Arm and were concentrated near Eagle River. In September they continued to use Knik Arm and increased use of the Susitna delta, Turnagain Arm and Chickaloon Bay, and also extended use along the west coast of the upper Inlet to Beluga River. In October, beluga whales ranged widely down the Inlet in coastal areas, reaching Chinitna Bay and Tuxedni Bay and continued to use Knik Arm, Turnagain Arm, Chickaloon Bay, and Trading Bay (MacArthur River). November use was similar to September. In December, belugas moved offshore with locations distributed throughout the upper to mid-inlet. In January, February, and March, they used the central offshore waters moving as far south as Kalgin Island and slightly beyond. Belugas also ranged widely during February and March with excursions to Knik and Turnagain Arms, in spite of greater than 90 percent ice coverage. Average daily travel distance ranged from about 7 to 19 miles. Belugas were not tracked by satellite tags from April through mid July.

Historic data suggest the Cook Inlet beluga population once numbered around 1,300 (Calkins, 1989), but it has declined significantly. Systematic aerial surveys in 1994 counted 653 belugas and 347 belugas in 1998 (Hobbs *et al.*, 2000). Aerial surveys conducted each June/July from 1999 to 2005 produced estimates of 367, 435, 386, 313, 357, 366, and 278 belugas for each year, respectively (Rugh *et al.*, 2005, NMFS unpublished data). A NMFS 2006 stock assessment report estimated the Cook Inlet belugas population at 278 with a minimum population estimate of 238. The 2006 survey estimated the population to be 302 belugas (Rugh *et al.*, 2006). Subsistence harvest is believed to have been the major contributor to the population decline (Federal Register 2008). This stock is listed as depleted under the Marine Mammal Protection Act and was proposed for listing under the Endangered Species Act on April 20, 2007 (72 FR 19854).

Cook Inlet beluga distribution has narrowed as their population declined (Rugh *et al.*, 2000); however, there is obvious and repeated use of certain habitats. From April through November, whales concentrate at river mouths and tidal flat areas, moving in and out with the tides. The timing and location of eulachon and salmon runs affect beluga whale feeding behavior and have a strong influence on their summer movements. Beluga and prey distribution are heavily influenced by tides in Knik Arm. Monitoring data in 2006 reported approximately 70 percent of sightings at POA were around low tide.

Beluga whales are opportunistic feeders. They eat octopus, squid, crabs, shrimp, clams, mussels, snails, sandworms, and fish such as capelin, cod, herring, smelt, flounder, sole, sculpin, lamprey, lingcod, and salmon (Perez, 1990; Haley, 1986; Klinkhart, 1966). Belugas capture and swallow their prey whole, using their blunt teeth only to grab. They often feed cooperatively. Hazard (1988) hypothesized that beluga whales were more successful feeding in rivers where prey were concentrated than in bays where prey were dispersed. Concentrations of Cook Inlet belugas offshore from several important salmon streams in the upper Cook Inlet are assumed to be a feeding strategy which takes advantage of the bathymetry. The fish are funneled into the channels formed by the rivers where they are more vulnerable to the waiting belugas. At POA, belugas have been observed to position one whale along a rip-rap dock, while a second whale herded salmon along the structure toward the stationary beluga.

NMFS has estimated the relative value of four habitats as part of the management and recovery strategy in the ‘‘*Draft Conservation Plan for the Cook inlet Beluga Whale* (*Delphinapterus leucas*)’’ (Federal Register, 2008). These are sites where beluga whales are most consistently observed, where feeding behavior has been documented, and where dense numbers of whales use a relatively confined area of the Inlet. Type 1 habitat is termed ‘‘High Value/ High Sensitivity’’ and includes what NMFS believes to be the most important and sensitive areas of the Inlet for beluga whales. Type 2 is termed ‘‘High Value,’’ and includes summer feeding areas and winter habitats in waters where whales typically are in lesser densities or in deeper waters. Type 3 habitat is in the offshore areas of the mid and upper Inlet and also includes wintering habitat. Type 4 habitat describes the remaining areas of their range in Cook Inlet. The habitat that would be dredged o used for disposal at POA is considered to be Type 2 habitat. The area just north of POA is Type 1.

Beluga peak hearing sensitivity underwater is between 10 and 100 kHz (summarized in Richardson *et al.* 1995); at the most sensitive frequencies within that range their hearing threshold approaches 42 dB re 1 µPa. The bandwidth of their hearing extends to as high as 150 kHz , but above 100 kHz their sensitivity drops off rapidly (Au 1993). Below 8 kHz, the decrease in sensitivity is more gradual, approximately 11 dB per octave (Awbrey *et al.* 1988). Beluga whales are able to hear frequencies as low as 40-75 Hz (Johnson *et al.* 1989), but at those frequencies their sensitivity is quite poor (the threshold level at 40 Hz is on the order of 140 dB re 1 µPa). For comparison, humans with the keenest hearing have a bandwidth about one-eight that of beluga whales (Au 1993).

This type of information is obtained from behavioral audiograms on trained captive animals. Audiograms represent the lowest levels of sound that an animal can detect in a quiet environment, which is usually different from conditions animals are subjected to in the wild. Critical ratios express the amount (in dB) by which a pure tone signal must exceed the spectrum level background noise (in dB re 1 $\mu Pa^2/Hz$) to be audible. In belugas, critical ratios are on average below 20 dB (re 1 Hz) up to frequencies of about 3 kHz; at higher frequencies the critical ratios continue increasing exponentially, reaching 25-30 dB at 20 kHz and 40-50 dB at 100 kHz (Johnson *et al.* 1989). Depth (i.e., pressure) has no effect on beluga hearing sensitivity (Ridgway *et al.* 2001). The same study also found that threshold levels for 500 Hz were 16-21 dB lower than previously-published numbers (i.e., Awbrey *et al.* 1988, Johnson *et al.* 1989) and hypothesized that this difference may be attributable to differences in methodology (Schusterman 1974).

Harbor Seal. Harbor seals are important upper trophic marine predators that occupy a broad range in Alaska from approximately 130ºW to 172ºE (more than 2,000 miles east to west) and from 61ºN to 51ºN (more than 600 miles north to south). Harbor seals in Alaska are in three stocks: Bering Sea, Gulf of Alaska (GOA), and Southeast Alaska. While new genetic information may lead to a reassessment of this delineation. Harbor seals in upper Cook inlet belong to the GOA stock. Based on aerial GOA and Aleutian Islands surveys in 1996 and 1999, the current abundance estimate for this stock is 45,975 (CV = 0.04) with a minimum population estimate of 44,453 (Federal Register, 2008).

Harbor seals haul out on rocks, reefs, beaches, and drifting glacial ice. They feed in marine, estuaries, and occasionally fresh waters. They are generally non-migratory, with local movements associated with tides, weather, season, food availability, and reproduction; however, some long-distance movements have been recorded from tagged animals (mostly juveniles). The major haul-out sites for harbor seals are lower Cook Inlet. The identified harbor seal haul-out closest to POA is approximately 25 miles south along Chickaloon Bay in southern Turnagain Arm. They sometimes are observed around POA. In 2004–2005, 22 harbor seal sightings were reported over a 13-month period comprising of 14,000 survey hours. From these surveys, it is estimated that about 1.7 harbor seals are in Knik Arm per month (LGL unpubl. data).

Pinniped hearing is measured for air and water. In water, hearing ranges from 1–180 kHz with peak sensitivity around 32 kHz. In air, hearing capabilities are greatly reduced to 1–22 kHz with sensitivity at 12 kHz. This range is comparable to human hearing (0.02 to 20 kHz). Harbor seals have the potential to be affected by both in-air and in-water noise.

Orca Whale. Orca whales (*Orcinus orca*) in the Gulf of Alaska are divided into two ecotypes: resident and transient. Orca whales are relatively common in lower Cook Inlet (at least 100 sightings from 1975 to 2002), but in the upper Inlet, north of Kalgin Island, sightings are infrequent (11 in 25 yrs). Transient orca whales are known to feed on the Cook Inlet stock of beluga whales and all recorded predation events were in the upper Inlet. Transient orca whales in Cook Inlet belong to the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient Stock or the small AT1 Stock. Based on the 2006 NMFS stock assessment reports, the minimum population estimate for the Gulf of Alaska, Aleutian Islands, and Bering Sea transient stock of orca whales is 314 animals based on the count of individuals using photo-identification. As of 2004, the AT1 population size is 8, a 64 percent decrease from 22 whales in 1989.

Orca whale hearing is well developed. They have hearing ranges of 0.05 to 100 kHz which is lower than many other odontocetes. Peak sensitivity is around 15 kHz.

Harbor Porpoise. Harbor porpoise (*Phocoena phocoena*) are in Cook Inlet, but are rarely in Knik Arm. NMFS (2006) estimated the Gulf of Alaska stock at 41,854 with a minimum population estimate of 34,740. Estimated density of harbor porpoise in Cook Inlet is only 7.2 per 1000 square kilometers (Dahlheim *et al.* 2000). The highest monthly count recorded in upper Cook Inlet between April and October was 18 (LGL 2006).

Harbor porpoise have a wide hearing range and the highest upper-frequency limit of all odontocetes studied. They have a hearing range of 250 Hz–180 kHz with maximum sensitivity between 16 and 140 kHz.

3.3.6 Essential Fish Habitat

NMFS maintains a web site showing essential fish habitat (EFH) in Alaska. This website and 2006 EFH assessment for the Knik Arm Crossing (KABATA 2006) 2 miles north of POA were used to develop this EFH assessment for dredging and disposal.

The following three groundfish, one forage fish, and five Pacific salmon species have designated EFH near POA:

Groundfish
- Pacific cod (*Gadus macrocephalus*)
- sculpin (*Cottidae* spp.)
- walleye pollock (*Theragra chalcogram)*

Forage fish
- eulachon (*Thaleichtys pacificus*)

Pacific salmon
- Chinook salmon (*Oncorhynchus tshawytscha*)
- chum salmon (*O. keta*)
- coho salmon (*O. kisutch*)
- pink salmon (*O. gorbuscha*)
- sockeye salmon (*O. nerka*)

Information about period of occurrence and relative abundance for each of the EFH-designated species in Knik Arm is based on available published literature and data collected by KABATA in the course of their 2-year marine fish and benthic invertebrate study (KABATA 2006a). The study employed a variety of gear types (beach seine, tow net, otter trawl) to capture fishes in shoreline and mid-channel habitats of Knik Arm. A total of approximately 440 sets were made, capturing 7,200 fish during July through November 2004 and April through July 2005. No mid-channel tow net sampling was conducted in 2004, and the otter trawl was not used from July to November 2004.

3.3.7 Importance of EFH Species Stocks in Upper Cook Inlet

Most fish species with designated EFH near POA are important sport or commercial fishery species in Cook Inlet and its tributaries and are prey species for beluga whales.

3.3.8 Importance of EFH Species to Beluga Whales

Knik Arm EFH species Pacific cod, sculpin, walleye pollock, eulachon, and likely all five Pacific salmon species have been found in stomachs of Cook Inlet beluga whales. Stomach contents in April and May included Knik Arm EFH species walleye pollock, Pacific cod, eulachon, and unidentified salmon; July through September contents consisted primarily of salmon; and contents from October contained Knik Arm EFH species Pacific staghorn sculpin (*Leptocottus armatus*). Beluga also fed on other species that do not have EFH near POA. The stomach data are somewhat limited, but indicate the relative importance of fish with EFH near POA as prey species for Cook Inlet belugas.

3.3.9 EFH Species in the Study Area

Groundfish:
Pacific cod. No Pacific cod were collected in KABATA (2006a) shoreline sampling of Knik Arm during July through November 2004 or in shoreline and mid-channel sampling in April through July 2005. Pacific cod were also not caught during extensive seine and trawl surveys in Knik Arm in 1983 (FHWA 1984 and ADOT&PF), suggesting that the density of this species is very low or zero in Knik Arm.

Sculpin spp. The sculpin family (Cottidae) contains numerous species that have successfully adapted to a wide range of salinities and environments. The only cottid species collected in Knik Arm was the Pacific staghorn sculpin, suggesting that this may be the only cottid in Knik Arm.

Walleye Pollock. Only three walleye pollock were collected during a 2-year sampling effort of Knik Arm (KABATA 2006a). They were caught in beach seine sampling conducted in April through July 2005. No walleye pollock were collected during extensive trawl and beach seine sampling in 1983 (FHWA 1984 and ADOT&PF). These data indicate that density of this species is low within Knik Arm.

Forage Fish:
Eulachon. Eulachon spawn in upper Cook Inlet streams, including those of Knik Arm, in April and are present until early summer. The personal use fishery typically takes gravid adults in April and post spawning adults in May.

Pacific Salmon Species:
Juveniles and adults of five Pacific salmon species use Knik Arm. Adult salmon use the near shore environments of Knik Arm as a migratory corridor to river and stream spawning and rearing areas between May and September (KABATA 2006a). Juvenile salmon numbers peak in Knik Arm from May into August, depending on species, and are found in the near shore environment as well as in mid-channel surface waters (Moulton 1997; KABATA 2006a). Analysis of length, frequency, and timing patterns suggests that juvenile pink and chum salmon move through Knik Arm relatively quickly and do not grow much in this environment. On the other hand, Knik Arm may be important rearing habitat for the juvenile coho, chinook, and sockeye salmon emerging from streams and rivers that discharge into Knik Arm. Juveniles of these species appear to be feeding and growing actively in Knik Arm into August (FHWA 1984 and ADOT&PF; Moulton 1997; KABATA 2006a).

Coho salmon. Shoreline sampling of Knik Arm from July through November 2004 and shoreline and mid-channel sampling in April through July 2005 showed that coho juveniles were relatively abundant in Knik Arm during May through July and present into late November (KABATA 2006a). Coho salmon were the most abundant juvenile salmon captured in beach seine sampling in 2005 and the second most abundant in 2004. Adults were commonly caught in beach seines during July and August. These results are consistent with the reported Anchorage, Matanuska-Susitna freshwater runtime peak of August (present during July through September) for adult coho salmon (ADF&G 2005a). No adult coho salmon were captured in Knik Arm after August.

Chum salmon. Shoreline sampling of Knik Arm from July through November 2004 and shoreline and mid-channel sampling in April through July 2005 collected a few chum salmon juveniles April followed by significant increases in May and June. No chum salmon juveniles were collected in the 2004 and 2005 July samples. Chum salmon were fourth in abundance relative to all juvenile salmonids behind coho, chinook, and sockeye salmon. Adults were caught in beach seine samples during July. This is consistent with the reported Anchorage, Matanuska-Susitna freshwater runtime peak of July and August (present July through September) for adult chum salmon (ADF&G 2005a). No adult chum salmon were captured during August to November beach seining.

Pink salmon. No juvenile pink salmon were observed in July through November 2004 shoreline sampling of Knik Arm and few were expected because the larger even-year pink runs in this region of Alaska would produce odd-year outmigrants. In 2005, only 33 pink salmon juveniles were captured in beach seines (1.9 percent of all juvenile salmonids), most of which were captured in May. A few pink salmon juveniles were captured in April, June, and July. Adults were caught in beach seine samples during July. This pattern is consistent with the reported Anchorage, Matanuska-Susitna freshwater runtime peak of July (present during July and August) for adult pink salmon (ADF&G 2005a).No adult pink salmon were captured in August to November beach seining.

Chinook salmon. Shoreline sampling of Knik Arm July through November 2004 and shoreline and mid-channel sampling in April through July 2005 indicated highest

Chinook juvenile abundance during May and June, with a steady decline in abundance into mid- and late summer. Chinook juveniles were considerably longer in May than in June, perhaps because of the Chinook smolt releases from the Ship Creek hatchery, which occur in May. Only one adult Chinook salmon was captured during 2004 and 2005 sampling. The fish was collected in May, just before reported Anchorage and Mat-Su freshwater runtime peak of June and July (present during May through August) for adult chinook salmon (ADF&G 2005a).

Sockeye salmon. Sockeye salmon were the most abundant juvenile salmon collected during July to November beach seine sampling during 2004. During the April through July 2005 sampling period, juvenile sockeye were third in abundance among salmonids, behind coho and chinook in beach seine samples. Overall, juvenile sockeye catches were variable from May through August, highest in August, lowest in April and September through October, and zero in November. Adults were caught in beach seine samples during July. This is consistent with the reported Anchorage and Matanuska-Susitna freshwater runtime peak of July through August for adult sockeye salmon (ADF&G 2005b). No adult sockeye salmon were captured during August to November beach seine sampling.

3.3.10 Threatened and Endangered Species

Vegetation. There are no listed species of vegetation near POA.

Fish. All West Coast salmon species (and associated Evolutionary Significant Units [ESU's]) currently listed as threatened or endangered under the ESA originate in freshwater habitat in Washington, Idaho, Oregon, and California. No stocks of Pacific salmon or steelhead from freshwater habitat in Alaska are endangered species. Some listed species migrate as adults into marine waters off Alaska, but none are likely to occur in Upper Cook Inlet.

Marine Mammals. Seven species of whales listed as endangered by the NOAA Fisheries under the ESA are in Alaska waters. They are: sperm whale (*Physeter macrocephalus*); bowhead whale (*Balaena mysticetus*); humpback whale (*Megaptera novaeangliae*); northern right whale (*Eubalaena japonica*); fin whale (*Balaenoptera physalus*); sei whale (*Balaenoptera borealis*); and blue whale (*Balaenoptera musculus*) (NOAA Fisheries 2004a). Fin, sei, and humpback whales occasionally range into the lower-most sections of Cook Inlet, but are uncommon to rare in Upper Cook Inlet. The remaining four species are generally found in deeper offshore waters of the Gulf of Alaska, Bering Sea, and Beaufort Sea, and are not in Upper Cook Inlet (NOAA Fisheries 2003a). None of these species have been observed in Upper Cook Inlet.

The endangered western population of Steller sea lion (*Eumatopias jubatus*) and the proposed threatened distinct population segment of northern sea otter (*Enhydra lutris kenyoni*) range into Lower Cook Inlet, but are not known in Upper Cook Inlet (NOAA Fisheries 2003b, USFWS 2004a)

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 PHYSICAL RESOURCES

4.1.1 Air Quality

The transitional dredging activities described in the Proposed Action would add a temporary increment in air pollutant emissions which would add to emissions from port expansion construction and by on-going maintenance dredging. The table below shows the estimated maximum combined dredging equipment to be deployed over the course of the project, with 2007 representing the equipment typical needs for historical O&M dredging, and 2012 representing a return to routine maintenance dredging (USACE 2007).

Table 5. Estimated Equipment Requirements for Transitional Dredging

Equipment (assumed power)	2007	2008	2009[a]	2010	2011[a]	2012
Hopper Dredge (7000 hp total installed power)	1	1	1	1	1	1
Clamshell Dredge (1500 hp)	1	2	2-3	2	2-3	1
Dump Scows, unpowered (0 hp)	1	2	2-3	2	2-3	1
Tug or other tender (3000 hp)	1	2	2-3	2	2-3	1
Cutter – Suction Dredge (4000 hp total installed power)	0	0	1	0	1	0
Hydraulic Excavator (700 hp)	0	0	1	0	1	0
Total hp on site/season	11500	16000	21500	16000	21500	11500

hp: horsepower

[a]During 2009 and 2011, dredging requirements for removal of new material would be two clam shell dredges, or a cutter-suction dredge, or a hydraulic excavator. The combination generating the most horsepower is used in the season tally.

Federal actions in air quality non-attainment or maintenance areas that could interfere with the state's ability to maintain air quality standards in a non-attainment or maintenance area must comply with General Air Conformity regulations (40 CFR 51, Subpart W). There is an air quality maintenance area for carbon monoxide exists in the Municipality of Anchorage, but POA and the transitional dredging site is that area. The General Air Conformity regulations do not pertain to the proposed transitional dredging. "Maintenance dredging" is exempt from General Conformity requirements, per 40 CFR 51.853(c)(ix); if General Conformity were applied to the transitional dredging, it would apply only to emissions greater than from annual maintenance dredging.

Table 6 displays the results of cursory and very conservative calculations of expected emissions from transitional dredging. The assumed power output (horsepower) of the different types of equipment expected to be used has been multiplied by hours of operation and by emission factors for large diesel engines developed by the US EPA (EPA 1995). These calculations assume continuous (24 hours/day, 7 days/week) operation of all equipment over a 169-day period each year (15 May through 31 October), for a total of 4,056 operations hours per year.

Table 6. Transitional Dredging Estimated Pollutant Emissions, tons per year

	2007	2008	2009	2010	2011	2012
Horsepower on site/year	11500	16000	21500	16000	21500	11500
Carbon monoxide (CO), tons	128	178	239	178	242	128
Nitrous oxides (NOx), tons	303	419	565	422	571	303
Sulfur dioxide (SOx), tons	63	85	119	89	122	63
Particulate material (PM) total, tons	16	22	30	23	31	16
Emission Factors (EPA 1995): CO: 0.0055 lb/hp-hr NOx (controlled): 0.013 lb/hp-hr SOx (0.34% average sulfur diesel): 0.0081 lb/hp-hr * (%S) PM: 0.0007 lb/hp-hr						

For comparison, selected reported emissions (point source and non-point source) for the Municipality of Anchorage in 2001, inclusive of POA, are shown in the table below.

Table 7. 2001 Air Pollutant Emissions, Municipality of Anchorage

	CO	*NOx*	*SOx*	*PM_{10}*
Tons Emitted	80,882	8,757	673	5,506

US EPA 2005

Air emissions from dredging for POA expansion clearly an extremely small percentage of existing emissions and would not add appreciably to those emissions. Timing further reduces potential for adverse effects. The critical period for Anchorage air quality standards is during the winter when temperature inversions trap pollutants in the Anchorage bowl. Dredges would not be operating during that period.

4.1.2 Noise

Current maintenance dredging employees a clamshell dredge, tug and a barge dredging near the dock face, and a hopper dredge in the outer harbor. A hydraulic excavator or a cutter-head dredge could be used to remove the new material at the north and south end of the POA project. Either option would require two additional barges and tugs. A pipeline could be used with the cutter-head dredge. Another option for dredging new material during POA expansion would be to employ two additional clamshell dredges. Sound signatures from these noise sources were discussed earlier in this EA. The discussion that follows addresses expected sound energy and its effects from that potential use.

Combining Multiple Sound Sources. When sounds are being generated in the same general area by more than one source, either at the same levels or at different levels, it is possible to determine the total contribution of these sources to the noise environment. Because sound is measured on a logarithmic scale, it is not possible to determine the combined effect by simply adding the measured values together (i.e. 180 dB +180 dB ≠ 360 dB). Two examples are provided below showing how the total overall noise levels are derived from sounds generated at the same level, and from sounds generated at different levels.

(a) Combining Sounds Generated at the Same Level. Adding multiple sources of the same sound pressure level (SPL) uses on the following formula:

SPL_{total} = (10 * log (# of sources))+SPL of one source
For instance, 3 tugs operating at 140 dB would be calculated thusly:
SPL_{total} = (10 * log (3))+140 ≅ 145 dB re 1 μPa

If sounds at a 140 dB level were generated by two sources in the same area, the total sound level would be logarithmically calculated to be 143 dB. If the140 dB sounds were generated from five sources in the same area, the total sound level would be 147 dB. If ten sources were each generating a 140 dB sound in the same area, the total sound would be 150 dB. This means that in general, for every 10 sources in the same area generating sounds at the same level, the overall sound level increases by 10 dB. Clearly, the addition of a few extra vessels of similar sound pressure levels (e.g. tugs) that would be necessary for dredging during the POA expansion project would make very little difference in the overall underwater sound environment.

(b) Combining Sounds Generated at the Different Levels. When multiple noise sources generating sounds at different SPLs are present in the same general area, the sound with the highest dB value will essentially "mask" the sounds with lower dB values.
Since dB levels are on a logarithmic scale, it is necessary to understand the relation between the different noise sources. For instance, 160 dB can be written as 10 * log (10^16 / 1) and 140 dB is 10 * log (10^14 / 1). 10^14 is only $1/100^{th}$ of 10^16. $1/100^{th}$ = 0.01.

Adding multiple sources of the different SPLs is based on the following formula:

SPL_{total} = (10 * log (1.0 for the higher dB value + the decimal value of the lesser source))+SPL of the higher source
For instance, a 140 dB tug operating in the same area as a 160 dB tug would yield the following:

SPL_{total} = (10 * log (1.0 + .01)) + 160 dB ≅ 160.04 dB
Likewise, if there were five sources generating sounds at 140 dB in the same area as the

source generating the 160 dB sounds, the combined sound would be calculated to be 160.8 dB. One important result of this would be that the combined sounds (at 160.8 dB) would diminish to background levels in approximately the same distance from the sources as the sound with the highest level (160 dB). Therefore, it is a similar situation to adding 1 to 1,000; it makes very little difference. Clearly, the addition of a few extra dredges producing sound at 120dB would be meaningless if a tug was producing 150dB in the same area.

Cargo ships commonly produce underwater sounds on the order of 180 dB re 1 μPa-m (i.e., at 1 meter) while cruising (Richardson *et al.* 1995). While these ships would likely dominate the underwater noise environment while they enter and leave the POA, the time spent entering and leaving the port is very small relative to dredging that would take place nearly continuously for several months during the summer and fall. Again, 180 dB re 1 μPa-m is a likely source level calculated for a single ship (the *Emerald Bulker*) at the Port of Anchorage (Blackwell and Greene 2002). Source levels have to be inferred through mathematical regression since it is not possible to measure a large moving cargo ship at a distance of one meter. Using site-specific spreading loss terms calculated at the Port of Anchorage for the departure of the *Emerald Bulker* (-21 dB/tenfold increase in distance as per Blackwell and Greene 2002), the sound pressure level would decrease to approximately 160 dB re 1 μPa-m at 10 meters, 140 dB re 1 μPa-m at 100 meters, 120 dB re 1 μPa-m (i.e. at or near many local ambient noise measurements) at 1,000 meters, and 100 dB re 1 μPa-m at 10,000 meters which is at or below all but one recorded ambient noise level measured in upper Cook Inlet (a recording near Birchwood was only 94 dB re 1 μPa-m).

<u>No Action</u>. An average of 2 million cubic yards of bottom sediment would continue to be dredged annually in Anchorage Harbor. This dredging would continue to occur between May and October. Noise produced from this activity would likely continue at existing levels unless the dredging equipment changed significantly in size or the dredging method changed from clamshell dredging to another technique.

<u>Proposed Action</u>. Large-scale changes in the noise environment at the POA in the near term are unlikely given this alternative, although this may change slightly over time with potential changes in ship design and changes in the size of ships frequenting the Port of Anchorage. These potential changes may increase the level underwater noise and its spectral components at the harbor if the size of the ships and their propulsion systems increase, but future advances in ship and propulsion system design might also decrease the level underwater noise and its spectral components. Given the rapid attenuation rates in the turbid water near the Port of Anchorage and the variation in the spectral components of the noise over a variety of operating conditions, changes in underwater noise levels (i.e. source levels at ~1 meter) would probably need to change up or down at least 10 dB re 1 μPa on average to approach a meaningful level.

4.1.3 Water Quality

No Action. Maintenance dredging would continue with the same schedule and operational procedures that are used now. Water quality would remain about the same as it is now.

Annual maintenance dredging would continue to cause minor localized increases in turbidity and suspended sediment levels and minor decreases in dissolved oxygen concentrations. These effects would continue to be limited to the areas where the work has historically been performed and would continue to be or little consequence in the turbid, but well-oxygenated environment of Knik Arm.

Proposed Action. The proposed action would temporarily increase the volume of material dredged, transported and disposed of annually and expand the areas affected by dredging and disposal activities. When the port expansion and deepening projects were completed, maintenance dredging volumes would return to near historical levels, although the expanded footprint would b expected to increase maintenance dredging quantities. Larger equipment or dredging over a longer time periods could be required.

Although more material would be dredged, transported and disposed of during construction, the nature and magnitude of the water quality impacts would not change appreciably. The new material that would be dredged contains more gravel, cobbles, and boulders than is being dredged now for maintenance but the material is otherwise physically and chemically similar. The presence of the larger material would not alter water quality impacts. A temporary increase is expected in the amount of equipment operating near the port, and increased maintenance operations may extend the dredging season slightly, although ice conditions in the spring and storm activity in the Gulf of Alaska in the fall will continue to govern when equipment can operate at POA. This could result in a temporary increase in the frequency and total number of actions causing water quality impacts but the overall increase water quality effects would be minor and would end when construction was complete.

The risk of accidental spills would temporarily increase as a result of increased vessel traffic during construction. That increased risk would be relatively small and would be minimized through enforcement of standard port operational controls that maintain safe operational and navigation conditions. Compliance with established contingency plans that would limit impacts if there was an accidental spill.

4.1.4 Water Circulation Patterns and Sedimentation

No Action. If routine operation and maintenance dredging were continued as they are conducted now, water circulation and sedimentation would remain unchanged.

Proposed Action. If the maintenance dredging is increased as proposed for POA expansion, changes in sedimentation during construction would be temporary and would not affect operation of POA.

Modeling indicates that during flood tides, the POA project would produce a pattern of increasing flood current strength from south to north along the dock face. This pattern generally suggests a divergent flow environment, which may reduce sedimentation along much of the dock during incoming tides. (MARAD EA, 2005).

4.2 CULTURAL RESOURCES

Corps dredging would not affect any identified cultural resource. This determination has been coordinated with the State Historical Preservation Officer.

4.3 BIOLOGICAL RESOURCES

4.3.1 Vegetation

Dredging and disposal would be confined to areas with naturally high suspended sediment loads that is scoured and modified by tidal action. Disposed dredged material is rapidly dispersed and mixed to become a small part of the naturally heavy silt load. Vascular plants and attached seaweed do not survive in those areas, so dredging and disposal would not adversely affect those resources.

4.3.2 Marine Invertebrates

Marine invertebrates in the POA area are discussed in section 3.3.2. The principal identified concern related to those invertebrates was related to their availability at the surface where they would be available as prey to birds and small fish that may feed in less turbid water at the surface.

Marine invertebrates in or on the bottom could be entrained into a suction dredge or excavated along with bottom material in a clamshell dredge. The only relatively abundant animals living in the bottom material in the Knik Arm are polychaete worms in the shallower waters nearer to shore. There is no indication that they or any other invertebrate are present in substantial numbers in bottom material that would be dredged or in the disposal site.

Small bottom-dwelling shrimp and other small crustaceans collected in Knik Arm could be in the areas to be dredged in at least small numbers. Those bottom-dwelling invertebrates could be injured or killed by the mechanical effects of dredging or could be smothered in the disposal site. Dredging would, over the course of the project, remove the bottom material from about 750 acres of Knik Arm with potential loss of marine invertebrates living on the bottom in that area. This would affect a sparse population in a relatively small area of Knik Arm. Effects would be temporary. The dredged bottom could repopulate rapidly with shrimp and other invertebrates transported in the current if the habitat after dredging was suitable. If it was not, then the productivity of that area of bottom would be lost to Knik Arm. Suitability of the habitat for recolonization cannot be predicted.

The project would use the same disposal site as past maintenance dredging projects, but would expand that site, see figure 4. The site is described as "highly dispersive," which means that any material (or organism) on the bottom is likely to be carried back into the water column to be deposited somewhere else. The heavy silt loads in other dynamic areas of Knik Arm clearly show that the same dispersal mechanism is almost constantly redistributing bottom material throughout most of that water body. Invertebrate populations in those sites would be sparse. The disposal actions would not affect more stable bottom areas that could be more suitable habitat for bottom-dwelling invertebrates.

Dredging typically does not appreciably affect surface water characteristics, provided that dredged material and excess water is discharged deeply enough so that it will remain beneath the surface. Effects to surface water quality and invertebrates would be avoided by requiring dredging contractors to discharge beneath the surface and by monitoring to ensure additional measures were not required.

4.3.3 Fish

The principal concerns of dredging and disposal are temporary and local increases of suspended sediment over the already high ambient levels near POA, and their potential effects on juvenile salmon. Suspended solids in estuarine waters have been reported to injure juvenile salmon and could reduce their ability to sight-feed on surface and near-surface invertebrates.

Effects of turbidity and suspended solids on juvenile salmon are summarized in a comprehensive compilation by Bash et al. (2001). The impacts of high suspended solids concentrations on salmonids have been reported to include mortality, reduced survival, reduced growth, reduced feeding, stress, disease, avoidance, displacement, change in body color, alerted behavior, and reduced tolerance to salt water (Loyd 1987 in Bash et al. 2001). Potential severity of effects is related to: (1) duration of exposure, (2) frequency of exposure, (3) toxicity, (4) temperature, (5) life stage of fish, (6) angularity of particles, (7) size of particles, (8) type of particles, (9) severity and magnitude of pulse, (10) natural background turbidity, (11) time of occurrence, (12) other stressors and general condition of biota, and (13) availability of and access to areas with less suspended material.

Much of the research on juvenile salmonids and turbidity was done in laboratory settings. Applicability to field situations has not been thoroughly verified. Other research applies to headwaters and systems that are normally clear except for seasonal and infrequent sediment. Turbidity values reported by some research may not be a consistent and reliable tool for determining the effects of suspended solids on salmonids. Bash et al. concluded that, "salmonids encounter naturally turbid conditions in estuaries and glacial streams," but that this does not necessarily mean that salmonids in general can tolerate increases of suspended sediments over time. Relatively low levels of anthropogenic turbidity may adversely affect salmonid populations that are not naturally exposed to relatively high levels of natural turbidity (Gregory 1992 in Bash et al. 2001). Bash et al. also noted that managers are interested in learning whether there is something inherent in "natural" turbidity sources that make them somehow less harmful to fish than are anthropomorphic sources of turbidity because it is apparent that salmonids are able to cope with some level of turbidity at certain life stages. Evidence of their ability to cope is illustrated by the presence of juvenile salmonids in turbid estuaries and local streams with high natural levels of glacial silt (Gregory and Northcote 1993 in Bash et al. 2001).

Feeding efficiency of juvenile salmonids has been shown to be impaired by turbidities in excess of 70 NTU (Bisson and Bilby, 1982), well below typical and persistent levels in Knik Arm (Pentec, 2005a). Section 3.3.3 discussed reports that juvenile salmon and saffron cod may feed and grow in surface water microhabitats in Knik Arm where short periods (minutes) of relative quiescence in the generally turbulent water allow partial clearing.

Section 3.3.2 presented information indicating that dredging would have little effect on surface and near-surface invertebrates. Dredging would have equally little effect on any fish sight-feeding on those invertebrates. Collection data indicate that juvenile salmon are largely or entirely in the upper 10 feet of water in Knik Arm, so mechanical effects of dredging and turbidity produced by dredging at project depths also would be unlikely to A surface, peak tidal currents might be able to lift some of the material to the surface where it could increase near-surface local turbidity for short periods. This could affect ability of juvenile fish to feed at or near the surface in small areas when dredged material was being dumped. Near-surface turbidity will be monitored during dredging for the proposed action to see if it is affected by disposal activity. Effects on fish near-surface habitat use will be determined or dredging and disposal methodology will be modified to avoid effects if near-surface turbidity is higher.

Adult salmon in the project areas of Knik Arm could be subjected to higher suspended solids concentrations from dredging and dispersion of disposed material. Pentec (2005a) and other sources indicate that returning adults tend to run in shallow water, probably to reduce predation by beluga whales. This shallow water orientation would tend to keep them away from dredging and dredged material disposal, which would be largely in deeper water.

There is no indication that noise and turbidity, both natural and from dredging at POA, are affecting salmon migration. Salmon regularly return to Ship Creek, which terminates adjacent to POA, and to other area streams. This lack of apparent effect could be expected because near-shore and upper water column natural suspended material concentrations are comparable to those being dredged and at disposal sites. The apparent lack of effect at POA is consistent with the literature, which indicates a similar lack of effect in other areas where salmon migrate near dredging and other activity.

4.3.4 Birds

The proposed action would cause no more than minor impacts to birds and bird habitat. Dredging would be in and near areas that are dredged each summer and autumn. Those areas are not critical or important bird habitat and are used only sparsely by birds. Small numbers of gulls and waterfowl would be temporarily displaced by tug, barge, and ship traffic associated with dredging, but this area is not nesting habitat and there is no indication that is it especially important to any species of bird.

4.3.5 Marine Mammals

Beluga Whale. There are no consistent observed threshold levels at which belugas, and marine mammals in general, respond to introduced sound. Beluga responses to sound stimuli are reported to be highly dependent upon their behavioral state and their motivation to remain in or leave an area. Few field studies involving industrial sounds have been conducted on beluga whales. Reactions of belugas in those studies varied. In Awbrey and Stewart (1983) (as summarized in Southall et al., 2007), recordings of noise from SEDCO 708 drilling platform (non-pulse) were projected underwater at a source level of 163 dB rms. Beluga whales less than 1.5 km from the source usually reacted to onset of the noise by swimming away (RLs approximately 115.4 dB rms). In two instances groups of whales that were at least 3.5 km from the noise source when playback started continued to approach (RLs approximately 109.8 dB rms). One group approached to within 300 m (RLs approximately 125.8 dB rms) before all or part turned back. The other group submerged and passed within 15m of the projector (RL approximately 145.3 dB).

Man-made sounds can mask whale calls or other sounds potentially relevant to whale vital functions. Masking occurs when the background noise is elevated to a level which reduces an animal's ability to detect relevant sounds. Belugas have been known to increase their levels of vocalization as a function of background noise by increasing call repetition and shifting to higher frequencies (Lesage *et al.*, 1999; Scheifele *et al.*, 2005). Low tonal frequencies of construction noise and the ability of belugas to adapt vocally to increased background noise would tend to minimize masking potential interruption of behaviors such as feeding and communication.

Many marine mammals, including beluga whales, perform vital functions (e.g., feeding, resting, traveling, socializing) on a diel (i.e., 24 hr) cycle. Repeated or sustained disruption of these functions 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 from the proposed construction activities will become habituated and tolerant after initial exposure to these sounds, as demonstrated by beluga vessel tolerance (Richardson *et al.*, 1995, Blackwell and Green, 2002).

Although POA is a highly industrialized area supporting a large volume of ship traffic, belugas are present almost year round. Belugas evidently have become habituated to POA operations and annual dredging activities. Belugas are routinely sighted near dredges used each summer for maintenance at POA. Belugas also demonstrate tolerance to ship traffic around POA, as documented in numerous surveys conducted by LGL in that area.

Belugas are and will continue to be exposed to greater than background noise levels from dredging; however background sound levels in Knik Arm are already higher than most other marine and estuarine systems due to strong currents and eddies, recreational vessel traffic, and commercial shipping traffic entering and leaving POA. During clamshell (bucket) dredging, the strongest sounds are actually produced by the tugs that dump the barges of dredged material and reposition the clam shell dredges. Hopper and pipeline dredges also produce sound levels similar to tugs and large ship traffic that routinely operate near the POA.

Noise from dredging would coincide with noise from pile driving. Given the principles of additive noise and combined sound sources of different sound pressure levels in the same area presented earlier in the EA, the combination of dredging noise and pile driving would not be substantially greater than the sounds of pile driving alone. Belugas would not likely alter their behavior in a way that prevents them from entering and/or transiting throughout Knik Arm. Belugas are currently known to associate with vessels emitting loud low-frequency sounds around the Port.

Harbor Seal, Orca Whale, and Harbor Porpoise. Given the low density of these marine mammals in upper Cook Inlet and near the Port of Anchorage, impacts from dredging noise or a combination of noise from dredging, shipping, and pile driving are unlikely. The infrequent occurrence coupled with the issues addressed above on belugas and likely mitigation for pile driving decreases the likelihood of negative effects to marine mammals from underwater noise at the Port of Anchorage.

4.3.6 Essential Fish Habitat

Reintroduction of sediments into the Knik Arm water column during dredging and disposal is not expected to adversely impact essential fish habitat (EFH). Knik Arm is a highly turbid ecosystem with high and variable suspended sediment concentrations and mobile soft-bottom sediments that are shifted consistently by extreme tidal forces. Pacific salmon and other EFH species that might be in the area have adapted to high suspended sediment levels and would likely avoid the immediate area near the discharge without suffering adverse impacts. It is unlikely that noise generated from additional dredging and disposal for port expansion would impact EFH. The additional equipment would not substantially increase the overall underwater sound environment at POA.

4.3.7 Threatened and Endangered Species

The proposed action would not affect endangered or threatened species.

5.0 Cumulative Effects, Irreversible & Irretrievable Commitment of Resources

5.1 CUMULATIVE EFFECTS

The 2005 MARAD environmental assessment (EA) for POA expansion considered cumulative impacts of port expansion. This Corps of Engineers EA for dredging to support the MARAD project relies on the earlier MARAD analysis and decision. Corps dredging to expand and maintain POA is the only major on-going dredging and disposal action in Knik Arm or anywhere in upper Cook Inlet. The only other past or reasonably foreseeable future dredging is related to the following:

1) Construction and maintenance of Point McKenzie port facilities. This comparatively small port is in a high-energy environment that has not required substantial dredging for construction or maintenance. Point McKenzie facilities may be expanded in the future, but plans for activities that would substantially increase dredging or suspended material in Knik Arm are not advanced enough to be useful for predicting future impacts.

2) Knik Arm Bridge. This major Knik Arm project would not be likely to require substantial dredging. It could, however, influence tidal currents and movement of bottom material. Potential for effects depend upon project design, which is still being studied. In a less turbid system, sediment loads might be increased substantially over background levels until the system reached some kind of equilibrium. In Knik Arm, where huge volumes of sediment are constantly suspended, distributed, deposited, and resuspended, potential effects of a bridge on suspended solids appear to be less than significant.

3) New construction or dredging near POA. Minor expansion and maintenance by other agencies and individuals have included dredging for moorage, construction, and utilities placement. Those actions have been, and would likely continue to be, much smaller in scale and effect than the regular maintenance dredging at POA. Additive effects would be comparatively minor.

5.2 INCOMPLETE AND UNAVAILABLE INFORMATION

The CEQ guidelines requre that:

"When an agency is evaluating reasonably foreseeable significant adverse effects on the human environement in an environmental impact statement and there is incomplete or unavailable information, the agency shall always make clear that such information is lacking (40 CFR 1502.22)."

Scoping for this EA identified conserns specifically related to dredging effects. Those concerns focused on potential effects of dredging and dredged material disposal on birds, fish, and mammals that occupy and depend upon habitat at and near POA. Adequacy of data for those resources is as follows:

Birds: Data are adequate to determine that bird useage in areas directly affected by the proposed action is realtively sparse and that the project would not affect important habitat. The only possible exception is the remining question about feeding microhabiat at the surface. See discussion of "fish" below.

Marine mammals: Data are adequate to show that beluga whales are the only species likely to be regularly present and to determine that they regularly are near POA regardless of port loading and traffic activities.   Data also are adequate to show that dredging noise does not and would not add substantially to existing background levels. Noise generated by dredging is known, although attenuation rates are uncertain in the very turbid conditions at POA. Mitigation measures to limit dredging noise when belugas are near would further lessen any uncertainty about potential effects on belugas.

Marine invertebrates: Data regarding invertebrates in Knik Arm are not extensive, but are sufficient to show that populations are limited in diversity and numbers, are broadly distributed in the water, and are not abundant as infauna seaward of the intertidal zone. Dredging affects, and would continue to affect, relatively small areas of benthic (near-bottom) habitat and would have little effect on turbidity or marine invertebrates near the surface.

Fish: Data in the literaure are not conclusive in some respects, but clearly show that salmon and sticklebacks are the primary species present during dredging operations and strongly indicate that the two predominate salmon species juveniles (coho and sockeye) are feeding sucessfully at the surface. Available information indicates that this habitat is not substantially affected by dredging or discharge. Data are considered adequate for a qualified decision, but would be confirmed by additional water quality data collection if the project proceeds.

6.0 PUBLIC INVOLVEMENT

The MARAD scoping process for the Port Expansion project was extensive and the Corps accepted these issues and concerns and expounded upon them where this action was relevant. In addition, the Corps held an agency meeting on 14 March, 2008 to review the dredging operations and gather additional comments or concerns from agencies.

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APPENDIX A

U.S. FISH AND WILDLIFE SERVICE COORDINATION ACT REPORT

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Anchorage Fish & Wildlife Field Office
605 West 4th Avenue, Room G-61
Anchorage, Alaska 99501-2249

IN REPLY REFER TO

AFWFO

April 25, 2008

Colonel Kevin J. Wilson
District Engineer, Alaska District
U. S. Army Corps of Engineers
Post Office Box 6898
Anchorage, Alaska 99506-6898

Re: Final Anchorage Dredging CAR

Dear Colonel Wilson:

Attached is the U.S Fish and Wildlife Service's Final Fish and Wildlife Coordination Act Report (AFWFO-CAR-08-01) for the Corps of Engineers, Alaska District Port of Anchorage Dredging and Disposal Operations, Anchorage, Alaska dated April 2008.

If you have any questions regarding this report, please contact project biologist Phil Brna at 271-2440, or by email at phil_brna@fws.gov.

Sincerely,

Ann G. Rappoport
Field Supervisor

cc: G. McConnell, CE
L. Rabbe, CE

attachment

Final
Fish and Wildlife Coordination Act Report
(AFWFO-CAR-08-01)

Corps of Engineers, Alaska District
Port of Anchorage
Dredging and Disposal Operations
Anchorage, Alaska

Prepared by: Philip J. Brna, Fish and Wildlife Biologist
Approved by: Ann G. Rappoport, Field Supervisor

April 2008

U. S. Fish and Wildlife Service, Alaska Region
Anchorage Fish and Wildlife Field Office
605 W. 4th Avenue, Room G-61
Anchorage, Alaska 99501
(907) 271-2888

This is the U. S. Fish and Wildlife Service's (Service) Fish and Wildlife Coordination Act Report on the U. S. Army Corps of Engineers (Corps) proposed dredging and disposal operations at the Port of Anchorage, Alaska. The purpose of this report is to provide the Corps with planning information regarding fish and wildlife trust resources likely to be affected by the project; define potentially significant impacts that could result from meeting project purposes and objectives; and highlight potential measures to mitigate impacts to fish and wildlife and their habitats.

PROPOSED PROJECT

The Port of Anchorage proposes to construct an expanded facility in five 1-year phases between 2007 and 2012. Phasing is necessary to maintain commercial operations at the Port during the construction period.

The 2005 Energy and Water Development Appropriations Act directs the Corps to provide maintenance dredging to a depth of -35 feet MLLW to maintain commercial shipping operations at the new dock areas as they become available during construction. Under this requirement, new material would be removed at the north end of the new facility in 2009, and at the south end of the facility in 2011. During other construction years routine maintenance dredging would continue, although the footprint would change to incorporate these new areas, and to eliminate traditional dredging areas that lie under the new construction. The Corps will accomplish dredging by use of a clam shell dredge and a suction/hopper dredge.

The Corps will deepen the harbor once the port construction phase is completed. During 2012 the harbor will be deepened to its final project depth, currently anticipated to be -45 feet MLLW. This work will occur primarily within the current dredge prism area (in front of the new port construction identified as the north and south replacement areas, and about half of the north replacement area). The area that would be deepened is shown on Figure 1 as the blue cross hatched area.

Post construction maintenance dredging will be located in the areas shown in Figure 1. The profile shows that the harbor will be maintained to a varying depth ranging from -25 feet MLLW at the north end to -45 feet MLLW in the central area. The annual maintenance quantity is expected to be between 2.0 and 2.5 million cubic yards, up from the current quantity of 1.5 to 2.0 million cubic yards. This increase is expected due to a larger footprint, and changed hydraulic conditions in the post construction project area.

As a result of the changed hydraulic conditions created by the port construction activities, the Corps anticipates that additional sedimentation will occur resulting in higher dredging and disposal quantities than have been historically dredged. The Corps estimate of total annual dredging requirements in millions of cubic yards by year is: 2008- 2.0; 2009- 5.6; 2010- 3.8; 2011- 5.7; 2012- 2.4; 2013- 2.2; 2014- 2.1; and 2015- 2.1 (McConnell 2008).

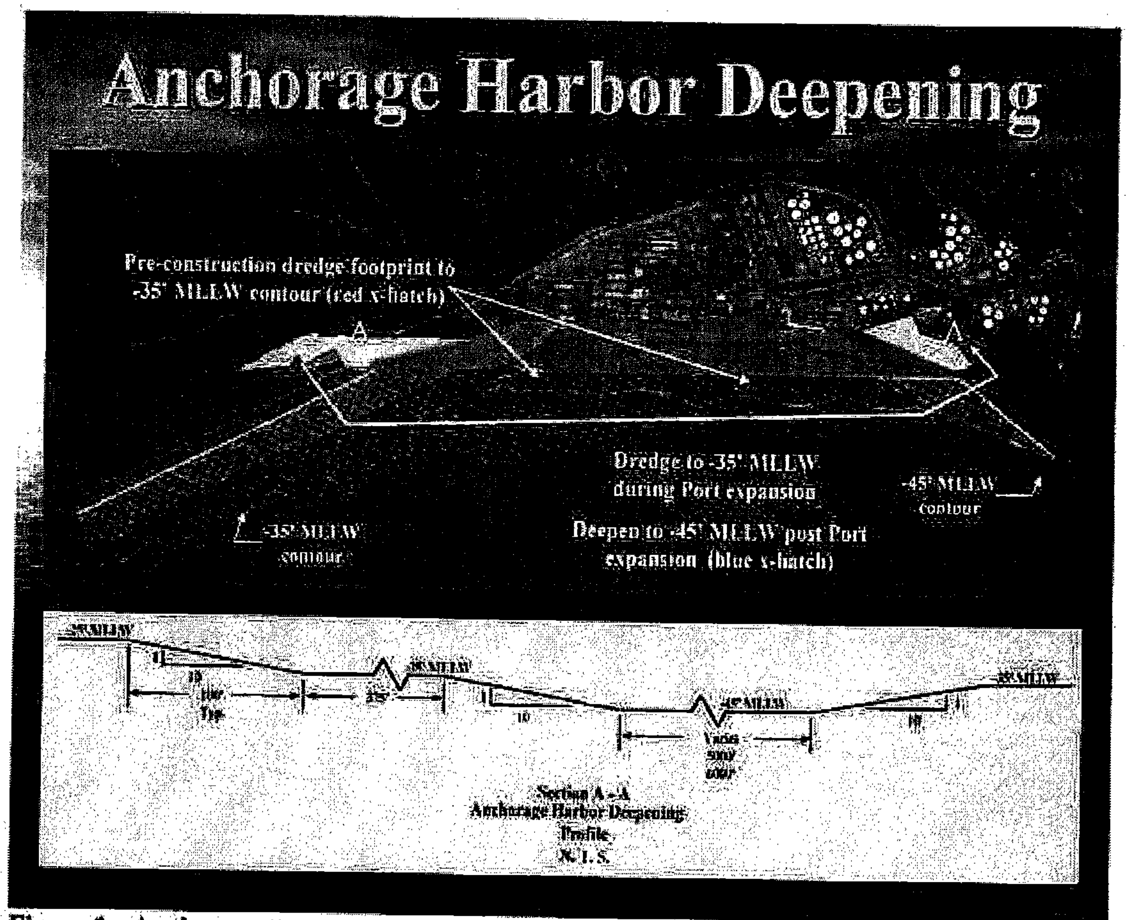

Figure 1: Anchorage Harbor deepening and dredging areas (source: Corps of Engineers).

The Corps is also proposing to expand the existing dredged material disposal site as shown in Figure 2. According to information provided by the Corps (U.S. Army Corps of Engineers 2008), the dredged material is free of contaminants and is suitable for open water disposal using criteria from the Puget Sound Dredging Disposal Analysis Program (U.S. Army Corps of Engineers 2005). Background suspended sediment of the inlet is high, particularly in summer. Measurements taken over the last year (2007) show summer highs of nearly 2500 mg/l and winter lows of roughly 150 mg/l. The tidal volume of Knik Arm north of Point Woronzof is about 2,340,000,000,000 liters. That water volume carries with it about 4,000,000 metric tons of suspended sediment (1700 mg/l). At the existing dock the contractor has dredged up to 15,000 cubic yards a week or one-half of a percent of the suspended sediment associated with the tidal volume (Peterson 2008a). The dredged material is similar to the material historically removed by annual maintenance dredging. The existing disposal site has been shown to be a dispersive site. The expanded disposal area is deeper than the current disposal site, and with the additional depth and rapid dispersion, the Corps does not anticipate any capacity problems (McConnell 2008). Since 1980, the Corps has disposed of more than 18 million cubic yards of dredged material. If the site was not dispersive there would be a change in bathymetry which has not occurred. The Corps calculates that if the site was not dispersive, the entire existing disposal site would have a mound of silt with an average height of 30 feet (Peterson 2008b).

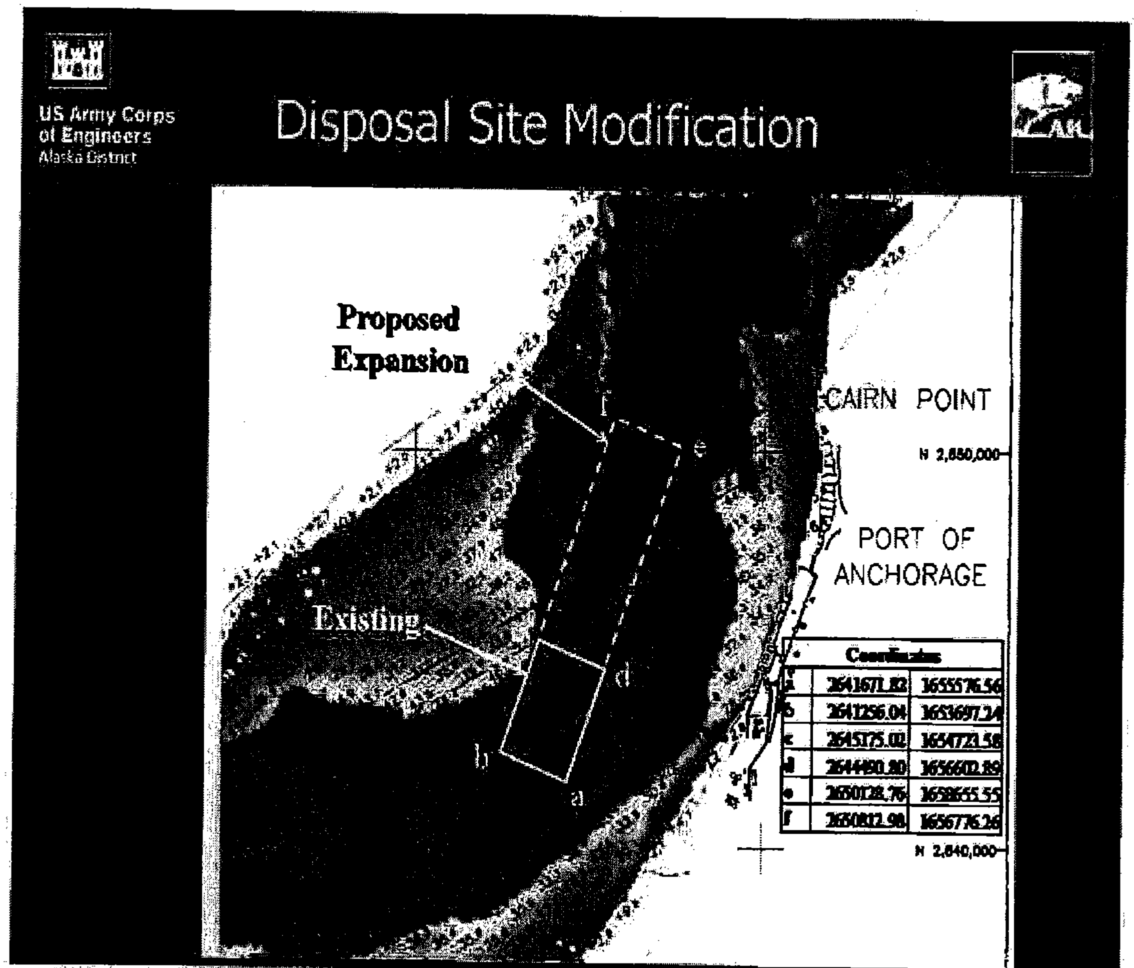

Figure 2. Existing Knik Arm disposal site and proposed expansion area (source: Corps of Engineers).

USFWS TRUST BIOLOGICAL RESOURCES

Service trust resources include migratory birds, species listed under the Endangered Species Act, some species of marine mammals, wetlands, Service lands, and inter-jurisdictional fishes.[1] Interjurisdictional fish are populations that are managed by two or more states, nations or Native American tribal governments because of their geographic distribution or migratory patterns. Anadromous fish (e.g. salmon, steelhead, eulachon, some Dolly Varden, whitefish) in Alaska are interjurisdictional fish and are therefore trust resources of the Service. Non-anadromous species of fish are not considered to be

[1] Interjurisdictional fish are the only trust resource discussed in this report. Other trust resources are either not present or are not of concern in relation to the proposed project.

interjurisdictional fish and are therefore not Service trust species. However, these fish are all important parts of a healthy ecosystem.

Eighteen streams which are known to support anadromous fish are direct tributaries of Knik Arm (Johnson and Weiss 2007). Fish from other streams which enter Upper Cook Inlet, such as the Susitna and Little Susitna Rivers, may also be present in Knik Arm. The number of salmon using Knik Arm on an annual basis is unknown, but conservatively, thousands or tens of thousands of adult salmon migrate through the Arm on their way to natal streams; and millions of juvenile fish migrate through Knik Arm from natal streams to marine waters. Salmon in Upper Cook Inlet support personal use, recreational, and commercial fisheries and these fish also provide a critical component of a productive ecosystem. There is little information available about populations or distribution of anadromous fish other than salmon. Knik Arm supports chinook, coho, sockeye, pink and chum salmon and less than 15 other species of fish (Moulton 1997; Houghton et al. 2005a; Houghton et al 2005b). Salmon are the primary anadromous species of concern to agencies and the public in Upper Cook Inlet.

Until recently, a commonly-held belief, although based on little or no data, was that both adult and juvenile anadromous fish (salmon) quickly migrated through the turbid waters of Knik Arm and that it had little habitat value for these fish (Wheeler 1996). The high turbidity of northern Cook Inlet marine waters limits light penetration and retards marine productivity (Moulton 1997). Larrance et al. (1977) found that lower Cook Inlet marine productivity decreased in a northerly direction. Moulton (1997) was the first to indicate that upper Cook Inlet (south of Knik Arm) was used as more than just a migratory corridor by salmon and other fish. He found that: pink and chum salmon were more abundant than chinook, coho, and sockeye salmon; that juvenile salmon were mostly found in the top 2 meters of the water column; that pink and chum salmon resided in the study area for several months; and that all species fed extensively on drift insects; and that growth was comparable to other regions of Alaska where the water was not glacially occluded.

At the request of Federal and State resource agencies, studies were conducted to provide baseline fisheries information to support environmental evaluations for the Port of Anchorage expansion, the Knik Arm Crossing and the Chuitna Coal Project. Based on the limited data now available, it appears that fish species diversity and abundance are surprisingly high for what has been perceived as a harsh environment. Further, it appears that low salinity Knik Arm provides valuable habitat for juvenile salmon during the early portion of their marine residence as they make the transition from fresh to salt water.

While there is still relatively little detailed information about anadromous fish use of habitat in Knik Arm, indications are that the Arm is used by adult salmon throughout the summer months as they migrate to natal streams. Adult salmon exhibited an "extreme orientation to shallow nearshore areas (where they may gain some refuge from beluga whale predation (Houghton et al. 2005b)."

Juvenile salmon are present in Knik Arm at least through all ice free months (from April through November, when sampling was conducted) and abundance appears to be highest from May through August. Juvenile chinook and coho salmon appear to feed and reside in the Arm for several months before moving down Cook Inlet, whereas juvenile pink and chum salmon appear to move out of Knik Arm relatively rapidly; but they appear to spend much of June and July in Upper Cook Inlet between the Forelands and Fire Island (Moulton 1997). Juvenile chinook, chum, and coho salmon were the most abundant fish species present in the intertidal areas near the Port of Anchorage and Port Mackenzie. Juvenile salmon abundance along the studied shorelines surpasses abundance of threespine stickleback, which overall, was the most abundant fish species observed in Knik Arm. Juvenile chinook were present in low numbers in April, peaked in May and declined sharply in July. Coho and to a lesser degree sockeye juveniles, had the largest and longest presence in the Arm, compared to other juvenile salmon species. Juvenile coho salmon were the most abundant salmonid in April, increased to a peak in August before declining. However, juvenile coho were caught through November when ice conditions made sampling too difficult. Sockeye were observed beginning in April, were most abundant from June through August and then declined in September and October (Houghton et al. 2005a; Houghton et al. 2005b).

A comparison (Table 1) of Port of Anchorage tow netting and beach seine data and the KABATA beach seine data by the Service suggests a strong intertidal or nearshore preference by juvenile chinook and coho salmon. Juvenile chum and sockeye salmon appear to use both intertidal and off-shore habitats in Knik Arm, while juvenile pink salmon are primarily found in off-shore habitat (Houghton et al. 2005a; Houghton et al. 2005b).

	CPUE Intertidal / Nearshore Habitat		**CPUE Off-shore Habitat**	
Species	**POA 2004/2005 Beach Seines**	**KABATA 2005 120-foot Beach Seines**	**POA 2005 Tow Net Transects**	**KABATA 2005 Tow Net Transects**
Juvenile Chinook	0.84	1.3	0	0.2
Juvenile Chum	0.33	1.0	0	2.5
Juvenile Coho	1.86	1.6	0.1	0.3
Juvenile Pink	0.06	0.2	0	1.3
Juvenile Sockeye	0.42	1.1	0	2.4

Table 1: CPUE data comparison, juvenile salmon- beach seines versus tow nets, 2004-2005, POA and KABATA fish reports (Houghton et al. 2005a; Houghton et al. 2005b.)

Use of acoustic monitoring showed that fish densities were higher along the shoreline of Knik Arm than in the open water in the center of Knik Arm. The contrast between the June/July period (when fish density estimates were highest in the developed areas) to the August/September/October period (when estimates were highest in undeveloped areas) may be the result of a change in fish community. Fish species composition appeared to change from mostly juvenile salmon in the early summer to one that was mostly adult salmon, smelt, and stickleback. Fish densities in Knik Arm decreased steadily over the course of the season. Compared to the Susitna Flats surveys, conducted at the same time, fish densities in Knik Arm were lower and contained higher proportions of threespine stickleback and starry flounder, while having fewer eulachon. Densities were also higher along the shoreline of Knik Arm than in the open water, in the center of Knik Arm. (Nemeth et al. 2007).

The primary intertidal habitat types within Knik Arm are mud and sand flats. Along the east shoreline (to the north of the POA), the beaches above high tide line consist of gravel and cobble mixes with some bands of sand and extensive deposits of silt and clay. In the intertidal zone, the substrate consists of large boulders and gravel scattered at the upper edge, patches of soft or hard clay in the middle intertidal zones, and large boulders, gravel and sand in the lower intertidal zone. On the western shore of Knik Arm (north of Point MacKenzie), the substrate composition is similar to that of the eastern shore. The upper intertidal zone is a mix of sand and gravel with occasional large boulders, the middle zone is mostly clay, and the lower zone is a mix of coarse gravel and cobble, with a cobble shelf extending a considerable distance offshore. Subtidal zones in Knik Arm consist primarily of flat, silty/sandy bottoms with some cobbles and boulders in the steeper sections. The extreme tidal oscillations usually scour the deeper portion of the channel, preventing sediment from accumulating (Funk et al. 2005a). Intertidal vegetation on both the west and east shorelines is scarce, but include patches of green algae, *Enteromorpha linza, E. intestinalis, E. prolifera* and rockweed (*Fucus gardneri*) attached to cobbles and occasionally to clay or gravels (Houghton et al. 2005a; Nemeth et al. 2007).

Extreme tides and large volumes of water exchanged daily and resulting currents in the area, along with seasonal icing, turbidity, high sediment loads, beach instability and abrasion by sediments, generally result in low primary productivity in Knik Arm (Backus et al. 1979; Houghton et al. 2005a; Houghton et al. 2005b; Nemeth et al. 2007). Houghton et al. (2005b) found that Knik Arm supported low to moderate densities of invertebrates and zooplankton, some of which provide potential prey for fish (and birds). The majority of invertebrates found were of generally larger sizes than can be consumed by smaller juvenile salmon. Larval herring were the most common zooplankton in Knik Arm. These were common in the diet of juvenile salmon in northern Cook Inlet (Moulton 1997), but were not common in the diets of juvenile salmon in Knik Arm (Houghton et al. 2005b).

Limited analysis of juvenile salmon diets has been conducted in Knik Arm. Terrestrial insects dominated the diets of both juvenile chinook and chum salmon. The most revealing measure of overall significance in the diet combines the percent biomass with the percent of the total number of prey items, relative to the frequency of each prey item in the diet. This Index of Relative Importance (IRI) suggests that aphids are the most important prey item for juvenile chinook salmon, followed by the Nereid polychaete *Neanthes limincola*, and mayflies (order Ephemoptera). Chum salmon diet IRIs were dominated by aphids, flies and midges; polychaetes had a low IRI (Houghton et al. 2005b). Houghton (2005b) speculates that the extreme turbidity and poor visibility in Knik Arm severely limit the success of visual feeding by fish in all but a small portion of the total habitat present. Based on observations, it appears that visual feeding may be possible in microhabitats within the surface waters of the Arm when short periods of quiescence in the generally turbulent water allow partial surface clearing and feeding by fish.

POTENTIAL EFFECTS ON TRUST RESOURCES

The potential mechanisms by which dredging could adversely affect fish using Knik Arm are discussed below. At this time, the Service believes that the proposed project will have no measurable adverse effect on salmon even though both adult and juvenile fish are present during dredging. However, this is based on project information provided by the Corps and the limited biological data available from Knik Arm. Given the importance of Knik Arm to the aquatic species and residents of this area, we remain concerned about the incomplete information available which limits our ability to assess direct, indirect, and cumulative effects of this project.

In their literature search of dredging effects, Nightingale and Simenstad (2001) conclude that "the direct biologic effects of both maintenance and new project dredging activities include entrainment mortalities, behavioral effects, contaminant release, and noise effects that can induce behavioral change or cause injury and fitness risks. However, with the exception of contaminant exposure, these effects tend to be temporary and localized. The literature reflects that fish gill injury from exposure to high suspended sediment loads is likely the principle mechanism of injury. The most relevant issue is likely the ability of fish to avoid plumes and dredge activity areas. This requires an understanding of the nature of fish present and the options available to them in order to avoid the dredge areas."

Entrainment- Nightingale and Simenstad (2001) report that some species of anadromous fish are susceptible to dredge entrainment. They also report that there appears to be a consensus amongst scientists that in the case of salmonids, juvenile migration would be more vulnerable to disruption than adult migration due to dredging related disturbance. We do not believe that the dredging methods proposed in Knik Arm are likely to result in entrainment mortalities of salmon. Adult salmon are highly mobile, strong swimmers and they move rapidly though Knik Arm to natal streams. They should be able to avoid entrainment. Available data indicate that juvenile salmon are found at or near the water surface in Knik Arm and either of the proposed methods of dredging occur at depths where juvenile salmon are not thought to be present.

Water Quality- Suspended sediments and related turbidity released into the water column by dredging or other activities can affect fish and other organisms in various ways. The effects include interference with breathing, feeding and predator-prey relationships (Nightingale and Simenstad 2001). Suspended sediments result in various responses from aquatic organisms, primarily because many attributes of the physical environment are affected. For example, increased light attenuation caused by turbidity reduces visibility and shortens the depth of the photic zone (Moore 1978; Wilber and Clark 2001). The principal potential near-field injury is to fish gills when fish are present in waters with high suspended sediment concentrations. This is also common to juvenile salmon migrating in naturally turbid estuaries (Servizi 1988). Experiments have revealed obvious evidence of stress in fish at sustained levels of suspended concentrations (>500 mg l^{-1}), but what is unknown is the actual extent and duration of exposure in the natural environment.

Knik Arm has high natural suspended sediment and turbidity levels. As dredging plumes may differ in scope, timing, duration, and intensity from natural conditions, it is important to assess the risks to fish by a variety of criteria. Criteria for risk assessment include: 1) predicting plume spatial and temporal dynamics, 2) identifying thresholds of tolerance for particular species at different life-history stages, and 3) predicting the probability of populations encountering dredge plumes that exceed their tolerance levels (Nightingale and Simenstad 2001). The Service has no information related to physical characteristics of dredging plumes in Knik Arm, and the physiological response of salmon to the natural conditions in Knik Arm has not been studied. However, it is likely that juvenile salmon are more susceptible to adverse effects of water with naturally high levels of suspended sediments and turbidity than are adult fish. Nightingale and Simenstad (2001) summarize studies on the effects of human generated and natural turbidity on salmon in fresh and marine waters but none of these studies have been conducted in areas with the naturally high sediment levels found in Knik Arm.

It is unknown what behavioral mechanisms are triggered as various fish species encounter patches of increased turbidity, such as dredging plumes, in naturally turbid waters to which they are accustomed. It is unknown what threshold of turbidity might exist that serves as a cue to fish to avoid light reducing turbidity. Simenstad (1990) describes the behavioral effects that would impact migrating fishes, such as reduced foraging success, increased risk of predation, and migration delay to be highly dependent upon duration of exposure. The primary determinant of risk level is likely to lie in the spatial and temporal overlap between the area of elevated turbidity, the degree of turbidity elevation, the occurrence of fish, and the options available to the fish relative to carrying out the critical function of their present life-history stage. For example, dredging operations in the center of a channel concentrated at depth will likely have an insignificant effect on migrating juveniles compared to operations with plumes running from bank to bank or for long distances along the shoreline (Nightingale and Simenstad 2001). Based on the limited sampling data available, it does not appear that the five species of juvenile salmon are evenly distributed in Knik Arm. The best available information is that all species (except pink salmon) show a preference for shallow littoral areas and not the deeper waters where dredge material disposal and elevated turbidity levels will occur. Juvenile salmon in Knik Arm may differ in their ability to avoid potential injury related to adverse conditions. Smaller fish like juvenile pink and chum salmon may simply be carried where tides and currents take them, and larger juveniles like chinook, coho and sockeye salmon may be able to move away from potential injury, especially during periods of slack tides.

Contaminants- Contaminated sediments are normally of particular concern due to the risk of contaminant transport and exposure posed to aquatic organisms and humans through bioaccumulation and biomagnification in the marine food web. Based on information provided by the Corps, dredged material from Knik Arm is free of contaminants (U.S. Army Corps of Engineers 2008). Therefore, contaminant effects of dredging on salmon in Knik Arm is not of concern to the Service at this time.

Noise- Fish detect and respond to sound utilizing its cues to hunt for prey, avoid predators and for social interaction. It has been documented that noise can influence fish behavior; however, most literature deals with the effects of underwater blasting or pile driving and there is little information on the effects of other noise on fish (Nightingale and Simenstad 2001). There is concern that the presence of human-generated sounds in the aquatic environment could impact aquatic mammals, diving birds, fishes, amphibians, reptiles, and perhaps even invertebrates. Despite the concerns raised by increased human-generated sound in the aquatic environment, little is known about the effects of exposure to such sounds on marine mammals, and far less is known about the effects on fish. Even in cases where data are available, it is difficult to extrapolate between species, even for identical stimuli. Moreover, it is difficult to extrapolate results between stimuli because the characteristics of the sources (e.g., air guns, sonar, ship noise, pile driving) differ significantly from one another (Hastings and Popper 2005) and the particular characteristics of an area also influence how noise effects animals. Suspended sediment in the water does not affect sound propagation (thus attenuation). Factors that do affect sound propagation are the composition of the bottom (i.e., rock versus mud), water depth, and possibly the presence of current (S. Blackwell, Greeneridge Sciences Inc. personal communication, November 2005). Blackwell and Greene (2003) made recordings of background noise levels in Cook Inlet in 2001, in areas with and without industrial noise. Additionally, noise information was gathered at Port MacKenzie during pile driving in 2004 (Blackwell 2005). There is no information available about noise generated from dredging activities in Knik Arm and no information available about dredging related noise effects on fish. Therefore, the Service cannot provide any comments on the potential noise effects from dredging in Knik Arm on fish.

RECOMMENDATIONS

Much of the available literature on dredging effects on anadromous fish may not be applicable to the current proposal because of potentially unique natural conditions in Knik Arm, including extreme tidal fluctuations, high suspended sediment and turbidity levels and low primary productivity. Measures to assist in avoiding, minimizing, or compensating for impacts to our trust resources are difficult to recommend due to lack of data regarding anadromous fish use of Knik Arm and dredging related effects on those fish. We considered recommending that dredging be completely avoided between May 15 and August 15, the period of peak juvenile salmon abundance in Knik Arm, which is consistent with the permit that the Corps issued for the Port of Anchorage expansion project[2]. However, existing data on the effects of dredge operations on anadromous fish is insufficient to support a similar timing restriction. Therefore, our recommendations are

[2] The relevant portion of the special condition from the Corps permit for the port expansion is "The Port of Anchorage shall either avoid pile driving activities between 15 May and 15 August of conduct an on-site fish study to analyze the impacts of vibratory and impact hammer sheet pile driving activities on salmonids at various distances and measured sound pressure levels. Based on the results of the study, this condition may be modified and/or supplemented to minimize adverse impacts to salmonids (including timing restrictions."

focused on conducting additional research which may provide direction in the future. The Service offers the following recommendations.

1. The Corps of Engineers should support and fund additional fish studies in Knik Arm to provide better information concerning seasonal fish distribution and abundance and association of fish with particular habitat types and locations. With larger sample sizes and more advanced knowledge of fish species and targets, use of acoustics is a promising way to address the issue of fish distribution in any future studies.

2. The Corps of Engineers should support and fund studies on noise generated by dredging and disposal operations. These studies should commence with dredging planned for summer 2008. If dredging noise is found to significantly exceed background levels, than studies which evaluate the effects on fish should be initiated.

3. The Corps of Engineers should monitor the sediment plume resulting from dredge material disposal and in conjunction with fish studies, attempt to determine the behavioral response of anadromous fish.

4. The Service is concerned about the cumulative effects of development projects in Knik Arm and upper Cook Inlet, and the loss or alteration of intertidal and nearshore salmon habitat. While the loss or alteration of important habitat is not a direct effect of the proposed dredging project, the extensive nature and number of currently proposed projects in combination have the potential to result in significant and irreversible effects on anadromous fish (and other species). The Corps dredging project is related to other proposed and planned developments such as the Port of Anchorage expansion, Port MacKenzie, the Knik Arm Crossing, and the Knik Arm Ferry. We recommend that the Corps, through both its Regulatory and Civil Works programs, take the lead and work with other agencies, local governments and the public to begin a comprehensive planning effort in Upper Cook Inlet / Knik Arm to identify high value fish and wildlife habitat, potential alternatives, and opportunities that avoid and minimize likely impacts from future developments.

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APPENDIX B

SHPO CONCURRENCE LETTER

STATE OF ALASKA

SARAH PALIN, GOVERNOR

DEPARTMENT OF NATURAL RESOURCES

DIVISION OF PARKS AND OUTDOOR RECREATION

OFFICE OF HISTORY AND ARCHAEOLOGY

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March 25, 2008

File No.: 3130-1R COE/Environmental

SUBJECT: Dredging of harbor, Port of Anchorage, Anchorage, Alaska

Guy R. McConnell
Chief, Environmental Resources Section
U. S. Army Corps of Engineers, Alaska District
P. O. Box 6898
Anchorage, AK 99506-0898

Dear Mr. McConnell:

The State Historic Preservation Office has reviewed your correspondence (received 3/14/2008) regarding the referenced project under Section 106 of the National Historic Preservation Act. Based on your consultation with Dave McMahan, State Archaeologist, it appears that the unidentified concrete object within the dredge area is not likely to be eligible for the National Register of Historic Places. Even if it is a World War II era pillbox, it is out of its original context and no longer retains historic integrity. We concur with your finding therefore that no historic properties are affected by this project.

Please contact Stefanie Ludwig at 269-8720 if you have any questions or if we can be of further assistance.

Sincerely,

Judith E. Bittner
State Historic Preservation Officer

JEB:sll

APPENDIX C

CLEAN WATER ACT
40 CFR Part 230
SECTION 404(b)(1) EVALUATION

EVALUATION UNDER SECTION 404(b)(1)
OF THE CLEAN WATER ACT
FOR
ANCHORAGE HARBOR DREDGING & DISPOSAL
ANCHORAGE, ALASKA

I. PROPOSED PROJECT DESCRIPTION

The U.S. Army Corps of Engineers, Alaska District proposes to dispose of sediment dredged in association with the Anchorage Harbor Deepening project in Anchorage, Alaska. This disposal is being evaluated under Section 404 of the Clean Water Act of 1977 (33 CFR 1344) also referenced as Federal Water Pollution Control Act. Although this evaluation under the 404(b)(1) Guidelines addresses only the proposed dredged material disposal, some background information is also provided with regard to the dredging work.

Dredging Profile, Dimensions and Quantities. The proposed design for dredging the Port of Anchorage to accommodate the POA expansion project would be to dredge the port to a depth of -25 ft MLLW on the north end, -45 ft MLLW in the center, and -35 ft MLLW on the south end (Figure 1). The area and quantity by depth proposed for dredging is summarized in Table 1. The lower half of Figure 1 is a cross section of the proposed dredging profile. The cross hatched areas of the upper half of Figure 1 are the areas that would be dredged to the depths in Table 1.

Table 1. Depth and footprint proposed for construction dredging to support the new dredging footprints required as a result of the POA expansion project.

Depth (MLLW)	Dredge Footprint (ft^2)	Dredge Footprint (acres)
-25	956,000	22
-35	2,701,000	62
-45	10,301,000	236

Table 2 is the estimated dredging schedule and quantities of dredging anticipated during the construction of the expanded harbor facilities. The quantities in tables 1 and 2 are the estimated quantities from the construction phase and the incipient maintenance phase that would be discharged into the disposal area from 2008 through 2015. Project details are contained in the Environmental Assessment titled Anchorage Harbor Dredging and Disposal to which this evaluation is appended.

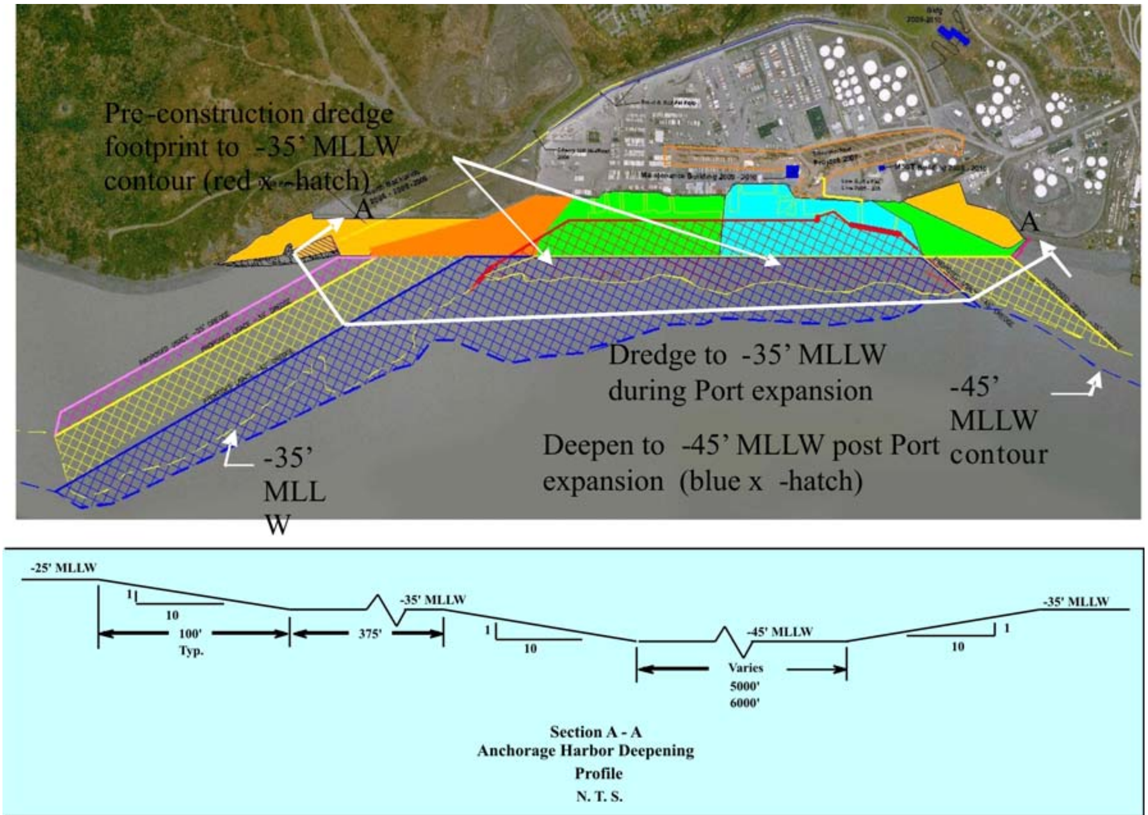

Figure 1. The Anchorage Port Expansion project area (solid blocks), the present and proposed future dredge footprints (hatched blocks), and cross section profile of Corps of Engineers new dredging depths.

Table 2. Quantities (yd^3) of sediment by category estimated to be dredged during the Anchorage Port Expansion project for the years 2008-2015.

Year	Current Maintenance Footprint	Virgin	Future Maintenance Footprint	Total
2008	2,000,000	0	0	2,000,000
2009	3,000,000	1,463,000	1,131,000	5,594,000
2010	1,500,000	0	2,284,000	3,784,000
2011	1,500,000	553,000	3,633,000	5686000
2012	0	0	2,377,000	2,377,000
2013	0	0	2,250,000	2,250,000
2014	0	0	2,150,000	2,150,000
2015	0	0	2,100,000	2,100,000
Totals	8,000,000	2,016,000	15,925,000	25,941,000

The method of dredging is expected to be both clamshell dredging near the docks and hydraulic suction dredging for areas further from the dock that require maintenance dredging of soft, accumulated sediments. Sediment dredged by clamshell would be loaded into a barge, possibly a split-hull barge and transported to the disposal area with a tug boat. Clamshell dredging results in lower turbidity and higher containment of sediments during the dredging process compared to cutter head dredging that re-suspends sediment during the dredging process and results in a substantial overflow of carrier water if loading onto a barge or other transport vessels.

Disposal. Disposal of sediment dredged during construction dredging of the harbor would be in the existing Upper Cook Inlet disposal site that has been used for maintenance dredging over the past 40 years (NOAA chart 16665, Figure 2). Although finer sediments rapidly dissipate on strong tidal currents, heavier sediments composed of gravel and cobble, and small boulders from dredging virgin sediment might stay longer on the disposal site. The Corps is proposing to enlarge the existing 138 acre disposal site by 275 acres to a new total acreage of approximately 413 acres to accommodate that probability. The existing disposal site is permitted under state id number AK0103-08AA. Figure 2 is the existing disposal site and its proposed expansion.

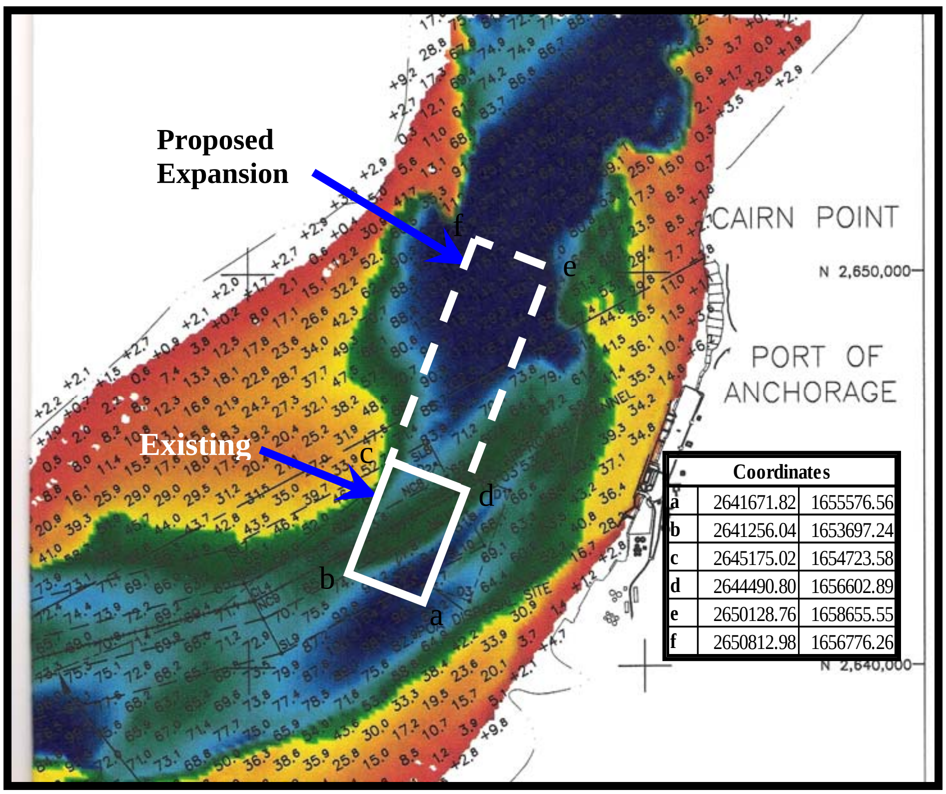

Figure 2. The existing Port of Anchorage disposal area and its proposed area of expansion, Upper Cook Inlet, Alaska.

It should be noted that the following analysis is in regard to the disposal site as it is the action that is regulated and follows the format of 40 CFR Part 230 - Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material.

II. SUBPART B—COMPLIANCE WITH THE GUIDELINES

<u>Sec 230.10 Restrictions on discharge</u>.

(a) Alternatives Test:

1. Based on the discussions in subparts D & E, there are no available, practicable alternatives having less adverse impact on the aquatic ecosystem and without other significant adverse environmental consequences that do not involve discharges into "waters of the U.S." or at other locations within these waters.

The Corps has conducted maintenance dredging at the Port of Anchorage for approximately 40 years and has always used this general disposal site as it is the most cost effective and efficient way to quickly dispose of these large quantities of materials from the port. The materials are not suitable for upland or beneficial uses and would be extremely costly to dewater and dispose of in an upland site. The request to enlarge the disposal site simply reduces risk that increased dredging quantities will still disperse in the small disposal site we currently use.

2. Based on subpart E, the proposed disposal site is not located within a special aquatic site.

(b) Special Restrictions.

1. The proposed discharge would not violate state water quality standards**.**

The proposed project would not be expected to have a long-term adverse effect on water quality or recreation. The proposed disposal action is not expected to introduce substantial petroleum hydrocarbons, radioactive materials, residues, or other pollutants into wetlands and other waters of the United States. The proposed dredge area was tested in 2006 and no contaminations were found. The material was deemed suitable for deep water disposal (USACE, 2007). The sediments associated with this project are suitable for in water disposal and are natural sediments that would be taken from one place in Upper Cook Inlet and transported to another. There would be no net loss or gain of sediments in Upper Cook Inlet as a result of this disposal action, and background turbidity levels are high by nature in the Upper Cook Inlet.

2. The proposed discharge would not violate toxic effluent standards [under Section 307] of the Clean Water Act**.**

The proposed project is not expected to increase levels of contaminants to the aquatic ecosystem of Upper Cook Inlet. The proposed dredge site was tested in 2006 and was found to have no contamination (USACE, 2007). Best management practices on the vessels are also taken to prevent spills and contaminant release into the environment from equipment associated with the disposal action.

3. The proposed discharge would not jeopardize endangered or threatened species or their critical habitat**.**

The proposed disposal action would be conducted within the range of the Cook Inlet beluga whale. This population has experienced a rapid decline in recent years and is a candidate for listing as threatened or endangered (NOAA 2007). This disposal action could have minor and temporary avoidance effects on belugas of the Cook Inlet population, but is not expected to result in harmful noise levels or be a deterrent to their recovery. If belugas are seen within X radius of the vessel, operations will cease until they have passed by.

Steller's eider, a threatened sea duck that winters in Lower Cook Inlet is not expected to be in vicinity of the disposal operation. Steller's eiders are present in Lower Cook Inlet from about November through March annually. This disposal action is not expected to have any effect on Steller's eiders.

This determination has been coordinated with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, agencies responsible for management of protected species.

4. The proposed discharge would not violate standards set by the Department of Commerce to protect marine sanctuaries, as there are no marine sanctuaries in the project area.

(c) Other restrictions:

1. The discharge would not contribute to significant degradation of "waters of the U.S." through adverse impacts to human health or welfare, through pollution of municipal water supplies, fish, shellfish, wildlife and/or special aquatic sites**.**

There are no municipal water supplies in the area that could be negatively affected by the proposed project. This disposal action would result in taking sediment suitable for in water disposal from one place in Upper Cook Inlet and placing it in another. There would be no net loss or gain of sediment in Upper Cook Inlet. Although there would initially be increases in sediment and turbidity, no substantial impacts are expected to occur to plankton, fish, shellfish, and/or wildlife. Tidal action and currents are extreme, which would make the disposed material dissipate quickly, and natural background levels of turbidity are high. There are no special aquatic sites within the proposed disposal site

2. The discharge would not contribute to significant degradation of "waters of the U.S." through adverse impacts to life stages of aquatic life and/or wildlife**.**

The disposal would not substantially impact various life stages of aquatic life and/or wildlife. For further discussion see Subparts C and D below.

3. The discharge would not contribute to significant degradation of "waters of the U.S." through adverse impacts to diversity, productivity, and stability of the aquatic life and other wildlife or its habitats, nor to the loss of the capacity of wetlands to assimilate nutrients, purify water or reduce wave energy.

The disposal of these materials would occur in deep waters that are very dispersive. The actual discharge would take place approximately 10 foot below the water surface from the hull of a hopper dredge, so surface feeders aren't affected (as commented on page 4, may need to verify discharge would definitely take place 10 feet below the water surface) . The disposal has no impact on wetlands ability to assimilate nutrients, purify water or reduce wave energy.

4. The discharge would not contribute to significant degradation of "waters of the U.S." through adverse impacts to recreational, aesthetic, and/or economic values.

Conversely, if dredging does not continue to accommodate the Port's needs, recreational and economic values will be impacted, as both commercial and recreational vessels will have delays and/or the inability to dock at the port.

(d) Actions to minimize potential adverse impacts [mitigation].
All appropriate and practicable steps [40 CFR 230.70-77] would be taken to minimize potential adverse impacts of the discharge on the aquatic ecosystem. Disposal is in an area where the sediments would be dissipated to the maximum extent by strong tidal currents. During both the dredging and disposal operations, vessel operators are required to watch for beluga whales and cease engine noise if a beluga is within the project boundary.

<u>Sec 230.11 Factual Determinations (Short/Long term effects on physical, chemical, & biological components of aquatic environment)</u>

(a) Physical substrate determinations. See Subpart C below.

(b) Water Circulation, Fluctuation, and salinity determinations. See Subpart C below.

(c) Suspended particulate/turbidity determinations. See Subpart C below.

(d) Contaminant determinations.

As further discussed in Subpart G below, there are no contaminants in levels of concern to be found in the materials that are to be disposed.

(e) Aquatic ecosystem and organism determinations.

The disposal area is under deep, highly turbid, brackish water. No special aquatic sites exist in the disposal area. Plant life on the disposal site consists of diatoms and single-celled algae. No rooted or holdfast vegetation of any kind is known to grow on the site. The additional disposal of material from this project will not substantially affect the aquatic ecosystem or organisms. For further information, see Subpart D below.

(f) Proposed disposal site determinations.

1. The original disposal site was chosen because it had the following qualities to include: a good mixing zone, dispersive currents and tidal action, and water depth. The additional area adjacent to the existing zone simply enlarges the area the Corps could dispose of the material and that area is even deeper than the existing zone.

2. The following factors were considered in determining the acceptability of a proposed mixing zone:

(i) Depth of water at the disposal site: Depths are greater than 70 feet;
(ii) Current velocity, direction, and variability at the disposal site: Velocities and direction are variable due to the tides; however, they are strong enough to move the light sediment out of the area;
(iii) Degree of turbulence: Background is already turbid so this factor didn’t hinder site selection years ago;
(iv) Stratification attributable to causes such as obstructions, salinity or density profiles at the disposal site: Not applicable;
(v) Discharge vessel speed and direction if appropriate. Not applicable.
(vi) Rate of discharge. Discharge rate is relative to density and composition of dredged material;
(vii) Ambient concentration of constituents of interest.
(viii) Dredged material characteristics, particularly concentrations of constituents, amount of material, type of material (sand, silt, clay etc.) and settling velocities: Material is comprised mostly of silts and some clays;
(ix) Number of discharge actions per unit of time. Two to four barge trips (occasionally five trips) each transport about 1,500 cubic yards of material from each dredge to the disposal site each day during the dredging season;
(x) Other factors of the disposal site that affect the rates and patterns of mixing.

(g) Determination of cumulative effects on the aquatic ecosystem.

The designated disposal site could also serve as a disposal site for future dredging of the Knik Arm Shoal and potentially other future dredging or construction projects. Given the dispersive and naturally turbid nature of the Upper Cook Inlet, combined with the fact that this site has been used as a dredged material disposal site without incident for the past 40 years, no substantial negative cumulative effects are expected to occur as a result of this project. Further and future analysis of effects will be generated from a model of

Upper Cook Inlet that is currently being designed by the Corps of Engineers' Engineering, Research and Development Center (ERDC). This model will provide a more systematic tool for evaluating the Upper Cook Inlet hydrodynamics and sedimentation patterns.

(h) Determination of secondary effects on the aquatic ecosystem.

Secondary effects of this project would include:

- temporary increases in noise and vessel traffic during operation. Based upon noise readings from ERDC, any expected noises from the proposed work would remain below thresholds known as harmful to marine mammals.
- increased frequency of temporary disturbance to wildlife using Upper Cook Inlet. The physical presence of tugs and barges would temporarily displace most sea birds and marine mammals from the immediate disposal area during dumping operations. Juvenile salmon and other fishes are mostly surface oriented due to the high sediment bed-loads in strongly mixed tidal estuaries like Upper Cook Inlet. These fishes would tend to avoid temporary increases in surface turbidity and would temporarily be displaced from the area. This temporary displacement from a relatively small part of Upper Cook Inlet is not expected to have more than a minimal impact on the growth rates or overall survival of juvenile salmonids or other fishes in Upper Cook Inlet. There could be mortality of bottom-dwelling fish and less mobile aquatic organisms such as smolts;
- potential for marine mammal strikes from vessels. This is not likely, however, if belugas are seen within the operational boundaries of the vessel, operations will cease until they pass by;
- the potential for fuel to be introduced into the water column from dredge and boat equipment. These potentials are minimized by using best management practices;
- temporary delays in boater traffic to avoid the dredge and disposal operations. There is a potential that recreational and/or commercial vessels will have to work around the operations of the crews which could result in small delays.

Secondary effects resulting from the proposed project would not be substantial.

III. SUBPART C – POTENTIAL IMPACTS ON PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE AQUATIC ECOSYSTEM.

Sec. 230.20 Substrate.

According to NOAA chart 16665 the substrate on the bottom of Upper Cook Inlet at the disposal site is medium gray sand (med gy S) graduating to fine gray sand (fne gy S) on the eastern margin. This project will not alter the composition of substrates.

Sec 230.21 Suspended particulates/turbidity.

The disposal site is highly dispersive and the background levels of the Upper Cook Inlet are naturally high. This project will not substantially change background levels of suspended particulates or turbidity within this area of the Upper Cook Inlet. Additional information on particulate suspension will be generated by the ERDC model that is currently being designed. The model results will provide a more in depth understanding of particulate suspension and settling rates.

Sec 230.22 Water.

The discharge of dredged material in association with this project will not change the chemistry and the physical characteristics of the receiving water at the disposal site through the introduction of any chemical constituents in suspended or dissolved form.

Sec 230.23 Current patterns and water circulation.

Upper Cook Inlet is a complex aquatic ecosystem characterized by highly turbid brackish water, extreme diurnal mean tide range of 25.9 ft and extreme range of 40.7 ft, strong tidal currents, bore tides, extensive tide flats, and broken ice cover in winter. The marine water of upper Cook Inlet receives significant influx of fresh water from several major river systems, especially during the summer months. This fresh water influx is mixed throughout the water column by tidal currents in all but the deepest areas, resulting in brackish surface water. Tides are more extreme during summer than during winter.

Tide currents in Cook Inlet can exceed 4 knots ($2.05m^{-1}$) in some areas. NOAA chart 16665 notes strong currents in the disposal area. The disposal site ranges in depth from roughly 60 to 164 feet MLLW, with the deepest water on the north end of the proposed expansion area. Disposal will place sediment taken from one place on Upper Cook Inlet and deposit it to another. The overall net quantity of sediment in Upper Cook Inlet will not change because of this action.

The proposed disposal is not expected to have a measurable effect on current patterns or water circulation. The ERDC model currently under construction will provide additional information on the hydrodynamics of the Upper Cook Inlet for future evaluation.

Sec 230.24 Normal water fluctuations.

This disposal project will not affect water fluctuations in the Port of Anchorage harbor.

Sec. 230.25 Salinity gradients.

This disposal project has no affect on salinity gradients in the Port of Anchorage harbor.

IV. SUBPART D – POTENTIAL IMPACTS ON BIOLOGICAL CHARACTERISTICS OF THE AQUATIC ECOSYSTEM

Sec 230.30 Threatened and endangered species.

The proposed disposal action would be conducted within the range of the Cook Inlet beluga whale. This population has experienced a rapid decline in recent years and is a candidate for listing as threatened or endangered (NOAA 2007). This disposal action could have minor and temporary avoidance effects on belugas of the Cook Inlet population, but is not expected to result in harmful noise levels or be a deterrent to their recovery.

Steller's eider, a threatened sea duck that winters in Lower Cook Inlet is not expected to be in vicinity of the disposal operation. Steller's eiders are present in Lower Cook Inlet from about November through March annually. This disposal action is not expected to have any effect on Steller's eiders.

This determination has been coordinated with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, agencies responsible for management of protected species. While there were no conditions listed by either Service, the Corps is requiring vessels cease operations if belugas, which are being considered for listing, are within their operational boundaries.

Sec. 230.31 Fish, crustaceans, mollusks, and other aquatic organisms in the food web.

There are at least 20 species of fish in Upper Cook Inlet. A complete list of species can be found in the Environmental Assessment to which this evaluation is appended. Several of these species are important for commercial, recreational, subsistence, and personal uses. These important include five species of Pacific salmon of the genus *Oncorhynchus*, Eulachon, Bering cisco, Pacific herring, tom cod, saffron cod and wall eye pollock. Although not especially important for the uses mentioned the remaining species are important to the overall ecosystem of Upper Cook Inlet. The several salmonid species, eulachon, cisco, and stickleback are anadromous, spending their adult growing years at sea before ascending freshwater rivers to spawn.

Of major importance are the juveniles of the five Pacific salmon species. These juvenile salmonids migrate and feed through Knik Arm upper Cook Inlet on their way to the North Pacific Ocean where they rear to adulthood. Depending on the species, they can spend up to about 4 months feeding on zooplankton, shrimp-like invertebrates, small fish, and even terrestrial insects in Upper Cook Inlet.

This disposal action would not adversely impact essential fish habitat (EFH) including salmon, groundfish, and forage fish populations or their habitats. It will result in temporary turbidity that juvenile and adult Pacific salmon will avoid, but it will not interfere with the homing instinct of migration timing of adults and will have only minor effects, if any on juvenile salmon. However, there is potential for some impact to smolt not strong enough to navigate the tides and currents well enough to avoid more turbid areas, and/or to groundfish who are not visual navigators. Any potential impacts are expected to be minor and limited to a small area in the vicinity of the dredge hull.

This determination has been coordinated with the National Marine Fisheries Service, which is responsible for managing EFH under the Magnuson-Stevens Fishery Conservation and Management Act.

The invertebrates in Upper Cook Inlet are mostly crangonid and mysid shrimp of which there are about 6 known species listed in the environmental assessment of which this evaluation is appended. Other invertebrates include amphipods, marine worms, and at least one common species of clam, the Baltic macoma. These invertebrates are filter feeders and scavengers, and in turn are food for seabirds, fish and marine mammals. Compared to the area of Upper Cook Inlet, relatively small number of invertebrates, especially non-motile invertebrates, could be smothered by heavier sediments that sink to the bottom of the disposal area. Smothering of non-motile invertebrates can not be reasonably mitigated through modifications in disposal operations, but the disposal action is mitigated through selection of a disposal area away from intertidal areas that are most used by wildlife.

Sec 230.32 Other wildlife.

Wildlife on the disposal site consists of marine mammals, fish, invertebrates, and marine birds. Marine mammals are the Cook Inlet stock of beluga whales, harbor seals, and occasionally harbor porpoise and orca whale (a large dolphin). Beluga whales, harbor seals and porpoise feed on fish that include Pacific salmon, Eulachon, cisco and smelt in Upper Cook Inlet. Orca whales feed on fish if they are resident orcas or on marine mammals if they are transient orcas. Pacific gray whales of the eastern Pacific stock infrequently get lost during migration and enter Upper Cook Inlet.

Common birds are several species of gulls of which the glaucous-winged and mew gull are the most numerous. Arctic terns are also common during the summer months. Upper Cook Inlet water is typically too turbid for sea ducks to dive for benthic invertebrates, but sea and bay ducks may be found resting in the vicinity of the disposal area. The mud flats of Upper Cook Inlet in the vicinity of the disposal area are important feeding and resting areas for large numbers of waterfowl during the spring, summer and fall months. Shorebirds on the mud flats of Upper Cook Inlet can be abundant during the spring migration and common during the summer and fall months.

V. SUBPART E – POTENTIAL IMPACTS ON SPECIAL AQUATIC SITES.

The definition of special aquatic sites is found in Sec. 230.3 (q-1).

None of this Subpart E is applicable to this project.

Sec. 230.40 Sanctuaries and refuges.

None are in the project area.

Sec. 230.41 Wetlands.

None are in the project area.

Sec. 230.42 Mud flats.

None are in the project area.

Sec. 230.43 Vegetated shallows.

None are in the project area.

Sec. 230.44 Coral reefs.

None are in the project area.

Sec 230.45 Riffle and pool complexes.

None are in the project area.

VI. SUBPART F – POTENTIAL EFFECTS ON HUMAN USE CHARACTERISTICS

Sec. 230.50 Municipal and private water supplies.

There are no water supply sources or uses associated with this project.

Sec. 230.51 Recreational and commercial fisheries.

Commercial fisheries

Commercial Fisheries in Upper Cook Inlet are managed by the Alaska Department of Fish and Game with Upper Cook Inlet Management Plan and Strategies defined by the Alaska Board of Fisheries. Commercial fishing strategies for the Northern District of Upper Cook Inlet in which the disposal area in located are: 1) Northern District Chinook salmon management plan (5AAC 21.366); 2) Northern District salmon management Plan (5 AAC 21.358); and 3) Northern Cook Inlet coho salmon management plan. The commercial fisheries regulated by these plans and strategies are conservatively managed. The nearest commercial fishing sites to the disposal area would be on Fire Island approximately 17 km south of the disposal area. Previous disposal at the site did not have any adverse effects on commercial fishing in Upper Cook Inlet, and the proposed disposal is not expected to have any adverse effects on commercial fishing.

Sport Fishing

Sport fishing in the turbid water of Upper Cook Inlet is not typically practiced in the navigation channels. However, in Upper Cook Inlet, sport fishing does occur. In 2006 there were 46 boat angling trips and 1,072 shoreline saltwater fishing trips reported in the Anchorage area of Upper Cook Inlet (ADFG 2008). Sport fishing on rivers and creeks entering Upper Cook Inlet is highly pursued. The sport fishery nearest to the disposal site is at Ship Creek, approximately 1.2 km south. The main attraction to this urban sport fishery is hatchery-released Chinook and coho salmon. In 2006 10,831 anglers made 26,908 fishing trips to Ship Creek. These anglers harvested 3,060 Chinook salmon and 8,079 coho salmon.

The Ship Creek fishery is intertidal from the mouth of Ship Creek to a dam about 0.8km upstream. The banks of Ship Creek are steep, slippery and muddy as a result of the large tidal range and high sediment load in Upper Cook Inlet. The water in Ship creek is very turbid on the incoming tide, but clears for a short time at the lowest point in the diurnal tidal cycle.

Adult salmon would avoid the immediate area of disposal. Monitoring of disposal operations in other drainages such as the Nushagak River Estuary at Dillingham, Alaska show that disposal does not have noticeable effects on the homing instinct or migration timing of adult salmon. Consequently, disposal in the designated area is not expected to have other than minimal and unnoticed effects on the sport fishery in Ship Creek However, there is potential for some impact to smolt not strong enough to navigate the tides and currents well enough to avoid more turbid areas. Any potential impacts are expected to be minor and limited to a small area in the vicinity of the dredge hull.

Sec 230.52. Water-related recreation.

The only water related recreation on the disposal site would be the passage of small recreation boats launched at the nearby Ship Creek boat launch. These small boats would have to avoid passage near the tug and hopper barges operating between the dredging and disposal site. This would not be problematic as these operations have been conducted for approximately 40 years and the Port Authority and harbor users are accustomed to this activity.

Sec. 230.53 Aesthetics.

The act of disposing dredge material into Cook Inlet at the designated site would have the effect of seeing and hearing the dredge and transport barge in operation during the dredging periods listed in Table 2. The Port of Anchorage is relatively busy year around with container, tanker and other commercial vessels and the temporary addition of a dredge barge, hopper barge and tugs would have only minor effects on the aesthetics of the Anchorage waterfront and Upper Cook Inlet.

There would also be a slight and temporary increase in turbidity on the disposal site in the already very turbid water when the sediment is dumped from the transport barge. These increases in turbidity would not be noticeable to persons on shore and would not affect the aesthetics of Upper Cook Inlet to any noticeable degree.

Sec. 230.54 Parks, national and historic monuments, national seashores, wilderness areas, research sites, and similar preserves.

There are no parks or preserves associated with this project.

VII. SUBPART G – EVALUATION AND TESTING

Sec. 230.60 General evaluation of dredged or fill material.

Sediment from the Port of Anchorage was last tested for contamination in 2006(USACE, 2007). No petroleum hydrocarbons, pesticides or PCBs were detected. All heavy metal concentrations were well below management levels and the sediment is suitable for in water disposal. Sediment dredged from the Port of Anchorage would be taken from one place in Upper Cook Inlet and placed in another, the offshore disposal site. Heavier materials would sink to the bottom of the disposal area and the finer sediments that would remain in suspension for a longer time would be spread thinly in many areas of Upper Cook Inlet. The concentration of heavier sediments on the bottom and the thin layer of finer sediment in Upper Cook Inlet are not expected to have noticeable effects on the aquatic ecosystem of Upper Cook Inlet. The ERDC model currently under construction will provide additional information on the Upper Cook Inlet hydrodynamics and sedimentation for future analysis and refinement of dredging operations.

VIII. SUBPART H – ACTIONS TO MINIMIZE ADVERSE EFFECTS

Note: There are many actions which can be undertaken in response to Sec. 230.10(d) to minimize the adverse effects of discharges of dredged or fill material. Some of these, grouped by type of activity, are listed in this subpart.

Sec. 230.70 Actions concerning the location of the discharged.

The location for disposal of materials associated with operations and maintenance of the Port of Anchorage harbor has been established and used for approximately 40 years. The disposal site is deep, the material for disposal is similar in content to substrate in the disposal area boundaries and is close to the dredge area.

Sec. 230.71 Actions concerning the material to be discharged.

Based upon testing results, the proposed dredge spoils are free of contaminants in levels of any concern. Therefore, all of the material is suitable for open water disposal.

Sec. 230.72 Actions controlling the material after discharge.

Based upon testing results, there is no need to contain or control the material after discharge. The idea is to let the materials naturally dissipate from the disposal site by the strong tidal forces.

Sec. 230.73 Actions affecting the method of dispersion.

In this section, the Corps proposes to minimize by both examples (a) & (d) in the regulations. For part (a), the Corps is requesting a larger disposal footprint to orient the material to take advantage of the deeper waters and avoid any unforeseen build-up and for part (d) the Corps is making the best use of currents and circulation patterns to mix, disperse and dilute the discharge.

Sec. 230.74 Actions related to technology.

The intent of this section is to address technologies that would reduce the impact to wetlands or waters of the U.S. In this type of operation, the only way to remove the materials and then dispose of them is via dredge equipment. Both clam shell and hydraulic suction dredges are used at Port of Anchorage; however, the disposal method is the same. The material in each operation ends up on a barge that discharges the material approximately 10 feet below the water surface via a split hull.

Sec. 230.75 Actions affecting plant and animal populations.

Actions to minimize effects to animal populations include watching out for belugas in the area and ceasing operations if the animal approaches the vessel within the dredging or disposal operational boundaries. Additionally, use of a split hull for disposal would disperse sediments beginning approximately 10 feet below the water surface. This would reduce potential impacts to smolt which are found at the water's surface.

Sec. 230.76 Actions affecting human use.

The discharges do not appear near public water supplies or affecting aesthetic features of the system.

Sec. 230.77 Other actions.

There are no items under this section that apply to this action.

Sec. 230.12 Findings of Compliance or Non-compliance with the restrictions on discharge:

The discharge complies with the guidelines, with the inclusion of the appropriate and practicable conditions listed below to minimize pollution or adverse effects to the aquatic ecosystem:

1) If belugas are within the operational boundaries of the dredge or disposal activities, operations must shut down until the animal has passed by.

REFERENCES

Chemical Data Report, Anchorage Harbor ROST study for Anchorage Harbor Expansion, NPDL WO#06-046 Materials Section, Engineering Services Branch, January 2007.