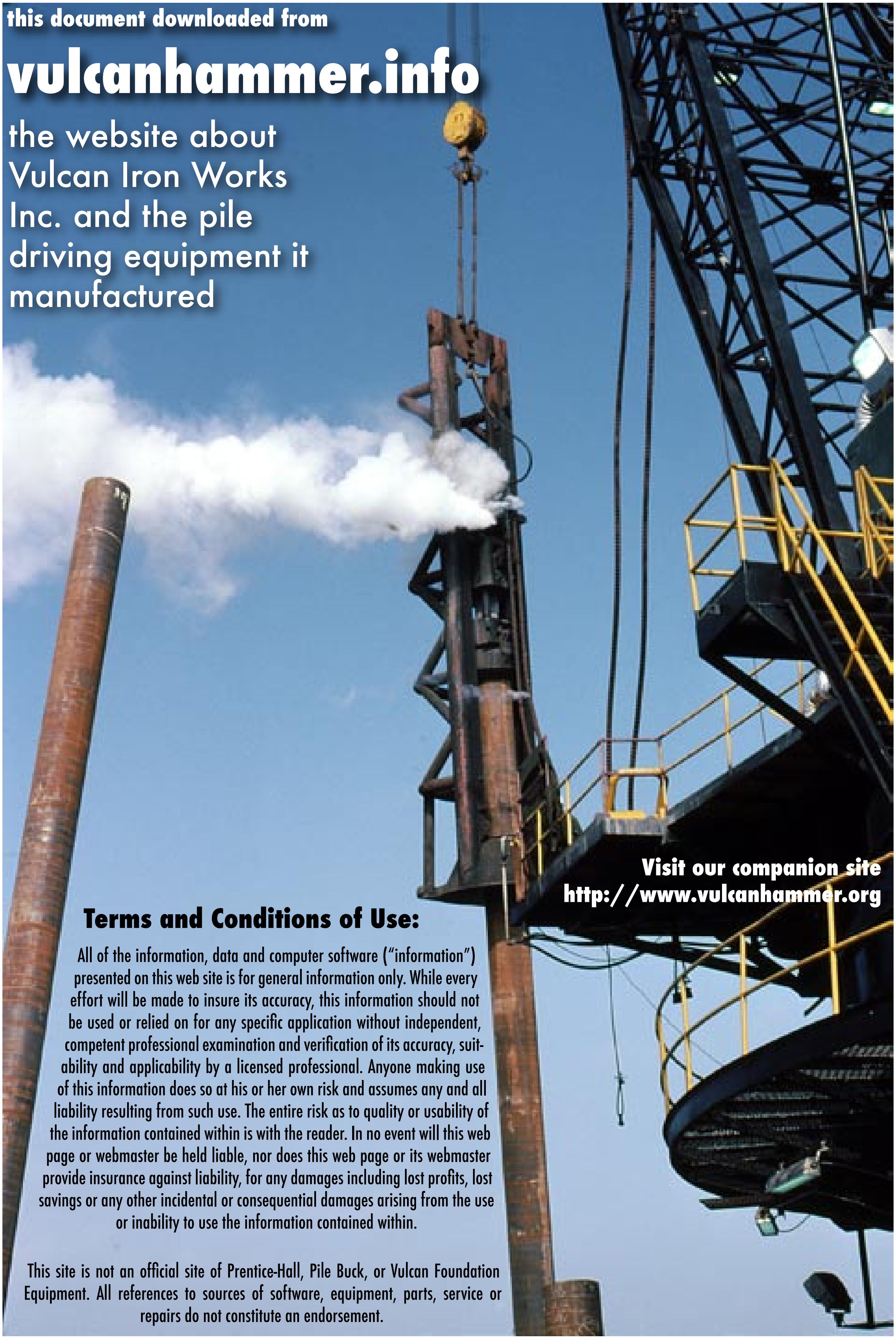

KNIK ARM CROSSING

PILE-DRIVING NOISE ATTENUATION MEASURES TECHNICAL REPORT FINAL

PROJECT 21132

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Abbreviations and Acronyms

ADOT&PF	Alaska Department of Transportation and Public Facilities
AS	Alaska Statutes
Anchorage	Municipality of Anchorage
EIS	Environmental Impact Statement
Elmendorf	Elmendorf Air Force Base
FHWA	Federal Highway Administration
Fort Richardson	Fort Richardson Military Base
KABATA	Knik Arm Bridge and Toll Authority
KAC	Knik Arm Crossing
LGL	LGL Alaska Research Associates, Inc.
Mat-Su	Matanuska-Susitna
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
PAFF	Permanent Aviation Fuel Facility
POA	Port of Anchorage
SAS	Sound Attenuation System

Executive Summary

Noise attenuation is primarily needed during pile driving activities. Most other proposed construction activities are not expected to create significant amounts of underwater noise and potentially affected species can easily avoided the area. However, driving piles in the range of four foot diameter and larger with the high energy capacity hammers may cause significant harm and/or death to fish, marine mammals, and other marine animals. This is a complex interaction between the environment and different species and is discussed by others on the Study Team.

A number of underwater noise attenuation techniques have been developed for pile driving projects. This report, in conjunction with a constructability report and the beluga whale mitigation report by others on the Study Team, evaluates which techniques should be considered. Knik Arm provides a unique and challenging construction environment that is not typical of projects else where in the United States so the effectiveness of one technique may be severely compromised due to the environmental conditions.

There are three mitigation techniques that may be effective in Knik Arm. The first is the use of a confined air bubble curtain. A curtain has been tested in current up to 3 knots in California's Oakland Bay. The configuration of this curtain would need to be modified to ensure that the fabric and seams remain intact during construction. The fast tidal currents (6-11 knots) of Knik Arm may make success of this option difficult or impossible to duplicate. The confined air bubble curtain is a different system than the unconfined air bubble curtain that has been used in low current project areas. The unconfined air bubble curtain system would not be effective in the Knik Arm environment.

The second technique is a propriety device in development. This device attaches to the pile during pile driving and creates an air pocket. No testing has occurred and development of the device is in the early stages so the ability to provide more than a proto type for construction is small.

The third potentially viable underwater noise mitigation technique is the sleeve or jacket. This is essentially a cofferdam with an air bubbler between the pile being driven and the outer sleeve. It is expected that the sound attenuation would be similar to that achieved with the Gunderboom® system in a California pilot study but the sleeve should be able to withstand the environmental forces from harsh Knik Arm environment. It appears this type of system has only been field tested once but its failure is likely due to material selection and not because of the concept itself.

1.0 Introduction

This Technical Report provides documentation of pile driving noise attenuation measures in the Matanuska-Susitna Borough (Mat-Su) and the Municipality of Anchorage (Anchorage) that would be required by the proposed Knik Arm Crossing (KAC) project. This report applies to the entire Study Area and the alternatives forwarded in the Draft Environmental Impact Statement (EIS), which are described below.

Several different techniques are available to mitigate or attenuate underwater noise created during marine construction projects involving pile driving. Each of these techniques can be appropriate depending on the circumstance and environment where the pile driving occurs.

Most evaluations to date on underwater noise and its affects on marine life have focused on fish. There is significantly less information on affects to whales and other marine mammals. However, there are observations as to behavior, which are often a startle and escape response and sometimes an avoidance response. A draft report by LGL Alaska Research Associates, Inc., "Options for Mitigating Construction-Related Effects on Beluga Whales:," provides more detail on the currently available information on impacts to marine mammals and specifically beluga whales (Funk and Rodrigues, 2005 draft)

2.0 Project Description

More than 80 years of transportation, land use, and economic plans and studies for the Upper Cook Inlet region of Alaska have addressed the need for a Knik Arm crossing project to connect Anchorage with the Mat-Su.

In 2003, the Alaska State Legislature established the Knik Arm Bridge and Toll Authority (KABATA) as a public corporation and an instrumentality of the State of Alaska within the Alaska Department of Transportation and Public Facilities (ADOT&PF). The specific mission of KABATA is to "… develop, stimulate, and advance the economic welfare of the state and further the development of public transportation systems in the vicinity of the Upper Cook Inlet with construction of a bridge to span Knik Arm and connect the Municipality of Anchorage and the Matanuska-Susitna Borough" (Alaska Statutes [AS] Chapter 19.75).

In accordance with this mission, the purpose of the proposed KAC project would be to provide improved access and connectivity between Anchorage and the Mat-Su Borough through an efficient and financially feasible crossing of Knik Arm, including adequate connections to the committed roadway network on both sides of Knik Arm. A Knik Arm Crossing would:

- improve regional transportation infrastructure to meet existing and projected population growth in Upper Cook Inlet

- enhance the movement of people, freight, and goods between Anchorage, the Mat-Su Borough, and Interior Alaska
- offer safe, alternative connections between regional airports, ports, hospitals, and fire, police and disaster relief services for emergency response and evacuation

The length of the proposed bridge crossing of Knik Arm would be approximately 2.5 miles and located approximately 1.25 miles north of Cairn Point (see Figure 2.1). The roadway connection on the Mat-Su side of Knik Arm would be Point MacKenzie Road near the Port MacKenzie District. The roadway connections on the Anchorage side of Knik Arm would be the A-C and Ingra-Gambell Couplets, generally in the Port of Anchorage/Government Hill/Ship Creek area. The total length of the project from the intersection of Point MacKenzie and Burma Roads to the intersections of the A-C and Ingra-Gambell Couplets with Third Avenue would be approximately 19 miles.

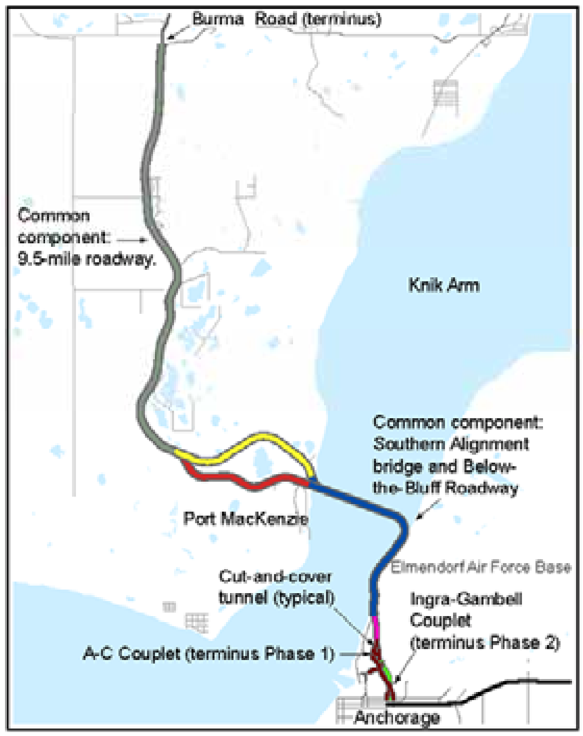

Figure 2.1 shows that the proposed project begins at Burma Road and ends in Downtown Anchorage. Components common to all routes being considered are also identified.

The proposed project would be a controlled access toll facility with a toll plaza located in the Mat-Su near the western bluff of Knik Arm. The proposed project would be classified as a rural principal arterial in the Mat-Su and across Knik Arm, transitioning to an urban principal arterial in Anchorage in the vicinity of the Port of Anchorage. The proposed project would be phase-constructed as travel demand warrants and would be anticipated to generally be an initial two-lane facility with expansion to a four-lane facility by 2030, the design year. Initial construction would include a connection to the existing A-C Couplet and, by approximately 2022–2025, to a new viaduct (elevated bridge) connection across the Ship Creek rail yard would be constructed to connect with the Ingra-Gambell Couplet.

Right-of-way widths for the project vary from approximately 400–450 feet in the Mat-Su, approximately 66 feet of pile supported bridge deck structure across Knik Arm, approximately 83 feet below the east bluff along the Anchorage approach, approximately 83–95 feet between the Port of Anchorage and Elmendorf, transitioning to a cut-and-cover tunnel under Government Hill either along a Degan Street or

Erickson Street area alignment, and extending southward to the project terminus at Third Avenue along approximately 80 feet of pier-supported viaduct across the Ship Creek rail yard.

The Federal Highway Administration (FHWA) is preparing an EIS as part of the National Environmental Policy Act (NEPA) process to evaluate a Knik Arm crossing sponsored by the Knik Arm Bridge and Toll Authority (KABATA).

2.1 Description of the Proposed KAC Project Study Area

The Study Area for the proposed KAC project is located within the boundaries of Anchorage and the Mat-Su in the Upper Cook Inlet region of Southcentral Alaska (Figure 2.2). This area has a combined population of nearly 350,000, which represents over 50 percent of Alaska's total population. Separating the Anchorage and Mat-Su portions of the Study Area is a 30-mile-long waterway, Knik Arm, which varies in width from 2 to 6 miles. Anchorage is just 2 to 3 miles from Port MacKenzie and its adjacent industrial district in the Mat-Su.

Although this physical separation consists of only a short span of waterway, the only current surface transportation access between Anchorage and the Port MacKenzie District is by 80 miles of existing roadway around the head of Knik Arm.

Located along the eastern shore of Knik Arm, Anchorage consists of 1,961 square miles, 84 percent of which is occupied by National Forest, State Parklands, and tidelands. With an additional 6 percent occupied by military reservations, only about 10 percent of the entire municipality is inhabited and available to accommodate existing and future growth. Most residents of Anchorage live in the Anchorage Bowl, the most urbanized portion of the municipality. The Anchorage Bowl occupies approximately 112 square miles and is bounded by Chugach State Park, Knik and Turnagain Arms, Elmendorf Air Force Base (Elmendorf), and Fort Richardson Military Base (Fort Richardson). Anchorage residents outside the Anchorage Bowl live either further north in the suburban communities of Chugiak-Eagle River or in small residential areas along the Glenn Highway and Turnagain Arm. Also located within this portion of the Study Area are the Port of Anchorage (POA), a vital intermodal facility, and the adjacent Ship Creek industrial area.

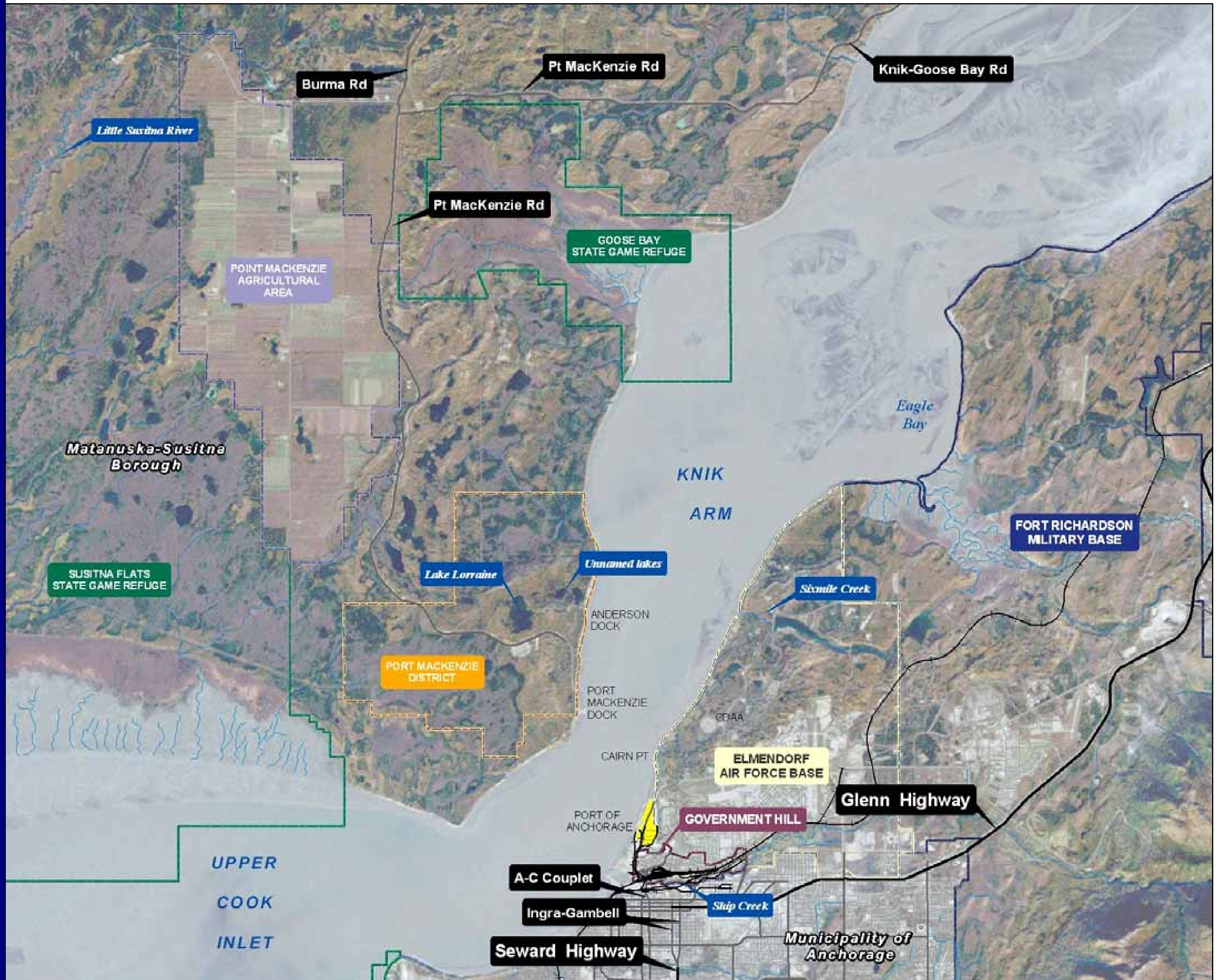

Figure 2.2 KAC Draft EIS Study Area. The Study Area has no specific, fixed boundaries because the Study Team has created a unique one for each resource or issue assessed in the Draft EIS. Study Area, thus, has a context-specific meaning that shifts from one resource to another.

On the western shore of Knik Arm, the Mat-Su consists of an area of 24,683 square miles, which encompasses approximately 23 percent of all private land in the state of Alaska. Because the Mat-Su has substantial undeveloped land available, it creates an alternative to more costly and limited residential, commercial, and industrial lands within Anchorage. This has resulted in numerous changes that have recently taken place or will be occurring in the Mat-Su, including construction of Port MacKenzie in the late 1990s, existing and planned expansion of the connecting transportation network to and from Port MacKenzie, and planned development of the 10,000-acre port district. The Mat-Su Borough is also developing a ferry link between Port MacKenzie and the POA; the ferry is projected to begin operation in 2007–2008.

2.2 Alternatives

The proposed KAC project would begin at the intersection of Point MacKenzie and Burma Roads and follow the existing roadway alignment south to the western boundary of the port district. From here, there would be two alternative routes for getting to the proposed bridge crossing. The proposed Point MacKenzie Road Alternative would use the existing Point MacKenzie Road most of the way through the port district before deviating from the established road and heading toward the bridge crossing near the western bluff. The proposed Northern Access Alternative would skirt the core port area on the north side on a new alignment. With either proposed alternative, there would be a toll plaza and intersection/access road to allow access to and from Port MacKenzie.

The proposed crossing itself would measure approximately 2.5 miles bluff-to-bluff across Knik Arm. The proposed bridge would begin approximately 1,500 feet south of Anderson Dock on the Mat-Su side and end 1.25 miles north of Cairn Point on the Anchorage side.

From the eastern bridge abutment, the proposed Anchorage approach road would travel southwest on fill along the tidelands and below the bluff, toward Cairn Point, then turn southward, closely following the natural curve of the shoreline, where the proposed roadway would climb to and parallel the eastern boundary of the POA. From this point, the remainder of the route would connect to the A-C Viaduct and a proposed Ingra-Gambell Viaduct by way of either of two routes: the Erickson Alternative or the Degan Alternative.

The proposed Degan Alternative would follow the alignment of Degan Street through a cut-and-cover tunnel that would initially connect to East Loop Road with an at-grade T-intersection (Phase 1). As travel demand would warrant, the route would continue on a new viaduct structure (Ingra-Gambell Viaduct) over the Ship Creek rail yard before tying into the Ingra-Gambell Couplet at 3rd Avenue. At that time, Loop Road would be elevated over the proposed KAC route to provide access to Government Hill and Elmendorf. The proposed Erickson Alternative would be similar, but the cut-and-cover tunnel would align with Erickson Street and connect directly into Loop Road in Phase 1 (ramps would continue to provide access to Government Hill and Elmendorf). When travel demand would warrant, or Phase 2, the route would continue in a parallel cut-and-cover tunnel under Erickson Street onto the proposed Ingra-Gambell Viaduct (crossing the Ship Creek rail yard) and would tie into the Ingra-Gambell Couplet at 3rd Avenue.

2.3 Preferred Alternative

FHWA screened the range of alternatives against criteria for purpose and need and technical criteria to identify reasonable alternatives for detailed study in the Draft EIS. Based on these screening criteria and subsequent detailed evaluations, FHWA has identified a Preferred Alternative.

The preferred approach route to the proposed Knik Arm Bridge on the Mat-Su side is Point MacKenzie Road from the intersection with Burma Road south to the Port MacKenzie District and the Northern Access Alternative through the port district. FHWA chose this route because it would avoid wetlands, would not impact Port MacKenzie operations, and is favored by Mat-Su Borough and Port MacKenzie officials.

The proposed Southern Alignment is the preferred route for the bridge to cross Knik Arm. The Southern Alignment, with its accompanying Below-the-Bluff Roadway on the Anchorage approach, would be the most technically feasible and practical alignment that would avoid the Cairn Point Trench (a submarine trough), would not impact military mission and operations at Elmendorf, and would minimize potential impacts to beluga whales that congregate in areas of Knik Arm further to the north.

An 8,200-foot-long pier-supported bridge is preferred over a 14,000-foot long bridge because a shorter bridge would require fewer piers, result in less construction noise and pile driving impacts that might adversely affect beluga whales and marine fishes, would require shorter in-water construction time, and would have substantially lower construction costs.

The preferred Anchorage approach to the proposed bridge would be a cut-and-cover tunnel under Government Hill, either along the proposed Degan or Erickson Street alignments, to connect initially to the A-C Couplet, and ultimately to the Ingra-Gambell Couplet.

All reasonable alternatives evaluated in the Draft EIS are under consideration and have been developed to a comparable level of detail. Final identification of a Recommended Alternative will not occur until the alternatives, impacts, written comments on the Draft EIS, and comments received at the public hearings have been fully evaluated and considered. The Recommended Alternative will be provided in the Final EIS.

3.0 Methodology

This technical report is intended to provide specific information on noise attenuation of pile driving during construction. This report evaluates and discusses the potential for creating underwater noise by construction methods proposed by others on the Study Team and provides a discussion on the potential mitigation methods for attenuation. No field studies were conducted in support of this report.

4.0 Affected Environment

This report evaluates the constructability aspects of different options to minimize the impacts of pile driving underwater noise to marine life. The affected environment includes fish, marine mammals, and other marine animals, for example diving birds, which may be in the area during pile driving activities. The affects on the environment depend on which species are present and their vicinity to the pile driving when pile driving occurs. The mitigation plan will provide a specific safety zone with distances from the active pile driving activities. Inside the safety zone is the area considered to be potentially harmful to the species of concern. Outside of the safety zone is the area considered to be safe for the species of concern.

Noise attenuating options are being evaluated for inclusion into the permit mitigation plan. The intent of this report is to supplement the biological discussion on how underwater noise affects marine species, specifically beluga whales, in determining which options should be included in the mitigation package. LGL Alaska Research Associates, Inc. (LGL) is completing the beluga whale studies and will be providing a mitigation plan for the project (Funk and Rodrigues, 2005 draft). As part of preparing for the preparation of a mitigation plan, they evaluated various options for attenuating construction-related affects due to pile driving.

The LGL report cited above provides the regulatory framework under which the mitigation plan must comply. This report does not include a discussion of the regulatory framework but instead provides an analysis of the construction impacts of the various mitigation options discussed in the LGL report and in other construction methodology reports prepared for this project (Howlett, 2005; Funk and Rodrigues, 2005 draft).

4.1 Physical Barriers

Physical barriers of a size that would exclude beluga whales from the safety zone would be difficult if not impossible to design, construct, and maintain during construction due to the extreme forces likely to be placed on such a structure (Funk and Rodrigues, 2005 draft). An electric seine has also been tried in other parts of the country for fish exclusion. This is probably not an option for this project as the size would be prohibitive.

LGL also discusses the possibility of combining the physical barrier with a noise reduction technique. The difficulties of designing and maintaining this type of structure in Knik Arm remain the same for most any size of barrier so even a significant reduction in the safety zone boundary is unlikely to mitigate the deployment issues.

4.2 Acoustic and Non-Acoustic Deterrents

LGL did not consider acoustic and non-acoustic deterrents to be likely options for mitigating underwater sound from pile driving activities. The only type of deterrent discussed that might affect construction activities is ramping up as the other types discussed do not involve the equipment themselves. Ramping up would require the contractor to use soft-start procedures where the hammer is not used at full strength at the start of a pile driving session. While being inefficient for construction there would likely be little impact to construction with this technique (Funk and Rodrigues, 2005 draft).

4.3 Noise Reduction Techniques

Pile Driver Silencer The pile driver silencer described in LGL's report likely has little effect on underwater sound (Funk and Rodrigues, 2005 draft). The sound is propagated from the pile within the water column, not from the direct strike of the hammer onto the pile.

Wood Block Silencer Another technique not described by LGL but similar in theory to the pile driver silencer is to use a wood block to dampen the noise. The block of wood reduces the hammer energy being imparted onto the pile. The air noise level may be reduced but more significantly the higher frequency wave lengths are reduced. The human ear hears a low frequency thud instead of a high frequency ping. A similar effect occurs underwater. Unfortunately, it is the lower frequencies that have proven to be more harmful and damaging to the fish and is believed to be more harmful for marine mammals as well. While this technique has been used in other states, the true effectiveness of the method in attenuating underwater noise is unproven and likely ineffective as the contractor usually is forced to use a larger hammer with greater energy to counteract the reduced driving capabilities of the hammer due to the block of wood. Projects that have used this technique have smaller pile sizes, in the 24 inch diameter range, so it is unlikely that the use of this technique with large pile, greater than 36 inches and up to the 8 foot range, would be effective.

Bubble Curtains and Gunderboom® The introduction of air to eliminate underwater noise is effective. However, the curtain of air around the sound must be perfect (no gaps or holes in the curtain). The most effective means of doing this is a cofferdam (to be discussed later). Cofferdams can be expensive and more harmful than the intended pile driving. A compromise is the use of a bubble curtain; these will be referred to as confined and unconfined (Wilson, 2001; Christopherson and Wilson, 2002).

The unconfined air bubble curtain is the least expensive means of placing a wall of air around a source (Christopherson and Wilson, 2002). However, the bubbles are subject to horizontal movement (see Figure 4.1). An unconfined air bubble curtain will completely break apart in the types of tides and currents Knik Arm experiences on a daily basis.

The confined air bubble curtain has been shown to be highly effective in up to 3 knot current and likely will be effective beyond that velocity with the limitation being the stresses the seams of the fabric can withstand. The Gunderboom® Sound Attenuation System (SAS) is the only known example of a confined bubble curtain that has been field tested. The SAS is comprised of two layers of fabric with air blown into the bottom between the layers. During testing, the fabric itself acts as an effective attenuator. Also, this system was better able to attenuate the harmful low frequency waves than an unconfined bubble curtain. During the field testing in California, the system proved to be expensive. Gunderboom, Inc is currently working on a less expensive alternative that will be more competitive with unconfined systems (Christopherson and Wilson, 2002).

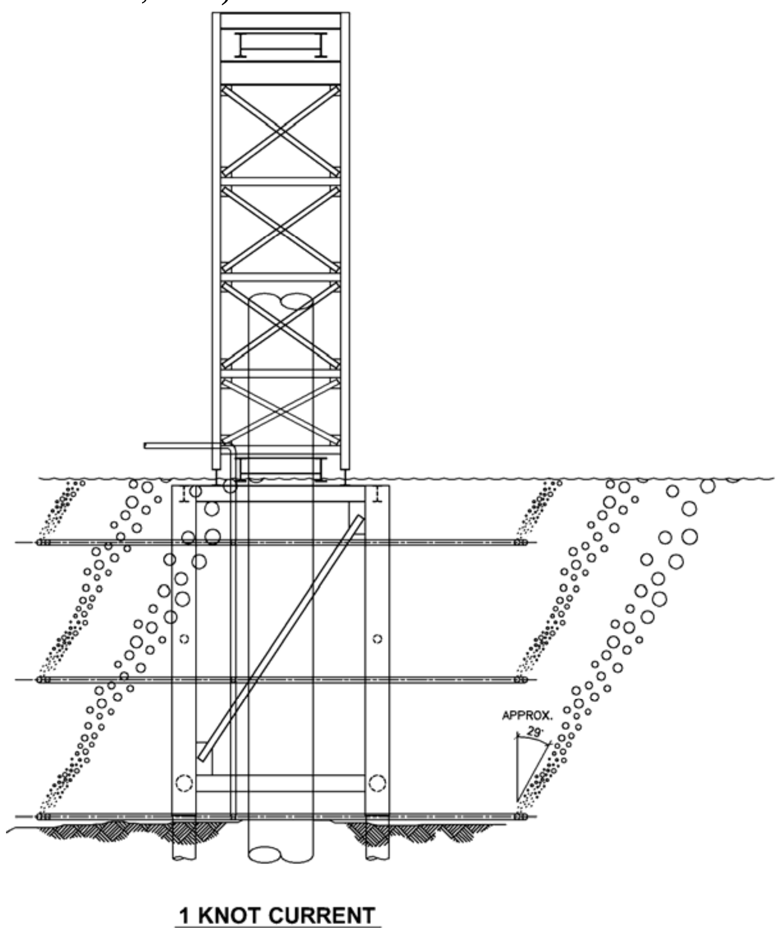

Figure 4.1 Deterioration of unconfined bubble curtain in 1 knot of current (Christopherson and Wilson, 2002).

Waterwing A variation of the confined air bubble curtain is currently under development and a patent is pending. The "waterwing" concept involves placing an air filled tube around the pile secured with heavy duty Velcro. The tube would necessarily be in segments to facilitate removal of the tube in segments while driving as the tube moves with the driven pile. Some issues that have to be considered include removing the tube at the bottom of the pile, keeping a “perfect” pillow of air around the pile while it is being driven, and the connection between the template and the tube around the pile. This system would likely require a diver to move the tubes.

Cofferdams Cofferdams, with the water removed, are the perfect underwater noise attenuator (Christopherson and Wilson, 2002). Their effectiveness is significantly reduced if the water is left inside. However, cofferdams are not without trade offs. The cofferdam must be larger in diameter than the items being driven. In the case of a Knik Arm Bridge, this would likely be a single, large pile and likely in the order of magnitude of 8 feet in diameter. In order to achieve a water tight seal, the pile would have to be driven into the sediment with an impact hammer then all the water pumped out. A template would likely need to be driven after the cofferdam structure is in place, which usually entails 4-6 smaller piles to hold the template in place. More may be necessary in Knik Arm as the tidal exchange can be very strong with currents up to 11 knots possible. Only after the cofferdam and template are in place and the cofferdam is dewatered can the permanent pile be driven in the dry. The cofferdam is then removed.

The sheet pile cofferdam is installed by driving interlocking sheet piles in a cell (circle) around the driving site using a vibratory hammer. The template for the permanent pile is often welded inside the cell. It is unlikely that a sheet pile cofferdam would be used on this project as sheet piles are limited in length as they flex easily. As all piles are in deeper water, the use of sheet piles is unlikely.

Sleeve Two variations on the cofferdam have been evaluated. The first concept involves vibrating in a steel pile that is larger than the pile to be driven (sleeve) and then bubble air inside the sleeve pile. The purpose of the steel pile is to create a solid barrier that would withstand strong tidal forces. Some development issues will be designing the sleeve to accommodate the pile driving template and crushing of the pile. Hong Kong tested a similar concept in 2004 for the Permanent Aviation Fuel Facility (PAFF) (The Government of Hong Kong, 2002 & 2005). The test was conducted in 55 ft (17 meters) with a 4 foot sleeve pile outside of a 3 foot pile that was being driven. The sleeve pile was only 3/10 inch (8 mm) thick and failed during the test. The sleeve pile was lined with neoprene or rubber bumpers to prevent direct contact of the driving pile with the sleeve pile. There were problems with controlling the pile during initial installation as well. The test did not take into consideration uplift of the pile or the crushing forces of the water at depth. The failure of this test was likely due to the selection of the sleeve pile so the results should not be considered. Additionally testing would be necessary to determine if this is a viable option.

The second variation is a combination of the sleeve and decoupler device. The concept is to line the entire sleeve pile with neoprene, which has trapped air bubbles, soft rubber, or soft plastic. This concept needs further development and has not been tested. Some of the design issues that would need to be addressed include determining if the space between the driving pile and the sleeve must be dewatered, what material will work to dampen sound transmission, and constructability issues.

Decoupled Sources The intent of decoupled sources is to reduce the unintentional transmission of transient noise from equipment other than the pile driving hammer through short-circuiting of vibration isolation mechanisms. While this may reduce some underwater noise, it is unlikely that equipment is a major source of noise (Funk and Rodrigues, 2005 draft).

Jetting In Piles This is a technique that in effect loosens the material that the pile is being driven into by forcing a strong jet of water in front of the pile tip. This technique is often used when the sediment is very dense and creates a refusal type scenario. This technique requires the use of the impact hammer and may act to attenuate the pile driving underwater noise because the pile is being driven farther with each impact and the pile acts less like it is at refusal. Refusal is when the most amount of energy is likely to enter the water column. This technique is not being further considered for constructability reasons and because the attenuation reduction will be minimal. Additionally, there is a risk of an oil spill and increased turbidity due to the use of the high pressure water (Howlett, 2005).

Pre-Drill Piles This technique is similar to that used when anchoring a pile into bedrock. The pile is seated into place with either a vibratory hammer or an impact hammer depending on how far the pile can be driven into the top of the material and holds itself. The hammer is removed and a drill is placed above the pile and a pilot hole is drilled through the pile into the sediment. The drill is then removed and the impact hammer is placed on the pile and driving commences. As with jetting, this technique can be effective at driving piles in very dense sediments. Also similar to jetting, this method does not meet the constructability requirements of the project and is unlikely to significantly reduce the level of underwater noise from the pile driving activity (Howlett, 2005).

Concrete Pile Installation A concrete foundation structure will be technologically challenging to construct in Knik Arm. Pre-cast concrete piles would still require driving though they likely have a different signature than steel piles. Another option is to pour in place concrete piles. This would require a cofferdam, which has been discussed above. Usually a vibratory device is used to remove bubbles from the concrete right after pouring it to ensure the concrete meets specifications. The vibratory device could create underwater noise that would need to be mitigated. Noise attenuation would need to be evaluated for any part of the construction methodology that includes pile driving or vibratory activities.

4.4 Timing of Construction Activities

The timing of construction activities to avoid the species of concern is usually the most effective means of mitigating harm. However, the beluga whale tends to be present year round, according to the field work conducted by the Study Team. There does appear to be a window when there is reduced use by beluga whales (winter and spring) but these are also difficult times of year for construction. Construction must take place when there are not significant amounts of floe ice. The safety of equipment, workers, and emergency response is compromised during the winter.

4.5 Monitoring

Monitoring of species of concern presence has been effectively used in other projects. In these other projects, all pile driving activities are halted while the species of concern is within a prescribed distance from the construction area. However, this technique is usually reserved for a portion of the construction season. Additionally, this project will have a short construction season so any delays caused by the ever present beluga whale will result in unacceptable construction delays and costs.

5.0 Potentially Affected Options

There are a number of options being discussed for each crossing alternative. However, there is a limited number of options that will be discussed here as any option that does not require pile driving is excluded from the discussion because the major source of construction noise is from pile driving activities. In general, noise generated by barges and other vessels during construction will not exceed the levels established by the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS).

Matanuska-Susitna Borough. Similar to the Anchorage approach discussed above, there is likely to little to no generation of underwater sound by pile driving construction activities. As none of the proposed routes parallel the shoreline, it is unlikely that the approach will require shoreline stabilization with driven piles.

The Crossing. There are several parts to the crossing that can potentially generate underwater sound during construction. These include the fill approach, abutments and the foundation structure for the bridge.

Construction of the fill approach is not likely to generate underwater noise. No pile driving is anticipated. Vibro-compaction may be used but this is not likely to generate appreciable underwater noise.

There are two types of abutments being considered; open cell and sloped abutments. The open cell abutment consists of a series of cells created by driving sheet pile then filling behind the cell wall with material. A vibratory hammer is used to install the sheets. The sloped abutment consists of a fill area with a wide base and contoured sides. This type of abutment does not require pile driving but typically has a much larger footprint.

The foundation structure for the bridge will be comprised of piers. The most likely type of foundation will be a steel pile bent comprised of several driven steel piles. An impact hammer will be used to driven the steel piles. The size of the piles and the hammer will depend on the geology and design requirements. A concrete pier structure is not likely due to the constructability restraints.

Anchorage. The approaches through Anchorage and to the crossing itself are not likely to be sources of underwater noise. Underwater noise is generated when there is direct contact of the source with the water column. The potential to generate underwater noise during construction of the Anchorage approach depends largely on the final design and if there will be a need for sheet piles or other bank shoring.

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