DRAFT
ENVIRONMENTAL IMPACT STATEMENT
FOR
PROPOSED MORTAR AND ARTILLERY TRAINING AT RICHARDSON TRAINING AREA, JOINT BASE ELMENDORF-RICHARDSON, ALASKA

(VOLUME II–APPENDICES)

2025

APPENDIX A–JBER IMPACT AREA SITING ANALYSIS

Appendix A:
JBER IMPACT AREA SITING ANALYSIS

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FORT RICHARDSON IMPACT AREA FEASIBILITY ANALYSIS

SUMMARY

U.S. Army Alaska (USARAK) is preparing an Environmental Impact Statement to analyze the expansion of Eagle River Flats (ERF) Impact Area to facilitate all season live fire training with expanded impact area in order to increase realism for Combined Arms Live Fire Exercise (CALFEX) live fire proficiency. The National Environmental Policy Act (NEPA) and its implementing regulations require USARAK to consider a full range of reasonable alternatives when deciding how to implement the proposed action.

In being consistent with the general NEPA requirement to analyze all reasonable alternatives for implementing a proposed action, USARAK began to analyze whether there exists on Richardson Training Area a feasible site for the expansion of ERF Impact Area to facilitate all season live fire training with expanded impact area in order to increase realism for CALFEX live fire proficiency. The Richardson Training Area Range Control initiated this analysis by using the current existing Eagle River Flats Impact Area (2,483 acres) as a size requirement for the resumption of all season live fire training optempo. Additionally, Training Circular 3-20.0 Integrated Weapon Training Strategy states that optimally, a CALFEX range maneuver area would be 5 to 10 kilometers deep and 3 to 5 kilometers wide (possibly smaller for a defensive scenario), with multiple terrain features, and would allow for some cross and flanking fires. In addition, active component CALFEX qualifications are only valid for a 9-month period and thereby necessitating the resumption of all season live-fire training into ERF Impact Area. USARAK Range Control has determined that a CALFEX Live Fire Proficiency Gate could be used in conjunction with the existing Infantry Platoon Battle Course (IPBC) with an expansion of approximately 400 acres to the existing Eagle River Flats impact area. With these requirements in mind, Range personnel identified all potential sites on Richardson Training Area capable of supporting these minimum spatial requirements. These potential sites, three in total, represent a reasonable consideration of locations on post without duplication. The analysis then assesses each potential site's ability to meet several additional, mandatory criteria for a permanent impact area. These mandatory criteria reflect essential regulatory and safety-related considerations. Adjustments to site configuration were made, where practicable, to promote each potential site's consistency with these criteria. After full analysis of all three sites, it was determined that only one area of the Richardson Training Area could potentially meet the requirements of the expanded impact area.

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1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this document is to analyze the viability of establishing all season live fire training that meets training and certification requirements with expanded impact area in order to fully meet Combined Arms Live Fire Exercise (CALFEX) live fire proficiency in accordance with Army training strategy. In recent years, seasonal limitations have restricted training capabilities at Richardson Training Area's only permanent impact area, thus negatively impacting the ability of U.S. Army Alaska (USARAK) to meet mission requirements. USARAK has commissioned an Environmental Impact Statement to examine facilitation of all season live fire training that meets training and certification requirements with expanded impact area in order to fully meet CALFEX live fire proficiency in accordance with Army training strategy. The Purpose and Need of this EIS may be distilled into the following objectives:

- Maximize the ability to train units to a common standard, including use of a full array of indirect- and direct-fire weapons and munitions at Richardson Training Area.
- Maximize all season opportunities for live-fire weapons training at Richardson Training Area to ensure that Soldiers can train prior to deployments that may occur at any time of the year.
- Ensure long-term, realistic training at Richardson Training Area that will provide Soldiers the opportunities to practice their skills in combat-like conditions.
- Improve Solider quality of life and Family stability by minimizing the need for travel to other installations for small-unit training (company and below).
- Minimize overall training costs.
- Avoid land use conflicts.
- Ensure compliance with applicable environmental laws, regulations, and executive orders.

Training to a common standard requires that procedures used by Soldiers and units to operate, maintain, and fight with major weapons and equipment systems are performed in the same manner and at the same basic level of proficiency throughout the Army. This concept is designed to reduce the effects of personnel turnover and ensure that modular military organizations can operate effectively within any assigned formation. The indirect live-fire weapons systems assigned to units at Richardson Training Area are the 60-mm mortar, 81-mm mortar, 155-mm Howitzer, 105-mm Howitzer, and 120-mm mortar.

1.2 CURRENT INDIRECT LIVE-FIRE TRAINING CAPABILITY AT RICHARDSON TRAINING AREA

1.2.1 Current Seasonal Use

Eagle River Flats (ERF) Impact Area supported heavy year-round unrestricted use until 1990 when USARAK voluntarily implemented a temporary firing suspension due to the discovery of a high rate of mortality in dabbling waterfowl. The temporary suspension of firing at ERF Impact Area did not eliminate or reduce waterfowl mortality and the Army sought to resume firing at ERF Impact Area. During 1991, the Army conducted an Environmental Assessment to determine environmental impacts related to resuming firing at ERF. This Environmental Assessment considered four alternatives for resuming firing at ERF and the Army ultimately selected "The Winter Firing Only" alternative in a Finding of No Significant Impact. Currently, USARAK may fire artillery and mortars at ERF only during the period from approximately 1

November through 31 March when ice thicknesses are sufficient to protect underlying sediments from disturbance.

1.2.2 Size

ERF Impact Area is a 2,483-acre impact area at Richardson Training Area used for both small arms and potentially dud-producing munitions. ERF Impact Area encompasses a large tidal salt marsh known as Eagle River Flats, which is located at the mouth of Eagle River. ERF Impact Area also encompasses the steep bluffs that surround the Flats as well as some adjacent upland terrain.

1.2.3 Firing Points

There are currently 9 mortar firing points and 17 artillery firing points and other open areas throughout the training lands that are commonly used for indirect live-fire training at ERF Impact Area with 60-mm, 81-mm, and 120-mm mortars, as well as the 105-mm Howitzer artillery system. These firing points have been established at a variety of distances to the impact area to support tactical execution of the primary mission of indirect fire systems, in accordance with current doctrinal practices. All of the firing points used to support indirect live-fire training at ERF Impact Area are located on the northern portion of Richardson Training Area.

1.2.4 Impact Area

Simply defined, an impact area is a location where targets are emplaced for weapons system engagement. Access to impact areas is heavily restricted due to safety concerns associated with the potential for unexploded ordnance. Within the perimeter of the impact area is contained a smaller area which contains the targets to be engaged from a specific firing point. This area is known as the target area. The size of the target area within the impact area is based on the safety distances for the effects of each type of munitions used in training. To support the full range of tactical operations, the target area (and by extension, the impact area) must be large enough to accommodate the variety of target sets required to support the full range of tactical operations. This variety of target sets must represent static or moving targets, and must be located in a single point or positioned in a variety of arrays. Currently at ERF Impact Area, there exists sufficient space to facilitate emplacement of the variety of target sets necessary to meet mission requirements for the full range of indirect fire systems.

1.2.5 Surface Danger Zones

A surface danger zone (SDZ) is defined as the ground and airspace designated within the training complex (to include associated safety areas) for vertical and lateral containment of projectiles, fragments, debris, and components resulting from the firing of weapons systems. (DA Pam 385-63, Glossary). SDZs are munitions and weapons systems-specific; are developed to ensure personnel safety during training exercises; and are calculated so as to contain all the effects of a given weapon and munitions. Specifically, the probability of hazardous fragments leaving the SDZ may not exceed 1:1,000,000. The SDZ essentially delineates a safety boundary which surrounds the firing point, the target area, and all points in between. Applicable regulations require SDZs to remain within installation boundaries (DA Pam 385-63, Paragraph 1-5b). The SDZs associated with the target arrays and firing points described above for ERF Impact Area meet all regulatory requirements.

2.0 ERF IMPACT AREA EXPANSION ANALYSIS METHODOLOGY

2.1 SIZE REQUIREMENTS

- Existing ERF footprint is 2,483 acres in size
- Same size (2,483 acres) requirement is necessary for a No-Action Alternative
- Same size requirement is necessary for Resumption of condition driven all season live-fire training at ERF Impact Area.
- Same size requirement (2,483 acres) plus approximately 400 more contiguous acres to ERF is required to resume all season live fire training that meets training and certification requirements with expanded impact area in order to fully meet CALFEX live fire proficiency in accordance with Army training strategy. Training Circular 3-20.0 Integrated Weapon Training Strategy states that optimally, a CALFEX range maneuver area would be 5 to 10 kilometers deep and 3 to 5 kilometers wide (possibly smaller for a defensive scenario), with multiple terrain features, and would allow for some cross and flanking fires. USARAK Range Control has determined that a CALFEX Live Fire Proficiency Gate could be used in conjunction with the existing Infantry Platoon Battle Course (IPBC) and with the expansion of approximately 400 acres to the existing Eagle River Flats impact area.

2.2 SURFACE DANGER ZONES

As introduced in Section 1.2.5, applicable regulations require SDZs for indirect fire systems to remain within installation boundaries (DA Pam 385-63, Paragraph 1-5b). Accordingly, SDZs may not overlay private property, including the Alaska Railroad corridor which bisects the northern portion of Richardson Training Area.

2.3 RESULTS OF APPLYING SIZE REQUIREMENT

Based on an initial application of the size requirement, a total of three discrete sites on Richardson Training Area meet the above parameters. These three sites are shown in Figures 4-1, 4-2, and 4-3.

3.0 MANDATORY (GO / NO-GO) CRITERIA

3.1 INTRODUCTION

In addition to mere size, there are other requirements that a potential site location absolutely must meet in order to be a feasible location for an impact area. These mandatory (or “GO/NO-GO”) criteria are directly rooted in regulatory requirements, doctrinal training methods, and/or other Army publications that govern training and safety. Each GO/NO-GO criterion is listed below and accompanied by brief descriptions of the requirement necessitating each criterion, applicable definitions, the method of analysis, and the basic method for evaluating the criterion. The initial application of these criteria to each potential site will be followed, if necessary, with certain site-specific adjustments in an attempt to achieve full compliance with applicable criteria.

The GO/NO-GO Siting Analysis Maps in Figure 3.1 and Figure 3.2 feature a map legend that depicts each of the mandatory GO/NO-GO criteria. In order to analyze the siting of a potential impact area location, each of the criteria were designated with a buffer area distance in order to be spatially represented on a map. Additional consideration was given to steepness of slopes throughout the training landscape. Steep slopes impair forward observer line of site during mortar and artillery training. Forward observers must be able to see the impact of the rounds being fired at a target within the impact area in order to communicate back to the artillery units how to adjust their fire for increased accuracy. It was determined that all slopes greater than 30% were colored "red" because of this identified training impairment.

All the areas on the map that are represented with the color "red" are the combined no-go criteria and considered not suitable for the siting of an impact area. In contrast, the areas on the map that are represented with the color "green" are considered suitable for analysis; however, they must still meet the size requirements as indicated above in Section 2.1.

3.2 CONFLICT WITH HARDENED FACILITIES

Definitions
A hardened facility is any developed infrastructure, hardened structure or area required to support mission training requirements, operational needs, installation support, or utilities systems. This includes but is not limited to automated ranges, training complexes, administrative buildings, dwellings, utilities, improved training area roads, landing strips, drop zones, mission support facilities, golf courses, and cemeteries.

Criteria Requirement
It is imperative to examine any negative impact that locating the proposed impact area would have on existing hardened facilities. Impact areas are generally incompatible with hardened facilities. The end state must be that no current training capability be eliminated or degraded as the result of the expansion of the impact area. For hardened facilities, a 250-meter buffer area was designated to buffer and protect those assets. All designated range and drop zone footprint assets were colored red within their designated footprint boundaries.

Analysis
The first step in this process is to apply the hardened facilities to identified potential sites and examine if the areas fall into the GO or NO-GO buffers as identified by the GO/NO-GO Siting Analysis Map.

Evaluation
A site is not considered feasible if it would require the development of the expanded impact area at a developed hardened facility.

3.3 CONFLICT WITH PUBLIC TRANSPORTATION ROUTES

Definitions
Public transportation routes are the roads that provide unrestricted public access, as well as the railroad right-of-way. On Richardson Training Area the only routes outside of the cantonment area that qualify as public transportation routes are Arctic Valley Road and the Alaska Railroad right-of-way. It is not within the Army's authority or otherwise practicable to relocate either of these routes. All other roads on the installation are controlled by the installation and can be closed for training purposes.

Criteria Requirement
USARAK 350-2 and regulatory guidance (DA Pam 385-63, paragraph 11-4k(4); DA Pam 385-63, paragraph 10-1a) prohibit indirect firing over public transportation routes as defined above. A protection buffer distance of 725 meters was designated for hardened public facilities such as installation infrastructure, public roads, and the railroad.

Analysis
The first step in this process is to apply the public transportation routes to identified potential sites and examine if the areas fall into the GO or NO-GO buffers as identified by the GO/NO-GO Siting Analysis Map.

Evaluation
A site is not considered feasible if it would necessitate firing over public transportation routes or other public use facilities.

3.4 HAZARDOUS NOISE

Definitions
Hazardous noise is determined by applicable standards outlined below: Municipality of Anchorage hazardous noise emissions standards (AMC 15.70.100.). Hazardous noise limits are based upon the number of impulse noise events at a particular amplitude over a particular 24-hour period. Under the Municipal Code, any impulse event causing noise 145 decibels (dB) or greater is considered hazardous; at 135 dB, anything over 10 impulse noise events is considered hazardous; and at 125 dB, anything in excess of 100 impulse events is considered hazardous.

The Environmental Noise Management Plan requires installations to implement environmental noise policies to identify and control the effects of noise. Among these policies is the requirement to predict noise levels for long-range planning, including preparation of noise contour maps. The maps delineate up to three different noise zones, which are based on the expected percentage of the population that would be highly annoyed by environmental noise. AR 200-1, paragraph 14-4a(9) states that single event noise limits, as depicted in Table 3-2 (of AR-200-1), correspond to areas of low to high risk of noise complaints from large caliber weapons and weapons systems. These should be used to supplement the noise zones defined in Table 14-1 (of AR 200-1) for land use decisions. Noise sensitive land uses are discouraged in areas where PK 15(met) is between 115 and 130 dB; medium risk of complaints. Noise sensitive land uses are strongly discouraged in areas equal to or greater than PK 15(met) = 130 dB; high risk of noise complaints. For infrequent noise events, installations should determine if land use compatibility within these areas is necessary for mission protection. In the case of infrequent noise events, such as the detonation of explosives, the installation should communicate with the public.

Consistent with Municipal code and the Army Environmental Noise Management Plan, a new impact area will not be located on Richardson Training Area where training would cause any noise impact on non-Army property of 130 dB or above. Installation Range Officer experts deem this restriction necessary to ensure that training events, which frequently entail more than 10 impulsive noise events from a given firing point, do not cause hazardous noise to enter non-Army property.

Criteria Requirement
A noise buffer of 458 meters was place around the populated border areas of the installation on the eastern and southern boundaries. No noise buffer was added to the Public Land Order 6624 acreage because that is a non-populated area that is not affected by noise.

Analysis
The first step in this process is to apply the noise buffer size to identified potential sites and examine if the areas fall into the GO or NO-GO buffers as identified by the GO/NO-GO Siting Analysis Map.

Evaluation
A site is not considered feasible if it would fall within the boundary noise buffer zone.

3.5 LIMITATIONS ASSOCIATED WITH SDZS

Definitions
The definitional parameters of an SDZ are explained in Sections 1.2.5 and 2.2.

Criteria Requirement
The SDZs for CALFEX training operations cannot extend beyond the installation boundary. Additionally, the SDZs cannot extend into area with hardened facilities or public transportation routes.

Analysis
The first step in this process is to apply various SDZs that would be utilized during CALFEX training operations to the identified potential sites and examine if the areas meet the criteria requirements.

Evaluation
A site is not considered feasible if it would necessitate firing over public transportation routes or other public use facilities.

3.6 CONSIDERATIONS ASSOCIATED WITH RESTRICTED OR SPECIAL USE AIRSPACE

Definitions
Restricted or Special Use Airspace is not considered a mandatory GO/NO-GO criteria for NEPA siting analysis and is therefore not officially included for this siting analysis, however the restricted airspace for Richardson Training Area has been added to the siting analysis maps so that it can be seen in relation to the potential siting locations. Units conducting CALFEX exercises have the option to incorporate and utilize aerial drones or unmanned aerial vehicles (UAVs) in various CALFEX scenarios to increase and improve combat realism within a training environment. Considerations pertaining to restricted or special use airspace for the operation of drones and UAVs during these types of training exercises must be taken into account.

Additionally there are certain types of activities and exercises that may require special use airspace such as artillery fire, mortars, missiles and rockets, air-to-ground and ground–to-air weapon systems, aerial target practice, laser operations, demolition and explosive devices, electronic warfare devices, remotely piloted and unmanned aerial systems, conducting hazardous activities, small arms ranges and any other activity considered to be hazardous or non-compatible with other users of the airspace. Predominately, there are two types of special use airspace that are taken into consideration when scheduling training at Richardson Training Area.

- Restricted Areas – which is airspace identified by an area on the surface of the earth within which the flight of aircraft, while not wholly prohibited, is subject to restrictions. Restricted areas will be designated when determined necessary to confine or segregate activities considered to be hazardous to nonparticipating aircraft. Examples of those activities include, but are not limited to, artillery, aerial gunnery, or guided missile firing.
- Controlled Firing Areas (CFAs) – which are established to contain activities that, if not conducted in a controlled environment, would be hazardous to nonparticipating aircraft. The distinguishing feature of a CFA, as compared to other Special Use Airpsace, is that its activities are suspended immediately when spotter aircraft, radar, or ground lookout positions indicate an aircraft might be approaching the area. Examples of CFAs are small arms or Explosive Ordnance Disposal (EOD) ranges.

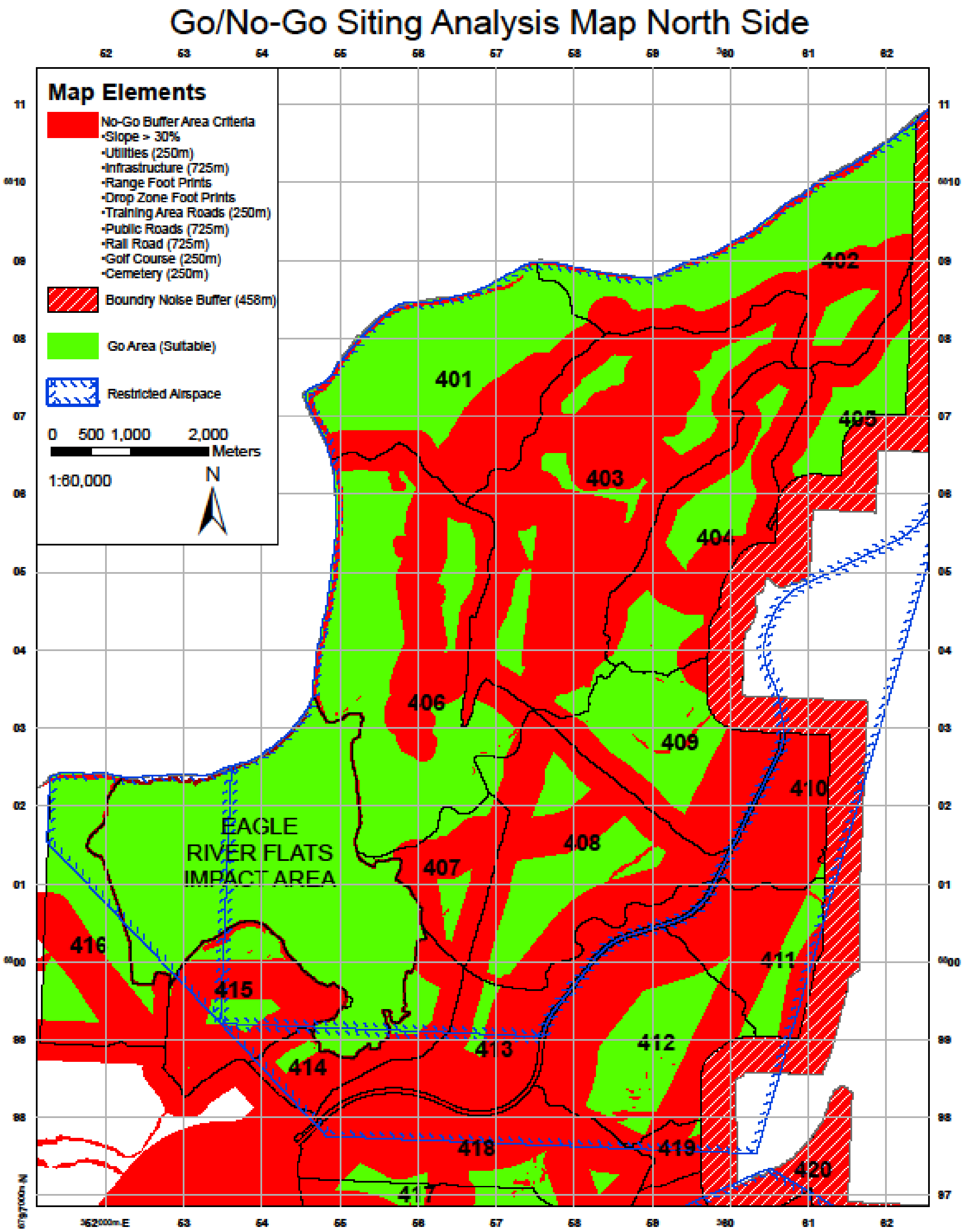

Figure 3.1 – GO/NO-GO Siting Analysis Map North Side

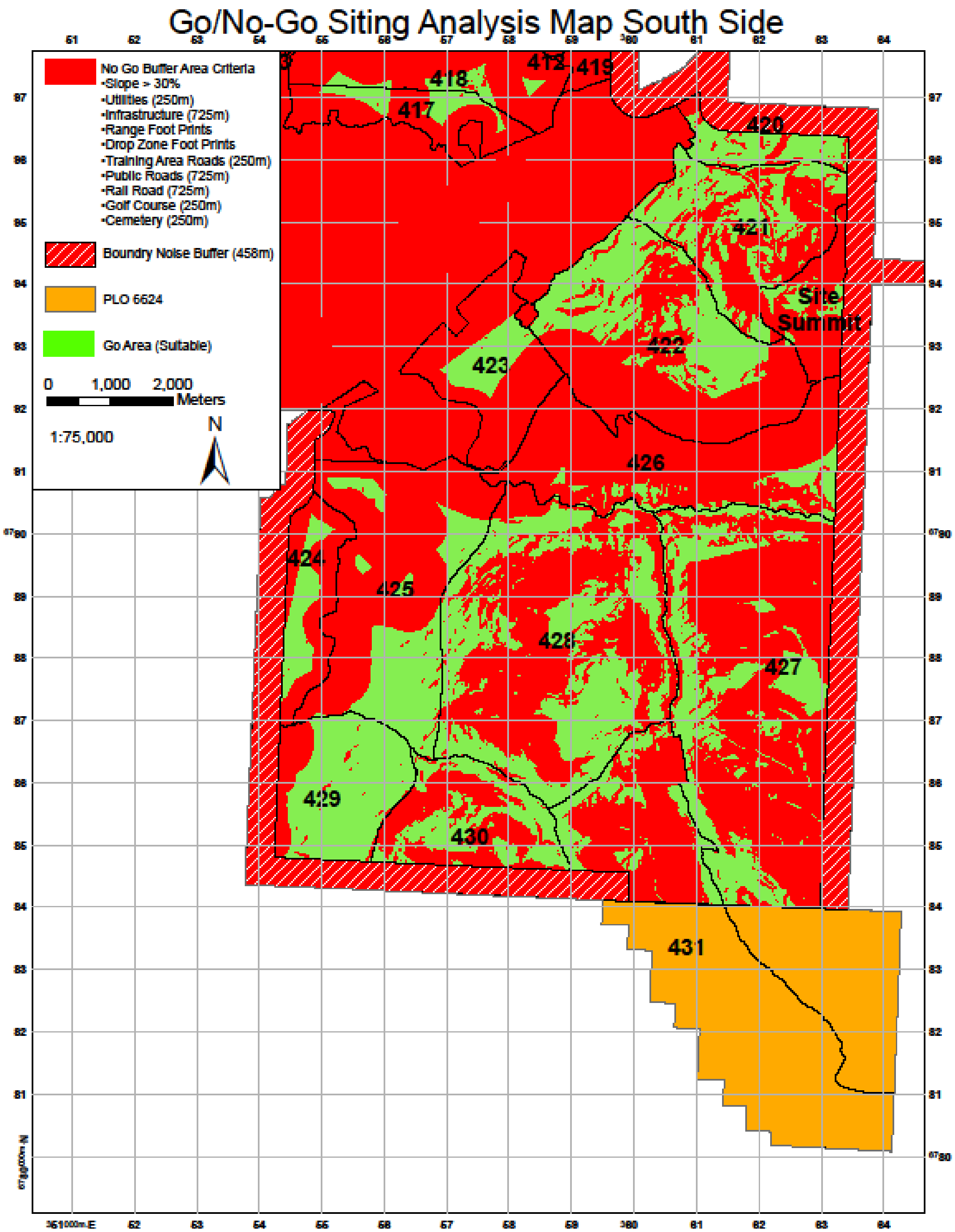

Figure 3.2 – GO/NO-GO Siting Analysis Map South Side

4.0 SITE EVALUATION

4.1 SITE EVALUATION PROCESS

Potential sites are evaluated through the following process:

1. Apply the existing ERF Impact Area size (2,483 acres) with an additional approximate 400-acre expansion to meet CALFEX training requirements.
2. Assess potential sites' ability to meet mandatory criteria.
3. Where mandatory criteria are not met, attempt to resolve conflicts through practicable Reconfiguration.
4. Re-assess potential sites' ability to meet mandatory criteria in light of practicable Reconfiguration.

Please note that based on the screening criteria and size requirements of the existing ERF area, there is no suitable land on south side of the installation to feasibly be used as an impact area.

4.2 INDIVIDUAL SITE EVALUATION RESULTS

The following sections evaluate each potential site based on the evaluation criterion listed above. Each section contains an illustration showing the application of the Artillery and Mortar Range Template to the potential site. The illustration will also highlight other relevant considerations such as hardened facilities, public transportation routes, and noise contours.

4.2.1 Potential Site Option 1

Criteria 1: Potential Site Option 1 is a GO for this criterion. This potential site meets the practical reconfiguration of the site evaluation process and does not conflict with hardened facilities. The CALFEX safety firing fan extends into the buffer zone of a hardened maneuver trail but does not extend over the actual maneuver trail itself and is considered acceptable because of the length limitations of the firing fan parameters.

Criteria 2: Potential Site Option 1 is a GO for this criterion. This potential site does not conflict with any public transportation routes.

Criteria 3: Potential Site Option 1 is a GO for this criterion. This potential site does not conflict with the noise contour overlay.

Criteria 4: Potential Site Option 1 is a GO for this criterion. This potential site does not conflict with the SDZ leaving the installation.

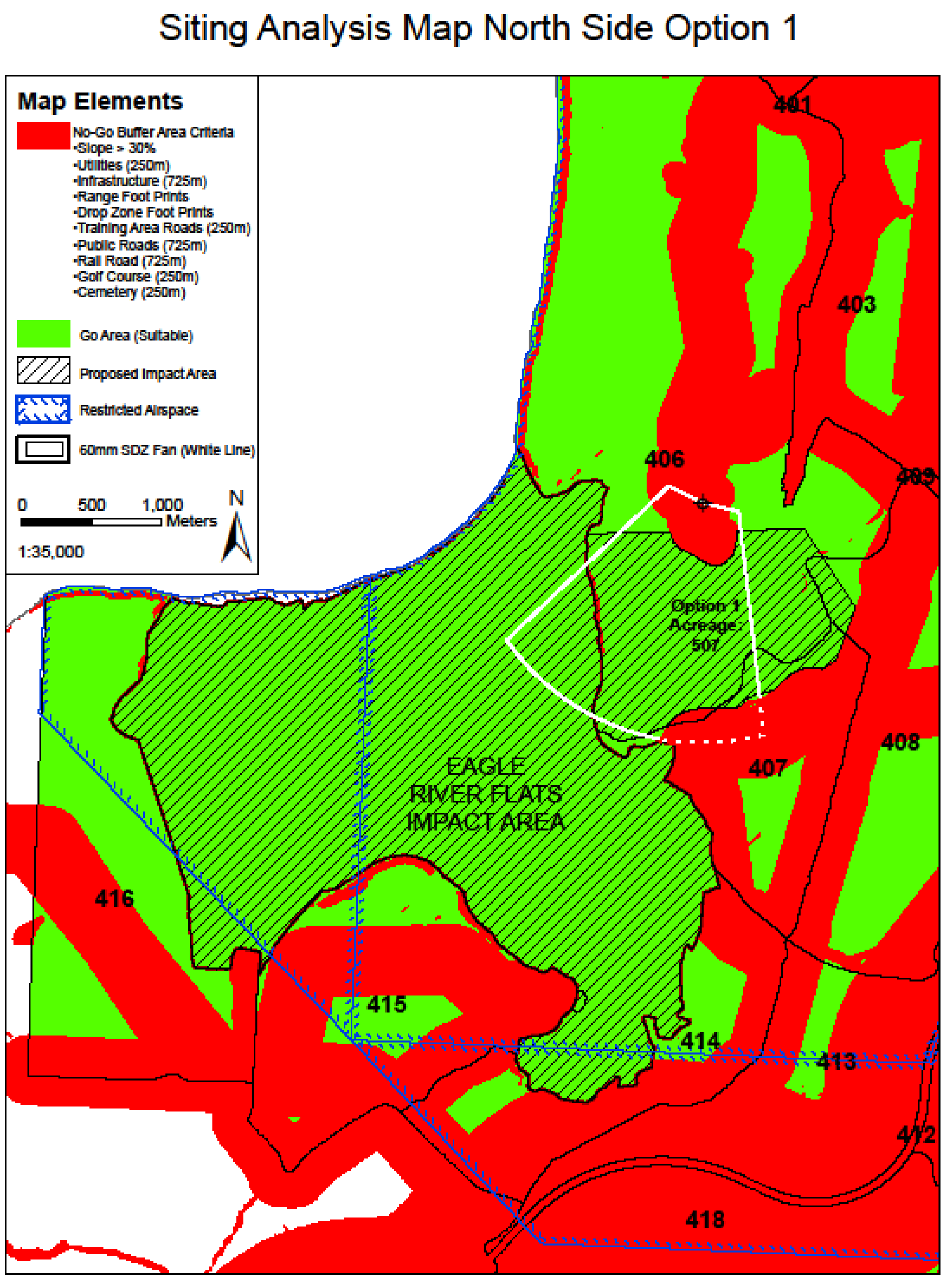

Figure 4.1 Siting Analysis Map North Side Option 1

4.2.2 Potential Site Option 2

Criteria 1: Potential Site Option 2 is a GO for this criterion. This potential site does not conflict with hardened facilities.

Criteria 2: Potential Site Option 2 is a GO for this criterion. This potential site does not conflict with any public transportation routes.

Criteria 3: Potential Site Option 2 is a GO for this criterion. This potential site does not conflict with the noise contour overlay.

Criteria 4: Potential Site Option 2 is a NO-GO for this criterion. This potential site does conflict with the SDZ leaving the installation and also presents safety issues concerning mortar fire occurring directly overhead of soldiers during a CALFEX event.

Siting Analysis Map North Side Option 2

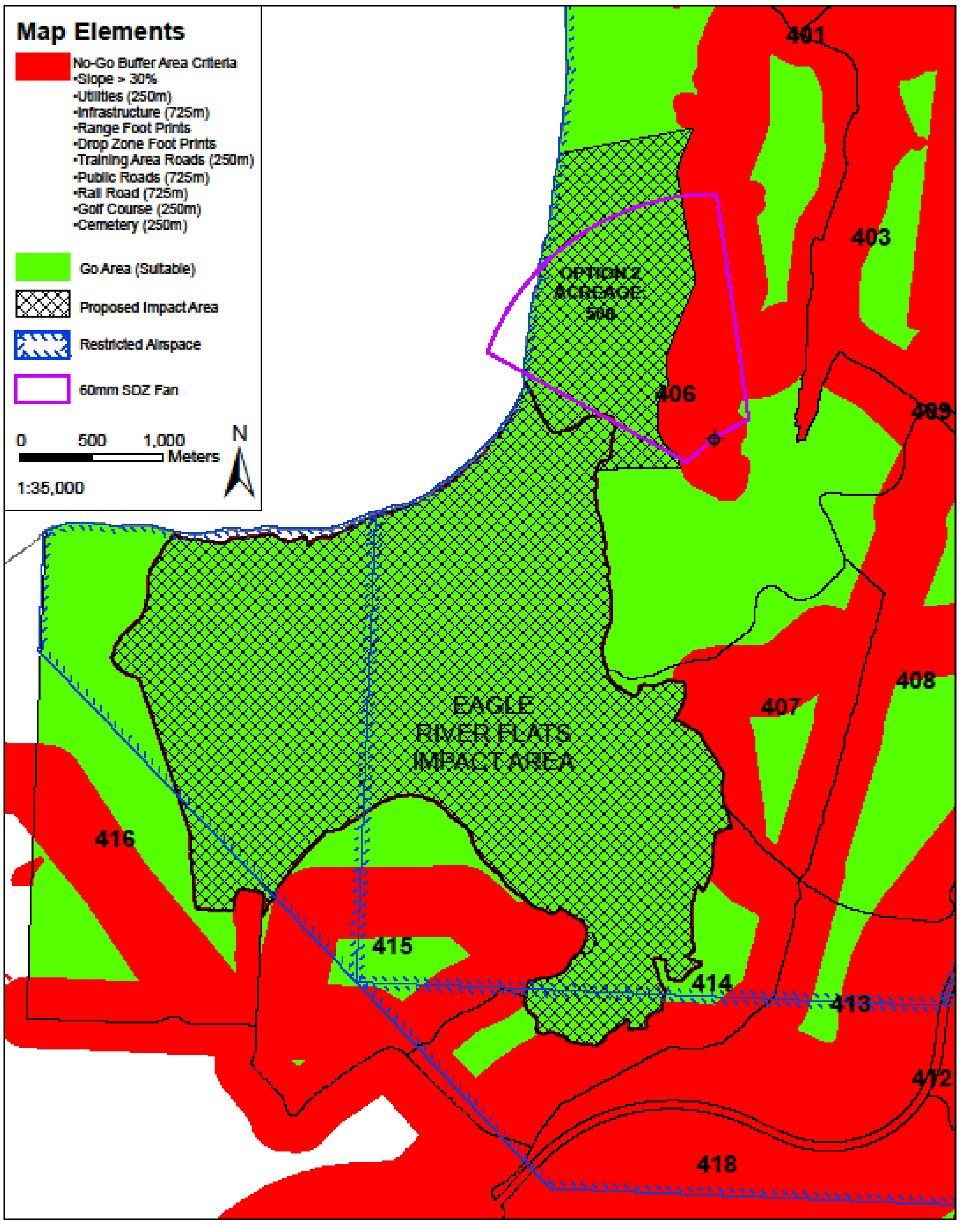

Figure 4.2 Siting Analysis Map North Side Option 2

4.2.3 Potential Site Option 3

Criteria 1: Potential Site Option 3 is a NO-GO for this criterion. This potential site does conflict with potentially impacting a high tension power line within TA 417 and a hardened EOD facility during live fire operations.

Criteria 2: Potential Site Option 3 is a GO for this criterion. This potential site does not conflict with any public transportation routes.

Criteria 3: Potential Site Option 3 is a GO for this criterion. This potential site does not conflict with the noise contour overlay.

Criteria 4: Potential Site Option 3 is a NO-GO for this criterion. This potential site is not practical for CALFEX operations because live fire cannot directly be observed and felt by units negotiating the exercise from the IPBC, therefore the safety firing fan was not applied to the map for this Option.

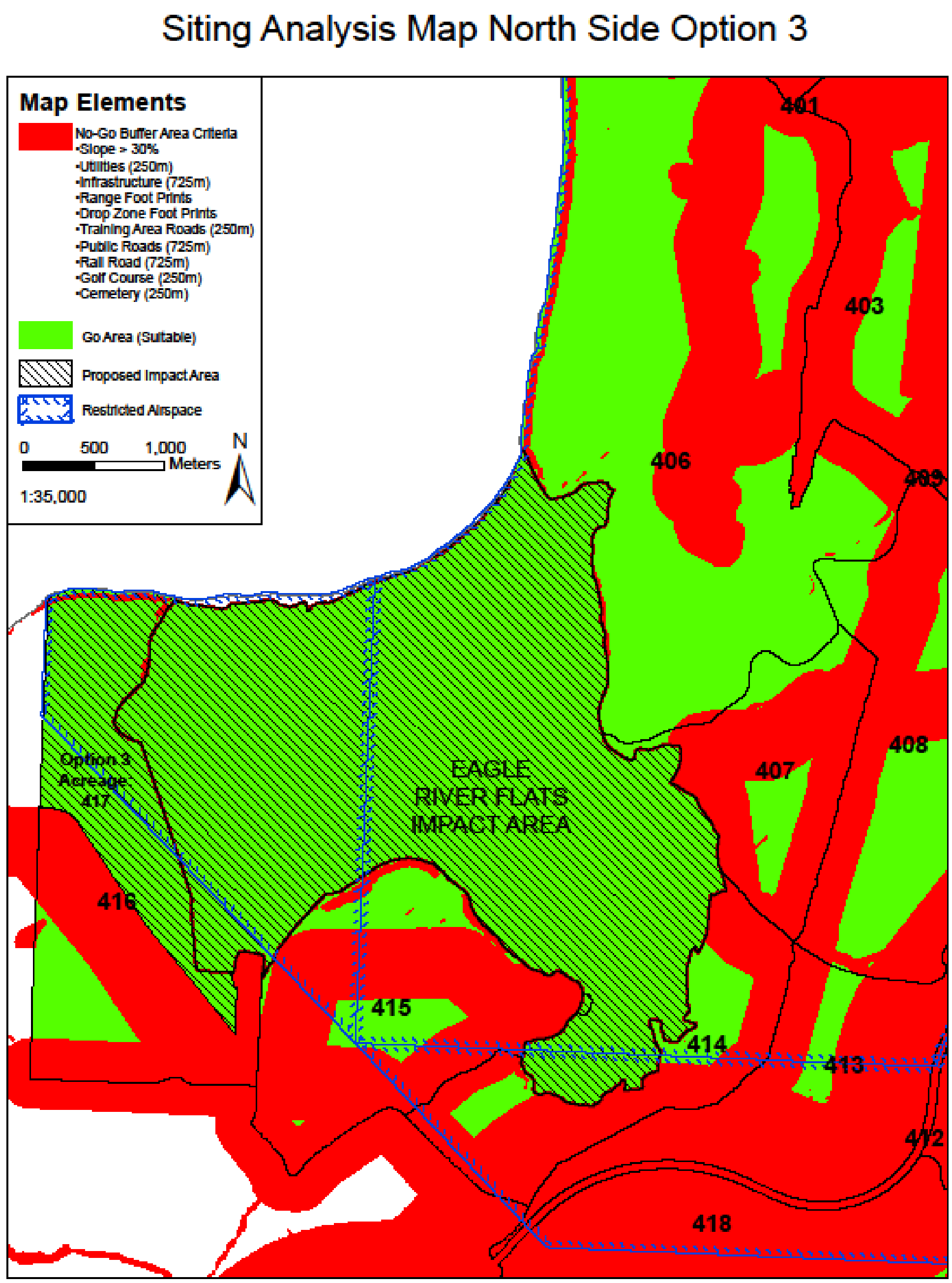

Figure 4.3 Siting Analysis Map North Side Option 3

5.0 CONCLUSION

This analysis uses essential training and safety-related criteria to evaluate the feasibility of siting an expanded ERF Impact Area on Richardson Training Area. The results of this analysis demonstrate that Potential Site Option 1 is the only location on Richardson Training Area capable of supporting the expansion of ERF Impact Area to facilitate condition driven all season live-fire training optempo and meet the CALFEX Live Fire Proficiency Gate.

6.0 REFERENCES

ANSI 1990
AR 200-1
AR 385-63
FM 3-22.90, Mortars, December 2007
FM 6-50, Tactics, Techniques, and Procedures for the Field Artillery Cannon Battery, December 1996
DA Pam 385-63
DA Pam 350-38, Standards in Weapons Training, 2008
Transformation EIS (USARAK 2004)
USARAK 350-2
Training Circular 3-20.0 Integrated Weapon Training Strategy

APPENDIX B–AGENCY COORDINATION AND PUBLIC INVOLVEMENT

CONSULTATION/COORDINATION

Consultation/coordination was conducted during the environmental impact analysis process with various local, state, and federal authorities including, but are not limited to, the agencies listed below. The Air Force is committed to working with state and federal regulatory agencies with special expertise in addressing potentially affected environmental resources. The Air Force solicited comments from interested local, state, and federal elected officials and agencies and Alaska Native organizations by mailing a memorandum announcing scoping on 6 April 2020 and Notice of Availability of this EIS. Scoping comments were received from the U.S. Army Corps of Engineers and U.S. Environmental Protection Agency. No responses to the 6 April 2020 memorandum were received from other federal or state agencies.

Federal Agencies

- U.S. Bureau of Indian Affairs
- Department of Agriculture
- Department of Interior – Office of Environmental Policy & Compliance
- U.S. Environmental Protection Agency
- U.S. Federal Aviation Administration
- U.S. Fish and Wildlife Service (USFWS)
- National Marine Fisheries Service (NMFS)
- National Park Service
- Bureau of Land Management (BLM)
- U.S. Army Corps of Engineers
- U.S. Department of Transportation

State Agencies

- Alaska Department of Fish and Game (ADF&G)
- Alaska Department of Environmental Conservation (ADEC)
- Alaska State Historic Preservation Officer (SHPO)
- Alaska Department of Natural Resources (DNR)

Local Agencies

- Municipality of Anchorage
- Local community council organizations

Entities

- Native Village of Eklutna
- Chickaloon Village Traditional Council
- Knik Tribe
- Native Village of Tyonek
- Cook Inlet Regional Incorporated
- Eklutna Inc.

The Air Force sent memoranda to the Alaska State Historic Preservation Officer (SHPO), the Anchorage Historic Preservation Commission, and Alaska Native entities to initiate consultations on 1 April 2020 and 3 April 2020 for the proposed project, consistent with 36 CFR § 800.4, and invited the Advisory Council on Historic Preservation to consult on the proposed project, consistent with Section 106 of the National Historic Preservation Act of 1966 as amended (54 U.S.C. § 300101 et seq.), as implemented in 36 CFR Part 800 and directed by Air Force Manual (AFMAN) 32-7003.

Notification of Intent to Initiate Section 7 Consultation under the ESA was sent to NMFS on 31 March 2020. Section 7(a)(2) of the ESA (16 U.S.C. § 1531 et seq.) requires that the Air Force (Federal Action Agency) consult with NMFS with respect to any action authorized, funded, or undertaken by that agency that may affect listed species or their critical habitat. The Air Force has prepared a Biological Assessment (BA) to describe how the actions proposed in the EIS may affect listed marine mammal species and their critical habitat in the vicinity of the project (Appendix D). Request for Informal Consultation with NMFS was requested by the Air Force on 10 February 2025 with the submittal of a BA. The BA, which utilized the best available scientific and commercial data, indicates that all potential effects of the proposed action (with mitigation measures) would be either insignificant or discountable. JBER has thus determined that the proposed project may affect but is not likely to adversely affect Cook Inlet beluga whales, Cook Inlet beluga whale designated critical habitat, or Steller sea lions. The Air Force requested concurrence with the "may affect, but not likely to adversely affect" determination.

Notification of Intent to Initiate EFH Consultation was sent to the NMFS Regional EFH Director and the Alaska Region Habitat Conservation Division on 31 March 2020. The Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. § 1801 et seq.) requires federal agencies to consult with NMFS on actions that may adversely affect EFH. EFH includes those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. Generally, EFH consultation consists of a federal agency notifying NMFS regarding an action that may adversely affect EFH and providing them with an EFH assessment (50 CFR § 600.920[e]). JBER has prepared an EFH assessment to describe how the actions proposed in the EIS may affect designated EFH and the managed species in the action area (Appendix E). Correspondences related to the EFH dated 16 July 2024, 9 September 2024, and 1 October 2024 are included in Appendix B. EFH consultation ended with NMFS's consideration and acceptance of the response by the Air Force dated 1 October 2024.

The Air Force coordinated with NMFS regarding the results of noise modeling, protective measures, potential presence of marine mammals in the specific geographic region of the project, and potential project impacts on marine mammals. On 1 October 2024 the Air Force submitted a request for an incidental take authorization (ITA) under section 101(a)(5)(A) of the Marine Mammal Protection Act of 1972, as amended, for the take of marine mammals incidental to conducting the proposed mortar and artillery training. In a memorandum to the Air Force dated 3 January 2025, NMFS responded that after review of the ITA request, including the proposed mitigation and monitoring measures detailed in the ITA request and based on the analysis included in the memorandum, NMFS has determined that the incidental take of marine mammals is not reasonably likely to occur because the specified activities would not harass (as defined for a "military readiness activity" under 16 U.S.C. § 1362(18)(B)) or result in the mortality of any marine mammal or marine mammal stock. Therefore, an ITA under the Marine Mammal Protection Act is not necessary for the specified activities.

GOVERNMENT-TO-GOVERNMENT AND SECTION 106 CONSULTATION RESPONSES

The Air Force extended invitations to six Tribal entities to consult on a government-to-government basis for the project on 17 April 2020. Consistent with National Historic Preservation Act implementing regulations (36 CFR Part 800); Department of Defense (DoD) Instruction (DoDI) 4710.02, DOD Interactions with Federally Recognized Tribes; Department of the Air Force Instruction (DAFI) 90-2002, Interactions with Federally Recognized Tribes; AFMAN 32-7003, Environmental Conservation; and EO 13007, Indian Sacred Sites, the Air Force is consulting with Federally Recognized Alaska Native Tribes, Alaska Native Corporations, and Alaska Native groups that are historically affiliated with the geographic region of each site being considered in the proposed action and alternatives regarding the potential to affect properties of cultural, historical, or religious significance to the Alaska Native Tribes, Alaska Native Corporations, and Alaska Native groups.

This appendix provides a summary of Air Force communications for Government-to-Government consultation with potentially affected Alaska Native Tribes, Alaska Native Corporations, and Alaska Native groups and consultation under Section 106 of the National Historic Preservation Act. Correspondence that included confidential information is not included in this appendix. Entities listed in Table B-1 received letters notifying them of the project, requesting Government-to-Government and Section 106 consultation. Follow up correspondence was conducted for entities that did not respond to initial consultation and coordination efforts. This additional outreach included telephone and email correspondence, as summarized in Table B-1.

Table B-1: Summary of Consultation and Correspondence

Entity	Summary Response	NEPA Notification Letter	Government-to-Government and Section 106 Letters	Follow-Up Correspondence (emails/phone calls and meetings)
Chickaloon Village Traditional Council	3 June 2022 responded requesting continuing engagement; request to be signatory on MOA 23 January 2023 23 January 2023 Letter sent to USACE from Chickaloon Native Village formally requesting to be a signatory to the MOA.	6 April 2020 scoping notification letter	17 April 2020 20 May 2022 23 January 2023	Informal call 17 March 2020; informal call 17 December 2020 and letter re-sent; calls made 22 July 2022; emails July 17 and 26, 2022; calls made August 24, 29, 30, 2022 (busy/left voicemails); calls made September 12 and 13 (left voicemail, no answer); response 23 January 2023; ongoing coordination for the MOA through 2023. 13 January 2023 MOA/PA meeting with Tribes and SHPO. 24 May 2023 Archaeological Site Visit with Tribes and I Installation Tribal Liaison Officer (ITLO). Representatives of the Native Village of Eklutna, Knik Tribe, and Chickaloon Village Traditional Council attended a project overview meeting on 29 February 2024. Email correspondence transmitting the Programmatic Agreement for signature on 27 June 2024. Email correspondence transmitting the Programmatic Agreement for signature on 27 June 2024.
Cook Inlet Region, Inc.	No response	6 April 2020 scoping notification letter	17 April 2020 20 May 2022	No response

Entity	Summary Response	NEPA Notification Letter	Government-to-Government and Section 106 Letters	Follow-Up Correspondence (emails/phone calls and meetings)
Eklutna, Inc.	No response	6 April 2020 scoping notification letter	17 April 2020 20 May 2022	Informal call 17 March 2020; ongoing coordination for the MOA through 2023. 13 January 2023 MOA/PA meeting with Tribes and SHPO. 24 May 2023 Archaeological Site Visit with Tribes and ITLO. Email correspondence transmitting the Programmatic Agreement for signature on 27 June 2024. Email correspondence transmitting the Programmatic Agreement for signature on 27 June 2024.
Knik Tribe	21 September 2020 letter requesting Government-to-Government consultation to discuss significant Cultural Sites	6 April 2020 scoping notification letter	17 April 2020, 20 May 2022	Informal call 17 March 2020. Phone call 18 Sept 2020 to discuss archaeological survey results; ongoing coordination for the MOA through 2023. 13 January 2023 MOA/PA meeting with Tribes and SHPO. 24 May 2023 Archaeological Site Visit with Tribes and ITLO. Email correspondence transmitting the Programmatic Agreement for signature on 27 June 2024. Representatives of the Native Village of Eklutna, Knik Tribe, and Chickaloon Village Traditional Council attended a project overview meeting on 29 February 2024. Email correspondence transmitting the Programmatic Agreement for signature on 27 June 2024.
Native Village of Eklutna	Government-to-Government meeting October 2020	6 April 2020 scoping notification letter	17 April 2020 9 September 2020 20 May 2022	Informal call 17 March 2020. Phone call 21 July 2020 to discuss archaeological survey results and potential impacts on natural resources. Correspondence sent on 14 September 2020; ongoing coordination for the MOA through 2023. 13 January 2023 MOA/PA meeting with Tribes and SHPO. 24 May 2023 Archaeological Site Visit with Tribes and ITLO. Representatives of the Native Village of Eklutna, Knik Tribe, and Chickaloon Village Traditional Council attended a project overview meeting on 29 February 2024. Email correspondence transmitting the Programmatic Agreement for signature on 27 June 2024.
Native Village of Tyonek	No response	6 April 2020 scoping notification letter	17 April 2020, 20 May 2022	No response

Entity	Summary Response	NEPA Notification Letter	Government-to-Government and Section 106 Letters	Follow-Up Correspondence (emails/phone calls and meetings)
State Historic Preservation Officer (SHPO)	1 May 2020 email received from SHPO confirming receipt on 3 April 2020 of the 29 March 2020 letter and agreeing to defined Area of Potential Effect. Additional correspondence to discuss archaeological survey results. 24 March 2021 Letter SHPO recommended amending the 2012 MOA and minimizing effects to resources.	1 April 2020 scoping notification letter	29 March 2020 9 September 2020 2 November 2022	Response was received – ongoing coordination for the MOA through 2023. 13 January 2023 MOA/PA meeting with Tribes and SHPO. Email correspondence transmitting the Programmatic Agreement for signature on 27 June 2024. 28 October 2024 letter from SHPO with signature page for the Section 106 agreement.
Municipality of Anchorage - Historic Preservation Commission	2 April 2020 email from Anchorage Historic Preservation Commission requesting to be added to consultation list for the EIS.	1 April 2020	29 March 2020	Response was received – no additional follow-up required. Email correspondence transmitting the Programmatic Agreement for signature on 27 June 2024.
Advisory Council on Historic Preservation	2 February 2021 letter declining participation and noting that 2012 MOA is still valid. 23 May 2024 Letter acknowledging notification and supporting documentation received 13 May 2024 of the Programmatic Agreement and declining participation in consultation.	N/A	21 January 2021 (notice of intent to amend 2012 MOA)	Response was received – no additional follow-up required. 12 December 2024 letter acknowledging receipt of the executed Section 106 agreement.

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, 673rd AIR BASE WING
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

MEMORANDUM FOR THE ALASKA STATE HISTORIC PRESERVATION OFFICER
ATTN: MS. JUDITH BITTNER, SHPO
Alaska Department of Natural Resources
Division of History and Archaeology
550 W. 7th Avenue, Suite 1310
Anchorage, AK 99501

FROM: 673 CEG/CC
6346 Arctic Warrior Drive
JBER, AK 99506-3240

SUBJECT: Section 106 Consultation for the Proposal for Mortar and Artillery Training (PMART) at Richardson Training Area, Joint Base Elmendorf-Richardson, Alaska

1. The United States Air Force (USAF) is proposing to modify the conditions under which indirect live-fire weapons training can be conducted at Joint Base Elmendorf-Richardson (JBER), Alaska. An Environmental Impact Statement (EIS) is being prepared for the proposed action, which will evaluate the potential impacts associated with conducting all-season indirect live-fire weapons training at Richardson Training Area, Eagle River Flats (ERF) Impact Area. The new EIS is being prepared in accordance with the National Environmental Policy Act (NEPA), the Council on Environmental Quality (CEQ) implementing regulations (40 Code of Federal Regulations [CFR] Part 1500-1508) and USAF NEPA regulations (32 CFR Part 989).

2. Current restrictions limit training on JBER's only explosive munitions impact area to winter months (November 1 to March 31), dependent on ice cover. The USAF, in coordination with the United States Army Alaska (USARAK), has delineated an Area of Potential Effect (APE) for the proposal that takes into account the potential effects of the Project as required in 36 CFR 800.4(1). For the purposes of Section 106 of the National Historic Preservation Act, the APE includes ERF Impact Area, which is comprised of 2,160 acres of tidal salt marsh and 323 acres of associated upland buffer areas. The APE also includes a 585-acre expansion area located adjacent to ERF. A map is included with this letter. Within the APE, potential effects to cultural resources that may be eligible for the National Register of Historic Places could include physical damage or destruction from live-fire munitions, change in the character of the property's use, as well as the introduction/modification of visual, atmospheric, and/or audible elements to an associated historic property.

3. The USAF would like to initiate consultations on this proposal consistent with 36 CFR 800.4 and invites the Alaska State Historic Preservation Officer to consult on the proposal consistent with Section 106 of the National Historic Preservation Act of 1966 (54 United States Code 300101 et seq.) as implemented in 36 CFR Part 800 and directed by Air Force Instruction 32-7065 (revised 2016).

4. If you wish to consult on this project and/or meet with me to discuss the PMART as well as your concerns about the effects on your interests if this proposal is implemented, contact our Cultural Resource Manager, Ms. Margan Grover at (907) 384-3467, or via email at margan.grover@us.af.mil.

STAPLES.MICHAEL.R.1006515084 Digitally signed by STAPLES.MICHAEL.R.1006515084 Date: 2020.03.29 21:32:35 -08'00'

MICHAEL R. STAPLES, Col, USAF
Commander

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, 673rd AIR BASE WING
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

MEMORANDUM FOR ANCHORAGE HISTORIC PRESERVATION COMMISSION
ATTN: MONTY ROGERS, CHAIR
Municipality of Anchorage c/o Planning Department
PO Box 196650
Anchorage, AK 99519-6650

FROM: 673 CEG/CC
6346 Arctic Warrior Drive
JBER, AK 99506-3240

SUBJECT: Section 106 Consultation for the Proposal for Mortar and Artillery Training (PMART) at Richardson Training Area, Joint Base Elmendorf-Richardson, Alaska

1. The United States Air Force (USAF) is proposing to modify the conditions under which indirect live-fire weapons training can be conducted at Joint Base Elmendorf-Richardson (JBER), Alaska. An Environmental Impact Statement (EIS) is being prepared for the proposed action, which will evaluate the potential impacts associated with conducting all-season indirect live-fire weapons training at Richardson Training Area, Eagle River Flats (ERF) Impact Area. The new EIS is being prepared in accordance with the National Environmental Policy Act (NEPA), the Council on Environmental Quality (CEQ) implementing regulations (40 Code of Federal Regulations [CFR] Part 1500-1508) and USAF NEPA regulations (32 CFR Part 989).

2. Current restrictions limit training on JBER's only explosive munitions impact area to winter months (November 1 to March 31), dependent on ice cover. The USAF, in coordination with the United States Army Alaska (USARAK), has delineated an Area of Potential Effect (APE) for the proposal that takes into account the potential effects of the Project as required in 36 CFR 800.4(1). For the purposes of Section 106 of the National Historic Preservation Act, the APE includes ERF Impact Area, which is comprised of 2,160 acres of tidal salt marsh and 323 acres of associated upland buffer areas. The APE also includes a 585-acre expansion area located adjacent to ERF. A map is included with this letter. Within the APE, potential effects to cultural resources that may be eligible for the National Register of Historic Places could include physical damage or destruction from live-fire munitions, change in the character of the property's use, as well as the introduction/modification of visual, atmospheric, and/or audible elements to an associated historic property.

3. The USAF would like to initiate consultations on this proposal consistent with 36 CFR 800.4 and invites the Anchorage Historic Preservation Commission to consult on the proposal consistent with Section 106 of the National Historic Preservation Act of 1966 (54 United States Code 300101 et seq.) as implemented in 36 CFR Part 800 and directed by Air Force Instruction 32-7065 (revised 2016).

4. If you wish to consult on this project and/or meet with me to discuss the PMART as well as your concerns about the effects on your interests if this proposal is implemented, contact our Cultural Resource Manager, Ms. Margan Grover at (907) 384-3467, or via email at margan.grover@us.af.mil.

STAPLES.MICHAEL.R.1006515084 Digitally signed by STAPLES.MICHAEL.R.1006515084 Date: 2020.03.29 21:32:44 -08'00'

MICHAEL R. STAPLES, Col, USAF
Commander

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, 673rd AIR BASE WING
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

6 April 2020

MEMORANDUM FOR ANNOUNCEMENT OF SCOPING

FROM: 673 CES/CEI
730 Quartermaster Road
JBER AK 99505

SUBJECT: Proposal for Mortar and Artillery Training (PMART) at Richardson Training Area, Joint Base Elmendorf-Richardson, Alaska – Environmental Impact Statement

1. As a direct result of the National Emergency declared by the President on Friday, March 13, 2020, in response to the coronavirus (COVID-19) pandemic in the U. S., and the Center for Disease Control's recommendations for social distancing and avoiding large public gatherings, the United States Air Force (USAF) has cancelled the two public scoping meetings scheduled to occur on April 13, 2020 and April 14, 2020. In lieu of the public scoping meetings, the USAF will use the alternative means set forth below to inform the public and stakeholders and to obtain input for scoping the proposed action.

2. The USAF is proposing to modify the conditions under which indirect live-fire weapons training can be conducted at Joint Base Elmendorf-Richardson (JBER), Alaska. An Environmental Impact Statement (EIS) is being prepared for the proposed action, which focuses on live-fire weapons training at the Richardson Training Area, Eagle River Flats (ERF) Impact Area. All-season training is necessary to ensure that Soldiers achieve and maintain critical combat skills. Current live-fire restrictions limit training on JBER's only currently usable explosive munitions impact area to winter firing only (November 1 to March 31), dependent on ice cover requirements.

3. The U.S. Army Alaska (USARAK) has used ERF Impact Area for live-fire training since the 1940s. Restrictions put in place in 1991 allow use of the impact area for winter firing only (1 November through 31 March), provided required ice thickness conditions are also met. With these seasonal restrictions in place, units stationed at JBER have not been able to conduct the full range of required indirect live-fire training exercises at JBER, and must deploy to other installations during portions of the year to conduct their required small unit training.

4. A new EIS is now being prepared in accordance with the National Environmental Policy Act (NEPA) of 1969 and the Council on Environmental Quality (CEQ) regulations implementing NEPA (40 Code of Federal Regulations [CFR] Part 1500-1508) and USAF NEPA regulations at 36 CFR Part 989.

5. The EIS will evaluate the potential impacts associated with the proposed action, which includes indirect live-fire training during all-seasons at ERF Impact Area on JBER, in order to meet Army training standards. The proposed action also includes expansion of ERF impact area by approximately 585 acres. In addition, the EIS will evaluate an action alternative that would marginally meet Army training standards, and would not include expansion of ERF impact area. The no action alternative will also be evaluated in the EIS, under which the Army would continue to train

with the existing seasonal restrictions and which would require JBER home station units to deploy to other Army-controlled training lands to conduct required training. The USAF is the NEPA lead agency and the US Army is a cooperating agency for this EIS process.

6. To define the full range of issues to be evaluated in the EIS, the USAF will determine the scope of the analysis by soliciting comments from interested local, state, and federal elected officials and agencies, Alaska Native organizations, as well as interested members of the public and others. This is being done by providing a website where the public can submit comments and/or by having comments mailed to the mailing address provided below.

7. In lieu of scoping meetings, information on the proposal will be available on the project website at: https://JBER-PMART-EIS.com. For those who do not have ready access to a computer or the internet, the scoping-related materials posted to the website will be made available upon request. Inquiries, requests for scoping-related materials, and comments regarding the EIS may be submitted by mail to JBER Public Affairs, JBER.PA@US.AF.MIL, (907) 552–8151; (US Post Office) JBER Public Affairs c/o Matthew Beattie, 10480 Sijan Ave., Suite 123, JBER, AK 99506.

8. Written scoping comments will be accepted at any time during the environmental impact analysis process up until the public release of the Draft EIS. However, to ensure the USAF has sufficient time to consider public input in the preparation of the Draft EIS, scoping comments should be submitted to the website or the address listed above by no later than May 11, 2020.

9. If you wish to receive additional information please contact JBER Public Affairs at 907-552-8151 or JBER.PA@US.AF.MIL.

JENNI DORSEY-SPITZ, USAF
Chief Installation Management
673d Civil Engineer Squadron

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, JOINT BASE ELMENDORF-RICHARDSON
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

MEMORANDUM FOR EKLUTNA, INC.
ATTN: MR. MICHAEL E. CURRY, CHAIR AND PRESIDENT
Eklutna, Inc.
1615 Centerfield Drive, Suite 201
Eagle River AK 99577

FROM: 673 ABW/CC
10471 20th Street, Suite 139
JBER AK 99506-2200

SUBJECT: Consultation for the Proposal for Mortar and Artillery Training (PMART) at Richardson Training Area, Joint Base Elmendorf-Richardson, Alaska (AK)

1. The United States Air Force (USAF) is proposing to modify the conditions under which indirect live-fire weapons training can be conducted at Joint Base Elmendorf-Richardson (JBER), Alaska. An Environmental Impact Statement (EIS) is being prepared for the proposed action, which will evaluate the potential impacts associated with indirect live-fire training to occur during all seasons at Richardson Training Area, Eagle River Flats (ERF) Impact Area. The new EIS is being prepared in accordance with the National Environmental Policy Act (NEPA) of 1969 and the Council on Environmental Quality (CEQ) regulations implementing NEPA (40 Code of Federal Regulations [CFR] Part 1500-1508) and USAF NEPA regulations at 36 CFR Part 989.

2. All-season training is necessary to ensure Soldiers achieve and maintain critical combat skills. Current live-fire restrictions limit training on JBER's only usable explosive munitions impact area to winter firing only (November 1 to March 31), dependent on ice cover requirements. The winter firing restriction was put in place in 1991. With these seasonal restrictions in place, units stationed at JBER have not been able to conduct the full range of required indirect live-fire training exercises at JBER, and must deploy to other installations during portions of the year to conduct their required small unit training. In 2010, a Draft EIS to resume all-season indirect live-fire training at the former Fort Richardson was developed. In addition, the USAF and USARAK consulted with Tribes and the Alaska State Historic Preservation Officer (SHPO) consistent with Section 106 of the National Historic Preservation Act (NHPA). Since the release of the Draft EIS, organizational changes resulted in the joint basing of former Elmendorf Air Force Base and Fort Richardson into JBER. As the managing agency of JBER, the USAF is the lead agency for the preparation of a new EIS. USARAK retains operational responsibility for training areas and ranges, and is a cooperating agency on this new EIS.

3. The USAF, in coordination with USARAK, has delineated an Area of Potential Effect (APE) for the proposal that takes into account the potential effects of the Project as required in 36 CFR 800.4(1). For the purposes of Section 106 of the NHPA, the APE includes ERF Impact Area, which currently consists of approximately 2,160 acres of tidal salt marsh and 323 acres of associated upland buffer areas. The APE also includes a 585-acre "impact area expansion" parcel that would involve

clear cutting approximately 430 acres of vegetation and creating approximately 1.83 miles of gravel service roads and pads. In addition, a 2.41-mile fire break will be created to contain wildland fires. A map is included with this letter. Within the APE, potential effects to cultural resources that may be eligible for the National Register of Historic Places could include physical damage or destruction from live-fire munitions, change in the character of the property's use, as well as the introduction/modification of visual, atmospheric, and/or audible elements to an associated historic property. The APE includes primary and secondary buffer areas that extend beyond proposed target areas. These areas provide sufficient space such that effects from fired or launched ammunition and explosives, namely from fragments, debris, and components from explosive projectiles, would not be expected to exceed the allocated buffer.

4. The USAF wishes to extend an invitation to Eklutna, Inc. to consult for the PMART. As part of the NEPA process, government-to-government consultation with Federally recognized Native American tribal entities is required per Executive Order 13175: *Memorandum on Government-to-Government Relations with Native American Tribal Governments*; Department of Defense (DoD) Instruction 4710.02: *DoD Interactions with Federally-Recognized Tribes*; and Air Force Instruction (AFI) 90-2002: *Air Force Interactions with Federally-Recognized Tribes*. Such authorities also require consultation with Alaska Native corporations on any proposed action that may have a substantial direct effect on corporate lands, waters, or other natural resources. In addition, consultations are being conducted in accordance with the NHPA and regulations (36 CFR Part 800). If you are interested in consulting on this proposal, the USAF requests your review and comments on the APE within 30 days of receiving this consultation request; however, a lack of response does not preclude your ability to consult or request consultation on this project.

5. As the 673d Air Base Wing Commander, I am offering to discuss our proposal in detail with you, and would like to hear from you regarding any comments, concerns, and suggestions you may have, including concerns regarding actions from the PMART that may affect corporate lands, waters, or other natural resources. If you determine that this action affects such resources and wish to consult on this action or discuss the PMART, please contact our Tribal Liaison Officer, Ms. Margan Grover, at (907) 384-3467, or via email at margan.grover@us.af.mil, to discuss any concerns or issues.

PATRICIA A. CSANK
Colonel, USAF
Commander

2 Attachments:
1. JBER Project Vicinity Map and Location of Eagle River Flats Impact Area
2. Section 106 Area of Potential Effects

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, JOINT BASE ELMENDORF-RICHARDSON
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

MEMORANDUM FOR KNIK TRIBAL COUNCIL
ATTN: MR. MICHAEL TUCKER, PRESIDENT
Knik Tribal Council
PO Box 871565
Wasilla AK 99687

FROM: 673 ABW/CC
10471 20th Street, Suite 139
JBER AK 99506-2200

SUBJECT: Government-to-Government Consultation for the Proposal for Mortar and Artillery Training (PMART) at Richardson Training Area, Joint Base Elmendorf-Richardson, Alaska (AK)

1. The United States Air Force (USAF) is proposing to modify the conditions under which indirect live-fire weapons training can be conducted at Joint Base Elmendorf-Richardson (JBER), Alaska. An Environmental Impact Statement (EIS) is being prepared for the proposed action, which will evaluate the potential impacts associated with indirect live-fire training to occur during all seasons at Richardson Training Area, Eagle River Flats (ERF) Impact Area. The new EIS is being prepared in accordance with the National Environmental Policy Act (NEPA) of 1969 and the Council on Environmental Quality (CEQ) regulations implementing NEPA (40 Code of Federal Regulations [CFR] Part 1500-1508) and USAF NEPA regulations at 36 CFR Part 989.

2. All-season training is necessary to ensure Soldiers achieve and maintain critical combat skills. Current live-fire restrictions limit training on JBER's only usable explosive munitions impact area to winter firing only (November 1 to March 31), dependent on ice cover requirements. The winter firing restriction was put in place in 1991. With these seasonal restrictions in place, units stationed at JBER have not been able to conduct the full range of required indirect live-fire training exercises at JBER, and must deploy to other installations during portions of the year to conduct their required small unit training. In 2010, a Draft EIS to resume all-season indirect live-fire training at the former Fort Richardson was developed. In addition, the USAF and USARAK consulted with Tribes and the Alaska State Historic Preservation Officer (SHPO) consistent with Section 106 of the NHPA. Since the release of the Draft EIS, organizational changes resulted in the joint basing of former Elmendorf Air Force Base and Fort Richardson into JBER. As the managing agency of JBER, the USAF is the lead agency for the preparation of a new EIS. USARAK retains operational responsibility for training areas and ranges, and is a cooperating agency on this new EIS.

3. The USAF, in coordination with USARAK, has delineated an Area of Potential Effect (APE) for the proposal that takes into account the potential effects of the Project as required in 36 CFR 800.4(1). For the purposes of Section 106 of the NHPA, the APE includes ERF Impact Area, which currently consists of approximately 2,160 acres of tidal salt marsh and 323 acres of associated upland buffer areas. The APE also includes a 585-acre "impact area expansion" parcel that would involve

clear cutting approximately 430 acres of vegetation and creating approximately 1.83 miles of gravel service roads and pads. In addition, a 2.41-mile fire break will be created to contain wildland fires. A map is included with this letter. Within the APE, potential effects to cultural resources that may be eligible for the National Register of Historic Places could include physical damage or destruction from live-fire munitions, change in the character of the property's use, as well as the introduction/modification of visual, atmospheric, and/or audible elements to an associated historic property. The APE includes primary and secondary buffer areas that extend beyond proposed target areas. These areas provide sufficient space such that effects from fired or launched ammunition and explosives, namely from fragments, debris, and components from explosive projectiles, would not be expected to exceed the allocated buffer.

4. The USAF wishes to extend an invitation to Knik Tribal Council to consult on a government-to-government basis for the PMART. As part of the NEPA process, government-to-government consultation with Federally recognized Native American tribal entities is required per Executive Order 13175: *Memorandum on Government-to-Government Relations with Native American Tribal Governments*; Department of Defense (DoD) Instruction 4710.02: *DoD Interactions with Federally-Recognized Tribes*; and Air Force Instruction (AFI) 90-2002: *Air Force Interactions with Federally-Recognized Tribes*. In addition, consultations are being conducted in accordance with the NHPA and regulations (36 CFR Part 800). If you are interested in consulting on this proposal, the USAF requests your review and comments on the APE within 30 days of receiving this consultation request; however, a lack of response does not preclude your ability to consult or request government-to-government consultation on this project.

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PATRICIA A. CSANK
Colonel, USAF
Commander

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DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, JOINT BASE ELMENDORF-RICHARDSON
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

MEMORANDUM FOR THE NATIVE VILLAGE OF EKLUTNA TRADITIONAL COUNCIL
ATTN: MR. AARON LEGGETT, PRESIDENT
Native Village of Eklutna Traditional Council
26339 Eklutna Village Road
Chugiak AK 99567

FROM: 673 ABW/CC
10471 20th Street, Suite 139
JBER AK 99506-2200

SUBJECT: Government-to-Government Consultation for the Proposal for Mortar and Artillery Training (PMART) at Richardson Training Area, Joint Base Elmendorf-Richardson, Alaska (AK)

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3. The USAF, in coordination with USARAK, has delineated an Area of Potential Effect (APE) for the proposal that takes into account the potential effects of the Project as required in 36 CFR 800.4(1). For the purposes of Section 106 of the NHPA, the APE includes ERF Impact Area, which

currently consists of approximately 2,160 acres of tidal salt marsh and 323 acres of associated upland buffer areas. The APE also includes a 585-acre "impact area expansion" parcel that would involve clear cutting approximately 430 acres of vegetation and creating approximately 1.83 miles of gravel service roads and pads. In addition, a 2.41-mile fire break will be created to contain wildland fires. A map is included with this letter. Within the APE, potential effects to cultural resources that may be eligible for the National Register of Historic Places could include physical damage or destruction from live-fire munitions, change in the character of the property's use, as well as the introduction/modification of visual, atmospheric, and/or audible elements to an associated historic property. The APE includes primary and secondary buffer areas that extend beyond proposed target areas. These areas provide sufficient space such that effects from fired or launched ammunition and explosives, namely from fragments, debris, and components from explosive projectiles, would not be expected to exceed the allocated buffer.

4. The USAF wishes to extend an invitation to the Native Village of Eklutna to consult on a government-to-government basis for the PMART. As part of the NEPA process, government-to-government consultation with Federally recognized Native American tribal entities is required per Executive Order 13175: *Memorandum on Government-to-Government Relations with Native American Tribal Governments*; Department of Defense (DoD) Instruction 4710.02: *DoD Interactions with Federally-Recognized Tribes*; and Air Force Instruction (AFI) 90-2002: *Air Force Interactions with Federally-Recognized Tribes*. In addition, consultations are being conducted in accordance with the NHPA and regulations (36 CFR Part 800). If you are interested in consulting on this proposal, the USAF requests your review and comments on the APE within 30 days of receiving this consultation request; however, a lack of response does not preclude your ability to consult or request government-to-government consultation on this project.

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PATRICIA A. CSANK
Colonel, USAF
Commander

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DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, JOINT BASE ELMENDORF-RICHARDSON
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

MEMORANDUM FOR THE NATIVE VILLAGE OF TYONEK
ATTN: MR. ALFRED GOOZMER, PRESIDENT
Native Village of Tyonek
PO Box 82009
Tyonek AK 99682

FROM: 673 ABW/CC
10471 20th Street, Suite 139
JBER AK 99506-2200

SUBJECT: Government-to-Government Consultation for the Proposal for Mortar and Artillery Training (PMART) at Richardson Training Area, Joint Base Elmendorf-Richardson, Alaska (AK)

1. The United States Air Force (USAF) is proposing to modify the conditions under which indirect live-fire weapons training can be conducted at Joint Base Elmendorf-Richardson (JBER), Alaska. An Environmental Impact Statement (EIS) is being prepared for the proposed action, which will evaluate the potential impacts associated with indirect live-fire training to occur during all seasons at Richardson Training Area, Eagle River Flats (ERF) Impact Area. The new EIS is being prepared in accordance with the National Environmental Policy Act (NEPA) of 1969 and the Council on Environmental Quality (CEQ) regulations implementing NEPA (40 Code of Federal Regulations [CFR] Part 1500-1508) and USAF NEPA regulations at 36 CFR Part 989.

2. All-season training is necessary to ensure Soldiers achieve and maintain critical combat skills. Current live-fire restrictions limit training on JBER's only usable explosive munitions impact area to winter firing only (November 1 to March 31), dependent on ice cover requirements. The winter firing restriction was put in place in 1991. With these seasonal restrictions in place, units stationed at JBER have not been able to conduct the full range of required indirect live-fire training exercises at JBER, and must deploy to other installations during portions of the year to conduct their required small unit training. In 2010, a Draft EIS to resume all-season indirect live-fire training at the former Fort Richardson was developed. In addition, the USAF and USARAK consulted with Tribes and the Alaska State Historic Preservation Officer (SHPO) consistent with Section 106 of the NHPA. Since the release of the Draft EIS, organizational changes resulted in the joint basing of former Elmendorf Air Force Base and Fort Richardson into JBER. As the managing agency of JBER, the USAF is the lead agency for the preparation of a new EIS. USARAK retains operational responsibility for training areas and ranges, and is a cooperating agency on this new EIS.

3. The USAF, in coordination with USARAK, has delineated an Area of Potential Effect (APE) for the proposal that takes into account the potential effects of the Project as required in 36 CFR 800.4(1). For the purposes of Section 106 of the NHPA, the APE includes ERF Impact Area, which currently consists of approximately 2,160 acres of tidal salt marsh and 323 acres of associated upland buffer areas. The APE also includes a 585-acre "impact area expansion" parcel that would involve

clear cutting approximately 430 acres of vegetation and creating approximately 1.83 miles of gravel service roads and pads. In addition, a 2.41-mile fire break will be created to contain wildland fires. A map is included with this letter. Within the APE, potential effects to cultural resources that may be eligible for the National Register of Historic Places could include physical damage or destruction from live-fire munitions, change in the character of the property's use, as well as the introduction/modification of visual, atmospheric, and/or audible elements to an associated historic property. The APE includes primary and secondary buffer areas that extend beyond proposed target areas. These areas provide sufficient space such that effects from fired or launched ammunition and explosives, namely from fragments, debris, and components from explosive projectiles, would not be expected to exceed the allocated buffer.

4. The USAF wishes to extend an invitation to the Native Village of Tyonek to consult on a government-to-government basis for the PMART. As part of the NEPA process, government-to-government consultation with Federally recognized Native American tribal entities is required per Executive Order 13175: *Memorandum on Government-to-Government Relations with Native American Tribal Governments*; Department of Defense (DoD) Instruction 4710.02: *DoD Interactions with Federally-Recognized Tribes*; and Air Force Instruction (AFI) 90-2002: *Air Force Interactions with Federally-Recognized Tribes*. In addition, consultations are being conducted in accordance with the NHPA and regulations (36 CFR Part 800). If you are interested in consulting on this proposal, the USAF requests your review and comments on the APE within 30 days of receiving this consultation request; however, a lack of response does not preclude your ability to consult or request government-to-government consultation on this project.

5. As the 673d Air Base Wing Commander, I am offering to discuss our proposal in detail with you, and would like to hear from you regarding any comments, concerns, and suggestions you may have, including concerns regarding actions from the PMART that may affect protected tribal rights or resources. If you determine that this action affects protected tribal rights or resources and wish to consult on this action or discuss the PMART, please contact our Tribal Liaison Officer, Ms. Margan Grover, at (907) 384-3467, or via email at margan.grover@us.af.mil, to discuss any concerns or issues.

Patricia A. Csank

PATRICIA A. CSANK
Colonel, USAF
Commander

2 Attachments:
1. JBER Project Vicinity Map and Location of Eagle River Flats Impact Area
2. Section 106 Area of Potential Effects

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, JOINT BASE ELMENDORF-RICHARDSON
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

MEMORANDUM FOR CHICKALOON VILLAGE TRADITIONAL COUNCIL
ATTN: MR. GARY HARRISON, TRADITIONAL CHIEF
Chickaloon Village Traditional Council
PO Box 1105
Chickaloon AK 99674

FROM: 673 ABW/CC
10471 20th Street, Suite 139
JBER AK 99506-2200

SUBJECT: Government-to-Government Consultation for the Proposal for Mortar and Artillery Training (PMART) at Richardson Training Area, Joint Base Elmendorf-Richardson, Alaska (AK)

1. The United States Air Force (USAF) is proposing to modify the conditions under which indirect live-fire weapons training can be conducted at Joint Base Elmendorf-Richardson (JBER), Alaska. An Environmental Impact Statement (EIS) is being prepared for the proposed action, which will evaluate the potential impacts associated with indirect live-fire training to occur during all seasons at Richardson Training Area, Eagle River Flats (ERF) Impact Area. The new EIS is being prepared in accordance with the National Environmental Policy Act (NEPA) of 1969 and the Council on Environmental Quality (CEQ) regulations implementing NEPA (40 Code of Federal Regulations [CFR] Part 1500-1508) and USAF NEPA regulations at 36 CFR Part 989.

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3. The USAF, in coordination with USARAK, has delineated an Area of Potential Effect (APE) for the proposal that takes into account the potential effects of the Project as required in 36 CFR 800.4(1). For the purposes of Section 106 of the NHPA, the APE includes ERF Impact Area, which currently consists of approximately 2,160 acres of tidal salt marsh and 323 acres of associated upland buffer areas. The APE also includes a 585-acre "impact area expansion" parcel that would involve

clear cutting approximately 430 acres of vegetation and creating approximately 1.83 miles of gravel service roads and pads. In addition, a 2.41-mile fire break will be created to contain wildland fires. A map is included with this letter. Within the APE, potential effects to cultural resources that may be eligible for the National Register of Historic Places could include physical damage or destruction from live-fire munitions, change in the character of the property's use, as well as the introduction/modification of visual, atmospheric, and/or audible elements to an associated historic property. The APE includes primary and secondary buffer areas that extend beyond proposed target areas. These areas provide sufficient space such that effects from fired or launched ammunition and explosives, namely from fragments, debris, and components from explosive projectiles, would not be expected to exceed the allocated buffer.

4. The USAF wishes to extend an invitation to Chickaloon Village Traditional Council to consult on a government-to-government basis for the PMART. As part of the NEPA process, government-to-government consultation with Federally recognized Native American tribal entities is required per Executive Order 13175: *Memorandum on Government-to-Government Relations with Native American Tribal Governments*; Department of Defense (DoD) Instruction 4710.02: *DoD Interactions with Federally-Recognized Tribes*; and Air Force Instruction (AFI) 90-2002: *Air Force Interactions with Federally-Recognized Tribes*. In addition, consultations are being conducted in accordance with the NHPA and regulations (36 CFR Part 800). If you are interested in consulting on this proposal, the USAF requests your review and comments on the APE within 30 days of receiving this consultation request; however, a lack of response does not preclude your ability to consult or request government-to-government consultation on this project.

5. As the 673d Air Base Wing Commander, I am offering to discuss our proposal in detail with you, and would like to hear from you regarding any comments, concerns, and suggestions you may have, including concerns regarding actions from the PMART that may affect protected tribal rights or resources. If you determine that this action affects protected tribal rights or resources and wish to consult on this action or discuss the PMART, please contact our Tribal Liaison Officer, Ms. Margan Grover, at (907) 384-3467, or via email at margan.grover@us.af.mil, to discuss any concerns or issues.

PATRICIA A. CSANK
Colonel, USAF
Commander

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DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, JOINT BASE ELMENDORF-RICHARDSON
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

MEMORANDUM FOR COOK INLET REGION, INC. (CIRI)
ATTN: MR. BEN MOHR, MANAGER, SURFACE ESTATE
Cook Inlet Region, Inc.
PO Box 93330
Anchorage AK 99509

FROM: 673 ABW/CC
10471 20th Street, Suite 139
JBER AK 99506-2200

SUBJECT: Consultation for the Proposal for Mortar and Artillery Training (PMART) at Richardson Training Area, Joint Base Elmendorf-Richardson, Alaska (AK)

1. The United States Air Force (USAF) is proposing to modify the conditions under which indirect live-fire weapons training can be conducted at Joint Base Elmendorf-Richardson (JBER), Alaska. An Environmental Impact Statement (EIS) is being prepared for the proposed action, which will evaluate the potential impacts associated with indirect live-fire training to occur during all seasons at Richardson Training Area, Eagle River Flats (ERF) Impact Area. The new EIS is being prepared in accordance with the National Environmental Policy Act (NEPA) of 1969 and the Council on Environmental Quality (CEQ) regulations implementing NEPA (40 Code of Federal Regulations [CFR] Part 1500-1508) and USAF NEPA regulations at 36 CFR Part 989.

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4. The USAF wishes to extend an invitation to Cook Inlet Regional Inc. to consult on the PMART. As part of the NEPA process, government-to-government consultation with Federally recognized Native American tribal entities is required per Executive Order 13175: *Memorandum on Government-to-Government Relations with Native American Tribal Governments*; Department of Defense (DoD) Instruction 4710.02: *DoD Interactions with Federally-Recognized Tribes*; and Air Force Instruction (AFI) 90-2002: *Air Force Interactions with Federally-Recognized Tribes*. Such authorities also require consultation with Alaska Native corporations on any proposed action that may have a substantial direct effect on corporate lands, waters, or other natural resources. In addition, consultations are being conducted in accordance with the NHPA and regulations (36 CFR Part 800). If you are interested in consulting on this proposal, the USAF requests your review and comments on the APE within 30 days of receiving this consultation request; however, a lack of response does not preclude your ability to consult or request consultation on this project.

5. As the 673d Air Base Wing Commander, I am offering to discuss our proposal in detail with you, and would like to hear from you regarding any comments, concerns, and suggestions you may have, including concerns regarding actions from the PMART that may affect corporate lands, waters, or other natural resources. If you determine that this action affects such resources and wish to consult on this action or discuss the PMART, please contact our Tribal Liaison Officer, Ms. Margan Grover, at (907) 384-3467, or via email at margan.grover@us.af.mil, to discuss any concerns or issues.

PATRICIA A. CSANK
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KNIK TRIBAL COUNCIL

KNIK, THE OLDEST VILLAGE IN COOK INLET

September 21, 2020

Margan Grover
Cultural Resource Manager &
Installation Tribal Liaison Officer
673 CES/CEIEC
724 Quartermaster Road
JBER, Alaska

Re: Proposed Munitions and Artillery Training for all seasons at Eagle River Flats - JBER

Margan,

For the last 1500 years Knik Tribe has called all of the Upper Cook Inlet, as defined by Shem Pete, as Ancestral Territory. This includes the Municipality of Anchorage and JBER. Currently Knik Tribe and the Native Village of Eklutna have in place a MOA stating: “Tribes to support each other in the identification, documentation, recognition and stewardship of mutually important historical and cultural sites, such as Tak’at, in our ongoing efforts to increase public respect toward Upper Inlet Dena’ina, our Significant Cultural Properties, and to preserve information for generations to come.”

Knik Tribe considers the historic sites outlined in the September SHPO Letter to be Significant Dena’ina Cultural Sites and would like to establish Government to Government consultation with JBER concerning these sites. In this, Richard L. Martin, our Historic Preservation Officer, would be the lead in this consultation. He can be contacted at 907-885-8968 or rmartin@kniktribe.org. In addition, Kin Tribe would like to be a party to any MOA concerning these sites.

Sincerely,

Richard Porter

Richard Porter
Executive Director
Knik Tribe

P.O. BOX 871565
WASILLA, AK 99687
(907) 373-7991
(907) 373-7993
FAX: (907) 373-2161
E-MAIL: RPORTER@KNIKTRIBE.ORG

February 10, 2021

Ms. Margan A. Grover
Cultural Resources Manager
673 CES/CEIEC
724 Quartermaster Road
Joint Base Elmendorf Richardson, AK 99505

Ref: *Proposed Munitions and Artillery Training on Richardson Training Area*
Joint Base Elmendorf Richardson, Alaska
ACHP Project Number: 016485

Dear Ms. Grover:

On January 27, 2021, the Advisory Council on Historic Preservation (ACHP) received your notification and supporting documentation regarding the potential adverse effects of the referenced undertaking on a property or properties listed or eligible for listing in the National Register of Historic Places. Based upon the information you provided, we have concluded that Appendix A, *Criteria for Council Involvement in Reviewing Individual Section 106 Cases*, of our regulations, "Protection of Historic Properties" (36 CFR Part 800) implementing Section 106 of the National Historic Preservation Act, does not apply to this undertaking. Accordingly, we do not believe our participation in the consultation to resolve adverse effects is needed.

However, if we receive a request for participation from the State Historic Preservation Officer, Tribal Historic Preservation Officer, affected Indian tribe, a consulting party, or other party, we may reconsider this decision. Should the undertaking's circumstances change, consulting parties cannot come to consensus, or you need further advisory assistance to conclude the consultation process, please contact us.

Pursuant to Section 800.6(b)(1)(iv), you will need to file the final Section 106 agreement document (Agreement), developed in consultation with the Alaska State Historic Preservation Office and any other consulting parties, and related documentation with the ACHP at the conclusion of the consultation process. The filing of the Agreement and supporting documentation with the ACHP is required in order to complete the requirements of Section 106 of the National Historic Preservation Act.

In reviewing this notification, we are reminded that this current undertaking is similar to an undertaking considered in 2010 regarding year-round firing at the Eagle River Flats Impact Area. At that time the ACHP elected not to participate in that consultation or the execution of the 2012 *Memorandum of Agreement Between Joint Base Elemendorf-Richardson, U.S. Army Alaska, Native Village of Eklutna, and the Alaska State Historic Preservation Officer Regarding Resumption of Year-Round Firing at Eagle River Flats Impact Area at JBER-Richardson* (2012 MOA). Per Stipulation XIII, this MOA would be valid for 10 years after the signing of the National Environmental Policy Act's Record of Decision (ROD). It is our understanding that the ROD was never executed, which makes the 2012 MOA still valid. It is recommended that Joint Base Elmendorf-Richardson either amend the agreement to change the duration of the agreement (to a specific date in this calendar year) in accordance with Stipulation VIII, or to terminate the agreement in accordance with Stipulation X.

Thank you for providing us with your notification of adverse effect. If you have any questions or require our further assistance, please contact Ms. Katharine R. Kerr at (202) 517-0216 or by e-mail at kkerr@achp.gov and reference the ACHP Project Number above.

Sincerely,

Artisha Thompson

Artisha Thompson
Historic Preservation Technician
Office of Federal Agency Programs

THE STATE
of ALASKA
GOVERNOR MIKE DUNLEAVY

Department of Natural Resources

DIVISION OF PARKS AND OUTDOOR RECREATION
Office of History & Archaeology

550 West 7th Avenue, Suite 1310
Anchorage, AK 99501-3561
907-269-8700
http://dnr.alaska.gov/parks/oha

March 24, 2021

File No.: 3130-1R Air Force / 2020-00432

Mark Prieksat
Deputy Commander, JBER
Department of the Air Force
Headquarters, 673D Air Base Wing

Subject: Archaeological Survey for a Portion of Proposal for Munitions and Artillery Training (PMART) Project, Joint Base Elmendorf-Richardson

Dear DCOM Prieksat:

The Alaska State Historic Preservation Office (AK SHPO) received your correspondence (dated January 28, 2021) regarding the subject project and report titled *Archaeological Site Evaluations, Proposal for Mortar and Artillery Training at Richardson Training Area, Joint Base Elemendorf-Richardson, Alaska* on February 9, 2021. Our office requested and received additional information on March 2, 2021. The AK SHPO has entered tolling in response to COVID-19. Per ACHP direction, responses received from our office should be considered by the federal agency after the 30-day time periods outlined in 36 CFR 800 until our office has returned to normal status.

Our office has reviewed the referenced undertaking under Section 106 of the National Historic Preservation Act, and we agree that it is appropriate to reconsult on the project, keeping in mind the executed (February 28, 2012) Memorandum of Agreement (MOA) that was negotiated for a prior iteration of this proposal.

Our office concurs that archaeological site ANC-04565 is eligible for listing in the National Register of Historic Places (NRHP) under Criteria C and D. We also concur that the cluster of depressions at ANC-04563 is not eligible for the NRHP under the theme of military and defense, but several of the depressions may not be of military origin. Our office recommends consideration of their potential association with ancestral use by the Dena'ina and their ability to contribute under Criterion C to a possible historic district comprised of archaeological sites on the Eagle River uplands, including but not limited to ANC-02606 and ANC-04564. Our office recommends that the NRHP eligibility of ANC-02602, ANC-02603, ANC-02606, and ANC-04554 remain pending until additional information (NLURA's forthcoming report) can be provided to support JBER's NRHP eligibility determinations.

Our office agrees that JBER has established that the PMART project will likely adversely affect historic properties. We recommend amending the MOA to reflect changes in the project, extending the duration, and revisiting the stipulations based on the increased scope of the proposal and confirmation of adverse effects to historic properties documented in your correspondence. The sites with pending NRHP status can also be acknowledged in the preamble of the amendment and addressed through phasing in the stipulations or additional information could be provided to our office prior to execution of the MOA amendment. We also agree that it is appropriate to include measures to minimize effects. We recommend that these be incorporated into the MOA amendment draft for consideration by Signatories and consulting parties.

Our office also recommends that JBER consult with the Knik Tribal Council, the Chickaloon Village Traditional Council, and other neighboring Tribes about the project and their potential interest in becoming a consulting and/or concurring party to the MOA.

We look forward to working with your office to amend the MOA. Thank you for the opportunity to comment. Please contact Sarah Meitl at sarah.meitl@alaska.gov if you have any questions or if we can be of further assistance.

Sincerely,

Judith E. Bittner

Judith E. Bittner
State Historic Preservation Officer

JEB:sjm

Ecc: Margan Grover (margan.grover@us.af.mil)

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, JOINT BASE ELMENDORF-RICHARDSON
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

20 May 2022

MEMORANDUM FOR COOK INLET REGION, INCORPORATED
ATTN: MS. SOPHIE MINICH, PRESIDENT & CEO
PO BOX 93330
ANCHORAGE AK 99509-3330

FROM: Joint Base Elmendorf-Richardson Vice Commander
10471 20th Street
JBER AK 99506

SUBJECT: Project Update on the Proposal for Mortar and Artillery Training at Richardson Training Area, Joint Base Elmendorf-Richardson

1. This letter is to provide an update regarding the Proposed Mortar and Artillery Training at Joint Base Elmendorf-Richardson (JBER). Since the last update presented in October 2020, the project, has been delayed in order to satisfy additional noise analysis modeling requirements. The results of the noise analysis will be integrated into the ongoing Environmental Impact Statement (EIS) process as we now move forward.

2. The United States Air Force (USAF) is proposing to modify the conditions under which indirect live-fire weapons training can be conducted at JBER. An EIS is being prepared for the proposed action, which focuses on live-fire weapons training at Richardson Training Area, Eagle River Flats (ERF) Impact Area. All-season training is necessary to ensure that Soldiers achieve and maintain critical combat skills. Current live-fire restrictions limit training on JBER's only currently usable explosive munitions impact area to winter firing only (November 1 to March 31), dependent on ice thickness requirements.

3. The U.S. Army Alaska (USARAK) has used ERF Impact Area for live-fire training since the 1940s. In 1991, use was restricted to winter firing only (1 November to 31 March), provided required ice thickness conditions are also met. With seasonal restrictions in place, units stationed at JBER have not been able to conduct the full range of required indirect live-fire training exercises at JBER, and must deploy to other installations during portions of the year to conduct their required unit training. In 2010, a Draft EIS to resume all-season indirect live-fire training was developed. In addition, the USAF and USARAK consulted with Tribes and the Alaska State Historic Preservation Office (SHPO) consistent with Section 106 of the National Historic Preservation Act (NHPA). To resolve potential adverse effects from the 2010 proposal, the USAF, USARAK, Alaska SHPO, and Native Village of Eklutna signed a Memorandum of Agreement on February 28, 2012, which has since expired. Since the release of the 2010 Draft EIS, organizational changes resulted in joint basing, combining Elmendorf Air Force Base and Fort Richardson into a single installation, JBER. As the lead service at JBER, the USAF is responsible for the preparation of the new EIS. USARAK retains operational responsibility for training areas and ranges, and is a cooperating agency on this EIS. In 2020, the National Marine Fisheries Service became a cooperating agency on the EIS.

4. Scoping for the new EIS was completed in 2020 and the EIS is now being prepared in accordance with NEPA and the Council on Environmental Quality regulations implementing NEPA (40 Code of

Federal Regulations [CFR] Part 1500-1508) and USAF NEPA regulations at 36 CFR Part 989. The EIS will evaluate the potential impacts associated with indirect live-fire training to occur during all seasons at ERF Impact Area on JBER.

5. The USAF, in coordination with USARAK, has delineated an Area of Potential Effect (APE) for the proposal that takes into account the potential effects of the project as required in 36 CFR 800.4(1). For the purposes of Section 106 of the NHPA, the APE includes ERF Impact Area, which currently consists of approximately 2,160 acres of tidal salt marsh and 323 acres of associated upland buffer areas. The APE also includes a 585-acre "impact area expansion" parcel that would involve clear cutting approximately 430 acres of vegetation and creating approximately 1.83 miles of gravel service roads and pads. In addition, a 2.41-mile fire break will be created to contain wildland fires. Within the APE, potential effects to cultural resources that may be eligible for the National Register of Historic Places could include physical damage or destruction from live-fire munitions, change in the character of the property's use, as well as the introduction/modification of visual, atmospheric, and/or audible elements to an associated historic property.

6. In 2021, following survey and reporting and through consultation with the SHPO, Tribes, and the Advisory Council, it was determined that the project will have adverse effects to cultural resources in the impact expansion area that will require a new Memorandum of Agreement. At present, USAF and USARAK are evaluating potential mitigation measures which will support development of a new Memorandum of Agreement.

7. As a part of the NEPA process, government-to-government consultation with Federally Recognized Native American tribal entities is required per Executive Order 13175, *Memorandum on Government-to-Government Relations with Native American Tribal Governments*; Department of Defense (DoD) Instruction 4710.02, *DoD Interactions with Federally Recognized Tribes*; and Air Force Instruction (DAFI) 90-2002, *Interactions with Federally Recognized Tribes*. In addition, consultations are conducted in accordance with the NHPA and regulations at 36 CFR Part 800. Following receipt of this letter, government-to-government consultation will be scheduled to hear any comments, concerns, and suggestions you may have regarding this project and latest update.

8. Please contact our Tribal Liaison, Ms. Joy Boston, at (907) 551-1598, or via email at joy.boston.2@us.af.mil, to discuss any concerns or issues.

DENTER.DEAN.HAROLD.1151954894 Digitally signed by DENTER.DEAN.HAROLD.1151954894 Date: 2022.05.11 14:50:31 -08'00'

DEAN H. DENTER
Colonel, U.S. Army
Vice Commander

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, JOINT BASE ELMENDORF-RICHARDSON
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

20 May 2022

MEMORANDUM FOR CHICKALOON VILLAGE TRADITIONAL COUNCIL
ATTN: MR. GARY HARRISON, TRADITIONAL CHIEF
PO BOX 1105
CHICKALOON AK 99674-1105

FROM: Joint Base Elmendorf-Richardson Vice Commander
10471 20th Street
JBER AK 99506

SUBJECT: Project Update on the Proposal for Mortar and Artillery Training at Richardson Training Area, Joint Base Elmendorf-Richardson

1. This letter is to provide an update regarding the Proposed Mortar and Artillery Training at Joint Base Elmendorf-Richardson (JBER). Since the last update presented in October 2020, the project, has been delayed in order to satisfy additional noise analysis modeling requirements. The results of the noise analysis will be integrated into the ongoing Environmental Impact Statement (EIS) process as we now move forward.

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Federal Regulations [CFR] Part 1500-1508) and USAF NEPA regulations at 36 CFR Part 989. The EIS will evaluate the potential impacts associated with indirect live-fire training to occur during all seasons at ERF Impact Area on JBER.

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8. Please contact our Tribal Liaison, Ms. Joy Boston, at (907) 551-1598, or via email at joy.boston.2@us.af.mil, to discuss any concerns or issues.

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DEAN H. DENTER
Colonel, U.S. Army
Vice Commander

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, JOINT BASE ELMENDORF-RICHARDSON
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

20 May 2022

MEMORANDUM FOR EKLUTNA, INCORPORATED
ATTN: MR. KYLE FOSTER, GENERAL MANAGER
16515 CENTERFIELD DRIVE, SUITE 201
EAGLE RIVER AK 99577

FROM: Joint Base Elmendorf-Richardson Vice Commander
10471 20th Street
JBER AK 99506

SUBJECT: Project Update on the Proposal for Mortar and Artillery Training at Richardson Training Area, Joint Base Elmendorf-Richardson

1. This letter is to provide an update regarding the Proposed Mortar and Artillery Training at Joint Base Elmendorf-Richardson (JBER). Since the last update presented in October 2020, the project, has been delayed in order to satisfy additional noise analysis modeling requirements. The results of the noise analysis will be integrated into the ongoing Environmental Impact Statement (EIS) process as we now move forward.

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DEAN H. DENTER
Colonel, U.S. Army
Vice Commander

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, JOINT BASE ELMENDORF-RICHARDSON
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

20 May 2022

MEMORANDUM FOR KNIK TRIBAL COUNCIL
ATTN: MR. RICHARD PORTER, CEO
PO BOX 871565
WASILLA AK 99687

FROM: Joint Base Elmendorf-Richardson Vice Commander
10471 20th Street
JBER AK 99506

SUBJECT: Project Update on the Proposal for Mortar and Artillery Training at Richardson Training Area, Joint Base Elmendorf-Richardson

1. This letter is to provide an update regarding the Proposed Mortar and Artillery Training at Joint Base Elmendorf-Richardson (JBER). Since the last update presented in October 2020, the project, has been delayed in order to satisfy additional noise analysis modeling requirements. The results of the noise analysis will be integrated into the ongoing Environmental Impact Statement (EIS) process as we now move forward.

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DEAN H. DENTER
Colonel, U.S. Army
Vice Commander

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, JOINT BASE ELMENDORF-RICHARDSON
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

20 May 2022

MEMORANDUM FOR NATIVE VILLAGE OF EKLUTNA TRADTIONAL COUNCIL
ATTN: MR. AARON LEGGETT, PRESIDENT
26339 EKLUTNA VILLAGE ROAD
CHUGIAK AK 99567-6339

FROM: Joint Base Elmendorf-Richardson Vice Commander
10471 20th Street
JBER AK 99506

SUBJECT: Project Update on the Proposal for Mortar and Artillery Training at Richardson Training Area, Joint Base Elmendorf-Richardson

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DEAN H. DENTER
Colonel, U.S. Army
Vice Commander

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, JOINT BASE ELMENDORF-RICHARDSON
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

20 May 2022

MEMORANDUM FOR NATIVE VILLAGE OF TYONEK
ATTN: MR. JOHANN BARTELS, PRESIDENT
PO BOX 82009
TYONEK AK 99682-0009

FROM: Joint Base Elmendorf-Richardson Vice Commander
10471 20th Street
JBER AK 99506

SUBJECT: Project Update on the Proposal for Mortar and Artillery Training at Richardson Training Area, Joint Base Elmendorf-Richardson

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DEAN H. DENTER
Colonel, U.S. Army
Vice Commander

Chickaloon Village Traditional Council
(Nay'dini'aa Na' Kayax)

VIA EMAIL/FIRST CLASS MAIL

June 3, 2022

Joy E. Boston
673d ABW Community Partnerships &
Alaska Native Liaison
Joint Base Elmendorf-Richardson, Alaska
DSN: 317-551-1598
Comm: (907) 551-1598
Cell: (907) 223-0721

RE: PMART (Eagle River flats) update and G2G offer letter

Dear Joy Boston,
Chickaloon Native Village (CNV) is a federally-recognized Ahtna Dene Tribe in southcentral Alaska, governed by CVTC. CNV's ancestral territory and traditional area of influence include trading trails that span from the Beaufort Sea to the Copper River Delta. This territory also encompasses much of southcentral Alaska; the Upper Cook Inlet; the Copper River Region; the Alaska Range; the Susitna River watershed; and the Matanuska watershed. We acknowledge that this region overlaps neighboring Dene and other Tribal traditional customary use areas.

Actions that occur within Dene traditional ancestral territory and customary area of use (as noted above) may impact the environment, Dene cultural resources, and the health of Tribal citizens and community members. To mitigate these impacts, CVTC employs a Tribal Historic Preservation Officer working to identify, protect and preserve cultural sites and artifacts.

On May 12, 2022 CVTC received a letter with an update on JBER's Proposed Mortar and Artillery Training (PMART) initiative in Eagle River flats. CVTC requests ongoing Government-to-Government consultation for this proposed project at this time.

Our oral history narrates interactions with the land of *Nuti* (Knik Arm) for various cultural activities in the area that now encompasses JBER prior to WWII at which point access was denied to Dene. Today these homelands are still not available for Dene People. The natural, biologically rich estuary environments of *Nuti* support concentrations of numerous Dene cultural sites.

Thank you for allowing us to review archaeological sites on May 24, 2022 on JBER. During that trip CVTC Tribal citizens and representatives recognized a significant potential Traditional Cultural Property that was not previously identified by JBER as well as many culturally modified trees (CMTs) in the Eagle River Flats. Please keep CVTC apprised of any investigations to learn more about the TCP.

We would like to ensure JBER is aware Dene cultural sites could be affected. Coastal sites containing ancestral remains are of particular concern as there is a long history of sites eroding into *Nuti* (Knik Arm). CVTC requests continued consultation on this proposed project.

CVTC appreciates the opportunity to comment on this project with JBER to steward Dene land, particularly in these culturally sensitive areas. We look forward to working with you, if you have any questions please contact Angela Wade, Tribal Historic Preservation Officer at alwade@chickaloon-nsn.gov or Norma Johnson, Deputy Tribal Historic Preservation Officer at nmjohnson@chickaloon-nsn.gov.

May Nek'eltaeni (Creator) Guide our Footsteps,

Chief Gary Harrison
Chief Gary Harrison (Jun 5, 2022 10:01 AKDT)
Traditional Chief Gary Harrison
Chickaloon Village Traditional Council

PO BOX 1105 Chickaloon, Alaska 99674 **Phone (907) 745-0749** **Fax (907) 745-0709**
e•mail: cvadmin@chickaloon-nsn.gov **Home Page: http://www.chickaloon-nsn.gov**

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, 673D AIR BASE WING
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

November 2, 2022

MEMORANDUM FOR: ALASKA DEPARTMENT OF NATURAL RESOURCES
OFFICE OF HISTORY AND ARCHAEOLOGY
ALASKA STATE HISTORIC PRESERVATION OFFICER
ATTENTION: JUDITH E. BITTNER

FROM: 673 CES/CEIEC
6326 Arctic Warrior Drive
JBER AK 99506

SUBJECT: Update to Proposal for Munitions and Artillery Training (PMART) Project, Joint Base Elmendorf-Richardson

1. Purpose and Need: The purpose and need is unchanged from our original letter. The Joint Base Elmendorf-Richardson (JBER) Environmental Conservation Section (673d CES/CEIEC) is coordinating the cultural resource consultation for the Proposal for Munitions and Artillery Training (PMART) project. We last contacted your office about this project on January 21, 2021. The purpose of this letter is to provide you an update on the project and to confirm an assessment of effect to historic properties based on archaeological investigations in the project's area of potential effect.

2. Project Description and Area of Potential Effect: The description of the undertaking and area of potential effect is mostly unchanged from our previous letters. Although the preferred alternative has not been selected, the action alternatives hold several commonalities. The Air Force continues proposing to modify the conditions under which indirect live-fire weapons training can be conducted at JBER to meet Army doctrinal standards. All-season training is necessary to ensure that Soldiers achieve and maintain critical combat skills. The only significant change in our earlier description of the area and potential effect is that the Army removed its requirement to utilize white phosphorus smoke mortar rounds on JBER under any alternative which should result in lower risk of damage to cultural or archaeological sites. As a review of our earlier letter, the action alternatives in the Environmental Impact Statement will include various formulations to achieve the Army's purpose and need.

1. Change indirect-fire weapons systems currently in use at JBER. Specifically, this would include the use of 155-mm Howitzers, which are not currently allowed on JBER. This may include various fuze types (such as impact, near-surface, proximity, and delay fuzes) and various materials (such as high-explosive, illumination, smoke, or inert, but no white phosphorous smoke).
2. Shift to all-season training which currently is limited to winter only based on ice conditions.
3. An expanded impact area is included in some action alternatives. The maximum size of the proposed expansion was used to define the area of potential effect for purposes of Section 106

consultation. The expansion would allow for greater training capacity and capability. All action alternatives include the existing Eagle River Flats Impact Area in the area of potential effect.

4. One of the action alternatives includes modifying and expanding service roads, service pads, and fire breaks in Eagle River Flats and the expanded impact area.

The area of potential effect consists of the 2,160-acre Eagle River Flats Impact Area and the proposed 585-acre impact expansion area (Figure 1). The expansion area would connect the Eagle River Flats Impact Area to the Infantry Platoon Battle Course (Figure 2). Each action alternative includes different parts of the area of potential effect. Once a preferred alternative is selected, the area of potential effect may be reduced. It was defined in order to capture the maximum extent of direct and indirect effects.

[redacted]

Figure 1. *PMART area of potential effect and known cultural resources.*

[redacted]

Figure 1. *Proposed layout of PMART expansion area and archaeological sites.*

3. Historic Properties and the Area of Potential Effect: Based on correspondence during 2021, 673 ABW and SHPO concur ANC-04565, ANC-02603, ANC-02606, and ANC-04564 are eligible sites.

ANC-02603 is the remains of an early 20th century log cabin within the ERF Impact Area.
ANC-02606 is a multiroom Late Dena'ina period house pit and three possible cache pits on the bluff overlooking the ERF.
ANC-04564 is a multiroom Late Dena'ina period house pit and midden deposit on the bluff overlooking the ERF.
ANC-04565 is a multiroom Late Dena'ina period house pit below the bluff overlooking the ERF.
TA-406 Archaeological District is comprised of ANC-02606, ANC-04564, and ANC-04565. The presence of three house pits indicates there was a Late Dena'ina period settlement at this location on the north side of the ERF.

4. Assessment of Effect: Our assessment of effects is slightly changed from our previous letter dated January 28, 2021. In our earlier letter, we stated the PMART project will adversely affect ANC-02606 and ANC-04565, and may indirectly affect ANC-00265, ANC-02603, and ANC-04564. We are now recommending that the ***PMART project will indirectly adversely affect ANC-02603, ANC-2606, ANC-***

04564, and ANC-04565 and adversely affect presumed sites in the Eagle River Flats. Our proposed protective measures are unchanged from the earlier letter in which all action alternatives include a vegetation buffer and warning signs to avoid direct effects to the site. We changed our analysis from direct to indirect effects for two reasons. First, the sites below the bluff gain additional protections from topography. The bluff causes direct fire weapons fired from the bluff to typically overshoot them, and the slope from the bluff tends to prevent indirect fire rounds from impacting immediately below the bluff. Despite ANC-04565 lying within the impact area, there is no apparent damage from indirect fires to date. Second, the vegetative buffers and associated tree piles or berms should be sufficiently protective of the sites from direct fires involved in the CALFEX. However, there continues to be significant risk that any of these sites could be directly and adversely affected by inadvertent firing or troop maneuvering in their proximity or by an indirect fire round. We also continue to agree that direct effects will occur to any unknown cultural resources in Eagle River Flats that may have survived since the impact area began being used; the impact area cannot be surveyed for cultural resources because of its status as a dedicated impact area. Indirect effects may also occur from the change in indirect-fire weapons systems and expansion of infrastructure, provided that that the expanded impact area is included in the undertaking. If the selected alternative does not include the expanded impact area, we continue to assess the degree of indirect effects will be greatly reduced (e.g., there will be no need for new service roads, pads, and fire breaks).

We are in the process of developing a Memorandum of Agreement (MOA) to resolve adverse effects and complete our Section 106 requirements under the National Historic Preservation Act per 36 CFR 800.5. The MOA retains the stipulations regarding potential historic properties in Eagle River Flats and adds mitigation stipulations for indirect effects to historic properties in the expanded impact area, if developed. We will submit the draft MOA in the coming weeks for your review. The draft EIS will also be available for review. Please let us know if you would like a copy or excerpts.

We request a meeting to discuss the MOA with the key stakeholders in order to finalize the MOA ahead of the EIS Record of Decision. If you have any questions, please contact Margan Grover, 673 CES/CEIEC, at 384-3467.

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Date: 2022.11.02 08:46:13 -08'00'

JEANNE L. DYE-PORTO, GS-14, DAF
Chief, Installation Management Flight

Chickaloon Village Traditional Council
(Nay'dini'aa Na' Kayax)

January 20, 2023
U.S. Army Corps of Engineers
Alaska District
Regulatory Division, CEPOA-RD
2204 3rd Street, Post Office Box 6898
JBER, Alaska 99506-0898

RE: PMART MOA

Dear Margan Grover,

Chickaloon Native Village (CNV) is a federally-recognized Ahtna Dene Tribe in southcentral Alaska, governed by CVTC. CNV's ancestral territory and traditional area of influence include trading trails that span from the Beaufort Sea to the Copper River Delta. This territory also encompasses much of southcentral Alaska, Upper Cook Inlet, the Copper River Region, the Alaska Range, the Matanuska watershed, and the Susitna River watershed. We acknowledge that this region overlaps neighboring Dene and other Tribal traditional customary use areas.

Actions that occur within Dene traditional ancestral territory and customary area of use (as noted above) may impact the environment, Dene cultural resources, and the health of Tribal citizens and community members. To mitigate these impacts, CVTC employs a Tribal Historic Preservation Officer working to identify, protect and preserve cultural sites and artifacts.

CVTC participated in the January 13, 2023 meeting. Thank you for continuing consultation on the Proposal for Mortar and Artillery Training (PMART) at Richardson Training Area, Joint Base Elmendorf-Richardson (JBER). At this point CVTC formally requests to be a signatory to the PMART Memorandum of Agreement (MOA).

There are several important details in this MOA that are a significant improvement in the consideration of cultural resources including Phase I surveys with updated and standardized methods such as subsurface testing and recordation of culturally modified trees.

Tribal citizens continue to mourn the loss of access to Traditional Cultural Properties on JBER. It is an improvement that munitions would be routinely cleared to ensure the impacted area could be accessed by Tribal citizens in the future. This plan would also better serve the animals who live in the area.

Further, CVTC applauds the recognition that traditional Dena'ina knowledge is an integral part of all the work associated with this MOA and should involve a Dena'ina and other interested Dene cultural subject matter experts involved in both execution of the compensatory survey and the development of the interpretive product. We urge even

PO BOX 1105 Chickaloon, Alaska 99674 **Phone (907) 745-0749 Fax (907) 745-0709**
e•mail: cvadmin@chickaloon-nsn.gov **Home Page: http://www.chickaloon-nsn.gov**

Chickaloon Village Traditional Council
(Nay'dini'aa Na' Kayax)

Chief Gary Harrison, *Chairman/Elder*
Philip Ling, *Vice-Chair*
Cheryl Sherman *Secretary*
Doug Wade, *Treasurer/Elder*
Emily Ling, *Member*
Lisa Wade, *Executive Director*
Serena Martino, *Executive Assistant*

January 20, 2023
U.S. Army Corps of Engineers
Alaska District
Regulatory Division, CEPOA-RD
2204 3rd Street, Post Office Box 6898
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e•mail: cvadmin@chickaloon-nsn.gov **Home Page: http://www.chickaloon-nsn.gov**

stronger inclusion of Dene to “shall” include instead of “should.” CVTC anticipates continuing to be a Dene partner in this proposed MOA.

CVTC appreciates the opportunity to comment on this project with the JBER to steward Dene land, particularly in these culturally sensitive areas. We look forward to working with you, if you have any questions please contact Angela Wade, Tribal Historic Preservation Officer at alwade@chickaloon-nsn.gov, Norma Johnson, Deputy Tribal Historic Preservation Officer at nmjohnson@chickaloon-nsn.gov, and thpo@chickaloon-nsn.gov.

May Nek’eltaeni (Creator) Guide Our Footsteps,

Chief Gary Harrison
Chief Gary Harrison (Jan 22, 2023 22:41 AKST)

Chief Gary Harrison

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, 673D AIR BASE WING
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

30 MAY 2024

MEMORANDUM FOR RECORD: PRESENTATION OF BIOLOGICAL DATA AND ANALYSIS FOR DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR PROPOSED MORTAR AND ARTILLERY TRAINING AT RICHARD SON TRAINING AREAS, JOINT BASE ELMENDORF-RICHARDSON

FROM: 673 CES/CEIEC
6326 Arctic Warrior Drive
JBER AK 99506-3240

SUBJECT: Narrative of Meeting for Presenting Biological Data and Analysis related to the Preliminary Draft Environmental Impact Statement (PDEIS) for the Proposed Mortar and Artillery Training (PMART) at Richardson Training Areas, Joint Base Elmendorf-Richardson (JBER) on 29 FEB 2024

1. **Introduction**: The 673d CES and 11 ABN on JBER organized a meeting with Federally Recognized Tribes and Alaska Native entities about the PMART project on 29 FEB 2024. The meeting was held remotely. The purpose of the meeting was to provide an overview of the project, share information on biological resources of particular concern, and present preliminary mitigation measures.

2. **Background**: The 673d CES and 11 ABN are developing a PDEIS and other environmental analysis to support the PMART. The PDEIS assesses environmental consequences that would result from the proposal to modify the conditions under which indirect live-fire weapons training can be conducted at JBER. The proposed action would optimize recurring indirect live-fire weapons training at JBER to meet home station training requirements in accordance with current Army training doctrine. Both action alternatives would remove winter firing restrictions at Eagle River Flats Impact Area (ERF-IA) and reinstate all-season indirect live-fire training. The action alternatives also include built-in protection measures to avoid or reduce impacts to beluga whales and other resources, including (but not limited to) habitat buffers based on acoustic modeling, limited fire periods for HE rounds, and redistribution of targets. The 673d CES and 11 ABN recognize the importance of integrating input from Federally Recognized Tribes and Alaska Native entities into the analysis early in the process. A list of attendees is included in Table 1. Slides were prepared by 11 ABN (purpose/need, timeline and milestones, habitat buffers and SDZs), Chris Garner (Cook Inlet Beluga Whales), and Colette Brandt (fisheries and habitat).

Table 1. Meeting participants

	Organization	Contact information
Joy Boston	673 ABW/CP	907-551-1598
Kylene Lang	673 CES/CEIEC	907-384-2440 kylene.lang.1@us.af.mil
Chris Garner	673 CES/CEIEC	907-384-2479 christopher.garner.9@us.af.mil

Colette Brandt	673 CES/CEIEC	907-384-3380 colette.brandt@@us.af.mil
Charlene Johnson	673 CES/CEIE	907-384-3913 charlene.johnson.3@us.af.mil
Liz Ortiz	673 CES/CEIEC	907-384-2444 Elizabeth.ortiz.10@us.af.mil
Margan Grover	673 CES/CEIEC	907-384-3467 margan.grover@us.af.mil
Steve Tucker	11 ABN DIV (ITAM)	907-384-2059 steven.l.tucker2.civ@army.mil
Steve Thurmond	11 ABN DIV (RTA)	907-384-6233 steven.b.thurmond.civ@army.mil
Brandon Berta	11 ABN DIV (RTA)	907-384-3163 brandon.c.berta.civ@army.mil
Brenda Hewitt	Native Village of Eklutna	~~
Marc Lamoureaux	Native Village of Eklutna	marcl@eklutna.org
Carrie Brophil	Native Village of Eklutna	cbrophil@eklutna.org
Kyle Robillard	Native Village of Eklutna	krobillard@eklutna.org
Bruce Wright	Knik Tribe	bwright@kniktribe.org
Angela Wade	Chickaloon Village Traditional Council	alwade@chickaloon-nsn.gov
Norma Johnson	Chickaloon Village Traditional Council	nmjohnson@chickaloon-nsn.gov
Jessica Winestaffer	Chickaloon Village Traditional Council	jewinnestaffer@chickaloon- nsn.gov

3. **Narrative**: The meeting began with an opening land acknowledgement and offer for statements from guests. After participants introduced themselves, they were given a brief overview of the roles of the 673 CES and 11 ABN. They were reminded that notes would be taken during the meeting and a meeting narrative would be created for inclusion in the administrative record. If there were any concerns about confidential topics, they were directed to contact Ms. Boston.

   Steve Tucker described the purpose and need for the project. There was a request for clarification on how mortars work, specifically at what point they explode (ground or air), and where they are fired (on map). A clarification was also requested on the current and proposed seasonality and limitations on training in ERF-IA. An interesting question was posed about why training does not use non-explosive rounds. Tucker explained the training is designed to build simulate real world conditions, which builds confidence and creates better training outcomes. There was a request to clarify a map on slide 3 and where live fire training occurs. Tucker emphasized that live fire training only occurs currently in winter in Eagle River Flats Impact Area (ERF-IA). He noted that live fire training occurs on other areas of JBER throughout the year and that the proposed action would expand timing and the area used in ERF-IA. At that point, an attendee asked for additional information on accuracy of live fire training. She reminded JBER that in 2023, training round had landed adjacent to archaeological sites. Tucker explained the process for reporting rounds out of safe. He then offered to hold a separate meeting to discuss the results of the investigation into the incident near the sites.

   An attendee asked why ERF-IA is used instead of upland areas. In the past, wetland areas were preferred for training so forward observers could see where rounds landed. Tucker explained that 11 ABN looked at areas south of the Glenn Highway and farther north to build a new impact area but the terrain is too steep or they are too close to the installation boundaries. Surface danger zones cannot expand outside the JBER boundaries, which limits placement of impact areas. The attendee then noted that fewer species would be impacted in upland areas. She wondered if 11 ABN had looked at them. Tucker responded that upland species are discussed in the EIS. In addition, 11 ABN will begin using the upland area southwest of Eagle River Flats (currently part of ERF-IA) for targets. This is possible because Eagle River is now closed to navigation and this allows firing over the river. They anticipate fewer rounds will land in the flats in proximity to the river as a result.

Finally, Tucker shared the timeline for the EIS process. There were no questions.

Colette Brandt presented information on anadromous fish monitoring on JBER as they relate to the PMART project. Several attendees suggested JBER start studying additional species – lamprey and stickleback. The former because it is thought to be important for Cook Inlet Beluga Whale survival and the latter because it is an important subsistence species that is poorly understood. Brandt and Garner both stated that these species were on their list for additional research and that they would like to work with Tribes to develop studies. A representative from Chickaloon Village Traditional Council noted that the University of Illinois is tracking stickleback in the Mat-Su Valley.

Brandt was asked about whether JBER is documenting details of escapement by species. She explained that this was only possible when the installation was using a fish wheel (2012-2016/17). Brandt added that JBER is working with US Fish and Wildlife to begin netting and collecting eDNA, which will address this concern. This was followed by a question about how we deal with counting fish running downstream. Brandt stated that Eagle River, in particular, is an open system so it's difficult to do so. She stated that JBER does a general count that includes number of fish and direction.

Christopher Garmer then shared information about Cook Inlet Beluga Whales in Eagle Bay and Eagle River. A question was posed on slide 18 about why there were no beluga observed in July. Garner responded that researchers are not quite sure. They hypothesize that the animals are drawn to other areas; for example, the west side of Knik Arm for the large salmon run. A discussion ensued about how beluga presence and absence is usually food related but also that they use the opaque water to avoid predators. Lamprey were brought up again. In particular, that they migrate in late fall. [This was in relation to observation and acoustic data showing beluga presence peaking in August and September] Garner stated that JBER is planning eDNA studies to examine the role of lamprey and other species in this habitat.

An attendee asked about how beluga data and fish escapement data compare. Garner and Brandt replied that this can be difficult. Fish are counted upstream and beluga are counted downstream, so it's difficult to correlate the data. A representative from Native Village of Eklutna noted that the timing if beluga match their fish net data. A conversation then followed about Tribes knowledge of similar correlations seen in Kenai Lake. JBER is planning projects to explore whether there is a correlation in Eagle River and Eagle Bay among beluga and salmonid presence.

At this point, Tucker presented slides about mitigation measures proposed in the EIS. A question was asked about contaminants from ordnance. Tucker stated that munitions constituents are addressed in the EIS. However, he added that JBER will continue monitoring for these constituents as agreed to in the past.

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, 673D AIR BASE WING
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

22 OCTOBER 2024

MEMORANDUM FOR RECORD: PRESENTATION OF BIOLOGICAL DATA AND ANALYSIS FOR DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR PROPOSED MORTAR AND ARTILLERY TRAINING AT RICHARD SON TRAINING AREAS, JOINT BASE ELMENDORF-RICHARDSON

FROM: 673 CES/CEIEC
730 Quartermaster Road
JBER AK 99505

SUBJECT: Summary of Meeting for Presenting Biological Data and Analysis related to the Preliminary Draft Environmental Impact Statement (PDEIS) for the Proposed Mortar and Artillery Training (PMART) at Richardson Training Areas, Joint Base Elmendorf-Richardson (JBER) on 29 FEB 2024

1. The 673d CES and 11 ABN on JBER organized a meeting with Federally Recognized Tribes and Alaska Native entities about the PMART project on 29 FEB 2024. The meeting was held remotely. The purpose of the meeting was to provide an overview of the project, share information on biological resources of particular concern, and present preliminary mitigation measures.

2. Presentations with slides were given by 11 ABN (purpose/need, timeline and milestones, habitat buffers and SDZs), Chris Garner (Cook Inlet Beluga Whales), and Colette Brandt (fisheries and habitat). A meeting narrative was distributed to all meeting participants, which included representatives from the Native Village of Eklutna, Knik Tribe, and Chickaloon Village Traditional Council.

3. The following bullets summarize topics of interest to attendees and questions or concerns for consideration in the PDEIS.

   a. Discussion of artillery, mortars, and how they work (point of explosion and location of impacts). Inclusion of maps and diagrams was recommended. There was also a conversation about accuracy of live fire training.
   b. Conversation about the current and proposed seasonality and limitations on training in ERF-IA. An explanation of the process for reporting rounds out of safe was recommended.
   c. An attendee asked why ERF-IA is used instead of upland areas. An explanation of the role of forward observers is recommended. A dialogue on why other areas on JBER were eliminated from consideration for impact areas took place, including surface danger zones and terrain limitations. An attendee noted that fewer species would be impacted in upland areas.
   d. Several attendees suggested JBER start studying lamprey and stickleback. The former because it is thought to be important for Cook Inlet Beluga Whale survival and the latter because it is an important subsistence species that is poorly understood.
   e. Discussion about methods used for documenting escapement by species (fish wheel or net, use of eDNA, recording species, quantity, and direction in system).

f. There was some conversation about when Cook Inlet Beluga Whales (CIBW) were recorded in Eagle Bay and Eagle River, the methods used to document their presence, and what draws them to other areas of the inlet. A discussion ensued about how CIBW presence and absence is usually food related but also that they use the opaque water to avoid predators. Lamprey were brought up again; specifically in relation to observation and acoustic data showing CIBW presence peaking in August and September.
g. An attendee asked about how CIBW data and fish escapement data compare. Fish are counted upstream and CIBW are counted downstream, so it's difficult to correlate the data. An attendee noted that this correlation was documented in other areas of the inlet, including Eklutna River and Kenai Lake.
h. Regarding mitigation measures proposed in the EIS, a question was asked about contaminants from ordnance. JBER will continue monitoring for these constituents as agreed to in the past.
i. An attendee stated that they liked the buffer zones in Eagle Bay, Eagle River, and lower Otter Creek.
j. During the discussion of buffers, a map included overlays of example surface danger zones. An attendee noted that the target areas seemed small for what was being proposed. It was explained that ERF-IA is a small impact area, which limits training scenarios.

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MARGAN A GROVER
Cultural Resource Manager, Environmental Conservation

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, 673rd AIR BASE WING
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

MEMORANDUM FOR NATIONAL MARINE FISHERIES SERVICE (NOAA FISHERIES)
ATTN:
REGION, HABITAT CONSERVATION DIVISION

FROM: 673 CEG/CC
6346 Arctic Warrior Drive
JBER, AK 99506-3420

SUBJECT: Notification of Intent to Initiate Essential Fish Habitat (EFH) Consultation for the Proposal for Mortar and Artillery Training (PMART) at Richardson Training Area, Joint Base Elmendorf-Richardson (JBER), Alaska

1. The United States Air Force (USAF) is proposing to modify the conditions under which indirect live-fire weapons training can be conducted at Joint Base Elmendorf-Richardson (JBER), Alaska, in order to meet United States Army (Army) doctrinal standards at home station. An Environmental Impact Statement (EIS) is being prepared for the proposed action, which focuses on live-fire weapons training at the Richardson Training Area, Eagle River Flats (ERF) Impact Area. All-season training is necessary to ensure that Soldiers achieve and maintain critical combat skills. Current live-fire restrictions limit training on JBER's only currently usable explosive munitions impact area to winter firing only (November 1 to March 31), dependent on ice cover requirements. By enhancing small-unit and live-fire training opportunities at JBER, and avoiding land use conflicts, United States Army Alaska ( ) can attain mandatory Army-wide training standards in a timely manner, respond to continuing high operations tempo, provide a long-term local training solution, provide a more stable family environment for Soldiers, and limit costly and time-consuming movement of equipment and personnel to other installations.

2. In 2010, a Draft EIS was developed to resume all-season indirect live-fire training at the former Fort Richardson. Since the release of the Draft EIS, organizational changes resulted in the joint basing of former Elmendorf Air Force Base and Fort Richardson into a single installation, JBER, and the EIS was never finalized. The new EIS will analyze new alternatives that allow all-season live-fire training, and will incorporate new project and resource information. The EIS is being prepared in accordance with the National Environmental Policy Act (NEPA) of 1969, Council on Environmental Quality regulations implementing NEPA (40 Code of Federal Regulations [CFR] Part 1500-1508), and USAF NEPA regulations at 36 CFR Part 989. As the managing agency of JBER, the USAF is the lead agency for the preparation of the EIS. USARAK retains operational responsibility for training areas and ranges and is a cooperating agency on the updated EIS.

3. The Magnuson-Stevens Fishery Conservation and Management Act (MSA; 16 U.S.C. §§ 1801 et seq.) requires Federal agencies to consult with NOAA Fisheries on actions that may adversely affect EFH. EFH includes those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. Generally, EFH consultation consists of a Federal agency notifying NOAA Fisheries regarding an action that may adversely affect EFH and providing them with an EFH

assessment (50 CFR 600.920(e)). As such, JBER will conduct an EFH assessment to describe how the actions proposed in the EIS may affect designated EFH and the managed species within the action area.

4. Five species of Pacific salmon (Chinook, coho, chum, pink, and sockeye) have EFH designated within the ERF impact area and will be analyzed in the EFH assessment. NOAA Fisheries classifies salmon EFH to include Eagle Bay of Knik Arm of the Cook Inlet as well as waterways (and contiguous wetlands) that support anadromous salmonids within ERF impact area. The EFH assessment will include the agency's conclusions regarding the effects of the proposed action on EFH and managed species, as well as proposed mitigation, if applicable.

5. If you have questions, please contact Mr. Brent Koenen, Environmental Conservation Chief, at (907) 384-6224, or via email at brent.koenen@us.af.mil

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MICHAEL R. STAPLES, Col, USAF
Commander

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, 673D AIR BASE WING
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

16 July 2024

MEMORANDUM FOR NOAA FISHERIES NOAA FISHERIES, ALASKA REGION
ATTN: MR. JON KURLAND, REGIONAL ADMINISTRATOR

FROM: 673 CES/CEIEC
724 Quartermaster Road
JBER, AK 99506

SUBJECT: Submittal of Essential Fish Habitat Assessment for the Proposed Mortar and Artillery Training Project, Fort Richardson Training Lands, Joint Base Elmendorf-Richardson, Alaska

1. The United States Air Force proposes to remove to modify the conditions under which indirect live-fire weapons training can be conducted at Joint Base Elmendorf-Richardson (JBER), Alaska, to meet United States Army (Army) doctrinal standards at home station. Management of JBER is the responsibility of the Air Force, and the Army retains operational responsibility for training areas and ranges. All-season training is necessary to ensure that Soldiers achieve and maintain critical combat skills. Current live-fire restrictions limit training on JBER's only currently usable explosive munitions impact area to winter firing only (November 1 to March 31), dependent on ice cover requirements. By enhancing small-unit and live-fire training opportunities at JBER, and avoiding land use conflicts, United States Army Alaska (USARAK) can attain mandatory Army-wide training standards in a timely manner, respond to continuing high operations tempo, provide a long-term local training solution, provide a more stable family environment for Soldiers, and limit costly and time-consuming movement of equipment and personnel to other installations.

2. Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) and the Fish and Wildlife Coordination Act requires federal agencies to consult with the National Marine Fisheries Service on all actions that may adversely affect essential fish habitat (EFH) and other aquatic resources. The EFH consultation process is guided by the requirements of our EFH regulation at 50 CFR 600 Subpart K, which mandates the preparation of EFH assessments and generally outlines each agency's obligations in this consultation process.

3. The North Pacific Fishery Management Council (NPFMC) has identified EFH for nearshore marine waters in the vicinity of Eagle River Flats-Impact Area to include EFH for several species of groundfish, forage fish and all five species of Pacific salmon [full list in Table 3-1 of the EFH Assessment, Attachment 2]. The NPFMC and the Alaska Department of Fish and Game's Anadromous Waters Catalog identifies Eagle River and several secondary tributaries as supporting anadromous fish, including [Chinook, sockeye, coho, chum, and pink; juvenile, and immature and mature adults].

4. Please find the attached essential fish habitat (EFH) assessment submitted under Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable

Fisheries Act of 1996 (Public Law 104-267), for effects to EFH and EFH managed species/species complexes incidental to the Proposed Mortar and Artillery Training (PMART) Project at Richardson

Training Area, Joint Base Elmendorf-Richardson, Alaska. The EFH Assessment considers two action alternatives for the proposed project which modify the conditions under which indirect live-fire weapons training can be conducted at Joint Base Elmendorf-Richardson (JBER), Alaska, to meet United States Army (Army) doctrinal standards at home station.

5. We value your assistance and look forward to consulting further regarding protected resources that may be affected by this project. If you have additional questions or comments, please contact Ms. Charlene Johnson, Environmental Planner, at (907) 384-3913 or via email at Charlene.johnson.3@us.af.mil.

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Charlene Johnson, GS-12
JBER Environmental Planner

2 Attachment:
1. Notification of Intent to Initiate Essential Fish Habitat (EFH) Consultation for the Proposal for Mortar and Artillery Training (PMART) at Richardson Training Area, Joint Base Elmendorf-Richardson (JBER), Alaska, 29 March 2020
2. Essential Fish Habitat Assessment for Proposed Mortar and Artillery Training at Richardson Training Area, Joint Base Elmendorf-Richardson, Alaska, July 2024

Cc:
Cathy Coon - NOAA Federal cathy.coon@noaa.gov
Sean McDermott – NOAA Federal sean.mcdermott@noaa.gov
Jodi Pirtle – NOAA Federal Jodi.Pirtle@noaa.gov
Doug Limpinsel – NOAA Federal Doug.Limpinsel@noaa.gov
Colette Brandt – 673d Civil Engineer Squadron (CES) Fisheries Biologist colette.brandt@us.af.mil
Kylene Lang – 673d CES Environmental Conservation Chief kylene.lang.1@us.af.mil
Jeanne Dye-Porto – 673d CES Installation Flight Chief jeanne.dye-porto@us.af.mil
David Martin – Air Force Civil Engineer Center, NEPA Program Manager david.martin.127@us.af.mil

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
P.O. Box 21668
Juneau, AK 99802-1668

September 3, 2024

Charlene Johnson, Environmental Planner
673d CES/CEIEC
Environmental Conservation
724 Quartermaster Road Door 5
JBER, AK 99505

Re: Proposed Mortar and Artillery Training Expansion, Joint Base Elmendorf-Richardson, Alaska; NMFS ECO AKRO-2022-03644

Dear Ms. Johnson:

The National Marine Fisheries Service has reviewed the Essential Fish Habitat (EFH) Assessment, provided on July 17, 2024, regarding the above referenced action. The U.S. Air Force (USAF), representing the U.S. Army (Army), proposes to remove existing winter firing restrictions (November 1 to March 31) to allow for all-season indirect, live-fire mortar and artillery training in Eagle River Flats Impact Area (ERF-IA). The existing ERF-IA (2,483-acres) is a tidal salt marsh and estuary complex draining Eagle River, Otter Creek and several other unnamed and relict channels. We have been in discussions with the USAF on this topic since 2010. We have been a cooperating agency since 2018. The USAF has discussed and analyzed potential impacts and jointly proposed numerous mitigation measures to reduce impacts. The EFH Assessment provided considers two project alternatives. Alternative 1 (Army's preferred alternative), includes expanding ERF-IA by approximately 585 acres into a separate though adjacent upland area. Alternative 2 would not change the existing impact area boundaries. All other aspects of the two alternatives would remain the same.

Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) and the Fish and Wildlife Coordination Act require Federal agencies to consult with us on all actions that may adversely affect EFH and other aquatic resources. The EFH consultation process is guided by the regulation at 50 CFR 600 Subpart K, which mandates the preparation of EFH assessments and outlines each agency's obligations. In support of this consultation process, you provided a notice of the proposed action and your agency's conclusion regarding impacts on EFH. We offer the following comments and recommendations on this project.

Essential Fish Habitat

The North Pacific Fishery Management Council (NPFMC 2021) has designated EFH for all five species of anadromous Pacific salmon in the Eagle River watershed, Eagle Bay, and nearshore marine waters of Knik Arm. Pacific salmon presence within the project areas is documented by both the Alaska Department of Fish and Game's Anadromous Waters Catalog (Giefer and Graziano. 2024) and ongoing studies conducted by the USAF (AERC 2022a,b).

The NPFMC (2020) also identifies EFH for several species of groundfish and forage fish in Eagle Bay and Knik Arm including Pacific eulachon, smelt, Pacific cod, walleye pollock, saffron cod, and yellowfin sole (Dames & Moore 1983, Pentec Environmental 2005, Schoofs et al. 2018).

Assessment of Effects to EFH

The USAF has concluded that expanding to all-season indirect, live-fire mortar and artillery training in Eagle River Flats may adversely affect EFH and managed fish species. The EFH regulations define an adverse effect as "any impact that reduces the quality and/or quantity of EFH" (50 CFR 600.810(a)). Based on our review of the information provided, we agree with your conclusion of effects. Of particular concern are the effects of explosions, shrapnel, and contaminants on EFH, including prey, as well as federally managed fish. Explosions from mortar and artillery fire can result in serious or lethal injury of living organisms from shrapnel, or serious physical injury from sound pressure waves. Exposure to explosions and impulsive sound may decreased ability of juvenile and adult fish to forage or avoid predators. The proposed action may alter aquatic habitat through cratering, soil compaction, soil erosion, and vegetation removal, creating the potential for increased sediment runoff. This would indirectly result in some loss or disturbance to the macroinvertebrate prey base for juvenile salmonids. Managed species and prey may be exposed to contaminants in munitions residues in the sediment and water column. Residues can also persist in the environment and can be toxic depending on chemical constituent and exposure levels.

Mitigation Measures

To increase operational and training opportunities and reduce impacts to EFH, the Army has adopted the following mitigation measures (also listed in the EFH Assessment section 5.1.1):

- Seasonal no fire windows for high explosive ordinance in designated areas.
- Direct fire away from EFH by creating a new 585 acre standalone upland area.
- Expanding habitat protective buffers near EFH.
- Limiting and reducing areas where high explosives are deployed.
- Prohibit firing into waterbodies during inundating tides.
- Maintain the existing Dual Frequency Identification Sonar (DIDSON) monitoring program for adult salmon escapement.
- Potentially developing a water quality monitoring program for explosives residues.
- Potentially developing sound verification studies to validate results of acoustic models.

The potential adverse effects to EFH and associated federally managed species can be reduced under the proposed action if these identified conservation recommendations and best management practices are implemented, as well as the conservation recommendations below.

EFH Conservation Recommendations

In accordance with Section 305(b)(4)(A) of the MSA, we offer the following conservation recommendations to further avoid, minimize, mitigate, or otherwise offset effects:

- We support Alternative 1 as this alternative includes the 585 acre expansion area into adjacent uplands, further reducing potential impacts to primary EFH in the Eagle River Flats area during salmon runs. Directing any live-fire mortar and artillery training away from EFH in the Eagle River Flats would reduce potential impacts to designated EFH, Pacific salmon and other federally managed fish, and their prey base from direct and indirect impacts of this action.

- Expand the no fire window in the Eagle River Flats to include June 1 through September 1 (92 days). This no fire date range would increase protections to Chinook salmon during their documented migration season. As indicated in the Environmental Impact Statement and EFH Assessment, “the total average number of indirect-fire training days scheduled by all units stationed at [Joint Base Elmendorf-Richardson] is 134 days”. This proposed 92 day no fire window provides the Army 253 days for indirect-fire training.
- Continue DIDSON monitoring and numeration surveys. DIDSON surveys remain the most robust tool for monitoring annual escapement and recruitment, and overall health and condition of the returning Eagle River salmon populations. Annual monitoring and enumeration will also allow justification and implementation of future adaptive management approaches if large scale fluctuations are seen in the monitoring data.
- Expand buffer zones and/or seasonal firing restrictions to include the Relict Channel located in area TA 413 and TA 414 or restrict live fire in this area to the lower end of tide cycle. Current evidence from surveys indicates salmon species (e.g. coho) rear in these tidally influenced remnant channels.

The EFH consultation process promotes our agency’s mission to support sustainable fisheries, the recovery and conservation of protected resources, and healthy ecosystems. Further, our consultation process incorporates an ecosystem-based fisheries management approach to evaluating adverse effects and providing recommendations. Our recommendations for protecting and conserving EFH may have synergistic benefits for supporting the Primary Constituent Elements (PCE) to the recovery of Cook Inlet Beluga whales (CIBW). Those PCEs include, but are not limited to, prey species (e.g., Pacific salmon and eulachon), intertidal and subtidal habitats less than 30 feet mean lower low water, and within 5 miles of high and medium flow anadromous streams (76 CFR 20179, April 11, 2011). These PCEs for CIBW overlap the attributes of EFH identified in this consultation.

A written response to our conservation recommendations is required within 30 days pursuant to Section 305(b)(4)(B) of the MSA. If your response is inconsistent with our recommendations, explain the reasons for not following our recommendations, including the scientific justification for any disagreements over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)). If you will not make a decision within 30 days, provide letter to that effect and indicate when a full response will be provided. Significant changes to the project may require reinitiating consultation. Douglas Limpinsel (Doug.Limpinsel@noaa.gov) is available to answer questions or discuss further actions.

Sincerely,

Catherine Coon
Assistant Regional Administrator
Habitat Conservation

cc: Kylene Lang - kylene.lang.1@us.af.mil
Jeanne Dye-Porto - jeanne.dye-porto@us.af.mil
David Martin - david.martin.127@us.af.mil
Colette Brandt - colette.brandt@us.af.mil

References

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DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, 673D CIVIL ENGINEER SQUADRON
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

RESPONSE FOR NATIONAL MARINE FISHERIES SERVICE
ESSENTIAL FISH HABITAT CONSULTATION LETTER of 3 SEPTEMBER 2024
ATTENTION: MS. CATHERINE COON

TO: 1 October 2024

NOAA Fisheries
National Marine Fisheries Service
P.O. Box 21668
709 West 9th Street
Juneau, AK 99802

FROM: 673 CES/CEIEC
724 Quartermaster Road, Door 5
JBER, AK 99505

SUBJECT: Essential Fish Habitat Consultation for Proposed Mortar and Artillery Training (PMART) project at Richardson Training Area, Joint Base Elmendorf Richardson (JBER), Alaska (AK), NMFS ECI AKRO-2022-03644

1. The United States Air Force received your review and recommendations letter dated September 3, 2024 regarding consultation for Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) and the Fish and Wildlife Coordination Act. The Air Force appreciates your analysis and recommendations and shares your commitment to minimizing the impact of the proposed action on these important fish species. As explained below, the Air Force concurs with two recommendations and partially concurs with another but is unable to fully implement all of your recommendations consistent with the purpose and need of the PMART proposed action.

2. Your letter offered four EFH conservation recommendations to further avoid, minimize, mitigate, or otherwise offset effects. The Air Force has carefully considered each of your recommendations and our response is detailed below.

- <u>NMFS Recommendation #1:</u> We support Alternative 1 as this alternative includes the 585-acre expansion area into adjacent uplands, further reducing potential impacts to primary EFH in the Eagle River Flats area during salmon runs. Directing any live-fire mortar and artillery training away from EFH in the Eagle River Flats would reduce potential impacts to designated EFH, Pacific salmon and other federally managed fish, and their prey base from direct and indirect impacts of this action.

  <u>Air Force Response - Concur:</u> Alternative 1 is the preferred alternative. Your analysis and recommendation further strengthens our conclusion that the expansion area directly and substantially reduces potential adverse effects on fish species.

- NMFS Recommendation #2: Expand the no fire window in the Eagle River Flats to include June 1 through September 1 (92 days). This no fire date range would increase protections to Chinook salmon during their documented migration season. As indicated in the Environmental Impact Statement and EFH Assessment, "the total average number of indirect-fire training days scheduled by all units stationed at [Joint Base Elmendorf-Richardson] is 134 days." This proposed 92 day no fire window provides the Army 253 days for indirect-fire training.

  Air Force Response – Does Not Concur: The Air Force is unable to adopt this recommendation because the recommended expansion of the High Explosive (HE) closure period would not provide sufficient flexibility for training days to meet periodic qualification requirements and still maintain a protective closure period for Cook Inlet beluga whale (CIBW).

  Cook Inlet Beluga Whale Closure Period

  In consultation with the Army, the Air Force included a protective measure in the EFH Assessment consisting of an HE closure period[1] from 15 August – 30 September, in conjunction with enhanced habitat buffers and other measures, as protective of both EFH and CIBW. After considering the proposed action, NMFS recommended a 71-day closure period from 9 August – 18 October as protective of CIBW and most of the anadromous salmon runs.[2] This expansion of the closure period reduced flexibility but provided sufficient flexibility among training days across the year to meet the Army's training and qualification requirements. Adopting your recommendation to start the HE closure period on 1 June and still retain the NMFS-recommended closure through 18 October, in order to fully protect both EFH and CIBW, would result in a 140-day closure which would significantly hamper the ability to complete all required training. Shifting the end of the HE closure period to 1 September consistent with your recommendation, would be inconsistent with the NMFS recommendation to protect CIBW. In light of the comparative risk of population level effects between CIBW and the fish species of concern, the Air Force has decided to maintain the recommended HE closure period through 18 October.

  Recurring Nature of Training Requirements

  Your recommendation, in considering only the total available days outside the recommended closure period, does not account for the periodic nature of the Army's training requirement detailed in Section 1.2 of the EFH Assessment. Army Training Circulars 3-20.0, 3-20.33, and 3-09.8 detail the full array of annual, semi-annual, and quarterly training requirements for the units that train at JBER. The timing of the training requirement is driven by a variety of factors. The proposed training has historically

[1] The Air Force uses the term HE closure period rather than "no fire" period since units may continue to fire training rounds and other ordinance that do not produce the explosion and shrapnel risks detailed in the EFH Assessment and mentioned in your analysis.
[2] August 9, 2024 letter from NMFS Office of Protected Resources and Alaska Regional Office, Subject: NMFS Recommendations Regarding a Potential Seasonal Closure Window for High Explosive Mortar and Artillery Training at Richardson Training Area, Joint Base Elmendorf Richardson

required an average of 134 days per year to complete all mortar and artillery training requirements for JBER-based units. However, sufficient scheduling flexibility is also required to accomplish certifications and qualifications throughout the year, on not less than a quarterly schedule. Additionally, as detailed in Section 1.2.2 of the EFH Assessment, crew condemnation criteria incurred by personnel losses or moves must be routinely repaired as they happen. This may reset the "quarterly" requirement at any point in the year; so the "quarterly" requirement cannot be assumed to follow a standard calendar pattern from year to year.

Combined Assessment

While EFH conservation, CIBW protection, and periodic training are each important objectives, they cannot all be simultaneously achieved and a balancing approach is necessary. While periodic training is required, the implementation of habitat buffers and adoption of the proposed expansion area substantially reduces the explosion and shrapnel risks discussed in your review. The adoption of the recommended HE closure window from 9 August to 18 October covers a substantial period of the closure window you recommended. Finally, the other mitigation measures you noted, such as the prohibition against firing into inundated areas and enhanced habit monitoring, complement all of these protective actions. While the Air Force cannot adopt the entirety of the HE closure window you recommend, the Air Force concludes that adopting an HE closure window from 9 August to 18 October, along with the other protective measures mentioned, constitutes a rational balance of all these competing objectives.

- <u>NMFS Recommendation #3:</u> Continue DIDSON monitoring and numeration surveys. DIDSON surveys remain the most robust tool for monitoring annual escapement and recruitment, and overall health and condition of the returning Eagle River salmon populations. Annual monitoring and enumeration will also allow justification and implementation of future adaptive management approaches if large scale fluctuations are seen in the monitoring data.

  <u>Air Force Response - Concur:</u> Sonar monitoring (e.g. DIDSON) and enumeration surveys are currently accomplished cooperatively between the Air Force and the Army. Both the 673rd Civil Engineer Squadron and Range Control intend to continue using sonar for its annual enumeration program and adopt improved sonar monitoring technology as it becomes available and resources permit.

- <u>NMFS Recommendation:</u> Expand buffer zones and/or seasonal firing restrictions to include the Relict Channel located in area TA 413 and TA 414 or restrict live fire in this area to the lower end of tide cycle. Current evidence from surveys indicates salmon species (e.g. coho) rear in these tidally influenced remnant channels.

  <u>Air Force Response – Partially Concur:</u>

  Expanded Buffer Zones

Both project alternatives include a built-in protective buffer of the Otter Creek Complex where it is currently known that predominant salmon rearing occurs, as well as Otter Creek and Eagle River where the salmon runs (for all five species) occur. Training for indirect fire requires developing proficiency from a variety of firing points to a variety of targets. Applying the additional suggested buffers would restrict mortar firing at six locations, constraining the ability to fulfill the purpose and need for this project.

The Air Force adopts the intent of this recommendation by incentivizing units firing in the vicinity of the relict channel to schedule their training at the lower end of the tide cycle and to primarily use Full Range Practice Cartridges (FRPC) in lieu of HE to the greatest extent possible. Range Control will implement this measure by requiring a finding of necessity at an appropriate level of command prior to using HE rounds during median and high tide conditions. Based on fire control measures included in the action alternatives, the largest weapon systems (155-mm howitzers and 120-mm mortars) will not fire HE or HE practice rounds into the southernmost portion of the impact area adjacent to TA 413 and TA 414 thus eliminating effects from the largest net explosive weight projectiles. With the current buffers along Knik Arm, Eagle River, Otter Creek, and Otter Creek Complex plus the additional Surface Danger Zone (SDZ) safety zones, HE fires will already be restricted in roughly half of the existing impact area.

Although not detailed in the EFH Assessment, the normal progression of training missions also limits the risk to juvenile salmon. Effective training requires soldiers to fire at a specific target. In TA 413 and 415, these targets would consist of static targets placed on high ground as far away from the channel as practicable. Accordingly, the rounds will be directed away from the channels by virtue of the training objectives themselves. When coupled with the existing prohibition on firing into open water, this greatly reduces the likelihood of rounds exploding in direct proximity to the relict channel. The restrictions on HE rounds noted above will limit HE training in this area to 60 mm and 81 mm mortars only. Based on the JASCO noise modeling for the munitions in this area (modeled scenario COMB1 and COMB5), the maximum distances from edge of waterbody during typical high-tide thresholds for mortality, potential mortal injury, and recoverable injury was 4m and distance to the SEL24h TTS threshold was 12m[3] . Finally, a training mission begins with individual fires that allow soldiers to fine tune aiming within the target area prior to initiating multiple simultaneous fires for effect. The combination of all these factors—the location of targets, the limited net explosive weight of the rounds used, and the initial individual fires—limit the likelihood of impacts on juvenile salmon and provide them an opportunity to temporarily avoid the area during training.

Seasonal Firing Restrictions

For the reasons discussed above in response to your second recommendation, it is not practicable to adopt a 140-day closure beginning on 1 June. A separate seasonal closure

[3] JASCO. 2022. Weapon Firing at the Joint Base Elmendorf-Richardson (JBER) Eagle River Flats (ERF) Impact Area: Supplemental In-air and Underwater Noise Modeling. Document 02747, Version 1.1. Prepared by J.E. Quijano, C.H. Grooms, and M.E. Austin of JASCO Applied Sciences for AECOM Technical Services, Inc.

was considered for the southern portion of the impact area in the vicinity of the relict channel, but there are concerns that multiple closure periods could potentially cause confusion and result in a higher risk to CIBW.

3. The Air Force appreciates your analysis and recommendations, and the responses above adopt them to the full extent practicable while still achieving the purpose and need of the proposed action. We look forward to your cooperation and assistance in applying the results of the adaptive management and sampling efforts described in the EFH Assessment to enhance these measures in the future and further minimize the effects of this vital training on EFH. If you have questions, please contact Ms. Charlene Johnson, 673 CES/CEIEC, at (907) 384-3913.

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Kylene Lang, GS-13, DAF
Chief, Environmental Conservation
Joint Base Elmendorf-Richardson

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From: JOHNSON, CHARLENE C CIV USAF PACAF 673 CES/CEIC
Sent: Tuesday, October 1, 2024 11:36 AM
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Subject: Request for Incidental Take Authorization - Proposed Mortar and Artillery Training (PMART), Joint Base Elmendorf-Richardson, Alaska

01 October 2024

Jolie Harrison, Division Chief
Permits and Conservation Division, Office of Protected Resources,
1315 East-West Highway, F/PR1 Room 13805,
Silver Spring, MD 20910

Dear Ms. Harrison:

Please find the attached request for an incidental take authorization under section 101(a)(5) of the Marine Mammal Protection Act of 1972, as amended, for the take of marine mammals incidental to conducting Proposed Mortar and Artillery Training (PMART) at Richardson Training Areas, Joint Base Elmendorf-Richardson by the U.S. Air Force (Air Force) and 11th Airborne Division of the U.S. Army (Army).

The Air Force and Army plan to conduct Proposed Mortar and Artillery Training in the Eagle River Flats, adjacent to the Knik Arm of Cook Inlet, Alaska to meet military training requirements beginning January 2026. Because the Air Force and Army's activities have the potential to cause behavioural take of marine mammals, we are requesting *a Letter of Authorization for Incidental Harassment of Marine Mammals*.

We look forward to working with you and your staff to answer any questions you may have about this application. Please feel free to contact myself or Ms. Kylene Lang (kylene.lang.1@us.af.mil, 907-384-2440) with additional questions.

Charlene C. Johnson, M.S., P.W.S.

Environmental Planner and NEPA Practitioner

673d CES/CEIEC

Joint Base Elmendorf-Richardson, Alaska

907-384-3913 (office)

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Charlene.johnson.3@us.af.mil

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
1315 East-West Highway
Silver Spring, Maryland 20910

TO:	**David Martin, DAF AFCEZ/CZN, Program Manager**
FROM:	**National Marine Fisheries Service (NMFS) Office of Protected Resources (OPR)**
DATE:	**January 3, 2025**
SUBJECT:	**NMFS Assessment of an Incidental Take Authorization Request for Proposed Mortar and Artillery Training at Richardson Training Area, Joint Base Elmendorf Richardson**

Introduction

On October 1, 2024 the U.S. Air Force (USAF) submitted a request for an incidental take authorization (ITA) under section 101(a)(5)(A) of the Marine Mammal Protection Act (MMPA) of 1972, as amended, for the take of marine mammals incidental to conducting Proposed Mortar and Artillery Training (PMART) at Richardson Training Area, Joint Base Elmendorf-Richardson (JBER) by USAF and the 11th Airborne Division of the U.S. Army (Army).

The USAF and Army have proposed to conduct year-round indirect live-fire mortar and artillery training in Eagle River Flats (ERF), located adjacent to the Knik Arm of Cook Inlet, Alaska, to meet military training requirements. The proposed action would also expand the ERF impact area (ERF-IA) by approximately 585 acres into adjacent uplands and allow use of 155-millimeter howitzers containing high explosives (HE) during training at ERF-IA. The USAF determined that these activities have the potential to cause incidental take of marine mammals, and therefore requested 7-year incidental take regulations and a Letter of Authorization for the incidental take, by harassment only, of four species of marine mammals: Cook Inlet beluga whale (*Delphinapterus leucas*), harbor porpoise (*Phocoena phocoena*), Steller sea lion (*Eumetopias jubatus*), and harbor seal (*Phoca vitulina*). The subject training activities qualify as military readiness activities pursuant to the MMPA, as amended by the National Defense Authorization Act (NDAA) for Fiscal Year 2004 (NDAA 2004).

After careful review of the ITA request, including the proposed mitigation and monitoring measures detailed in the ITA request (summarized in Appendix A) and based on the analysis included herein, NMFS has determined that the incidental take of marine mammals is not reasonably likely to occur because the specified activities would not harass (as defined for a "military readiness activity" under 16 U.S.C. § 1362(18)(B)) or result in the mortality of any marine mammal or marine mammal stock. Therefore, an ITA under the MMPA is not necessary for the specified activities. Primarily, NMFS' determination is based on the USAF's commitment to implementing the following mitigation and monitoring measures, in addition to measures provided in Appendix A:

- The placement of protective habitat buffers[1] into which no rounds would be fired along the Eagle Bay shoreline, Eagle River, Otter Creek, and selected tributaries and upstream locations that are larger than in-water harassment distances modeled during typical high tide conditions[2]. The implementation of these buffers means take due to underwater noise would not occur during firing exercises performed during typical tidal ranges (including low to non-inundating[3] high tides) in these waterways because detonations would occur outside these habitat buffers.
- A prohibition on firing of HE rounds and 155-mm training rounds into areas inundated by high tide events (predicted and observed). The implementation of this measure means that underwater acoustic thresholds for non-auditory injury, auditory injury, and behavioral disturbance would not be reached for any of the four marine mammal species in the action area during periods of time when the habitat buffers and upland target areas may be underwater (i.e., take due to underwater noise would not occur during inundating tides because HE rounds and 155-mm training rounds would not be fired into inundated areas).
- A prohibition on firing of HE rounds and 155-mm training rounds into ERF during the peak beluga whale upriver visitation period (August 9 through October 18[4]) (i.e., a seasonal closure). This measure provides added protection for beluga whales from noise impacts when they are most likely to be present in the action area, further reducing the

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[1] Habitat buffer distances were calculated by JASCO (2022) by modelling the minimum distances from a waterbody required to avoid exceeding underwater criteria thresholds during on-land ammunition detonations during typical high tide conditions from six representative locations for all charge sizes (i.e., distance to effect modeling).

[2] See Section 1.5.2.1 and Table 6-8 in the ITA request for habitat buffer and modeled harassment distances, respectively. Note, acoustic modelling included in the ITA request followed NMFS 2018 Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (NMFS 2018). In 2024, NMFS published an update to this guidance (NMFS 2024a). The application of the updates in NMFS (2024a) would not result in any changes to our determinations. Estimated underwater ensonified areas for beluga whales and harbor porpoises would be the same or smaller based on higher underwater thresholds for these species. Estimated underwater ensonified areas for pinnipeds would be larger, however, are still expected to be smaller than the proposed habitat buffers. Lastly, estimated air-borne ensonified areas exceeding thresholds would be smaller for pinnipeds.

[3] The word "inundated" is used specifically to refer to the tidal inundation that occurs when higher tides cause flooding outside the banks of Eagle River and into the surrounding floodplain. A 31-foot or high tide level predicted at the Goose Creek, Cook Inlet Tide Station (ID 9455963), or as observed on the ground, is considered as an inundated tide.

[4] USAF and the Army chose the dates of this window based on a recommendation from NMFS (2024b), which analyzed passive acoustic data collected from 2018 through 2021 by USAF in EFR. Based on NMFS' (2024b) analysis, a seasonal closure window from August 9 through October 18 (70 days) was deemed to best minimize any potential impacts from the training activities on Cook Inlet beluga whales, based on this time period representing periods of time when belugas were consistently acoustically recorded in high numbers throughout ERF. Note, HE rounds could still be fired into the proposed expansion area during this seasonal closure.

likelihood that take of this species would occur. This measure also provides added protection for harbor porpoises, harbor seals, and Steller sea lions in the action area during this time, including reduced modelled in-air distances to harassment thresholds for pinnipeds.

- The application of human safety measures to marine mammals (e.g., effective placement of impact areas (including Surface Danger Zones), and minimum human safety distances along all waterways). This measure affords marine mammals the same protections as personnel, prohibiting the firing of any rounds into areas where hazardous fragments would have a 1 in 1,000,000 chance of striking marine mammals.

Cook Inlet Beluga Whale

The implementation of habitat buffers along many of the waterways in ERF-IA means that the underwater acoustic thresholds for non-auditory injury, auditory injury, or behavioral disturbance for beluga whales would not be reached, and that the likelihood of injury or mortality from shrapnel would be reduced to a less than 1:1,000,000 chance. Further, firing of HE rounds and 155-mm training rounds during inundating tides would be prohibited, reducing the likelihood that these rounds would detonate in water and that harassment thresholds would be met. While it is possible that individual animals may travel upstream undetected in the few unbuffered waterways within the target areas[5], it is not reasonably likely that they would be within the spatial and temporal proximity of a detonation that would be required to experience a temporary threshold shift (TTS) or behavioral disturbance (i.e., ≤ 10 meters[6]; Level B harassment), or within the small ensonified Level A harassment radii (i.e., < 8 meters[6]) for a period of time long enough to incur auditory injury (AUD INJ)[7], which may include permanent threshold shifts (i.e., Level A harassment). Lastly, the implementation of the seasonal closure would eliminate any potential incidental harassment from HE rounds and 155-mm training rounds during the time period when beluga whales are most likely to be present in greatest numbers within ERF (NMFS 2024b). Slow start firing procedures and the presence of and measures to be implemented by forward observers and protected species observers (PSOs) further reduce the likelihood of incidental take of this species such that take is not considered reasonably likely to occur.

Harbor Porpoise

NMFS' assessment for harbor porpoise is similar to that of beluga whales described above and is only briefly summarized here: habitat buffers, tidal firing restrictions, and the application of human protection measures to marine mammals are expected to prevent harbor porpoise from being exposed to underwater acoustic noise that could result in non-auditory injury, auditory injury or behavioral disturbance[6], and that the likelihood of injury or mortality from shrapnel would be reduced to a less than 1:1,000,000 chance. The implementation of additional mitigation

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[5] See Appendix A.

[6] See Table 6-8 in the ITA request for modeled harassment distances.

[7] Terminology is from NMFS (2024a).

and monitoring measures (Appendix A) would further reduce the likelihood of incidental take of this species such that take is not considered reasonably likely to occur.

Harbor seal

Underwater noise criteria and thresholds for AUD INJ, TTS, and behavioral disturbance for harbor seals would not be met, and the likelihood of physical injury or mortality is expected to be discountable due to the aforementioned proposed mitigation and monitoring measures. Further, while it is possible that individual harbor seals may travel upstream undetected in the few unbuffered waterways within the ERF-IA, it is not reasonably likely that they would be in water close enough to and at the same time as a detonation that would be required to experience TTS or behavioral disturbance (i.e., ≤ 38 meters[8]) or within the ensonified Level A harassment radii (i.e., < 26 meters[8]) for a period of time long enough to incur AUD INJ. The seasonal closure window for HE rounds proposed for beluga whales overlaps with the months that JBER has reported observing harbor seals most consistently in Eagle Bay/River[9], and thus would provide added protection to harbor seals from any potential impacts from HE rounds, further reducing the likelihood of incidental take of this species.

Airborne noise thresholds, however, would be exceeded.[10] Despite this, NMFS has determined that it is not reasonably likely that the impacts to harbor seals from the specified activity would rise to the level of harassment for purposes of a military readiness activity[11]. Hauled-out harbor seals have not been observed in Knik Arm during NMFS aerial surveys in more than 15 years[12]. NMFS has observed aggregations of hauled-out harbor seals consistently near the Chickaloon Bay/River and the Susitna River/Delta (Rugh et al. 2005; Shelden et al. 2013, 2015, 2017, 2022, Shelden and Wade 2019); however, these locations are located outside the 22.6-kilometer modelled distance for behavioral disturbance during the seasonal closure period and just within or near the outer rim of the 50-kilometer modeled distance for behavioral disturbance outside the seasonal closure period.[13] Therefore, any individual harbor seals that may be hauled-out during training activities are expected to be located outside of or just within areas ensonified by sound exceeding in-air noise criteria and thresholds for Level B harssment.[14] Source proximity is an important factor in predicting behavioral disturbance (e.g., Dunlop et al. 2018, Southall et al.

[8] See Table 6-8 in the ITA request for modeled harassment distances.

[9] See Section 4.4.3 of the ITA request for details regarding harbor seal presence in the action area.

[10] See Tables 6-6 and 6-7 in the ITA request for modeled harassment distances.

[11] See the MMPA definition of "harassment" for military readiness activities at 16 U.S.C. § 1362(18)(B).

[12] Kim Shelden, personal communication, December 20, 2024.

[13] 50-kilometers was deemed to be a reasonable maximum distance based on local topography and likely environmental conditions.

[14] The ITA request indicates that 6.3 percent of 79 observations of harbor seals made by JBER during 2008-2021 surveys were hauled out in Eagle Bay/River; however, no information is given regarding the percentage observed in the ERF-IA. Further, even if all observations were within the ERF-IA, the low number of hauled-out individuals over 13-years suggests that it is not reasonably likely that individual hauled out harbor seals would be present, unobserved by forward observers, and within spatial and temporal proximity of a detonation to experience harassment.

2019); therefore, the likelihood of behavioral disturbance at these extended distances is decreased. If a harbor seal happens to be exposed to airborne noise within the modeled airborne Level A harassment distance (i.e., 81 meters during the seasonal closure or 176 meters outside the seasonal closure) it is unlikely that it would remain with the ensonfied radii long enough to incur AUD INJ (i.e., 24 hours).

Long-term monitoring of harbor seals exposed to sonic booms and other impulsive noises has indicated that behavioral disturbances from airborne noise were temporary, that no abnormal behavior or pup abandonment occurred, and that no population-level effects are expected from those disturbances (e.g., Holst et al. 2005, Holst et al. 2011, U.S. Navy 2023, United States Space Force (USSF) 2024, Ugoretz and Greene Jr. 2012). Based on these and other observations, should hauled-out harbor seals be present within the airborne modeled ensonified zones, any behavioral disturbances resulting from exposure to in-air noise from the proposed training activities are anticipated to be temporary, and behavioral patterns are not anticipated to be abandoned or significantly altered.[15] Lastly, visual marine mammal monitoring of pinnipeds local to upper Cook Inlet provides data to suggest that they are habituated to multiple forms of anthropogenic disturbance (e.g., 61N Environmental 2021, 2022a, 2022b). The area where exposures may occur is already subject to in-air noise from commercial, private, and military aircraft; port operations; construction activities; commercial and sport fishing, and recreational boating. For these reasons, the ITA request states that impacts to harbor seals are expected to be minimal; NMFS concurs with this assessment and has determined that incidental take of this species resulting from the specified activities is not reasonably likely.

Steller sea lion

Similar to harbor seals, the underwater noise criteria and thresholds for AUD INJ, TTS, and behavioral disturbance for Steller sea lions would not be met, and the likelihood of physical injury or mortality is expected to be discountable, due to the aforementioned proposed mitigation and monitoring measures. Airborne noise thresholds would be exceeded[16]; however, Steller sea lions are rare in upper Cook Inlet and there are no known haul-out or breeding sites. Monitoring data has suggested that Steller sea lion reactions to blasting or launch noise are variable, but are of minimal severity (e.g., alert behavior, entering water from haulout; Demarchi et al. 2012, USSF 2024), and that behavioral patterns are not abandoned or significantly altered.[15] Additionally, the area where exposures may occur is already subject to in-air anthropogenic noise as mentioned above, so the small number of Steller sea lions that frequent the area are likely already habituated to such noises. Given the low numbers of Steller sea lions in the proposed action area (including no known haul-out locations), and observations suggesting minimal reactions of pinnipeds to similar sound sources (e.g., Holst et al. 2005, Demarchi et al. 2012, U.S. Navy 2023, USSF 2024, Ugoretz and Greene Jr. 2012), the likelihood of behavioral

[15] See the MMPA definition of "harassment" for military readiness activities at 16 U.S.C. § 1362(18)(B).

[16] See Tables 6-6 and 6-7 in the ITA request for modelled harassment distances.

patterns being abandoned or significantly altered is low and, therefore, any disturbance resulting from airborne noise exposure would not constitute harassment. For these reasons, NMFS has determined that take of Steller sea lions from airborne noise incidental to the specified training activities is not reasonably likely to occur.

Conclusion

Based on our assessment of these measures, in addition to the best management practices and conservation measures outlined in the ITA request and the PMART Draft Environmental Impact Statement, NMFS has determined that the incidental take of marine mammals resulting from proposed year-round live-fire training at EFR-IA is not reasonably likely to occur, and thus an ITA is not necessary.

As established in the foregoing, no incidental take (as defined under the MMPA) is expected to result from the planned military readiness activities. Accordingly, given that no incidental take is anticipated to occur, we have concluded that issuance of an ITA under the MMPA in response to the application is not warranted.

In the event of an unanticipated incidental take of a marine mammal, the USAF should contact our office immediately to provide notification of the incident and to work through the necessary steps to ensure MMPA compliance moving forward, which could include submitting a request for an ITA.

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Appendix A. Proposed Mitigation and Monitoring Measures for the PMART Action[17]

USAF has included in their ITA request mitigation and monitoring measures that would greatly reduce the likelihood of incidental take of marine mammals resulting from exposure to noise produced by the live-fire training and would virtually eliminate the risk of marine mammals being struck by hazardous fragments. These measures include:

- Implementation of habitat protective buffers[18] along the Eagle Bay shoreline, Eagle River, Otter Creek, and selected tributaries and upstream locations that are larger than estimated ensonified harassment distances for which no rounds would be fired into (see Figure 1).
- Implementation of slow start measures to training events, in which artillery and mortar units would register their weapons by firing individual rounds prior to beginning multiple gun engagements.
- Implementation of a no-firing restriction for HE rounds into areas inundated by high tide events (predicted and observed).
- Implementation of a no-firing restriction for HE rounds into ERF during the peak beluga whale upriver visitation period (August 9 through October 18)[19].
- Forward observers to ensure the target area is clear to fire into, and that the correct targets are engaged. Forward observers would also monitor for observable open water and ensure that rounds are visually observed impacting or bursting (a requirement of U. S. Army Alaska Regulations 350-2)[20].
- Monitoring of marine mammals by military personnel who have training and adequate experience to identify marine mammal species and describe relevant behaviors that may occur in the action area (i.e., PSOs[21]).
- During open water conditions[22], visual monitoring of marine mammals for a minimum of 30 minutes prior to the commencement of firing (i.e., hot time), during firing, and for a minimum of 30 minutes after the end of the firing mission (i.e., cold time) by at least two land-based PSOs.
- A cease-fire or delay of firing if marine mammals are spotted in Eagle River or Otter Creek before or during a training event. Training would only resume after marine mammals are

[17] The proposed mitigation and monitoring measures included in the ITA request are also included in the Draft Environmental Impact Statement prepared under the National Environmental Policy Act.

[18] Distances of proposed habitat protective buffers were determined based on the results of the acoustic modeling for marine mammals (and fish) (JASCO 2020, 2022) and through coordination with JBER.

[19] USAF and the Army chose the dates of this window based on a recommendation from NMFS (2024b), which analyzed passive acoustic data collected from 2018 through 2021 by USAF in EFR. Based on NMFS' (2024b) analysis, a seasonal closure window from August 9 through October 18 (70 days) was deemed to best minimize any potential impacts from the training activities on Cook Inlet beluga whales, based on this time period representing periods of time when belugas were consistently acoustically recorded in high numbers throughout ERF. Note, HE rounds could still be fired into the proposed expansion area during this time.

[20] This restriction would lead to no rounds being fired into rivers, streams, lakes, ponds, or other waterbodies that are deep enough that the impacts/effects of rounds could not be observed.

[21] PSOs are referred to as marine mammal observers (MMO) in the ITA request.

[22] Visual monitoring would not be feasible during the winter season and non-open water conditions.

observed traveling into Eagle Bay or 15 to 30 minutes have passed without resighting (30 minutes for beluga whales, 15 minutes for all other marine mammals).
- Implementation of archival passive acoustic monitoring, which would augment visual monitoring efforts when possible and be used to examine trends in marine mammal presence in Eagle Bay and Eagle River.

Additional mitigation measures have been identified and proposed by USAF in the ITA request based on an analysis of potential impacts to marine mammals from hazardous fragment strikes and from acoustic impacts from 155-mm training rounds:
- During ice-off conditions (ice proxy to be developed), the location of weapon system impact areas (including Surface Danger Zones) would be placed to effectively afford marine mammals the same protections as personnel and would prohibit the firing of rounds into areas where hazardous fragments would have a 1 in 1,000,000 or greater chance of striking marine mammals.
- Implementation of minimum human safety distances to protect marine mammals during ice-off conditions in portions of upper Eagle River, Otter Creek, and the Otter Creek complex, areas where marine mammals are less likely to occur.[23]
- Expansion of protective measures that specifies limited fire periods for HE rounds to include 155-mm training rounds.[24]

Additionally, USAF and the Army have detailed in their ITA request that they will adhere to additional best management practices and conservations measures, which would include, but are not limited to:
- Annual monitoring of marine mammal usage of Eagle River and Eagle Bay using visual and acoustic methods.
- Annual monitoring of ice conditions in Eagle River.
- Monitoring of salmon populations within ERF-IA.
- Assisting other researchers (e.g., NMFS, Alaska Department of Fish and Game), when practicable, with marine mammal studies and conservation efforts in Cook Inlet.

Lastly, the ITA request addresses the potential impacts that the proposed action may have on marine mammal habitat and prey species. These impacts would be reduced through best management practices and conservation measures, as well as mitigation and monitoring measures, such as the implementation of habitat protective buffers (Figure 1), described above.

[23] In other words, while there may be a greater than 1:1,000,000 chance for fragments to land in portions of the river/creek/complex where infrequent marine mammal visitation is expected, minimum human safety distances should further reduce the potential risks to any marine mammals that could be in these areas.

[24] 155-mm training rounds, like full HE rounds, would not be fired into inundated areas during inundated tide events and would not be fired into ERF during the seasonal closure period of August 9 through October 18 (155-mm training rounds could still be fired into the proposed expansion area during this time).

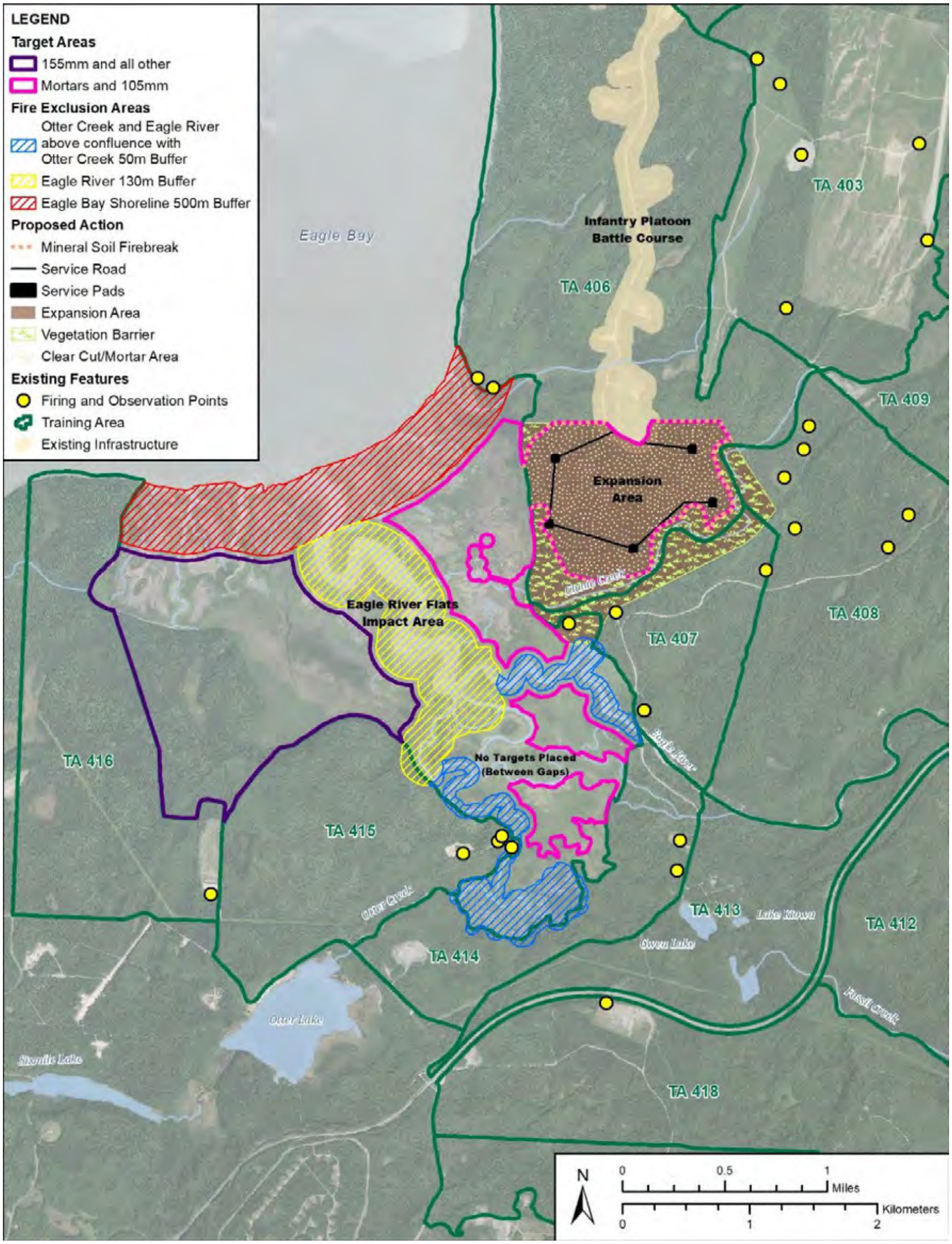

Figure 1. Proposed ERF-IA Habitat Buffer Map[25].
Sources: JBER 2020a, 2023c; MOA 2019; USGS 2020. Imagery: JBER 2018.

[25] Figure 1-9 from the USAF's ITA Request. Note: The buffers on this figure are non-georectified representations of written descriptions. They may change with stream movement over time.

From:	JOHNSON, CHARLENE C CIV USAF PACAF 673 CES/CEIC
To:	JBER-PMART-EIS-AR
Subject:	FW: Request for Informal Consultation - Proposed Mortar and Artillery Training, Joint Base Elmendorf-Richardson
Date:	Monday, February 10, 2025 1:03:42 PM
Attachments:	PMART_BA_Final_20250210_FINAL.pdf

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Subject: Request for Informal Consultation - Proposed Mortar and Artillery Training, Joint Base Elmendorf-Richardson

Dear Ms. Eich,

Please find the attached Biological Assessment for the Proposed Mortar and Artillery Training (PMART) at Richardson Training Areas, Joint Base Elmendorf-Richardson submitted by the U.S. Air Force (Air Force) and 11th Airborne Division of the U.S. Army (Army).

The Air Force and Army plan to conduct Proposed Mortar and Artillery Training in the Eagle River Flats, adjacent to the Knik Arm of Cook Inlet, Alaska to meet military training requirements beginning January 2026. The attached analysis, which utilized the best available scientific and commercial data, indicates that all potential effects of the proposed action (with mitigation measures) would be either insignificant or discountable. JBER has thus determined that the proposed project may affect but are not likely to adversely affect Cook Inlet beluga whales, Cook Inlet beluga whale designated critical habitat, or Stellar sea lions. The Air Force requests concurrence with our "may affect, but not likely to adversely affect" determination.

We look forward to working with you and your staff to answer any questions you may have about this application. Please feel free to contact myself or Ms. Kylene Lang (kylene.lang.1@us.af.mil, 907-384-2440) with additional questions.

Thank you,

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APPENDIX C–NOISE TECHNICAL REPORT

NOISE TECHNICAL REPORT— REVISION

PROPOSED MORTAR AND ARTILLERY TRAINING AT RICHARDSON TRAINING AREA, JOINT BASE ELMENDORF-RICHARDSON, ALASKA

Prepared by AECOM
3900 C Street, Suite 403
Anchorage, AK 99503
9 May 2023

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LIST OF ACRONYMS AND ABBREVIATIONS

µPa	microPascal
AFH	Air Force Handbook
AFI	Air Force Instruction
AGL	above ground level
AICUZ	Air Installation Compatible Use Zone
AR	Army Regulation
BASH	Bird Aircraft Strike Hazard
BNOISE2	U.S. Army Blast Noise Model version 2
CDNL	C-weighted Day-Night Average Noise Level
COMB	combined (used to refer to acoustic modeling scenarios)
dB	decibel
dBA	A-weighted decibel
dBP	unweighted peak sound level
DNL	average day/night sound level
DoD	Department of Defense
DTE	Distance to Effect
EIS	Environmental Impact Statement
ERF	Eagle River Flats
FAA	Federal Aviation Administration
FP	Firing Points
GIS	Geographic Information System
HE	high explosive
HUD	United States Department of Housing and Urban Development
INRMP	Integrated Natural Resources Management Plan
JBER	Joint Base Elmendorf-Richardson
kHz	kilohertz
km	kilometer(s)
Lmax	maximum sound level
Lpk	peak sound pressure level
mm	millimeter
NEW	Net Explosive Weight
NMFS	National Marine Fisheries Service
PE	probable error
PK15	peak sound pressure level
PK 15 (met)	A metric that represents calculated peak noise level, unweighted, expected to be exceeded by 15 percent of all events and that accounts for variations due to weather.
PMART	Proposed Mortar and Artillery Training
PTS	permanent threshold shift
SARNAM	Small Arms Noise Assessment Model
SEL	sound exposure level

$SEL_{24\text{-}hr}$	sound exposure level 24-hour period
SPL	sound pressure level
TNT	trinitrotoluene
TTS	temporary threshold shift
U.S.	United States
USAF	United States Air Force
USEPA	United States Environmental Protection Agency

1 INTRODUCTION

This technical report has been prepared in support of the Environmental Impact Statement (EIS) for Proposed Mortar and Artillery Training (PMART) at Richardson Training Area, Joint Base Elmendorf-Richardson (JBER), Alaska. The proposed action entails a modification of conditions in which indirect live-fire weapons training can be conducted at Eagle River Flats (ERF) Impact Area, to allow all-season live-fire training. The EIS considers two action alternatives, one of which includes a proposal to expand ERF Impact Area.

This report documents and describes the noise analysis methods, findings, and results for existing conditions, as well as all alternatives that are being considered in the EIS:

- Alternative 1—All-season live-fire training with expanded impact area (Proposed Action)
- Alternative 2—All-season live-fire training at ERF Impact Area only
- No Action Alternative—Continuation of live-fire training at ERF Impact Area with seasonal restrictions (winter-only firing)

Alternatives 1 and 2 would increase the amount of annual live-fire training at ERF Impact Area, as home station units would no longer need to complete a part of their training at other Army training lands. There is no difference between the two action alternatives as far as the maximum number of rounds that could be fired at ERF Impact Area. However, under Alternative 1, the impact area would be expanded into adjacent uplands to the east.

The noise analysis presented in this report considers community noise exposure from airborne noise, including the potential for nighttime sleep disturbance, daytime speech interference, school-day classroom learning interference, and potential for hearing loss. Discussion pertaining to community noise is presented in acres for consistency with guidelines and regulations. The analysis also considers potential effects to fish and wildlife from noise, including both in-air and underwater noise associated with the action. Information from an in-air and underwater noise modeling report prepared for the project (JASCO Applied Sciences 2020, 2022) has been incorporated into the effects analysis for fish and marine mammals. Additionally, the analysis considers best management practices and other protective measures to avoid or minimize adverse impacts, which are described in Section 2. The findings presented in this report will be incorporated into the EIS.

In this document, the discussion pertaining to fish, wildlife, and marine mammals presents quantities in metric units for consistency with guidelines and regulations.

1.1 GUIDELINES AND REGULATIONS

1.1.1 General Noise Guidelines and Regulations

Federal, state, and local governments have established noise guidelines and regulations for the purpose of protecting citizens from potential hearing damage and from various other adverse physiological, psychological, and social effects associated with noise. The Noise Control Act of 1972, as amended by the Quiet Communities Act of 1978, requires compliance with state and local noise laws and ordinances. The United States (U.S.) Department of Housing and Urban Development (HUD), in coordination with the Department of Defense (DoD) and the Federal Aviation Administration (FAA), has established criteria for acceptable noise levels for aircraft operations relative to various types of land use.

The United States Air Force (USAF), through Air Force Handbook (AFH) 32-7084, Air Installation Compatible Use Zone (AICUZ) Program Manager's Guide, consolidates existing guidance related to weapon system noise found in multiple Air Force Instructions (AFIs) into one primary guidance document and provides more detailed direction (USAF 2017). This AFH directs the use of noise models and metrics, provides information that can be used to manage and explain noise exposure to off-base populations, and provides guidance for analyzing the effects of noise on the natural and human environments when conducting environmental impact analysis. It supports compatible land use analysis, comprehensive planning, management of noise inquiries/complaints, and the USAF Environmental Impact Analysis Process Program.

The U.S. Army, through Army Regulation (AR) 200-1, Environmental Protection and Enhancement, implements federal laws concerning environmental noise from U.S. Army activities (U.S. Army 2007). The USAF's Integrated Installation Planning (AFI 32-1015) sets service requirements for the AICUZ Program and provides guidance to air bases and local communities in planning land uses compatible with airfield operations (USAF 2015). The AICUZ program describes existing aircraft noise and flight safety zones on and near USAF installations and joint bases.

1.1.2 Land Use Guidelines

The USAF has adopted guidelines regarding the compatibility of land uses with various noise levels using different metrics for aircraft noise, large arms noise, and small arms noise. The development of these guidelines was intended to establish a consistent process for estimating noise compatibility and also aid local jurisdictions that have not established land use guidelines with respect to airports and surrounding lands. These land use compatibility guidelines are consistent with land use compatibility guidelines developed by other federal agencies such as the FAA, U.S. Environmental Protection Agency (USEPA), and HUD.

These USAF land use compatibility guidelines do not constitute a federal determination that a specific land use is acceptable or unacceptable under federal, state, or local laws. The responsibility for planning and defining acceptable land uses for a community rests with the local authorities through their zoning laws and ordinances.

Land use guidelines for aircraft, small arms, and large arms noise contours are provided in Appendix A.

1.1.3 Fish and Wildlife Regulations

Although most noise regulations are established for protection of humans, the impact of noise to fish and wildlife is also a concern. For most fish and wildlife species, there are no regulations specific to noise levels, although there are a number of studies that indicate wildlife are impacted by noisy environments. Instead, there is guidance for assessing effects of human-made sound on fish and wildlife species, which typically results in implementation of regulated buffer areas to protect species from noise disturbance as well as other effects such as visual and habitat disturbance. For instance, bald and golden eagles do not have established threshold sounds levels for evaluating impacts from noise, but guidance under the Bald and Golden Eagle Protection Act could prevent blasting and other loud noises within an 800-meter buffer of active nests. Noise also has the potential to affect migratory birds protected under Migratory Bird Treaty Act, although there are no specific sound threshold levels provided in that regulation or associated guidance documents. Species with specific noise thresholds are protected by federal laws such as the Endangered Species Act and Marine Mammal Protection Act. For species with the potential to be affected by the proposed action, only marine mammals and fish have specific threshold sound levels to protect species from injury and mortality.

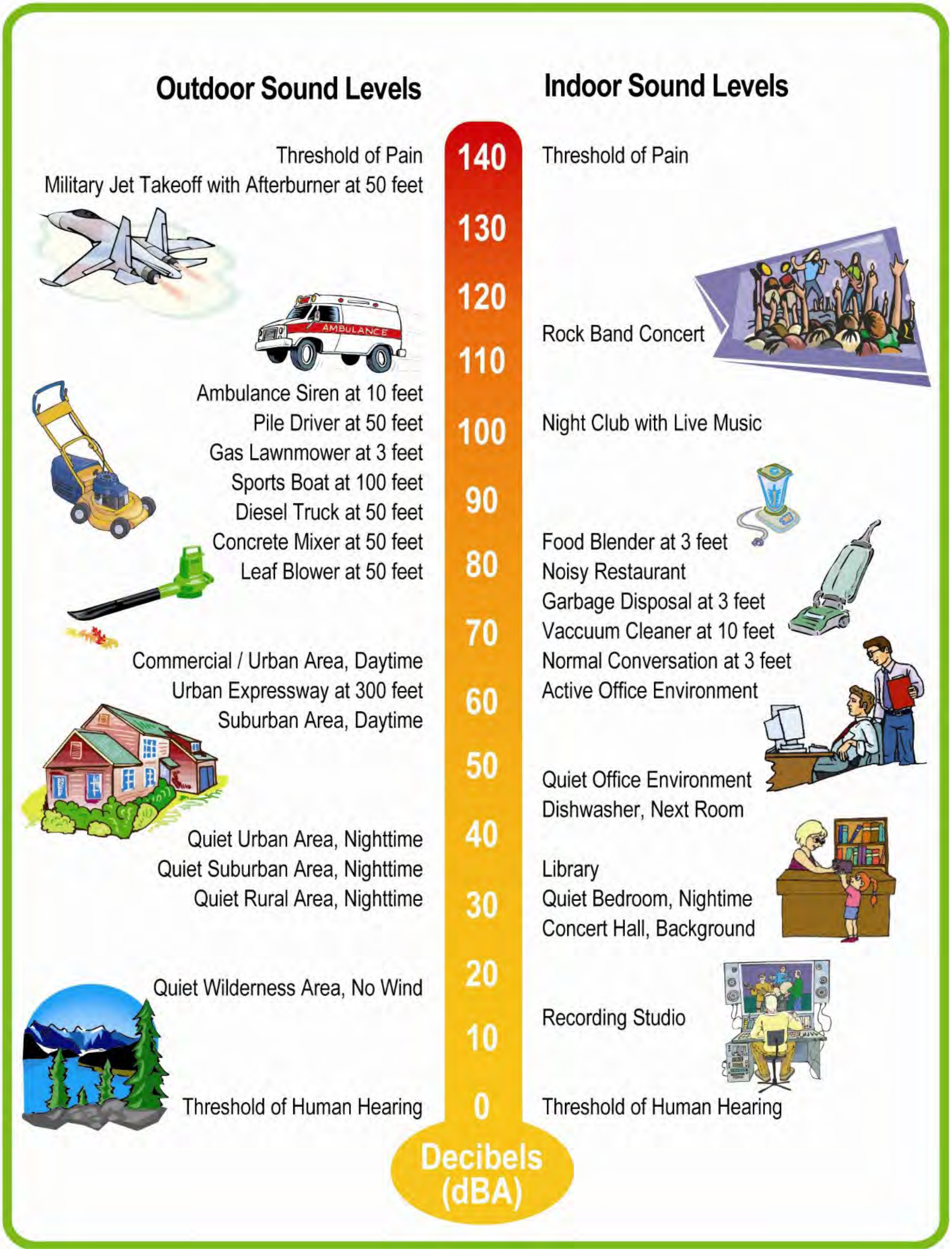
1.2 NOISE DEFINITIONS AND BACKGROUND INFORMATION

1.2.1 Community Noise

Sound is defined as a fluctuation in the ambient air pressure produced by a given source and resulting in a particular auditory impact (e.g., the sound of rain on a rooftop). Noise and sound share the same physical aspects; however, noise is considered a disturbance, while sound is defined as an auditory impact. Noise is defined as any sound that is undesirable because it interferes with communication, is intense enough to damage hearing, or is otherwise annoying. Noise can be intermittent or continuous, steady or impulsive, and can involve any number of sources and frequencies. Noise can be readily identifiable or generally nondescript. Human response to increased sound levels varies according to the source type, characteristics of the sound source, distance between the source and receptor, receptor sensitivity, and time of day. Affected receptors are specific (e.g., residential areas, schools, churches, or hospitals) or broad (e.g., nature preserves or designated districts) areas where occasional or persistent sensitivity or noise above ambient levels exists; these are generally referred to as noise-sensitive receptors.

Sound levels vary with time. For example, the sound increases as an aircraft approaches, then falls and blends into the ambient, or background, sound environment as the aircraft recedes into the distance. Because of this variation, it is often convenient to describe a particular noise "event" by its highest or maximum sound level (Lmax). Note that Lmax describes only one dimension of an event and provides no information on the cumulative noise exposure generated by a sound source. Two events with identical Lmax levels may produce very different total noise exposures; one may be of very short duration, while the other may last much longer.

Human response to noise varies, as do the metrics used to quantify it. Generally, sound can be calculated with instruments that record instantaneous sound levels in decibels (dB). Community noise levels are described using in-air decibels, which use a reference sound wave pressure of 20 microPascals (μPa), consistent with thresholds for human hearing. A-weighted decibel (dBA) is the unit used to characterize sound levels that can be sensed by the human ear. "A-weighted" denotes that a frequency-weighted adjustment has been applied to the sound pressure level to account for the frequency response of the average human to sense an audible event. The lower threshold of audibility is generally in the range of 10 to 25 dBA for normal adults. The threshold of pain occurs at the upper boundary of audibility, which is normally about 135 dBA (USEPA 1981a). Figure 1 compares common sounds and shows how they rank in terms of auditory impacts. As shown, a quiet night-time bedroom is normally 30 dBA and considered to be very quiet, while an urban expressway 300 feet away is considered an intrusive noise at 60 dBA. Noise levels can become annoying at 80 dBA and very annoying at 90 dBA. To the human ear, each 10 dBA increase seems twice as loud (USEPA 1981b).



Source: URS Corporation 2008

Figure 1: Typical Sound Levels

1.2.2 Noise Exposures to Fish and Wildlife

1.2.2.1 Fish

Noise Definitions

In-water noise levels are described using in-water decibels, which are different from in-air decibels in that the reference value for sound wave pressure is 1 μPa, whereas in-air sound uses a reference value of 20 μPa. Fish have the basic acoustic processing capabilities of other vertebrates (Popper et al. 2003; Ladich and Popper 2004). Fish discriminate between sounds of different magnitudes or frequencies, detect specific sounds when other signals are present, and determine the direction of a sound source; however, their auditory systems differ from those of marine mammals. Mechanisms for auditory detection of sound (i.e., hearing) also vary widely among fish (Ladich and Fay 2013; Popper et al. 2014). Hearing abilities have been determined for relatively few (approximately 100) of the more than 34,000 extant fish species (Eschmeyer and Fong 2016).

All fishes have two sensory systems that can detect sound in the water: the inner ear, which functions similarly to the inner ear in other vertebrates; and the lateral line, which consists of a series of receptors along the body of a fish (Popper 2008). The pressure component of sound is represented by sound waves, which are characterized by the medium compressing and expanding as sound energy moves through it. At the same time, the particles that form the medium move back and forth (particle motion). All fish directly sense the particle motion component of sound (Fay 1984), although relatively few fish sense both the particle and pressure components (Popper et al. 2003). The ears of all fish consist of otolith- (or otoconia-) containing end organs that function as inertial accelerometers. Fish that sense pressure have additional morphological adaptations that allow them to detect acoustic pressure (e.g., Popper et al. 2003; Popper and Hawkins 2019). In these fish, gas-filled bladders such as the swim bladder, which is near the ear, or mechanical connections such as Weberian ossicles, which are between the gas-filled bladder and the ear, convey sound pressure from the water to the ear when pressure deforms the bladder (reviewed in JASCO Applied Sciences 2020, 2022).

Most fish detect only particle motion, not pressure, and their hearing frequency range is typically limited to frequencies below 1 kilohertz (kHz). Pressure-sensing fish tend to have extended hearing bandwidth and lower detection thresholds. They are often capable of detecting signals up to 3–4 kHz, with thresholds that may be 20 dB or more lower than pressure-insensitive fish (Hastings and Popper 2005). Fish hearing groups tend to be defined by species that possess a similar continuum of anatomical features, which result in varying degrees of hearing sensitivity (Popper and Hastings 2009; Popper and Fay 2011). Hearing capabilities between different fish species, especially those that are taxonomically or geographically distant, must be extrapolated with caution. Categories and descriptions of hearing sensitivities for fish are provided in Section 5.2.1.

Background Information

ERF Impact Area, including Eagle River, Otter Creek, and adjacent Eagle Bay, supports a variety of fish species, including five species of salmonids, as well as various groundfish and forage fishes. Intertidal, backwater channels and ponds associated with the Otter Creek complex in the southern portion of the site also support rearing salmonids. Many of these fish are recognized for their importance to the commercial, recreational, and subsistence fishery, and all comprise an important component of the ecosystem. Four of the five salmon species are identified as primary constituent elements (primary prey) for the endangered Cook Inlet beluga whale. Underwater noise and vibrations from live-fire training would increase with resumption of all-season mortar and artillery firing at ERF Impact Area under Alternatives 1 and 2. Although firing activities would be of relatively short duration (each event less than 24 hours, with events ranging from 7 to 14 days) and occur on a seasonal or semi-annual basis, these activities would occur during periods when fish may be present in the project area and may be exposed to acoustic impacts. Short-term, high-level underwater noise has the potential to cause the following effects on fish and essential fish habitat:

mortality; external and internal injury, such as damage to swim bladders; reduction to fitness due to physiological/behavioral stress; increased predation; reduced feeding efficiency; and avoidance of preferred habitats (Wright and Hopky 1998; Hastings and Popper 2005; Popper and Hastings 2009; Halvorsen et al. 2012; Buehler et al. 2015; Popper and Hawkins 2019; Popper et al. 2019).

Fish hearing groups are defined by species that possess a similar continuum of anatomical features, which result in varying degrees of hearing sensitivity (Popper and Hastings 2009; Popper and Fay 2011). Categories and descriptions of hearing sensitivities are based on guidelines from Popper et al. (2014 and 2019):

- Fishes without a swim bladder—hearing capabilities are limited to particle motion detection and are best at frequencies well below 1 kHz (e.g., flatfishes, eulachon, sculpin)
- Fishes with a swim bladder not involved in hearing—species lack notable anatomical specializations and primarily detect particle motion at frequencies below 1 kHz (e.g., salmonids)
- Fishes with a swim bladder involved in hearing—species can detect frequencies below 1 kHz and possess anatomical specializations to enhance hearing and are capable of sound pressure detection up to a few kHz (e.g., saffron cod)
- Fishes with a swim bladder and high-frequency hearing—species can detect frequencies below 1 kHz and possess anatomical specializations and are capable of sound pressure detection at frequencies up to 10 kHz to over 100 kHz (e.g., Pacific herring)

1.2.2.2 Terrestrial Wildlife

Noise Definitions

Animals rely on meaningful sounds for communication, navigation, danger avoidance, and to locate food against a background of noise. In the discussions of noise exposures to fish and wildlife in this report, noise is defined as "any human sound that alters the behavior of animals or interferes with their functioning." The level of disturbance may be qualified as damage (i.e., harming health, reproduction, survivability, habitat use, distribution, or abundance) or disturbance (i.e., causing a detectable change in behavior). The sensitivities of various groups of wildlife to in-air sound (Kaseloo and Tyson 2004) can be summarized as:

- Mammals—less than 10 Hz to 150 kHz; sensitivity to -20 dB
- Birds (more uniform than mammals)—100 Hz to 8-10 kHz; sensitivity from 0-10 dB
- Amphibians—100 Hz to 2 kHz; sensitivity from 10-60 dB

Background Information

Most species indigenous to Southcentral Alaska can be found on JBER (JBER 2023a), as the base contains a variety of habitats and supports a diverse array of wildlife species. JBER is known to support 36 mammal, 1 amphibian, and 144 bird species, including 15 avian species of concern (ADF&G 2015, JBER 2023a). Many of these species may occupy habitats that occur in ERF Impact Area and the proposed expansion area on either a seasonal or year-round basis.

Many animals hear sounds with frequencies outside the range of human hearing. Some animals have ears that move and are shaped to help localize the direction where noise originates. Despite limited data, it is assumed that animals in general have better hearing than humans.

Not all animals respond the same way to similar sound sources, and not all individuals of a species respond the same way. Animal response to sound depends on a number of complicated factors, including noise level and frequency, distance and event duration, equipment type and condition, frequency of noisy events over time, topography, weather conditions, previous exposure to similar noises, hearing sensitivity, reproductive status, time of day, behavior during the noise event, and the animal's location relative to the noise source

(Delaney and Grubb 2004). Responses can be visual (e.g., head-turning or flushing from a nest), or the animal may show little reaction.

Three levels of noise impacts have been described for wildlife: primary effects (resulting in damage to hearing organs and temporary or permanent hearing loss), secondary effects (startle response, movement away from the noise), and tertiary effects (population-level changes, including increased mortality, reduced reproductive rate, or habitat abandonment/changes in local distribution) (Jansen 1980).

1.2.2.3 Marine Mammals

Noise Definitions

The potential for anthropogenic sounds to impact marine mammals is largely dependent on whether the sound occurs at frequencies that an animal can hear well, unless the sound pressure level is so high that it can cause physical tissue damage regardless of frequency. Based on hearing and frequency sensitivity, cetaceans (which includes all whales and dolphins) are broken down into low, mid, and high frequency hearing groups, and pinnipeds (seals and sea lions) are broken down into Phocids (seals without external ears) and Otariids (seals with external ears). Auditory (frequency) weighting functions reflect an animal's ability to hear a sound. Sound spectra are weighted at particular frequencies in a manner that reflects an animal's sensitivity to those frequencies (Nedwell and Turnpenny 1998; Nedwell et al. 2007). Auditory weighting functions have been proposed for marine mammals, specifically associated with thresholds for onset of temporary threshold shift (TTS) and permanent threshold shift (PTS). They are expressed in metrics that consider what is known about marine mammal hearing (e.g., sound exposure level [SEL]) (Southall et al. 2007, 2019, 2021; Erbe et al. 2016; Finneran 2016). In-depth weighting information can be found in NMFS (2018) and Southall et al. (2019). Table 1-1 provides a summary of the sound production and hearing capabilities of marine mammal hearing groups. Figure 2 shows the marine mammal auditory weighting curves for underwater hearing sensitivity, and Figure 3 shows the pinniped auditory weighting curves for in-air hearing sensitivity.

Table 1-1: Hearing and Vocalization Ranges for Marine Mammal Functional Hearing Groups

Functional Hearing Group	Species in Project Area	Functional Hearing Range
Low-frequency cetaceans	Humpback whale, fin whale, gray whale	7 Hz to 35 kHz
Mid-frequency cetaceans	Killer whale, beluga whale	150 Hz to 160 kHz
High-frequency cetaceans	Harbor porpoise	275 Hz to 160 kHz
Phocidae	Harbor seal	In-water: 50 Hz to 86 kHz In-air: 75 Hz to 30 kHz
Otariidae	Steller sea lion	In-water: 60 Hz to 39 kHz In-air: 50 Hz to 75 kHz

Key: Hz = Hertz; kHz = kilohertz.
Source: NMFS 2018.

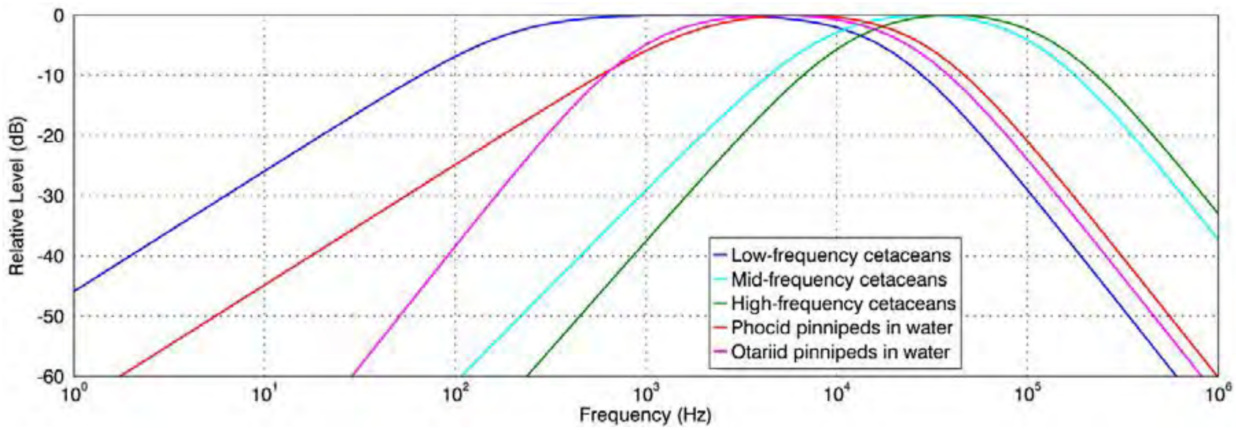


Figure 2: Auditory Weighting Functions for Underwater Hearing Sensitivity for Functional Marine Mammal Hearing Groups as Recommended by NMFS (2018)

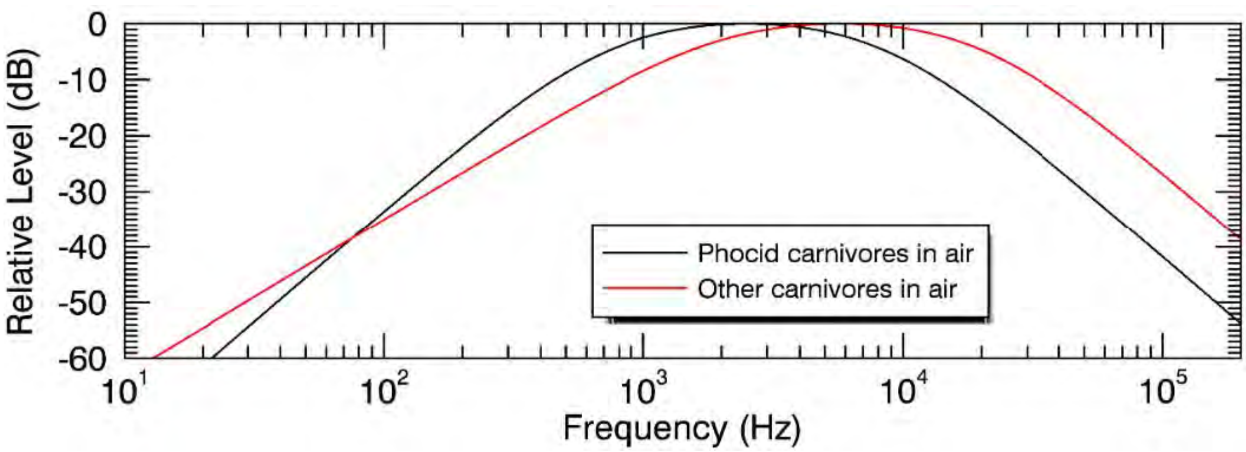


Figure 3: Auditory Weighting Functions for In-air Hearing Sensitivity for Pinniped Hearing Groups as Recommended by Southall et al. (2019)

Background Information

In Eagle River, Eagle Bay, and Knik Arm, only Cook Inlet beluga whales and harbor seals are frequently observed, with harbor porpoise also being acoustically detected in Eagle Bay and Eagle River (JBER 2023a). Fin whales, humpback whales, gray whales, killer whales, and Steller sea lions are considered to be rare or infrequent visitors to Eagle Bay and less likely to be impacted. Therefore, Cook Inlet beluga whales, harbor porpoise, and harbor seals are the focus of the impact analysis in this report.

All marine mammals that have been studied can produce sounds and use sounds to forage, orient, detect, and respond to predators, and to facilitate social interactions (Richardson et al. 1995). Measurements of marine mammal sound production and hearing capabilities provide some basis for assessing whether exposure to a particular sound source may affect a marine mammal behaviorally or physiologically. The National Marine Fisheries Service (NMFS) have used such measurements to develop the acoustic thresholds utilized in this analysis.

Marine mammals could be exposed to energy and sound from live-firing training under Alternatives 1 and 2. Depending on proximity and magnitude, energy from ammunition detonation is capable of causing mortality, injury, hearing loss, minor or major behavioral disturbance, masking, or physiological stress, depending on the level and duration of exposure. Underwater sound from detonations could also impact marine mammal prey such as fish (see Section 5.2.2).

2 PROTECTIVE MEASURES

Best management practices currently integrated into management strategies, policies, and actions would be continued under each alternative. For the No Action Alternative, existing buffers at ERF Impact Area would continue to be in place. For Alternatives 1 and 2, revised buffers based on acoustic modeling and additional reasonable and practicable protective measures have been identified to protect marine mammals and fish from noise impacts associated with live-fire training (Figure 4). These protective measures are incorporated into the alternatives for the purpose of impact analysis in this report. Mitigation measures, which are not discussed in this report, may be identified in the course of developing the EIS and in cooperation with NMFS during consultation under the Endangered Species Act, Marine Mammal Protection Act, and Magnuson-Stevens Fishery Conservation and Management Act. Mitigation measures, if developed, will be presented in the EIS and pertinent consultation documents and incorporated into the Record of Decision.

Habitat buffers would be secondary to the primary protective measure of conducting live-fire training when beluga whales are unlikely to be present in Eagle River. Other protective measures include new target placement, visual clearing of the impact area before firing, electronic acoustic monitoring, "soft start" to firing, and appropriate indirect fire control measures.

2.1 PROTECTIVE BUFFERS

Distances of proposed habitat protective buffers have been determined based on the results of the acoustic modeling for fish and marine mammals, as summarized in this report and described in detail in the acoustic modeling reports (JASCO Applied Sciences 2020, 2022). Proposed protective buffer distances from the Knik Arm shoreline and the banks of Eagle River, Otter Creek, and the Otter Creek complex (Figure 4) have been developed based on the findings in the acoustic modeling report. These buffer width distances have been slightly modified from the current protective buffers and will be finalized in coordination with NMFS. Protective buffers would be translated into No Fire Areas in artillery fire support computers and loaded as Geographic Information System (GIS) layers into the Range Facility Management Support System for planning and tracking. These buffer distances would be periodically reviewed and may be altered during updates to JBER's Integrated Natural Resources Management Plan (INRMP). No targets would be placed within the protective buffers, and no rounds would be intentionally fired into the buffer areas. Targets would be placed far enough outside the buffers to allow for adjustment of rounds without the rounds impacting the buffer areas. The following buffers and restrictions are proposed. All buffers were identified based on the 2020 and 2022 modeling of the typical high tide event (JASCO Applied Sciences 2020, 2022):

- Keep the current 500-meter shoreline habitat buffer along Eagle Bay, which exceeds the 254-meter distance to the largest of the TTS thresholds for marine mammals and fish for the highest explosive weight (155-millimeter [mm]) round.
- Keep the current 130-meter habitat buffer from each bank of Eagle River, beginning from the mouth at Eagle Bay and extending upstream to a point 100 meters above the confluence with Otter Creek. This protective buffer is more than triple the 36-meter distance to the largest of the TTS thresholds for marine mammals and fish.
- Keep the current 50-meter habitat buffer from either bank of Otter Creek and the associated Otter Creek complex within 100 meters of its confluence with Eagle River. This protective buffer exceeds the 36-meter distance to the largest of the TTS thresholds for marine mammals and fish.
- Keep the current 50-meter habitat buffer from either bank of Otter Creek and the Otter Creek complex from 100 meters above its confluence with Eagle River to the impact area boundary. This protective buffer exceeds the 20-meter distance to the largest of the TTS thresholds for marine mammals and fish.

- Eliminate the current 1,000-meter buffer for 120-mm high explosive (HE) rounds. The acoustic modeling indicates only a 254-meter buffer is required for protection, and the 500-meter buffer will be nearly twice that distance.
- Extend the current 130-meter habitat buffer from either bank of Eagle River approximately 0.5 km (kilometer) upstream to encompass the Eagle River/Otter Creek confluence area.
- Extend the current 50-meter habitat buffer approximately 0.25 km south and east to encompass the Otter Creek backwater channel complex.
- Prohibit firing into Eagle Bay, Eagle River, and Otter Creek.
- Restrict firing into the Otter Creek complex to the area outside of the established protective buffer areas to include its multiple small tributaries, branches, and connected open water.

2.2 Other Protective Measures

Alternatives 1 and 2 consider additional protections for areas within ERF immediately along Eagle River, Otter Creek, the Otter Creek complex, and the Eagle Bay shoreline. These protections would include the following limited fire periods for HE rounds (training rounds[1] could still be fired):

- During all inundating tide events, as predicted by a 31-foot or higher tide at the Anchorage tide station (station ID 9455920) or as observed on the ground. Inundated areas will become no-fire areas during predicted and actual flooding events.
- During inundating tide events, the closure period would begin at high tide and extend for 2.5 hours after high tide, as determined by the Anchorage tide station. Eagle Bay high tide occurs approximately 1 hour after the Anchorage high tide, so the closure would occur approximately 1 hour prior to local high tide to 1.5 hours after local high tide.
- The peak Cook Inlet beluga whale visitation period, as determined by local studies, is tentatively 15 August through 15 September. This closure date would be finalized in coordination with NMFS, and would be periodically reviewed in conjunction with the INRMP.

The following fire control measures and restrictions under Alternatives 1 and 2 would also help minimize the risk of noise impacts:

- The Forward observers would be present at ERF Impact Area during training. Artillery and mortar units register their weapon systems by firing individual rounds prior to beginning multiple gun engagements, which provides an opportunity for submerged/unseen marine mammals to safely depart an area (i.e., a “slow start”) or for observers to halt firing if marine mammals are observed.
- The Installation Range Control Officer would redistribute targets within ERF Impact Area to support No Fire Areas established along the Knik Arm shoreline, Eagle River, Otter Creek, and the Otter Creek complex. Target redistribution may include siting new targets, moving existing targets, obscuring existing targets, highlighting existing targets, or removing existing targets. The

[1] The term training rounds refers to rounds used during training that are similar to their HE counterparts but with no or much reduced HE. Depending on the caliber of the weapon and the manufacturer of the round, these can also be called practice rounds. “Training rounds” has been used for both in this report. For purposes of community noise modeling, all training rounds that would be fired at ERF Impact Area are considered "inert” except the 155-mm practice round, which has a reduced amount of HE (1.3 kg Net Explosive Weight) that detonates in the impact area.

end goal is to establish an array of targets to focus the indirect fire and to preclude inadvertent targeting of rounds inside the protective buffer areas.

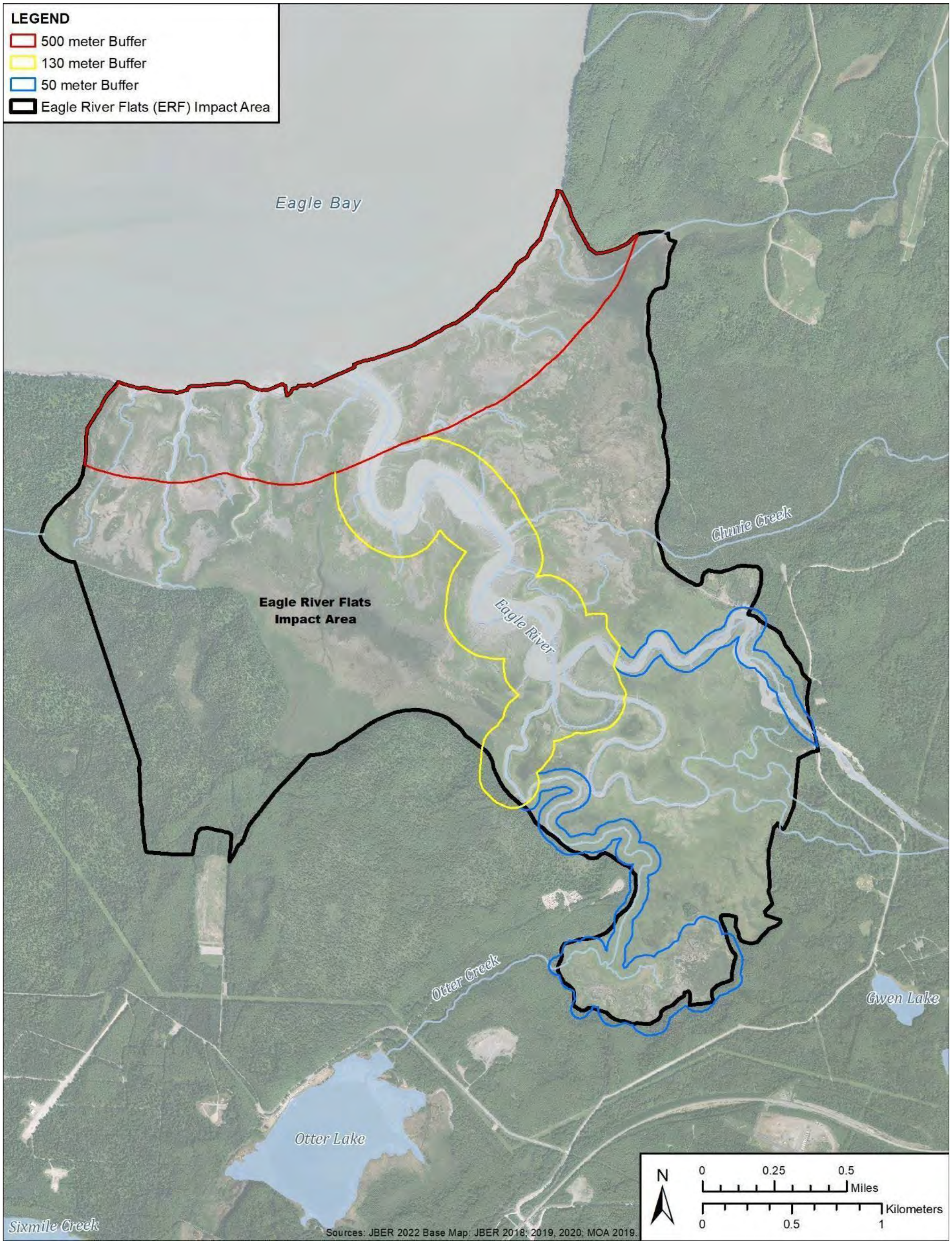


Figure 4: Proposed ERF Impact Area Acoustic and Habitat Buffer Map

3 COMMUNITY NOISE EXPOSURE METHODOLOGY

3.1 AIRCRAFT NOISE

3.1.1 Metrics

For the analysis of aircraft noise, the average day/night sound level (DNL) metric is a measure of the total community noise environment. DNL is the average A-weighted sound level over a 24-hour period, with a 10 dBA adjustment added to the night-time levels (between 2200 and 0700 hours). This adjustment is an effort to account for increased human sensitivity to night-time noise events. DNL was endorsed by the USEPA for use by federal agencies and was adopted by HUD. DNL is an accepted unit for quantifying annoyance to humans from general environmental noise, including aviation and construction noise. Land use compatibility and incompatibility are determined by comparing the predicted DNL at a site with the recommended land uses. Noise levels occurring at night generally cause greater annoyance than the same levels occurring during the day. It is generally agreed that people perceive intrusive noise as being 10 dBA louder at night than during the day, at least in terms of potential for causing community annoyance.

Due to the DNL descriptor's close correlation with the degree of community annoyance from aircraft noise, most federal agencies have formally adopted DNL for measuring and evaluating aircraft noise for land use planning and noise impact assessment. Federal committees such as the Federal Interagency Committee on Urban Noise and the Federal Interagency Committee on Noise, which include the USEPA, the FAA, DoD, HUD, and the Veterans Administration, found DNL to be the best metric for land use planning. They also found no new cumulative sound descriptors or metrics of sufficient scientific standing to substitute for DNL.

DNL accounts for the noise levels in terms of sound exposure level of all individual aircraft events, the number of times those events occur, and the period of day/night when they occur. Values of DNL can be measured with standard monitoring equipment or predicted with computer models, such as NOISEMAP. DNL contours are a graphical representation of how the noise from JBER's aircraft operations is distributed over the surrounding area. AFH 32-7084 requires plotting DNL contours of 65, 70, 75, 80, and 85 dB for use in analyzing land use compatibility for both the current mission and the projected mission in the 5- to 10-year range. AFH 32-7084 requires the use of NOISEMAP to produce these noise contours and to analyze noise levels at noise-sensitive areas, except at major commercial airports where the National Environmental Policy Act noise requirement is met by using the FAA methodology and noise model.

3.1.2 Analysis Methodology

JBER completed an update to the AICUZ study in 2019 (JBER 2019). The aircraft noise contours produced for the AICUZ were used to represent existing conditions in the analysis. These contours were produced per AFH 32-7084 using NOISEMAP, the DoD standard aircraft noise model; U.S. Army Blast Noise Model version 2 (BNOISE2), the DoD standard large arms noise model, and Small Arms Noise Assessment Model (SARNAM), the DoD standard small arms noise model.

According to information in the AICUZ study, during 2019 there were approximately 39,198 aircraft operations at Elmendorf Airfield and approximately 18,250 aircraft operations at Bryant Army Airfield. The primary aircraft operations at JBER include the F-22 Raptor, C-17 Globemaster III, C-130 Combat King/Hercules, E-3 Sentry, and H-60 Blackhawk/Pavehawk, in addition to other aircraft. A breakdown of operations by aircraft type is provided in Table 3-1.

Table 3-1: Annual Aircraft Operations for 2019 JBER AICUZ

Aircraft	Arrival/Departure	Closed Patterns[1]	Total
Elmendorf Airfield			
F-22	13,020	1,952	14,972
C-17	1,188	7,484	8,672
C-12	1,454	756	2,210
C-35	136	96	232
E-3	408	1,900	2,308
C-130	1,430	2,902	4,332
H-60	880	366	1,246
GASEPF	1,758	316	2,074
All Transients	3,152	--	3,152
TOTAL	**23,426**	**15,772**	**39,198**
Bryant Army Airfield			
UH-60	2,500	11,250	1,3750
C-130H	200	500	700
Robinson R-22/44	200	2,300	2,500
UAS	300	--	300
All Transient	800	200	1,000
Total	**4,000**	**14,250**	**18,250**
Grand Total	**27,426**	**30,022**	**57,488**

Notes:
[1] Closed Patterns consist of one arrival and one departure.
Key: AICUZ = Air Installation Compatible Use Zone; GASEPF = General Aviation Single Engine Piston Pitch Fixed; JBER = Joint Base Elmendorf-Richardson; UAS = Unmanned Aircraft Systems.
Source: JBER 2019.

Detailed discussion regarding operating characteristics for aircraft flight operations at JBER can be found in the 2019 JBER AICUZ Study (JBER 2019). This includes runway use, flight tracks and flight track use, and noise abatement procedures.

Analysis of existing conditions for aircraft noise entailed overlaying the 2019 AICUZ contours on an aerial map showing local land use to identify which land uses are in aircraft contours of DNL 65 dB and above, and to identify any areas of potential community impact based on USAF compatibility guidelines (Appendix A). GIS was used to calculate the area of each land use category (on- and off-post) in each contour band. Because there would be no changes to aircraft operations associated with the alternatives, this analysis was only performed for existing conditions.

3.2 SMALL ARMS

3.2.1 Metrics

Small arms consist of all weapons systems of .50 caliber and smaller. For the analysis of small arms noise, the unweighted peak sound pressure level is used as a measure of the total community noise environment. The peak sound pressure level (Lpk) is the highest sound level resulting from an individual firing event. To account for statistical variations in noise levels due to weather, the analysis of small arms noise uses the PK15 (met) metric, which represents calculated peak noise level, unweighted, expected to be exceeded by

15 percent of all firing events. This metric accounts for statistical variation in the received single-event peak noise level that is due to weather. This metric does not account for the number of events of each weapon type that occur at any receiver location. AFI 32-1015 requires plotting PK15 contours of 87 and 104 dB for use in analyzing land use compatibility of noise impacts resulting from the operation of small arms ranges for both the current mission and the projected mission in the 5- to 10-year range. AFI 32-1015 requires the use of SARNAM to produce these noise contours and to analyze noise levels at noise-sensitive areas. See Appendix A for suggested land use compatibility guidelines within each noise contour.

3.2.2 Analysis Methodology

The small arms activity noise contours produced for the 2019 AICUZ were used to analyze existing conditions small arms noise. These contours were produced per AFI 32-1015 using the SARNAM Model, the DoD/U.S. Army standard small arms noise assessment model.

Analysis of existing conditions for small arms noise entailed overlaying the contours developed for the AICUZ on an aerial map showing local land use to identify which land uses are in the PK15 87 dB and above contours and to identify any areas of potential community impact based on USAF compatibility guidelines (Appendix A). GIS was used to calculate the area of each land use category (on- and off-base) in each contour band. Because there would be no changes in small arms operations associated with the alternatives, the analysis was only performed for existing conditions, and no modeling nor additional analysis was prepared for this document.

3.3 LARGE ARMS

3.3.1 Metrics

Large arms consist of any weapon system of 20 mm or larger and includes howitzers and mortars used regularly at JBER. AFI 32-1015 provides the DoD/USAF guidance to perform large arms activity noise modeling for use in environmental documents. The guidance requires the use of the DoD/BNOISE2.

AFI 32-1015 requires the use of a C-weighted Day-Night Average Noise Level (CDNL) noise metric to categorize the noise environment involving the use of large caliber weapons systems and explosives demolition in a ground training range. CDNL levels are used to de-emphasis the extremely low frequencies not heard by the human ear while still accounting for the fact that impulse noise generated by large arms may produce intense noise levels that can be heard and felt as vibrations. BNOISE2 contours should be developed at CDNL levels of 57, 62, and 70 dB. Impact analysis references CDNL 62 and 70 dB, and CDNL 57 dB represents a buffer zone used for local land use planning. See Appendix A for suggested land use compatibility guidelines for large arms noise contours.

3.3.2 Analysis Methodology

As required by AFI 32-1015, the DoD BNOISE2 model was used to perform large arms activity noise modeling for the proposed action. The BNOISE2 model produces noise contour estimates based on actual measured data of most weapon systems and munitions types available to the DoD.

Data in the BNOISE2 modeling included weapons systems used, munitions types and number of rounds expended per type, firing points by weapon system, target areas by weapon system and munitions type, and time of day, which were provided by JBER. The data indicate a slight change in large arms activity levels under existing conditions, as compared to the 2019 AICUZ. Table 3-2 provides a breakdown of the modeled annual large arms munitions usage under existing conditions, by munitions type and weapon system. The number of rounds presented in the table slightly overestimates the maximum number that could actually be fired under the No Action Alternative because of the way numbers are entered into the model. For each category (e.g., 60-mm HE day) the total number of rounds is divided evenly among multiple firing points and then rounded up to the closest integer. This rounding is shown in more detail in Appendix B, which provides a breakdown of large arms data, including annual usage under Alternatives 1 and 2.

Table 3-2: Existing Condition Munitions Usage[1]

Weapon System	High Explosive	High Explosive	Inert[2]	Inert[2]	Total
	Day[3]	Night[3]	Day[3]	Night[3]	
60-mm Mortar	392	140	1,246	420	**2,198**
81-mm Mortar	231	84	714	252	**1,281**
120-mm Mortar	288	96	984	336	**1,704**
105-mm Howitzer	986	340	544	187	**2,057**
155-mm Howitzer	--	--	--	--	**--**
Total	**1,897**	**660**	**3,488**	**1,195**	**7,240**

Notes:
[1] Numbers presented in this table slightly overestimate the number of rounds of each weapon system type due to rounding.
[2] Refers to all types of rounds that do not detonate in the impact area, including illumination rounds, HC smoke rounds, and Full Range Training Rounds.
[3] Day 0700-2159 hours; Night 2200-0659 hours.
Key: -- = not applicable; mm = millimeter.
Source: JBER 2023b.

The large arms contours generated by the BNOISE2 model were overlaid on an aerial map showing local land use, and GIS was used to calculate the area of each land use category (on- and off-base) in each contour band. Because large arms usage would be the same for Alternatives 1 and 2, one noise contour was generated for both alternatives, using the center of the existing ERF Impact Area as a detonation area. The loudest munitions (155-mm howitzers) would not be fired in the expansion area under Alternative 1, and it was determined that there would not be a noticeable difference in large arms noise contours between the two alternatives. Calculation of land use areas within the noise contours was done for the alternatives.

3.4 SUPPLEMENTAL METRICS

Although DNL is an effective metric for assessing land use compatibility or the average of all noise events in a day, DNL may not be the best method of describing community annoyance associated with occasional loud events and their potential impact on communities. DNL accounts for the total noise exposure a community experiences over a period of time. The DoD often uses supplemental metrics such as "unweighted" peak sound levels (dBP) and maximum sound levels to assess noise levels of impulsive and single events. This is necessary because the DNL (average) noise metric may understate the intensity of the impulsive events (small arms, artillery, tank gun, explosive detonations) since DNL averages noise peaks with ambient quiet times (DoD 2018).

Under different weather conditions, weapon firing event noise would be perceived differently, as peak noise in PK15 (met) measures the level under more extreme or unfavorable weather condition and PK50 (met) reflects the level under average or favorable weather condition.

While peak noise levels using PK15 (met) are used for impact analysis of small arms, PK15 (met) noise contours for large arms are used to determine complaint risks associated with the use of a large arms range. Table 3-3 provides the complaint risk associated with each noise levels as determined by the U.S. Army and provided in AR 200-1. PK50 (met) noise contours are also used to reflect complaint risks under average weather conditions.

Table 3-3: Complaint Risk Associated with Large Arm Peak Noise Levels

Risk of Noise Complaints	Large Caliber Weapons Noise Limits—PK15 (met) dB
Low	< 115
Medium	115-130
High	130-140
Risk of physiological damage to unprotected human ears and structural damage claims	>140

Key: dB = decibel; PK15 (met) = metric that represents calculated peak noise level, unweighted, expected to be exceeded by 15 percent of all firing events and that accounts for variations due to weather.
Source: U.S. Army 2007.

4 COMMUNITY NOISE EXPOSURE ASSESSMENT RESULTS

4.1 AIRCRAFT

Figure 5 shows aircraft noise contours under existing conditions, based on the 2019 JBER AICUZ study. Table 4-1 provides a detailed breakdown of land use in the aircraft noise contours. Residential and medical land uses are inside aircraft noise contours of DNL 65 dB and above and are considered incompatible land uses. Any required mitigation is provided for in the 2019 JBER AICUZ and is outside the scope of this document.

Neither Alternative 1 nor Alternative 2 would result in changes to fixed wing or rotary wing aircraft activity at JBER; therefore, there would be no change from existing condition aircraft noise contours and associated impact areas under these alternatives.

Table 4-1: Land Use Estimates in Existing Aircraft DNL Noise Exposure Areas (Acres)

Category[1]	65-70 dB	70-75 dB	75-80 dB	80-85 dB	85 dB+	Total[2]
On Base						
Admin	9.0	50.2	26.7	6.6	--	**92.5**
Airfield	8.5	131.0	427.7	405.4	422.2	**1,394.9**
Air Operations Maintenance	62.2	147.7	139.5	55.3	3.4	**408.2**
Commercial	359.2	405.3	176.7	10.6	6.3	**958.1**
Community Services	263.9	26.8	11.1	2.7	--	**304.5**
Accompanied Housing	84.8	18.3	--	--	--	**103.1**
Unaccompanied Housing	59.8	15.8	--	--	--	**75.6**
Industrial	352.7	39.3	--	--	--	**391.9**
Land Restoration	167.0	--	--	--	--	**167.0**
Railroad	70.1	18.9	4.5	--	--	**93.6**
Medical	--	1.7	--	--	--	**1.7**
Open Space	2,683.4	844.4	146.8	36.3	6.2	**3,717.0**
Outdoor Recreation	100.1	2.0	15.1	0.0	--	**117.2**
Training	32.4	1.9	4.0	--	--	**38.3**
Water	121.9	20.5	--	--	--	**142.4**
Total	**4,374.8**	**1,724.0**	**952.0**	**517.0**	**438.0**	**8,005.9**
Off Base						
No Data	2.8	0.5	--	--	--	**3.3**
Transportation	87.8	50.9	--	--	--	**138.7**
Total	**90.6**	**51.4**	**0.0**	**0.0**	**0.0**	**142.0**
TOTAL	**4,465.4**	**1,775.3**	**952.0**	**517.0**	**438.0**	**8,147.9**

Notes:
[1] Knik Arm is not included in Water calculations or off-base totals.
[2] Some totals may not reflect the sum of values due to rounding.
Key: -- = not applicable; DNL = average day/night sound level.

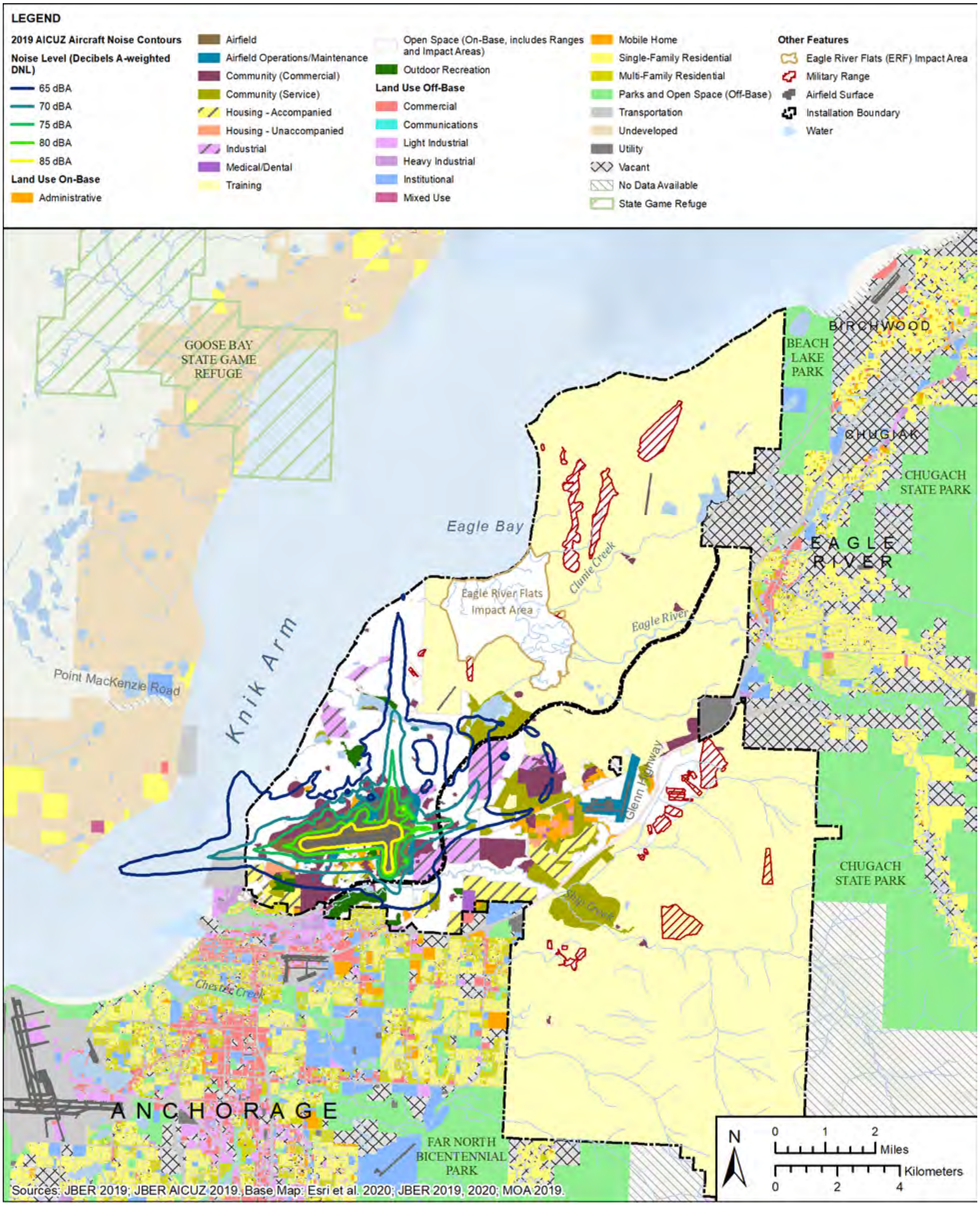


Figure 5: Aircraft Noise Contours—Existing Conditions

4.2 SMALL ARMS

Figure 6 shows the small arms PK15 noise contour under existing conditions, based on the 2019 JBER AICUZ. Table 4-2 provides a detailed breakdown of land use in the small arms noise contour. Residential and medical land uses are inside small arms noise contours of PK15 87 dB and above and are considered incompatible land uses. Any required mitigation is provided for in the 2019 JBER AICUZ and is outside the scope of this document.

As with the aircraft noise contours, neither Alternative 1 nor Alternative 2 would result in changes to small arms activity on JBER; therefore, there would be no change from existing condition small arms noise contours and associated impact areas under these alternatives.

Table 4-2: Land Use Estimates in Existing Small Arms PK15 Noise Exposure Areas (Acres)

Category[1]	87-104	104 +	Total[2]
On Base			
Admin	91.1	--	**91.1**
Airfield	12.9	--	**12.9**
Air Operations Maintenance	218.2	--	**218.2**
Commercial	487.2	38.0	**525.2**
Community Services	1,307.9	--	**1,307.9**
Accompanied Housing	46.3	--	**46.3**
Unaccompanied Housing	9.9	--	**9.9**
Industrial	150.0	--	**150.0**
Land Restoration	128.3	--	**128.3**
Railroad	171.0	--	**171.0**
Medical	4.2	--	**4.2**
Open Space	3,325.1	2,502.3	**5,827.4**
Outdoor Recreation	4.4	--	**4.4**
Training	31,281.0	8,278.4	**39,559.4**
Range	38.3	22.0	**60.3**
Water	500.4	91.9	**592.3**
Total	**37,776.2**	**10,932.7**	**48,708.9**
Off Base			
Commercial	161.6	--	**161.6**
Heavy Industrial	17.5	--	**17.5**
Institutional	217.0	--	**217.0**
Light Industrial	10.3	--	**10.3**
Mobile Home	135.3	--	**135.3**
Multi-Family Residential	277.5	--	**277.5**
No Data Available	28.1	--	**28.1**
Parks and Open Space	1,360.6	--	**1,360.6**
Single-Family Residential	589.4	--	**589.4**

Category[1]	87-104	104 +	Total[2]
Transportation	758.1	19.7	**777.8**
Utility	292.0	37.0	**329.0**
Vacant	2,465.3	--	**2,465.3**
Water	11.5	--	**11.5**
Total	**6,324.2**	**56.8**	**6,381.0**
TOTAL	**44,100.4**	**10,989.5**	**55,089.9**

Notes:
[1] Knik Arm is not included in Water calculations or off-base totals.
[2] Some totals may not reflect the sum of values due to rounding.
Key -- = not applicable; PK15 = peak sound pressure level.

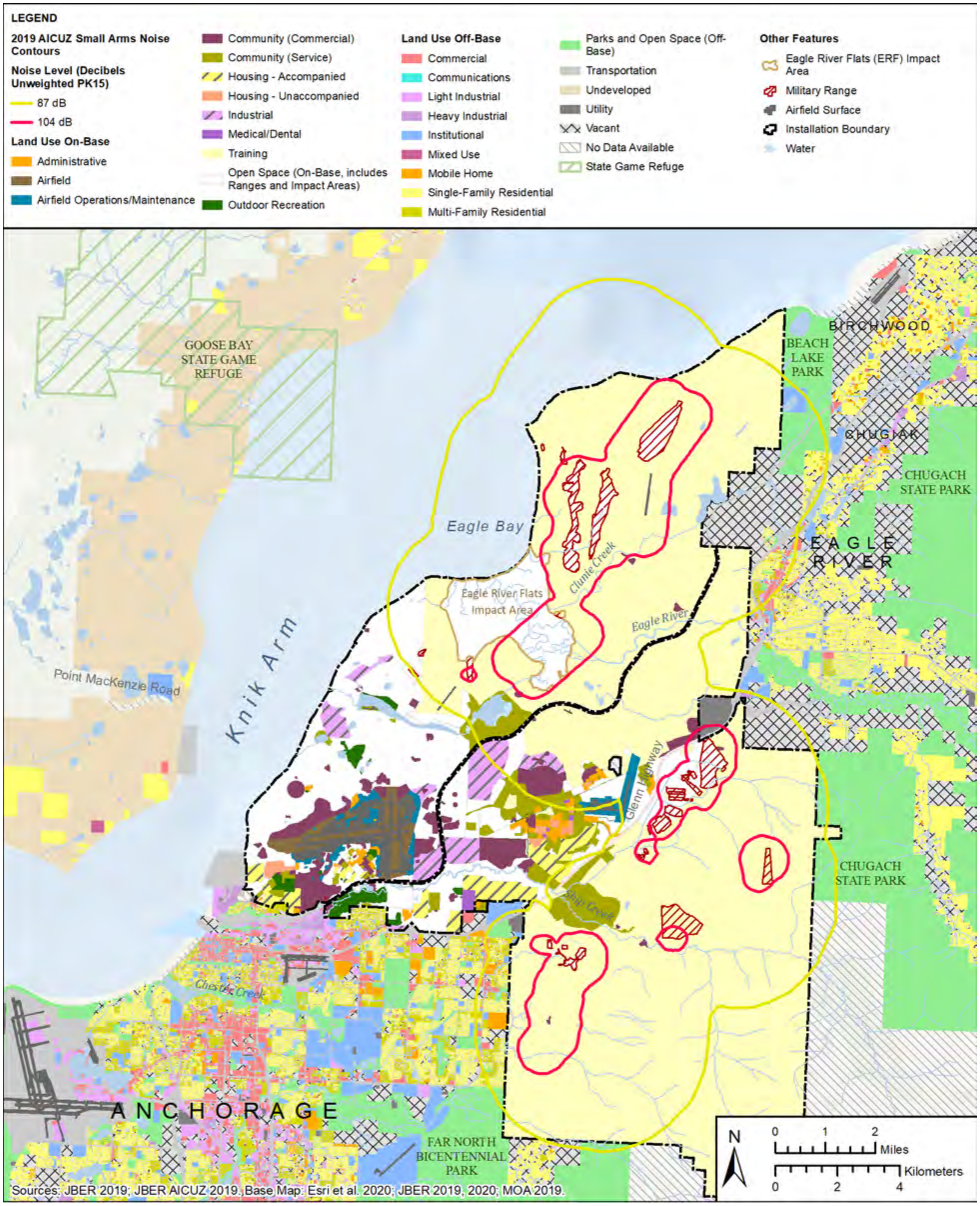


Figure 6: Small Arms Noise Contours—Existing Conditions

4.3 LARGE ARMS

The analyses of noise from large arms activity considers existing conditions and three EIS alternatives: the No Action Alternative, Alternative 1, and Alternative 2. Because there would be no change in large arms usage under the No Action Alternative, it is identical to existing conditions.

4.3.1 No Action Alternative

The No Action Alternative is a continuation of indirect-live fire training at current levels at ERF Impact Area and only includes operations during winter when ice thickness requirements are met.

Table 4-2 presents the munitions usage under existing conditions. There would be no change in large arms munitions usage under the No Action Alternative. A detailed breakdown of firing points by weapon system and munitions type is provided in Appendix B. Figure 7 presents the existing condition and the No Action Alternative large arms noise contours. Table 4-3 provides a breakdown of land use in the large arms CDNL contours. As shown in the figure and detailed in the table, there are no noise-sensitive receptors or land uses within the CDNL 62 dB and above large arms noise contours under existing conditions and the No Action Alternative; therefore, the use of supplemental metrics including night-time sleep disturbance, daytime speech interference, potential for hearing loss, and school day learning interference was determined to be unnecessary.

Table 4-3: Land Use Estimates in No Action Alternative Large Arms CDNL dBC Noise Exposure Areas (Acres)

Category[1]	57-62	62-70	70+	Total[2]
On Base				
Commercial	90.15	18.63	11.54	**120.32**
Community Services	19.29	324.66	80.40	**424.35**
Industrial	294.28	38.90	--	**333.18**
Land Restoration	104.25	--	--	**104.25**
Open Space	1,629.84	1,914.96	1,745.70	**5,290.50**
Outdoor Recreation	22.12	--	--	**22.12**
Range	27.70	--	--	**27.70**
Training	5,991.63	7,845.08	2,674.25	**16,510.96**
Water	208.00	128.03	260.34	**596.37**
Total	**8,387.25**	**10,270.26**	**4,772.23**	**23,429.75**
Off Base				
No Data Available	0.19	--	--	**0.19**
Transportation	115.50	70.53	--	**186.03**
Vacant	143.53	64.27	--	**207.80**
Water	0.74	0.35	--	**1.08**
Total	**259.95**	**135.14**	--	**395.09**
TOTAL	**8,647.20**	**10,405.40**	**4,772.23**	**23,824.84**

Notes:
[1] Knik Arm is not included in Water calculations or off-base totals.
[2] Some totals may not reflect the sum of values due to rounding.
Key: -- = not applicable; CDNL = C-weighted Day-Night Average Noise Level; dBC = C-weighted decibel.

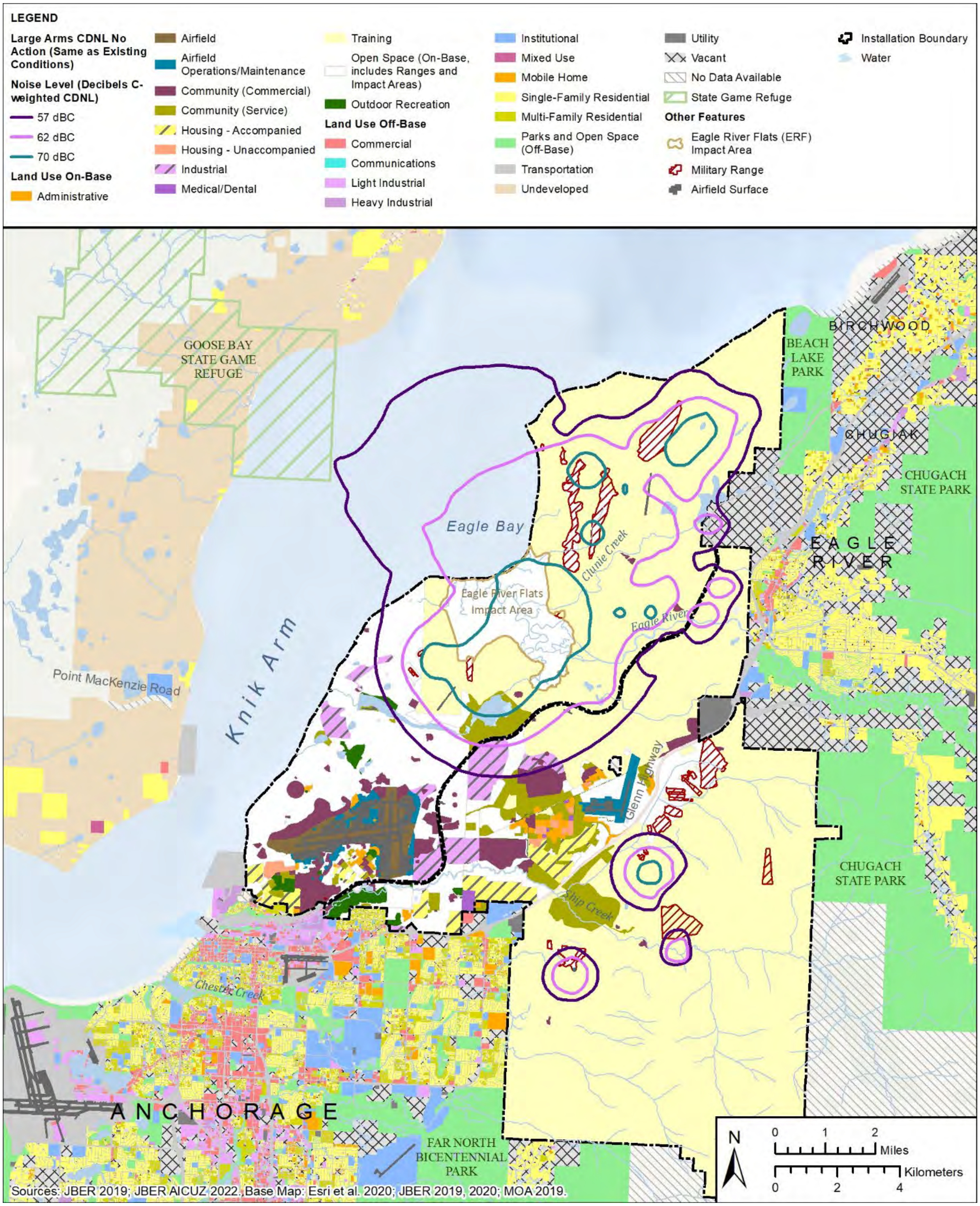


Figure 7: Large Arms Noise Contours—Existing Conditions and the No Action Alternative

4.3.2 Alternative 1—All Season Live-Fire Training with Expanded Impact Area (Proposed Action)

Alternative 1 consists of allowing all-season operation of ERF Impact Area, expanding the impact area, and allowing the use of 155-mm howitzers. Table 4-4 presents the munitions usage table for both action alternatives. The number of rounds presented in the table slightly overestimates the maximum number that could actually be fired under this alternative because of the way numbers are entered into the model. For each category (e.g., 60-mm HE day) the total number of rounds are divided evenly among multiple firing points and then rounded up to the closest integer. This rounding is shown in more detail in Appendix B, which provides a detailed breakdown of firing points by weapon system and munitions type. Figure 8 presents the large arms noise contours for both action alternatives. A breakdown of land use in the large arms CDNL contours is provided in Table 4-5. As shown in the figure and detailed in the table, there would be no noise-sensitive receptors or land uses in the CDNL 62 dB and above large arms noise contours under Alternative 1; therefore, the use of supplemental metrics including night-time sleep disturbance, daytime speech interference, potential for hearing loss, and school day learning interference was determined to be unnecessary.

Table 4-4: Large Arms Munitions Usage, Alternatives 1 and 2[1]

Weapon System	High Explosive	High Explosive	HE Training[2]	HE Training[2]	Inert[3]	Inert[3]	Total
	Day[4]	Night[4]	Day[4]	Night[4]	Day[4]	Night[4]	
60-mm Mortar	784	266	--	--	2,478	826	**4,354**
81-mm Mortar	462	168	--	--	1,428	483	**2,541**
120-mm Mortar	576	192	--	--	1,944	648	**3,3,60**
105-mm Howitzer	1,972	663	--	--	1,003	340	**3,978**
155-mm Howitzer	108	36	675	225	792	270	**1,206**
Total	**3,902**	**1,325**	**675**	**225**	**7,645**	**2,567**	**15,439**

Notes:
[1] Numbers presented in this table slightly overestimate the number of rounds of each weapon system type due to rounding.
[2] HE training rounds are only applicable to 155-mm weapons systems.
[3] Refers to all types of rounds that do not detonate in the impact area, including illumination rounds, HC smoke rounds, and Full Range Training Rounds.
[4] Day 0700-2159 hours; Night 2200-0659 hours.
Key: -- = not applicable; HE = high explosive.
Source: JBER 2023b.

Table 4-5: Land Use Estimates in Large Arms CDNL dBC Noise Exposure Areas, Alternatives 1 and 2 (Acres)

Category[1]	57-62	62-70	70+	Total[2]
On Base				
Commercial	375.45	34.64	11.54	421.63
Community Services	161.28	324.66	87.40	573.34
Unaccompanied Housing	4.16	--	--	4.16
Industrial	406.98	85.27	--	492.25
Land Restoration	128.25	--	--	128.25
Open Space	2,267.34	1,771.81	2,141.73	6,180.88
Outdoor Recreation	36.17	--	--	36.17
Administrative	34.76	--	--	34.76

Range	33.54	--	--	33.54
Air Operations (maintenance)	7.16	--	--	7.16
Training	6,340.09	9,176.65	4,091.90	19,608.64
Water	186.33	216.53	278.41	681.27
Total	**9,981.51**	**11,609.56**	**6,610.98**	**28,202.07**
Off Base				
Institutional	33.77	--	--	33.77
No Data Available	0.39	0.01	--	0.40
Transportation	75.17	148.88	0.32	224.38
Undeveloped	0.03	--	--	0.03
Utility	14.57	--	--	14.57
Vacant	224.37	137.92	--	362.28
Water	0.72	0.45	--	1.18
Total	**349.02**	**287.26**	**0.32**	**636.61**
TOTAL	**10,330.54**	**11,896.82**	**6,611.30**	**28,838.68**

Notes:
[1] Knik Arm is not included in Water calculations or off-base totals.
[2] Some totals may not reflect the sum of values due to rounding.
Key: -- = not applicable; CDNL = C-weighted Day-Night Average Noise Level; dBC = C-weighted decibel.

4.3.3 Alternative 2—All Season Live-Fire at Eagle River Flats Impact Area Only

Alternative 2 consists of all-season indirect live-fire training at ERF Impact Area, allowing the use of 155-mm howitzers, but does not expand the impact area. From a community noise perspective, Alternative 2 is identical to Alternative 1. Maximum annual munitions usage would be the same as under Alternative 1 (Table 4-4). Large arms noise contours (Figure 8) and land use area within the noise contours (Table 4-5) would also be the same (although the impact area expansion shown in Figure 8 would not occur).

Figure 9 presents a comparison between the large arms noise contours for the action alternatives and contours for existing conditions. Table 4-6 provides a comparison of the land use totals between the action alternatives and existing conditions. As shown in the table, under both Alternatives 1 and 2 land area within the three contour levels would increase by approximately 5,015 acres, including 242 acres of off-base land, relative to the No Action Alternative. The increases consist of approximately 3,100 acres of training land and 900 acres of open space on base and approximately 155 acres of vacant land use off base. The vacant off-base land is adjacent to JBER's eastern boundary, south and east of Lake Clunie, approximately 0.5 mile northwest of the nearest developed residential area (the community of Eagle River). It should be noted that there are no noise-sensitive locations or land uses in these contours.

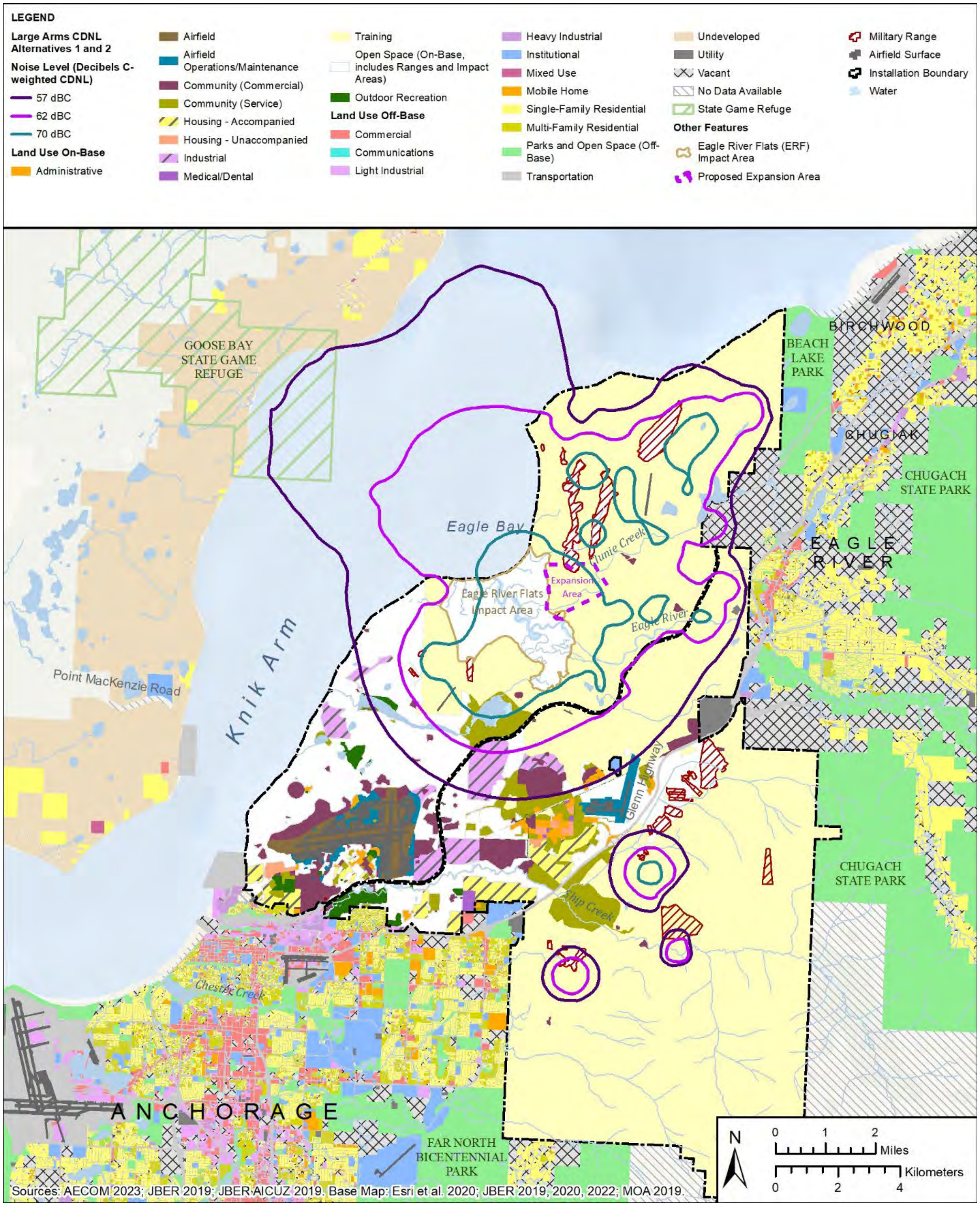


Figure 8: Large Arms Noise Contours—Alternatives 1 and 2

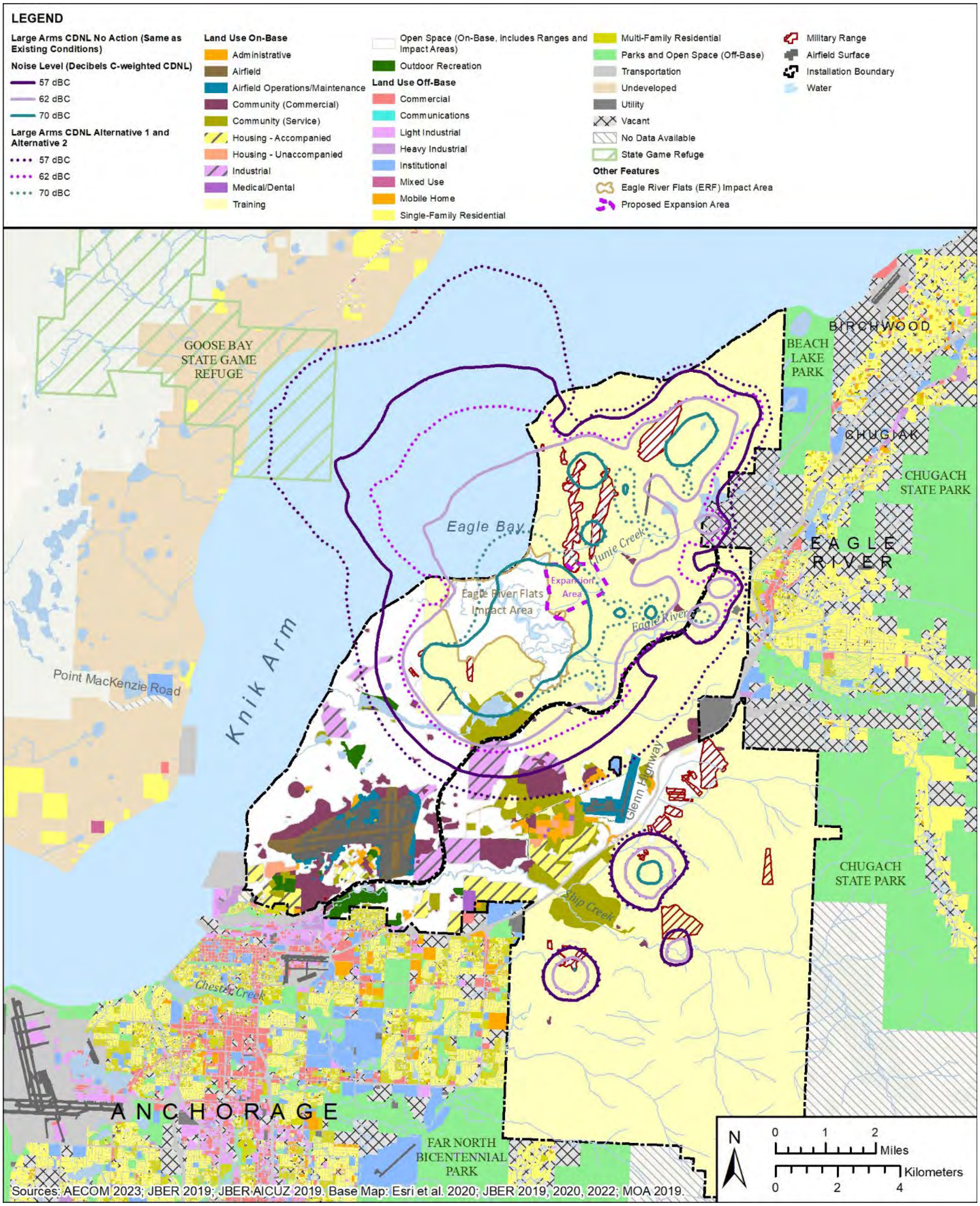


Figure 9: Large Arms Noise Contours—Alternatives Comparison

Table 4-6: Comparison of Land Use Estimates CDNL dBC Noise Exposure Areas (Acres)

Category	Existing/No Action	Alternatives 1 and 2
On Base		
Commercial	120.32	421.63
Community Services	424.35	573.34
Unaccompanied Housing	--	4.16
Industrial	333.18	492.25
Land Restoration	104.25	128.25
Open Space	5,290.50	6,180.88
Outdoor Recreation	22.12	36.17
Administrative	--	34.76
Range	27.70	33.54
Air Operations (maintenance)	--	7.16
Training	16,510.96	19,608.64
Water	596.37	681.27
Total	**23,429.75**	**28,202.07**
Off Base		
Institutional	--	33.77
No Data Available	0.19	0.40
Transportation	186.03	224.38
Undeveloped	--	0.03
Utility	--	14.57
Vacant	207.80	362.28
Water	1.08	1.18
Total	**395.09**	**636.61**
TOTAL	**23,824.84**	**28,838.68**

Notes: Knik Arm is not included in Water calculations or off-base totals.
Key: -- = not applicable; CDNL = C-weighted Day-Night Average Noise Level; dBC = C-weighted decibel.

4.3.4 Analysis of Supplemental Metrics

BNOISE2 was used to compute peak noise levels in PK15 (met) and PK50 (met) to evaluate the risk of complaints under both extreme and average weather conditions from these large arms firing events.

Figures 10 and 11 present the PK15 (met) and PK50 (met) noise contours for existing conditions and the action alternatives. As shown in these figures, the area of medium complaint risk (between 115 and 130 dBP) leaves the confines of JBER and affects limited sensitive receptors within Beach Lake Park under extreme weather conditions. However, the medium complaint risk PK50 contours would not affect any sensitive receptors under average weather conditions. It should be noted that other than for the area within Beach Lake Park, the potential event peak noise complaint risk under Alternatives 1 and 2 would essentially remain the same as under the No Action Alternative. Therefore, no mitigation is required for complaint risk of large arms peak noise levels.

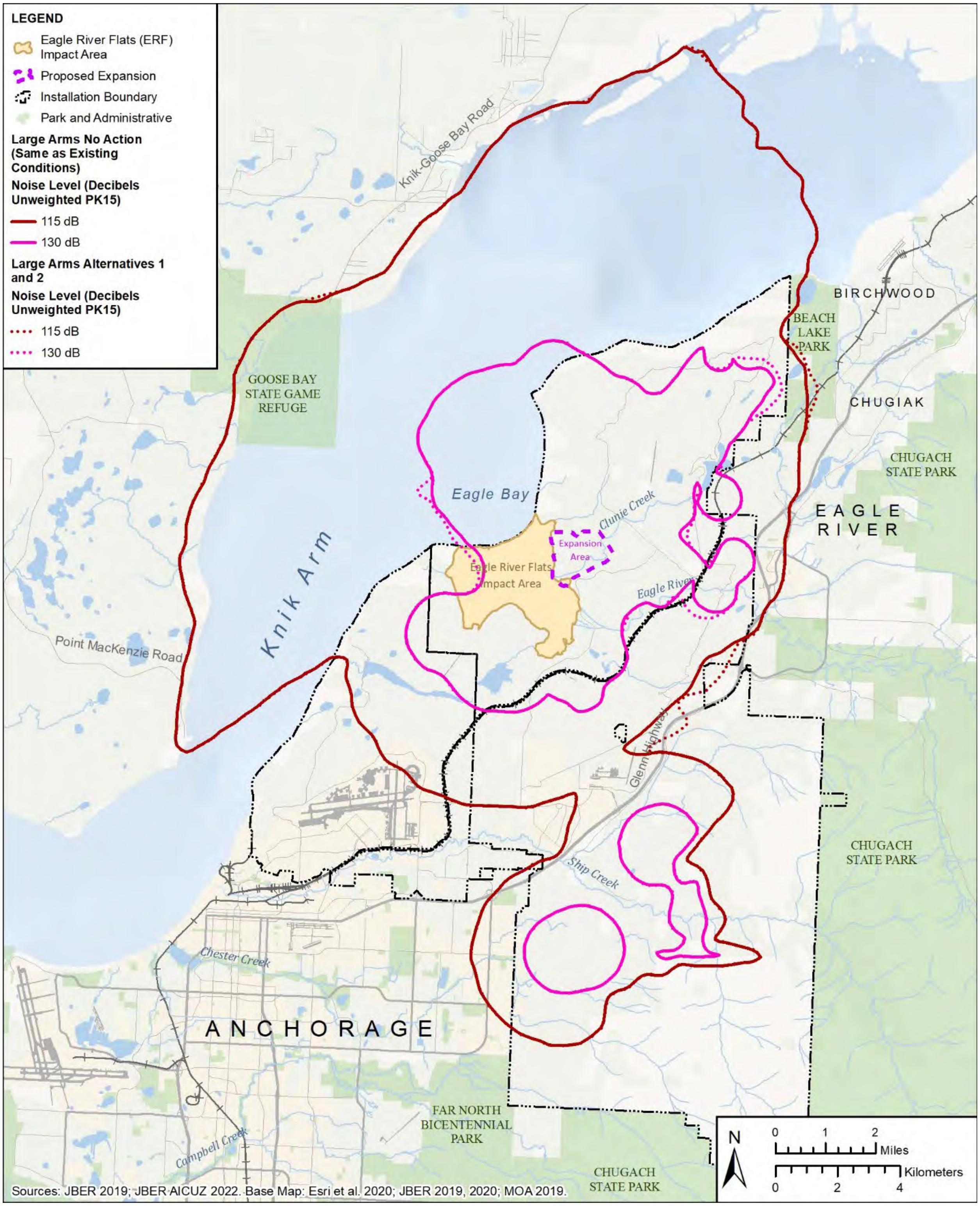


Figure 10: Large Arms Peak Noise Contours (PK15)—Alternatives Comparison

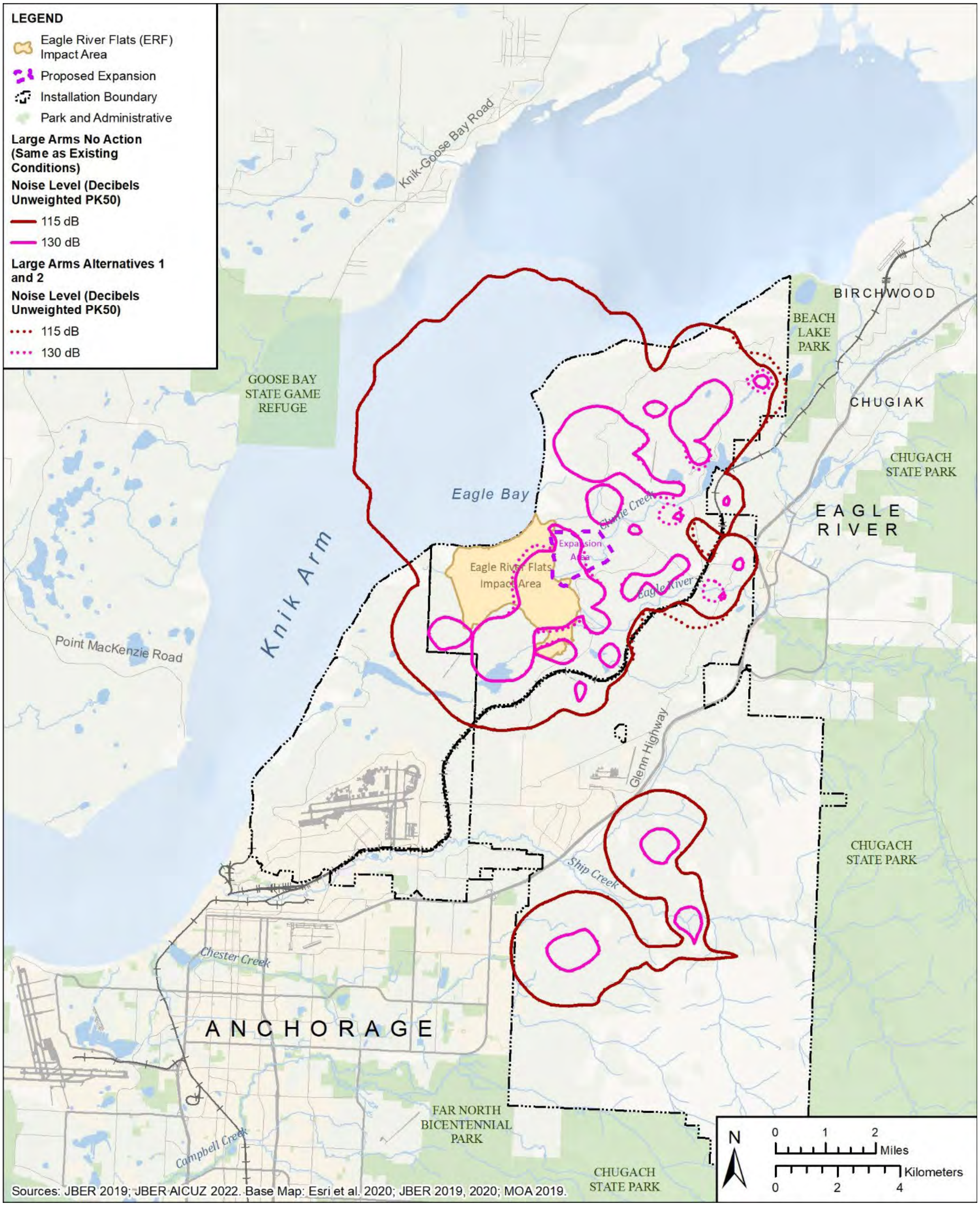


Figure 11: Large Arms Peak Noise Contours (PK50)—Alternatives Comparison

5 EFFECTS OF NOISE ON FISH AND WILDLIFE

This chapter considers in-air and underwater noise exposures to fish and wildlife in ERF Impact Area and its vicinity as a result of indirect live-fire training. The analysis considers what species are likely to be present in the area during live-fire training, the size and number of munitions detonated, and the potential for noise exposure under each alternative. Under the No Action Alternative (which represents existing conditions), only species that are present during winter months with frozen conditions at ERF Impact Area (1 November through 31 March, subject to ice thickness) would be exposed to mortar and artillery training. Under Alternatives 1 and 2, munitions detonation could occur at any time of the year, including during warmer periods when ice does not limit access by aquatic species into Eagle River, Otter Creek, and Eagle Bay. Under Alternatives 1 and 2, the size and number of munitions detonated would be greater than under the No Action Alternative, resulting in a greater frequency and intensity of munitions detonation. Both Alternatives 1 and 2 would result in the same types of detonations in the same portions of ERF. Under Alternative 1, however, some of the detonations would occur in the upland expansion area instead of ERF, and there would be fewer detonations at ERF when compared to Alternative 2.

5.1 ACOUSTIC MODELING METHODOLOGY

JASCO Applied Sciences (2020) conducted numerical modeling to evaluate the potential impacts to marine mammals and fish due to underwater and in-air noise from mortar and artillery firing at ERF Impact Area. JASCO Applied Sciences also conducted a supplemental analysis in 2022 to evaluate additional training scenarios, analyze non-auditory effects (for marine mammals), and estimate areas where detonations should be avoided to prevent underwater noise effects to marine mammals and fish. Multiple training scenarios were analyzed involving explosive ammunition fired by 105-mm and 155-mm howitzers and by 60-mm, 81-mm, and 120-mm mortars during both summer and winter scenarios to reflect representative training sessions and firing locations (JASCO Applied Sciences 2020, 2022). For this analysis, the trinitrotoluene (TNT)-equivalent explosive mass for the ammunition is indicated as Net Explosive Weight (NEW). This modeling considers environmental parameters such as water sound speed profile, bathymetry, seabed geoacoustics, atmospheric conditions, and soil flow resistivity in winter and summer.

The modeling included the use of a pre-determined firing point (FP3) and several detonation points (AF1, DP2, and DP3) of several training event scenarios (Figure 12). Detonation points DP2 and DP3 are located approximately 100 meters from Eagle River. AF1 represents an accidental firing scenario where a round is inadvertently fired into Eagle River near the mouth of Eagle Bay. These points were chosen by the U.S. Army as representative locations to inform how sound would propagate throughout ERF Impact Area and firing areas. Note that the modeled detonation points were target arrays that were chosen based on historical firing and are not the only areas that the U.S. Army could fire into. Targets could be placed outside of these traditional target arrays as long as they are situated outside of the established buffers.

In the supplemental analysis (JASCO Applied Sciences 2022), Distance to Effect (DTE) modeling was performed by simulating potential firing scenarios at six representative locations along Eagle Bay, Eagle River, and Otter Creek complex (Figure 12) during typical high tide conditions to determine minimum impact distances from the waterbody required to avoid exceeding underwater noise thresholds for marine mammals and fish (JASCO Applied Sciences 2022). DTE modeling utilized an iterative process where the ground impact point was shifted away from the edge of the nearest waterbody until thresholds were no longer exceeded in the water.

For underwater sound propagation, it was concluded that the coupling of acoustic energy from the air-ground-water pathway has the greatest potential to affect marine mammals and fish (JASCO Applied Sciences 2020, 2022). The modeling considered typical high tide events as well as typical inundating tide events that may occur in ERF Impact Area during summer, although DTE modeling only considered typical high tide conditions. During lower tide conditions, there would be an even greater pathway for ground-detonation noise to propagate into the water column, further reducing noise levels. For this reason, typical high tide conditions represent a conservative scenario for firing, outside of the infrequent periods of inundation, which have been modeled separately.

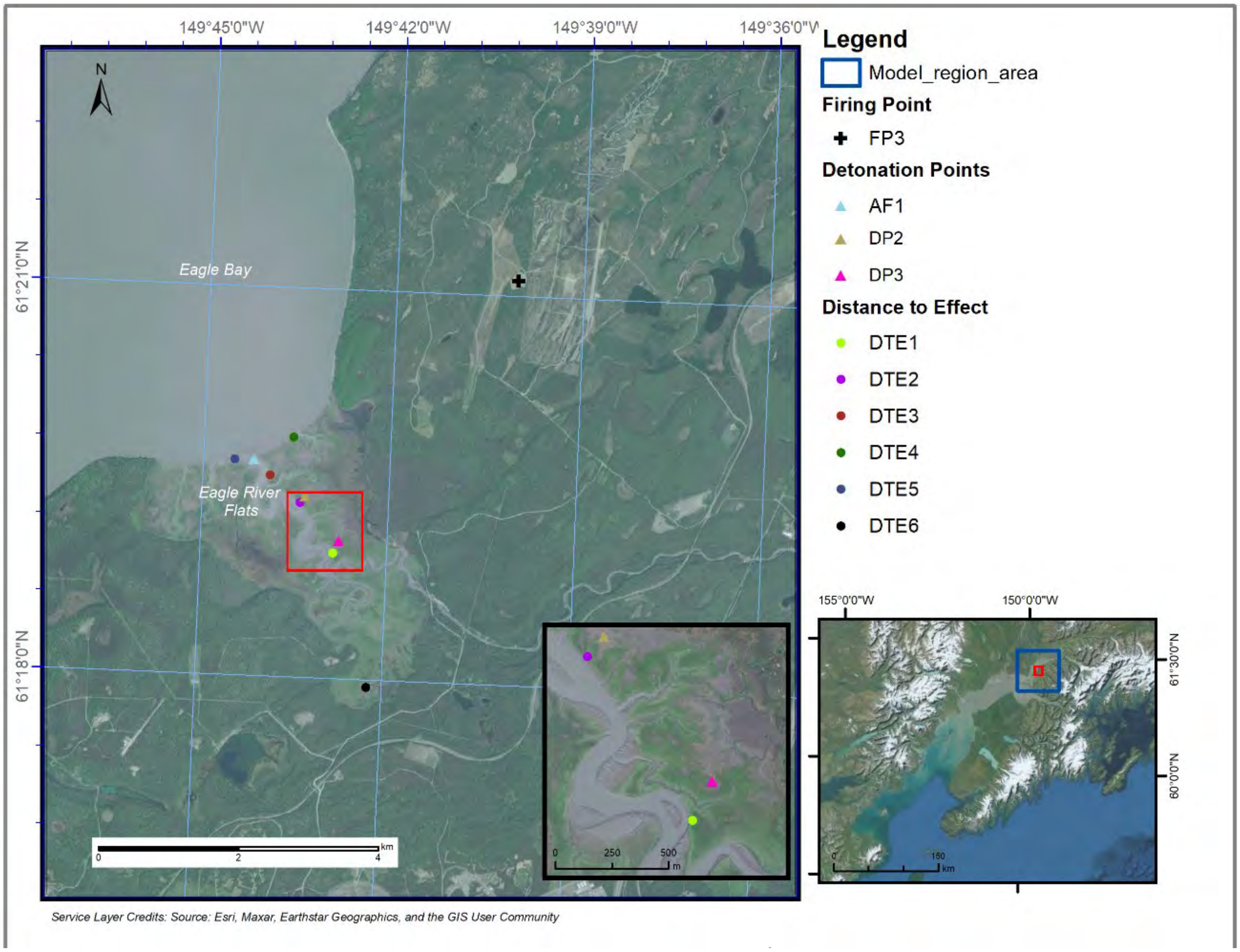


Figure 12: Firing and Detonation Points Analyzed at ERF Impact Area

Although flooding may also occur during other periods of the year, the summer inundation condition was modeled to represent the "worst-case" scenario for effects to marine mammals and fish because frozen ground conditions and ice cover would attenuate sound propagation more than an ice-free flooded marsh plain. Summer flooding events may coincide with periods of rain or snow/glacial melt or moderate to strong southerly winds (10+ knots), resulting in higher-than-predicted water elevations (Lawson et al. 1996). During these events, shallow water can cover certain areas of the flats surrounding Eagle River and Otter Creek not normally inundated during high tide, and munition rounds could detonate upon impact with the ground in the submerged (0.5-meter depth) target array locations. This would lead to detonation sound propagating through ground as well as water and potentially into Eagle River, Otter Creek, or Eagle Bay, if these areas are hydrologically connected.

The analysis in this report references various combined (COMB) live firing scenarios modeled by JASCO Applied Sciences (2020, 2022) that may be used at JBER. Where applicable, the nomenclature from the acoustic modeling reports (e.g., COMB5, COMB21) is used. Table 5-1 contains a summary of the firing scenarios used in this analysis, which are the subset of the scenarios modeled by JASCO Applied Sciences that were selected to evaluate the most conservative effects on sensitive fish and wildlife receptors. Additional details about these scenarios can be found in the acoustic modeling reports.

Table 5-1: Summary of Modeled Firing Scenarios Used in This Analysis

Scenario	Scenario with Equivalent DTE Parameters	Round Characteristics	
		Total Maximum # of Rounds/Day	NEW of Ammunition (kg)
COMB5 (summer)	COMB7 (summer)	47	1.06
		186	0.87
COMB9 (summer)	COMB11 (summer)	75	3.58
		179	1.89
COMB13 (summer)	COMB15 (summer)	212	3.81
		40	2.36
COMB18 (winter)	--	36	7.12
		262	2.84
COMB21(summer)	COMB23 (summer)	36	10.93
		262	2.84

Key: -- = not applicable; COMB = combined; DTE = Distance to Effect; kg= kilogram; NEW = Net Explosive Weight.
Source: JASCO Applied Sciences 2020, 2022.

5.2 EFFECTS ON FISH

5.2.1 Impact Assessment Methodology

For fish, distances to thresholds were computed for the following potential effects: mortality, potential mortal injury, and hearing impairment (JASCO Applied Sciences 2020, 2022) using the mortality and impairment criteria recommended by the Fisheries Hydroacoustic Working Group (Popper et al. 2014). The criteria include underwater unweighted Lpk and unweighted SEL values for mortality or potential mortal injury, and hearing impairment for fish. $SEL_{24\text{-hr}}$ is a cumulative measure of sound related to the sound energy in one or more pulses that could be emitted in a 24-hour period. For fish, Lpk metrics are used to evaluate noise for a single detonation, whereas SEL metrics are used to evaluate noise from the total maximum number of rounds/day for each charge. SEL metrics are more representative of ERF live firing scenarios and thus provide more appropriate underwater noise thresholds for fish.

The acoustic modeling identified maximum distance effect thresholds from the modeled “worst-case” firing scenario (highest weight HE round fired during a typical inundating tide event) (JASCO Applied Sciences 2020). This live firing scenario is expected to have the greatest potential effect to fish and their habitat. The supplemental DTE modeling was performed to determine how close to a waterbody the target arrays could be located before underwater noise thresholds would be exceeded for typical high tide conditions (JASCO Applied Sciences 2022). As described in Section 2.2, HE rounds would not be fired during typical inundating tide events, so the actual worst-case firing scenarios considered included (1) firing of training rounds during typical inundating tide events, (2) firing of HE rounds during typical high tide conditions, and (3) accidental firing into a waterbody during training exercises.

For detonations above typical maximum high tide level when the target locations are not inundated and hydrologically connected to adjacent waterbodies, none of the underwater noise thresholds for fish mortality, potential mortal injury, or impairment were reached for any of the potential firing scenarios at the representative detonation points (DP2 or DP3) throughout the year. During a typical inundating tide event, several acoustic effects thresholds for fish were reached. Thresholds found to be exceeded during the modeling efforts are described in the Impact Analysis (Section 5.2.2).

The impact analysis for the No Action Alternative considers existing habitat protection buffers for Eagle River, Otter Creek, and Eagle Bay at ERF Impact Area. The impact analysis for Alternatives 1 and 2 considers the proposed habitat buffers and other protective measures discussed in Section 2.

5.2.2 Impact Analysis

5.2.2.1 Existing Conditions and No Action Alternative

Indirect live-fire training at ERF Impact Area and associated noise exposures to fish under the No Action Alternative would not change from existing conditions. Noise impacts to fish from training would be intermittent and long-term, occurring only during weapons firing. Noise impacts would be seasonally reduced because firing would continue to occur only during winter months, when Eagle River freezes over.

With winter-only firing restrictions in place, live-fire training would not occur during the adult salmon spawning run. Juvenile Chinook, sockeye, and coho salmon are known to rear throughout the year in ERF (Eagle River, Otter Creek and its interconnected intertidal channels) as well as adjacent Eagle Bay. Although juvenile salmon may overwinter under ice, they generally prefer habitats with low water velocity, cover, and relatively warmer water from springs or upwelling groundwater (Giannico and Hinch 2003; Hillman et al. 1987; Cunjak 1996; Davis and Davis 2015). Overwintering sites were previously undocumented on JBER but sampling (2019) documented presence of juvenile coho in intertidal channels and backwater ponds connected to Otter Creek (JBER 2023a). These small channels have the greatest potential to support overwintering coho salmon in ERF Impact Area. Munition detonations during snow- and ice-covered conditions tend to mitigate sound waves better relative to detonations during unfrozen saturated conditions.

Underwater Noise Typical High Tide Conditions

Under existing conditions, winter firing occurs when ERF has ice cover; however, this analysis considers acoustic impacts to fish from live firing for both the typical high tide and typical inundating tide events, as there may be some areas where ice does not provide a complete barrier to the waterbody. This approach also maintains consistency with the Impact Analysis for Alternatives 1 and 2.

The DTE modeling was evaluated for the COMB13 scenario to determine how close target arrays could be located near a waterbody before underwater noise thresholds would be exceeded during typical high tide conditions under the No Action Alternative (JASCO Applied Sciences 2022). The COMB13 scenario involves the largest munition round currently used (105-mm howitzer [3.81 kilogram (kg) NEW]) and was used as a proxy to represent the worst-case scenario for acoustic impacts to fish, as it generates the largest distances to effect thresholds under the No Action Alternative (JASCO Applied Sciences 2020).

Minimum buffer distances for each waterbody in ERF that are required to avoid threshold exceedances to fish are provided in Table 5-2. Based on the modeling results and information presented in this table, it is apparent that existing buffers for Eagle Bay, Eagle River, and the primary Otter Creek channel are sufficient to protect fish during typical high tide conditions under the No Action Alternative. However, the existing buffers are not adequate to protect the full extent of intertidal, backwater channels and ponds associated with the Otter Creek complex. Live-fire training when ERF is covered with ice would continue to reduce the potential for impacts to fish, unless the flats are tidally inundated.

Table 5-2: Maximum Distances from Edge of Waterbody Where Threshold Exceedances to Fish May Occur under the No Action Alternative (Typical High Tide)

Effect	Species	Threshold (dB re 1 μPa2·s)	Eagle River		Eagle Bay			Otter Creek Complex
			DTE1	DTE2	DTE3	DTE4	DTE5	DTE6
Recoverable injury; SEL	Fish with no swim bladder	216 dB	--	--	--	--	--	--
	Fish with swim bladder	203 dB	--	2 m	-	2 m	-	6 m
Mortality and potential mortal injury; SEL	Fish with no swim bladder	219 dB	--	--	--	--	--	--
	Fish with swim bladder involved in hearing	210 dB	--	--	--	--	--	4 m
	Fish with swim bladder not involved in hearing	207 dB	--	--	--	--	--	4 m
TTS; SEL	All fish	186 dB	16 m	24 m	18 m	24 m	22 m	18 m
Existing Buffers	--	--	**50-130 m**		**500-1000 m**			**50 m**

Notes: Distances provided in this table are based on the modeled COMB13 scenario, which assumes summer firing of the largest round used under the No Action Alternative. Winter firing was not modeled.
Key: -- = not applicable; COMB = combined; dB = decibel; dB re 1 μPa^2·s = decibels referenced to 1 microPascal; DTE = Distance to Effect; m = meter; SEL = sound exposure level; TTS = temporary threshold shift.
Source: JASCO Applied Sciences 2022, modeled COMB13 scenario.

Underwater Noise Typical Inundating Tide Events

The same COMB13 scenario was used as a proxy to represent the worst-case scenario for acoustic impacts to fish under the No Action Alternative, as it generates the largest distances to effect thresholds (JASCO Applied Sciences 2020). This scenario was only modeled to identify distances to fish effects thresholds for a summer inundating tide event (it was not modeled under existing winter firing conditions). Modeling results for summer firing are overly conservative because they consider typical inundating tide events during unusually high tides and that may coincide with periods of high discharge from snow or glacial melt and intense southerly winds. As shown in Tables 5-3 and 5-4, maximum distances for TTS effects ($SEL_{24\text{-hr}}$) may extend up to 870 meters, with acoustic effects on fish with swim bladders extending distances of up to 530 meters from the source (using Lpk values).

Although the existing 1,000-meter buffer for Eagle Bay would be adequately protective, various injury and impairment thresholds for fish could be exceeded for Eagle River and Otter Creek, even with existing buffers in place. The presence of snow on the ground would result in less energy coupling into the ground-to-water path. In addition, the ice coverage expected during winter would introduce additional acoustic losses to the propagation of sound underwater (Thiele et al. 1998) due to scattering loss. During these events, shallow water can cover certain areas of the flats surrounding Eagle River and Otter Creek, and munition rounds can detonate upon impact with the ground within the submerged (0.5-meter depth) target array. This would lead to detonation sound propagating underground as well as through water and potentially into Eagle River, Otter Creek, or Eagle Bay, if these areas are hydrologically connected. However, the probability that live firing would occur during a winter tidally inundated condition is very low, which would reduce the potential for acoustic effects to fish under the No Action Alternative.

Table 5-3: Maximum Distances Where Fish Mortality, Potential Mortal Injury, and Impairment Thresholds May Be Exceeded Due to 105-mm HE[1] Ammunition Detonation Noise during Typical Inundating Tide Events under the No Action Alternative

Mortality and Potential Mortal Injury Thresholds (dB re 1 µPa2·s)			Impairment Thresholds (dB re 1 µPa2·s)[2]		
			Recoverable Injury		Temporary Threshold Shift
Fish with no swim bladder: >219	Fish with swim bladder not involved in hearing: 210	Fish with swim bladder involved in hearing: 207	Fish with no swim bladder: >216	Fish with swim bladder: 203	All fish: >186
120 m	280 m	350 m	170 m	450 m	870 m

Notes:
[1] 105-mm HE rounds modeled have 3.81 kg NEW.
[2] Thresholds provided are $SEL_{24\text{-hr}}$ values with units of dB re 1 µPa^2·s (decibels referenced to 1 microPascal).
Key: HE = high explosive; kg = kilogram; m = meter; mm = millimeter; NEW = Net Explosive Weight; $SEL_{24\text{-hr}}$ = sound exposure level 24-hour period.
Source: JASCO Applied Sciences 2022, modeled scenario COMB13; Popper et al. 2014.

Table 5-4: Maximum Distances Where Fish Mortality, Potential Mortal Injury, and Recoverable Injury Peak Thresholds May Be Exceeded Due to 105-mm HE[1] Ammunition Detonation Noise during Typical Inundating Tide Events under the No Action Alternative

Mortality, Potential Mortal Injury, and Recoverable Injury Peak Thresholds[2]	
Fish with no swim bladder: >213 (dB re 1 µPa2·s)	Fish with swim bladder: >207 (dB re 1 µPa2·s)
380 m	530 m

Notes:
[1] 105-mm HE rounds modeled have 3.81 kg NEW.
[2] Thresholds provided are unweighted peak thresholds (dB re 1 µPa).
Key: dB re 1 µPa = decibels referenced to 1 microPascal; HE = high explosive; kg = kilogram; m = meter; mm = millimeter; NEW = Net Explosive Weight.
Source: JASCO Applied Sciences 2022, modeled scenario COMB13; Popper et al. 2014.

5.2.2.2 Alternatives 1 and 2

Juvenile salmonids and other fishes in ERF Impact Area use the channelized portions of Eagle River and Otter Creek—and inter-tidal, backwater areas that are connected to Otter Creek (Otter Creek complex) on the southern side of ERF—for rearing. Adults tend to use the main Eagle River and Otter Creek channels for transit to off-site spawning areas. Spawning of salmon is not known to occur in ERF Impact Area, with the closest known spawning area occurring in Otter Creek upstream of ERF. Natural levees occur along the edge of Eagle River and the larger tributary streams near Eagle River. The combination of tides and river discharge cause variable levels of flooding across the flats. In some cases, areas behind the levees flood less frequently than nearby ponds because of their higher elevations (CH2MHill 1997); however, flooding can occur from farther upstream, which could then flood the adjacent flats, bypassing areas with levees (C. Brandt, personal communication, October 6, 2020).

Most training activities are not expected to introduce firing noise directly into the aquatic environment; noise would be attenuated by air and sediment before exposure to fish or other aquatic organisms. Direct coupling of airborne sound into the water is not a major contributor of underwater noise due to the sound wave impinging the water at grazing angles shallower than the critical angle (77 degrees) (JASCO Applied Sciences 2022). Although very high airburst detonations at close distances to the water could exceed the critical angle, these scenarios would not occur during the proposed training. Most of the proposed habitat buffers, discussed in Section 2, were identified based on acoustic modeling results to protect endangered beluga whales, which generally require a larger protective buffer than fish. Therefore, these buffers would be protective of fish as well. The buffer of the Otter Creek complex was identified based on modeling results for fish, which provide the most conservative estimate for this location.

Underwater Noise Typical High Tide Conditions

DTE modeling was performed for a live-firing scenario involving the largest HE munition type during summer (COMB21) to determine how close target arrays could be located near waterbodies before underwater noise thresholds for fish would be exceeded for the typical high tide condition (JASCO Applied Sciences 2022). This scenario was chosen because it represents the worst-case scenario with respect to acoustic impacts (155-mm howitzer; 10.93 kg NEW). Typical high tide conditions are appropriate because HE rounds would not be fired during inundating tide events. Maximum distances from the edge of waterbodies in ERF Impact Area where threshold exceedances to fish may occur are provided in Table 5-5. Based on the information presented in this table, it is apparent that proposed buffers along Eagle Bay, Eagle River, and the Otter Creek complex are sufficient to protect fish under Alternatives 1 and 2. These expanded buffers would increase protections along the Eagle River main channel and the Otter Creek complex (Figure 4).

Table 5-5: Maximum Distances from Edge of Waterbody Where Threshold Exceedances to Fish May Occur Under Alternatives 1 and 2 (Typical High Tide)

Effect	Species	Threshold (dB re 1 µPa2·s)	Eagle River		Eagle Bay			Otter Creek Complex
			DTE1	DTE2	DTE3	DTE4	DTE5	DTE6
Recoverable injury; SEL	Fish with no swim bladder	216 dB	-	-	-	-	-	-
	Fish with swim bladder	203 dB	-	2 m	-	2 m	-	6 m
Mortality and potential mortal injury; SEL	Fish with no swim bladder	219 dB	-	-	-	-	-	-
	Fish with swim bladder involved in hearing	210 dB	-	-	-	-	-	4 m
	Fish with swim bladder not involved in hearing	207 dB	-	-	-	-	-	4 m
TTS; SEL	All fish	186 dB	18 m	26 m	22 m	26 m	26 m	20 m
Proposed Buffers	**-**	**-**	**50-130 m**		**500 m**			**50 m**

Notes: For a discussion of the proposed buffers, see Section 2.1.
Key: dB = decibels; ; dB re 1 µPa^2·s = decibels referenced to 1 microPascal; DTE = Distance to Effect; m = meters; SEL = sound exposure level; TTS = temporary threshold shift.
Source: JASCO Applied Sciences 2022, modeled scenario COMB21.

Underwater Noise Typical Inundating Tide Events

Acoustic modeling was used to identify the reduced distances over which mortality, potential mortal injury, and hearing impairment thresholds may be reached during use of training rounds. Because only training rounds would be used during a typical inundating tide event, the distances over which mortality, potential mortal injury, and hearing impairment thresholds may be reached would be greater than the distances associated with use of HE rounds. The training round with the greatest potential for acoustic effect on fish is a 155-mm howitzer weapon system training round that contains a small explosive component of 2.8 pounds (1.3 kg) NEW. Underwater noise impacts on fish for the most similar HE weight round (NEW 1.9 kg) and number of rounds fired modeled in JASCO Applied Sciences (2020, 2022) are summarized in Tables 5-6 and 5-7. These scenarios (COMB 9 and 11) involve indirect live firing at two representative locations (DP2 and DP3, respectively) (Figure 12). As shown in Tables 5-6 and 5-7, maximum distances for TTS effects (SEL_{24hr}) may extend up to 850 meters, with acoustic effects on fish with swim bladders potentially occurring up to 410 meters from the source (using Lpk values). Although the 500-meter Eagle Bay buffer would be protective of fish, the proposed buffers at Eagle River and Otter Creek would not be adequately protective when firing training rounds during a typical inundating tide event.

Table 5-6: Maximum Distances Where Fish Mortality, Potential Mortal Injury, and Impairment SEL Thresholds May Be Exceeded Due to 155-mm Training Round[1] Detonation Noise during Typical Inundating Tide Events

Mortality and Potential Mortal Injury Thresholds (dB re 1 μPa2·s)			Impairment Thresholds (dB re 1 μPa2·s)[2]		
			Recoverable Injury		Temporary Threshold Shift
Fish with no swim bladder: >219	Fish with swim bladder not involved in hearing: 210	Fish with swim bladder involved in hearing: 207	Fish with no swim bladder: >216	Fish with swim bladder: 203	All fish: >186
110 m	260 m	320 m	150 m	410 m	850 m

Notes:
[1] 155-mm training rounds have 1.3 kg NEW.
[2] Thresholds provided are $SEL_{24\text{-}hr}$ values with units of dB re 1 μPa^2·s (decibels referenced to 1 microPascal)
Key: HE = high explosive; kg = kilogram; m = meter; mm = millimeter; NEW = Net Explosive Weight; $SEL_{24\text{-}hr}$ = sound exposure level 24-hour period.
Source: JASCO Applied Sciences 2020, modeled scenario COMB9; Popper et al. 2014.

Table 5-7: Maximum Distances Where Fish Mortality, Potential Mortal Injury, and Recoverable Injury Peak Thresholds May Be Exceeded Due to 155-mm Training Round[1] Detonation Noise during Typical Inundating Tide Events

Mortality, Potential Mortal Injury, and Recoverable Injury Thresholds[2]	
Fish with no swim bladder: >213 (dB re 1 μPa2·s)	Fish with swim bladder: >207 (dB re 1 μPa2·s)
350 m	490 m

Notes:
[1] 155-mm training rounds modeled have 1.3 kg NEW.
[2] Thresholds provided are unweighted peak thresholds (dB re 1 μPa).
Key: HE = high explosive; kg = kilogram; m = meter; mm = millimeter; NEW = Net Explosive Weight.
Sources: JASCO Applied Sciences 2020, modeled scenario COMB9; Popper et al. 2014.

Modeling was also conducted to determine if any of the relevant underwater thresholds would be reached under an accidental firing scenario during training exercises (rounds would never be intentionally fired into Eagle Bay, Eagle River, or Otter Creek). The modeled scenario involved an accidental detonation of one 155-mm HE round (10.9 kg NEW) in Eagle River at location AF1 (Figure 12). As shown in Tables 5-8 and 5-9, maximum distances for TTS effects (SEL_{24hr}) may extend up to 4,140 meters, with acoustic effects on fish with swim bladders extending as far as 9,130 meters from the source (using Lpk values). The modeled scenario is highly unlikely because the round would impact outside the Surface Danger Zone; statistically the chance is no greater than 1:1,000,000.

Table 5-8: Maximum Distances Where Fish Mortality, Potential Mortal Injury, and Impairment Thresholds May Be Exceeded Due to 155-mm HE[1] Ammunition Detonation Noise From Accidental Detonation in Eagle River during Typical Inundating Tide Events

Mortality and Potential Mortal Injury Thresholds (dB re 1 µPa2·s)			Impairment Thresholds (dB re 1 µPa2·s)		
			Recoverable Injury		Temporary Threshold Shift
Fish with no swim bladder: >219	Fish with swim bladder not involved in hearing: 210	Fish with swim bladder involved in hearing: 207	Fish with no swim bladder: >216	Fish with swim bladder: 203	All fish: >186
30 m	140 m	240 m	50 m	360 m	4,140 m

Notes:
[1] 155-mm HE rounds modeled have 10.93 kg NEW.
[2] Thresholds provided are $SEL_{24\text{-}hr}$ values with units of dB re 1 µPa^2·s (decibels referenced to 1 microPascal).
Key: HE = high explosive; kg = kilogram; m = meter; mm = millimeter; NEW = Net Explosive Weight; $SEL_{24\text{-}hr}$ = sound exposure level 24-hour period.
Source: JASCO Applied Sciences 2022, modeled scenario AF1; Popper et al. 2014.

Table 5-9: Maximum Distances Where Fish Mortality, Potential Mortal Injury, and Recoverable Injury Peak Thresholds May Be Exceeded Due to 155-mm HE[1]Ammunition Detonation Noise From Accidental Detonation in Eagle River during Typical Inundating Tide Events

Mortality, Potential Mortal Injury, and Recoverable Injury PeakThresholds[2]	
Fish with no swim bladder: >213 (dB re 1 µPa2·s)	Fish with swim bladder: >207 (dB re 1 µPa2·s)
3,640 m	9,130 m

Notes:
[1] 155-mm HE rounds modeled have 10.93 kg NEW.
[2] Thresholds provided are unweighted peak thresholds (dB re 1 µPa).
Key: dB re 1 µPa = decibels referenced to 1 microPascal; HE = high explosive; kg = kilogram; m = meter; mm = millimeter; NEW = Net Explosive Weight.
Sources: JASCO Applied Sciences 2022, modeled scenario AF1; Popper et al. 2014.

A relict channel exits Eagle River in the vicinity of Bravo Bridge, extends through the southcentral portion of the impact area, and re-enters Eagle River near the Otter Creek confluence. The channel only flows with fresh water when Eagle River is at flood stage, typically in the spring. The channel periodically floods on higher high tides. Since 2018, harbor porpoise have been acoustically detected one time in the lower portion of the relict channel. A proposed 130-meter buffer in Alternatives 1 and 2 includes the area where harbor porpoise was detected. Above the buffered area, the channel becomes increasingly shallow and narrow. While it is possible various fishes may utilize the upper channel at higher high tides, none have been observed, and it is unlikely salmon transit the channel and re-enter the main stem of Eagle River. Additionally, harbor porpoise has not been detected above the proposed buffer area, and beluga whales have not been acoustically or visually detected along the length of the relict channel. During the seasonal closure period for HE rounds (tentatively 15 August to 15 September), noise impacts to fish would be minimized through the use of training rounds only; however, if salmon do swim in and out of this channel during flood tides, approximately 75 percent of the historical salmon spawning run times fall outside the proposed seasonal closure.

Underwater noise thresholds could be exceeded if an errant round were to inadvertently be detonated within a buffered area. In such an accidental scenario, sound propagation could cause mortality/injury or behavioral effects if fish are present in adjacent waterbodies, including off-channel ponds, gullies, or over the mudflats. The risk of such an occurrence is low. The probability of an errant round landing outside of the designated impact area has been estimated at approximately 1 in a million, provided standard firing procedures are followed (U.S. Army 2014). If a round does land outside of the weapon system impact area, a check fire is called and all firing immediately stops. Firing does not resume until a full investigation is completed to determine the cause of the errant round.

Protective measures under Alternatives 1 and 2 would include prohibiting firing of HE rounds during the typical inundating tide event (Section 2). This would substantially reduce the risk of fish mortality, potential mortal injury, and hearing impairment, although there is still potential for acoustic impacts to fish from firing of training rounds. Risks for adverse impacts to fish would be slightly lower under Alternative 1 than Alternative 2, because a portion of the annual allotment of rounds would be fired into the upland expansion area rather than ERF. There would be fewer opportunities for impacts to fish, and potentially a lower likelihood of errant rounds affecting fish and their habitat.

5.3 Effects on Terrestrial Wildlife

5.3.1 Impact Assessment Methodology

While noise impacts of live-fire munitions training to human receptors (Section 4), fish (Section 5.2), and marine mammals (Section 5.4) have been analyzed through noise modeling methods, conclusions cannot be extrapolated to other wildlife species because each animal species has unique auditory sensitivities. Instead, the impact analysis for terrestrial mammals relied on observational data of wildlife responses acquired during live-fire training activities on JBER and a review of published literature on wildlife responses to military training activities.

While weapons training activities have the potential to disturb wildlife species, these training events are intermittent and limited in nature. A review of available literature indicates that wildlife species can generally become accustomed to loud military training noise. Specific conclusions based on the literature review include the following:

- Waterfowl, cranes, gulls, and shorebirds, as well as avian species of concern such as Hudsonian godwit, lesser yellowlegs, short-billed dowitcher, solitary sandpiper, horned grebe, and red-throated loon are likely to be temporarily disturbed by live-fire training activities (USAG Unpublished Data 2007). Birds in noisy environments may compensate for decreased auditory cues by increasing vigilance behavior (such as visual scans from the nest entrance or flushing from the nest), leading to changes in energy allocation or extended periods away from the nest during incubation. This behavior appears to be followed by a high rate of nest abandonment (Strasser and Heath 2013). Many individuals will return to their original location following detonation, while some will move to other parts of ERF or leave the area entirely. However, it is unlikely that birds would chronically avoid ERF due to the intermittent nature of weapons training.
- Bald eagles and other raptor species can become habituated to weapons-testing noise, especially if noise impacts are greater than 1.6 km from their nests and/or roost sites (Brown et al. 1999; Stalmaster and Kaiser 1997).
- Wolves can become accustomed to loud artillery noise and may breed in close proximity to, or in, military training areas (Merrill and Erickson 2003; Thiel et al. 1998).
- Large mammals, such as moose, may be disturbed by military activity and noise (Anderson et al. 1996; USAG Unpublished Data 2007).
- Individual bears are unlikely to be affected by military training noise, as habitat use is mostly a function of available habitat/vegetation types and not firing activity (Telesco and Van Manen 2006). Denning bears may be more susceptible to military activities that occur within 1 km of a den (Linnell et al. 2000).
- Hibernating bats have been found to be tolerant of blasting noise (Summers et al. 2022), and bats may be less susceptible to noise-induced hearing loss than other mammals (Simmons et al. 2016).

5.3.2 Impact Analysis

5.3.2.1 Existing Conditions and No Action Alternative

Noise impacts from training would be intermittent and long-term, occurring only during weapons firing. Under the No Action Alternative, only species present during winter would be exposed to large arms noise, fewer munitions would be fired into ERF Impact Area, and training events would be less frequent than under Alternatives 1 and 2. Wildlife likely to be present in and around ERF Impact Area during the winter firing period include moose, wolves, and some bird species. Some noise disturbance of these species would continue to occur. However, live-fire training would not occur during waterfowl migration periods (generally mid-April to mid-May for spring migration, and August to October for fall migration).

5.3.2.2 Alternatives 1 and 2

Noise impacts from training would continue to be intermittent and long-term, occurring only during weapons firing. Under Alternatives 1 and 2, indirect live-fire training could occur at ERF Impact Area during any time of the year; therefore, the potential for noise exposure would exist for all species that use habitats in this area, regardless of season of use.

It is expected that large land mammals would be able to habituate to an extent to the increased noise disturbances from live-fire training. Increases in firing activity during spring under Alternatives 1 and 2 may influence the continued use of any active wolf denning sites, although wolves have become tolerant of military training exercises in other areas. However, a wolf den has been documented inside the proposed expansion area (Saalfeld and Shreve 2020), which would likely be abandoned under Alternative 1 as a result of noise disturbance.

Additionally, summer firing activities may impact brown bear feeding and travel patterns as areas of increased noise levels are avoided. It is expected that large mammals would continue to moderately habituate to intermittent noise disturbances.

Increased noise would have long-term, intermittent impacts on bird species. Based on past observations, most waterfowl would either not respond or temporarily move to other areas of ERF during indirect live-fire training events; however, some waterfowl may leave ERF. Use of ERF Impact Area during summer months or during migration, when waterfowl are present, may cause birds to favor other wetland areas or to avoid ERF. While there is a potential for increased bird aircraft strike hazard (BASH) from birds leaving ERF in response to increased noise disturbances, the majority (90+ percent) of strikes occur below 3,000 feet above ground level (AGL), with takeoff and landing being the phase of flight where strikes occur the most often. Because restricted airspace over the eastern two-thirds of ERF Impact Area is 11,000 feet AGL, and restricted airspace over the western one-third of ERF Impact Area is 5,000 feet AGL, the BASH risk is low. Firing events are intermittent and would only occur quarterly or semi-annually, and not all rounds fired during training exercises would generate the same levels of noise as HE rounds.

The protective measures listed in Section 2 would provide some protections to waterfowl that use ERF Impact Area during migration. Generally, fall migration of waterfowl occurs from August to October in the area (Alaska Biological Research 2021; Racine et al. 1992), partially overlapping with the proposed seasonal closure (15 August–15 September).

Summertime firing into ERF Impact Area (including the proposed upland expansion area under Alternative 1) may also impact eagles, especially as a result of noise disturbance. Studies have shown that eagles may flush or temporarily leave the area in response to military live-fire activities. As bald eagles nest near, and are often present in, ERF Impact Area and the proposed expansion area, these impacts are likely unavoidable under Alternatives 1 and 2. However, because previous studies show limited reactions and habituation by bald eagles to munitions noise, it is anticipated that live-fire activities under this alternative would result in minimal disturbance or otherwise take of eagles.

5.4 EFFECTS ON MARINE MAMMALS (INCLUDING COOK INLET BELUGA WHALES)

5.4.1 Background Information

5.4.2 Impact Assessment Methodology

To evaluate potential exposure of marine mammals to noise, JASCO Applied Sciences conducted numerical acoustic propagation modeling for in-air and underwater sound that would be generated by live-fire training at ERF, as described in Section 5.1.

Three sets of criteria were considered: those that define thresholds for onset of temporary or permanent noise-induced hearing damage (both TTS and PTS), those that define thresholds for behavioral disturbance as probabilities of a behavioral response at a given received sound level, and those that define potential internal injury from barotrauma (NMFS 2016, 2018; Southall et al. 2019, Finneran et al. 2017). Thresholds are presented in the acoustic modeling reports (JASCO Applied Sciences 2020, 2022). The evaluated thresholds for potential internal injury include mortality, slight lung injury, and gastrointestinal track injury. The thresholds for potential internal injury from baurotrauma are only relevant to accidental detonation of explosive rounds within the waters of Eagle Bay or Eagle River and would not be exceeded under any planned firing scenarios. Such accidental detonations are not included in this analysis.

Auditory fatigue, or TTS, may result from overstimulation of the delicate hair cells and tissues in the auditory system. The result of TTS is a temporary increase in hearing threshold (i.e., decreased hearing sensitivity), which eventually returns to normal. Decreased hearing sensitivity that does not return to normal after a relatively long period of time post-exposure (usually weeks) is considered auditory injury or PTS (Southall et al. 2016).

Distances for onset of TTS and PTS are modeled using peak sound pressure levels (based on a single round) and 24-hour cumulative SEL (based on the cumulative effect of multiple firing rounds within a 24-hour period). Cumulative SEL thresholds are generally conservative, as they assume that an individual remains in the esonified area for the full daily duration of the activity. Distances to peak thresholds are often shorter than SEL distances but are just as important, since they are based on a single detonation and not multiple detonations over time, as is the case for cumulative SEL values.

For typical inundating tide events, where underwater detonation may occur, the modeling included the use of a pre-determined firing point (FP3) and several detonation points (AF1, DP2, and DP3) of several training event scenarios, as described in Section 5.1.

For all other times, where rounds would be detonated on land (i.e., typical high tide conditions), the DTE modeling (described in Section 5.1) represents the worst-case scenario to inform the distance from a waterbody needed to prevent exceedance of the most relevant thresholds. The most relevant thresholds were selected based on the most sensitive hearing group with potential to occur in the nearest waterbody.

5.4.2.1 In-Air Noise (Applicable to Alternatives 1 and 2)

In-air noise has the potential to impact pinnipeds when they are hauled out or have their heads above water while swimming. For in-air propagation with no-wind conditions, the largest spatial extent for behavioral disturbance was reached for scenarios that include detonating the largest ammunition type in this study (155-mm HE round with 10.93 kg NEW).

Distances to acoustic harassment criteria for phocid carnivores and other marine carnivores during summer are provided in Table 5-10. For the summer scenario, the greatest distance modeled was more than 50 km from DP2 (behavioral disturbance to harbor seals). Distances to acoustic harassment criteria for phocid carnivores and other marine carnivores during winter are provided in Table 5-11. For the winter period, the greatest distance modeled was 42.3 km from DP2 (behavioral disturbance to harbor seals).

Table 5-10: Maximum Distances (from DP2) over which Acoustic Harassment Criteria for In-Air Noise May Be Exceeded (Summer)

Functional Hearing Group	Species	Level A Criteria		Level B Criteria		
		PTS SEL	PTS Peak	TTS SEL	TTS Peak	Behavioral RMS*
Phocid carnivores	**Harbor seal**	168 m	57 m	641 m	107 m	>50,000 m**
Other marine carnivores	Steller sea lion	23 m	13 m	48 m	22 m	39,100 m**

Notes:
Functional hearing group/species in **bold** are expected to occur in the area that includes Eagle River, Eagle Bay, and Knik Arm. Other species are considered to be rare in this area.
* NMFS-established threshold of 90 dB RMS for phocids and 100 dB RMS for other pinnipeds, referenced to 20 µPa.
**SPL threshold reached beyond the 25 x 25 km modeled area. Reported distance corresponds to the radii along an azimuth of 242 degrees, which was modeled as far as 50 km.
Key: µPa = microPascal; dB = decibel; km = kilometer; m = meter; NMFS = National Marine Fisheries Service; PTS = permanent threshold shift; RMS = root mean square; SEL = sound exposure level; TTS = temporary threshold shift.
Source: JASCO Applied Sciences 2022, modeled scenario COMB23 Summer.

Table 5-11: Maximum Distances (from DP2) Over Which Acoustic Harassment Criteria for In-Air Noise May Be Exceeded (Winter)

Functional Hearing Group	Species	Level A Criteria		Level B Criteria		
		PTS SEL	PTS Peak	TTS SEL	TTS Peak	Behavioral RMS*
Phocid carnivores	**Harbor seal**	115 m	57 m	396 m	107 m	42,300 m**
Other marine carnivores	Steller sea lion	23 m	13 m	38 m	22 m	20,900 m**

Notes:
Functional hearing group/species in **bold** are expected to occur in the area that includes Eagle River, Eagle Bay, and Knik Arm. Other species are considered to be rare in this area.
* NMFS-established threshold of 90 dB RMS for phocids and 100 dB RMS for other pinnipeds, referenced to 20 µPa.
**SPL threshold reached beyond the 25 x 25 km modeled area. Reported distance corresponds to the radii along an azimuth of 242 degrees, which was modeled as far as 50 km.
Key: µPa = microPascal; dB = decibel; km = kilometer; m = meter; NMFS = National Marine Fisheries Service; PTS = permanent threshold shift; RMS = root mean square; SEL = sound exposure level; SPL = sound pressure level; TTS = temporary threshold shift.
Source: JASCO Applied Sciences 2022, modeled scenario COMB 23 Winter.

5.4.2.2 Underwater Noise (Applicable to Alternatives 1 and 2)

For analysis of underwater noise impacts, the DTE modeling establishes the minimum buffers needed to prevent the exceedance of marine mammal thresholds during typical high tide conditions, when detonations would only occur on land. As described in Section 5.1, typical high tide conditions reflect the vast majority of time when ERF is not inundated. Table 5-12 provides a summary of the buffer distances established through the DTE modeling process.

Table 5-12: Maximum Distances from Edge of Waterbody Where Underwater Noise Threshold Exceedances for Marine Mammals May Occur Under Alternatives 1 and 2 (Typical High Tide)

Threshold	Eagle River (LF Cetaceans Not Present)		Eagle Bay (All Species May Be Present)			Otter Creek (LF Cetaceans Not Present)
	DTE 1	DTE 2	DTE 3	DTE 4	DTE 5	DTE 6
All PTS Thresholds	6 m or less	10 m or less	20 m or less	24 m or less	24 m or less	12 m or less
LF Cetacean TTS	Not Applicable	Not Applicable	106m	114 m	106 m	Not Applicable
MF Cetacean (beluga whale) TTS	2 m	6 m	6 m	4 m	4 m	8 m
HF Cetacean (harbor porpoise) TTS	14 m	18 m	18 m	18 m	20 m	20 m
Phocid (harbor seal) TTS	16 m	26 m	22 m	24 m	26 m	26 m
LF Cetacean Behavioral SEL	Not Applicable	Not Applicable	212 m	254 m	188 m	Not Applicable
MF Cetacean (beluga whale) Behavioral SEL	4 m	8 m	8 m	6 m	6 m	10 m
HF Cetacean (harbor porpoise) Behavioral SEL	18 m	24 m	22 m	22 m	26 m	26 m
Phocid (harbor seal) Behavioral SEL	28 m	36 m	32 m	38 m	36 m	35 m
No Action Buffers	**130 m**		**1,000 m**			**50 m**
Alternative 1 and 2 Buffers	**130 m**		**500 m**			**50 m**

Notes:
Functional hearing group/species in **bold** are expected to occur in the area that includes Eagle River, Eagle Bay, and Knik Arm. Other species are considered to be rare in this area.
Key: DTE = Distance to Effect; m = meter; LF = low frequency; HF = high frequency; MF = mid-frequency PTS = permanent threshold shift; SEL = sound exposure level; TTS = temporary threshold shift.
Source: JASCO Applied Sciences 2022, modeled scenario COMB 21 and COMB 23.

During an inundating tide event, water partially floods ERF Impact Area around Eagle River, and target areas above the typical high tide level can be covered by water. When ammunition detonation takes place under these circumstances, sound can propagate directly through the water column to include Eagle River and Eagle Bay more easily than during typical high tide conditions. Under a typical inundating tide event, the largest spatial extent for marine mammal PTS, TTS, and behavioral disturbance for underwater noise would be reached when detonating a 155-mm howitzer HE round (10.93 kg NEW; modeled in scenario COMB23) (Table 5-13).

Table 5-13: Maximum Distances Where Acoustic Harassment Criteria from Underwater Noise May Be Exceeded Due to 155-mm HE[1] Ammunition Detonation during a Typical Inundating Tide Event

Functional Hearing Group	Species	Level A Criteria		Level B Criteria		
		PTS SEL	PTS Peak	TTS SEL	TTS Peak	Behavioral SEL
Low-frequency cetaceans	Fin whale, humpback whale, gray whale	1,340 m	330 m	5,820 m	490 m	10,760 m
Mid-frequency cetaceans	**Beluga whale,** killer whale	600 m	150 m	1,340 m	250 m	2,080 m
High-frequency cetaceans	**Harbor porpoise**	4,110 m	740 m	10,830 m	1,150 m	12,600 m
Phocid pinnipeds in water	**Harbor seal**	870 m	350 m	4,510 m	510 m	10,520 m
Otariid pinnipeds in water	Steller sea lion	450 m	130 m	850 m	220 m	1,250 m

Notes:
Functional hearing groups/species in **bold** are expected to occur in the area that includes Eagle River, Eagle Bay, and Knik Arm. Other species are considered to be rare in this area.
[1]155-mm HE rounds modeled have 10.93 kg NEW.
Key: HE = high explosive; kg = kilogram; m = meter; mm = millimeter; NEW = Net Explosive Weight; PTS = permanent threshold shift; SEL = sound exposure level; TTS = temporary threshold shift.
Source: JASCO Applied Sciences 2022, modeled scenario COMB23.

Implementation of the protective measures described in Section 2.2 would limit the type of rounds used at ERF Impact Area during typical inundation events to only training rounds. To assess impacts during inundated conditions, the training round with the largest NEW (155-mm training round; 1.3 kg NEW) was considered, based on modeling results for a round with a similar NEW. As shown in Table 5-14, the maximum distances over which PTS, TTS, and behavioral thresholds may be reached for such training rounds would be smaller than those associated with 155-mm HE rounds (Table 5-13).

Table 5-14: Maximum Distances where Acoustic Harassment Criteria from Underwater Noise May Be Exceeded Due to 155-mm Training Round[1] Detonation during a Typical Inundating Tide Event

Functional Hearing Group	Species	Level A Criteria		Level B Criteria		
		PTS SEL	PTS Peak	TTS SEL	TTS Peak	Behavioral SEL
Low-frequency cetaceans	Fin whale, humpback whale, gray whale	1,160 m	190 m	4,930 m	310 m	10,540 m
Mid-frequency cetaceans	**Beluga whale,** killer whale	550 m	70 m	1,240 m	120 m	1,620 m
High-frequency cetaceans	**Harbor porpoise**	2,820 m	550 m	9,900 m	700 m	10,860 m
Phocid pinnipeds in water	**Harbor seal**	850 m	220 m	3,630 m	320 m	5,360 m
Otariid pinnipeds in water	Steller sea lion	380 m	60 m	760 m	100 m	1,140 m

Notes:
Functional hearing groups/species in **bold** are expected to occur in the area that includes Eagle River, Eagle Bay, and Knik Arm. Other species are considered to be rare in this area.
[1]155-mm training rounds modeled have 1.3 kg NEW.
Key: HE = high explosive; kg = kilogram; m = meter; mm = millimeter; NEW = Net Explosive Weight; PTS = permanent threshold shift; SEL = sound exposure level; TTS = temporary threshold shift.
Source: JASCO Applied Sciences 2020, modeled scenario COMB5 for Peak Criteria, COMB 9 for SEL Criteria (cumulative noise).

5.4.3 Impact Analysis

5.4.3.1 Existing Conditions and No Action Alternative

Under the No Action Alternative, noise impacts to marine mammals from training would be intermittent and long-term, occurring only during weapons firing. Noise impacts would be seasonally reduced because firing would continue to occur only during winter months when Eagle River is frozen over, Eagle Bay has high ice concentrations, and marine mammals have a low likelihood of being in ERF Impact Area. However, based on the potential risk of exposure of marine mammals to noise above airborne and underwater noise thresholds, impacts to marine mammals would still occur.

In-air Noise

Under the No Action Alternative, in-air noise from winter-only weapons firing has the potential to affect pinnipeds (i.e., harbor seal and Steller sea lion) in Knik Arm, Eagle Bay, and Eagle River. For harbor seals, noise levels that reach behavioral disturbance thresholds (based on the COMB18 [winter] scenario modeled in JASCO Applied Sciences 2020) would extend a distance of 37,500 meters from detonation points, potentially affecting harbor seals hauled out in Knik Arm. Based on the same scenario, TTS impairment would occur within 381 meters of a detonation, which is greater than the existing 130-meter habitat protection buffer on Eagle River, but within the 1,000-meter habitat protection buffer on Eagle Bay. Similarly, PTS injury to hearing would occur within 111 meters of a detonation, which is less than the 130-meter buffer on Eagle River. Therefore, there is potential for in-air behavioral and TTS disturbance to harbor seals hauled out or with their heads above water during the blast; however, injury is not expected. The risk of behavioral disturbance from in-air noise would be further reduced based on low sighting rates of harbor seals during winter months when there is ice cover in Eagle River and Eagle Bay.

Underwater Noise Typical High Tide Conditions

Based on modeling results applicable to the No Action Alternative, thresholds to underwater criteria for marine mammals from detonation points outside of the 1,000-meter buffer of Eagle Bay would not be reached under typical high tide conditions, as modeled by the DTE study (based on the COMB13 scenario). Marine mammals are not likely to be present in Eagle River and Otter Creek during the winter months when weapons firing would occur under the No Action Alternative. Even if harbor seal, harbor porpoise, or beluga whale were present, the existing 130-meter buffer on Eagle River and 50-meter buffer of Otter Creek would provide adequate protection.

Underwater Noise Typical Inundating Tide Events

During winter, flooding over ice is possible and there is a potential for detonations when targets are inundated, resulting in increased transmission of noise into Eagle River and Eagle Bay. While marine mammals are not expected to be present in Eagle River during the firing period, marine mammals may be present in Eagle Bay during this period. Because modeling for typical inundating tide events was not conducted for winter conditions, summer conditions are conservatively applied to winter-only firing.

The SEL behavioral disturbance zone for harbor seal, harbor porpoise, and beluga whale would extend into Eagle Bay distances of 6.14, 10.87, and 2.06 km, respectively, from the detonation point (modeled scenario COMB13 in JASCO Applied Sciences 2022). Because this distance is larger than the existing 1,000-meter buffer on Eagle Bay, there is a potential for behavioral effects to harbor seal, harbor porpoise, and Cook Inlet beluga whale under the No Action Alternative if they are present in Eagle Bay during live-fire training. TTS distances for harbor seal, harbor porpoise, and Cook Inlet beluga whale are also greater than 1,000 meters, and potential physiological and behavioral responses associated with TTS may occur to marine mammals in Eagle Bay as a result of firing into ERF Impact Area during typical inundating tide events.

PTS injury to hearing could occur to harbor seal, harbor porpoise, and beluga whale within 0.86, 3.90, and 0.58 km, respectively, of a detonation during a typical inundating tide event (modeled scenario COMB13 in JASCO Applied Sciences 2022). Of these, the PTS zone for harbor porpoise would exceed the 1,000-meter buffer of Eagle Bay; therefore live-fire training could result in PTS injuries to harbor porpoises that are present in Eagle Bay during the winter months when this training occurs.

5.4.3.2 Alternatives 1 and 2

Under Alternatives 1 and 2, indirect live-fire training could occur at ERF Impact Area during any time of the year, although there would be a closure period (tentatively 15 August through 15 September) during which HE rounds would not be used regardless of whether ERF is inundated or not. The buffers and other protective measures described in Section 2 would be implemented, including the use of training rounds only during typical inundating tide events. No buffer is proposed for the Eagle River relict channel under Alternatives 1 and 2. Water depth data collected at two locations within the first 2.0 km of its confluence with Eagle River, indicate that the lower half of the channel, at least, experiences tidally driven, bidirectional flow of brackish water per the semi-diurnal tidal regime of Cook Inlet (i.e., two floods per tidal day (JBER unpublished data). Harbor porpoise and beluga have been detected in the channel (JBER unpublished data), and it may also be utilized by foraging harbor seal, although no visual observation studies have occurred in the area. While it appears that harbor porpoise and beluga rarely use the upper half of the relict channel, the twice daily flooding would allow marine mammals egress for at least 2.0 km should they decide to venture upstream (e.g., chasing salmon). With no buffer on this portion of the channel, marine mammals could be subject to potential mortal injury or impairment if a detonation occurs in close proximity to the relict channel or within the channel itself. The protective measures discussed in Section 2.2 would help reduce but not entirely prevent such impacts.

Noise impacts from training would continue to be intermittent and long-term, occurring only during weapons firing. Noise impacts on marine mammals would likely increase because live-fire training would occur during ice-free periods when there are more recorded sightings of marine mammals in the area. The potential for impacts to marine mammals would likely be greater under Alternative 2 than Alternative 1 because a portion of the munitions would be fired into the proposed upland expansion area under Alternative 1. There would be no risk to marine mammals for injury from noise caused by detonations in the expansion area.

In-air Noise

As described in Section 5.4.2.1, in-air noise would have the potential to affect marine mammals in Knik Arm, Eagle Bay, and Eagle River under Alternatives 1 and 2. Harbor seals are typically present from May to October but most frequently observed in August and September. Harbor seals are commonly observed at the mouth of Eagle River and are occasionally observed within Eagle River as far upstream as Bravo Bridge, and (at high tide) within Otter Creek. No more than four harbor seals have been observed in Eagle River or Eagle Bay at any one time (JBER 2023a). Firing during summer would extend behavioral disturbance distances for harbor seals to greater than 50 km (Table 5-10). TTS impairment for harbor seals could occur within 641 meters of a detonation (modeled scenario COMB23 Summer in JASCO Applied Sciences 2022), which is outside the proposed 130-meter buffer on Eagle River and the proposed 500-meter buffer on Eagle Bay. PTS injury to hearing for harbor seals could occur within 168 meters of a detonation (Table 5-10).

The Army intends to place targets outside the buffer areas to prevent rounds from impacting within the buffers. Targets would not be placed any closer to the buffer areas than the probable error (PE) for range and deflection of the weapon systems. For 155-mm howitzers, the PE is approximately 53 meters for HE rounds. Where there is a 130-meter proposed buffer, the 155-mm howitzer targets would be placed no closer than 183 meters (130-meter buffer plus 53-meter PE) from the river edge or 553 meters (500-meter buffer plus 53-meter PE) from Eagle Bay. Therefore, there is potential for in-air behavioral and TTS disturbance to harbor seals. PTS injury thresholds would not be exceeded in Eagle Bay or the mouth of Eagle River where most harbor seal observations occur. PTS injury thresholds may be exceeded for harbor seals within

Eagle River from approximately 375 meters from the river's mouth to Bravo Bridge and within Otter Creek (at high tide). Placing targets more than 183 meters from the edge of the water substantially reduces the risk of PTS injury along the river.

Underwater Noise Typical High Tide Conditions

Based on the DTE modeling for underwater noise propagation during typical high tide conditions, none of the Level A or Level B thresholds to underwater criteria for harbor seals, harbor porpoise, or beluga whale would be reached under the buffers proposed for Alternatives 1 and 2 (Table 5-12). Modeling showed that a key aspect to minimize underwater noise is maintaining a buffer between detonation points and waterbodies, because sound undergoes strong attenuation as it propagates underground to reach the water. If ammunition were to be detonated at closer range from any waterbody, some of the thresholds could potentially be reached. The proposed 130-meter buffer on Eagle River and 50-meter buffer of Otter Creek are adequate to prevent threshold exceedances for harbor seal, harbor porpoise, and beluga whale under typical high tide conditions.

Underwater Noise Typical Inundating Tide Events

Firing HE rounds into ERF Impact Area during a typical inundating tide when the target area is underwater (but the targets are not) has the potential to result in PTS and TTS impairment to harbor porpoise, harbor seal, and beluga whale over the distances presented in Table 5-13. However, the limited fire periods for HE rounds (Section 2) would prevent their use during inundating tide events. Use of training rounds during these conditions would reduce the distances over which the thresholds from underwater noise for Alternatives 1 and 2 would be exceeded (Table 5-14). Under both Alternatives 1 and 2, the distances over which the PTS SEL, TTS SEL, and Behavioral SEL may be exceeded when 155-mm training rounds are detonated during a typical inundating tide event are greater than the proposed 130-meter buffer on Eagle River. In this situation, the proposed 500-meter buffer of Eagle Bay would prevent exposure of beluga whale located there from detonation noise above the PTS thresholds but not the TTS SEL and Behavioral SEL threshold (Table 5-13). While HE rounds would not be fired during the peak beluga whale visitation period, training rounds may still be fired, resulting in beluga whale being exposed to noise levels above the aforementioned thresholds.

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APPENDIX A—DEPARTMENT OF DEFENSE LAND USE COMPATIBILITY

This appendix contains the land use compatibility recommendations and guidelines as provided in Air Force Handbook (AFH) 32-7084, *AICUZ Program Manager's Guide*.

Attachment 3

RECOMMENDED LAND USE COMPATIBILITY FOR NOISE ZONES

A3.1. Suggested land use compatibility guidelines for noise zones are shown in Table A3.1. Additions to some land use categories have been incorporated into Table A3.1 subsequent to issuance of the SLUCM to reflect additional land uses and to clarify the categorization of certain uses. Tables A3.2 and Table A3.3 provide land use compatibility recommendations in relation to ground training noise sources such as small arms and blast noise from large caliber munitions and explosives. The land use compatibility recommendations are provided for local governments as well as AF for on-base planning.

Table A3.1. Land Use Compatibility in Aircraft Noise Zones.

LAND USE		SUGGESTED LAND USE COMPATIBILITY				
SLUCM NO.	LAND USE NAME	DNL or CNEL 65-69	DNL or CNEL 70-74	DNL or CNEL 75-79	DNL or CNEL 80-84	DNL or CNEL 85+
10	Residential					
11	Household units	N[1]	N[1]	N	N	N
11.11	Single units: detached	N[1]	N[1]	N	N	N
11.12	Single units: semidetached	N[1]	N[1]	N	N	N
11.13	Single units: attached row	N[1]	N[1]	N	N	N
11.21	Two units: side-by-side	N[1]	N[1]	N	N	N
11.22	Two units: one above the other	N[1]	N[1]	N	N	N
11.31	Apartments: walk-up	N[1]	N[1]	N	N	N
11.32	Apartment: elevator	N[1]	N[1]	N	N	N
12	Group quarters	N[1]	N[1]	N	N	N
13	Residential hotels	N[1]	N[1]	N	N	N
14	Mobile home parks or courts	N	N	N	N	N
15	Transient lodgings	N[1]	N[1]	N[1]	N	N
16	Other residential	N[1]	N[1]	N	N	N
20	Manufacturing					
21	Food and kindred products; manufacturing	Y	Y[2]	Y[3]	Y[4]	N
22	Textile mill products; manufacturing	Y	Y[2]	Y[3]	Y[4]	N
23	Apparel and other finished products; products made from fabrics, leather, and similar materials; manufacturing	Y	Y[2]	Y[3]	Y[4]	N
24	Lumber and wood products (except furniture); manufacturing	Y	Y[2]	Y[3]	Y[4]	N
25	Furniture and fixtures; manufacturing	Y	Y[2]	Y[3]	Y[4]	N
26	Paper and allied products; manufacturing	Y	Y[2]	Y[3]	Y[4]	N
27	Printing, publishing, and allied industries	Y	Y[2]	Y[3]	Y[4]	N
28	Chemicals and allied products; manufacturing	Y	Y[2]	Y[3]	Y[4]	N

LAND USE		SUGGESTED LAND USE COMPATIBILITY				
SLUCM NO.	LAND USE NAME	DNL or CNEL 65-69	DNL or CNEL 70-74	DNL or CNEL 75-79	DNL or CNEL 80-84	DNL or CNEL 85+
29	Petroleum refining and related industries	Y	Y[2]	Y[3]	Y[4]	N
30	Manufacturing (continued)					
31	Rubber and misc. plastic products; manufacturing	Y	Y[2]	Y[3]	Y[4]	N
32	Stone, clay and glass products; manufacturing	Y	Y[2]	Y[3]	Y[4]	N
33	Primary metal products; manufacturing	Y	Y[2]	Y[3]	Y[4]	N
34	Fabricated metal products; manufacturing	Y	Y[2]	Y[3]	Y[4]	N
35	Professional scientific, and controlling instruments; photographic and optical goods; watches and clocks	Y	25	30	N	N
39	Miscellaneous manufacturing	Y	Y[2]	Y[3]	Y[4]	N
40	Transportation, communication and utilities					
41	Railroad, rapid rail transit, and street railway transportation	Y	Y[2]	Y[3]	Y[4]	N
42	Motor vehicle transportation	Y	Y[2]	Y[3]	Y[4]	N
43	Aircraft transportation	Y	Y[2]	Y[3]	Y[4]	N
44	Marine craft transportation	Y	Y[2]	Y[3]	Y[4]	N
45	Highway and street right-of-way	Y	Y	Y	Y	N
46	Automobile parking	Y	Y	Y	Y	N
47	Communication	Y	25[5]	30[5]	N	N
48	Utilities	Y	Y[2]	Y[3]	Y[4]	N
49	Other transportation, communication and utilities	Y	25[5]	30[5]	N	N
50	Trade					
51	Wholesale trade	Y	Y[2]	Y[3]	Y[4]	N
52	Retail trade – building materials, hardware and farm equipment	Y	25	30	Y[4]	N
53	Retail trade – including shopping centers, discount clubs, home improvement stores, electronics superstores, etc.	Y	25	30	N	N
54	Retail trade – food	Y	25	30	N	N
55	Retail trade – automotive, marine craft, aircraft and accessories	Y	25	30	N	N
56	Retail trade – apparel and accessories	Y	25	30	N	N
57	Retail trade – furniture, home, furnishings and equipment	Y	25	30	N	N
58	Retail trade – eating and	Y	25	30	N	N

LAND USE		SUGGESTED LAND USE COMPATIBILITY				
SLUCM NO.	LAND USE NAME	DNL or CNEL 65-69	DNL or CNEL 70-74	DNL or CNEL 75-79	DNL or CNEL 80-84	DNL or CNEL 85+
	drinking establishments					
59	Other retail trade	Y	25	30	N	N
60	Services					
61	Finance, insurance and real estate services	Y	25	30	N	N
62	Personal services	Y	25	30	N	N
62.4	Cemeteries	Y	Y[2]	Y[3]	Y[4,11]	Y[6,11]
63	Business services	Y	25	30	N	N
63.7	Warehousing and storage	Y	Y[2]	Y[3]	Y[4]	N
64	Repair services	Y	Y[2]	Y[3]	Y[4]	N
65	Professional services	Y	25	30	N	N
65.1	Hospitals, other medical facilities	25	30	N	N	N
65.16	Nursing homes	N[1]	N[1]	N	N	N
66	Contract construction services	Y	25	30	N	N
67	Government services	Y[1]	25	30	N	N
68	Educational services	25	30	N	N	N
68.1	Child care services, child development centers, and nurseries	25	30	N	N	N
69	Miscellaneous Services	Y	25	30	N	N
69.1	Religious activities (including places of worship)	Y	25	30	N	N
70	Cultural, entertainment and recreational					
71	Cultural activities	25	30	N	N	N
71.2	Nature exhibits	Y[1]	N	N	N	N
72	Public assembly	Y	N	N	N	N
72.1	Auditoriums, concert halls	25	30	N	N	N
72.11	Outdoor music shells, amphitheaters	N	N	N	N	N
72.2	Outdoor sports arenas, spectator sports	Y[7]	Y[7]	N	N	N
73	Amusements	Y	Y	N	N	N
74	Recreational activities (including golf courses, riding stables, water recreation)	Y	25	30	N	N
75	Resorts and group camps	Y	25	N	N	N
76	Parks	Y	25	N	N	N
79	Other cultural, entertainment and recreation	Y	25	N	N	N
80	Resource production and extraction					
81	Agriculture (except live-stock)	Y[8]	Y[9]	Y[10]	Y[10,11]	Y[10,11]
81.5-81.7	Agriculture-Livestock farming including grazing and feedlots	Y[8]	Y[9]	N	N	N

LAND USE		SUGGESTED LAND USE COMPATIBILITY				
SLUCM NO.	LAND USE NAME	DNL or CNEL 65-69	DNL or CNEL 70-74	DNL or CNEL 75-79	DNL or CNEL 80-84	DNL or CNEL 85+
82	Agriculture related activities	Y[8]	Y[9]	Y[10]	Y[10,11]	Y[10,11]
83	Forestry activities	Y[8]	Y[9]	Y[10]	Y[10,11]	Y[10,11]
84	Fishing activities	Y	Y	Y	Y	Y
85	Mining activities	Y	Y	Y	Y	Y
89	Other resource production or extraction	Y	Y	Y	Y	Y

KEY:
SLUCM – Standard Land Use Coding Manual, U.S. Department of Transportation
Y (Yes) – Land use and related structures compatible without restrictions.
N (No) – Land use and related structures are not compatible and should be prohibited.
Y^x – Yes with restrictions. The land use and related structures generally are compatible. However, see note(s) indicated by the superscript.
N^x – No with exceptions. The land use and related structures are generally incompatible. However, see note(s) indicated by the superscript.
25, 30, or 35 – The numbers refer to noise level reduction (NLR) levels. NLR (outdoor to indoor) is achieved through the incorporation of noise attenuation into the design and construction of a structure. Land use and related structures are generally compatible; however, measures to achieve NLR of 25, 30, or 35 must be incorporated into design and construction of structures. However, measures to achieve an overall noise reduction do not necessarily solve noise difficulties outside the structure and additional evaluation is warranted. Also, see notes indicated by superscripts where they appear with one of these numbers.
DNL – Day-Night Average Sound Level.
CNEL – Community Noise Equivalent Level (normally within a very small decibel difference of DNL)
Ldn – Mathematical symbol for DNL.

NOTES:

1. General

a. Although local conditions regarding the need for housing may require residential use in these zones, residential use is discouraged in DNL 65-69 and strongly discouraged in DNL 70-74. The absence of viable alternative development options should be determined and an evaluation should be conducted locally prior to local approvals indicating that a demonstrated community need for the residential use would not be met if development were prohibited in these zones. Existing residential development is considered as pre-existing, non-conforming land uses.

b. Where the community determines that these uses must be allowed, measures to achieve outdoor to indoor NLR of at least 25 decibels (dB) in DNL 65-69 and 30 dB in DNL 70-74 should be incorporated into building codes and be considered in individual approvals; for transient housing, an NLR of at least 35 dB should be incorporated in DNL 75-79.

c. Normal permanent construction can be expected to provide an NLR of 20 dB, thus the reduction requirements are often stated as 5, 10, or 15 dB over standard construction and normally assume mechanical ventilation, upgraded sound transmission class ratings in windows and doors, and closed windows year round. Additional consideration should be given to modifying NLR levels based on peak noise levels or vibrations.

d. NLR criteria will not eliminate outdoor noise problems. However, building location, site planning, design, and use of berms and barriers can help mitigate outdoor noise exposure particularly from ground level sources. Measures that reduce noise at a site should be used wherever practical in preference to measures that only protect interior spaces.

2. Measures to achieve NLR of 25 must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

3. Measures to achieve NLR of 30 must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

4. Measures to achieve NLR of 35 must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

5. If project or proposed development is noise sensitive, use indicated NLR; if not, land use is compatible without NLR.

6. Buildings are not permitted.

7. Land use is compatible provided special sound reinforcement systems are installed.

8. Residential buildings require an NLR of 25

9. Residential buildings require an NLR of 30.

10. Residential buildings are not permitted.

11. Land use that involves outdoor activities is not recommended, but if the community allows such activities, hearing protection devices should be worn when noise sources are present. Long-term exposure (multiple hours per day over many years) to high noise levels can cause hearing loss in some unprotected individuals.

Table A3.2. Land Use Compatibility for Small Arms Noise

LAND USE		SUGGESTED LAND USE COMPATIBILITY	
SLUCM NO.	LAND USE NAME	Noise Zone II 87-104 dBP	Noise Zone III >104 dBP
10	Residential		
11	Household units	N[1]	N
11.11	Single units: detached	N[1]	N
11.12	Single units: semidetached	N[1]	N
11.13	Single units: attached row	N[1]	N
11.21	Two units: side-by-side	N[1]	N
11.22	Two units: one above the other	N[1]	N
11.31	Apartments: walk-up	N[1]	N
11.32	Apartment: elevator	N[1]	N
12	Group quarters	N[1]	N
13	Residential hotels	N[1]	N
14	Mobile home parks or courts	N[1]	N
15	Transient lodgings	25	N
16	Other residential	N[1]	N
20	Manufacturing		
21	Food and kindred products; manufacturing	Y[2]	Y[3]
22	Textile mill products; manufacturing	Y[2]	Y[3]
23	Apparel and other finished products; products made from fabrics, leather, and similar materials; manufacturing	Y[2]	Y[3]
24	Lumber and wood products (except furniture); manufacturing	Y[2]	Y[3]
25	Furniture and fixtures; manufacturing	Y[2]	Y[3]
26	Paper and allied products; manufacturing	Y[2]	Y[3]
27	Printing, publishing, and allied industries	Y[2]	Y[3]
28	Chemicals and allied products; manufacturing	Y[2]	Y[3]
29	Petroleum refining and related industries	Y[2]	Y[3]
30	Manufacturing (continued)		
31	Rubber and misc. plastic products; manufacturing	Y[2]	Y[3]
32	Stone, clay and glass products; manufacturing	Y[2]	Y[3]
33	Primary metal products; manufacturing	Y[2]	Y[3]
34	Fabricated metal products; manufacturing	Y[2]	Y[3]
35	Professional scientific, and controlling instruments; photographic and optical goods; watches and clocks	25	35

LAND USE		SUGGESTED LAND USE COMPATIBILITY	
SLUCM NO.	LAND USE NAME	Noise Zone II 87-104 dBP	Noise Zone III >104 dBP
39	Miscellaneous manufacturing	Y[2]	Y[3]
40	Transportation, communication and utilities		
41	Railroad, rapid rail transit, and street railway transportation	Y[2]	Y[3]
42	Motor vehicle transportation	Y[2]	Y[3]
43	Aircraft transportation	Y[2]	Y[3]
44	Marine craft transportation	Y[2]	Y[3]
45	Highway and street right-of-way	Y[2]	Y[3]
46	Automobile parking	Y[2]	Y[3]
47	Communication	25	35
48	Utilities	Y[2]	Y
49	Other transportation, communication and utilities	25	35
50	Trade		
51	Wholesale trade	Y[2]	Y[3]
52	Retail trade – building materials, hardware and farm equipment	25	35
53	Retail trade – including shopping centers, discount clubs, home improvement stores, electronics superstores, etc.	25	35
54	Retail trade – food	25	35
55	Retail trade – automotive, marine craft, aircraft and accessories	25	35
56	Retail trade – apparel and accessories	25	35
57	Retail trade – furniture, home, furnishings and equipment	25	35
58	Retail trade – eating and drinking establishments	25	35
59	Other retail trade	25	35
60	Services		
61	Finance, insurance and real estate services	25	35
62	Personal services	25	35
62.4	Cemeteries	Y[2]	Y[3]
63	Business services	25	35
63.7	Warehousing and storage	Y[2]	Y[3]
64	Repair services	Y[2]	Y[3]
65	Professional services	25	N
65.1	Hospitals, other medical facilities	N	N
65.16	Nursing homes	N	N
66	Contract construction services	25	35
67	Government services	25	35
68	Educational services	35	N
68.1	Child care services, child development centers, and nurseries	35	N
69	Miscellaneous Services	35	N

LAND USE		SUGGESTED LAND USE COMPATIBILITY	
SLUCM NO.	LAND USE NAME	Noise Zone II 87-104 dBP	Noise Zone III >104 dBP
69.1	Religious activities (including places of worship)	35	N
70	Cultural, entertainment and recreational		
71	Cultural activities	35	N
71.2	Nature exhibits	N	N
72	Public assembly	N	N
72.1	Auditoriums, concert halls	35	N
72.11	Outdoor music shells, amphitheaters	N	N
72.2	Outdoor sports arenas, spectator sports	N	N
73	Amusements	Y	N
74	Recreational activities (including golf courses, riding stables, water recreation)	N	N
75	Resorts and group camps	N	N
76	Parks	N	N
79	Other cultural, entertainment and recreation	N	N
80	Resource production and extraction		
81	Agriculture (except live- stock)	Y^{4}	Y^{5}
81.5	Livestock farming	Y^{4}	N
81.7	Animal breeding	Y^{4}	N
82	Agriculture related activities	Y^{4}	Y^{5}
83	Forestry activities	Y^{4}	Y^{5}
84	Fishing activities	Y	Y
85	Mining activities	Y	Y
89	Other resource production or extraction	Y	Y

Key:
SLUCM – Standard Land Use Coding Manual, U.S. Department of Transportation
dBP- unweighted Peak decibel level
Y (Yes) – Land use and related structures compatible without restrictions.
N (No) – Land use and related structures are not compatible and should be prohibited.
Y_x – Yes with restrictions. The land use and related structures generally are compatible. However, see note(s) indicated by the superscript.
N_x – No, with exceptions. The land use and related structures are generally incompatible. However, see note(s) indicated by the superscript.
25, 30, or 35 – The numbers refer to noise level reduction (NLR) levels. NLR (outdoor to indoor) is achieved through the incorporation of noise attenuation into the design and construction of a structure.

NOTES:

Note 1:

a. Although local requirements for on- or off-base housing may require noise-sensitive land uses within Noise Zone II, such land use is generally not recommended. The absence of viable alternative development options should be determined and an evaluation should be conducted locally prior to local approvals indicating that a demonstrated community need for the residential use would not be met if development were prohibited in these zones. Existing residential development is considered as pre-existing, non-conforming land uses.
b. Where the community determines that these uses must be allowed, measures to achieve outdoor to indoor NLR of at least 30 decibels (dB) in Noise Zone II should be incorporated into building codes and be considered in individual approvals.

c. Normal permanent construction can be expected to provide an NLR of 20 dB, thus the reduction requirements are often stated as 10 dB over standard construction and normally assume mechanical ventilation, upgraded sound transmission class ratings in windows and doors, and closed windows year round.
d. NLR criteria will not eliminate outdoor noise problems. However, building location, site planning, design, and use of berms and barriers can help mitigate outdoor noise exposure particularly from ground level sources. Measures that reduce noise at a site should be used wherever practicable in preference to measures that only protect interior spaces.

2. Measures to achieve NLR of 25 must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.
3. Measures to achieve NLR of 30 must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.
4. Residential buildings require an NLR of 30.
5. Residential buildings are not permitted.

Table A3.3. Land Use Compatibility for Artillery Explosives.

LAND USE		SUGGESTED LAND USE COMPATIBILITY		
SLUCM NO.	LAND USE NAME	LUPZ CDNL or CNEL 57-62	Noise Zone II CDNL or CNEL 62-70	Noise Zone III CDNL or CNEL 70+
10	Residential			
11	Household units	Y[1]	N[2,3]	N[3]
11.11	Single units: detached	Y[1]	N[2,3]	N[3]
11.12	Single units: semidetached	Y[1]	N[2,3]	N[3]
11.13	Single units: attached row	Y[1]	N[2,3]	N[3]
11.21	Two units: side-by-side	Y[1]	N[2,3]	N[3]
11.22	Two units: one above the other	Y[1]	N[2,3]	N[3]
11.31	Apartments: walk-up	Y[1]	N[2,3]	N[3]
11.32	Apartment: elevator	Y[1]	N[2,3]	N[3]
12	Group quarters	Y[1]	N[2,3]	N[3]
13	Residential hotels	Y[1]	N[2,3]	N[3]
14	Mobile home parks or courts	Y[1]	N[2,3]	N[3]
15	Transient lodgings	Y	Y	N
16	Other residential	Y[1]	N[2,3]	N[3]
20	Manufacturing			
21	Food and kindred products; manufacturing	Y	Y[4]	Y[4]
22	Textile mill products; manufacturing	Y	Y[4]	Y[4]
23	Apparel and other finished products; products made from fabrics, leather, and similar materials; manufacturing	Y	Y[4]	Y[4]
24	Lumber and wood products (except furniture); manufacturing	Y	Y[4]	Y[4]
25	Furniture and fixtures; manufacturing	Y	Y[4]	Y[4]
26	Paper and allied products; manufacturing	Y	Y[4]	Y[4]
27	Printing, publishing, and allied industries	Y	Y[4]	Y[4]
28	Chemicals and allied products; manufacturing	Y	Y[4]	Y[4]
29	Petroleum refining and related industries	Y	Y[4]	Y[4]
30	Manufacturing (continued)			
31	Rubber and misc. plastic products; manufacturing	Y	Y[4]	Y[4]
32	Stone, clay and glass products; manufacturing	Y	Y[4]	Y[4]
33	Primary metal products; manufacturing	Y	Y[4]	Y[4]

LAND USE		SUGGESTED LAND USE COMPATIBILITY		
34	Fabricated metal products; manufacturing	Y	Y[4]	Y[4]
35	Professional scientific, and controlling instruments; photographic and optical goods; watches and clocks	Y	N	N
39	Miscellaneous manufacturing	Y	Y[4]	Y[4]
40	Transportation, communication and utilities			
41	Railroad, rapid rail transit, and street railway transportation	Y	Y	Y
42	Motor vehicle transportation	Y	Y	Y
43	Aircraft transportation	Y	Y	Y
44	Marine craft transportation	Y	Y	Y
45	Highway and street right-of-way	Y	Y	Y
46	Automobile parking	Y	Y	Y
47	Communication	Y	N	N
48	Utilities	Y	Y	Y
49	Other transportation, communication and utilities	Y	Y	N
50	Trade			
51	Wholesale trade	Y	Y	N
52	Retail trade – building materials, hardware and farm equipment	Y	Y	N
53	Retail trade – including shopping centers, discount clubs, home improvement stores, electronics superstores, etc.	Y	Y	N
54	Retail trade – food	Y	Y	N
55	Retail trade – automotive, marine craft, aircraft and accessories	Y	Y	N
56	Retail trade – apparel and accessories	Y	Y	N
57	Retail trade – furniture, home, furnishings and equipment	Y	Y	N
58	Retail trade – eating and drinking establishments	Y	Y	N
59	Other retail trade	Y	Y	N
60	Services			
61	Finance, insurance and real estate services	Y	Y	N
62	Personal services	Y	Y	N
62.4	Cemeteries	Y	Y	Y
63	Business services	Y	Y	N
63.7	Warehousing and storage	Y	Y4	Y4
64	Repair services	Y	Y	N
65	Professional services	Y	Y	N
65.1	Hospitals, other medical facilities	Y1	N	N
65.16	Nursing homes	Y1	N	N
66	Contract construction services	Y	Y	N

LAND USE		SUGGESTED LAND USE COMPATIBILITY		
67	Government services	Y	Y	N
68	Educational services	Y1	N	N
68.1	Child care services, child development centers, and nurseries	Y1	N	N
69	Miscellaneous Services			
69.1	Religious activities (including places of worship)	Y1	N	N
70	Cultural, entertainment and recreational			
71	Cultural activities	Y1	N	N
71.2	Nature exhibits	Y1	N	N
72	Public assembly	Y1	N	N
72.1	Auditoriums, concert halls	Y1	N	N
72.11	Outdoor music shells, amphitheaters	Y1	N	N
72.2	Outdoor sports arenas, spectator sports	Y	N	N
73	Amusements	Y	Y	N
74	Recreational activities (including golf courses, riding stables, water recreation)	Y	N	N
75	Resorts and group camps	Y	N	N
76	Parks	Y	N	N
79	Other cultural, entertainment and recreation	Y	N	N
80	Resource production and extraction			
81	Agriculture (except live- stock)	Y	Y	Y
81.5	Livestock farming	Y	N	N
81.7	Animal breeding	Y	N	N
82	Agriculture related activities	Y	Y	Y
83	Forestry activities	Y	Y	Y
84	Fishing activities	Y	Y	Y
85	Mining activities	Y	Y	Y
89	Other resource production or extraction	Y	Y	Y

NOTES:

Note 1: LUPZ- Land Use Planning Zone is a subdivision of Land Use Zone I and functions as a buffer for Noise Zone II. Communities and individuals often have different views regarding acceptable or desirable levels of noise. To address this, some local governments have implemented land use planning measures beyond Noise Zone II limits. In addition to mitigating current noise impacts, implementing such controls within the LUPZ can create a buffer to prevent the possibility of future noise conflicts.

Note 2: Although local requirements for on- or off-base housing may require noise-sensitive land uses within Noise Zone II, such land use is generally not compatible within Noise Zone II. Measures to achieve overall noise level reduction inside structures do not solve noise difficulties outside the structure. Barriers are not effective reducing the noise from artillery and armor, the detonation of either large caliber military munitions or a large quantity of explosives. Additionally, noise level reduction inside structures does not mitigate the vibration generated by the low-frequency energy of large caliber weapons firing and detonations.

Note 3: Within Zones, existing “noise sensitive land uses are considered as pre-existing incompatible land uses. In most cases these uses are not a risk to either mission sustainment or a community’s quality of life. Most long-term members near Army installations or activities acknowledge hearing military operations and activities but they are usually not alarmed or bothered by the noise.
Note 4: Although noise levels may be compatible, caution should be exercised in siting any activity which may be sensitive to vibration.

APPENDIX B—ANNUAL MUNITIONS EXPENDITURES BY WEAPON SYSTEM, ORDNANCE TYPE, AND FIRING POINT

APPENDIX B

ANNUAL MUNITIONS EXPENDITURES BY WEAPON SYSTEM, ORDNANCE TYPE, AND FIRING POINT

This appendix contains the data used for the large arms noise modeling as provided by Joint Base Elmendorf-Richardson. The data are broken down by weapon system, firing point, and ordnance used for the No Action Alternative, Alternative 1, and Alternative 2.

60 MM MORTAR

60 MM Mortar: No Action Alternative

Firing Points	60mm Inert Day	60mm Inert Day Rounded	60mm Inert Night	60mm Inert Night Rounded	60mm HE Day	60mm HE Day Rounded	60mm HE Night	60mm HE Night Rounded	TOTAL
MFP Cole Lower	88.13	89.00	29.38	30.00	27.75	28.00	9.25	10.00	157.00
MFP Cole Upper	88.13	89.00	29.38	30.00	27.75	28.00	9.25	10.00	157
MFP Eagle	88.13	89.00	29.38	30.00	27.75	28.00	9.25	10.00	157
MFP Fagan	88.13	89.00	29.38	30.00	27.75	28.00	9.25	10.00	157
MFP Fox Lower	88.13	89.00	29.38	30.00	27.75	28.00	9.25	10.00	157
MFP Fox Upper	88.13	89.00	29.38	30.00	27.75	28.00	9.25	10.00	157
MFP Joe	88.13	89.00	29.38	30.00	27.75	28.00	9.25	10.00	157
MFP John	88.13	89.00	29.38	30.00	27.75	28.00	9.25	10.00	157
MFP Ken	88.13	89.00	29.38	30.00	27.75	28.00	9.25	10.00	157
MFP Lightning	88.13	89.00	29.38	30.00	27.75	28.00	9.25	10.00	157
MFP Moose	88.13	89.00	29.38	30.00	27.75	28.00	9.25	10.00	157
MFP Perry	88.13	89.00	29.38	30.00	27.75	28.00	9.25	10.00	157
MFP Vital	88.13	89.00	29.38	30.00	27.75	28.00	9.25	10.00	157
MFP Wolf	88.13	89.00	29.38	30.00	27.75	28.00	9.25	10.00	157
FP 1	0	0	0	0	0	0	0	0	0
FP 2	0	0	0	0	0	0	0	0	0
FP 3	0	0	0	0	0	0	0	0	0
FP 4	0	0	0	0	0	0	0	0	0
FP 5	0	0	0	0	0	0	0	0	0
FP 6	0	0	0	0	0	0	0	0	0
FP 7	0	0	0	0	0	0	0	0	0
FP 8	0	0	0	0	0	0	0	0	0
FP 9	0	0	0	0	0	0	0	0	0
FP 10	0	0	0	0	0	0	0	0	0
FP 16	0	0	0	0	0	0	0	0	0
FP 22	0	0	0	0	0	0	0	0	0
FP 23	0	0	0	0	0	0	0	0	0
FP 33	0	0	0	0	0	0	0	0	0
FP MALEMUTE	0	0	0	0	0	0	0	0	0
FP NEIBUR	0	0	0	0	0	0	0	0	0
		1246		420		392		140	2198.00

60 MM Mortar: Alternative 1—All Season Live-Fire Training with Expanded Impact Area

Firing Points	60mm Inert Day	60mm Inert Day Rounded	60mm Inert Night	60mm Inert Night Rounded	60mm HE Day	60mm HE Day Rounded	60mm HE Night	60mm HE Night Rounded	TOTAL
MFP Cole Lower	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311.00
MFP Cole Upper	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP Eagle	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP Fagan	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP Fox Lower	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP Fox Upper	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP Joe	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP John	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP Ken	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP Lightning	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP Moose	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP Perry	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP Vital	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP Wolf	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
FP 1	0	0	0	0	0	0	0	0	0
FP 2	0	0	0	0	0	0	0	0	0
FP 3	0	0	0	0	0	0	0	0	0
FP 4	0	0	0	0	0	0	0	0	0
FP 5	0	0	0	0	0	0	0	0	0
FP 6	0	0	0	0	0	0	0	0	0
FP 7	0	0	0	0	0	0	0	0	0
FP 8	0	0	0	0	0	0	0	0	0
FP 9	0	0	0	0	0	0	0	0	0
FP 10	0	0	0	0	0	0	0	0	0
FP 16	0	0	0	0	0	0	0	0	0
FP 22	0	0	0	0	0	0	0	0	0
FP 23	0	0	0	0	0	0	0	0	0
FP 33	0	0	0	0	0	0	0	0	0
FP MALEMUTE	0	0	0	0	0	0	0	0	0
FP NEIBUR	0	0	0	0	0	0	0	0	0
		2478		826		784		266	4354

60 MM Mortar: Alternative 2—All-Season Live-Fire Training at Eagle River Flats (ERF) Impact Area Only

Firing Points	60mm Inert Day	60mm Inert Day Rounded	60mm Inert Night	60mm Inert Night Rounded	60mm HE Day	60mm HE Day Rounded	60mm HE Night	60mm HE Night Rounded	TOTAL
MFP Cole Lower	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311.00
MFP Cole Upper	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP Eagle	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP Fagan	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP Fox Lower	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP Fox Upper	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP Joe	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP John	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP Ken	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP Lightning	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP Moose	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP Perry	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP Vital	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
MFP Wolf	176.25	177.00	58.75	59.00	55.50	56.00	18.50	19.00	311
FP 1	0	0	0	0	0	0	0	0	0
FP 2	0	0	0	0	0	0	0	0	0
FP 3	0	0	0	0	0	0	0	0	0
FP 4	0	0	0	0	0	0	0	0	0
FP 5	0	0	0	0	0	0	0	0	0
FP 6	0	0	0	0	0	0	0	0	0
FP 7	0	0	0	0	0	0	0	0	0
FP 8	0	0	0	0	0	0	0	0	0
FP 9	0	0	0	0	0	0	0	0	0
FP 10	0	0	0	0	0	0	0	0	0
FP 16	0	0	0	0	0	0	0	0	0
FP 22	0	0	0	0	0	0	0	0	0
FP 23	0	0	0	0	0	0	0	0	0
FP 33	0	0	0	0	0	0	0	0	0
FP MALEMUTE	0	0	0	0	0	0	0	0	0
FP NEIBUR	0	0	0	0	0	0	0	0	0
		2478		826		784		266	4354

81 MM MORTAR

81 MM Mortar: No Action Alternative

Firing Points	81mm Inert Day	81mm Inert Day Rounded	81mm Inert Night	81mm Inert Night Rounded	81mm HE Day	81mm HE Day Rounded	81mm HE Night	81mm HE Night Rounded	TOTAL
MFP Cole Lower	33.57	34.00	11.19	12.00	10.57143	11	3.52381	4	61.00
MFP Cole Upper	33.57	34.00	11.19	12.00	10.57143	11	3.52381	4	61
MFP Eagle	33.57	34.00	11.19	12.00	10.57143	11	3.52381	4	61
MFP Fagan	33.57	34.00	11.19	12.00	10.57143	11	3.52381	4	61
MFP Fox Lower	33.57	34.00	11.19	12.00	10.57143	11	3.52381	4	61
MFP Fox Upper	33.57	34.00	11.19	12.00	10.57143	11	3.52381	4	61
MFP Joe	33.57	34.00	11.19	12.00	10.57143	11	3.52381	4	61
MFP John	33.57	34.00	11.19	12.00	10.57143	11	3.52381	4	61
MFP Ken	33.57	34.00	11.19	12.00	10.57143	11	3.52381	4	61
MFP Lightning	33.57	34.00	11.19	12.00	10.57143	11	3.52381	4	61
MFP Moose	33.57	34.00	11.19	12.00	10.57143	11	3.52381	4	61
MFP Perry	33.57	34.00	11.19	12.00	10.57143	11	3.52381	4	61
MFP Vital	33.57	34.00	11.19	12.00	10.57143	11	3.52381	4	61
MFP Wolf	33.57	34.00	11.19	12.00	10.57143	11	3.52381	4	61
FP 1	33.57	34.00	11.19	12.00	10.57143	11	3.52381	4	61
FP 2	33.57	34.00	11.19	12.00	10.57143	11	3.52381	4	61
FP 3	33.57	34.00	11.19	12.00	10.57143	11	3.52381	4	61
FP 4	33.57	34.00	11.19	12.00	10.57143	11	3.52381	4	61
FP 5	33.57	34.00	11.19	12.00	10.57143	11	3.52381	4	61
FP 6	0	0	0	0	0	0	0	0	0
FP 7	0	0	0	0	0	0	0	0	0
FP 8	0	0	0	0	0	0	0	0	0
FP 9	0	0	0	0	0	0	0	0	0
FP 10	0	0	0	0	0	0	0	0	0
FP 16	0	0	0	0	0	0	0	0	0
FP 22	0	0	0	0	0	0	0	0	0
FP 23	0	0	0	0	0	0	0	0	0
FP 33	0	0	0	0	0	0	0	0	0
FP MALEMUTE	33.57	34.00	11.19	12.00	10.57143	11	3.52381	4	61
FP NEIBUR	33.57	34.00	11.19	12.00	10.57143	11	3.52381	4	61
		714		252		231		84	1281

81 MM Mortar: Alternative 1—All Season Live-Fire Training with Expanded Impact Area

Firing Points	81mm Inert Day	81mm Inert Day Rounded	81mm Inert Night	81mm Inert Night Rounded	81mm HE Day	81mm HE Day Rounded	81mm HE Night	81mm HE Night Rounded	TOTAL
MFP Cole Lower	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121.00
MFP Cole Upper	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP Eagle	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP Fagan	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP Fox Lower	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP Fox Upper	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP Joe	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP John	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP Ken	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP Lightning	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP Moose	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP Perry	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP Vital	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP Wolf	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
FP 1	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
FP 2	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
FP 3	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
FP 4	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
FP 5	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
FP 6	0	0	0	0	0	0	0	0	0
FP 7	0	0	0	0	0	0	0	0	0
FP 8	0	0	0	0	0	0	0	0	0
FP 9	0	0	0	0	0	0	0	0	0
FP 10	0	0	0	0	0	0	0	0	0
FP 16	0	0	0	0	0	0	0	0	0
FP 22	0	0	0	0	0	0	0	0	0
FP 23	0	0	0	0	0	0	0	0	0
FP 33	0	0	0	0	0	0	0	0	0
FP MALEMUTE	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
FP NEIBUR	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
		1428		483		462		168	2541

81 MM Mortar: Alternative 2—All-Season Live-Fire Training at Eagle River Flats (ERF) Impact Area Only

Firing Points	81mm Inert Day	81mm Inert Day Rounded	81mm Inert Night	81mm Inert Night Rounded	81mm HE Day	81mm HE Day Rounded	81mm HE Night	81mm HE Night Rounded	TOTAL
MFP Cole Lower	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121.00
MFP Cole Upper	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP Eagle	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP Fagan	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP Fox Lower	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP Fox Upper	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP Joe	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP John	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP Ken	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP Lightning	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP Moose	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP Perry	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP Vital	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
MFP Wolf	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
FP 1	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
FP 2	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
FP 3	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
FP 4	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
FP 5	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
FP 6	0	0	0	0	0	0	0	0	0
FP 7	0	0	0	0	0	0	0	0	0
FP 8	0	0	0	0	0	0	0	0	0
FP 9	0	0	0	0	0	0	0	0	0
FP 10	0	0	0	0	0	0	0	0	0
FP 16	0	0	0	0	0	0	0	0	0
FP 22	0	0	0	0	0	0	0	0	0
FP 23	0	0	0	0	0	0	0	0	0
FP 33	0	0	0	0	0	0	0	0	0
FP MALEMUTE	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
FP NEIBUR	67.14	68.00	22.38	23.00	21.14	22.00	7.05	8.00	121
		1428		483		462		168	2541

120 MM MORTAR

120 MM Mortar: No Action Alternative

Firing Points	120mm Inert Day	120mm Inert Day Rounded	120mm Inert Night	120mm Inert Night Rounded	120mm HE Day	120mm HE Day Rounded	120mm HE Night	120mm HE Night Rounded	TOTAL
MFP Cole Lower	0	0	0	0	0	0	0	0	0
MFP Cole Upper	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
MFP Eagle	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
MFP Fagan	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
MFP Fox Lower	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
MFP Fox Upper	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
MFP Joe	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
MFP John	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
MFP Ken	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
MFP Lightning	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
MFP Moose	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
MFP Perry	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
MFP Vital	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
MFP Wolf	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
FP 1	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
FP 2	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
FP 3	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
FP 4	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
FP 5	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
FP 6	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
FP 7	0	0	0	0	0	0	0	0	0
FP 8	0	0	0	0	0	0	0	0	0
FP 9	0	0	0	0	0	0	0	0	0
FP 10	0	0	0	0	0	0	0	0	0
FP 16	0	0	0	0	0	0	0	0	0
FP 22	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
FP 23	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
FP 33	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
FP MALEMUTE	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
FP NEIBUR	40.50	41.00	13.50	14.00	11.63	12.00	3.88	4.00	71
		984		336		288		96	1704

120 MM Mortar: Alternative 1—All Season Live-Fire Training with Expanded Impact Area

Firing Points	120mm Inert Day	120mm Inert Day Rounded	120mm Inert Night	120mm Inert Night Rounded	120mm HE Day	120mm HE Day Rounded	120mm HE Night	120mm HE Night Rounded	TOTAL
MFP Cole Lower	0	0	0	0	0	0	0	0	0
MFP Cole Upper	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP Eagle	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP Fagan	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP Fox Lower	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP Fox Upper	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP Joe	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP John	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP Ken	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP Lightning	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP Moose	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP Perry	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP Vital	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP Wolf	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
FP 1	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
FP 2	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
FP 3	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
FP 4	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
FP 5	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
FP 6	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
FP 7	0	0	0	0	0	0	0	0	0
FP 8	0	0	0	0	0	0	0	0	0
FP 9	0	0	0	0	0	0	0	0	0
FP 10	0	0	0	0	0	0	0	0	0
FP 16	0	0	0	0	0	0	0	0	0
FP 22	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
FP 23	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
FP 33	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
FP MALEMUTE	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
FP NEIBUR	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
		1944		648		576		192	3360

120 MM Mortar: Alternative 2—All-Season Live-Fire Training at Eagle River Flats (ERF) Impact Area Only

Firing Points	120mm Inert Day	120mm Inert Day Rounded	120mm Inert Night	120mm Inert Night Rounded	120mm HE Day	120mm HE Day Rounded	120mm HE Night	120mm HE Night Rounded	TOTAL
MFP Cole Lower	0	0	0	0	0	0	0	0	0
MFP Cole Upper	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP Eagle	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP Fagan	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP Fox Lower	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP Fox Upper	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP Joe	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP John	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP Ken	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP Lightning	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP Moose	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP Perry	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP Vital	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
MFP Wolf	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
FP 1	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
FP 2	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
FP 3	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
FP 4	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
FP 5	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
FP 6	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
FP 7	0	0	0	0	0	0	0	0	0
FP 8	0	0	0	0	0	0	0	0	0
FP 9	0	0	0	0	0	0	0	0	0
FP 10	0	0	0	0	0	0	0	0	0
FP 16	0	0	0	0	0	0	0	0	0
FP 22	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
FP 23	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
FP 33	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
FP MALEMUTE	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
FP NEIBUR	81.00	81.00	27.00	27.00	23.25	24.00	7.75	8.00	140
		1944		648		576		192	3360

105 MM HOWITZER

105 MM Howitzer: No Action Alternative

Firing Points	105mm Inert Day	105mm Inert Day Rounded	105mm Inert Night	105mm Inert Night Rounded	105mm HE Day	105mm HE Day Rounded	105mm HE Night	105mm HE Night Rounded	TOTAL
MFP Cole Lower	0	0	0	0	0	0	0	0	0
MFP Cole Upper	0	0	0	0	0	0	0	0	0
MFP Eagle	0	0	0	0	0	0	0	0	0
MFP Fagan	0	0	0	0	0	0	0	0	0
MFP Fox Lower	0	0	0	0	0	0	0	0	0
MFP Fox Upper	0	0	0	0	0	0	0	0	0
MFP Joe	0	0	0	0	0	0	0	0	0
MFP John	31.50	32.00	10.50	11.00	57.62	58.00	19.21	20.00	121
MFP Ken	0	0	0	0	0	0	0	0	0
MFP Lightning	31.50	32.00	10.50	11.00	57.62	58.00	19.21	20.00	121
MFP Moose	0	0	0	0	0	0	0	0	0
MFP Perry	0	0	0	0	0	0	0	0	0
MFP Vital	0	0	0	0	0	0	0	0	0
MFP Wolf	0	0	0	0	0	0	0	0	0
FP 1	31.50	32.00	10.50	11.00	57.62	58.00	19.21	20.00	121
FP 2	31.50	32.00	10.50	11.00	57.62	58.00	19.21	20.00	121
FP 3	31.50	32.00	10.50	11.00	57.62	58.00	19.21	20.00	121
FP 4	31.50	32.00	10.50	11.00	57.62	58.00	19.21	20.00	121
FP 5	31.50	32.00	10.50	11.00	57.62	58.00	19.21	20.00	121
FP 6	31.50	32.00	10.50	11.00	57.62	58.00	19.21	20.00	121
FP 7	31.50	32.00	10.50	11.00	57.62	58.00	19.21	20.00	121
FP 8	31.50	32.00	10.50	11.00	57.62	58.00	19.21	20.00	121
FP 9	31.50	32.00	10.50	11.00	57.62	58.00	19.21	20.00	121
FP 10	31.50	32.00	10.50	11.00	57.62	58.00	19.21	20.00	121
FP 16	0	0	0	0	0	0	0	0	0
FP 22	31.50	32.00	10.50	11.00	57.62	58.00	19.21	20.00	121
FP 23	31.50	32.00	10.50	11.00	57.62	58.00	19.21	20.00	121
FP 33	31.50	32.00	10.50	11.00	57.62	58.00	19.21	20.00	121
FP MALEMUTE	31.50	32.00	10.50	11.00	57.62	58.00	19.21	20.00	121
FP NEIBUR	31.50	32.00	10.50	11.00	57.62	58.00	19.21	20.00	121
		544		187		986		340	2057

105 MM Howitzer: Alternative 1—All Season Live-Fire Training with Expanded Impact Area

Firing Points	105mm Inert Day	105mm Inert Day Rounded	105mm Inert Night	105mm Inert Night Rounded	105mm HE Day	105mm HE Day Rounded	105mm HE Night	105mm HE Night Rounded	TOTAL
MFP Cole Lower	0	0	0	0	0	0	0	0	0
MFP Cole Upper	0	0	0	0	0	0	0	0	0
MFP Eagle	0	0	0	0	0	0	0	0	0
MFP Fagan	0	0	0	0	0	0	0	0	0
MFP Fox Lower	0	0	0	0	0	0	0	0	0
MFP Fox Upper	0	0	0	0	0	0	0	0	0
MFP Joe	0	0	0	0	0	0	0	0	0
MFP John	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
MFP Ken	0	0	0	0	0	0	0	0	0
MFP Lightning	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
MFP Moose	0	0	0	0	0	0	0	0	0
MFP Perry	0	0	0	0	0	0	0	0	0
MFP Vital	0	0	0	0	0	0	0	0	0
MFP Wolf	0	0	0	0	0	0	0	0	0
FP 1	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 2	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 3	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 4	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 5	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 6	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 7	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 8	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 9	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 10	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 16	0	0	0	0	0	0	0	0	0
FP 22	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 23	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 33	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP MALEMUTE	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP NEIBUR	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
		1003		340		1972.00		663.00	3978

105 MM Howitzer: Alternative 2—All-Season Live-Fire Training at Eagle River Flats (ERF) Impact Area Only

Firing Points	105mm Inert Day	105mm Inert Day Rounded	105mm Inert Night	105mm Inert Night Rounded	105mm HE Day	105mm HE Day Rounded	105mm HE Night	105mm HE Night Rounded	TOTAL
MFP Cole Lower	0	0	0	0	0	0	0	0	0
MFP Cole Upper	0	0	0	0	0	0	0	0	0
MFP Eagle	0	0	0	0	0	0	0	0	0
MFP Fagan	0	0	0	0	0	0	0	0	0
MFP Fox Lower	0	0	0	0	0	0	0	0	0
MFP Fox Upper	0	0	0	0	0	0	0	0	0
MFP Joe	0	0	0	0	0	0	0	0	0
MFP John	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
MFP Ken	0	0	0	0	0	0	0	0	0
MFP Lightning	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
MFP Moose	0	0	0	0	0	0	0	0	0
MFP Perry	0	0	0	0	0	0	0	0	0
MFP Vital	0	0	0	0	0	0	0	0	0
MFP Wolf	0	0	0	0	0	0	0	0	0
FP 1	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 2	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 3	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 4	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 5	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 6	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 7	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 8	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 9	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 10	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 16	0	0	0	0	0	0	0	0	0
FP 22	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 23	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP 33	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP MALEMUTE	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
FP NEIBUR	58.85	59.00	19.62	20.00	115.24	116.00	38.41	39.00	234
		1003		340		1972		663	3978

155 MM HOWITZER

155 MM Howitzer: No Action Alternative

Firing Points	155mm Inert Day	155mm Inert Day Rounded	155mm Inert Night	155mm Inert Night Rounded	155mm HE Day	155mm HE Day Rounded	155mm HE Night	155mm HE Night Rounded	155mm Training Day	155mm Training Night	TOTAL
MFP Cole Lower	0	0	0	0	0	0	0	0	0	0	0
MFP Cole Upper	0	0	0	0	0	0	0	0	0	0	0
MFP Eagle	0	0	0	0	0	0	0	0	0	0	0
MFP Fagan	0	0	0	0	0	0	0	0	0	0	0
MFP Fox Lower	0	0	0	0	0	0	0	0	0	0	0
MFP Fox Upper	0	0	0	0	0	0	0	0	0	0	0
MFP Joe	0	0	0	0	0	0	0	0	0	0	0
MFP John	0	0	0	0	0	0	0	0	0	0	0
MFP Ken	0	0	0	0	0	0	0	0	0	0	0
MFP Lightning	0	0	0	0	0	0	0	0	0	0	0
MFP Moose	0	0	0	0	0	0	0	0	0	0	0
MFP Perry	0	0	0	0	0	0	0	0	0	0	0
MFP Vital	0	0	0	0	0	0	0	0	0	0	0
MFP Wolf	0	0	0	0	0	0	0	0	0	0	0
FP 1	0	0	0	0	0	0	0	0	0	0	0
FP 2	0	0	0	0	0	0	0	0	0	0	0
FP 3	0	0	0	0	0	0	0	0	0	0	0
FP 4	0	0	0	0	0	0	0	0	0	0	0
FP 5	0	0	0	0	0	0	0	0	0	0	0
FP 6	0	0	0	0	0	0	0	0	0	0	0
FP 7	0	0	0	0	0	0	0	0	0	0	0
FP 8	0	0	0	0	0	0	0	0	0	0	0
FP 9	0	0	0	0	0	0	0	0	0	0	0
FP 10	0	0	0	0	0	0	0	0	0	0	0
FP 16	0	0	0	0	0	0	0	0	0	0	0
FP 22	0	0	0	0	0	0	0	0	0	0	0
FP 23	0	0	0	0	0	0	0	0	0	0	0
FP 33	0	0	0	0	0	0	0	0	0	0	0
FP MALEMUTE	0	0	0	0	0	0	0	0	0	0	0
FP NEIBUR	0	0	0	0	0	0	0	0	0	0	0
											0

155 MM Howitzer: Alternative 1—All Season Live-Fire Training with Expanded Impact Area

Firing Points	155mm Inert Day	155mm Inert Day Rounded	155mm Inert Night	155mm Inert Night Rounded	155mm HE Day	155mm HE Night	155mm Training Day	155mm Training Night	TOTAL
MFP Cole Lower	0	0	0	0	0	0	0	0	0
MFP Cole Upper	0	0	0	0	0	0	0	0	0
MFP Eagle	0	0	0	0	0	0	0	0	0
MFP Fagan	0	0	0	0	0	0	0	0	0
MFP Fox Lower	0	0	0	0	0	0	0	0	0
MFP Fox Upper	0	0	0	0	0	0	0	0	0
MFP Joe	0	0	0	0	0	0	0	0	0
MFP John	0	0	0	0	0	0	0	0	0
MFP Ken	0	0	0	0	0	0	0	0	0
MFP Lightning	0	0	0	0	0	0	0	0	0
MFP Moose	0	0	0	0	0	0	0	0	0
MFP Perry	0	0	0	0	0	0	0	0	0
MFP Vital	0	0	0	0	0	0	0	0	0
MFP Wolf	0	0	0	0	0	0	0	0	0
FP 1	12.17	13.00	4.06	5.00	12.00	4.00	75.00	25.00	122
FP 2	0	0	0	0	0	0	0	0	0
FP 3	12.17	13.00	4.06	5.00	12.00	4.00	75.00	25.00	122
FP 4	12.17	13.00	4.06	5.00	12.00	4.00	75.00	25.00	122
FP 5	12.17	13.00	4.06	5.00	12.00	4.00	75.00	25.00	122
FP 6	12.17	13.00	4.06	5.00	12.00	4.00	75.00	25.00	122
FP 7	0	0	0	0	0	0	0	0	0
FP 8	0	0	0	0	0	0	0	0	0
FP 9	0	0	0	0	0	0	0	0	0
FP 10	12.17	13.00	4.06	5.00	12.00	4.00	75.00	25.00	122
FP 16	0	0	0	0	0	0	0	0	0
FP 22	12.17	13.00	4.06	5.00	12.00	4.00	75.00	25.00	122
FP 23	0	0	0	0	0	0	0	0	0
FP 33	0	0	0	0	0	0	0	0	0
FP MALEMUTE	12.17	13.00	4.06	5.00	12.00	4.00	75.00	25.00	122
FP NEIBUR	12.17	13.00	4.06	5.00	12.00	4.00	75.00	25.00	122
		117		45	108	36	675	225	1098

155 MM Howitzer: Alternative 2—All-Season Live-Fire Training at Eagle River Flats (ERF) Impact Area Only

Firing Points	155mm Inert Day	155mm Inert Day Rounded	155mm Inert Night	155mm Inert Night Rounded	155mm HE Day	155mm HE Night	155mm Training Day	155mm Training Night	TOTAL
MFP Cole Lower	0	0	0	0	0	0	0	0	0
MFP Cole Upper	0	0	0	0	0	0	0	0	0
MFP Eagle	0	0	0	0	0	0	0	0	0
MFP Fagan	0	0	0	0	0	0	0	0	0
MFP Fox Lower	0	0	0	0	0	0	0	0	0
MFP Fox Upper	0	0	0	0	0	0	0	0	0
MFP Joe	0	0	0	0	0	0	0	0	0
MFP John	0	0	0	0	0	0	0	0	0
MFP Ken	0	0	0	0	0	0	0	0	0
MFP Lightning	0	0	0	0	0	0	0	0	0
MFP Moose	0	0	0	0	0	0	0	0	0
MFP Perry	0	0	0	0	0	0	0	0	0
MFP Vital	0	0	0	0	0	0	0	0	0
MFP Wolf	0	0	0	0	0	0	0	0	0
FP 1	12.17	13.00	4.06	5.00	12.00	4.00	75.00	25.00	122
FP 2	0	0	0	0	0	0	0	0	0
FP 3	12.17	13.00	4.06	5.00	12.00	4.00	75.00	25.00	122
FP 4	12.17	13.00	4.06	5.00	12.00	4.00	75.00	25.00	122
FP 5	12.17	13.00	4.06	5.00	12.00	4.00	75.00	25.00	122
FP 6	12.17	13.00	4.06	5.00	12.00	4.00	75.00	25.00	122
FP 7	0	0	0	0	0	0	0	0	0
FP 8	0	0	0	0	0	0	0	0	0
FP 9	0	0	0	0	0	0	0	0	0
FP 10	12.17	13.00	4.06	5.00	12.00	4.00	75.00	25.00	122
FP 16	0	0	0	0	0	0	0	0	0
FP 22	12.17	13.00	4.06	5.00	12.00	4.00	75.00	25.00	122
FP 23	0	0	0	0	0	0	0	0	0
FP 33	0	0	0	0	0	0	0	0	0
FP MALEMUTE	12.17	13.00	4.06	5.00	12.00	4.00	75.00	25.00	122
FP NEIBUR	12.17	13.00	4.06	5.00	12.00	4.00	75.00	25.00	122
		117		45	108	36	675	225	1098

APPENDIX D–BIOLOGICAL ASSESSMENT

FINAL BIOLOGICAL ASSESSMENT
FOR THE
PROPOSED MORTAR AND ARTILLERY TRAINING AT RICHARDSON TRAINING AREA, JOINT BASE ELMENDORF-RICHARDSON, ALASKA

NOAA FISHERIES, ALASKA REGION
PROTECTED RESOURCES DIVISION
709 WEST 9TH STREET
JUNEAU, AK 99802

PREPARED BY:
JBER AND AECOM

FEBRUARY 2025

EXECUTIVE SUMMARY

Background

This Biological Assessment (BA) addresses potential effects of Proposed Mortar and Artillery Training at Joint Base Elmendorf-Richardson (JBER), Alaska, on species and critical habitat protected under the Endangered Species Act (ESA). Section 7 of the ESA requires federal agencies to consult with the National Marine Fisheries Service (NMFS) and United States (U.S.) Fish and Wildlife Service, as appropriate, regarding the effects of their actions on species protected under the ESA. The U.S. Air Force (Air Force) is the lead agency for the proposed project. The U.S. Army (Army) is the proponent and a cooperating agency, and NMFS is also a cooperating agency. The Air Force is concurrently preparing an Environmental Impact Statement for this project.

The Air Force proposes to remove existing winter firing restrictions to allow for all-season indirect live-fire mortar and artillery training in Eagle River Flats (ERF) Impact Area (ERF-IA), an existing 2,483-acre dedicated explosive munitions impact area on JBER that includes ERF, a large tidal salt marsh, associated upland buffer areas, Eagle River, and Otter Creek. This proposed action would also expand ERF-IA by approximately 585 acres into adjacent uplands.

The existing winter firing restrictions, which have been in place since 1991, limit use of ERF-IA to winter months when established ice thickness requirements are met. The winter training window varies annually and does not allow units stationed at JBER to conduct the full range of training tasks at JBER. The proposed action is necessary to allow the Army to conduct frequent live-fire weapons training exercises under realistic conditions and standards throughout the year to prepare Soldiers for combat operations.

Proposed Action

Indirect-fire training at ERF-IA currently involves mortars (60-millimeter [mm], 81-mm, and 120-mm) and artillery (105-mm). The proposed action would add use of 155-mm howitzers at ERF-IA. Types of rounds fired by these weapons systems include high-explosive (HE), Illumination, smoke, and training rounds. White phosphorus rounds, which were previously linked to waterfowl mortality, are no longer fired at ERF-IA.

Table ES-1 shows the maximum annual number of rounds that would be fired into ERF-IA under the Army's proposed action, compared to baseline conditions. "Other Rounds" refers to illumination, smoke, blank rounds, and training rounds that do not contain HE (all training rounds except 155-mm). HE rounds have a much greater potential to impact aquatic species because they generate higher noise levels, can release munition residues, and produce shrapnel when they detonate in the impact area. Although 155-mm training rounds would also detonate in the impact area, they contain a lower amount of HE and do not produce shrapnel.

Table ES-1 Total Annual Number of Rounds Allocated

Munitions Type	Baseline (Current Conditions)	Proposed Action
60-mm Mortar HE Rounds	518	1,036
60-mm Mortar Other Rounds	1,645	3,290
81-mm Mortar HE Rounds	296	592
81-mm Mortar Other Rounds	940	1,880

Munitions Type	Baseline (Current Conditions)	Proposed Action
120-mm Mortar HE Rounds	372	744
120-mm Mortar Other Rounds	1,296	2,592
105-mm Howitzer HE Rounds	1,306	2,612
105-mm Howitzer Other Rounds	714	1,334
155-mm Howitzer HE Rounds	N/A	144
155-mm Howitzer HE Training Rounds	N/A	900
155-mm Howitzer Other Rounds	N/A	146
Total Rounds	**7,087**	**15,270**

Key: HE = high-explosive; mm = millimeter.

Expanding ERF-IA into 585 acres of adjacent uplands would entail clear-cutting approximately 350 acres of vegetation and creating approximately 1.8 miles of gravel service roads and five vehicle gravel service pads inside the cleared area. The gravel service roads would be approximately 15 feet wide, and each service pad would be approximately 50 feet by 50 feet. A firebreak approximately 16 feet wide and 3 miles in length would be created along the boundary of the cleared area to contain wildland fires and prescribed burns. An approximately 230-acre vegetated buffer would remain to reduce potential sediment releases from clearing and construction into Clunie Creek and Eagle River.

As part of the proposed action, JBER and its contractors would comply with applicable laws, regulations, and policies, including those that are relevant to the protection and conservation of ESA-listed species. Additionally, protective measures developed specifically to protect the endangered Cook Inlet beluga whale (*Delphinapterus leucas*) and other marine mammals are incorporated into the action. These measures include, but are not limited to, revised protective buffers based on acoustic modeling, limited fire periods for HE rounds (no firing during inundating tide events and during the peak Cook Inlet beluga whale upriver visitation period), and redistribution of targets.

ESA-Listed Species and Critical Habitat in the Action Area

The action area encompasses ERF-IA (including the proposed expansion area) as well as the spatial extent where live-fire noise may affect ESA-listed marine mammals via airborne and underwater noise exposures. The extent of the underwater noise action area includes Eagle River and portions of Eagle Bay, while the extent of the larger airborne action area includes much of Knik Arm and portions of Turnagain Arm.

Four ESA-listed marine mammal species have the potential to be present in the action area, as summarized in Table ES-2. However, based on JBER's observational records, presence of humpback whales (*Megaptera novaeangliae*) from the Western North Pacific distinct population segment (DPS) and Mexico DPS in Eagle Bay is extremely rare; these species are not considered in the BA analysis.

Table ES-2 ESA-listed Species and Potential Occurrence in the Action Area

Common Name *Scientific Name* **DPS**	**ESA Status and Listing Document**	**Critical Habitat and Species Occurrence in Action Area**
Beluga Whale *Delphinapterus leucas* Cook Inlet DPS	Endangered 73 FR 62919	Critical habitat is designated in Eagle Bay but does not include ERF-IA and other military lands of Joint Base Elmendorf-Richardson between Mean Higher High Water and Mean High Water, two areas for which the military has provided an INRMP that NMFS has determined provides benefits to the Cook Inlet beluga whale (76 FR 20180). Occurs almost exclusively in Cook Inlet.[1] Heaviest use of Knik Arm in areas near JBER, including Eagle River and Eagle Bay, occurs from August through November, but the species may be present in the area year-round.[2] Sightings recorded in and near ERF-IA.
Humpback Whale *Megaptera novaeangliae* Western North Pacific DPS	Endangered 81 FR 62260	Critical habitat is not designated in the action area (86 FR 21082). Observed in Lower Cook Inlet, but occurrence in Knik Arm and action area is rare and unlikely. In September 2017, a male humpback whale (DPS undetermined) was observed floating dead in Eagle Bay.[3]
Humpback Whale *Megaptera novaeangliae* Mexico DPS	Threatened 81 FR 62260	Critical habitat is not designated in the action area (86 FR 21082). Observed in Lower Cook Inlet, but occurrence in Knik Arm and action area is rare and unlikely. In September 2017, a male humpback whale was observed floating dead in Eagle Bay.[3]
Steller Sea Lion *Eumetopias jubatus* Western DPS	Endangered 62 FR 24345	Critical habitat is not designated in the action area (59 FR 30715). Observed in Lower Cook Inlet, but occurrence in Knik Arm and the action area is rare and unlikely. During intermittent marine mammal monitoring at the POA, Steller sea lions were observed in 2009, 2016, and 2020.[4] Six sightings were made across 4 days between 29 May and 24 June 2020.[4] Within the airborne noise portion of the action area, this species is expected to be occasionally present in small numbers.

Key: ESA = Endangered Species Act; DPS = distinct population segment; ERF-IA = Eagle River Flats Impact Area; FR = Federal Register; INRMP = Integrated Natural Resource Management Plan; JBER = Joint Base Elmendorf-Richardson; POA = Port of Alaska.

Sources: [1]Muto, 2021; [2]JBER unpublished data, cited in JBER, *United States Air Force Integrated Natural Resources Management Plan (INRMP)*, prepared by 673d Civil Engineer Squadron Installation Management Flight Environmental Element, Joint Base Elmendorf-Richardson, Alaska, 2023; [3]National Marine Fisheries Service, *Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to the Relocation of the Port of Alaska's South Floating Dock, Anchorage, Alaska*. 86 FR 31870. June 15, 2021; [4]Goetz, K.T., K.E.W. Shelden, C.L. Sims, J.M. Waite, and P.R. Wade, *Abundance of Belugas (Delphinapterus leucas) in Cook Inlet, Alaska, June 2021 and June 2022*, AFSC Processed Report 2023-03, Seattle, WA: Alaska Fisheries Science Center, National Marine Fisheries Service, 2023.

Of the species listed in Table ES-2, only the Cook Inlet beluga whale has designated critical habitat that overlaps with portions of the action area. Designated critical habitat for Cook Inlet beluga whale includes two areas encompassing 7,800 square kilometers (3,013 square miles) of marine habitat. Critical habitat Area 1 encompasses Knik Arm, including Eagle Bay. Critical habitat for Cook Inlet beluga whale does not include ERF-IA and other military lands of JBER between Mean Higher High Water and Mean High Water, two areas for which the military has provided an Integrated Natural Resources Management Plan (INRMP) that NMFS has determined provides benefits to the Cook Inlet beluga whale (76 Federal Register 20180).

Cook Inlet beluga whale is the only ESA-listed species known to regularly occur in the underwater noise portion of the action area. Foraging near ERF-IA occurs in Eagle Bay, at the mouths of Eagle River and Garner Creek, and along Eagle River and portions of Otter Creek. Within the airborne noise portion of the action area, Steller sea lion (*Eumetopias jubatus*, Western DPS) are known to occasionally be present.

Potential Project Effects on ESA-Listed Species

In support of the analysis of impacts, acoustic modeling was conducted to determine potential noise exposures to marine mammals and fish at representative detonation sites, as well as sites at various distances from waterbodies, under inundated and non-inundated conditions. Results of the modeling, which predicted underwater and in-air noise from various scenarios of mortar and artillery firing at ERF-IA, were used to evaluate potential impacts to marine mammals and fish and to identify avoidance and minimization measures for the proposed action.

Potential impacts from the proposed action on ESA-listed species and their habitats include acoustic noise from live-firing events, and changes to water and sediment quality via introduction of munitions contaminants into ERF waterbodies and related bioaccumulation of contaminants in fish that are prey species for ESA-listed marine mammals. Regarding cumulative effects, there is very little potential for the proposed action to have cumulative contribution with non-federal past, present, and reasonably foreseeable future activities in the region, because projects operating in coastal waters almost always have a federal nexus.

The Action Agency (Air Force) analyzed whether conducting all-season indirect live-fire mortar and artillery training at ERF-IA may affect ESA-listed species. Proposed protective measures (prohibiting firing into open water areas, restricting firing during typical inundating tide events, and enhancing existing protective buffers) and proposed avoidance and minimization measures (placing targets so that Surface Danger Zones do not overlap with areas potentially supporting marine mammals, not firing 155-mm training rounds during typical inundating tide events) have been proposed. These conservation measures would substantially reduce underwater noise effects to marine mammals and the potential for injury or mortality of ESA-listed marine mammals would be unlikely.

Potential impacts on marine mammal habitat could include physical disturbance, sedimentation and erosion, munitions and fragment strikes of prey species, release of residues from munitions into waterbodies, exposure of contaminants to marine mammal prey species (fish), bioaccumulation of contaminants in prey, underwater noise impacts on prey, and a potential decrease in prey abundance. In contrast to noise impacts previously described for individual marine mammals, increased noise levels and associated training exercises may affect marine mammal habitat in terms of missed foraging opportunities and prey availability. While the magnitude and scale of effects cannot be quantified, it is anticipated that there would be some reduction in salmon escapement and productivity in Eagle River and Otter Creek due to the potential impacts listed above. However, it is anticipated that the scale of effects would be localized in extent to a portion of the run or watershed level and would not affect fish at the population-scale for Upper Cook Inlet.

Table ES-3 summarizes the recommended effects determination for ESA-listed species from the proposed action.

Table ES-3 Recommended Effects Determination for ESA-listed Species and Critical Habitats

Common Name ***Scientific Name*** **DPS**	**Effects Determination for Species**	**Effects Determination for Critical Habitat**
Beluga Whale *Delphinapterus leucas* Cook Inlet DPS	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Steller Sea Lion *Eumetopias jubatus* Western DPS	May affect, not likely to adversely affect	No effect; designated critical habitat does not occur in the action area

Key: ESA = Endangered Species Act; DPS = distinct population segment.

Measures Taken or Proposed to Minimize Effects

Based on an analysis of potential impacts to marine mammals from fragmentation of HE rounds and from modeling of the potential acoustic impacts of live-fire training, JBER has identified measures that will substantially reduce the potential effects of the proposed action.

In addition to conservation measures built into the proposed action and other existing conservation measures, the following avoidance and minimization measures would be implemented to reduce potential effects to individual ESA-listed marine mammals:

- The Army will ensure that for each weapon fired, the weapon system impact area does not overlap habitat protective buffers, Eagle Bay, Eagle River, or Otter Creek.
- The Army will ensure that Areas A, B, and C of the Surface Danger Zone do not overlap Eagle Bay, Eagle River, or Otter Creek (specifically, the waterways where a 130- or 500-meter buffer are applied; for mortars, this measure does not apply to the 50-meter buffer areas on Upper Eagle River, Upper Otter Creek, or Otter Creek Complex). In effect, this restriction treats areas that may contain marine mammals as if personnel were present. JBER will expand the protective measure that specifies limited fire periods for HE rounds to include 155-mm training rounds.

Additionally, the following avoidance and minimization measures have been identified to reduce impacts to designated critical habitat for Cook Inlet beluga whale by reducing impact to important prey species:

- The Army will continue to follow the most recent guidance and recommendations on using types of munitions that will minimize impacts to aquatic receptors to the maximum extent practicable. This involves coordination with other military firing ranges and research institutions (e.g., Strategic Environmental Research and Development Program and Cold Regions Research and Engineering Laboratory) that have been conducting studies on fate, transport, and toxicity of insensitive munitions and traditional explosives over the past several decades.
- JBER will consider opportunities to protect, enhance, and/or restore salmon habitat in the affected area, including within and outside the JBER installation boundary.
- As part of an Adaptive Monitoring and Management Plan, JBER will develop and implement appropriate efforts for comparative sampling and monitoring of hydrologic and biometric conditions in areas within and adjacent to the proposed project area. The practicability of these efforts is dependent on safe access to relevant areas, as much of ERF-IA is a dedicated impact area with unexploded ordnances (UXOs). Hydrologic monitoring may include water quality sampling as well as biometric sampling of fish tissue and characterization of invertebrate communities in relevant areas. Data will be used to monitor changes in the condition of essential fish habitat, with appropriate consideration to all other potential confounding factors in the environment. Adaptive management measures may be considered where metrics indicate action-related degradation to essential fish habitat.
- The Army will consider redirection of appropriate training and operational firing into the proposed expansion area, rather than areas where juvenile fish may be present and during the height of salmon runs (mid-June through August), as appropriate. The practicality of trajectory adjustments depends on the type of round necessary to train and the location of appropriate firing points relative to the expansion area. The Army intends to maximize use of the expansion area and will adjust use as appropriate to meet training requirements.
- JBER will consider the practicability of acoustic testing on the effects of managed fish species within the proposed project area. While there are several potential confounding factors that may influence the acoustic measurements in the proposed project area, pilot studies may be developed to evaluate the range of noise inputs within ERF-IA and within various channel morphologies (e.g., primary, tributary, relict). These sound verification experiments and studies may use live species to validate acoustic modeling used to analyze potential impacts to fish. Data may be used to monitor

changes in the condition of fish habitat, with appropriate consideration to all other potential confounding factors in the environment. Adaptive management measures may be considered where metrics indicate action-related degradation to fish habitat. The practicability of these efforts is dependent on safe access to relevant areas, as much of ERF-IA is a dedicated impact area with UXOs.

- JBER will continue to evaluate rearing and residency of juvenile salmon and/or other fish species using trap surveys and/or eDNA (or other methods as appropriate) to monitor productivity in and adjacent to the action area. The practicability of these studies is dependent on safe access to relevant areas within ERF-IA.
- JBER will continue fisheries harvest management, population studies, and habitat protection efforts at Sixmile Lake, Eagle River, and Otter Creek, among others, which are currently prescribed within the most recent JBER INRMP to ensure fish resources are effectively managed on JBER. These programs can be incorporated into an Adaptive Monitoring and Management Plan, which may be contained as an appendix within the INRMP (updated annually). Data will be used to monitor changes in the condition of fish habitat and with appropriate consideration to all other potential confounding factors in the environment. Adaptive management measures may be considered where metrics indicate action-related degradation to fish habitat.

The effectiveness of the proposed avoidance and minimization measures and other conservation measures (Section 2.4) would be monitored through implementation of a Marine Mammal Monitoring and Mitigation Plan, which will include a year-round marine mammal monitoring and mitigation program that includes the synthesis of visual and acoustic data collection techniques. This monitoring and mitigation plan will be submitted to and approved by NMFS prior to the implementation of the proposed action.

Determination

Our analysis, which utilized the best available scientific and commercial data, indicates that all potential effects of the proposed action (with mitigation measures) would be either insignificant or discountable. JBER has thus determined that the proposed project may affect but are not likely to adversely affect Cook Inlet beluga whales, Cook Inlet beluga whale designated critical habitat, or Steller sea lions.

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LIST OF ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
µPa	microPascal
ADF&G	Alaska Department of Fish and Game
ANILCA	Alaska National Interest Lands Conservation Act
AUD INJ	Auditory Injury
ATP	Army Techniques Publication
BA	Biological Assessment
BOF	Alaska Board of Fisheries
CALFEX	Combined Arms Live-Fire Exercise
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COMB	combined
CRREL	Cold Regions Research and Engineering Laboratory
DA Pam	Department of the Army Pamphlet
dB	decibel
DNAN	dinitroanisole
DPS	distinct population segment
DTE	distance to effect
EFH	essential fish habitat
EIS	Environmental Impact Statement
ERF	Eagle River Flats
ERF-IA	Eagle River Flats Impact Area
ESA	Endangered Species Act
FR	Federal Register
FRPC	Full Range Practice Cartridge
GI	gastrointestinal
GOA	Gulf of Alaska
HC	hexachloroethane
HFD	hazardous fragmentation distance
HE	high-explosive
HO	high-order
Hz	hertz
IBCT	Infantry Brigade Combat Team
IHA	Incidental Harassment Authorization
ILLUM	illumination
IM	insensitive munition
IMX	insensitive munitions explosive
INRMP	Integrated Natural Resources Management Plan
JASCO	JASCO Applied Sciences
JBER	Joint Base Elmendorf-Richardson
kg	kilogram
kHz	kilohertz
LO	low-order
LOA	Letter of Authorization
L_{pk}	peak sound pressure level
mg/L	milligrams per liter
MLLW	mean lower low water
mm	millimeter
MMO	(Military) Marine Mammal Observer

MMPA	Marine Mammal Protection Act
MTR	Marine Terminal Redevelopment
NES	North Extension Stabilization
NEW	net explosive weight
NMFS	National Marine Fisheries Service
NPFMC	North Pacific Fisheries Management Council
NQ	nitroguanidine
NTO	3-nitro-1,2,4-triazol-5-one
NTU	nephelometric turbidity unit
NVT	Native Village of Tyonek
OB/OD	Open Burn/Open Demolition
OP	Observation Point
PAH	polycyclic aromatic hydrocarbon
PAM	passive acoustic monitoring
PAX	Picatinny Arsenal Explosive
PBF	physical or biological feature
PCE	primary constituent element
PCT	Petroleum and Cement Terminal
PK	peak sound pressure level
PMART	proposed mortar and artillery training
POA	Port of Alaska
PTS	permanent threshold shift
RDX	cyclotrimethylenetrinitramine
re	referenced to
rms	root mean square
SAFE	Stock Assessment and Fishery Evaluation
SDZ	Surface Danger Zone
SEL	sound exposure level
SEL24h	24-hour cumulative sound exposure level
the Services	National Marine Fisheries Service and U.S. Fish and Wildlife Service
SPL	sound pressure level
TL	transmission loss
TNT	trinitrotoluene
TSS	total suspended solids
TTS	temporary threshold shift
USACE	U.S. Army Corps of Engineers
USARAK	U.S. Army Alaska
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service
UXO	unexploded ordnance
WP	white phosphorus

1.0 INTRODUCTION

This Biological Assessment (BA) addresses proposed mortar and artillery training (PMART) at the Richardson Training Area on Joint Base Elmendorf-Richardson (JBER), Alaska. This BA is being prepared pursuant to the Endangered Species Act (ESA) of 1973 (16 United States Code [U.S.C.] 1531 *et seq.*), as amended, which established a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat on which they depend. Section 7 of the ESA requires federal agencies to consult with the National Marine Fisheries Service (NMFS) and United States (U.S.) Fish and Wildlife Service (USFWS, collectively “the Services”), as appropriate, regarding the effects of their actions on species protected under the ESA. In the case of the PMART, only species under the jurisdiction of NMFS have potential to be present in the action area, and consultation with USFWS will not be needed.

The U.S. Air Force (Air Force) proposes to remove existing winter firing restrictions to allow for all-season, indirect, live-fire mortar and artillery training in the Eagle River Flats (ERF) portion of the Richardson Training Area. The U.S. Army’s (Army’s) proposed action would also expand ERF Impact Area (ERF-IA) by approximately 585 acres. The Army needs to conduct frequent live-fire weapons training exercises under realistic conditions and standards throughout the year to prepare Soldiers for combat operations. Management of JBER is the responsibility of the Air Force, and the Army retains operational responsibility for training areas and ranges. The Air Force is the lead agency for preparation of the BA. The Army is the proponent and cooperating agency for the BA. NMFS is also a cooperating agency for the BA.

The purpose of consultation with the Services is to ensure that the proposed action is not likely to jeopardize the continued existence of species listed as threatened, endangered, or proposed to be listed, or result in the destruction or adverse modification of designated or proposed critical habitat. This BA has been prepared to facilitate the consultation process and support National Environmental Policy Act compliance and future permitting efforts.

A separate essential fish habitat (EFH) has been prepared that evaluates potential effects on EFH as defined by the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), as amended by the Sustainable Fisheries Act of 1996 (16 U.S.C. 1801 *et seq.*).

On October 1, 2024 the USAF submitted a request for an incidental take authorization (ITA) under section 101(a)(5)(A) of the Marine Mammal Protection Act (MMPA) of 1972, as amended, for the take of marine mammals incidental to indirect live firing training at JBER.

On January 3, 2025, NMFS notified USAF that, based on the proposed mitigation and monitoring measures detailed in the ITA request and NMFS' analysis of potential take, NMFS has determined that the incidental take of marine mammals is not reasonably likely to occur because the specified activities would not harass (as defined for a “military readiness activity” under 16 U.S.C. § 1362(18)(B)) or result in the mortality of any marine mammal or marine mammal stock. Therefore, NMFS determined that an ITA under the MMPA is not necessary for the specified activities.

1.1 PROJECT LOCATION

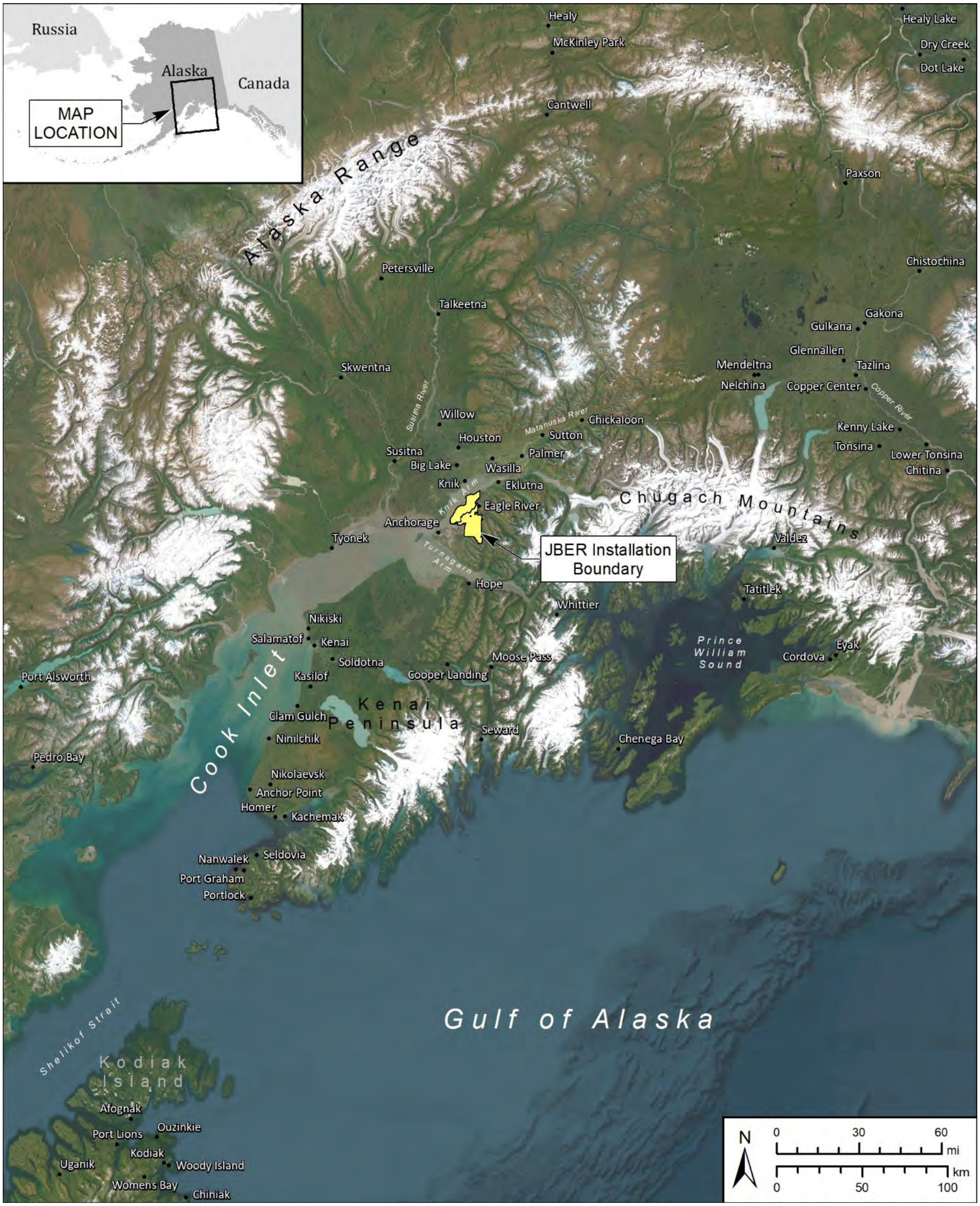
JBER is a 73,041-acre[1] military installation in southcentral Alaska, adjacent to Anchorage and the community of Eagle River (Figure 1-1 and Figure 1-2). Knik Arm borders JBER to the west and north for approximately 20 miles, Chugach State Park lies to the south and southeast, the community of Eagle River lies along the northeast border, and Anchorage forms the southwestern boundary. Knik Arm includes Eagle Bay, which lies outside the installation boundary. The proposed project area is in a portion of the Eagle

[1] Throughout this document, imperial (English) units of measure are generally used for areas, elevations, and some distances. Metric units are used for all other measurements. Where data from studies and/or scientific reports have been cited, the units used in those studies have been retained.

River watershed (5th field Hydrologic Unit Code [HUC] #1902080000) and the Lower Eagle River subwatershed (6th field HUC #190204010305), as well as the City of Anchorage–Frontal Cook Inlet (5th field HUC #1902040105) and Knik Arm–Frontal Cook Inlet (6th field HUC #190204010507). All of these drainages are in the Anchorage sub-basin (4th field HUC #19020401).

ERF-IA is an existing 2,483-acre dedicated explosive munitions impact area on JBER (Figure 1-2 and Figure 1-3). It encompasses approximately 2,092 acres of ERF, a large tidal salt marsh, as well as associated upland buffer areas, Eagle River, and Otter Creek. Throughout this BA, the term "ERF-IA" is used to denote the entire 2,483-acre explosive munitions impact area, while the term "ERF" is used to denote the overlapping 2,092-acre estuarine salt marsh area. ERF is surrounded on the northern and southern sides by steep bluffs vegetated with upland spruce and birch forest. The eastern side is lowland marsh with thick vegetation. Eagle River flows into ERF from the east, meanders through the middle of the impact area, and discharges into Eagle Bay. The outflow area of ERF and Eagle River along the coast of Eagle Bay is about 1.6 miles wide, and the width gradually narrows inland for approximately 2.6 miles upriver from the mouth.

Under the proposed action, ERF-IA would be expanded into 585 acres of adjacent land to the northeast (referred to as the "proposed expansion area" in this document) (Figure 1-3). The proposed expansion area is predominantly upland forested habitat, with limited wetlands and a minor waterbody (Clunie Creek) that supports a narrow riparian corridor. The portion of Clunie Creek in the proposed expansion area is an intermittent stream that drains Clunie Lake (shown on Figure 1-6) and other small ponds. Prior to reaching ERF, the creek becomes subterranean, reemerging at a small pond at the edge of ERF. Although Clunie Creek does not have a permanent surface water connection to Eagle River, it does effectively drain into the river via groundwater, subsurface flow, and overland sheet flow after the stream channel dissipates approximately 1.3 miles prior to reaching ERF (JBER 2023a). Clunie Creek has been found to support slimy sculpin (*Cottus cognatus*) but no salmonids or other fish species (Schoofs and Zonneville 2016).

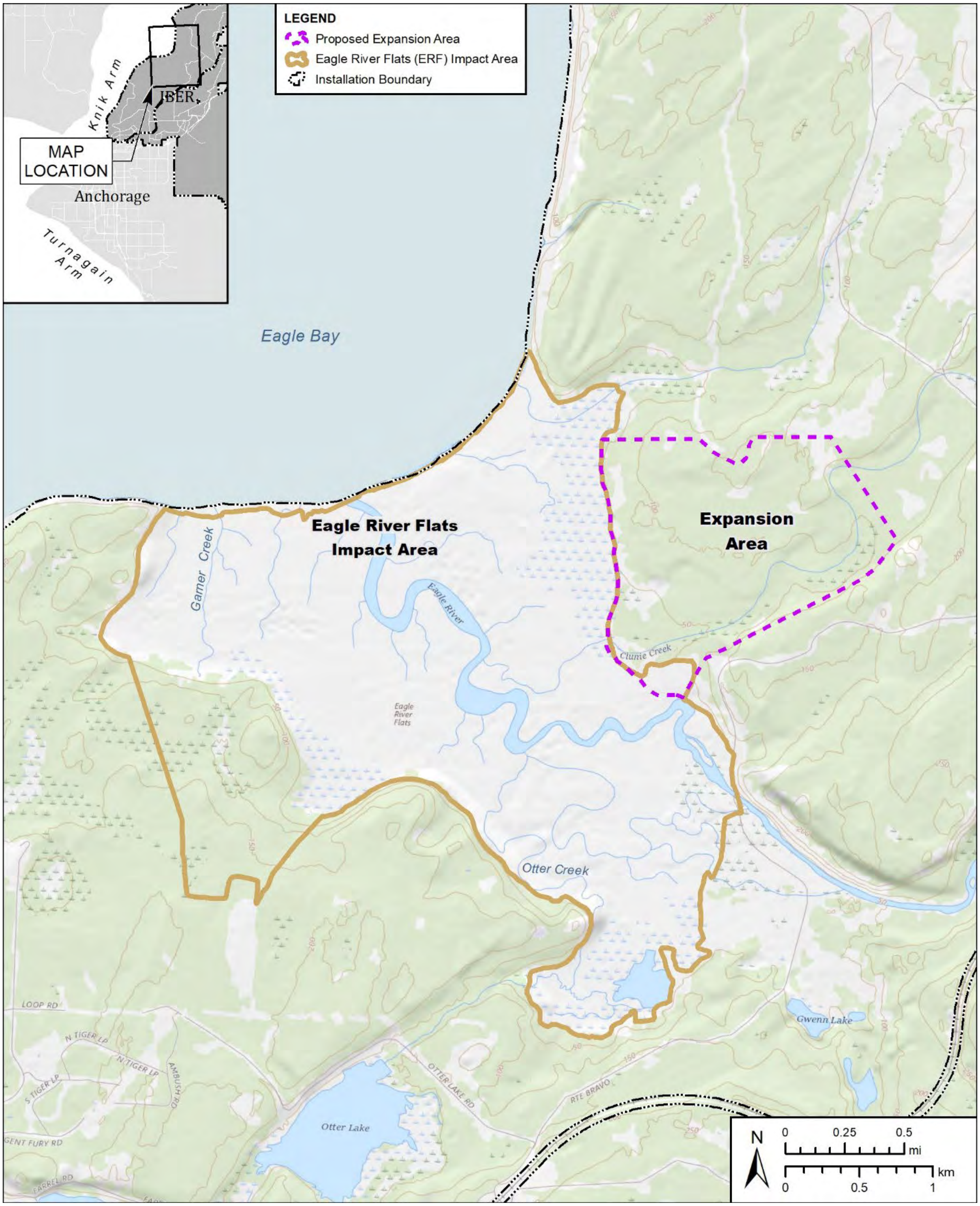


Source: JBER 2023b
Basemap: ADNR, Esri, and other contributors

Figure 1-1 JBER Project Location

Sources: ADNR 2018; ADOT & PF 2018; JBER 2019a, 2020a; 2023b, 2023c; MOA 2020
Basemap: ADNR, Esri, and other contributors

Figure 1-2 JBER Installation Boundary and Project Area



Sources: ADOT & PF 2018; JBER 2019a, 2019b, 2020, 2023c
Basemap: USGS The National Map

Figure 1-3 Proposed Project Area at Eagle River Flats, JBER, Alaska

1.2 ACTION AREA

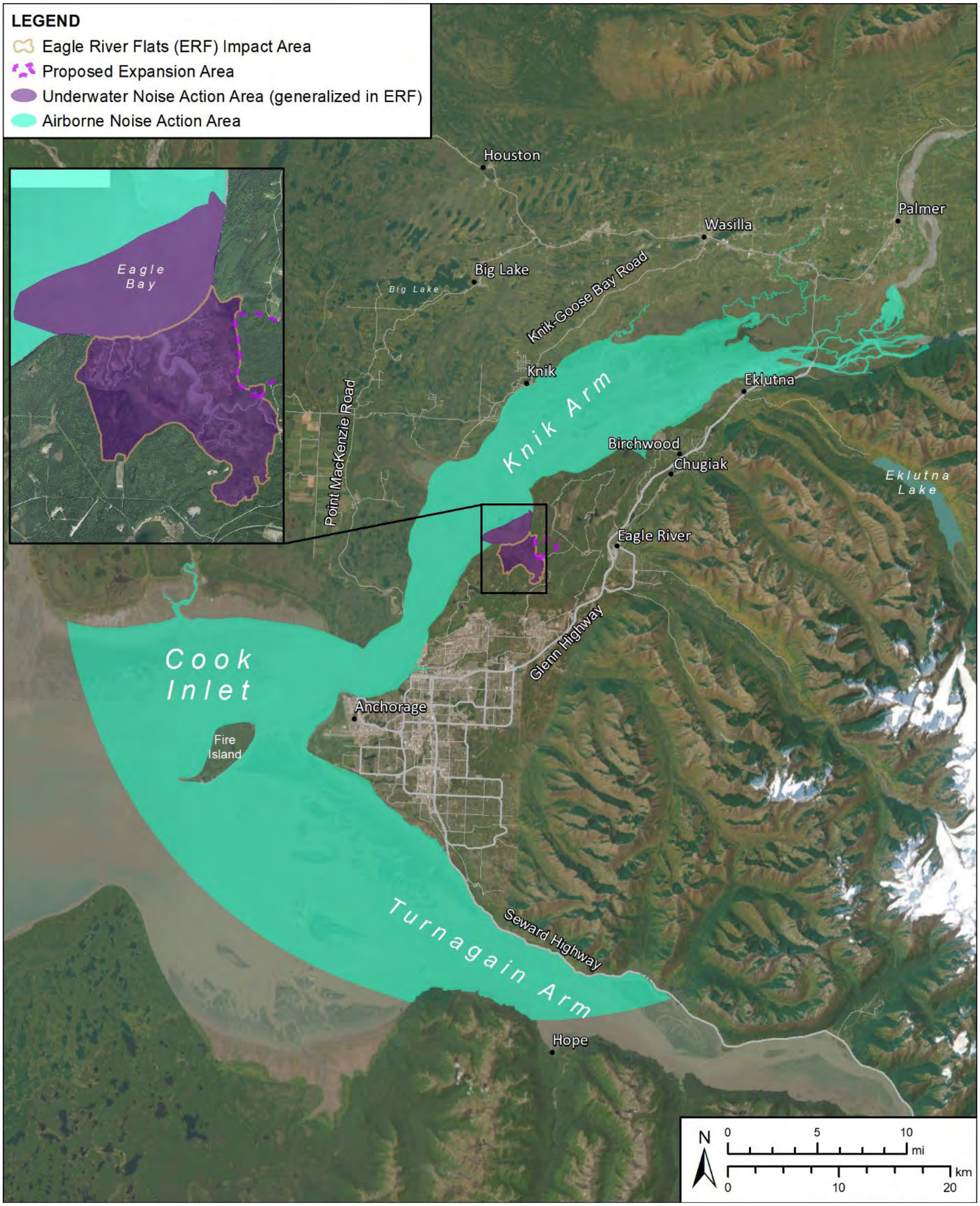
The action area includes all areas potentially affected directly or indirectly by the federal action (50 Code of Federal Regulations [CFR] 402.02). This area is the geographic extent of the potential physical, chemical, and biological effects (zones of impact) resulting from the project, including direct and indirect effects, and effects of interrelated and interdependent activities. This section briefly describes the geographical extent of potential impacts from the proposed action. Section 5.2 provides a more detailed description of how the outer bounds of the action area were determined based on the noise effects analysis (Figure 1-4).

The action area encompasses ERF-IA (including the proposed expansion area) as well as the spatial extent where live-fire noise may affect ESA-listed marine mammals via airborne and underwater noise exposures (Figure 1-4). The airborne portion of the action area is established by the modeled distance over which the in-air behavioral disturbance threshold for otariid pinnipeds (Steller sea lion [*Eumetopias jubatus*]) of 100 decibels (dB) referenced to (re) 20 microPascals (µPa) root mean square (rms) may be exceeded (Figure 1-4). The underwater noise portion of the action area is established by the modeled distance over which underwater noise from live-fire training would regularly exceed background noise levels in Eagle Bay and inundated portions of ERF-IA and thus could be audible to ESA-listed marine mammals if present. Eagle Bay and Eagle River receive limited vessel traffic and fishing activity but are proximal to heavy vessel traffic associated with the Port of Alaska (POA) in Anchorage and airplane traffic. A 2002 study of background underwater noise levels at the mouth of Eagle River found a mean value at 118 dB re 1 µPa (Blackwell and Greene 2002).

The underwater noise portion of the action area is limited to Eagle Bay and the tidally inundated portions of ERF-IA, which are located along Knik Arm (Figure 1-4). Knik Arm and its associated tidal systems are typified by high turbidity, extreme tidal variation, strong tidal currents, expansive mudflats exposed at low tides, and high winter ice scour. Knik Arm is approximately 31 miles long by 5 miles wide and is highly variable in depth, with a central trench in the southernmost part of the arm reaching depths of -160 feet mean lower low water (MLLW). This trench eventually splits into two shallower channels that follow both coasts around a large mudflat centered between Goose and Eagle Bays. ERF-IA is at latitude 61° 19.05’ north and longitude 149° 43.56’ west. Water depths in the action area are much shallower, with depths at typical high tide being 10 meters or less.

The airborne noise portion of the action area encompasses the area above the waters and shorelines of the entirety of Knik Arm, as well as portions of Upper Cook Inlet and Turnagain Arm (Figure 1-4). This includes areas where Steller sea lion may be exposed to airborne noise above NMFS established thresholds. While noise from live-fire below airborne noise thresholds may be audible to Steller sea lion, there are many discontinuous anthropogenic airborne noise sources around Cook Inlet, including but not limited to airplane traffic, marine vessels, and firearm discharges that pinnipeds in the area are likely habituated to. The extent of the airborne action area is based on the maximum extent of threshold exceedance based on the modeling described in Section 5.0. Due to terrain and changing atmospheric conditions, the actual extent of airborne noise above NMFS thresholds would likely be less than the full extent of the action area, as mapped in Figure 1-4.

Although designated critical habitat for Cook Inlet beluga whale (*Delphinapterus leucas*) does not include ERF (76 Federal Register [FR] 20180), several fish prey species known to spawn and rear in the Eagle River watershed comprise an essential component of their critical habitat. Because the proposed project could impact these prey species, a broader action area has been identified conceptually within Knik Arm and Upper Cook Inlet to include designated critical habitat areas outside of ERF-IA that are known to support fish species from ERF. This includes areas where juvenile salmonids may migrate after leaving ERF and could be consumed by beluga whale. While not shown on Figure 1-4, this conceptual broader action area is included because it is possible that project effects to fish from acoustic disturbance, munition contaminants, erosion/sedimentation, and direct strikes/fragmentation could affect beluga whale critical habitat outside of ERF-IA.



Sources: ADNR 2018; ADOT & PF 2018; JBER 2019a, 2020a, 2023b, 2023c; MOA 2020
Basemap: ADNR, Esri, Maxar, and other contributors

Figure 1-4 JBER Action Area of Analysis

1.3 PROJECT BACKGROUND AND CONSULTATION HISTORY

1.3.1 Past Military Training and Remediation at ERF-IA

The military has fired munitions into ERF-IA since the 1940s, and it is currently the only dedicated impact area at JBER. These munitions possibly included mortars, howitzers, missiles, rockets, grenades, illumination (ILLUM) flares, smoke rounds, and small arms (20-millimeter [mm] caliber and smaller) (CH2M Hill 1994). ERF-IA supported heavy all-season use until February 1990, when the Army implemented a temporary firing suspension due to a suspected correlation between munitions used during training at the impact area and a high rate of waterfowl mortality.

Prior to 1990, range records show that roughly 12,000 artillery and mortar rounds were fired into ERF-IA each year, which included about 9,000 high-explosive (HE) rounds and 440 white phosphorus (WP) rounds. Additionally, the Alaska Army National Guard has historically used ERF-IA to conduct required proficiency training. Historically, the most heavily used areas were in the center part of the impact area (along the northeast and southwest sides of Eagle River). Analyses of historical aerial imagery of ERF-IA show distinct impact craters in these heavily used target areas.

In 1994, JBER (formerly Fort Richardson) was placed on the U.S. Environmental Protection Agency's National Priorities List and designated as a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Superfund site. ERF was given the identifier "Operable Unit C," which includes ERF and an associated gravel pad where historic destruction of military ordnance was conducted (Open Burn/Open Demolition [OB/OD] pad). A comprehensive remedial investigation completed in 1996 concluded that the primary chemical of concern in the unit was WP and recommended that remedial action concentrate on hot ponds and be driven by waterfowl mortality (CH2M Hill 1997). The CERCLA Record of Decision in 1998 specified the process for remediating the WP contamination. The remedial action objectives were first met in 2006 and have been maintained since. Long-term monitoring continues as directed in the 1998 Record of Decision. The Army now prohibits WP from being fired into open waterbodies (rivers, streams, intertidal channels, gullies, lakes, ponds, or other areas that may contain water) or wetlands, as specified in Department of the Army Pamphlet (DA Pam) 385-63 (U.S. Army 2014). WP would not be fired into ERF-IA (including the proposed upland expansion area) as part of the proposed action.

In 2001, a notice of intent to sue was filed against the Army for activities in ERF-IA. This resulted in a settlement agreement in 2004. The Army fulfilled the requirements of the settlement agreement, which expired without protest in 2014. A timeline of actions pertaining to ERF-IA is presented in Figure 1-5.

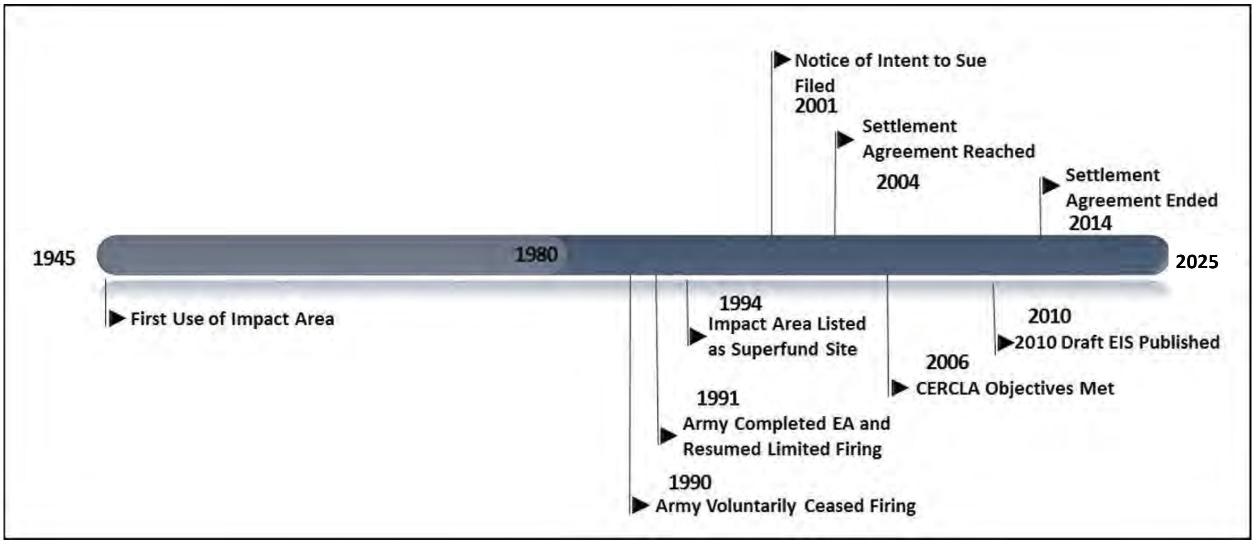


Figure 1-5 Historical Timeline for Eagle River Flats Impact Area

1.3.2 Consultation History

Cook Inlet beluga whales are present in Eagle Bay and Eagle River and may be influenced by live-fire weapons training at ERF-IA. In 2008, the Cook Inlet beluga whale was designated as an endangered species under the ESA. Critical habitat for the beluga whale was established in 2011. The designation under the ESA requires consultation for any actions that may impact the species. JBER is operating under a Letter of Concurrence from NMFS (#AKR-2016-9589) for winter live-fire training at JBER.

During the time from the seasonal firing suspension to the present, units stationed at JBER have not been able to conduct the full range of training tasks at JBER. Current restrictions limiting the use of ERF-IA to ice conditions during winter months were initiated by the Army to prevent WP in underlying sediments from being released into standing water. Because the temporal onset and duration of these specific ice conditions vary annually, it is difficult to precisely predict when and for how long firing into ERF-IA would be allowed each year. During warm winters, units may not be able to begin indirect-fire weapons training until late November and may be forced to stop training in early March, affording a short window of opportunity to conduct required training and qualification. Even with favorable conditions, the winter season is too short to fulfill quarterly and semi-annual standardized training and qualification requirements or to fulfill newly assigned Soldier training and qualification requirements. Based on the completion of CERCLA remediation and attainment of the CERCLA remedial action objectives, the Army decided to seek expansion of the capability to conduct mortar and artillery training.

In 2010, a draft BA was developed in support of a Draft Environmental Impact Statement (EIS) that proposed resuming all-season firing opportunities at JBER. In 2011, NMFS rendered a Biological Opinion. In 2015, a revised BA specifically for the Cook Inlet beluga whale was submitted to NMFS (JBER 2015); however, the EIS and BA were never finalized, primarily because of changes in the proposed action, identification of a new potential alternative, and reorganization of the installation. Based on these factors, a new EIS and BA are being prepared.

In March 2020, a Notification of Intent to Initiate Section 7 Consultation under the ESA for Proposed Mortar and Artillery Training at Richardson Training Area, JBER, Alaska, was sent to NMFS, informing the agency that a new EIS is being prepared that will analyze new alternatives to allow all-season live-fire training and that will incorporate new project and resource information. In April 2020, a pre-consultation meeting attended by representatives from NMFS and the JBER project team was conducted to introduce the project and project staff and provide project history, overview, and timeline. NMFS was invited to be a cooperating agency for the EIS on 16 July 2020 and agreed to be a cooperating agency on 22 July 2020.

Since April 2022, monthly meetings have been held with the Air Force, Army, and NMFS to coordinate on various aspects of the project, including the development of this BA. As a cooperating agency, NMFS has provided input on potential effects to protected species, conservation measures, and mitigation measures developed to protect marine mammals and their habitat, as presented in this document. NMFS also reviewed and provided input on the project ITA application submitted pursuant to the MMPA, ultimately determining that take of any marine mammal was not reasonably likely to occur given the analysis conducted by the AF.

On October 1, 2024 the USAF submitted a request for an incidental take authorization (ITA) under section 101(a)(5)(A) of the Marine Mammal Protection Act (MMPA) of 1972, as amended, for the take of marine mammals incidental to indirect live firing training at JBER.

On January 3, 2025, NMFS notified USAF that, based on the proposed mitigation and monitoring measures detailed in the ITA request and NMFS' analysis of potential take, NMFS has determined that the incidental take of marine mammals is not reasonably likely to occur because the specified activities would not harass (as defined for a “military readiness activity” under 16 U.S.C. § 1362(18)(B)) or result in the mortality of any marine mammal or marine mammal stock. Therefore, NMFS determined that an ITA under the MMPA is not necessary for the specified activities.

1.4 ARMY TRAINING OBJECTIVES AND TRAINING STANDARDS

1.4.1 Army Training Objectives

JBER currently supports Alaskan Command, 11th Air Force, 11th Airborne Division (U.S. Army) and more than 90 supported and tenant organizations. 11th Airborne Division is the proponent of the proposed project. Based on training doctrine, 11th Airborne Division has formulated the following objectives to meet the intent of the Army Training Standards:

- Optimize the ability to train units to a proficiency level in accordance with Army standards, including use of a full array of indirect-fire (the impacts of rounds are not seen from the firing location [e.g., mortars and artillery]) and direct-fire (the impacts of rounds are observed from the firing location [e.g., small arms/machine guns]) weapons and munitions at home station.
- Optimize opportunities for live-fire weapons training at JBER to ensure soldiers achieve and maintain individual and crew proficiency, qualify newly assigned soldiers throughout the year, train prior to deployments, and continually qualify weapons system crews in accordance with the Army training model requiring repetitive training.
- Ensure long-term, realistic training at JBER that will provide soldiers opportunities to practice their skills in combat-like conditions in accordance with the Army Integrated Weapons Training Strategy (TC-3-20-0), Army Doctrine Publication 7-0, and other applicable regulations and doctrine.
- Improve soldier quality of life and family stability by minimizing the need for travel to other installations for small unit training (company/battery/troop and below).
- Minimize overall training costs and lost time as a result of repetitive travel to other installations.
- Avoid land use conflicts.

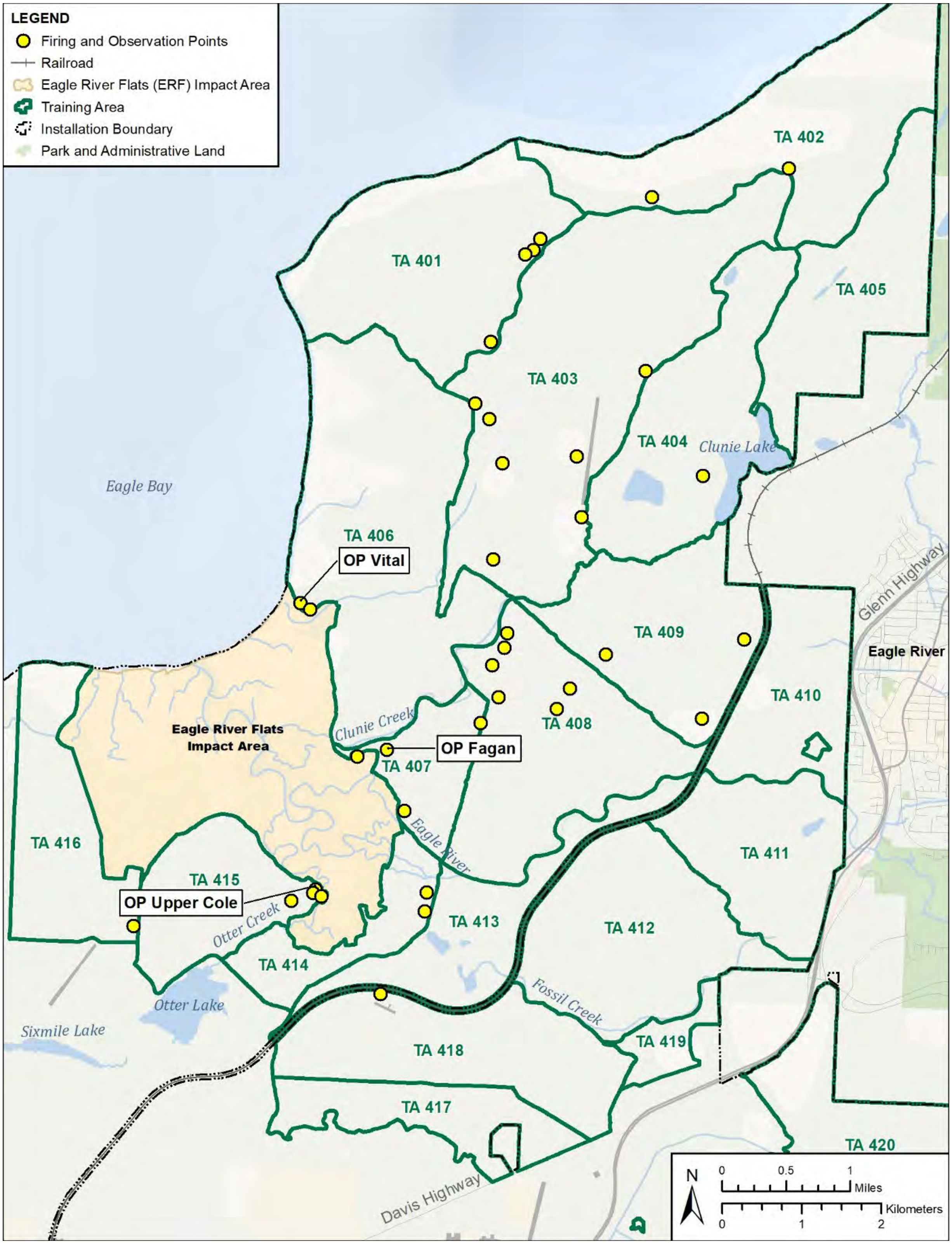
1.4.2 Army Training Standards

Live-fire artillery/mortar training is required at all levels (section, platoon, company, and battalion) on a recurring basis, and live-fire training and qualification is a key component of the Army Integrated Weapons Training Strategy DA Pam 350-38 (U.S. Army 2018) provides standardized training strategies for weapons training, identifies the amount of ammunition required to execute standardized training, and specifies the required frequency of repetitive training (i.e., quarterly, semi-annually, annually, and as required). The required intervals vary by unit based on the last time the unit, as a whole, qualified for the specific requirement. The qualifications cycle starts over if a Soldier who has not met the qualifications joins the unit.

Training standards for the 2nd Infantry Brigade Combat Team (IBCT), 11th Airborne Division include proficiency training using the following major weapon systems: 60-mm mortar, 81-mm mortar, 120-mm mortar, 105-mm howitzer, and 155-mm howitzer.

Figure 1-6 provides a visualization of the established training infrastructure at JBER that supports indirect live fire. Though firing points are identified, it should be noted that depending on the mission objective, a unit may use any open area for indirect live fire.

Under U.S. Army Forces Command regulation, units participating in a Combat Training Center rotation must complete all prerequisites at home station prior to the start of the rotation, which includes the participation of artillery crews, mortar crews, and infantry Soldiers in a company Combined Arms Live-Fire Exercise (CALFEX). Under the current seasonal restrictions, units stationed at JBER must travel to Fort Wainwright to conduct indirect live-fire qualification and training whenever ice cover requirements are not met at ERF-IA. Removing seasonal restrictions would allow live-fire training (including CALFEX) to occur at JBER at the required frequency to allow Soldiers to maintain critical combat skills.



Sources: ADOT & PF 2018; JBER 2020, 2023b; MOA 2019
Basemap: Esri, Garmin, and other contributors

Figure 1-6 Indirect Live-Fire Training Infrastructure at JBER

2.0 DESCRIPTION OF THE PROPOSED ACTION

The proposed action consists of modifying training conditions in which indirect live-fire weapons qualification, certification, and training can be conducted to meet Army training objectives and reinstating all-season live fire to meet Army regulatory and doctrinal standards. The action focuses on live-fire mortar and artillery training, which requires a dedicated impact area to contain explosive munitions, fragments, and debris. Current live-fire restrictions limit training on JBER's only dedicated impact area, with the result that units stationed at JBER must travel in excess of 700 miles (to Fort Wainwright) to train and qualify individual Soldiers and weapon system crews. Reinstating all-season live-fire training would enhance small-unit and live-fire training opportunities, avoid land use conflicts, and allow units stationed at JBER to attain mandatory Army qualification, certification, and training standards in an efficient manner. Additionally, it would provide a long-term local training solution, provide Soldiers a more stable family environment, and limit costly and time-consuming movement of equipment and personnel to and from Fort Wainwright.

The proposed action removes winter firing restrictions and reinstates all-season indirect live-fire training and qualification at ERF-IA. The action also modifies habitat protective buffers and implements additional protective measures to reduce underwater noise impacts (Section 2.4.4). ERF-IA would be expanded (into an upland area) by approximately 585 acres. With the ability to train during all seasons and the expanded impact area, the number of rounds that would be fired into ERF annually would increase from current annual levels. Additionally, 155-mm rounds would be added to the list of weapons available for use in ERF-IA. Currently, 155-mm rounds are not fired into ERF-IA.

If the proposed action is implemented, the Army intends to allow units to begin all-season firing in the existing ERF-IA as soon as practicable following the decision. The Army anticipates at least one to two construction seasons before the expansion area is ready for use.

2.1 WEAPON SYSTEMS AND MUNITIONS

Units stationed at JBER must train on direct-fire (e.g., small arms/machine guns) and indirect-fire (e.g., mortars and artillery) weapon systems. The proposed project would not modify current use of direct-fire weapon systems at JBER. Indirect-fire weapon systems currently at JBER are listed in Table 2-1. The proposed project would reinstate indirect-fire weapon systems use of ERF-IA during all four seasons, and 155-mm howitzers, which currently travel to Fort Wainwright to fire, would be incorporated into home station training and qualification on JBER.

Table 2-1 Assigned Indirect Weapon Systems and Frequency of Training

Weapon System	Number of Weapon Systems Assigned at JBER	Frequency of Qualification and Live-Fire Training
60-mm Mortar	14	Quarterly
81-mm Mortar	8	Quarterly
120-mm Mortar	12	Quarterly
105-mm Howitzer	12	Semi-annually
155-mm Howitzer	6	Semi-annually

Key: JBER = Joint Base Elmendorf-Richardson; mm = millimeter.

Mortar and howitzer ammunition incorporates a variety of fuze types. With the exception of delay fuzes, all of the following could be used at ERF-IA under the proposed action as training requirements dictate:

- Point-detonating, impact, or super quick fuzes, which detonate the cartridge on impact with the ground
- Near-surface burst fuzes, which explode on or near the ground
- Proximity (mechanical or variable time) fuzes, which explode above the ground
  - Mechanical time fuzes, which explode after a preselected time has elapsed from the round being fired
  - Variable time fuzes, which explode at a predetermined height and are not based on time
- Delay fuzes, which explode 0.05 second after impact
- Multi-option fuzes, which combine two or more of the other modes into one fuze

The cartridge, or projectile body of the round, may contain HE, ILLUM, smoke, or inert[2] materials. The function of each is described below. All of these types of materials could be used under the proposed action.

- HE is used against enemy combatants and light-materiel targets. An explosive, when reacted, produces a sudden expansion of the material, usually accompanied by the production of heat and large changes in pressure. This rapid expansion and change in pressure produce noise and fractures the metal casing, resulting in shrapnel.
- ILLUM is used in missions requiring illumination for assistance in observation or as a spotting or marking round. ILLUM rounds are classified as non-explosive pyrotechnic rounds and contain chemical compounds (typically magnesium and sodium nitrate) that produce heat, light, smoke, and/or sound. None of the ILLUM rounds for the mortar systems or artillery used by units stationed at JBER contain phosphorus.
- Smoke is used as a screening, signaling, spotting, marking, casualty-producing, or incendiary agent. Smoke rounds are also pyrotechnic rounds. Three types of smoke-producing agents are used in Army mortar and howitzer munitions: WP, red phosphorus, and hexachloroethane (HC). Rounds including WP or red phosphorus as the primary constituent are prohibited from use in wetlands or other waterbodies per Army regulation (USARAK 2020; U.S. Army 2014). Neither are used currently in ERF-IA, and neither will be used in the future at ERF-IA (including in upland areas). Thus, only HC smoke munitions are currently specified for use at ERF-IA.
- Full Range Practice Cartridge (FRPCs; for mortars only) are generally inert. FRPCs are essentially the same as their HE counterparts except that they contain an inert filler material such as gypsum or plaster of Paris. Each round is fitted with a point-detonating practice fuze that simulates the multi-option fuze and provides a flash, bang, and smoke that is channeled through exhaust holes in the rear of the round and does not produce shrapnel. The pyrotechnic charge within FRPCs typically contains 12 to 16 grams of an aluminum and potassium perchlorate mixture, a mixture which is commonly used in consumer and commercial fireworks. Approximately 4 to 6 grams of the mixture is explosive (potassium perchlorate).
- The primary training round[3] for the 155-mm howitzer weapon system consists of a metal projectile casing filled mostly with high-density concrete. A small charge of HE (1.3 kilograms [kg]) is positioned in the nose of the round just beneath the fuze. The fuze is made up of metals or metal alloys and contains a pyrotechnic charge used to detonate the HE filler.

The term “munitions constituent” refers to any material originating from unexploded ordnance (UXO), discarded military munitions, or other military munitions; this includes explosive and non-explosive materials and emission, degradation, or breakdown elements of such ordnance or munitions (10 U.S.C. 2710[e][3]). The primary components (about 97 percent by weight) of mortar and howitzer munitions are

[2] Note that inert rounds may contain a negligible amount of HE.
[3] The term “training rounds” refers to rounds used during training that are similar to their HE counterparts but with no or much reduced HE. Depending on the caliber of the weapon and the manufacturer of the round, these can also be called “practice rounds.” “Training rounds” is used for both in this report.

explosives, iron (in the form of steel), copper, and aluminum. The projectile body is the only part of the round that lands in the impact area and is most often made of steel or iron. Many of the rounds have copper alloy rotating bands, and the fuzes and fins are typically made of aluminum. The remaining components (2 to 3 percent) consist of trace amounts of numerous other compounds that can include metals (e.g., zinc, manganese, nickel, chromium, and cadmium), waxes, silicon, and pyrotechnics.

2.1.1 Total Live-Fire Ammunition Use for Mortars and Howitzers

Tables 2-2 and 2-3 collectively list the maximum number of mortar and artillery (howitzer) rounds (all indirect-fire weapon systems) that could be fired annually (by fiscal year) at ERF-IA by the IBCT currently stationed at JBER (excluding WP, which could only be fired at other installations). These numbers are based on the allocation specified in the 2018 version of DA Pam 350-38 (U.S. Army 2018). While the number of rounds allotted varies annually, the number fired at ERF-IA in a given year would not exceed the numbers shown in Tables 1-2 and 1-3. Note that while the standard Army allotment includes WP smoke rounds that may be fired at other installations, these rounds are listed as zero in the tables because they would not be used at ERF-IA. Larger unit exercises, which are included in these numbers, are likely to be conducted at other installations, which would decrease the total number of rounds expended at ERF-IA. Similarly, some smaller unit exercises may still be conducted at other installations, depending on training objectives and scenarios. The total number of rounds expended would also be reduced when units are called upon to deploy for overseas contingencies.

Table 2-2 Mortar Standard Training Munitions as Allotted Annually (Fiscal Year) by DA Pam 350-38

Weapon System	HE	SMOKE	ILLUM	FRPC
60-mm (2.4-inch) Mortar Rounds	1,036	0	490	2,800
81-mm (3.2-inch) Mortar Rounds	592	0	280	1,600
120-mm (4.7-inch) Mortar Rounds	744	0	360	2,232
TOTAL ANNUAL MORTAR ROUNDS	**2,372**	**0**	**1,130**	**6,632**

Key: DA Pam = Department of the Army Pamphlet; FRPC = Full Range Practice Cartridge; HE = high-explosive; ILLUM = illumination; mm = millimeter.

Table 2-3 Howitzer Standard Training Munitions as Allotted Annually (Fiscal Year) by DA Pam 350-38

Howitzer Type	HE	SMOKE[1]	ILLUM	BLANK	Training[2]
105-mm Howitzer	2,612	144	282	908	0
155-mm Howitzer	144	62	84	0	900
Total Annual Rounds	**2,756**	**206**	**366**	**908**	**900**

Notes:
[1] Howitzer smoke rounds approved for use on JBER are non-phosphorus rounds that contain HC.
[2] For 155-mm howitzers, these are training rounds that contain a small amount (2.8 pounds) of HE material.

Key: DA Pam = Department of the Army Pamphlet; HC = hexachloroethane; HE = high-explosive; ILLUM = illumination; JBER = Joint Base Elmendorf-Richardson; mm = millimeter.

Although rocket-assisted projectile rounds are also allocated by DA Pam 350-38, they are not used at JBER and are not included in these tables. Blank rounds are training rounds without actual projectiles that are used during non-firing exercises to simulate the noise and effect of live fire and do not require the use of a dedicated impact area. FRPCs have been developed for the 105-mm howitzer; however, they have never been funded for production and thus are not included in this action. As discussed in Section 2.1, 155-mm training rounds contain a small charge of HE (1.3 kg) that detonates in the impact area.

Although the number of training days varies annually, the total average number of indirect-fire training days scheduled by all units stationed at JBER is 134 days, at ranges on either JBER or Fort Wainwright. Although some training is likely to occur at Fort Wainwright, the analysis in this BA conservatively assumes that all firing would occur at ERF-IA. The number of rounds fired per hour or day is highly variable depending on the unit, the qualification table, the training objectives, and the current conditions. The total number of rounds per training session and the length of each training session would also vary, but weapons firing during training would be intermittent, with the number of rounds fired on a given day varying by whether units are qualifying or conducting a company CALFEX. As an example, the number of HE rounds fired in a day could range from 26 rounds fired over a period of 6 to 10 hours to 324 rounds fired over a period of 6 to 12 hours, with the high end of this range only occurring if the artillery battalion were to qualify every howitzer crew on the same day, which is unlikely. Other types of rounds could also be fired during these periods, although training rounds would not be fired for qualification. However, numerous representative firing combinations were developed for the detailed acoustic studies referenced in Section 5.0 of this BA.

2.1.2 Other Operational Assets

The following sections describe other operational assets required for Soldiers to conduct indirect live-fire training and fulfill their training requirements. Many of these features are shown in Figure 1-6.

2.1.2.1 Firing Points and Observation Points

Firing points are designated areas from which weapon systems fire munitions into an impact area. Indirect-fire weapons are fired from points that are not in the line-of-sight of targets in the impact area. Mortar firing points tend to be closer to the impact area than howitzer firing points, as the howitzer is a long-range indirect-fire weapon that can be fired from greater distances. In general, howitzers would be fired from locations at least 2.5 to 3.1 miles from the target area (which is in the impact area).

As specified in Army Techniques Publication (ATP) 3-09.42, a forward observer is an observer operating with front line troops and trained to adjust ground or naval gunfire and pass back battlefield information. Platoon forward observers are assigned to the fire support team supporting each infantry company or cavalry troop in the Brigade Combat Team, and to the battlefield surveillance brigade. During live-fire training, observation points are located in close proximity to impact areas to allow a forward observer to see and direct artillery and mortar fire onto a target (defined in Section 2.1.2.2). At ERF-IA, forward observers are located at one of the observation points that surround ERF (Figure 1-6). Primary forward observer locations are Observation Point (OP) Upper Cole, OP Fagan, and OP Vital.

When units fire at night, forward observers identify and observe targets either through visible light illumination or infrared illumination. For visible light, units fire visible light ILLUM rounds just prior to firing HE rounds, which allows the forward observers to observe targets relative to where rounds are impacting. Alternatively, forward observers can also use night vision equipment to see in the dark; infrared ILLUM rounds are often used to enhance night vision capability and target observation. In both scenarios, units would continually intermix ILLUM rounds with the HE until the training is complete. Based on sunrise/sunset and civil twilight, night firing could realistically occur from mid-August through mid-April. For the few nights each month when tide tables predict inundating tides, units will fire only at targets that are outside the areas that are routinely inundated (upland areas on the east or west side of Eagle River). Additionally, advanced target designation systems allow adjustments to be made after each round fired to improve the accuracy of subsequent rounds fired by the weapon in hitting targets.

2.1.2.2 Impact Areas, Target Areas, Surface Danger Zones

Indirect-fire weapons are fired into a selected impact area. An impact area is a designated site used for training with live munitions. An explosive munitions impact area is a site used for training with live-fire munitions (e.g., mortars or howitzers) that could result in UXO. UXO is a term for munitions that do not explode as designed when employed and therefore pose a risk of future detonation.

ATP 3-09.42 defines a “target” as an entity or object that performs a function for the adversary considered for possible engagement or other action (Department of the Army 2016). Targets may be static or moving and may either occur as a single point/object or as an array. Within ERF-IA, an example of a target array is six vehicles grouped together in a line just west of OP Fagan; any one of those vehicles would represent a point target.

A target area is the zone inside an impact area into which a weapon is fired. In DA Pam 385-63, Range Safety (U.S. Army 2014), a target area is defined as the point or location within a Surface Danger Zone (SDZ, defined later in this section) where targets (static/moving, point/array) are emplaced for weapon system engagement. For demolitions, it is the point or location where explosive charges are emplaced. Target areas in ERF-IA are limited by environmental restrictions set forth in U.S. Army Alaska (USARAK) Regulation 350-2 (USARAK 2020).

Additionally, each installation may designate exclusion zones inside its impact areas, in which the placement of targets is prohibited, in order to avoid damage to specific areas or to ensure that the impact area adequately contains the effects of live-fire training.

An SDZ is defined as the ground and airspace designated in the training complex (to include associated safety areas) for vertical and lateral containment of projectiles, fragments, debris, and components resulting from the firing of weapons systems. SDZs are munitions and weapons systems specific, are developed to ensure personnel safety during training exercises, and are calculated to contain effects of the given munitions. The probability of hazardous fragments leaving the SDZ may not exceed 1:1,000,000. The SDZ essentially delineates a safety boundary that surrounds the firing point, the target area, and all points in between. DA Pam 385-63 provides a standard methodology to construct SDZs (U.S. Army 2014).

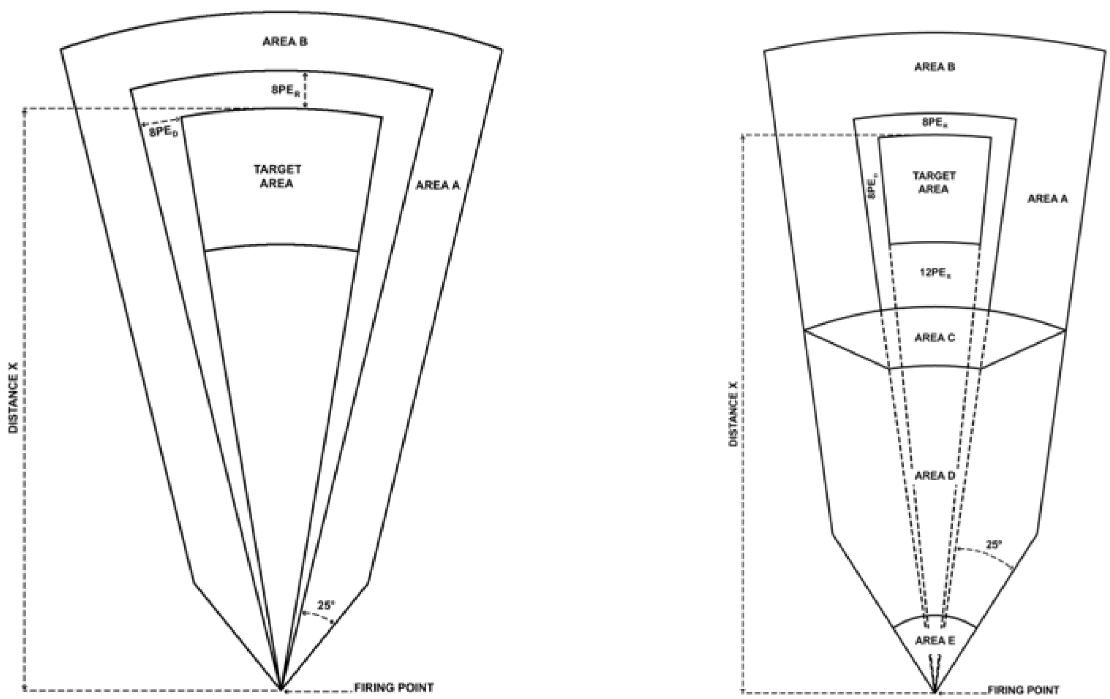


Figure 2-1 illustrates an SDZ for indirect artillery fire; similar diagrams exist for mortars and other weapon systems. The boundaries of the SDZ cannot extend past the installation boundaries per Army regulation (U.S. Army 2014). Personnel, including forward observers, are not allowed to enter an SDZ during training exercises, except under special circumstances, as described in the Army’s Range Safety regulations (U.S. Army 2014).

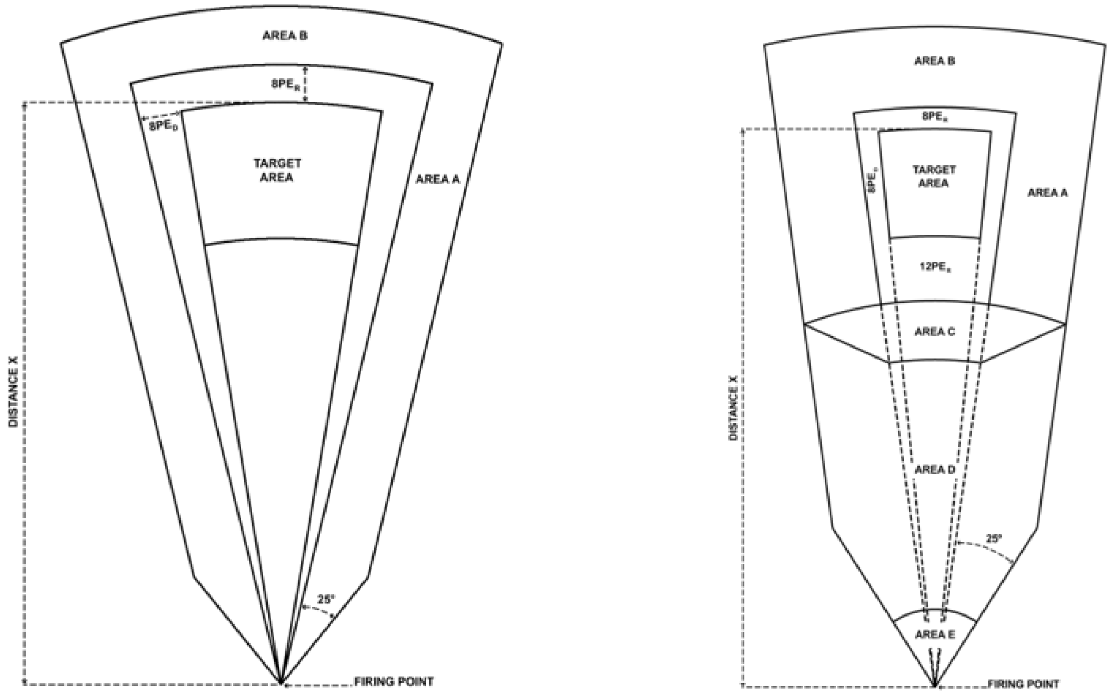


Figure 2-1 Surface Danger Zone for Indirect Mortar (Left) and Artillery (Right) Fire

Note: PE = probable error in range or deflection
Source: U.S. Army 2014

An SDZ consists of several areas, the dimensions of which are specific to each weapons system and munitions type.

- The **target area** is the point or location in the SDZ in which targets are placed for weapon system engagement (U.S. Army 2014). In Figure 2-1, the target area is shown as a box.
- The **weapon system impact area** is defined in USARAK 350-2 (for indirect fire) as including “the probable error for range and deflection” (8PE and 12PE in Figure 2-1). It consists of the target area plus an additional containment zone, designed to contain fired or launched ammunition and explosives. The weapon system impact area is constructed such that there is a 1 in 1,000,000 probability that a round would land outside of this containment zone under standard firing procedures. Firing procedures are established in regulations, field manuals, and training circulars; adherence is required. Failure to adhere would result in a formal investigation.
- **Areas A and B** are the secondary danger areas (buffer zones) that laterally parallel the impact area or ricochet area (depending on the weapon system) and contain fragments, debris, and components from frangible or explosive projectiles and warheads functioning on the right or left edge of the impact area or ricochet area.
- **Area C** (artillery only) is the secondary danger area (buffer zone) on the up-range side of the impact area and parallel to Area B, which contains fragments, debris, and components from frangible or exploding projectiles and warheads functioning on the near edge of the impact area.
- **Area D** (artillery only) is the safe area in which personnel are allowed, provided that ammunition certified for overhead fire is used during the exercise.

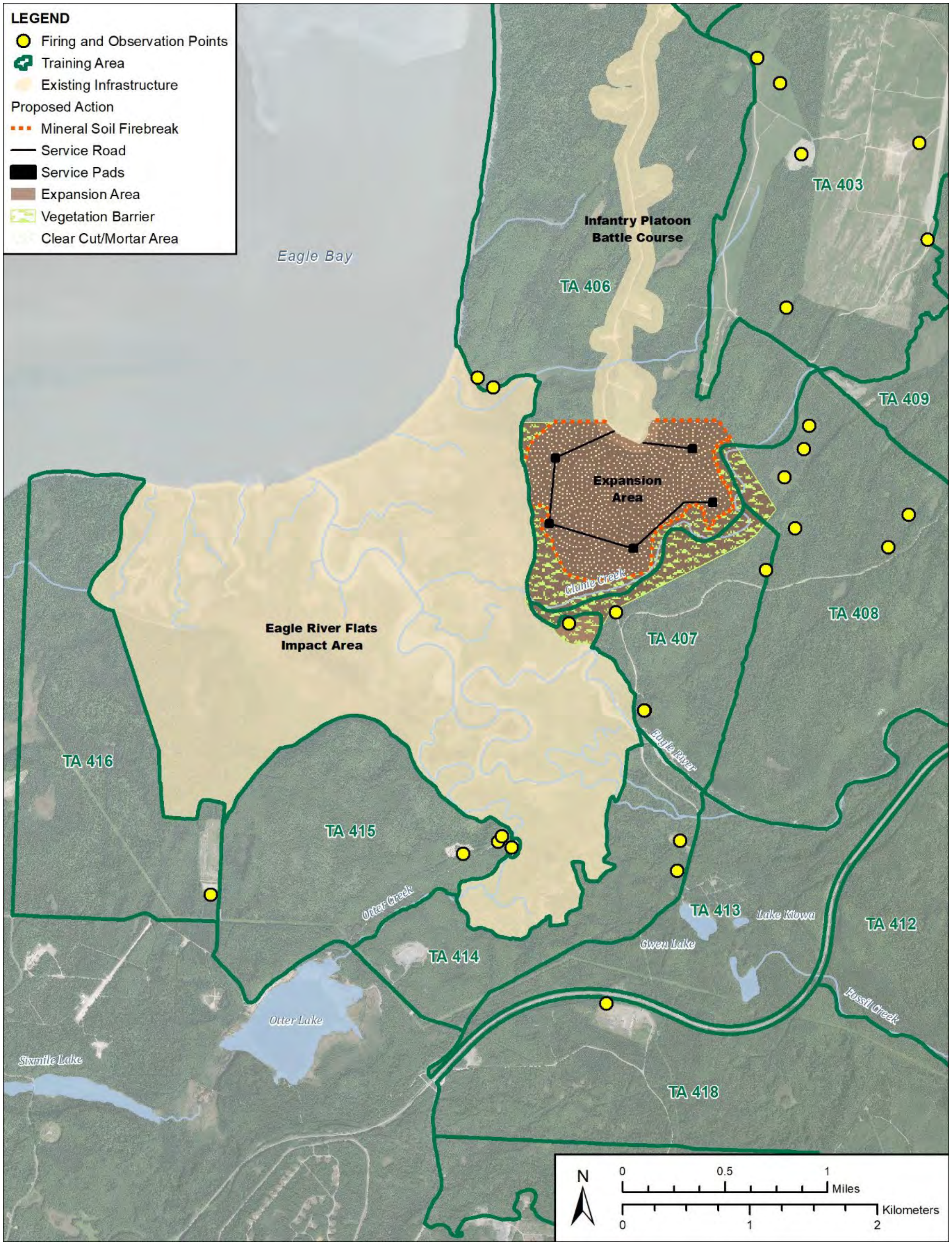
- **Area E** (artillery only) is the danger area directly in front of the weapon system, inside of which there is danger from muzzle debris, overpressure, blast, and hazardous impulse noise.

While mortar SDZs do not have an Area C or D, they can be authorized for overhead fire, which requires delineation of a more detailed SDZ (similar to an artillery SDZ) to enforce the minimum safety distances published in DA Pam 385-63.Because firing is directed at individual and grouped targets, the actual area impacted by munitions is generally only a small part of the overall impact area.

2.2 IMPACT AREA EXPANSION

Figure 2-2 provides a visualization of the proposed expansion area to support indirect live-fire training. Construction would occur entirely in the 585-acre site and would entail clear-cutting approximately 350 acres of vegetation and creating approximately 1.8 miles of gravel service roads and five vehicle gravel service pads inside the cleared area. The gravel service roads would be approximately 15 feet wide, and each service pad would be approximately 50 feet by 50 feet. In addition, a 3-mile firebreak would be created along the boundary of the cleared area to contain wildland fires and prescribed burns. The firebreak would be approximately 16 feet wide. An approximately 230-acre vegetated buffer would remain, as shown in Figure 2-2. This area would not be cleared but would be thinned to increase foot maneuverability and improve line of sight for training. To reduce the risk of wind throw, no more than one-third of the basal area of trees would be removed from the buffer.

Construction equipment would have access to the proposed expansion area to execute the design. Construction equipment (masticating hydro-axes, excavators, skidders, and feller bunchers) would clear vegetation, and salvageable trees would be disposed of in accordance with JBER forestry policy. Following clearing, the site would be reseeded with a native grass seed mix selected from the list of native seed mix recommendations provided in the *Integrated Natural Resources Management Plan* (INRMP) (JBER 2023a) to revegetate and stabilize the cleared area. The footprint of the service roads and pads would be grubbed and contoured to desired design prior to gravel installation. The firebreak would be constructed using a reciprocating Fecon machine to churn up the surface of the earth, creating a barrier of mineral soil that fire cannot spread through. Construction of the expansion area would take approximately 4 months to complete. The cleared portion of the expansion area would be maintained with controlled burning each year. The firebreak would be maintained by repeating the mechanical treatment with a Fecon machine every 2–3 years. Dud rounds would be cleared after each training event to prevent accumulation of UXO in the expansion area, in order to ensure its trafficability for infantry maneuver. There would also be annual maintenance to replace targets and clear the area around each target.



Sources: JBER 2018, 2020a, 2023c; MOA 2019; USGS 2020a
Imagery: JBER 2018

Figure 2-2 Proposed Impact Area Expansion under the Proposed Action

2.3 TRAINING UNDER THE PROPOSED ACTION

The maximum numbers of mortar and howitzer rounds that could be fired into ERF-IA annually under the proposed action are shown in Table 2-2 and Table 2-3. Figure 2-3 shows how the proposed project would allow the Army to meet its indirect live-fire training requirements at JBER, with the full circle representing the total rounds needed. The hatched areas represent WP smoke rounds that are allocated to JBER units but would not be fired into ERF-IA (in either wetland or upland areas).

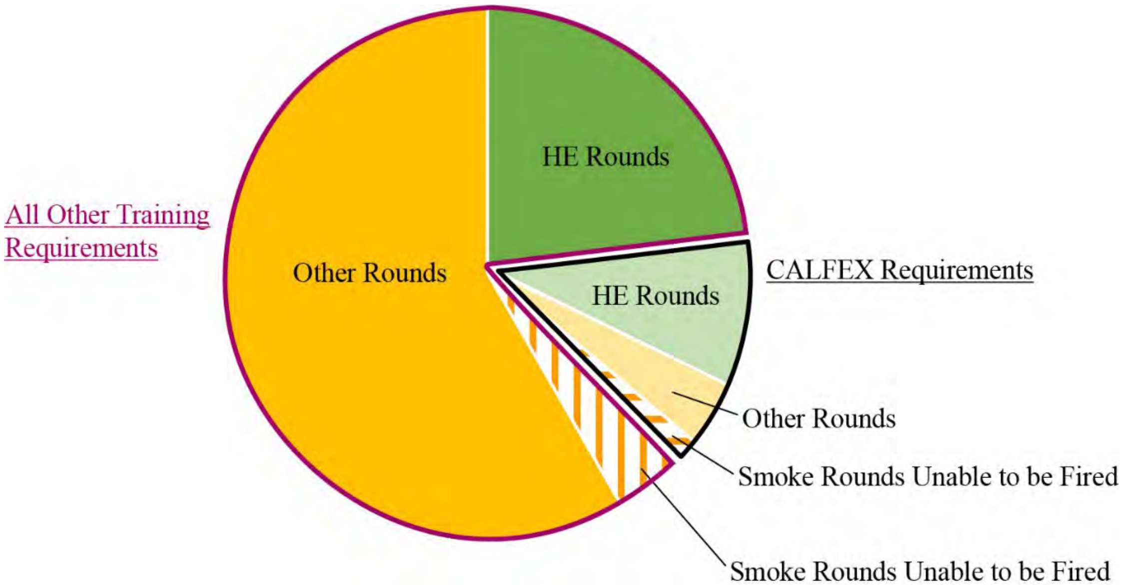


Figure 2-3 Indirect Live-Fire Training at JBER under the Proposed Action

With the proposed action, soldiers would gain the ability to conduct all-season live-fire qualification training using ERF-IA. Additionally, with the impact area expansion, a CALFEX live-firing proficiency exercise using a full array of weapons systems and munitions could be conducted. Table 2-4 provides an estimate of how many munitions would be fired in ERF (within the existing ERF-IA boundary) and how many would be fired in the upland expansion area under the proposed action. The total number of rounds per training session and length of each training session would vary. Noise modeling completed by JASCO Applied Sciences (JASCO) for the analysis in this BA considered various potential scenarios involving combinations of weapons systems (JASCO 2020, 2022).

Table 2-4 Munitions Fired into ERF and Proposed Expansion Area Annually under the Proposed Action

Weapon System	HE	SMOKE	ILLUM	FRPC/Blanks Training Rounds
60-mm Mortar Rounds (total)	1,036	0	490	2,800
ERF	700	0	448	2,800
Expansion Area	336	0	42	0
81-mm Mortar Rounds (total)	592	0	280	1,600
ERF	400	0	256	1,600
Expansion Area	192	0	24	0
120-mm Mortar Rounds (total)	744	0	360	2,232

Weapon System	HE	SMOKE	ILLUM	FRPC/Blanks Training Rounds
ERF	552	0	264	1,992
Expansion Area	192	0	96	240
105-mm Howitzer Rounds (total)	2,612	144	282	908
ERF	1,988	90	204	908
Expansion Area	624	54	78	0
155-mm Howitzer Rounds (total)	144	62	84	900
ERF	144	62	84	900
Expansion Area	0	0	0	0
TOTAL ANNUAL ROUNDS	**5,128**	**206**	**1,496**	**8,440**

Key: ERF = Eagle River Flats; FRPC = Full Range Practice Cartridge; HE = high-explosive; ILLUM = illumination; mm = millimeter.

Table 2-4 shows the maximum annual potential munitions usage for the proposed action. The focus of the action is to meet Army training objectives for small unit training; however, because JBER has some capability to support larger unit exercises, the ammunition resources allocated by DA Pam 350-38 for those exercises are included in this analysis. Ultimately, it would be up to unit commanders to determine the specifics of each training exercise, including where to conduct that exercise.

2.4 MITIGATION MEASURES TO PROTECT MARINE MAMMALS AND THEIR HABITAT

2.4.1 Conservation Measures

Conservation measures that are built into training activities at JBER include rigorous training by soldiers to avoid errors when firing munitions, use of SDZs for personnel and protective redundancies in firing protocol, marine mammal observation, and cease-fire protocols. The Army, JBER (Air Force, supported components, and tenant organizations), and contractors are required to comply with applicable laws, regulations, and policies. Mitigation measures will be implemented to further minimize potential impacts on marine mammals, including Cook Inlet beluga whales. These mitigation measures were developed based on site-specific knowledge from JBER biologists and review of project site conditions; they will be refined and modified as needed, in coordination with NMFS.

Key aspects of the best management practices and conservation measures included in the proposed action that reduce impacts to marine mammals include, but are not limited to, the following:

- Adherence to the Department of Defense Instruction 4715.03, *Natural Resources Conservation Program* (Department of Defense 2011), which establishes policy and assigns responsibilities for compliance with applicable regulations for the integrated management of natural resources including lands, air, waters, coastal, and nearshore areas managed or controlled by the Department of Defense.
- Adherence to the most current INRMP, which contains specific actions to protect, inventory, maintain, and improve fisheries resources and their habitats. This document is continually reviewed and revised to respond to new or increasing impacts on fisheries resources.

- Adherence to spill prevention and cleanup procedures outlined in the most current INRMP and JBER *Spill Prevention, Control, and Countermeasures Plan* (JBER 2023d).
- Adherence to the most current JBER *Industrial Storm Water Pollution Prevention Plan* (JBER 2022a).
- State and federal laws and regulations as they relate to fish resources. These include but are not limited to a prohibition on harassment of fish and wildlife. Any action that disturbs fish and wildlife is considered harassment by federal and Alaska State law. Examples of harassment include pursuit with vehicles or aircraft, feeding, and shooting of fish and wildlife. Vehicles, watercraft, and aircraft (including helicopters) may not be used to herd/chase fish and wildlife off ranges or training areas.
- Annual monitoring of marine mammal usage of Eagle River and Eagle Bay using visual and acoustic methods.
- Monitoring of marine mammals by military personnel, marine mammal observers (MMO), who have training and adequate experience to identify marine mammal species and describe relevant behaviors that may occur in the action area (similar to PSO).
- Implementation of archival passive acoustic monitoring, which would augment visual monitoring efforts when possible and be used to examine trends in marine mammal presence in Eagle Bay and Eagle River.
- Annual monitoring of ice conditions in Eagle River.
- Investigation of the effects of military noise on Cook Inlet beluga whale.
- Assisting other researchers (e.g., NMFS, Alaska Department of Fish and Game [ADF&G]), when practicable, with marine mammal studies and conservation efforts in Cook Inlet.
- Adherence to USARAK Regulation 350-2, which requires all rounds to be visually observed impacting or bursting. This restriction leads to not firing into rivers, streams, lakes, ponds, or other waterbodies that are deep enough that the impacts/effects of rounds cannot be observed.
- Monitoring of salmon populations within ERF-IA.

2.4.2 System for Accuracy of Indirect Fire

Indirect fire accuracy is determined by a variety of factors including known location of the gun, known location of the target, distance to the target, munitions ballistics, and weather data such as temperature, humidity, and wind. To address location data, JBER Range Control updates the map declination data annually and has surveyed each firing point. Artillery units use a survey team to emplace guns with sub-meter accuracy, while mortars typically use GPS coordinates with approximately 1-meter accuracy. All targets are stationary and recorded to 1-meter accuracy, and forward observers also use laser range finders to determine distances and locations. Lastly, the artillery battalion has a Meteorological Team that provides local, real-time weather data.

A Fire Direction Center (FDC) is used as the focal point for controlling artillery and mortars, and all the location data, munitions ballistics data, and weather data are combined in a fire control computer to provide actual firing solutions to each howitzer/mortar. As firing begins, all rounds must be observed, and units use two methods to observe where rounds impact on the ground: forward observers and radar. Forward observers are specially trained and equipped soldiers who observe rounds impacting, determine the distance from the target, and relay the information back to the FDC. Alternatively, units may use radar to track the trajectory of the round, then relay the point of impact back to the FDC. As the FDC receives information from the forward observer or the radar, it will recalculate firing data as necessary to make the next round more precise. In the interest of accuracy, units also conduct a registration fire mission to confirm the accuracy of the data before proceeding to qualification or CALFEX support. This is the same concept as zeroing a personal weapon.

USARAK Regulation 350-2 requires units to cease fire and initiate an investigation for any round that impacts outside the target area or that is not observed impacting. Of the two methods to determine whether a round impacts outside the target area (forward observer or radar), radar provides the fastest feedback. The SDZ can be entered into the radar's software with warning parameters to alert if a round impacts outside the target, then immediately transmit the information to the FDC. Forward observers overlay the SDZ onto their map, note the distance from the target, and alert the FDC via radio if the round impacts outside the target area. In the event of a round impacting outside the target area, the unit immediately directs a cease fire, removes soldiers from the immediate vicinity of the weapon, notifies the Range Operations Fire Desk Operator, and notifies their battalion/brigade commander. The unit is not allowed to resume firing until the appropriate investigation determines the cause of the incident and the Installation Range Officer authorizes the resumption of firing.

2.4.3 Regulations Pertaining to Open Water

USARAK Regulation 350-2 prohibits firing into or over any open navigable waterbody, unless specific coordination with the U.S. Army Corps of Engineers (USACE) occurs**.** Navigable waterbodies of the U.S. are those waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. A determination of navigability, once made, applies laterally over the entire surface of the waterbody and is not extinguished by later actions or events which impede or destroy navigable capacity (33 CFR § 329.4). DA Pam 385-63 defines a Navigable Waterway as any body of water open to the free movement of marine vessels. Eagle River is determined to be a navigable waterway from its mouth upstream to just west of Glenn Highway.

Each Service has procedures in place to fire into and over navigable waterways, such as the Army's action locally at JBER firing across Eagle River, the U.S. Navy (Navy) Point Magu Sea Range in California's Channel Islands, and the Air Force's Eglin Gulf Test and Training Range in the Gulf of Mexico. In accordance with DA Pam 385-63, USARAK requested that Eagle River be restricted where it flows through the impact area so units could fire over the river. USACE established a restricted area on JBER codified at 33 CFR § 334.1305 for Eagle River from Bravo Bridge to its mouth at Eagle Bay in Knik Arm. The designation was published in the *Federal Register* (FR) on 27 September 2022 (87 FR 58452) and made effective on 27 October 2022. The rule indicates that "Establishment of the restricted area will prevent all vessels, watercraft, and individuals from entering an active military range munitions impact area at all times, except for authorized vessels, watercraft, and individuals engaged in support of military training and management activities." The authority to allow entry lies with the 11th Airborne Division Commander. As a result of the USACE decision to close Lower Eagle River to the public, USARAK Regulation 350-2 will be updated to allow firing over (but not into) Eagle River where it flows through the area closed to the public. Additionally, Range personnel will post large, highly visible signage at the mouth of Eagle River and upstream of Bravo Bridge to inform the public of the closure.

Open water has multiple definitions that must be read in context. Open water generally refers to water not frozen. JBER's training protocols clearly state that there would be no intentional firing into open waterbodies and that targets would not be placed in open waterbodies. In this context, open waterbodies are defined as rivers, streams, intertidal channels, gullies, lakes, ponds, or other areas that contain water. That said, ERF has areas that frequently contain vegetated waters of varying depths. Forward observers will look for observable open water; if no such waters are observed in the intended target area, the live-fire training will proceed. It is possible that the target area will contain areas of flowing or standing water, fully covered by vegetation (typically tall grasses) where small fish, including juvenile salmon, may be present. USARAK Regulation 350-2 requires all rounds to be visually observed impacting or bursting. This restriction leads to not firing into waterbodies that are deep enough that the impacts/effects of rounds cannot be observed. So long as all rounds are visually observed impacting or bursting, which would indicate that they have not landed in water, firing will continue as intended. In this document, the word "inundated" is used specifically to refer to the tidal inundation that occurs when higher tides cause flooding outside the banks of Eagle River and into the surrounding floodplain.

The placement of protective habitat buffers into which no rounds would be fired along the Eagle Bay shoreline, Eagle River, Otter Creek, and selected tributaries and upstream locations that are larger than in-water harassment distances modeled during typical high tide conditions. The implementation of these buffers means take due to underwater noise would not occur during firing exercises performed during typical tidal ranges (including low to non-inundating high tides) in these waterways because detonations would occur outside these habitat buffers.

A prohibition on firing of HE rounds and 155-mm training rounds into areas inundated by high tide events (predicted and observed). The implementation of this measure means that underwater acoustic thresholds for non-auditory injury, auditory injury, and behavioral disturbance would not be reached for any of the four marine mammal species in the action area during periods of time when the habitat buffers and upland target areas may be underwater (i.e., take due to underwater noise would not occur during inundating tides because HE rounds and 155-mm training rounds would not be fired into inundated areas).

2.4.3.1 Monitoring During Open Water Conditions

Monitoring would be conducted during open water conditions by qualified, trained MMOs. MMOs are military personnel who are trained and adequately experienced to identify marine mammal species and describe relevant behaviors that may occur in Knik Arm, Eagle Bay, and Eagle River. The MMOs and associated training program will meet NMFS' minimum qualifications, available online at https://www.fisheries.noaa.gov/alaska/endangered-species-conservation/guidance-developing-marine-mammal-monitoring-plan.

During open water months, monitoring would occur from land-based stations with a vantage point allowing for visibility of the portions of Eagle River and Otter Creek proximal to the firing points in use. During live fire, a minimum of two MMOs would be in place and actively monitoring prior to commencement of any firing into ERF-IA.

Monitoring specifically for marine mammals would be conducted a minimum of 30 minutes prior to the commencement of firing (i.e., hot time), during firing, and for a minimum of 30 minutes after the end of the firing mission (i.e., cold time).

Monitoring would be conducted via concurrent visual observation and PAM (dipping hydrophones or equivalent acoustic instrument). Underwater passive acoustic detections would be logged and, in some instances, recorded, but no spectral analysis of these data is planned.

The lead MMO would maintain positive radio contact with Range Control and would call for a ceasefire when necessary to avoid the taking of a marine mammal.

If no means of acoustic monitoring is available to augment the visual efforts from the ground, the lead MMO would call for a cease fire when any marine mammal is observed in either Eagle Bay or Eagle River. Fire will cease for ERF-IA until the marine mammals are observed moving out of Eagle River or until 30 minutes have passed without resighting beluga whales, or 15 minutes have passed without resighting other marine mammals. If the animals are not observed again by the MMO during this time, firing can resume.

During winter and non-open water conditions, visual monitoring is not feasible. As described in Section 2.2.4.2, JBER remote imaging found that the middle and upper portions of Eagle River start to freeze in mid to late November in cold years and not until mid-December in warmer years and remain frozen over until mid-March at the earliest. Ice in the lower section of Eagle River breaks up earlier, in late January or February, and does not have 100 percent ice cover in warm years. Upstream transit of Eagle River by marine mammals is thought to be inhibited—if not precluded—by the presence of heavy river ice, estuarine ice, and stamukhi (thick ridges that become grounded during the winter and become a part of the fast ice zone). During winter, archival acoustic data would be implemented, or other technology if available.

A summary monitoring report would be submitted to NMFS annually. This report would contain at a minimum:

- Results of monitoring during frozen periods
    - Dates/times of all indirect live-fire training activities at ERF-IA
    - Weapon system and munition types used
    - Type and location of monitoring, if conducted
    - Presence/absence of marine mammals in Eagle River
    - If marine mammals are observed, species and approximate location
    - If marine mammals are observed, action taken to avoid takes
    - Recorded take numbers, if any*
- Results of monitoring during open water periods
    - Dates/times of all indirect live-fire training at ERF-IA
    - Weapon systems and munitions types used
    - Type and location of monitoring
    - Results of marine mammal monitoring: species and location.
    - Underwater passive acoustic detections from PAM (when possible or applicable)
    - If marine mammals are observed, any actions taken to avoid take
    - Recorded take numbers, if any*

* Any suspected take would also generate a contemporaneous report to NFMS, reinitiation of consultation under the ESA, and application for an incidental take authorization under the MMPA, if appropriate.

2.4.4 Seasonal Restrictions and Other Planned Protective Measures

Because of the non-persistent presence of Cook Inlet beluga whale, the multiple Pacific salmon runs (four of five salmon species are recognized as key physical or biological features [PBFs] for Cook Inlet beluga whale critical habitat), and large tidal fluctuations, scientifically determined protective buffers (particularly for HE rounds) have been identified as a key measure to protect marine mammals and Pacific salmon under the proposed action. Other protective measures to be executed include new target placement, “No Fire Areas” along streams and shorelines, visual clearing of the impact area before firing, “soft start” to firing, and appropriate indirect fire control measures. Each of these protective measures will continue to be secondary to the intent of firing HE rounds into ERF when Cook Inlet beluga whales are less likely to be present.

As part of ongoing coordination (Section 1.3.2), JBER requested assistance from NMFS in determining an appropriate seasonal closure window based on seasonal Cook Inlet beluga whale presence patterns in ERF. Recommendations from NMFS, as detailed in a 9 August 2024 memorandum (NMFS 2024a), were based on an analysis of passive acoustic data collected in Eagle River by JBER. Based on the most recent data from 2018 to 2021, the seasonal closure period for HE rounds and 155-mm training rounds recommended by NMFS is from 9 August through 18 October (70 days). This window corresponds to periods when Cook Inlet beluga whales were recorded in greatest numbers in Eagle River. Based on this recommendation, the protective measures built into the proposed action, as listed below, include this recommended seasonal closure period.

The following definitions pertain to the information provided in the following subsections and throughout this document:

- "Buffer" refers to a setback (e.g., from a river) identified to protect the habitat of a sensitive resource from an activity such as live-fire training.
- For the purposes of training, protective buffers are translated into "fire exclusion zones," which are delineated by Range Control as areas that may not be fired into.
- "No fire area" is an Army doctrinal term that refers to an indirect fire control measure that can be entered into the Advanced Field Artillery Tactical Data System to alert fire planners of an area that cannot be targeted.

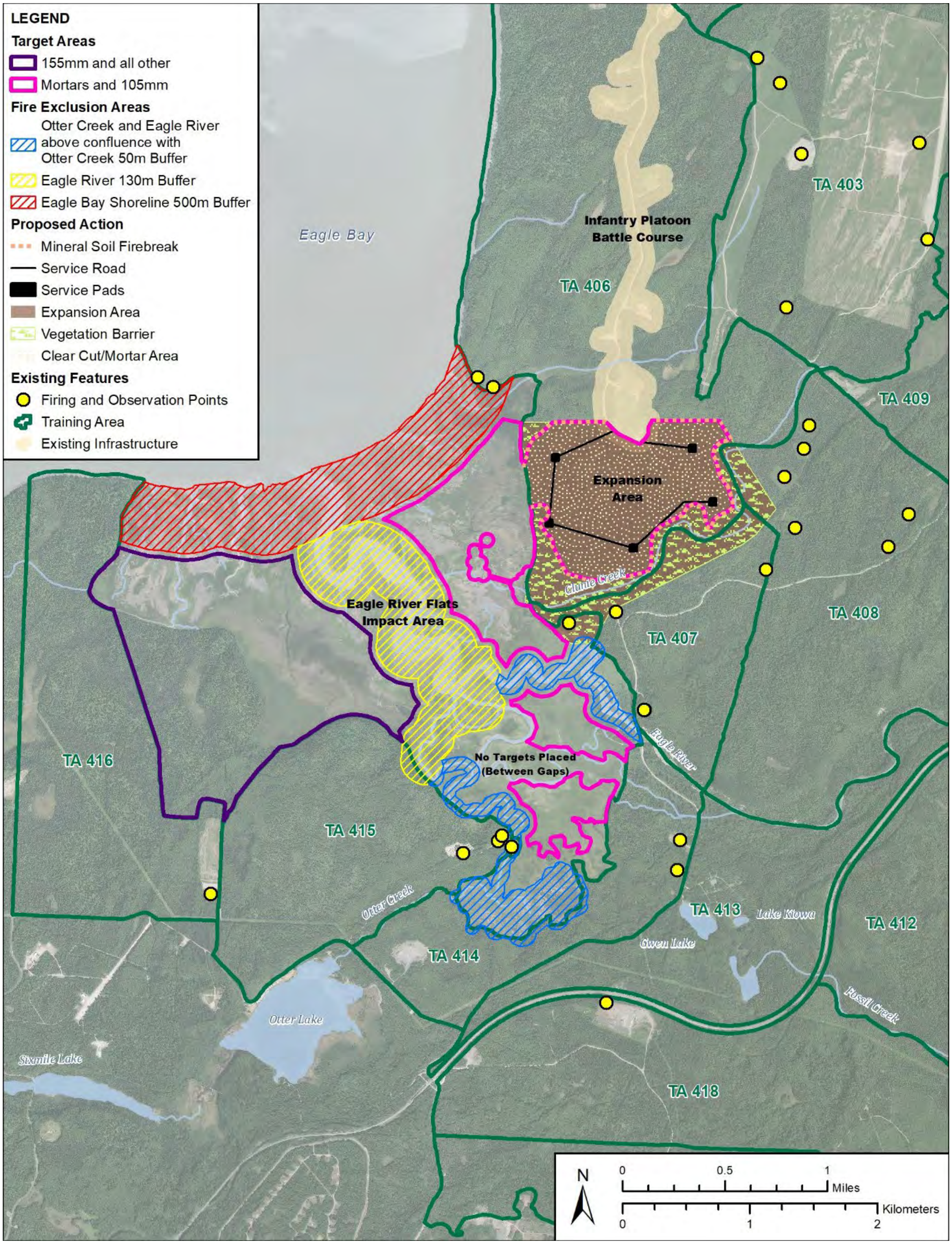
Implementation of recommended protective buffers identified by a detailed acoustic modeling report of munitions effects (see Section 2.4.4.1) should provide sufficient protection to marine mammals, but as an added protection, the proposed action considers additional protections for areas within ERF immediately along Eagle River, Otter Creek, the Otter Creek complex, and the Eagle Bay shoreline. The proposed action incorporates the following limited fire periods for full HE rounds and 155-mm training rounds (includes mitigation in Section 2.4). Mortar FRPCs may still be fired into ERF, and all rounds may still be fired into the proposed expansion area during these periods:

- During all inundating tide events as predicted by a 31-foot[4] or higher tide at the Goose Creek, Cook Inlet Tide Station (ID 9455963) or as observed on the ground. Inundated areas would become no-fire areas during predicted and actual flooding events. Inundation period closure was recommended by NMFS in an EFH Coordination Letter dated 26 July 2022. See Section 2.4.4.2 for a discussion of when the closure period will begin and end and other details. See Section 2.1.2 for a discussion of tools used to determine whether targets are in inundated areas at night.
- The peak Cook Inlet beluga whale upriver visitation period, as recommended by NMFS, is 9 August through 18 October (NMFS 2024a). The dates would be periodically reviewed in conjunction with the INRMP.

2.4.4.1 Protective Buffers

Distances of proposed habitat protective buffers were determined based on the results of the acoustic modeling for marine mammals (and fish) and through coordination with JBER. The acoustic modeling results are summarized in Section 5.0 of this document and described in detail in the acoustic modeling reports (JASCO 2020, 2022). Proposed protective buffer distances from the Knik Arm shoreline and the banks of Eagle River, Otter Creek, and the Otter Creek complex (Figure 2-4) have been slightly modified from the current protective buffers and will be finalized through consultation with NMFS. Protective buffers would be translated into No Fire Areas in artillery fire support computers and loaded as GIS layers into the Range Facility Management Support System for planning and tracking.

[4] While tides exceeding 30 feet result in flooding of ERF, the 31-foot tide level at the Goose Creek, Cook Inlet Tide Station (nearest tide station) is used as a reference for this restriction because there are no tide tables for 30 feet.



Sources: JBER 2020a, 20232c; MOA 2019; USGS 2020a
Imagery: JBER 2018

Figure 2-4 Proposed ERF-IA Habitat Buffer and Target Areas for Mortars and Artillery

The buffer distances would be periodically reviewed and may be altered during updates to JBER's INRMP. No targets would be placed within the protective buffers, no rounds would be intentionally fired into the buffer areas, and target placement would allow for adjustment of rounds without the rounds impacting the buffer areas. The following buffers and restrictions are proposed (Figure 2-4). All buffers were identified based on the 2020 and 2022 modeling of the typical high tide event (JASCO 2020, 2022) and were prescribed to protect the most sensitive marine mammal and fish receptors at each river/stream reach:[5]

- Keep the current 500-meter shoreline habitat buffer along Eagle Bay, which exceeds the 254-meter protective buffer indicated by the acoustic modeling report for the highest explosive weight (155-mm) round.
- Keep the current 130-meter habitat buffer from each bank of Eagle River, beginning from the mouth at Eagle Bay and extending upstream to a point 100 meters above the confluence with Otter Creek. This protective buffer is more than triple the 36-meter buffer indicated by the acoustic modeling report.
- Extend the current 130-meter habitat buffer from either bank of Eagle River approximately 0.5 kilometer upstream to encompass the Eagle River/Otter Creek confluence area.
- Keep the current 50-meter habitat buffer from each bank of the main Eagle River channel beginning at the point 100 meters upstream from the Otter Creek confluence and extending further upstream to the Route Bravo Bridge. This protective buffer exceeds the 36-meter buffer indicated by the acoustic modeling report.
- Keep the current 50-meter habitat buffer from either bank of Otter Creek and the associated Otter Creek complex within 100 meters of its confluence with Eagle River. This protective buffer exceeds the 36-meter buffer indicated by the acoustic modeling report.
- Keep the current 50-meter habitat buffer from either bank of Otter Creek and the Otter Creek complex from 100 meters above its confluence with Eagle River to the impact area boundary. This protective buffer exceeds the 20-meter buffer indicated by the acoustic modeling report.
- Extend the 50-meter Otter Creek habitat buffer approximately 0.25 kilometer south and east to encompass the Otter Creek backwater channel complex.
- Eliminate the current 1,000-meter shoreline habitat buffer along Eagle Bay for 120-mm HE rounds. The acoustic modeling indicates only a 254-meter buffer is required for protection, and the 500-meter buffer will be nearly twice that distance.
- Prohibit firing into Eagle Bay, Eagle River, and Otter Creek. (See Section 2.4.1 for additional waterbodies that receive protection through adherence to USARAK Regulation 350-2.)
- Restrict firing into the Otter Creek complex to the area outside of the established protective buffer areas. The buffered areas include multiple small tributaries, branches, and connected open water.
- No rounds will be fired into habitat protective buffers. Key habitat buffers that are most important for protecting marine mammals include:
    - A 500-meter shoreline habitat buffer along Eagle Bay shoreline;
    - A 130-meter buffer from each bank of Eagle River, beginning from the mouth at Eagle Bay and extending upstream to a point 900 meters above the confluence with Otter Creek;
    - A 50-meter buffer from each bank of the main Eagle River channel beginning at the point 900 meters upstream from the Otter Creek confluence and extending further upstream to the Route Bravo Bridge; and
    - A 50-meter buffer of Otter Creek and its tributaries.

[5] Marine mammals were determined to be the most sensitive biological receptors at each river/stream reach except for Otter Creek, where fish temporary threshold shift thresholds were more sensitive than marine mammals that could be present in this reach (JASCO 2022).

- No firing of HE rounds into ERF during the peak beluga whale upriver visitation period (9 August through 18 October; HE rounds could still be fired into the proposed expansion area during this time). This measure provides added protection for beluga whales from noise impacts when they are most likely to be present in the action area, further reducing the likelihood of disturbance.
- No firing of 155-mm rounds will occur in the unbuffered portions of the Eagle River relict channel due to space limitations.

2.4.4.2 Other Protective Measures

JBER has identified additional reasonable and prudent avoidance and minimization measures that are expected to provide additional protections to ESA-listed species and their prey species, and which are presented in this section. The analysis of effects assumes that these measures would be implemented.

New fire control measures and other protective measures will limit the exposure of marine mammals to the hazards associated with live-fire training. Fire control measures and restrictions are as follows:

1) Slow start. When driving pier pilings, the Navy uses a slow start technique whereby strikes to pilings begin with a single strike followed by a wait period then an increased number of strikes followed by another wait period; this pattern continues until the day's full work begins. During the slow start, trained observers monitor for protected marine wildlife and work typically stops if marine mammals are observed. The slow start provides an opportunity for unseen marine mammals to safely depart prior to the start of work. The Army doctrinal use of indirect fire and the registration process parallels this methodology. All rounds fired during training and qualification are observed by forward observers who ensure the area is clear to fire into and the correct targets are engaged. Artillery and mortar units register their weapon systems by firing individual rounds prior to beginning multiple gun engagements. This registration process, similar to a slow start, provides an opportunity for submerged/unseen marine mammals to safely depart an area or for observers to halt firing.
2) Firing Restriction. No firing full HE rounds or 155-mm training rounds into areas inundated by high tide events as predicted by a 31-foot level[6] at the Goose Creek, Cook Inlet Tide Station (ID 9455963) or as observed on the ground. During inundating tide events, the closure period will begin 1 hour before high tide and extend for 2.5 hours after high tide, as determined by the Goose Creek tide station. The timing of high tide as predicted by the station is consistent with JBER's field observations, and the tide tables account for tidal amplification. Firing will continue to be allowed in non-inundated areas meeting the No Fire Area limitations, including the proposed expansion area. While the tidal level imparts the major influence on inundation in ERF, multiple factors contribute, including the current river level, wind speed/direction, and ice volume. Given these additional variables, inundation may occur at lower tide levels; therefore, unit observers will confirm the impact area is not inundated prior to firing HE. Survivable flood monitors may also be emplaced to better indicate flooded areas hidden by tall grasses and shrubs. Note that while only restrictions on full HE rounds are built into the action, additional mitigation has been developed (Section 2.4) that would expand this restriction to include 155-mm training rounds. Additionally, because 105-mm howitzer training does not include the use of training rounds, no artillery rounds would be fired during inundated conditions. While there is no restriction on conditions during which mortar FRPCs (non-HE rounds) could be fired, in practice these rounds must be fired at targets on solid ground (i.e., targets in the impact area that are not experiencing inundation) to be effective for training and would therefore not be fired intentionally into lakes, ponds, streams, or temporarily inundated/flooded areas.

[6] While tides exceeding 30 feet result in flooding of ERF, the 31-foot tide level at the Goose Creek, Cook Inlet Tide Station (nearest tide station) is used as a reference for this protective measure because there are no tide tables for 30 feet.

3) Fire Control Measure. The Installation Range Control Officer will redistribute targets within ERF-IA to support No Fire Areas established along the Knik Arm shoreline, Eagle River, Otter Creek, and the Otter Creek complex. Target redistribution may include siting new targets, moving existing targets, obscuring existing targets, highlighting existing targets, or removing existing targets. The end goal is to establish an array of targets to focus the indirect fire and to preclude inadvertent targeting of rounds inside the protective buffer areas. Clearly identifiable targets, in conjunction with No Fire Areas, are key to precluding inadvertent targeting of rounds inside the protective buffer areas. For the few nights per month where inundating tides are likely, the Army will restrict units to targets outside areas that are routinely inundated, which will include upland areas on either the east or west side of Eagle River. See also Section 2.1.2 for a discussion of tools used to determine whether targets are in inundated areas at night.

4) Fire Control Measure. Units will continue to only use variable or mechanical time (air burst) or point-detonating super quick fuzes in ERF to minimize the risk of artillery and mortar rounds penetrating the ground and potentially exposing and redistributing WP. Delay fuzes, which allow projectiles to penetrate the ground, will not be used.

5) Firing Restriction. Proposed protective buffers (Section 2.4.4.1) will be finalized in coordination with NMFS and include an analysis of shrapnel and debris. As finally determined, these protective buffers will be translated into No Fire Areas in artillery fire support computers and loaded as GIS layers into the Range Facility Management Support System for planning and tracking. These buffer distances will be periodically reviewed and may be altered during INRMP updates. No targets will be placed within the habitat protective buffers, and no rounds will be intentionally fired into the buffer areas. Targets will be placed far enough outside the buffers to allow for adjustment of rounds without the rounds impacting the buffer areas.

6) Forward observers will ensure the area is clear to fire into and the correct targets are engaged and will observe all rounds fired during training and qualification. This will include monitoring for marine mammals. If marine mammals are spotted in Eagle River or Otter Creek before or during a training event, firing will not begin or units will cease fire and report back to Range Control, in accordance with USARAK 350-2. Fire will cease for ERF-IA until the marine mammals are observed traveling into Eagle Bay or 15 to 30 minutes have passed without resighting (30 minutes for beluga whale, 15 minutes for all other marine mammals)[9]. If the animals are not observed again during this time, firing can resume.

7) Forward observers will monitor for observable open water and ensure that rounds are visually observed impacting or bursting. If forward observers identify site or detonation conditions that could potentially result in harm to marine mammal prey species, firing will immediately cease, and a different target will be selected.

8) Training Area and Range Maintenance and Upgrades to Assist with Accuracy and Precision of Rounds Fired.
   - Update and mark permanent survey points at all firing points for ensured accuracy.
   - Enforce navigational closure of Eagle River within the impact area.
   - Conduct vegetation maintenance on observation points bordering ERF-IA to include OPs Cole, Fagan, and Vital to improve forward observer visibility. Continue to protect any identified cultural resources near all OPs in accordance with the *Integrated Cultural Resources Management Plan*.
   - Develop a detailed target list to provide units with authorized targets within ERF-IA and all the information needed to ensure they are engaging the correct target within prescribed guidelines. The target list will provide target description, grid coordinate, length, width, height, and restrictions.

Restrictions would include weapons systems that may not use the target, types of munitions that may not be used or must be used, and periods of time targets may not be engaged by any system.

9) Unit Training Measures.

- Expand the current leader-specific training for winter firing to include all-season considerations, with an emphasis on Cook Inlet beluga whale training. Currently, leader-specific training is conducted in units to ensure the leadership understands the current restrictions, which are unique to JBER. If firing opportunities are expanded, units will update standard operating procedures and institute additional training to fully depict the approved firing procedures, so leaders understand the protection requirements for both wildlife and cultural resources in the vicinity of their training.
- Routinely verify declination stations to ensure accuracy.
- Whenever practicable, units will use assigned radars in the registration process, for redundant observation, and to ensure accuracy.
- Ensure SDZs and fire support graphics account for the habitat buffers as No Fire Areas.

Additional terrestrial mitigation that would help protect aquatic habitat in ERF includes the creation of a 3-mile firebreak (approximately 16 feet wide) along the boundary of the proposed expansion area to contain wildland fires and prescribed burns and adherence to the JBER forestry policy for clearing of lands and disposal of vegetation; cleared areas would be reseeded with a native grass seed mix to revegetate and stabilize the grounds. These measures will minimize sedimentation and erosion impacts on marine mammal habitats.

2.5 AVOIDANCE AND MINIMIZATION MEASURES

The effects analysis considers policies and regulations already in place that reduce the true potential of occurrence of these effects, which are presented in Section 2.4.1, as well as protective measures incorporated into the proposed action, which are presented in Section 2.4.4. Proposed protective measures include (but are not limited to) revised protective buffers based on acoustic modeling, limited fire periods for HE rounds (during inundating tide events, during the peak Cook Inlet whale upriver visitation period), and redistribution of targets. During development of the EFH Assessment (JBER 2023d) and the Request for LOA (JBER 2024), JBER identified additional reasonable and prudent avoidance and minimization measures expected to provide additional protections to ESA-listed species and their prey species, and which are presented in this section. The analysis of effects assumes that these measures would be implemented.

Additional mitigation measures have been identified based on an analysis of potential impacts to marine mammals from hazardous fragment strikes and from acoustic impacts from 155-mm training rounds during inundated conditions. Refer to Figure 2-1 for a visual representation of SDZ areas and Figure 2-4 for protective buffers.

- During ice-off conditions (ice proxy to be developed), the following measures would effectively afford marine mammals the same protections as personnel and would prohibit the firing of rounds into areas where hazardous fragments would have a 1 in 1,000,000 or greater chance of striking marine mammals:
  - Ensure that for each weapon fired (mortar and artillery), the weapon system impact area (target area, 8PE, and 12PE portions of SDZ) does not overlap habitat protective buffers, Eagle Bay, or Eagle River.
  - Ensure that for each weapon fired (mortar and artillery), Areas A, B, and C of the SDZ do not overlap portions of Eagle Bay, Eagle River, or Otter Creek that have 130- or 500-meter buffers.
  - For portions of Upper Eagle River, Otter Creek, and the Otter Creek complex that have a 50-meter buffer, ensure that for artillery, Areas A, B, and C of the SDZs do not overlap the river/creek.

- During ice-off conditions, the following measure would apply to waterbodies with habitat protective buffers where marine mammals are less likely to occur:
    - For portions of Upper Eagle River, Otter Creek, and the Otter Creek complex that have a 50-meter buffer, ensure that for mortars, Area B of the SDZ does not overlap the river/creek. For mortars that overfly the river/creek, ensure the minimum safety distances in DA Pam 385-63 are applied to areas that overlap the river/creek. In other words, while there is a greater than 1:1,000,000 chance for fragmentation to land in portions of the river/creek/complex where infrequent marine mammal visitation is expected, minimum human safety distances would still be applied to protect marine mammals in these areas. Implementation of minimum human safety distances to protect marine mammals during ice-off conditions in portions of upper Eagle River, Otter Creek, and the Otter Creek complex, areas where marine mammals are less likely to occur.
- Expand the protective measure that specifies limited fire periods for HE rounds to include 155-mm training rounds. This means that 155-mm training rounds, like full HE rounds, would not be fired into inundated areas during inundating tide events and would not be fired into ERF during the seasonal closure period of 9 August through 18 October (155-mm training rounds could still be fired into the proposed expansion area during this time).

The following mitigation measures have been identified to reduce impacts to EFH at ERF, which provides important habitat for Cook Inlet beluga whale and other marine mammals.

- Follow the most recent guidance and recommendations on using types of munitions that will minimize impacts to aquatic receptors to the maximum extent practicable. This involves coordination with other military firing ranges and research institutions (e.g., SERDP and CRREL) that have been conducting studies on fate, transport, and toxicity of IMs and traditional explosives over the past several decades. Continue to evaluate rearing and residency of juvenile salmon and/or other managed fish species using trap surveys and/or eDNA (or other methods as appropriate) to monitor productivity. The practicability of these studies is dependent on safe access to relevant areas within ERF-IA.
- Continue fisheries harvest management, population studies (annual salmon enumeration studies), and habitat protection efforts at Sixmile Lake, Eagle River, and Otter Creek to ensure fish resources are effectively managed on JBER. Data will be used to monitor changes in habitat conditions with appropriate consideration to all other potential confounding factors. Additional management measures will be considered where metrics indicate action-related degradation to fish habitat. The following additional measures are being considered and will continue to be discussed, refined, and modified further, as needed, through consultation with NMFS: consider opportunities to protect, enhance, and/or restore salmon habitat in the affected area, including within and outside the JBER installation boundary; maximize use of the expansion area to reduce impacts to areas where juvenile fish may be present during the height of salmon runs (mid-June through August), as appropriate; consider the practicability of acoustic testing on the effects of managed fish species within the proposed project area; and, implementation of real-time or near real-time passive acoustic monitoring for belugas in Eagle River. While there are several potential confounding factors that may influence the acoustic measurements in the proposed project area, pilot studies may be developed to evaluate the range of noise inputs within ERF-IA and within various channel morphologies (e.g., primary, tributary, relict). The practicability of these efforts is dependent on safe access to relevant areas, as much of ERF-IA is a dedicated impact area.

3.0 ESA-LISTED SPECIES AND CRITICAL HABITATS

ESA-listed species and critical habitats potentially occurring in the action area were determined based on information from NMFS (2022a), USFWS (2022), and ADF&G (2015). Four species of marine mammals that are listed as federally endangered have the potential to occur in the action area, with occurrences ranging from frequent to unlikely (Table 3-1). While it is possible for all of the species listed in Table 3-1 to be present in Knik Arm, JBER's observational records since 2008 suggest that the presence of humpback whales (*Megaptera novaeangliae*) from the Western North Pacific distinct population segment (DPS) and Mexico DPS in Eagle Bay in Eagle Bay is extremely rare. As such, these species will not be considered further in this document.

No federally listed fish species or terrestrial plant or wildlife species (or their critical habitat) are expected to occur in the action area. All West Coast salmon species (and associated evolutionarily significant units) listed as threatened or endangered under the ESA originate in freshwater habitats in Washington, Idaho, Oregon, and California. In Alaska, no stocks of Pacific salmon or steelhead from freshwater habitat are listed as threatened or endangered species. Some ESA-listed fish species do migrate as adults into marine waters off Alaska, but none are likely to occur in Knik Arm and the action area.

Additional information regarding species distribution and likely occurrence in the action area is discussed in the following sections. The species are ESA-listed as a DPS, where appropriate.

Table 3-1 ESA-Listed Species and Potential Occurrence in Action Area

Common Name ***Scientific Name*** **DPS**	**ESA Status and Listing Document**	**Critical Habitat and Species Occurrence in Action Area**
Beluga Whale *Delphinapterus leucas* Cook Inlet DPS	Endangered 73 FR 62919	Critical habitat is designated in Eagle Bay but does not include ERF-IA and other military lands of Joint Base Elmendorf-Richardson between Mean Higher High Water and Mean High Water, two areas for which the military has provided an INRMP that NMFS has determined provides benefits to the Cook Inlet beluga whale (76 FR 20180). Occurs almost exclusively in Cook Inlet (Goetz et al. 2023). Heaviest use of Knik Arm in areas near JBER, including Eagle River and Eagle Bay, occurs from August through November, but the species may be present in the Action Area year-round (JBER unpublished data). Sightings recorded in and near ERF-IA.
Humpback Whale *Megaptera novaeangliae* Western North Pacific DPS	Endangered 81 FR 62260	Critical habitat is not designated in the action area (86 FR 21082). Observed in Lower Cook Inlet, but occurrence in Knik Arm and action area is rare and unlikely. In September 2017, a male humpback whale was observed floating dead in Eagle Bay (JBER unpublished data, cited in JBER 2023a).
Humpback Whale *Megaptera novaeangliae* Mexico DPS	Threatened 81 FR 62260	Critical habitat is not designated in the action area (86 FR 21082). Observed in Lower Cook Inlet, but occurrence in Knik Arm and action area is rare and unlikely. In September 2017, a male humpback whale (DPS unspecified) was observed floating dead in Eagle Bay (JBER unpublished data, cited in JBER 2023a).
Steller Sea Lion *Eumetopias jubatus* Western DPS	Endangered 62 FR 24345	Critical habitat is not designated in the action area (59 FR 30715). Observed in Lower Cook Inlet, but occurrence in Knik Arm and the action area is rare and unlikely. During intermittent marine mammal monitoring at the POA, Steller sea lions were observed in 2009, 2016, and 2020 (NMFS 2021a). In the most recent occurrence, six sightings were made across 4 days between 29 May and 24 June 2020 (NMFS 2021a). Within the airborne noise portion of the action area, this species is expected to be occasionally present in small numbers.

Key: ESA = Endangered Species Act; DPS = distinct population segment; ERF-IA = Eagle River Flats Impact Area; FR = Federal Register; INRMP = Integrated Natural Resource Management Plan; JBER = Joint Base Elmendorf-Richardson; POA = Port of Alaska.

Source: NMFS 2021a; JBER 2023a; Goetz et al. 2023

3.1 COOK INLET BELUGA WHALE

3.1.1 Status and Management

Beluga whales inhabiting Cook Inlet belong to the Cook Inlet DPS, one of five distinct stocks found in Alaska (Muto et al. 2021) (Figure 3-1). This DPS is identified as a depleted stock under the MMPA and endangered under the ESA (73 FR 62919).

The Cook Inlet beluga whale population may be affected by various natural and anthropogenic factors, including strandings, predation, parasitism and disease, environmental change, subsistence harvest, poaching, fishing (personal use, subsistence, recreational, and commercial), pollution, oil and gas, coastal development, vessel traffic, tourism and whale watching, noise, and research (NMFS 2008a, 2016). Although a number of known and potential threats have been identified, there is not enough known about the effect of each specific threat to definitively determine the level of impact that each threat has on the Cook Inlet beluga whale (NMFS 2008a). In addition, Cook Inlet beluga whales may be affected by synergistic interactions by multiple threats, compounding the impacts of the individual threats (NMFS 2008a).

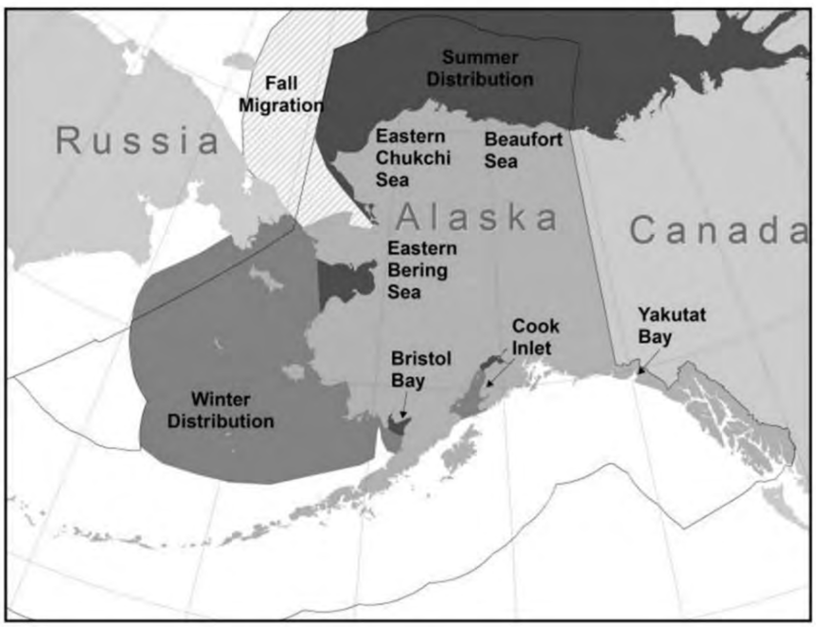


Figure 3-1 Approximate Distribution of All Five Beluga Whale Stocks

Note: The Beaufort Sea, Eastern Chukchi Sea, Eastern Bering Sea, and Bristol Bay beluga whale stocks summer in the Beaufort Sea (Beaufort Sea and Eastern Chukchi Sea Stocks) and Bering Sea (Eastern Bering Sea and Bristol Bay Stocks); they overwinter in the Bering Sea. The Bristol Bay and Cook Inlet beluga whale stocks show only small seasonal shifts in distribution, remaining in Bristol Bay and Cook Inlet, respectively, throughout the year. Summering areas are dark gray, wintering areas are lighter gray, and the hashed area is a region used by the Eastern Chukchi Sea and Beaufort Sea Stocks for autumn migration. The U.S. Exclusive Economic Zone is delineated by a black line.

Source: Muto et al. 2021

Population assessments of the Cook Inlet beluga whale population began in the mid-1990s, with a near 50 percent decline documented by 1998 (NMFS 2016). This rapid decline was initially attributed to a substantial, unregulated subsistence hunt that the population could not sustain (NMFS 2016). Public laws (106-31 and 106-553) in 1999 and 2000 required subsistence hunting through cooperative agreements, which allowed for the successful harvest of five Cook Inlet beluga whales during 2000–2006. NMFS promulgated harvest regulations for Cook Inlet beluga whales on 15 October 2008 (73 FR 60976), with no hunt allowed after 2006.

In June 2023, NMFS released an updated population estimate for this species of 331 individuals (Goetz et al. 2023), an increase from the previous estimate in 2018 at 279 individuals (Shelden and Wade 2019). Prior to the 2023 abundance estimate, the Cook Inlet beluga whale population exhibited negative growth, with an estimated abundance trend of approximately -2.3 percent per year from 2008 to 2018 (NMFS 2020a) (Figure 3-2), and between 1979 and 2018, this population experienced nearly an 80 percent decline (NMFS 2020a). However, with the 2023 abundance estimate, NMFS reported that, during the 10-year time period (2012–2022), the estimated trend in the abundance estimates now shows a slight increase of 0.9 percent per year, and suggests the population is stable or possibly increasing (Goetz et al. 2023). NMFS suggests that the 2008 to 2018 decline could have been part of a natural oscillation in the population or possibly due to an environmental impact, such as the unprecedented heat wave in the Gulf of Alaska (GOA) during the same time period. A detailed description of Cook Inlet beluga whale biology, habitat, and extinction risk factors may be found in the final listing rule for the species (73 FR 62919), the Conservation Plan (NMFS 2008a), the Recovery Plan (NMFS 2016), and the most recent 5-Year Review (NMFS 2022b). At this time, it is unknown what specific factor—or combination of factors—continues to limit this population's recovery.

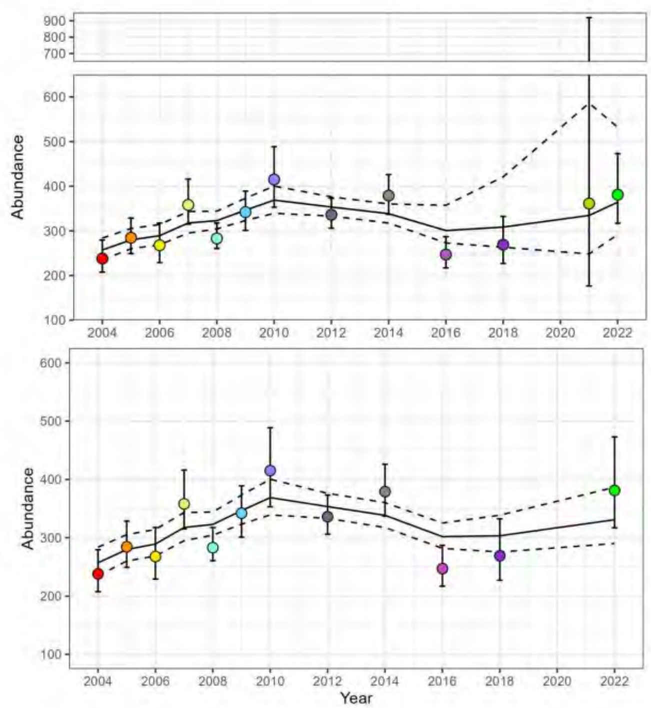


Figure 3-2 Cook Inlet Beluga Whale Annual Abundance Estimates (circles) and 95 Percent Probability Intervals (error bars) for the Survey Period 2004–2022

Note: The moving average is also plotted (solid line), with 95 percent probability intervals (dashed lines). The top panel shows abundance estimates, including data from the 2021 survey and the bottom panel excludes 2021 survey data (from Goetz et al. 2023).

Source: Shelden and Wade 2019

3.1.2 Critical Habitat

Critical habitat for Cook Inlet beluga whale was designated on 11 May 2011 in two areas encompassing 7,800 square kilometers (3,013 square miles) of marine habitat (76 FR 20180) (Figure 3-3). The critical habitat includes all waters of Upper Cook Inlet, with an exclusion area that includes the mouth of Knik Arm, the nearshore areas in the southwestern part of the inlet, and Kachemak Bay (76 FR 20180). The critical habitat is spatially separated into two zones. One of these zones (Area 1) encompasses Knik Arm. A critical habitat exclusion zone occurs near JBER that forms a triangle between Ship Creek, Point MacKenzie, and Cairn Point. In addition, designated critical habitat does not include two areas for which the military has provided an INRMP that NMFS has determined provides benefits to the Cook Inlet beluga whale pursuant to Section 4(a)(3)(B)(i) of the ESA: (1) the ERF Range on Fort Richardson (now referred to as JBER); and (2) military lands of JBER between mean higher high water and mean high water (76 FR 20180). Eagle Bay is part of Area 1, which has been identified by NMFS as the most valuable and is used intensively by beluga whales from spring through fall for foraging and nursery habitat (NMFS 2008a).

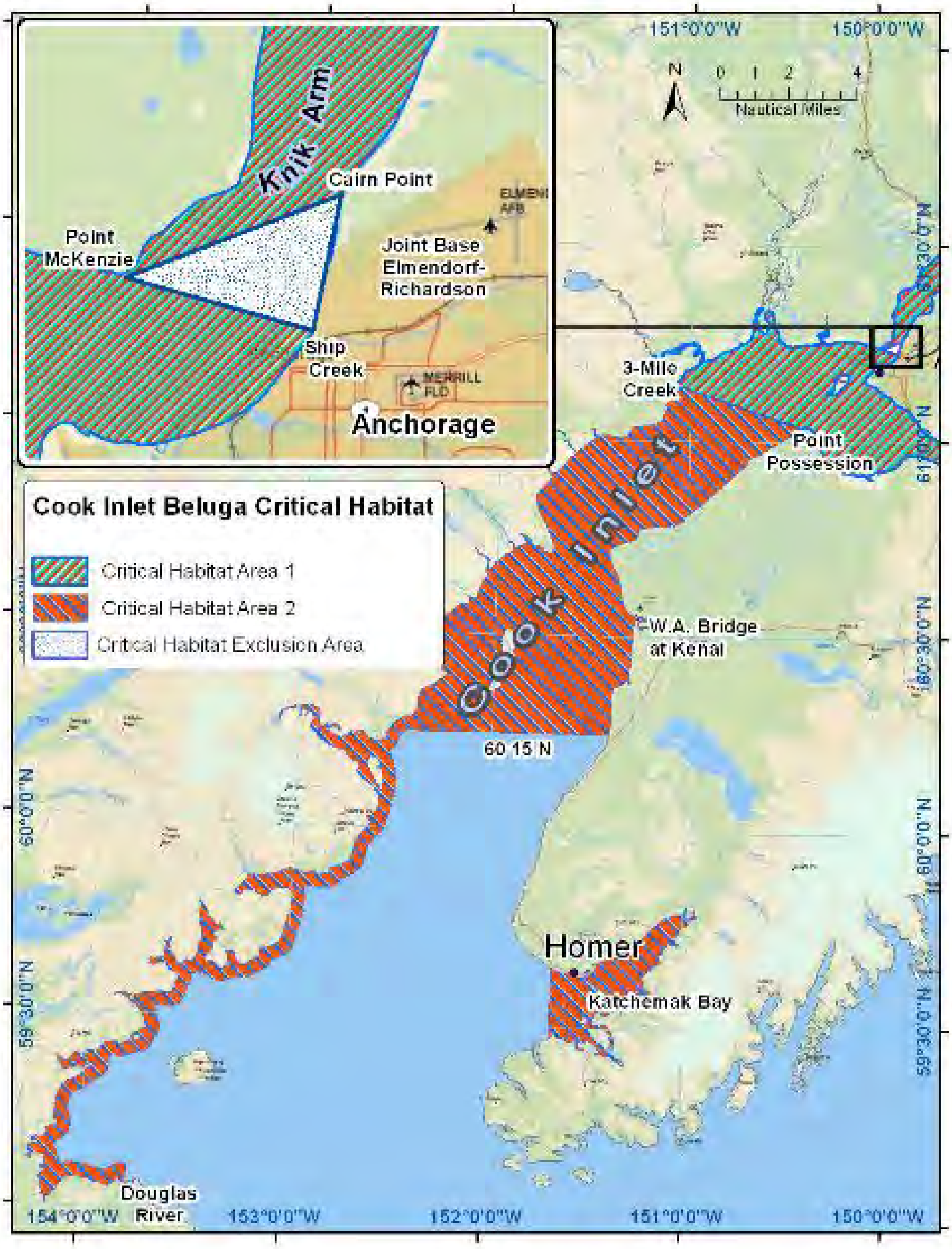


Figure 3-3 Designated Cook Inlet Beluga Whale Critical Habitat

Source: 76 FR 20180, April 2011

Figure 3-4 Designated Cook Inlet Beluga Whale Critical Habitat Near Action Area

NMFS considers PBFs when designating critical habitat. PBFs are characterized by physical and biological features that are essential to the conservation of a given species and that may require special management considerations or protection and may include (1) space for individual and population growth (normal behavior); (2) nutritional and physiological requirements (e.g., food, water, air, light, minerals); (3) cover or shelter; and (4) breeding site (e.g., reproduction, rearing of offspring) habitat protected from disturbance or of historic geographical and ecological distributions of species (76 FR 20180).[7]

The Cook Inlet beluga whale critical habitat final rule (76 FR 20180) included designation of five primary constituent elements (now referred to as PBFs) deemed essential to the conservation of the Cook Inlet beluga whale (50 CFR § 226.220[c]):

1. Intertidal and sub-tidal waters of Cook Inlet with depths less than 29.86 feet (9.1 meters) (MLLW) and within 4.97 miles (8 kilometers) of high and medium flow of anadromous fish streams.
2. Primary prey species—four species of Pacific salmon: Chinook (*Oncorhynchus tshawytscha*), sockeye (*O. nerka*), chum (*O. keta*), and coho salmon; Pacific eulachon (*Thaleichthys pacificus*); Pacific cod (*Gadus macrocephalus*); walleye pollock (*Gadus chalcogrammus*); saffron cod (*Eleginus gracilis*); and yellowfin sole (*Limanda aspera*).
3. Waters free of toxins or other agents of a type and amount harmful to Cook Inlet beluga whales.
4. Unrestricted passage in or between the critical habitat areas.
5. Waters with in-water noise below levels resulting in abandonment of critical habitat areas by Cook Inlet beluga whales.

Potential effects to designated critical habitat resulting from the proposed action will be evaluated through consultation with NMFS OPR as required by Section 7 of the ESA, which will include full consideration of the PBFs listed above. While ERF-IA does not overlap with designated critical habitat for Cook Inlet beluga whale, Eagle River and its associated tributaries do contain the PBFs described above, and the proposed action's effects on these habitat characteristics and their contribution to critical habitat are considered in this BA.

3.1.3 Distribution

The Cook Inlet DPS remains in Cook Inlet throughout the year (Goetz et al. 2012); however, the range of the beluga whale has contracted to the upper reaches of Cook Inlet because of the decline in the population (Rugh et al. 2010). Critical habitat Area 1 encompasses all marine waters of Cook Inlet north of a line connecting Point Possession (61.04°N, 150.37°W) and the mouth of Three Mile Creek (61.08.55°N, 151.04.40°W), including waters in the Susitna, Little Susitna, and Chickaloon Rivers. This area provides important habitat during ice-free months and is used intensively by Cook Inlet beluga whales between April and November (NMFS 2016).

Information on Cook Inlet beluga whale distribution, including aerial surveys and acoustic monitoring, indicates that the species' range in Cook Inlet has contracted markedly since the 1990s (Figure 3-5) (Shelden et al. 2015). Since 1993, NMFS has conducted annual aerial surveys in June, July, or August to document the distribution and abundance of beluga whales in Cook Inlet. The collective survey results show that beluga whales have been consistently found near or in river mouths along the northern shores of Upper Cook Inlet (i.e., north of East and West Foreland). In particular, beluga whale groups are seen in the Susitna River Delta, Knik Arm, and along the shores of Chickaloon Bay. Small groups were seen farther south in Kachemak Bay, Redoubt Bay (Big River), and Trading Bay (McArthur River) prior to 1996, but very rarely thereafter. Since the mid-1990s, most (96 to 100 percent) beluga whales in Upper Cook Inlet have been concentrated in shallow areas near river mouths, no longer occurring in the central or southern

[7] NMFS has updated the definition of PBFs in 50 CFR § 424.12. The description presented here is drawn from the Cook Inlet beluga whale critical habitat final rule for consistency with the rest of the discussion of the final rule.

portions of Cook Inlet (Hobbs et al. 2008). Based on these aerial surveys, the concentration of beluga whales in the northernmost portion of Cook Inlet appears to be consistent from June to October (Rugh et al. 2000, 2004, 2005a, 2005b, 2006, 2007).

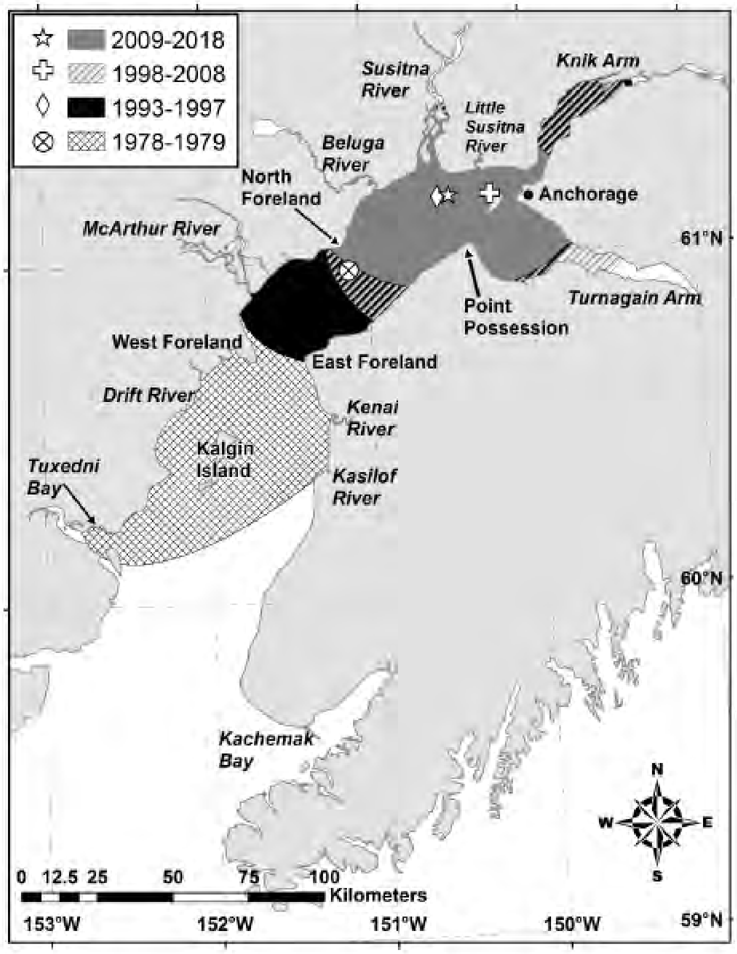


Figure 3-5 Summer Beluga Whale Range Contraction Over Time

Source: Adapted from Shelden and Wade 2019

Beluga whales generally occur in shallow, coastal waters, often barely deep enough to cover their bodies (Ridgway and Harrison 1981). While it is difficult to quantify the importance of various habitats in terms of the health, survival, and recovery of the Cook Inlet beluga whale, NMFS believes that certain areas are particularly important. As part of the conservation strategy detailed in the 2008 Conservation Plan, NMFS assigned relative values to habitats in Cook Inlet based on beluga whale usage (NMFS 2008a). Three "valuable habitat" types were stratified and characterized as follows (Figure 3-6):

- Type 1 Habitat—This habitat region encompasses all of Upper Cook Inlet northeast of a line 3 miles southwest of the Beluga River across to Point Possession. Type 1 habitat is considered the most valuable due to the high concentrations of beluga whales, which use these areas from spring through fall for foraging and nursery habitat. This region is characterized by shallow tidal flats, river mouths, and estuarine areas. The greatest potential for anthropogenic impacts to the Cook Inlet beluga whale population is in Type 1 habitat.

- Type 2 Habitat—This habitat region is south of Type 1 habitat and north of a line at 60.2500 north latitude. It follows the tidal flats south along the western side of the inlet into Kamishak Bay and down to Douglas Reef and includes an isolated section of Kachemak Bay. Type 2 habitat includes areas with known high fall and winter use, as well as some areas of less concentrated spring and summer use.
- Type 3 Habitat—This habitat region encompasses the remaining portions of Cook Inlet south of 60.2500 north latitude to a southern boundary stretching from Cape Douglas to Elizabeth Island. This region includes the areas of known historical usage by beluga whales.

Upper Cook Inlet, including Eagle Bay, is designated Type 1 habitat, which is the most valuable habitat type for Cook Inlet beluga whales.

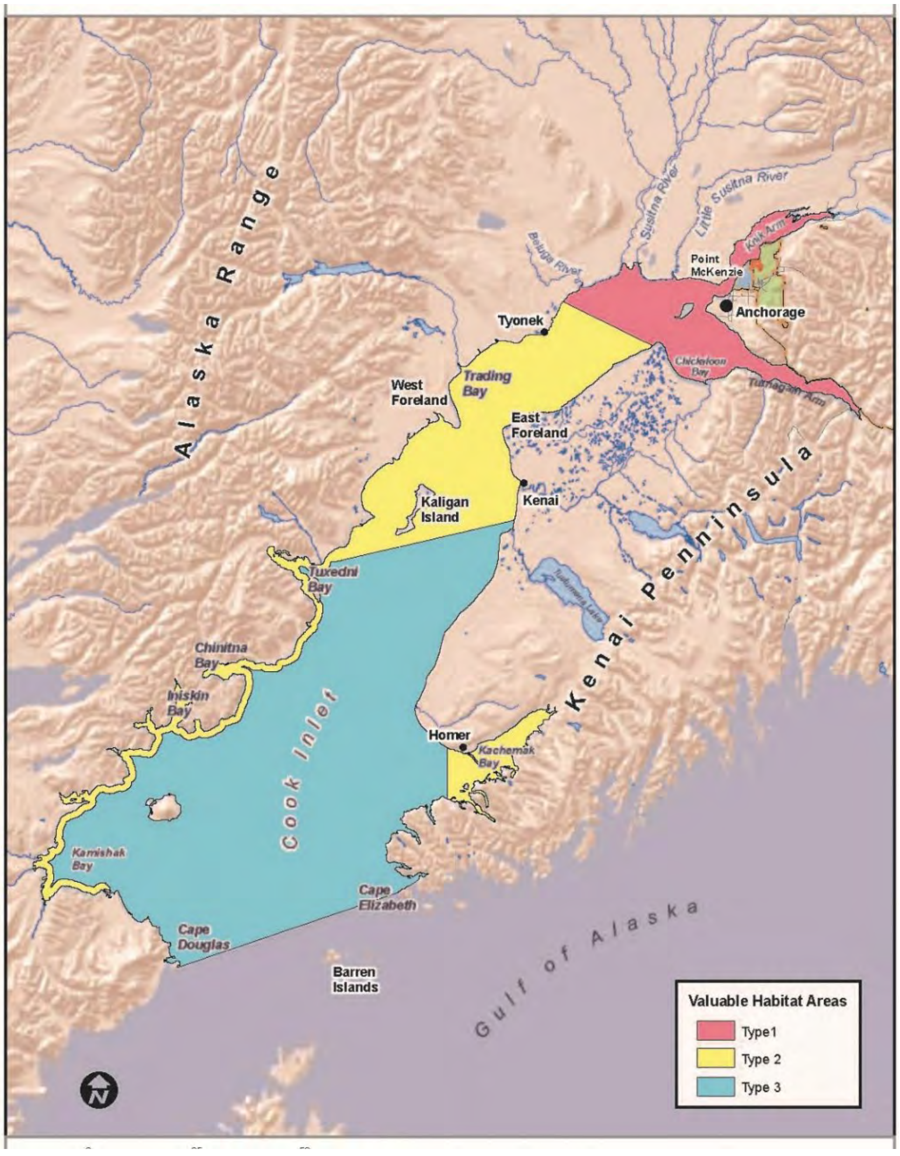


Figure 3-6 Cook Inlet Beluga Whale Valuable Habitat

Source: NMFS 2008a

According to NMFS (2008a), beluga whales in Cook Inlet often congregate near the mouths of rivers and streams where salmon runs occur during summer and fall. During winter they do not appear to be associated with river mouths but instead use the deeper waters of Cook Inlet. This is likely due to a decrease in prey (e.g., anadromous fish such as salmon and Pacific eulachon [*Thaleichthys pacificus*]) at the mouths of rivers and the formation of ice cover, which may hinder or prevent access to coastal areas (Goetz et al. 2012).

Upper Cook Inlet salmon escapement numbers and commercial harvest have fluctuated widely throughout the last 40 years, and there is no clear correlation between salmon runs and beluga whale population numbers. Dense concentrations of prey appear essential to beluga whale feeding behavior, but the relationship between beluga whale concentrations and salmon concentrations is not fully known (NMFS 2008a). Given that beluga whales do not always feed at streams with the highest runs of fish, water depth and fish density may be more important than sheer numbers of fish in their feeding success (NMFS 2008a). The channels and shallow water at some river mouths may concentrate salmon and funnel them past waiting beluga whales.

Very little is known about beluga whale breeding and mating behavior in Upper Cook Inlet. In April and May 2014, potential mating behavior was observed for the first time near the mouth of Middle River and McArthur River, in the west central side of Cook Inlet (Lomac-McNair et al. 2015). The lack of previous observations is likely due to survey timing (most surveys are conducted after early spring during peak beluga whale mating season) and difficulty of observing beluga whales in remote and typically silty waters in Cook Inlet (Lomac-McNair et al. 2015).

Similarly, until recently, little definitive information was known about the location and timing of calving in Cook Inlet (Hobbs et al. 2008), but it was thought that the shallow waters of Upper Cook Inlet may provide important calving and nursery areas (NMFS 2008a). The shallow tidal flats provide warmer water temperatures, which may benefit newborn beluga calves (neonates) that lack the thick insulating blubber layer of adults. Recent findings suggest that groups with calves are not found uniformly dispersed throughout the shallow water areas of Upper Cook Inlet. Certain areas were identified as hot spots (e.g., the Susitna River delta) for groups with calves, but these areas are also favored by beluga groups without calves. Use of shallow warm turbid waters of the upper inlet for calving and nursing is likely driven by greater prey availability than specific hydrographic conditions or other reasons (McGuire et al. 2020a).

McGuire et al. (2020b) suggested a Cook Inlet beluga whale calving season of July–October based on 12 years of photo-identification data gathered in Upper Cook Inlet, with neonates observed at Susitna River Delta, Knik Arm, Turnagain Arm, Chickaloon Bay, and Kenai River Delta. No calving areas were specifically identified in Eagle Bay. In contrast, Alaska Natives had described calving in Cook Inlet between April and August along the northern side of Kachemak Bay (April and May), off the mouths of the Beluga and Susitna Rivers (May), and in Chickaloon Bay and Turnagain Arm during summer (Huntington 2000). They also described northern Knik Arm, near Cottonwood Creek, as a nursery area (Huntington 2000). It is possible that the Cook Inlet beluga whale calving season has changed over time or that differences in survey methodology led to the differences in the estimated calving season (McGuire et al. 2020b). Aerial surveys of Upper Cook Inlet conducted in August (2005–2007 and 2009–2012) by NMFS found that cows with young calves appeared to prefer Knik Arm over the Susitna area or Turnagain Arm (Hobbs et al. 2012) during the survey period.

Researchers conducting photo-identification surveys (2005–2010) in Upper Cook Inlet consistently observed the first neonates of the season around the Susitna Delta but found that beluga whale groups in Knik Arm were more likely to contain calves and neonates than were groups in other areas (McGuire et al. 2008, 2009, 2011; McGuire and Bourdon 2012). Additionally, McGuire et al. (2013) reported that 58 percent of beluga whales positively identified in Eagle Bay were presumed to be reproductive females based on photographic records from 2005 to 2011, and 39 percent of the 69 whales identified in Eagle Bay in 2011 were accompanied by calves. While no distinct calving areas have been identified in published literature, McGuire et al. (2023a) provide evidence, including observations of suspected births, for a calving area in the Susitna River Delta. The authors noted, however, that calving is not restricted to this area as indicted by observations of a suspected birth in Turnagain (2016) and two in Knik Arm (2020 and 2021). Data gathered by JBER at ERF between 2008 and 2014 suggest the following average group composition of beluga whales using ERF based on color only (white versus gray), and color and size (gray whales versus smaller, darker gray calves): white (44 percent), gray (43 percent), and calves (13 percent). McGuire et al. (2013) includes the best available information regarding the potential sex ratio of beluga whales using the area, noting that 58 percent of beluga whales positively identified in Eagle Bay were presumed to be reproductive females based on photographic records from 2005 to 2011. This number can be used as a rough estimate of the minimum proportion of females among the beluga whales that use Eagle Bay. The real proportion is likely much higher because many of the whales not identified as reproductive (based on the presence of a calf during the study period) are also likely females.

3.1.4 Site-Specific Occurrence

Scientific and commercial studies and monitoring data collected in Upper Cook Inlet over the past 20 years were reviewed to evaluate use of the action area by Cook Inlet beluga whale. These include studies conducted by the POA, NMFS, LGL Alaska Research Associates Inc., the Cook Inlet Photo-ID Project, Alaska Pacific University, and JBER. Reports and publications cited in the 2020 POA Petroleum and Cement Terminal (PCT) Biological Opinion (NMFS 2020b) were reviewed, as well as monitoring data collected during POA terminal projects (61N Environmental 2021, 2022a, 2022b; Easley-Appleyard and Leonard 2022).

These data are particularly useful because they include recent information on presence and timing of belugas that are most likely transiting to Upper Knik Arm and Eagle Bay, where the species frequently occurs.

JBER's continuous acoustic and visual data provide the best available information on beluga whale presence in Eagle Bay and Eagle River (JBER unpublished data). JBER data collected between 2008 and 2018 indicate that Cook Inlet beluga whales may occur in ERF-IA from March through December, with substantial presence from August through October (Table 3-2). These periods of use in Eagle Bay are consistent with studies conducted by NMFS and other agencies, academic institutions, and conservation organizations in the Upper Knik Arm from 2005 to present.

Acoustic detections of beluga whales at various mooring locations in Knik Arm from 2008 to 2013 show that beluga whales can be found in Knik Arm year-round but are more frequently observed in the late summer and fall (Castellote et al. 2015, 2020). Foraging buzzes have been acoustically detected in North Eagle Bay and Eagle River, with foraging behavior most prevalent during summer, coinciding with the presence of the different anadromous fish runs (Castellote et al. 2020). Monitoring data collected at the POA from 2020–2022 show a similar trend, with higher abundances from mid-August to mid-October (61N Environmental 2021, 2022a, 2022b; Easley-Appleyard and Leonard 2022).

In 2020 and 2021, marine mammal monitoring was performed in support of the POA PCT Project (61N Environmental 2021, 2022a; Easley-Appleyard and Leonard 2022). Construction monitoring was conducted during in-water work activities from April to November 2020 and April to September 2021, while supplemental monitoring was performed by NMFS on non-pile driving days from July to October 2021. In 2020, marine mammal sightings included 245 groups of belugas comprising 987 individual animals. In 2021, 132 groups of belugas comprising 517 individual animals were sighted. In 2020, the highest abundances were recorded between late August and early September. In 2021, highest beluga sighting rates and longest duration periods were observed during September (61N Environmental 2021). The 2021 NMFS supplemental monitoring found that September had the highest sighting rate, with 4.08 whales per hour, followed by October and August (3.46 and 3.41, respectively) (Easley-Appleyard and Leonard 2022). Additional marine mammal monitoring was performed in May and June 2022 in support of the POA South Float Dock Construction Project (61N Environmental 2022b). The study was conducted outside of peak beluga use periods but did observe 9 groups of belugas comprising 41 individual animals during the monitoring period. NMFS compared JBER data to POA monitoring data and found evidence that beluga whales observed near the POA were traveling north and may spend time at Eagle Bay and potentially in Eagle River (NMFS 2023).

Table 3-2 Summary of Sighting Rates (i.e., Percent Positive Detection Days) Per Month for Cook Inlet Beluga Whale Acoustic (Year-Round) and Visual (Seasonal) Monitoring at JBER

% Positive Detection by Month at Eagle Bay and Eagle River, 2008-2018	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	4%	42%	7%	13%	12%	81%	86%	52%	33%	20%

Notes: The months in which more than 50 percent of days had a positive detection are highlighted in red; months when more than 30 percent of days had a positive detection are highlighted in yellow. A positive detection day is a day in which at least one Cook Inlet beluga whale detection, acoustic and/or visual, was logged during the 24-hour period.

Key: JBER = Joint Base Elmendorf-Richardson.

Source: JBER unpublished data.

From 2019 to 2023, the Alaska Beluga Monitoring Program, led by NOAA Fisheries, has monitored for beluga whales at the Ship Creek Small Boat Ramp, located approximately 10 miles southwest of Eagle Bay (AKBMP 2023). Intermittent monitoring has been conducted during the spring (March–May) and fall (August–November) months. A total of 455 sightings of beluga whales (non-unique individuals) was reported during the fall monitoring seasons. The number of beluga whales observed during a single monitoring session at Ship Creek ranged from 1 to 33 individuals. While belugas have been observed sporadically from August to mid-November, most belugas at this site are sighted during August and September (AKBMP 2023). Only three belugas were observed in the spring over the years 2021 through 2023. Among the beluga whales observed at Ship Creek, 60 percent of the recorded sightings were adults, 17 percent were subadults, 16 percent were categorized as unknown age, and 7 percent were calves (AKBMP 2023).

McGuire et al. (2017) reported that during boat- and land-based photo-identification surveys, large concentrations of beluga whales were present in Knik Arm from mid-August through mid-September. During this period, their movements in the area were typically characterized by traveling to Upper Knik Arm with the high tide and following the low tide down to Eagle Bay and the POA.

At JBER, there have been regular recorded sightings of beluga whales over the past two decades. Starting in 2005, standard operating procedures and monitoring protocols for beluga whales were implemented in and around ERF-IA, and intensive field surveys for beluga whales have been conducted from June through October of each year. In 2008, the survey methodology was modified to allow the capture of more statistically rigorous data.

Beginning in 2009, passive acoustic monitoring (PAM) was deployed to gain a more thorough picture of beluga presence in Eagle Bay and Eagle River. PAM efforts have continued through 2023. Unlike human observers, PAM can be deployed during all periods of the day and during all types of weather. In addition, PAM does not rely on visual cues for detection of whales; therefore, the persistent turbid conditions in Knik Arm do not appear to hinder acoustic detections under most circumstances. The use of PAM, while proving effective at gathering beluga whale presence/absence data and showing promise for future monitoring of specific behavioral states, is not without its limitations. Knik Arm is extremely dynamic, with widely varying bathymetry, huge tidal variation, strong currents, heavy ice cover in the winter, and a heavy burden of silt leading to rapid sedimentation in certain areas. Many instruments (and therefore data) have been lost in Eagle Bay and Eagle River from a combination of bank failures, ice entrainment, sedimentation, ice scour, physical damage from debris, and other unknown causes. In addition, deployment locations must be carefully chosen relative to bathymetry in order to avoid acoustic shadowing by hidden bottom features like bars and channels (JBER unpublished data 2015).

Since 2008, federal biologists (in addition to biologists from Colorado State University) have conducted annual visual observations of belugas and other marine mammals from a shore-based observation station at the mouth of Eagle River (usually June–November). Observers used a systematic sampling design consisting of a group follow protocol and focal group sampling method (Mann 1999) to record number, composition, behavior, and movement data on groups of whales over the course of serial 20-minute sampling rounds using naked eye, binoculars, and high-powered spotting scopes, depending on the distance from the group. Whale numbers were estimated using multiple instantaneous scans conducted throughout each 20-minute sampling round. Biologists conferred at the end of the day to provide a final estimate for the total number of whales observed for that day. Whale numbers were summed for each month across the years 2019 and 2021–2023. The total whale number observed per month across those 4 years[8] was then divided by the total number of days of observation in which whales were present per month across the same duration to produce a daily mean Cook Inlet beluga whale group size per month (Figure 3-7). Note that the month of August is depicted in two segments (1–14 August and 15–31 August) in Figure 3-7, to facilitate estimation of potential take during the first half of the month, a period in which HE rounds would be fired under the proposed action. Group size in this context refers to the maximum number of whales observed per day within the visual field (Eagle Bay) (i.e., whales are all within Eagle Bay at one time). This could also be described as a "supergroup" in that often, multiple distinct groups of whales move into Eagle Bay and merge into one large group.

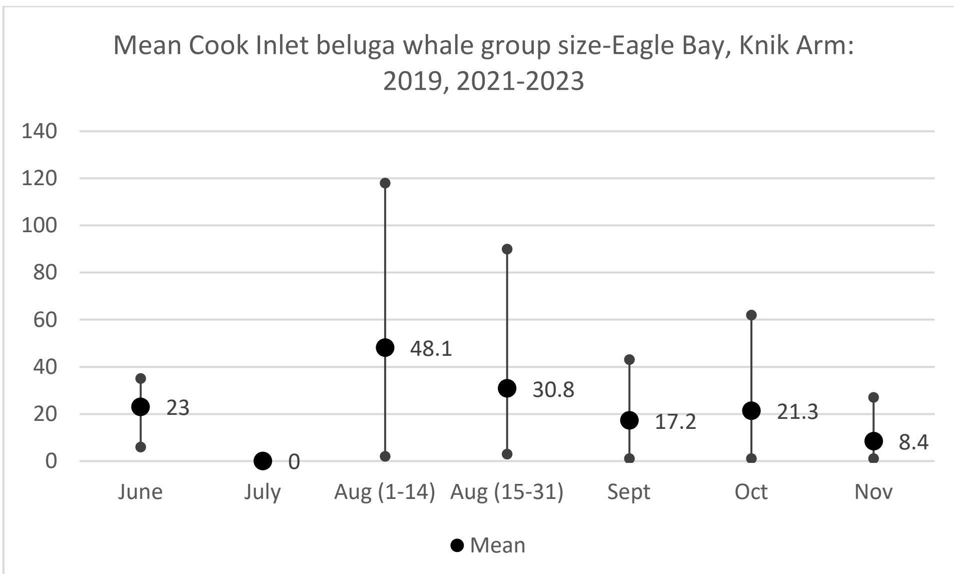


Figure 3-7 Mean (Minimum and Maximum also Depicted) Size of Daily Cook Inlet Beluga Whale Groups per Month Observed in Eagle Bay of Knik Arm, Upper Cook Inlet, Alaska, for Years 2019, 2021, 2022, and 2023

Notes: August is broken into two halves. The first half of the month, a period during which HE could be fired under the proposed action. Group size in this context refers to the maximum number of whales observed per day within the visual field (Eagle Bay) (i.e., whales are all within Eagle Bay at one time). This could also be described as a "supergroup" in that often, multiple distinct groups of whales move into Eagle Bay and merge into one large group (i.e., supergroup). Note that no observations were conducted in 2020 due to Covid 19 restrictions.

Overall, the Eagle Bay/Eagle River area appears to be an important area for a substantial portion of the Cook Inlet beluga whale population during the open water (not frozen) months. McGuire et al. (2013) found that 78 percent of the 307 Cook Inlet beluga whales in their photographic catalogue, representing most (if not all) of the population, had visited Eagle Bay at least once between 2005 and 2011. Large groups of beluga whales, occasionally exceeding 100 animals at once, move into the area where they travel, mill, feed, and socialize. Beluga whale groups in Eagle Bay usually consist of a mixture of white (presumably

[8] This time frame was used to depict the most recent data available, with the understanding that beluga group sizes and movement patterns can change over time. For instance, McGuire et al. (2023b) reported decreasing maximum Cook Inlet beluga whale group sizes in Upper Cook Inlet based on photo-identification conducted between 2005 and 2022. Similarly, Wade and Shelden (2023), noted smaller Cook Inlet beluga whale group sizes in 2021 and 2022 as compared to previous studies.

adults), gray (some adult and some juveniles/calves), calves, and newborn calves, with a large number of animals presumed to be reproductive females. McGuire et al. (2013) found that 39 percent of the beluga whales identified in Eagle Bay in 2011 were accompanied by calves.

The most intensive use of Eagle Bay/Eagle River by beluga whales occurs between August and November (Figure 3-8 through Figure 3-10).

Sighting rates for beluga whales are from visual observational studies conducted by JBER at the mouth of Eagle River from 2008 to 2014. Percentages of detected positive days (DPD; Figure 3-7) are from a combination of visual observational studies and PAM conducted by JBER at the mouth of Eagle River and in Eagle Bay from 2009 to 2015. Percentages of each month with positive beluga detections in Eagle River mouth (Figure 3-8) are from PAM in Eagle River and the mouth of Eagle River from 2018 to 2021. Beluga whale use of Eagle River appears to be concentrated between the mouth and about 1.5 kilometers (river distance) upstream, though beluga whales have been known to travel as far as 4.2 kilometers (river distance) upstream (JBER 2023a). These far-reaching forays occur from June through mid-November, with the bulk of far upstream movement occurring from mid-August to the end of September (JBER unpublished data).

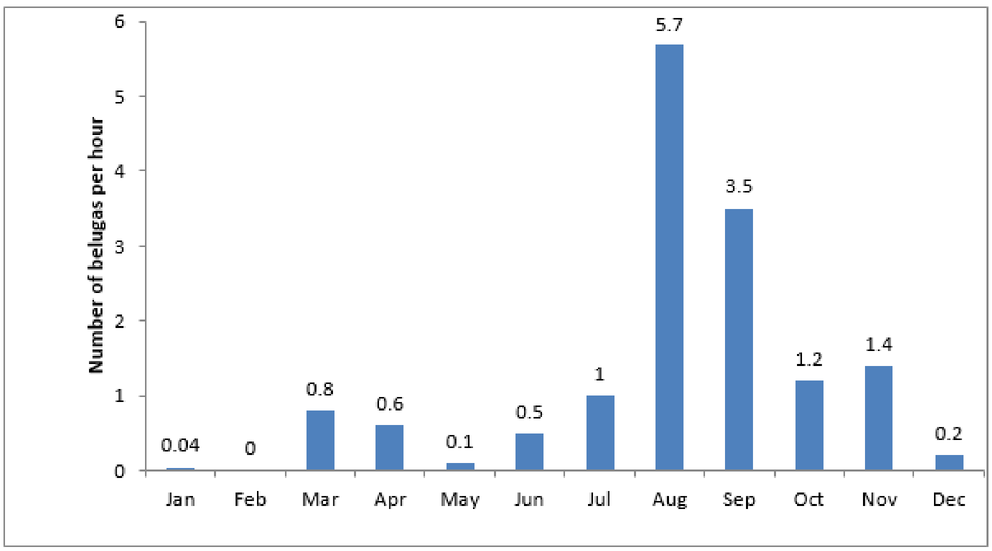


Figure 3-8 Monthly Sighting Rates of Cook Inlet Beluga Whales in Knik Arm

Note: Detections in whales per hour, from visual observational studies conducted by JBER 2008 to 2018

Source: JBER unpublished

Table 3-3 Monthly Sighting Rates for Beluga Whales at JBER (2008–2018)

July				
Year	**Total Effort (min)**	**Total Effort (hrs)**	**Total Whales**	**Sighting Rate (whales/hr)**
2008	3,147	52.45	59	1.12
2009	5,423	90.38	0	0.00
2010	10,974	182.90	7	0.04
2011	4,919	81.98	3	0.04
2012	8,281	138.02	4	0.03

2013	6,629	110.48	0	0.00
2014	1,523	25.38	0	0.00
2015	224	3.73	12	3.21
2016	188	3.13	0	0.00
2017	0	0.00	0	N/A
2018	385	6.42	0	0.00
			Mean	**0.44**
August				
Year	**Total Effort (min)**	**Total Effort (hrs)**	**Total Whales**	**Sighting Rate (whales/hr)**
2008	2,782	46.37	323	6.97
2009	4,162	69.37	348	5.02
2010	9,339	155.65	1,172	7.53
2011	9,889	164.82	895	5.43
2012	8,565	142.75	510	3.57
2013	9,737	162.28	542	3.34
2014	4,386	73.10	611	8.36
2015	2,303	38.38	413	10.76
2016	3,784	63.07	401	6.36
2017	272	4.53	44	9.71
2018	2,326	38.77	230	5.93
			Mean	**6.63**
September				
Year	**Total Effort (min)**	**Total Effort (hrs)**	**Total Whales**	**Sighting Rate (whales/hr)**
2008	3,182	53.03	238	4.49
2009	3,800	63.33	188	2.97
2010	8,314	138.57	499	3.60
2011	7,906	131.77	262	1.99
2012	8,528	142.13	331	2.33
2013	8,596	143.27	696	4.86
2014	4,586	76.43	342	4.47
2015	1,082	18.03	104	5.77
2016	1,000	16.67	159	9.54
2017	587	9.78	138	14.11
2018	2,059	34.32	116	3.38
			Mean	**5.23**

October				
Year	**Total Effort (min)**	**Total Effort (hrs)**	**Total Whales**	**Sighting Rate (whales/hr)**
2008	1,212	20.20	60	2.97
2009	3,680	61.33	148	2.41
2010	6,493	108.22	143	1.32
2011	6,945	115.75	19	0.16
2012	7,564	126.07	17	0.13
2013	10,589	176.48	97	0.55
2014	2,883	48.05	51	1.06
2015	2,135	35.58	93	2.61
2016	0	0.00	N/A	N/A
2017	0	0.00	N/A	N/A
2018	0	0.00	N/A	N/A
			Mean	**1.40**
November				
Year	**Total Effort (min)**	**Total Effort (hrs)**	**Total Whales**	**Sighting Rate (whales/hr)**
2008	1,978	32.97	16	0.49
2009	0	0.00	N/A	N/A
2010	3,030	50.50	110	2.18
2011	5,002	83.37	6	0.07
2012	6,560	109.33	20	0.18
2013	42,57	70.95	261	3.68
2014	585	9.75	18	1.85
2015	0	0.00	N/A	N/A
2016	0	0.00	N/A	N/A
2017	0	0.00	N/A	N/A
2018	0	0.00	N/A	N/A
			Mean	**1.41**
Density of Beluga Whales in Eagle Bay during Dec-June 2005 Estimated from Funk et al. (2005) Sighting Rates				
Month	**Sighting Rate per 20 Min per Location (whales/20 min)**			**Sighting Rate per Hour**
	Cairn Point[3]	**Sixmile[3]**	**Birchwood[3]**	**(whales/hr)**
Dec	0.02	--	0.14	0.42
Jan	0.02	0.02	0	0.06
Feb	0	0.00	0	0.00
Mar	0.4	0.40	0	1.20

Apr	0.52	0.10	0.02	1.56
May	0.08	0.02	0	0.24
Jun	0.1	0.34	0.02	1.02

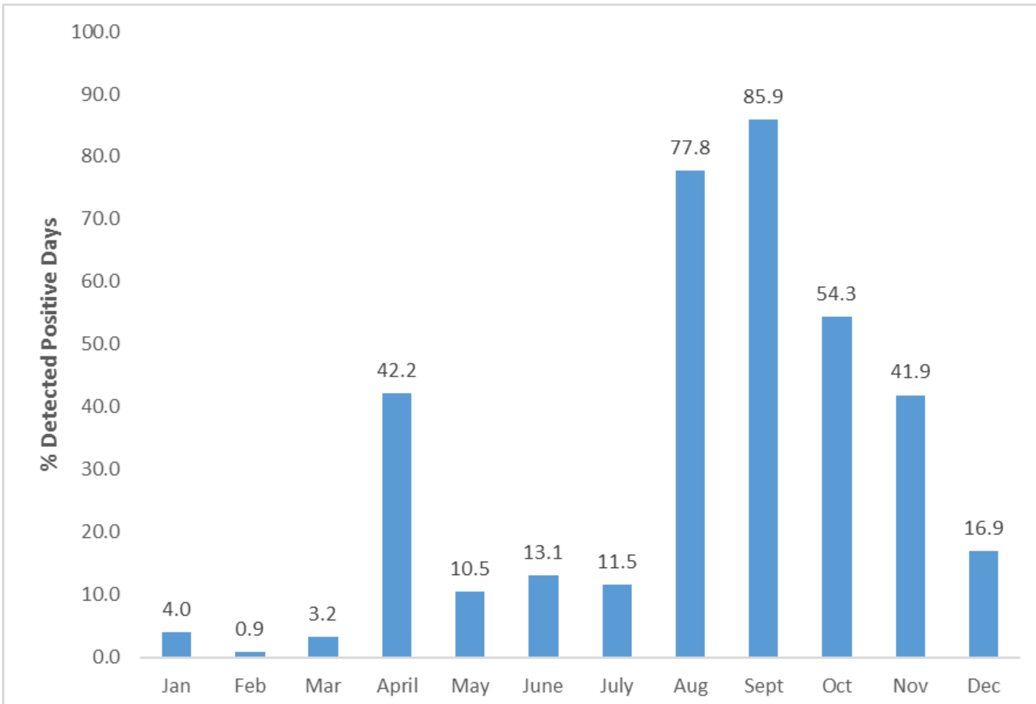


Figure 3-9 Percent Observation/Monitor Days with Positive Presence of Cook Inlet Beluga Whales in Knik Arm in or Near Eagle Bay

Note: Detections from combination of visual observational studies and passive acoustic monitoring conducted by JBER 2009 to 2015

Source: JBER unpublished

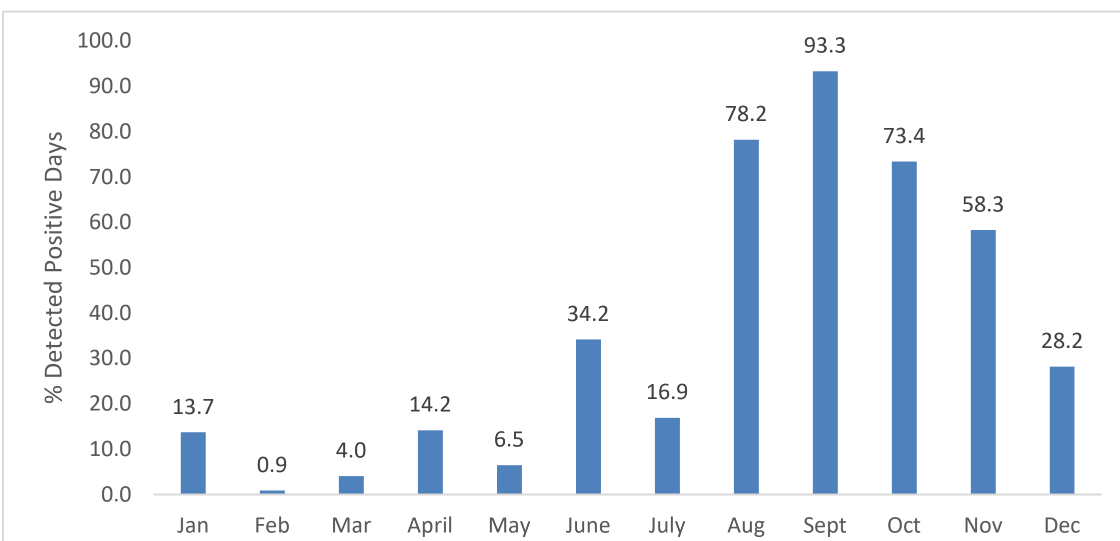


Figure 3-10 Percentage of Month with Positive Beluga Detections in Eagle River Mouth

Notes: Detections from passive acoustic monitoring 2018 to 2021.

Source: JBER unpublished

3.2 STELLER SEA LION

3.2.1 Status and Management

Two Steller sea lion DPSs are present in the waters of Alaska: Western and Eastern. Only the Western DPS is present in Cook Inlet and surrounding waters (Muto et al. 2021). However, some level of sympatry occurs with movements of individuals (particularly juveniles and adult males) between the two DPSs across the population boundary line at 144°W (Baker et al. 2005; Jemison et al. 2013, 2018). DPSs were classified based on distributional data, differences in population dynamics, and phenotypic and genotypic differences (Muto et al. 2021).

As summarized by Muto et al. (2021), the Western DPS of Steller sea lions decreased from an estimated 220,000 in the late 1970s to less than 50,000 in 2000. The population has generally increased slightly since the early 2000s, but this trend has not been observed in all areas of the population's range. Because neither a current population size nor a pup multiplier to estimate population size are known, an abundance estimate cannot be calculated (Muto et al. 2021). The agTrend model was used to estimate Western Steller sea lion pup and non-pup counts of 12,581 and 40,351, respectively, in Alaska in 2019 (Muto et al. 2021). The sum of 52,932 is used as the minimum population size for the U.S. portion of the Western DPS of Steller sea lions.

The Western DPS of Steller sea lions is currently listed as endangered under the ESA and depleted under the MMPA (Muto et al. 2021). Consequently, this DPS is considered a strategic stock under the MMPA (Muto et al. 2021). The minimum mean annual commercial fishery-related mortality and serious injury is above the potential biological removal threshold and is not considered insignificant; however, the total estimated annual level of human-caused mortality and serious injury is below the potential biological removal threshold (Muto et al. 2021). Key uncertainties exist in these estimations, as the amount of exchange between the two DPSs is not known, and the previous documented population decline is not explained by the documented levels of direct human-caused mortality and serious injury (Muto et al. 2021).

NMFS designated critical habitat for the Steller sea lion on 27 August 1993 (58 FR 45269), but critical habitat is not present in the action area.

3.2.2 Distribution

Steller sea lions' range along the North Pacific rim from northern Japan to California and occupy more than 300 haul-out sites (Loughlin et al. 1984) (Figure 3-11). NMFS has been able to delineate two discrete population segments of Steller sea lions within their geographic range: an eastern segment, which includes animals east of Cape Suckling, AK (144 °W. long.) and a western segment (Western DPS), which includes animals at and west of Cape Suckling, AK (62 FR 24345). Sea lions that breed in Asia are considered part of the Western DPS, although the only breeding colonies outside of Alaska are in Russia (Muto et al. 2021).

Land sites used by Steller sea lions are referred to as rookeries and haul-out sites. Rookeries are used by adult sea lions for pupping, nursing, and mating during the reproductive season (generally from late May to early July). Most adult Steller sea lions occupy rookeries from late May to early July (Gisiner 1985).

3.2.3 Site-Specific Occurrence

Little site-specific information is available for Steller sea lions in the proposed action area. Steller sea lions are rarely present in Knik Arm. While Steller sea lions primarily inhabit Lower Cook Inlet, they occasionally venture into Upper Cook Inlet and Knik Arm and may be attracted to salmon runs in the region (NMFS 2021). To JBER's knowledge, there are no published Steller sea lion densities for Upper Cook Inlet or known haul-out sites; the most robust data available come from the 2020 and 2021 Port of Alaska observation program.

In 2009, a single Steller sea lion was observed in transit in Eagle Bay. During long-term, intermittent marine mammal monitoring at the Port of Alaska, Steller sea lions were observed in 2009, 2016, 2020, 2021, and 2022 (NMFS 2021; 61N Environmental 2021, 2022a, 2022b). During the most recent Port of Alaska monitoring projects (2020–2022), a total of 18 Steller sea lions were observed (although some may have been resightings), with individuals detected intermittently between May and September (NMFS 2021; 61N Environmental 2021, 2022a, 2022b; Easley-Appleyard and Leonard 2022). Based on these data, occurrence of Steller sea lions in the action area region is considered likely but infrequent and in low numbers.

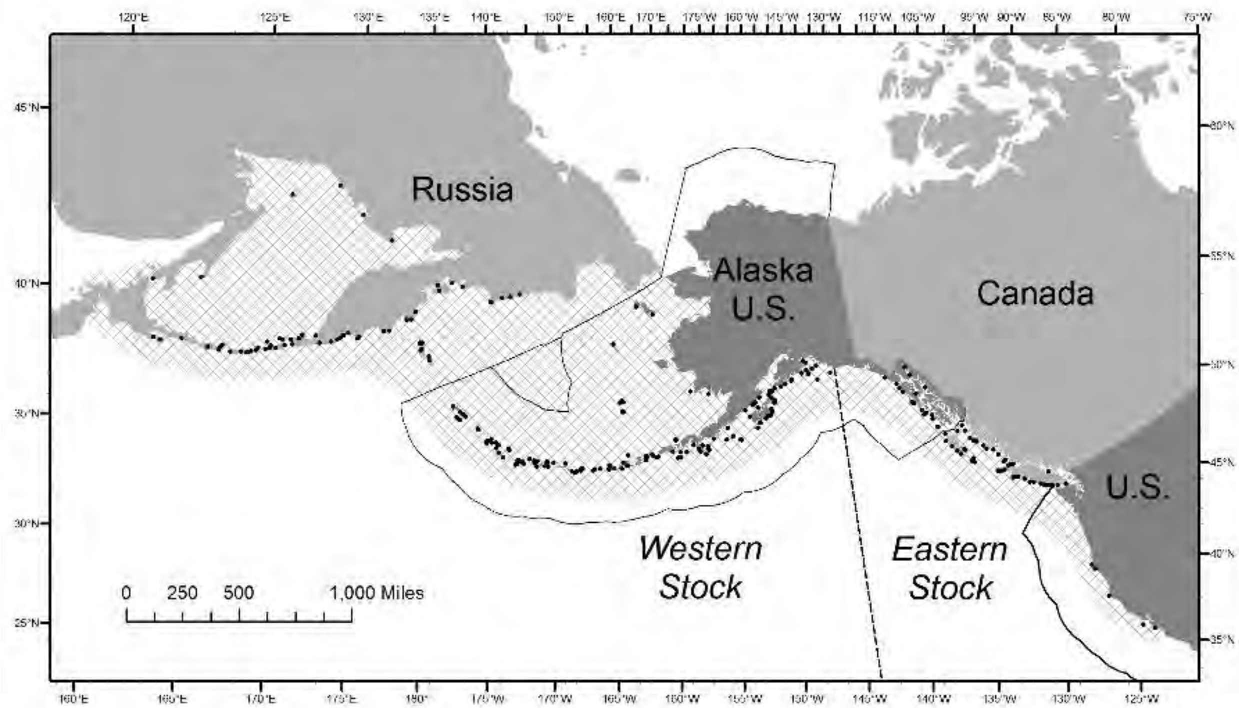


Figure 3-11 Distribution of Steller Sea Lions in the North Pacific

Note: Generalized distribution (crosshatched area) of Steller sea lions in the North Pacific and major U.S. haulouts and rookeries (50 CFR 226.202, 27 August 1993), as well as active Asian and Canadian (British Columbia) haulouts. Black dots indicate haulouts, a black dashed line (144°W) indicates the stock (DPS) boundary, and a black line delineates the U.S. Exclusive Economic Zone.

Source: Muto et al. 2021

4.0 ENVIRONMENTAL BASELINE

This section describes the environmental baseline, focusing on current habitat conditions and anthropogenic and natural activities in the action area and their influences on habitats used by listed species, including designated critical habitat. Species and critical habitat that may be affected by the proposed action include Cook Inlet beluga whales, Cook Inlet beluga whale critical habitat, and Western DPS Steller sea lions. These listed species—as well as other resident marine mammal species—may be impacted by a number of anthropogenic activities present in Cook Inlet. This section includes information outlined in recent biological opinions for proposed projects near the action area, including Hilcorp Alaska and Harvest Alaska Oil and Gas Activities, Cook Inlet, Alaska (NMFS 2019); the POA's PCT Project, Anchorage, Alaska (NMFS 2020b); and information from the 2016 Recovery Plan for the Cook Inlet Beluga Whale (NMFS 2016). The high degree of human activity—especially in Upper Cook Inlet—has produced anthropogenic risk factors that marine mammals must contend with, including coastal and marine development, oil and gas development, ship strikes, noise pollution, water pollution, prey reduction, direct mortalities, and research.

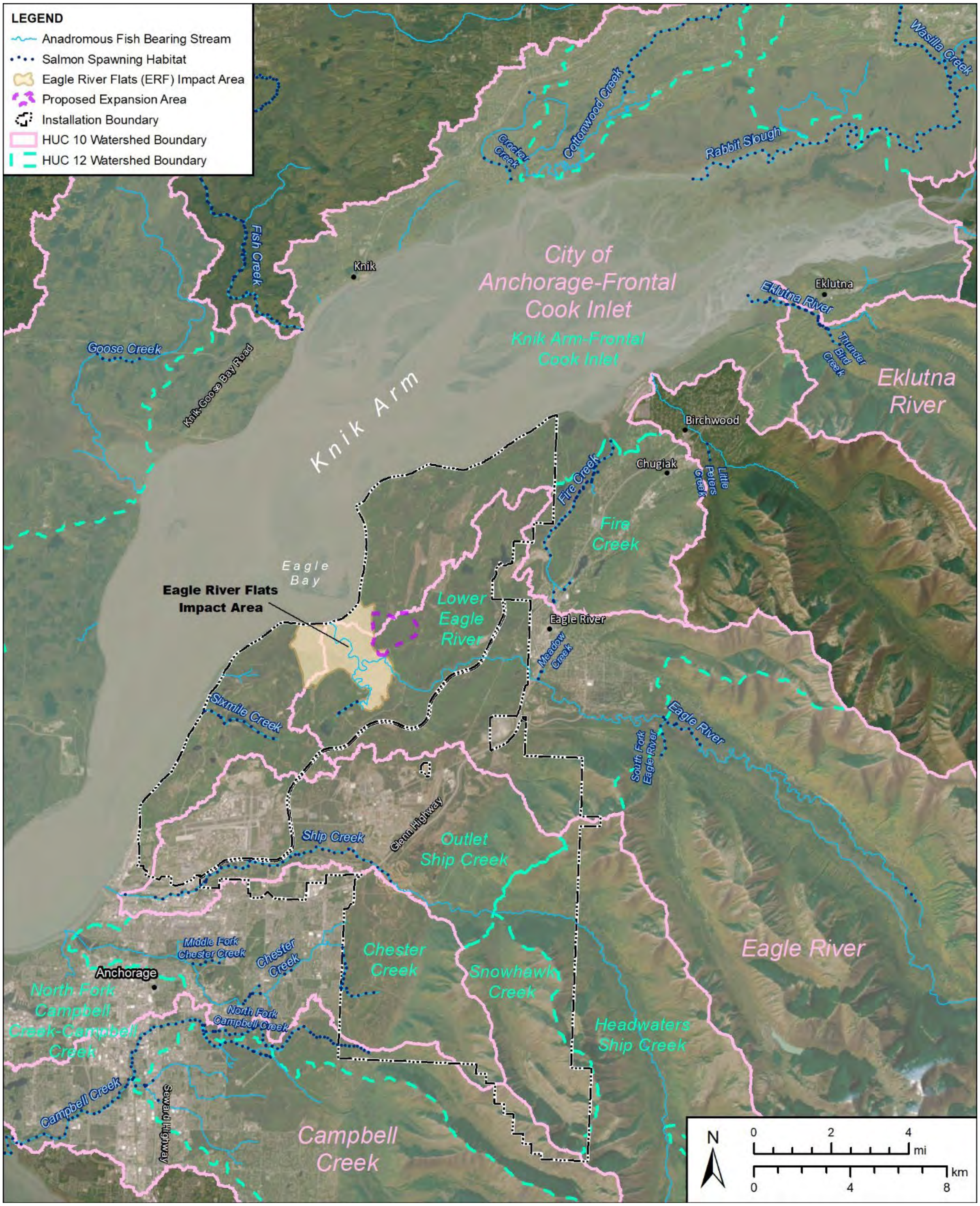
As described in Section 1.3.1, ERF-IA has been used for live-fire training for decades. With restrictions on live-fire activities since 1990, no indirect live-fire training has occurred at ERF-IA during the ice-free months when beluga whales are present. This means that at the times of the year when beluga whales frequent the action area, live-fire training has not occurred on JBER and, therefore, has not affected the Cook Inlet beluga whale population recovery. This conclusion is further supported by the fact that all-season live-fire weapons training at ERF-IA has historically occurred at levels greater than those outlined in the proposed action, with no measurable or even circumstantial impact to the Cook Inlet beluga whale population.

4.1 PHYSICAL AND BIOLOGICAL CONDITIONS

Knik Arm represents the northernmost extension of Upper Cook Inlet, and its waters bound approximately 20 miles of the northwestern portion of JBER (Figure 4-1). Knik Arm is typified by high turbidity, extreme tidal variation, strong tidal currents, expansive mudflats exposed at low tides, and high winter ice scour. Knik Arm is approximately 31 miles long by 5 miles wide and is highly variable in depth, with a central trench in the southernmost part of the arm reaching depths of -160 feet MLLW. This trench eventually splits into two shallower channels that follow both coasts around a large mudflat centered between Goose and Eagle Bays.

Eagle Bay is at the convergence of Knik Arm and Eagle River. The channel in Eagle Bay reaches depths of -30 feet MLLW and is closely associated with the shoreline of JBER, a nearly contiguous stretch of eroding bluffs reaching elevations of 150 feet. The bathymetry adjacent to Eagle Bay is dominated by mudflats exposed at MLLW and intersected by shifting networks of narrow tidal channels. Tidal activity in Eagle Bay has created an estuarine salt marsh encompassing ERF. Numerous ponds dot the marsh. Many are shallow mudflat ponds, less than 6 inches deep, that often dry up during summer. Others are more permanent, with depths greater than 20 inches. These deeper ponds often are fed by freshwater streams and springs.

Knik Arm receives much of its fresh water from eight rivers and streams (Chester Creek, Ship Creek, Eagle River, Peters Creek, Eklutna River, Knik River, Matanuska River, and Little Susitna River), with additional freshwater systems also contributing. At present, the Eklutna Dam helps prevent sedimentation into Eklutna River from Eklutna Lake and the glaciers around it. The glacial Knik and Matanuska Rivers contribute by far the most suspended sediment (Smith 2004). This suspended sediment, combined with glacial till eroding from high bluffs lining the arm, as well as sediment resuspended by turbulent conditions, contribute greatly to the high prevailing turbidity of the water in Knik Arm. The average natural turbidity of Knik Arm typically ranges from 400 to 600 nephelometric turbidity units (NTUs) (USACE 2017); higher turbidity is



Sources: ADF&G 2022a; JBER 2018, 2020a, 2020b, 2023b, 2023c; USGS 2020a; MOA 2019
Basemap: Esri, Maxar, and other contributors

Figure 4-1 Watersheds and Major Waterbodies in the Proposed Project Area and Vicinity

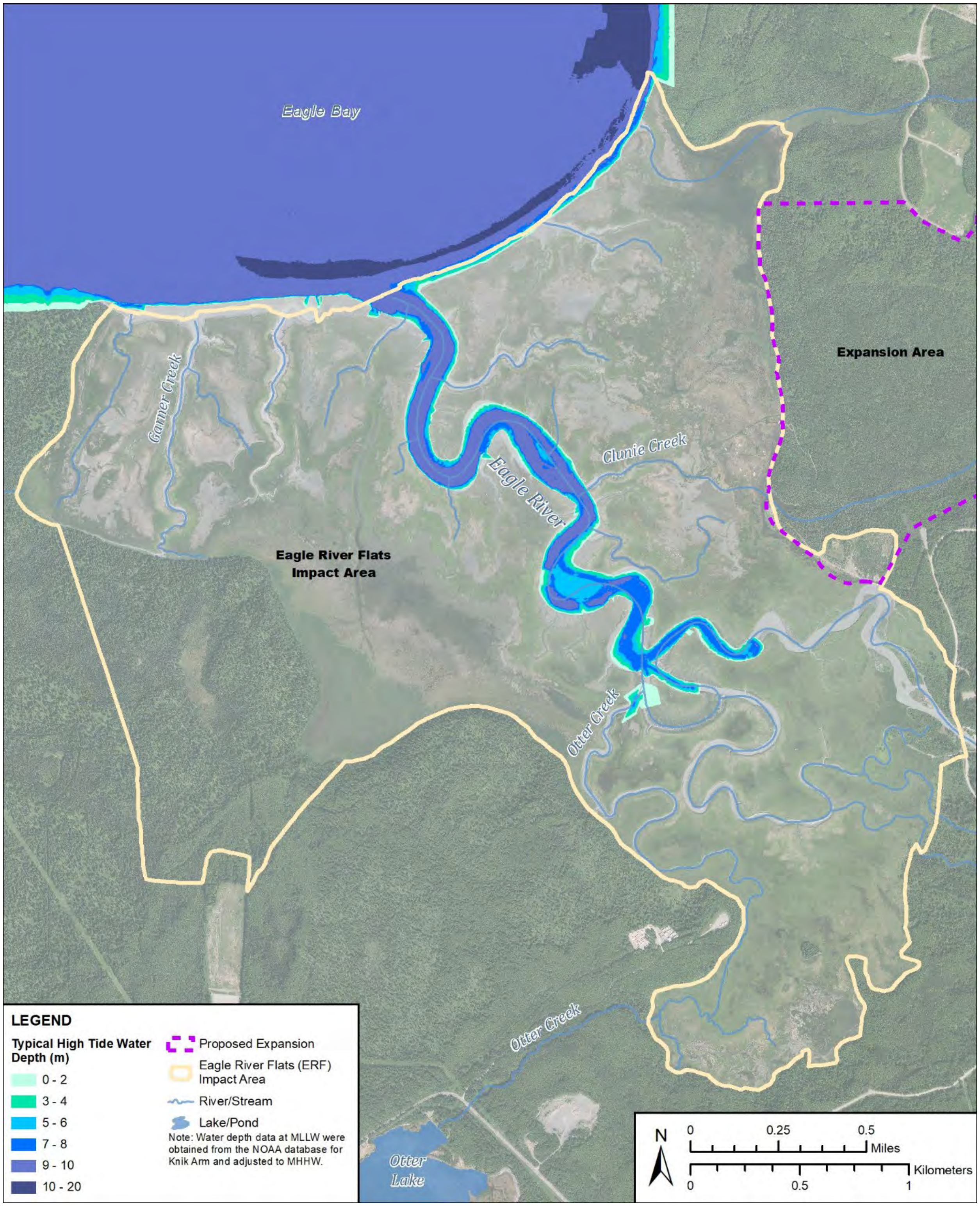
generally associated with the upper arm. In 2004 and 2005, between April and July, turbidity near Eagle Bay was 629 NTU (Pentec Environmental 2005). The turbulent nature of the system mixes the water and maintains relatively high dissolved oxygen concentrations throughout the entire water column. During periods of low wave activity, and in areas lacking vertical turbulence, a thin surface layer (4–10 centimeters) may be clear at times. However, overall high suspended sediment loads inhibit light penetration beyond the surface layer, which contributes to low water column primary productivity.

Nearshore estuaries such as Eagle Bay are rich in organic and detrital material that provide energy and essential nutrients to algae, plankton, and invertebrate species such as polychaete worms, mysids, and amphipods. These species provide the foundation for estuarine and nearshore trophic interactions that benefit forage fish, flatfish, groundfish, and invertebrates during larval and juvenile life stages. The presence, abundance, and biodiversity of Alaskan fish species in nutrient-rich, nearshore nursery habitats are well documented (Norcross et al. 1995; Abookire et al. 2000; Abookire and Piatt 2005; Johnson et al. 2012, cited in Windward 2014). Eagle Bay provides foraging habitat for marine mammals and appears to be important for a substantial portion of Cook Inlet beluga whales during the ice-free months. In addition, beluga whales tend to move with the tide through Eagle Bay, concentrating movement through a relatively deep channel that hugs the shoreline from the northern tip of Eagle Bay to the southern bank of Eagle River (shown in dark blue in Figure 4-2).

4.1.1 Tidal Conditions and Flooding

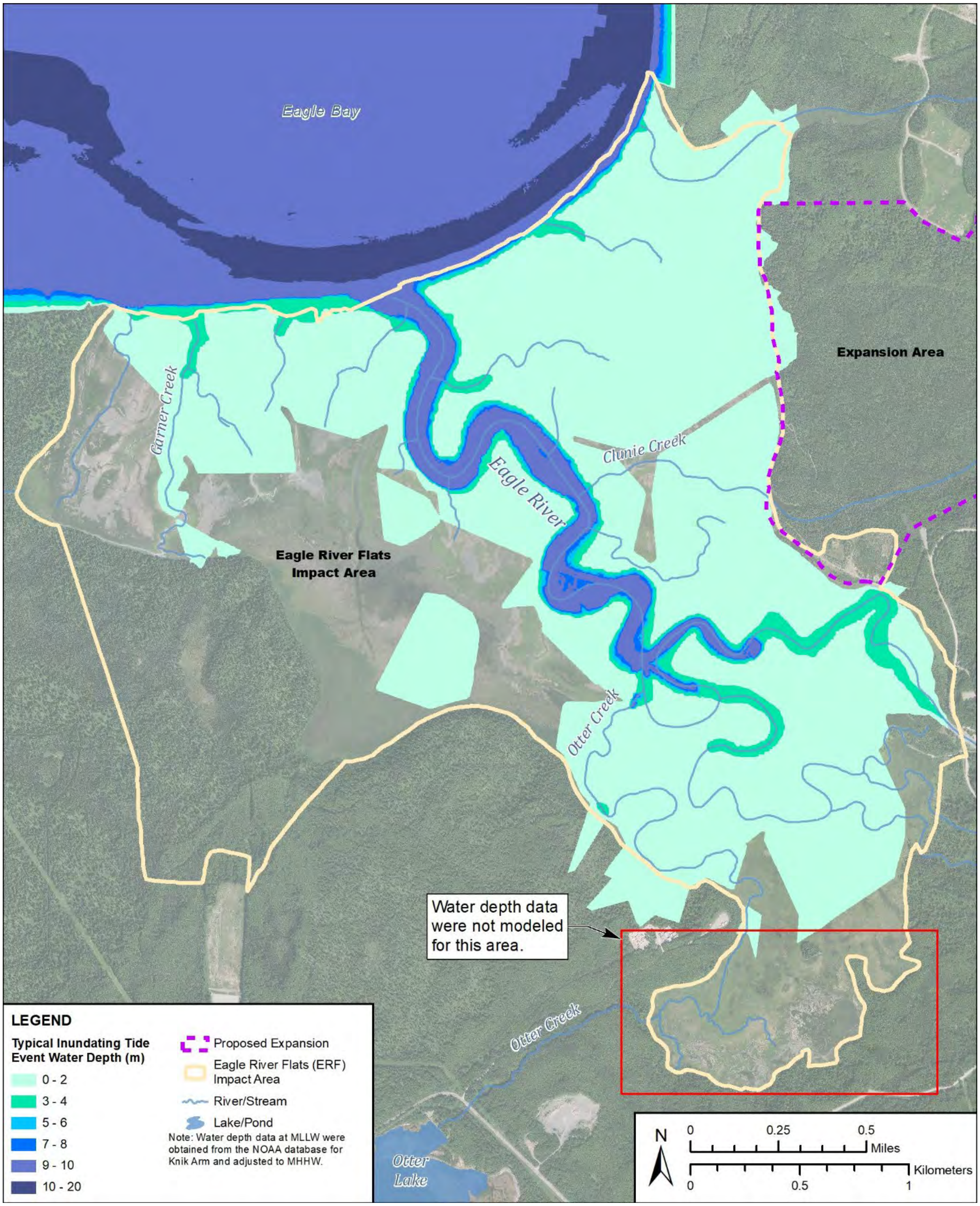
Tides in Knik Arm are semi-diurnal (two high and low tide events per lunar day [24.8 hours]), with a maximum tidal range (difference between high and low water events) approaching 40 feet. Tidal velocities vary greatly depending on the location in Knik Arm but often exceed 7 knots during the ebb tide, with flooding velocities measuring somewhat less (Smith 2004). Strong horizontal and vertical current shears exist throughout Knik Arm, most likely combining with the strong tidal flux to create a well-mixed, brackish water column. From April to November (2004–2005), salinities at Eagle Bay ranged from 0.3 to 18.9 parts per thousand (average of 12.0), and water temperatures during this period ranged from 0.1 degree Celsius (°C) to 16.6°C (average of 8.2°C) (Pentec Environmental 2005). For the purposes of this BA, typical high tide is synonymous with the water level at mean higher high water, or the highest water level associated with astronomically driven tides. During typical high tides, tidal channels are full, but there is little to no flooding of the Eagle River Flats, as shown in Figure 4-2.

Tidal flooding of ERF infuses ponds with salt water and sediments from Eagle Bay (Figure 4-2). Elevation, varying from mean sea level to 18 feet above mean sea level, determines frequency of floods. Flooding may occur daily during high tides in areas less than 12 feet above mean sea level (JBER 2023a). In areas 12 to 13 feet above mean sea level, flooding occurs only with the highest tide each month, and in areas above 13 feet, flooding occurs only during extremely high tides (JBER 2023a). Cold Regions Research and Engineering Laboratory (CRREL) measurements of water levels in the mud flats indicate that "typical inundating tidal events" may cause flooding up to 0.5 meter in ERF (reviewed in JASCO 2020), with more infrequent, maximum tide events occurring during the summer (C. Garner, personal communication, 14 September 2020) (Figure 4-3). ERF inundating tide events may occur at any time of the year but occur most frequently during the summer (August/September), coinciding with periods of high discharge. ERF can experience more than 60 flood events on an annual basis (Lawson et al. 1995). Flood events due to rainfall typically occur from August to October (Papineau and Holloway 2011). Lawson et al. (1995) noted that every predicted tide exceeding 30 feet between 16 August and 21 September 1994 resulted in flooding of the flats. For that same time frame in 2020, there were 32 tides over 30 feet (C. Garner, personal communication, 8 October 2020). If inundations in 2020 were similar to those in 1994 during that same seasonal range (16 August to 21 September), then 32 out of 72 high tides (44 percent) would have resulted in inundated conditions (C. Garner, personal communication, 8 October 2020).



Sources: JBER 2018, 2020a, 2020b, 2023c; MOA 2019
Imagery: JBER 2018

Figure 4-2 Modeled Water Depth of Nearshore Eagle Bay and Eagle River, Alaska, during Typical High Tide Conditions



Sources: JBER 2020a, 2020b, 2023c; MOA 2019
Imagery: JBER 2018

Figure 4-3 Modeled Water Depth of Nearshore Eagle Bay and Eagle River, Alaska, during a Typical Inundating Tide Event

Flooding typically begins in the coastal mudflats on Knik Arm and progressively moves inland up the Eagle River channel, backing river waters up each gully, and causing them to spill onto the inner mudflats. Water levels rise initially at a steady rate but rapidly decrease as the water crests the gullies and spills out over the mudflats. Water levels decline first in the coastal zone while tidal flood waters are still moving up Otter Creek and into the southwestern corner of the flats (Lawson et al. 1995). During flooding events, some juvenile salmonids and other fishes may use the flats for rearing but are expected to move out during the ebb tide as the water slowly recedes.

Flooding duration may vary, but ERF likely takes several hours to drain after typical inundating flooding events. Lawson et al. (1996a) show an inundation event with approximately 0.45 meter of water on 14 June 1995 (predicted tide height of 32.4 feet) that took approximately 2.4 hours to drain. This is consistent with Taylor et al. (1994), who reported that summer flood waters drained within “a few hours” after the high tide (some time would need to be added to this estimate to account for the time between inundation and slack high). Lawson et al. (1996b) observed that higher tides attributable to wind surge increase the height and volume of flood water and prolong the period of runoff during the ebb tide. In addition, it is likely that the same factors that are known to increase the height of the tide at ERF, such as winds from the south and increased discharge from Eagle River, would also lead to increased drain time. Extreme “maximum” tide events may cause more flooding of ERF (over 0.5-meter depth) during the summer months, but they are very infrequent because they are likely produced by a combination of high astronomical tide height, increased discharge from Eagle River, and mid/strong southerly winds.

4.1.2 Sea Ice Conditions

Winter sea ice coverage varies on an annual basis. Large masses of ice are transported up and down Knik Arm, and consequently Eagle River, in accordance with the semi-diurnal, hypertidal regime of Upper Cook Inlet. In general, Eagle Bay hosts moving pan ice that can be inches to feet thick and from 10 to 90 percent ice cover (i.e., no shore-fast ice sheets as seen in Eagle River) (C. Garner, personal communication, 20 March 2020). Mean sea ice concentration (relative measure of the surface area of water that is covered with ice) in Knik Arm was 70 to 80 percent between 1 December and 28 February (from 1986 to 1999) and 30 to 60 percent in March (Mulherin et al. 2001).The dates of first significant ice and ice-out for Upper Cook Inlet (defined as 10 percent ice concentration at the Phillips Platform) were documented in the 1970s and 1980s and varied widely, with a median “first ice” date of 23 November and a median ice-out date of 9 April (Mulherin et al. 2001). The amount of ice measured in Knik Arm in February 2020 was the most significant sea ice coverage in the past 7 years (Solina 2020).

The presence of sea ice greatly influences the distribution of marine mammals during the winter months, and may also influence the distribution of fish in nearshore areas. No studies of juvenile salmonid use of ice-covered areas have been conducted at ERF. However, other studies have reported mixed results regarding juvenile salmonid use and condition in these areas. Juvenile salmonids (predominantly coho salmon [*Oncorhynchus kisutch*]) are known to rear throughout the year in ERF (Eagle River, Otter Creek, and its interconnected intertidal channels) as well as adjacent Eagle Bay. Although juvenile salmon may overwinter under ice and may use ice as cover in areas where there are open leads (Jakober et al. 1998), they generally select habitats with low water velocity, cover, and relatively warmer water from springs or upwelling groundwater (Hillman et al. 1987; Cunjak 1996; Giannico and Hinch 2003; Davis and Davis 2015). Groundwater refugia in tributary streams or in the main river channels provide protection against ice and critically low temperatures and allow fish to remain mobile (Cunjak 1984). Overwintering sites were previously undocumented on JBER, but sampling in 2019 documented presence of juvenile coho in intertidal channels and backwater ponds connected to Otter Creek (JBER 2019c). These small channels have the greatest potential to support overwintering coho salmon in ERF-IA.

4.1.3 Eagle River

Eagle River (ADF&G Anadromous Waters Catalog [AWC] No. 247-50-10110) drains an area of approximately 123,550 acres, starting at its headwaters in the Chugach Mountains and terminating in Eagle Bay in Upper Cook Inlet (ADF&G 2022). The river flows 8.5 river miles through JBER property, with the last 4.1 river miles passing through ERF-IA. The upper extent of tidal influence extends upstream to about Bravo Bridge. Once Eagle River passes Bravo Bridge into ERF-IA, the river is characterized as intertidal, and the dominant substrate is silt with few rocks.

4.1.3.1 Hydrology

Otter Creek is Eagle River's major tributary on JBER, although Clunie Creek flows through the proposed expansion area and contributes subterranean flow to the river. The mean flow volume in Eagle River is greatly decreased in the frozen months from a low of 58 cubic feet per second (cfs) in March to a high of 1,730 cfs in July (Figure 2-4; USGS 2022). Periods of heavy rainfall or rapid melting from Eagle Glacier can generate water flow in excess of 10,300 cfs (NOAA 2014 in JBER 2023a).

Eagle River flows are primarily from Eagle Glacier (13 percent), which is the major source of flow during the warm months of the year, along with Eagle Lake and Symphony Lake. The river is generally clear in the winter, with higher visibility than during the spring and summer when glacial ice melts and contributes flow to the river, resulting in high suspended sediment loads; however, overall sediment loads are fairly low in comparison with other glacially fed streams in Alaska (CH2M Hill 1994 in JBER 2023a).

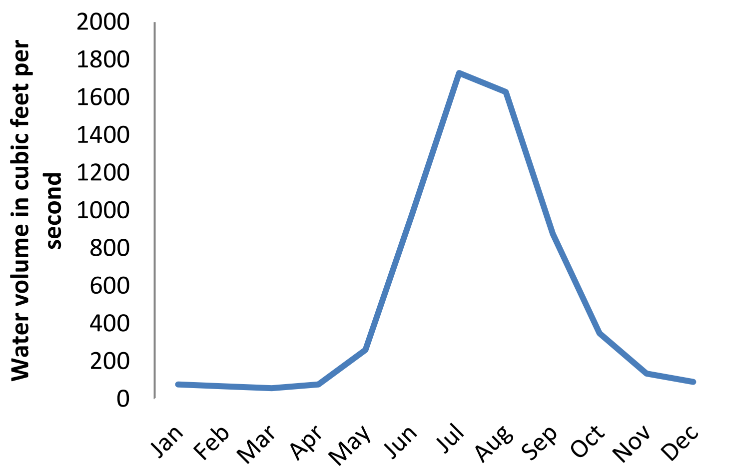


Figure 4-4 Monthly Mean Discharge of Water (1965–1981) in Cubic Feet per Second from Eagle River, Alaska (upstream from Glenn Highway)

Source: USGS 2022; most recent period of record available is 1965–1981

Eagle River is surrounded by various habitats including alpine meadow, high shrub, mixed broadleaf forest, urban areas, and an estuary tidal marsh. Natural levees occur along the edge of Eagle River and the larger tributary streams near Eagle River. The combination of tides and river discharge cause variable levels of flooding across the flats. In some cases, areas behind the levees flood less frequently than nearby ponds because of their higher elevations (CH2M Hill 1997); however, flooding can occur from farther upstream, which would lead to flooding of the adjacent flats bypassing areas with levees, which would reduce the potential for flooding (C. Brandt, personal communication, 6 October 2020).

4.1.3.2 Eagle River Ice Conditions

Eagle River and the shallow ponds and creeks in the southern portion of the flats (where juvenile salmonids likely overwinter) experience different ice conditions. Eagle River ice accumulation is influenced by Eagle Bay. Ice pans migrate through Eagle River (laterally and vertically) along the tidally influenced portion of the river. At a critical date (which differs annually and geographically), sections of Eagle River become 100 percent covered with ice and are no longer accessible to marine mammals. Once frozen, the ice will begin to accumulate vertically (ranging from 2 to 3 feet thick depending on the year and location) (JBER unpublished data). JBER remote imaging (see monitoring stations Mouth1 and ER1–ER5 depicted in Figure 4-5) has indicated that the upper river (ER4) typically freezes in mid-December but can vary from mid-November to early January. The mid-river (ER3) typically does not freeze until late December but can vary from late November to early February. The lowest portion of the river (Mouth1) typically does not freeze until mid-January but can vary from early to late January (JBER unpublished data) (Figure 4-5 through Figure 4-9). Ice in the lower river sections tends to break up first typically in late January to mid-February, though the lower river does not experience 100 percent ice cover in warm years. Ice cover in the mid-river is generally present until mid-March to mid-April, and upper river ice is typically present from late March to mid-April (JBER unpublished data) (Figure 4-5).

Ice thickness is measured at the Explosive Ordnance Disposal pad on the eastern side of ERF-IA to determine when firing activities may commence. Over the past several years, ice has been found to form as early as 1 November, and sediments may remain frozen through 30 March and beyond. Ice thickness has been shown to vary between 1 and 32 inches (JBER unpublished data).

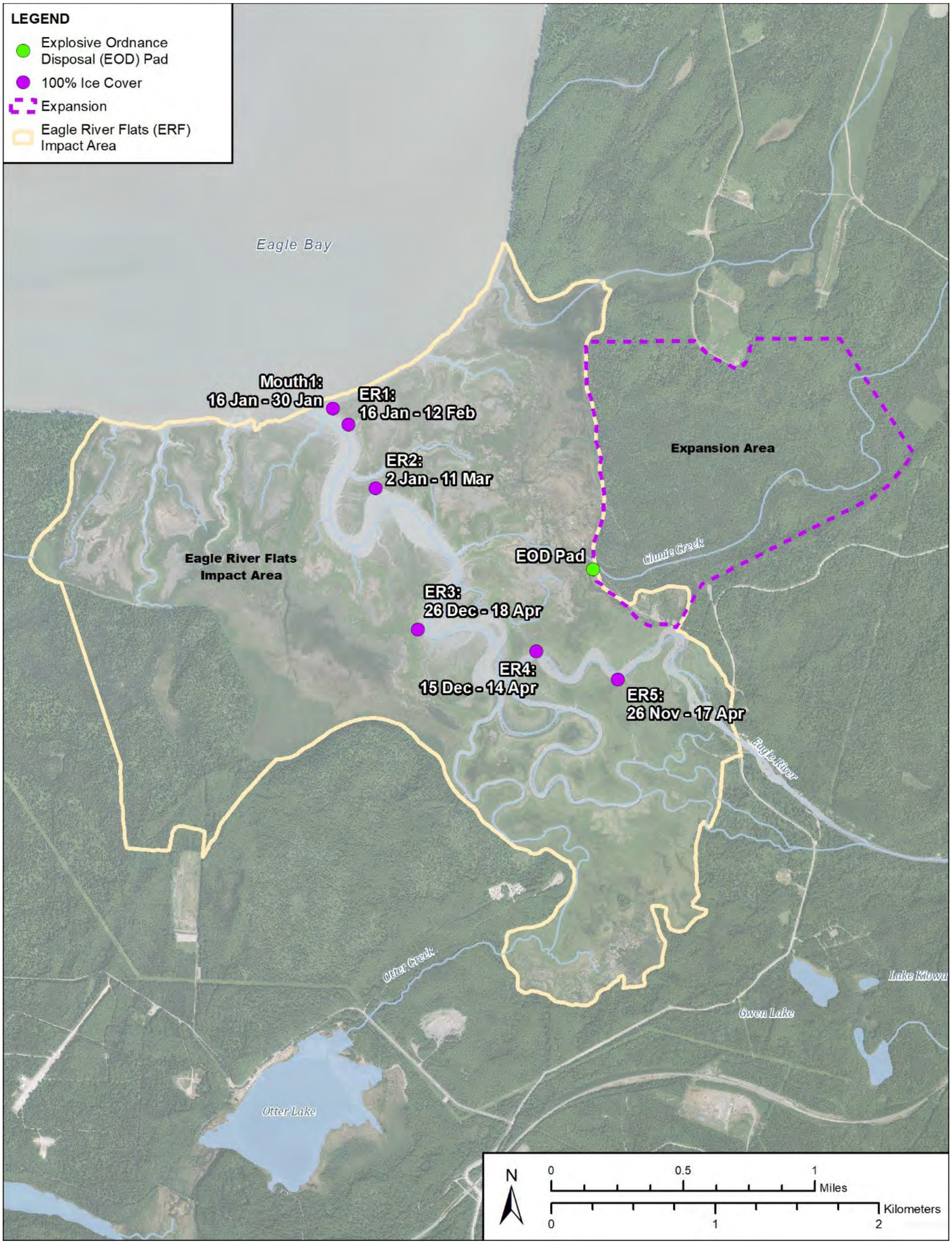


Figure 4-5 Period of 100% Ice Cover at Ice Monitoring Stations on Eagle River

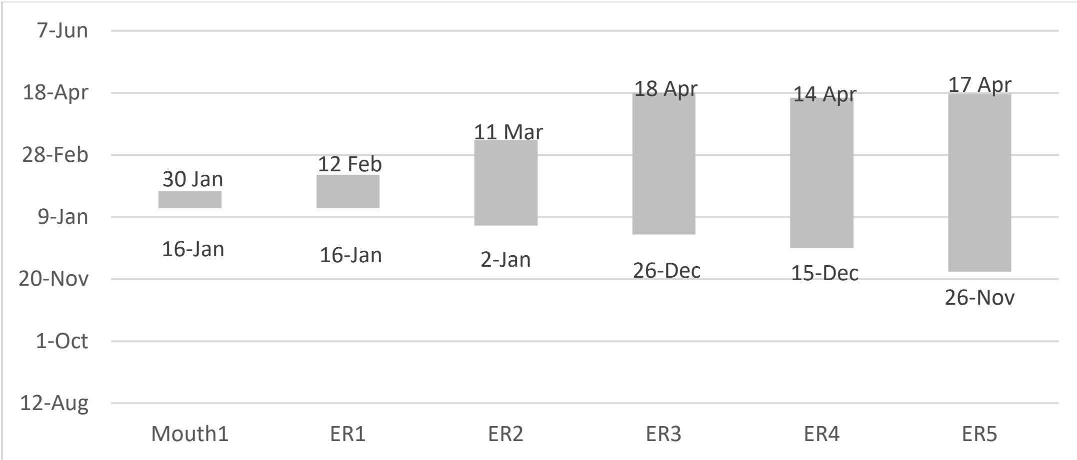
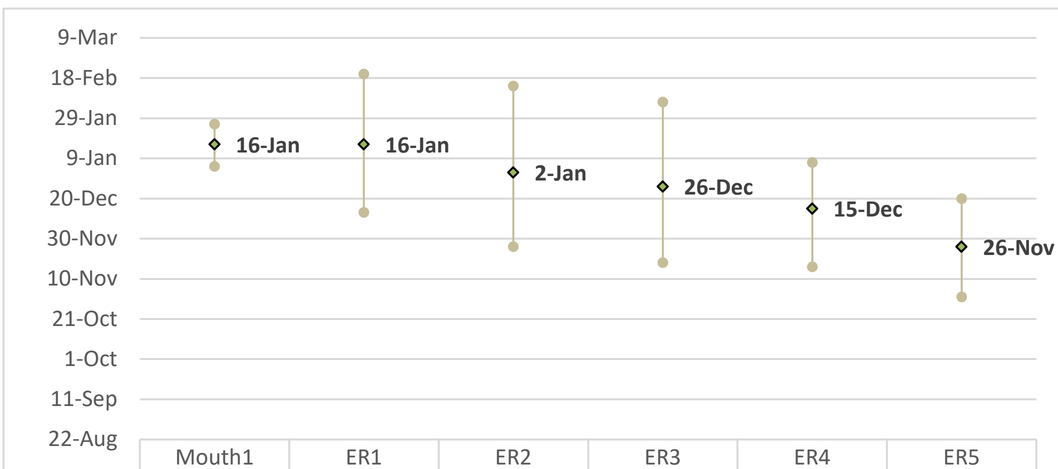


Figure 4-6 Mean Date Range of 100% Ice Cover per Station in Eagle River within Eagle River Flats (2017–2023)

Note: The bottom date is the mean date of the onset of 100% ice cover, and the top date is the onset of open water, a condition that typically happens within a single day. Mouth and ER1 experienced years (n=4 and 1, respectively) without 100% ice cover. Station locations are depicted in Figure 2-5.

Source: C. Garner, personal communication, 4 April 2024



	Mouth1	ER1	ER2	ER3	ER4	ER5
Min	5-Jan	13-Dec	26-Nov	18-Nov	16-Nov	1-Nov
Max	26-Jan	20-Feb	14-Feb	6-Feb	7-Jan	20-Dec
◆ Mean	16-Jan	16-Jan	2-Jan	26-Dec	15-Dec	26-Nov

Figure 4-7 Onset (Min–Max–Mean) of 100% Ice Cover per Station on Eagle River within Eagle River Flats (2017–2023)

Note: Mouth and ER1 experienced years (n=4 and 1, respectively) without 100% ice cover. Station locations are depicted in Figure 2-5.

Source: C. Garner, personal communication, 4 April 2024

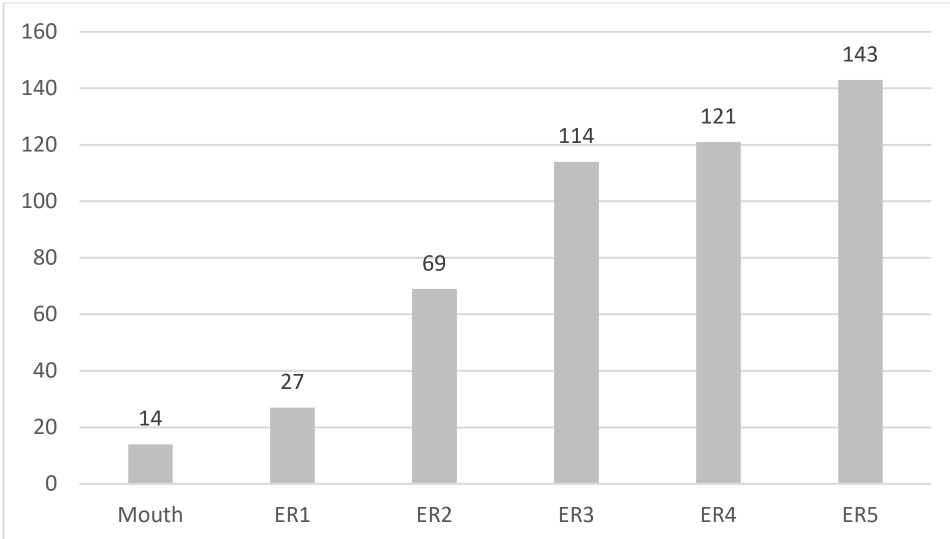
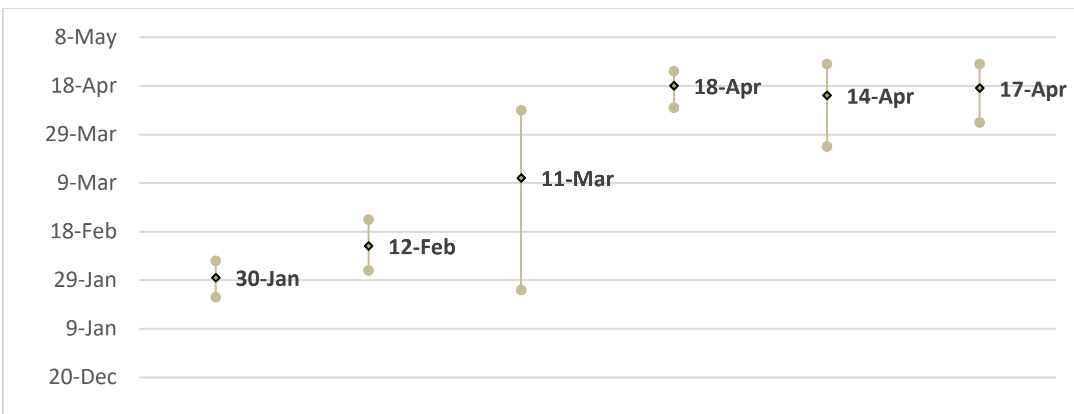


Figure 4-8 Mean Number of Days of 100% Ice Cover per Station on Eagle River within Eagle River Flats (2017–2023)

Note: Mouth and ER1 experienced years (n=4 and 1, respectively) without 100% ice cover. Station locations are depicted in Figure 2-5.
Source: C. Garner, personal communication, 4 April 2024



	Mouth1	ER1	ER2	ER3	ER4	ER5
Min	22-Jan	2-Feb	25-Jan	9-Apr	24-Mar	3-Apr
Max	6-Feb	23-Feb	8-Apr	24-Apr	27-Apr	27-Apr
◆ Mean	30-Jan	12-Feb	11-Mar	18-Apr	14-Apr	17-Apr

Figure 4-9 Onset (Min–Max–Mean) of Open Water per Station on Eagle River within Eagle River Flats (2017–2023)

Note: Mouth and ER1 experienced years (n=4 and 1, respectively) without 100% ice cover. Station locations are depicted in Figure 2-5.
Source: C. Garner, personal communication, 4 April 2024

4.1.4 Otter Creek

Otter Creek (ADF&G AWC No. 247-50-10110-2010) originates in Otter Lake, which is spring fed and flows into Eagle River in ERF-IA (ADF&G 2022a). Two intertidal Otter Creek channels were recently added to the ADF&G AWC: Otter Creek North Inter-Tidal Channel (247-50-10110-2010-3007) and Otter

Creek South Inter-tidal Channel (247-50-10110-2010-3009) (ADF&G 2022). Otter Creek flows through lowland and rocky broadleaf and needleleaf forests before entering the silt flats (JBER 2023a). Its substrate is composed of mostly fines and gravel (sizes 0.625 to 64 mm) until the flats, where it becomes more silt dominated. Otter Creek is characterized as a riffle-run system with dense vegetation prior to entering ERF-IA, at which point the vegetation changes to estuarine grasses and sedges, and the creek is tidally influenced. The lower portion of Otter Creek was dammed by beaver for several decades, which inhibited fish from entering the lake. Recent natural deterioration of the dam, reconstruction of a portion of the stream channel, and replacement of a culvert under Otter Lake Road has restored anadromy to this system. The return of adult salmon to Otter Lake was first recorded in 2017. Harbor seals (*Phoca vitulina*) have been observed using Otter Creek following the peak of salmon runs. Beluga whales have also been acoustically detected (a few days in September and October) in the lower reaches of Otter Creek.

Ice conditions on Otter Creek have not been studied but are expected to be similar to those of the uppermost Eagle River monitoring station (station ER5), as described in Section 2.2.4.2. Ice data from Eagle River are used as a proxy to estimate thickness and timing of ice onset and breakup in the southern ponds and creeks such as Otter Creek.

4.1.5 Marine Mammal Prey and Their Habitats

More than 20 different fish species have been observed in or adjacent to JBER waterbodies, representing a diverse species assembly that may be used as prey by Cook Inlet beluga whale and other marine mammals (JBER 2023a). Primary prey species in the action area include salmonids, eulachon, Pacific cod, walleye pollock, saffron cod, yellowfin sole, and other groundfish. As described in Section 3.1.2, many of these species comprise a critical habitat component for Cook Inlet beluga whale. Juvenile salmonids in ERF-IA primarily use the channelized portions of Eagle River and Otter Creek for rearing, while adults use the channelized portions of Eagle River and Otter Creek to transit to off-site spawning areas. Some juvenile salmonids may also use intertidal, backwater areas that are connected to Otter Creek on the southern side of ERF, or intertidal channels or tributaries connected to Eagle River or the Eagle River relict channel for rearing. Other marine mammal prey species, such as eulachon and various groundfish are known to use ERF-IA, although most groundfish usage is limited to Eagle Bay.

In addition, some mudflats and wetland areas of ERF have year-round, seasonal, or diurnal (tidal) ponded areas that may connect to receiving waters and provide rearing for various fish species, such as threespine stickleback (*Gasterosteus aculeatus*). Although salmonids are not known to use these areas for rearing, it is possible that some floodplain use by salmonids and other fish species in ERF-IA occurs during extreme high tidal conditions when water overtops the channel banks.

Clunie Creek is an intermittent stream in the proposed expansion area. The creek drains Clunie Lake and other small ponds among the moraines northeast of ERF-IA. Clunie Creek lacks a permanent surface water connection to Eagle River as the stream channel goes subterranean before reaching ERF. The stream reach in the proposed expansion area has been found to support slimy sculpin but no salmonids or other fish species (Schoofs and Zonneville 2016).

4.1.6 Fish in Eagle River

Eagle River is known to support all five Pacific salmon species (Chinook, chum, coho, pink [*O. gorbuscha*], and sockeye) (ADF&G 2022b; JBER 2023a) and supports eulachon and groundfish species that may be preyed upon by marine mammals. Information on the seasonality and migratory patterns of adult and juvenile salmon in ERF-IA and Eagle Bay is provided in

Table 4-1 and Table 4-2.

Table 4-1 Summary of Adult Salmon Run Timing in the Project Area

Species	Time of Year					
	May	Jun	Jul	Aug	Sep	Oct
Chinook						
Sockeye						
Pink						
Chum						
Coho						

Notes: Dark bars indicate peak migration periods; light bars represent estimated total period of occurrence. Timing is based on Eagle River data.
Sources: Johnson et al. 2015; Johnson and Bottom 2016; Schoofs et al. 2018; Weber and Seigel 2020a, 2020b; JBER 2023a.

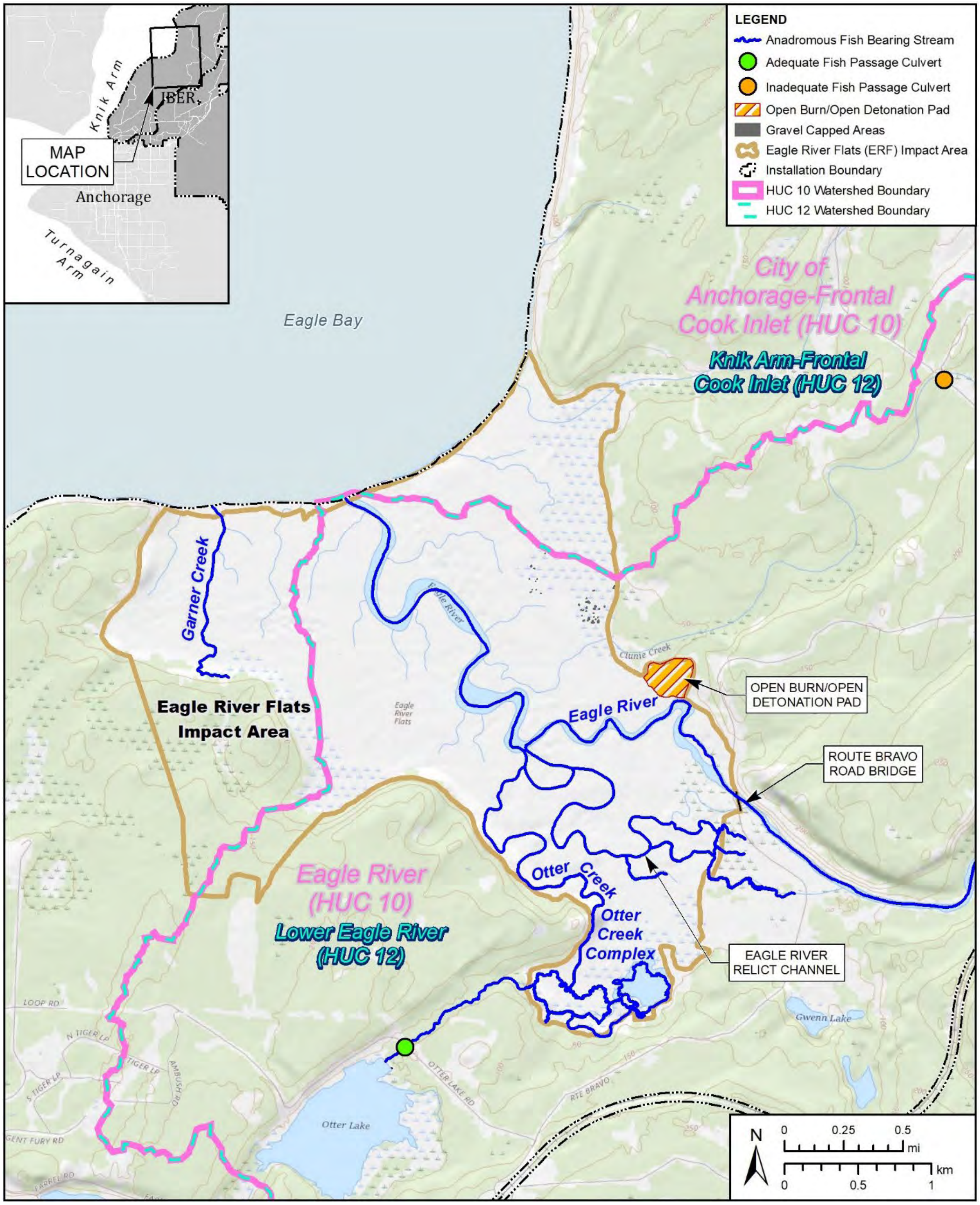
Table 4-2 Summary of Juvenile Salmon Rearing and Migration in the Project Area

Species	Time of Year											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chinook												
Sockeye												
Coho												
Chum												
Pink												

Note: Dark bars indicate peak presence, which includes emigration and rearing, while the lighter-colored bars represent general rearing presence. This table incorporates general and site-specific information and applies to all waterways within the project area.
Sources: Moulton 1997; Schoofs et al. 2017, 2018; Bogan et al. 2018, 2019; JBER 2019c; NPFMC et al. 2021.

Adult salmon migrate through Eagle River to access spawning areas outside of ERF-IA (e.g., Upper Otter Creek, Upper Eagle River and tributaries) (Figure 4-10). Adult salmon migration and juvenile rearing has been observed in Eagle River, but spawning has not been documented in ERF-IA (ADF&G 2022b; JBER 2023a). Eagle River within ERF-IA consists of silt substrate and does not provide suitable spawning habitat. Chinook salmon are the first and least abundant salmon species to return to Eagle River each year. The Chinook run generally occurs from mid-May through early July. Sockeye salmon are the second salmon species to return, with run timing from late June through August. Adult chum and pink salmon tend to return at the end of July, with the pink run complete by the end of August and the chum run ending in the first part of September. Coho salmon return to Eagle River around the end of July and is typically complete by early October (AERC 2021, 2022; Johnson and Bottom 2016; JBER 2023a).

Salmon returns to Cook Inlet drainages have been variable over the past 10 years, with some stocks and runs faring better than others. It is likely that fewer salmon are available to beluga whales in Upper Cook Inlet than in the past due to anthropogenic activity. Threats to salmon in Upper Cook Inlet include overfishing, dams, habitat loss, habitat degradation, stormwater runoff, variable ocean conditions, and climate change (ADF&G n.d.-a; Beamesderfer et al. 2015).



Sources: ADOT & PF 2018; JBER 2019a, 2019b, 2020a, 2020c, 2023b, 2023e; MOA 2019; USGS 2020a.
Basemap: USGS The National Map.

Figure 4-10 Existing Conditions for Anadromous Fish in ERF-IA

Eulachon return to spawning areas in Upper Cook Inlet from April through June. Particularly large runs of eulachon are found in the Susitna, Kenai, and Twentymile Rivers (Shields and Dupuis 2017). A total of 40 eulachon were captured during the 2017 Eagle Bay fish study, all in mid-May. All fish captured were assumed to be adults returning to spawn, although it was unclear whether their target was Eagle River or one of the larger glacial rivers at the head of Knik Arm (Schoofs et al. 2018). In mid-May to early June 2021, large numbers (n = 3,174) of small-sized fish (<25.4 centimeters) were detected during adult salmon monitoring in Eagle River (AERC 2022), and it was surmised that these fish were eulachon given the size class and run timing (C. Brandt, personal communication, 9 March 2023). This marked the first time that eulachon have been observed at the Eagle River sonar weir assembly site (6.4 kilometers upstream from river mouth), an observation made possible because the sonar devices were installed earlier than in previous years.

A 2016 ADF&G estimated eulachon spawning biomass in Upper Cook Inlet to be 48,000 tons (Willette and DeCino 2016). No additional studies on eulachon abundance have been implemented in Upper Cook Inlet. Throughout the GOA, abundance and biomass estimates of eulachon during 2021 were higher than in 2019, but lower than those observed from 2001–2015 (NPFMC 2022).

Pacific cod, walleye pollock, and yellowfin sole are groundfish species managed by NMFS and the North Pacific Fisheries Management Council (NPFMC) under the GOA Groundfish Management Plan (NPFMC 2022). Although saffron cod is not federally managed, it does comprise a component of beluga whale critical habitat. The presence of these species in the GOA and its estuaries and relationship and movement between marine and nearshore processes have been well documented (NPFMC 2020). Larval forms of each species are transported and concentrated in nutrient-rich nearshore habitat from winter through summer (depending on species). Although different groundfish life stages (larvae, juveniles, and adults) may be present in Eagle Bay, few groundfish species are known to use ERF-IA, so use of this area is predominantly limited to groundfish larvae that enter Eagle River during incoming tides during the summer months. Groundfish species migrate to open waters to assume their late juvenile and adult life stages in open pelagic waters or on benthic substrates (Windward 2014; NPFMC 2020).

The 2017 Eagle Bay beach seine study documented low abundances of groundfish species in Knik Arm (Schoofs et al. 2018). Groundfish species captured included saffron cod, walleye pollock, Pacific staghorn sculpin (*Leptocottus armatus*), and starry flounder (*Platichthys stellatus*). Upper Cook Inlet fish surveys found that walleye pollock juveniles were the most abundantly captured juvenile groundfish (Moulton 1997). Although rare, juvenile yellowfin sole have been documented in Knik Arm (Dames & Moore 1983); therefore, it is possible that they could be present in Eagle Bay. This also applies to the other groundfish species that were not identified in previous Knik Arm surveys.

Saffron cod may be the most likely groundfish species to use ERF-IA as they are known to enter coastal rivers up to the extent of tidal influence (Mecklenburg et al. 2002). The 2017 Eagle Bay study captured low numbers of adult and juveniles, as well as a gravid (egg-carrying) female during sampling from June to October. Similarly, Houghton et al. 2005 captured gravid cod in Knik Arm in October and November and noted that these fish are thought to move into estuaries and tidal portions of rivers in late fall and early winter to spawn. JBER scientists have observed an apparent change in beluga behavior from river-focused foraging during salmon runs to a more Eagle Bay channel-focused (i.e., deeper) orientation in the later fall (JBER unpublished data cited in Schoofs et al. 2018). This would seem to imply a switch to benthic prey such as cod, flounder, and invertebrates. Saffron cod movement into the tidal portions of rivers in the late fall might also explain beluga movement up Eagle River in October and November (Schoofs et al. 2018).

JBER personnel sampled portions of Eagle Bay, the tidally influenced reaches of Eagle River, Otter Creek, and Garner Creek in the northwestern portion of ERF between 2007 and 2011 as part of a study to identify fish species that could be a food source for humans and beluga whales (unpublished data, cited in Schoofs et al. 2018). Gill nets and minnow traps captured a total of 703 fish that represented nine different species and three developmental stages. The majority of fish captured (in order of abundance) were adult salmon species: coho, sockeye, chum, and pink salmon. Juvenile coho were the next most abundant species/ developmental stage captured. Lesser numbers of other fish captured included Chinook salmon, Dolly Varden (*Salvelinus malma*), threespine stickleback, slimy sculpin, and starry flounder. Additional species caught included saffron cod, eulachon, snailfish (*Liparis* spp.), and sand shrimp (*Crangon* spp.). Since 2012, JBER has conducted annual salmon enumeration studies on Eagle River to establish a baseline for salmon escapement and run timing (Weber and Seigle 2020a; AERC 2021, 2022, 2023). From 2012 to 2015, a Dual Frequency Identification Sonar and fish wheel were used to estimate salmon escapement and to document species run timing. The studies were conducted from mid-May to mid-October just upstream from ERF and were designed to encompass the majority of the run timing for adult salmonids. Species timing data for the last year (2015) that the fish wheel was deployed in Eagle River are provided in Figure 4-11 (Johnson and Bottom 2016).

Adult run timing (for all salmonids) in Eagle River from 2012 to 2021 is compared in Figure 4-11. The highest cumulative counts were recorded in 2021 (n = 14,007) and 2017 (n = 12,824) and lowest counts in 2018 (n = 1,336) and 2019 (1,103) (Weber and Seigle 2020a; AERC 2021, 2022, 2023a). A review of daily escapement among years indicates that the adult salmon run in Eagle River typically begins in late May, with modest escapement spikes during June and early July. Historically, the bulk of escapement occurs from mid-July through late August. Adult salmon runs steadily decrease from mid-to-late August through September and typically terminate by early October. However, peak escapement varies considerably by year, with highs occurring every 3 to 5 years (AERC 2023a; Figure 4-12). Recent diurnal patterns of fish movement past the sonar assembly indicate that more than 50 percent of observed fish migrated over a 9-hour period between mid-afternoon and late evening, consistent with the long-term patterns in Eagle River (Weber and Seigle 2020a; AERC 2022, 2023a). The 2021 study documented large numbers of smaller-sized fish (<25.4 centimeters) in early May (as shown in Figure 4-12). It was hypothesized that these fish were eulachon rather than juvenile salmonids based on the size lengths and run timing (AERC 2022).

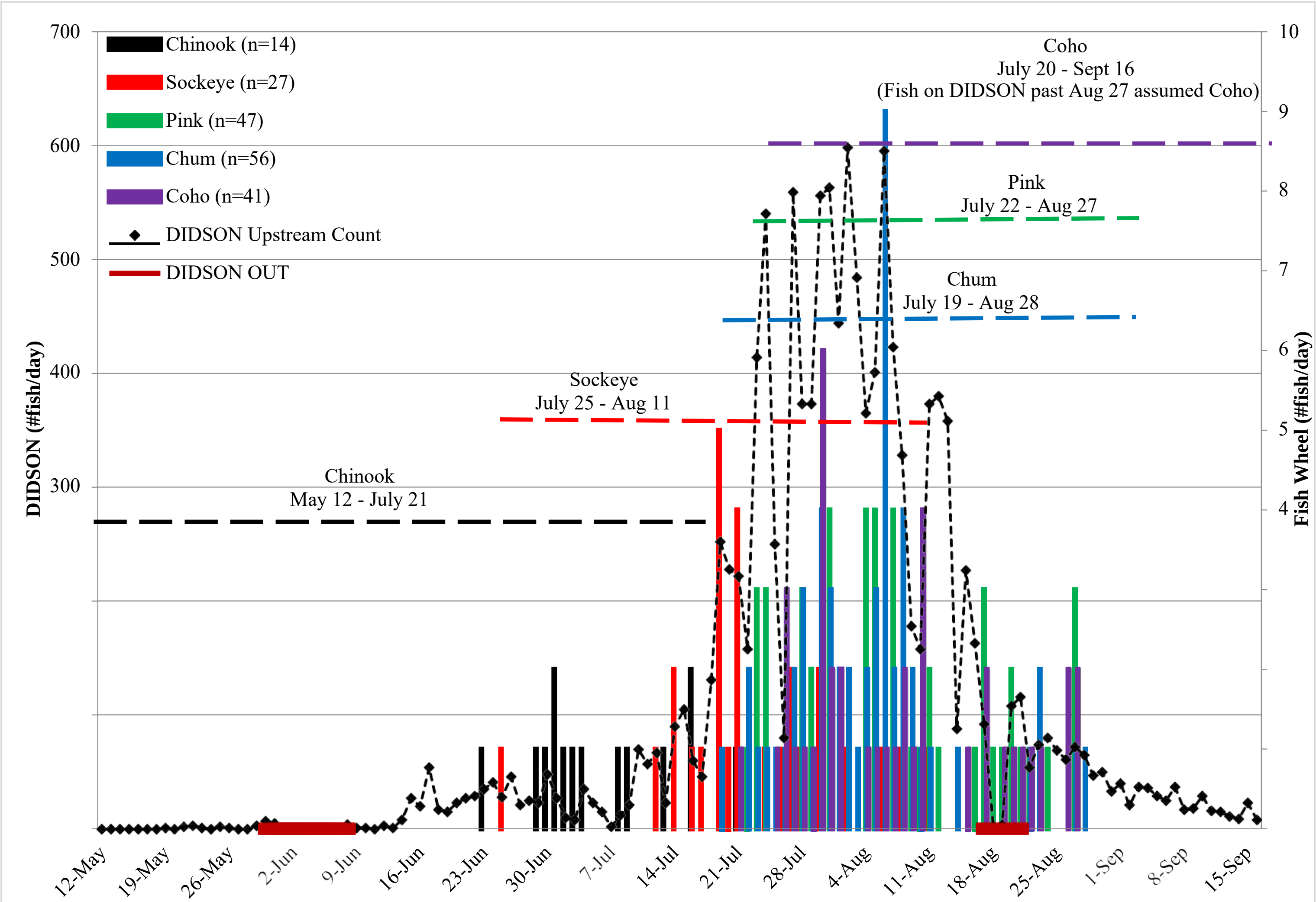


Figure 4-11 2015 Daily DIDSON Upstream Count (n = 12,755) and Fish Wheel Catch (n = 184) by Species in Eagle River

Source: Johnson and Bottom 2016

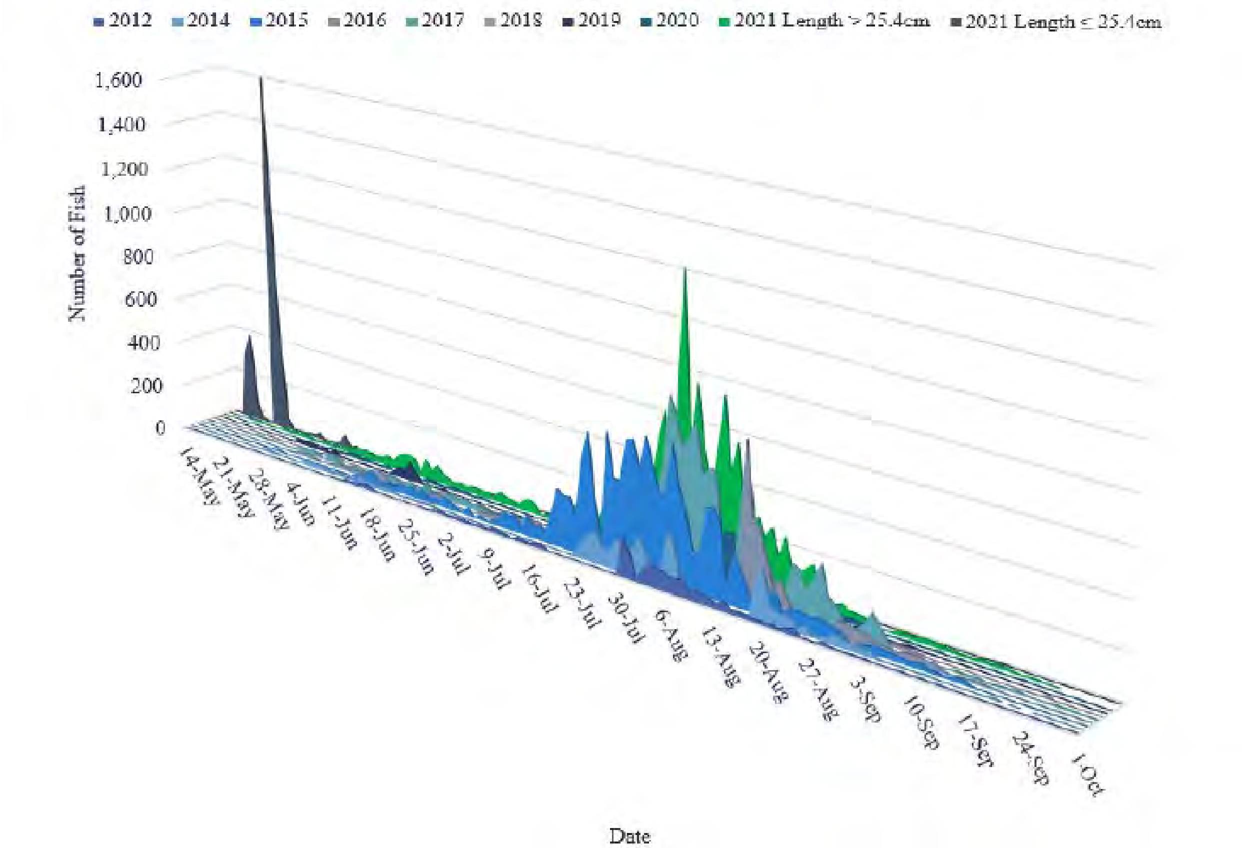


Figure 4-12 Total Daily Contribution of Salmonid Escapement, Plotted Cumulatively to Show Relative Year-by-Year Difference, at the DIDSON Weir on Eagle River, JBER, Alaska (2012–2021)

Source: AERC 2022

4.1.7 Fish in Otter Creek and Otter Lake

Adult salmon historically used Otter Creek to migrate into Otter Lake, but access was impeded starting in the 1960s by a series of beaver dams in Otter Creek, a culvert beneath Otter Lake Road with insufficient flow for fish passage, and a concrete weir that blocked fish passage at the lake outlet. ADF&G stocked Otter Lake with rainbow trout (*O. mykiss*) until 2006 and resumed stocking the lake in 2016 (Schoofs et al. 2017; Bogan et al. 2019). The lake functioned as a robust recreational fishing opportunity for trout until the illegal introduction of northern pike (*Esox lucius*) in around 2000 (POA 2011, cited in Weber and Seigle 2020b).

From 2015 to 2017, JBER and ADF&G conducted the Otter Lake/Creek Restoration Project to remove northern pike, remove obstructions to salmon passage, enhance spawning habitat, and reintroduce salmon into the system. The return of adult salmon to Otter Lake was first recorded in 2017. Coho salmon were observed in Otter Lake in 2017, and both coho and sockeye were observed in 2018, suggesting that habitat restoration efforts were successful (Weber and Seigle 2020). Over the past 2 years, stream surveys have been supplemented with autonomous fish counting equipment to estimate spawner escapement to Otter Lake. In 2022, it was estimated that 2,300 adult salmon (primarily coho) migrated into Otter Lake to spawn (AERC 2023b).

Adult coho, sockeye, and chum have been observed spawning in the upper reaches of Otter Creek as well (ADF&G 2022b; JBER 2023a). Rearing juvenile salmonids have been found in Otter Creek, ranging from lower tidally influenced reaches (in ERF-IA), upstream as far as Otter Lake (Weber and Seigle 2020b; ADF&G 2022b; JBER 2023a). Other fish species documented in Otter Creek include threespine and ninespine stickleback, slimy sculpin, Dolly Varden, and rainbow trout. These species are presumed to migrate upstream from Eagle River and possibly pass rainbow trout from Otter Lake. As part of a May to October 2018 juvenile salmonid dietary investigation in Otter Creek, juvenile rearing coho salmon in freshwater and intertidal areas of Otter Creek and intertidal tributaries to Otter Creek were documented (Bogan et al. 2019). Since then, the intertidal channels and backwater ponds connected to Otter Creek at the southern portion of ERF-IA have been found to provide high-quality rearing and refugia habitat for juvenile coho (and likely other salmonids and forage fishes).

4.2 SUBSISTENCE HARVEST

The practice of subsistence take for food and resources is regulated and protected by federal and state law. Subsistence harvest is comprised of more than harvesting food. It is a system of cultural practice, resource distribution, and community connections that extend beyond the boundaries of the household and community. JBER is within the traditional territory of the Dene, who occupied the area and harvested resources. The Federally Recognized Tribes of Native Village of Eklutna, Knik Tribe, and Native Village of Tyonek (NVT) are comprised of Dena'ina people. The members of Chickaloon Village Traditional Council are Ahtna and occupied JBER. They are collectively referred to as the Dene.

No locations in ERF-IA are currently used for subsistence, and the area has been restricted from traditional activities and subsistence use since the establishment of Fort Richardson. However, under the North Anchorage Land Use Agreement, Eklutna Inc. is not precluded from conducting future subsistence activities should the federal government ever declare JBER lands excess to military requirements. Additionally, impacts to marine mammals that use ERF-IA intermittently could affect individuals and stocks that are harvested in the region but outside of ERF-IA.

This section discusses subsistence use of the ESA-listed species discussed in this BA—Cook Inlet beluga whales and Steller sea lions—as well as subsistence fishing, which affects marine mammal prey species. Impacts of the proposed action on subsistence resources are discussed in the project EIS (JBER 2024.).

4.2.1.1 Subsistence – Cook Inlet Beluga Whale

In general, there is a rich history of subsistence harvest of beluga whales in portions of Cook Inlet. Concerns about the decline of the Cook Inlet stock resulted in a voluntary suspension of the subsistence hunt by Alaska Natives in 1999 (Mahoney and Shelden 2000). In 2000, NMFS issued a rule designating the Cook Inlet beluga whale as depleted under the MMPA, triggering regulation of the subsistence harvest. In 2003, NMFS issued an EIS for Subsistence Harvest Management of Cook Inlet Beluga Whales (NMFS 2003), with a supplemental EIS issued in 2008 (NMFS 2008b). The 2008 Final Subsistence Harvest Regulations (73 FR 60976), which reflect the ROD for the supplemental EIS (NMFS 2008c), implement a long-term plan to manage subsistence harvests of Cook Inlet beluga whales, from 2008 to recovery. The plan uses 5-year planning intervals to assess beluga whale populations and the prospect for resumption of harvests. According to the plan, the level of allowable subsistence harvest is based on average stock abundance from previous years, growth rates, and other relevant data. Subsistence harvest of Cook Inlet beluga whales is currently not allowed. The ROD stated that harvest levels would be set every 5 years, based on an assessment of the most recent Cook Inlet beluga population status, including the 5-year average abundance estimate and a 10-year measure of the population growth rate (NMFS 2008c). Subsistence harvest levels would follow a Harvest Table when the 5-year average beluga population is more than 350 whales. Harvest levels would be evaluated every 5 years and would increase in proportion to the average abundance and population growth rate. These regulations pre-date listing of the Cook Inlet beluga whale in 2011. Given its endangered status, NMFS will not authorize a subsistence hunt if it is determined that the activity is likely to jeopardize the continued existence of the species (NMFS 2016b). Additionally, a valid co-management agreement with NMFS must be in place in order for subsistence hunting to occur.

Because subsistence harvest of Cook Inlet beluga whales is currently prohibited, the proposed action would not interfere with current subsistence harvest. However, Alaska Native groups are interested in resuming subsistence harvest of this species in the future. During interviews with residents of the Native Village of Tyonek, all respondents reported that Tyonek should be allowed to continue hunting beluga whales if the population is high enough to sustain subsistence harvests, with estimates that between 1 and more than 10 whales would be adequate to support the Tyonek for 1 year (Steven R. Braund & Associates 2011). It is unknown at this time when the population could recover to levels that would allow subsistence harvest to resume. The recovery plan for this species (NMFS 2016b) noted that recovery could take up to two generations (50 years).

As discussed in Section 2.4, the proposed action incorporates best management practices and conservation and mitigation measures that are designed to substantially reduce the proposed action's impacts on Cook Inlet beluga whales and their prey base. By reducing impacts on the species, potential impacts to recovery of the species and future subsistence use are also minimized by maintaining the health of the regional population.

4.2.1.2 Subsistence – Steller Sea Lion

While the Steller sea lion is not known to be harvested by the Cook Inlet Dena'ina, who have ancestral ties to JBER lands, Alaska Native people from many cultures that occupy the area today continue subsistence practices brought from other regions. Between 1992 and 2008 (the most recent data available), 26 Steller sea lions were reported as harvested for subsistence use in the Upper Kenai–Cook Inlet area, with only four harvested after 1995 (ADF&G and Alaska Native Harbor Seal Commission 2009). With so few takes occurring over this large geography, subsistence use of this species in the action area is negligible.

As described in Section 4.3.3, Steller sea lions occur in ERF-IA or Upper Cook Inlet in small numbers and therefore are not likely to be affected at the population level by the proposed training. As such, the project would not affect availability of this species for the minimal level of subsistence use that occurs in the action area.

The best management conservation measures presented in Section 2.4 are designed to substantially reduce the proposed action's impacts on marine mammals and their prey base. These measures would also reduce potential impacts to subsistence use of Steller sea lions by maintaining the health of regional stocks.

4.2.1.3 Subsistence Fishing

ADF&G defines subsistence fishing as the taking of, fishing for, or possession of fish, shellfish, or other fisheries resources by a resident of the state for subsistence uses with gill net, seine, fish wheel, long line, or other means defined by the Alaska Board of Fisheries (BOF) (ADF&G n.d.-b). Title VIII of the Alaska National Interest Lands Conservation Act (ANILCA) applies to federal public lands in Alaska. As a result, some subsistence hunting and fishing in Alaska are regulated by the federal government. Alaska state law (Alaska Statute 16.05.940[32]) and federal law currently differ in who qualifies for participation in subsistence fisheries and hunts. Under federal law, rural Alaska residents qualify for subsistence harvesting. Since 1989, all Alaska residents are entitled to participate in state-administered subsistence hunts and fisheries outside nonsubsistence use areas (ADF&G 2023a). Subsistence fisheries include salmon, halibut, herring, bottomfish, and shellfish. Today, the use of fish for subsistence—with the exception of salmon and halibut—is considerably less than during the period prior to the establishment of local retail stores and easily accessible packaged foods. Of the groundfish species, cod and rockfish are the most extensively used, with flounders and greenling as lesser contributors. The action area is within the Anchorage, Matanuska/Susitna, and Kenai Nonsubsistence Area, which is identified by the Joint Board of Fisheries and Game as an area where dependence upon subsistence is not a principal characteristic of the economy, culture, and way of life; the Joint Board may not permit subsistence fishing in this area (AS 16.05.258(c)).

Although there are several subsistence salmon fisheries in Upper Cook Inlet and Knik Arm, subsistence harvest of fish does not occur on JBER at present. However, as mentioned previously, under the North Anchorage Land Use Agreement, future subsistence activities may occur should the federal government ever declare JBER lands excess to military requirements. According to ethnographic and archaeological data, Upper Cook Inlet Dene harvested all five species of salmon, eulachon, stickleback, and saffron cod in the area. The Native Village of Eklutna is the closest of the Upper Cook Inlet Tribes to JBER. For centuries, the Dene inhabited what are now the installation's lands, hunting, fishing, gathering, and establishing seasonal settlements. Residents in Chickaloon Native Village also harvest all five species of salmon as a primary resource. However, it should be noted that household surveys by ADF&G for Chickaloon are from a study year of 1982, and changes in harvest patterns may have occurred in the last four decades.

Subsistence harvest data for communities of Upper Cook Inlet for NVT and Chickaloon Native Village were reviewed in the Community Subsistence Information System, a database maintained by ADF&G. There is no community summary information available from this source for Eklutna or Knik (ADF&G 2022c). The 2013 ADF&G data for NVT reports that NVT harvested an estimated 24,248 pounds of subsistence resources, predominantly multiple salmon species (i.e., Chinook, pink, and coho), herring, cod, and halibut (ADF&G 2022c). In the 2013 summary data by ADF&G, NVT harvested an estimated 16,765 pounds of salmon and 1,863 pounds of non-salmon fish.

More recent (2018) subsistence salmon harvest data for a community near the action area were obtained from the salmon fisheries in the Tyonek Subdistrict in Upper Cook Inlet (Jones and Fall 2020). The 2018 estimated harvest of 1,649 salmon was lower than the 2017 harvest of 2,089 salmon and the historical (1980 to 2018) average of 1,825 salmon. Of the total estimated subsistence salmon harvest in 2018, 1,308 were Chinook salmon (79 percent), 188 were sockeye salmon (11 percent), 136 were coho salmon (8 percent), 10 were chum salmon (1 percent), and 7 were pink salmon (1 percent) (Jones and Fall 2020). Due to a low preseason Chinook salmon forecast for the 2019 season, the NVT subsistence fisheries were restricted by emergency order from 3 days per week to 2 days per week (Jones and Fall 2020).

4.3 RECREATIONAL AND COMMERCIAL FISHING

Freshwater and saltwater recreational fishing is permitted on JBER, provided harvest rates are sustainable and accordant with the carrying capacity of fish habitats. Recreational fishing is extremely popular year-round on JBER and is centered primarily on stocked lakes. JBER is part of the ADF&G Anchorage Management Area for sport fisheries, and fishing regulations for permitted fishing areas on JBER are provided in ADF&G 2023b. These regulations specify harvest limits for Chinook and other salmon, rainbow/steelhead trout, and Arctic char (*S. salpinus*)/Dolly Varden.

Fishing opportunities are available along Eagle River within and outside of the JBER boundary, but there is no access to ERF-IA for recreational fishing (JBER 2023a). ADF&G has limited information on fish populations in this system. Two sections of Ship Creek and upstream of Bravo Bridge on Eagle River are also open to fishing under state regulations and bag limits. Sixmile (upstream of mouth), Otter, and EOD Creeks are closed to fishing. To better estimate fishing pressure, users can self-report their fish harvest through creel surveys conducted through iSportsman. In 2020 and 2021, an average of approximately 10,000 fish (90 percent of which were rainbow trout) were reported harvested from JBER (JBER 2023a). The 2021 total included 8,345 rainbow trout, 461 Chinook salmon, 158 coho salmon, 127 Dolly Varden/Arctic char, 20 sockeye salmon, and 2 lake trout at Clunie Lake (JBER 2023a).

In 1990, an annual stocking program was initiated in Eagle River with approximately 105,000 Chinook salmon smolt of Ship Creek origin (Stratton and Cyr 1995, cited in Baumer and Blaine-Roth 2020). Due to poor returns and difficult fishing conditions, the stocking program was discontinued in 1995. Chinook salmon capture and harvest data for Eagle River are available from 1999 to 2018 (Baumer and Blaine-Roth 2020). Over this time period, the number of Chinook captured ranged from zero to 251 fish, and the number harvested ranged from zero to 109 fish. From 2012 to 2015, no Chinook salmon were reported caught or harvested in Eagle River. From 2016 to 2018, an average of 12 Chinook salmon were caught and harvested (Baumer and Blaine-Roth 2020). The failure to enhance the fishery with hatchery releases—and typically poor fishing conditions with high, fast water during the season open to Chinook salmon fishing—probably contributed to low angler effort and success. Anecdotal information and observations of fishery performance in-season suggest that the catch and harvest numbers will continue to remain low. Impacts of the proposed action on recreation are discussed in the project EIS.

Outside of JBER and Eagle Bay, recreational (including personal use fishing) and commercial fishing is common throughout much of Upper Cook Inlet. Targeted species include salmon, groundfish, herring, and smelt species, with Salmon being of particular importance. In 2022, 1.4 million salmon were harvested in Upper Cook Inlet, with the majority of those fish (1.1 million) being sockeye salmon (ADF&G 2022d). While exact recreational fishing harvest values are not available, it is a small fraction in comparison to commercial fishing. For example, in 2021 the personal use gillnet salmon fishery in Upper Cook Inlet landed approximately 30,000 salmon (Marston and Frothingham 2022). Based on the 2016 ADF&G Susitna River eulachon biomass study results, the BOF increased the Upper Cook Inlet eulachon commercial harvest cap from 100 to 200 tons in 2017. The 200-ton commercial harvest cap has been maintained since then without further fishery-independent assessments in Upper Cook Inlet. In 2023, the Alaska Wildlife Alliance submitted a proposal to the BOF requesting a reduction of the commercial eulachon harvest cap to 100 tons as a precautionary approach to protect the eulachon population due to the absence of a consistent time series of eulachon biomass assessments (ADF&G 2023c).

4.4 PORTS AND VESSEL TRAFFIC

The municipality of Anchorage is Alaska's most populous area, with 39 percent of the state's population (Alaska Department of Labor and Workforce Development 2022). Anchorage is a highly developed city, with a port, airports, highways, and railroads all situated near the coastline. This development has resulted in both the loss and alteration of nearshore beluga whale habitat and changes in habitat quality due to vessel traffic, noise, and pollution. Frequent use of shallow nearshore and estuarine habitats makes beluga whales particularly prone to regular interaction with human activities) and therefore likely to be affected by those activities. Steller sea lions use nearshore environments to rest, feed, and breed; therefore, they could be affected by any coastal development that impacts these activities.

4.4.1 Port of Alaska

The POA is a Municipality of Anchorage–owned and operated facility that serves Anchorage, the state of Alaska, and the nation. It opened as the Port of Anchorage in 1961 to support regional economic development. The Anchorage Assembly renamed Port of Anchorage to POA in October 2017 to reflect its regional, state, and national significance. Operations began at the POA in 1961 with a single berth. Plans were identified and updated for modernizing the POA infrastructure and facilities through the POA Modernization Program, which was instituted in 2014 to create four new terminals through a phased program. The POA's Modernization Program is a dock replacement program that aims to replace aging docks and related infrastructure before it fails. The program includes replacement of infrastructure; improvements to operational safety and efficiency; and work to accommodate modern shipping operations and improve resiliency for extreme seismic events and the marine environment. An initial step of the program was implementation of a Test Pile Program in the area of future development. Construction of the PCT Project, which was completed in 2022, was the first phase of the Modernization Program, with construction beginning in 2019. An Incidental Harassment Authorization (IHA) application for the project was prepared in 2019, with the IHA issued in 2020 (85 FR 19294). A south floating dock was completed at the POA in 2022.

POA's North Extension Stabilization (NES) Project addresses the North Extension failed bulkhead structure constructed between 2005 and 2011. The NES project removes the failed sheet pile structure and reconfigures and realigns the shoreline within the North Extension, including the conversion of approximately 0.05 square kilometers (13 acres) of developed land back to intertidal and subtidal habitat within Knik Arm.

The next phases of the program (contingent on funding) will include two cargo terminals that can accommodate modern shipping operations, improve design standards to withstand seismic events, a petroleum terminal, and demolition of a remaining cargo terminal (POA 2024).

4.4.2 Vessel Traffic

Vessels traveling in Knik Arm and Cook Inlet can be a threat to whales. The potential for ship strikes exists whenever ships and whales are concurrently in the area, although the risk increases with vessel speed. Although ship strikes have not been definitively confirmed in a Cook Inlet beluga whale death, in October 2007 a dead whale washed ashore with “wide, blunt trauma along the right side of the thorax,” (NMFS 2008a), suggesting that a ship strike was the cause of the injury. Vessel traffic can also produce noise disturbance to beluga whales, and pollution from the vessels may decrease the quality of their habitat.

There are eight port facilities in Cook Inlet. Commercial shipping occurs year-round, with container ships transiting between the Seattle/Puget Sound area and Anchorage. Other commercial shipping includes bulk cargo freighters and tankers. Currently, with the exception of the Fire Island Shoals and the POA, no other large-vessel routes or port facilities in Cook Inlet occur in high-value beluga whale habitat. Various commercial fishing vessels operate throughout Cook Inlet. Sport fishing and recreational vessels travel between Anchorage and several popular fishing streams that enter the upper inlet. Several small boat launches exist along the shores of Upper Cook Inlet and Knik Arm, including a float system for small watercraft near Ship Creek, maintained by the Municipality of Anchorage.

Due to their slower speed and straight-line movement, ship strikes from large vessels are not believed to pose a significant threat to Cook Inlet beluga whales or Steller sea lion. Beluga whales are regularly sighted in and around the POA (NMFS 2008a), passing near or under vessels (Blackwell and Greene 2002), indicating that these animals may have a high tolerance of large vessel traffic. However, smaller boats that travel at high speed and change direction often present a greater threat. In Cook Inlet, the concentration of beluga whales near river mouths predisposes them to strikes by high-speed watercraft associated with sport fishing and general recreation. High-speed vessels operating in these whale concentration areas have an increased probability of striking a whale, as evidenced by observations of Cook Inlet beluga whales with propeller scars (Burek 1999). Small boats and jet skis, which are becoming more abundant in Cook Inlet and Knik Arm, are also more likely to approach and disturb any whales that are observed.

4.5 AMBIENT AND BACKGROUND NOISE

Marine mammals produce sounds and use sounds to forage, orient, detect and respond to predators, and facilitate social interactions (Richardson et al. 1995). Beluga whales in particular use sound rather than sight for many important functions. They are often found in turbid waters in northern latitudes where darkness extends over many months. All whales also use sound to communicate, locate prey, and navigate; they may make different sounds in response to different stimuli. Whales produce high frequency sounds that they use as a type of sonar for finding and pursuing prey, and likely for navigating through ice-laden waters.

In Cook Inlet, marine mammals must compete acoustically with natural (ambient) and anthropogenic (background) sounds. Human-induced noises include large and small vessels, aircraft, pile driving, shore-based activities, dredging, filling, and other events. The effects of human-caused noise on beluga whales and associated increased background noises may be similar to humans’ reduced visibility when confronted with heavy fog or darkness. These effects depend on several factors, including the intensity, frequency, and duration of the noise; the location and behavior of the whale; and the nature of the acoustic environment. High-frequency noise diminishes more rapidly than low-frequency noises. Sound also dissipates more rapidly in shallow waters and over soft bottoms (sand and mud). Much of Upper Cook Inlet is characterized by shallow depth, sand/mud bottoms, and high background noise from currents and glacial silt (Blackwell and Greene 2002), which all make it a poor environment for propagating acoustics.

Measurements of underwater noise in Eagle Bay in August and September 2010 determined that mean ambient noise levels (devoid of anthropogenic and recording self-noise) were 97.9 +/-5.8 dB (Castellote et al. 2019). A 2001 acoustic research program in Upper Cook Inlet identified underwater noise levels (broadband) associated with anthropogenic activities that were as high as 149 dB re 20 µPa (Blackwell and Greene 2002). That noise was associated with a tugboat that was docking a barge. Ship and tugboat noise have been present at the POA for several decades and are expected to continue. The lowest underwater broadband average sampled was 95 dB re 1 µPa, obtained at Birchwood located approximately 10 kilometers up Knik Arm from Eagle Bay, and a location that is frequented by beluga whales (Blackwell and Greene 2002). The highest underwater broadband levels were obtained north of Point Possession during the incoming tide and reached 124 dB re 1 µPa (Blackwell and Greene 2002). Background underwater noise levels at the mouth of Eagle River were measured to be between the two, with a mean value at 118 dB.

Cook Inlet also experiences significant levels of aircraft traffic from Ted Stevens Anchorage International Airport, JBER, and several smaller runways. Even though airborne noise has poor transmission across the water surface, aircraft noise can be loud underwater when jet aircraft are directly overhead (Blackwell and Greene 2002). Beluga whales in the Beaufort Sea will dive or swim away when low-flying (below 500 meters) aircraft pass directly overhead (Richardson et al. 1995). However, in one study, survey aircraft flying at approximately 244 meters above Cook Inlet observed little or no change in beluga whale swim directions (Rugh et al. 2000), likely because beluga whales in Cook Inlet have habituated to routine small aircraft overflights. Beluga whales may be less sensitive to aircraft noise than vessel noise, but individual responses may be highly variable and depend on previous experiences, beluga whale activity at the time of the noise, and characteristics of the noise.

JBER currently maintains and operates a runway near—and airspace directly over—Knik Arm. Multiple types of military and commercial aircraft operate out of JBER. As a result, underwater noise from aircraft can be loud in the action area. The underwater sound pressure levels (SPLs) at the mouth of Eagle Bay resulting from F-22 takeoffs and landings have been measured at a mean of 95.3 dBrms and a maximum of 104.8 dBrms re 1 µPa (Castellote at al. 2019). Mean and maximum underwater noise from these aircraft is louder (by approximately 30 dBrms) in between Eagle Bay and Anchorage, as that is where the end of the JBER runways are located.

An analysis of the effects of F-22 overflights on Cook Inlet beluga whales and their designated critical habitat predicted a maximum underwater SPL (in Knik Arm off the end of the runway) resulting from an F-22 overflight at 137 dBrms re 1 µPa. Based partially on this prediction, NMFS—under informal consultation with JBER—agreed with JBER's determination that overflights by F-22s may affect, but were not likely to adversely affect, the Cook Inlet beluga whale, and that these overflights would not result in adverse modification to designated Cook Inlet beluga whale critical habitat (Department of the Air Force 2022).

Both the Army and Air Force on JBER train using HE, which is a source of in-air and underwater noise. Past military training at ERF-IA is discussed in Section 1.3.1. Since 1990, training in ERF-IA has not occurred during times of the year when beluga whales are observed in Eagle River. In addition, JBER conducts explosive ordinance training such as explosive ordnance disposal and demolition training. The Air Force and Army have designated training areas for live-fire training with conventional and improvised explosives. A recent study conducted by JBER and the Navy found that a 74-pound net explosive weight (NEW) charge of buried C4 detonated at one of the two primary explosive ordnance ranges on JBER (Demo III approximately 800 meters [2,625 feet] from Knik Arm) resulted in a maximum SPL of 139 dBrms re 1 µPa in Eagle Bay (Henderson et al. 2012). A later study found that a 69 kg (151 pound) NEW buried charge on the same range (Demo III) resulted in a maximum SPL of 145 dBrms re 1 µPa in

Eagle Bay (Henderson et al. 2013). Based partially on these results, NMFS—under informal consultation with JBER—agreed with JBER's determination that explosive ordnance activities[9] on base may affect, but were not likely to adversely affect, the Cook Inlet beluga whale, nor were they likely to adversely modify designated Cook Inlet beluga whale critical habitat.

4.6 WATER QUALITY AND CONTAMINANTS

Knik Arm is primarily fed by the Knik and Matanuska rivers, both glacial tributaries that make Knik Arm very turbid. A 0.5-mile section of the Matanuska River is listed on Alaska's 2010 Clean Water Act Section 303(d) list of impaired waterbodies due to residues from an active open dump in Palmer, Alaska (ADEC 2022). A total maximum daily load for debris and floatable trash has been developed for this waterbody.

The principal sources of pollution in the marine environment that have the potential to effect ESA-listed marine mammals are: 1) discharges from industrial activities not entering municipal treatment systems; 2) discharges from municipal wastewater treatment systems; 3) runoff from urban, mining, and agricultural areas; and 4) accidental spills or discharges of petroleum and other products (Moore et al. 2000).

Water quality in the Knik Arm is expected to be similar to water quality in other parts of Upper Cook Inlet. The Alaska Department of Environmental Conservation has listed Upper Cook Inlet as a Category 3 waterbody, indicating that there is insufficient data to assess water quality (ADEC 2022). A Category 3 designation is the result of insufficient information in determining whether the waterbody meets water quality standards.

Quality and chemical composition of water in the impact area varies seasonally based on factors such as snowmelt, precipitation, and tidal fluctuations/inundation. Salinity varies seasonally and spatially throughout ERF waterbodies, with the highest concentrations tending to be in shallow intermittent ponds and during warmer dry summers. Between May and July, salinity in ponds has been measured at 4 to 38 parts per thousand, with higher salinities occurring in shallow mudflat ponds (Racine and Brouillette 1995).

Prior to cleanup in 1996, 60 acres of ERF-IA was placed on the Section 303(d) list for non-attainment of the criteria for toxic and other deleterious organic and inorganic substances. Specifically, ERF-IA was flagged for contamination with WP and was designated as a Category 4b waterbody. The site was treated by pumping water out and allowing soils and sediments to dry, providing an environment for WP to sublimate. Active treatment ceased in 2005, and in 2008 the site was redesignated as a Category 2 waterbody. The latest water quality assessment found good conditions for aquatic life and wildlife at ERF-IA (ADEC 2022).

Other portions of Eagle River are not water quality limited (USARAK 2004). The U.S. Geological Survey monitored the water quality of Eagle River until 1981 and concluded that Eagle River was, in terms of water quality, similar to other glacially fed rivers, with no exceedances of water quality standards (USARAK 2004). Between 1970 and 1981, the pH of Eagle River ranged between 6.6 and 8.0. Dissolved oxygen levels measured in 1981 were found to range between 11.8 milligrams per liter (mg/L) and 12.9 mg/L (USGS 2020b).

Water quality data were collected in 2007 at various locations in Eagle River. The upstream sampling location was upstream of the former Fort Richardson boundary, the midstream measurements were taken at a location just upstream of ERF, and the downstream sampling location was at the mouth of the Eagle River. No exceedances of the most stringent water quality criteria were found in any samples in the Eagle River. In addition, no explosive residues or compounds (including High Melting Explosive, Royal Demolition Explosive, trinitrotoluene [TNT], or polychlorinated biphenyls) were detected in the river.

[9] Detonations of HE charges up to 40-pound NEW surface and 150-pound NEW buried at Demo III.

Eagle River data samples indicate that there is a general trend of increasing metals concentrations in water moving downstream, with the largest increase occurring in ERF-IA.

Because occurrence of Steller sea lion in the action area is rare, exposure of contaminants is primarily a concern for beluga whale. Contaminants released into beluga whale habitat can affect their overall health (Becker et al. 2000). The *Recovery Plan for the Cook Inlet Beluga Whale* (NMFS 2016) states that exposure to industrial chemicals—as well as to natural substances released into the marine environment—is a potential health threat for Cook Inlet beluga whales and their prey. An in-depth review of available information on pollution and contaminants in Cook Inlet is presented in the Recovery Plan.

Cook Inlet beluga whales appear to have lower levels of certain contaminants (i.e., polychlorinated biphenyls, chlorinated pesticides, and heavy metals[10]) stored in their bodies than do other populations of beluga whales (Becker et al. 2000, 2001); however, the impacts of contaminants on beluga whales in Cook Inlet are unknown (NMFS 2008a). A literature review of the potential chemical exposures for beluga whales in Cook Inlet identified a list of 19 chemical classes[11] that may warrant closer evaluation in regard to their potential adverse effects on Cook Inlet beluga whales (URS Corporation 2010).

One study of polycyclic aromatic hydrocarbons (PAHs) found that PAH levels in Cook Inlet sediment samples were moderately high compared to other areas with known environmental problems with PAH contamination (Wetzel et al. 2010). Sediments from the mouth of Eagle River had the highest PAH levels, although there were no statistical differences between the study locations. A highly toxic form of PAH, benzo[a]pyrene, was detected at low levels in all sample locations. Fish tissue samples exhibited the same general pattern in terms of types and concentrations of PAHs, as did the sediment; however, they contained little or no benzo[a]pyrene. Eulachon samples from the Little Susitna River exhibited the highest PAH values. Beluga whale tissue from Cook Inlet exhibited much higher PAH levels when compared to the tissue of beluga whales from the MacKenzie River delta. The study concluded that beluga whales in Cook Inlet appear to be bioaccumulating PAHs, and that concerns regarding the potential impacts to the recovery of the Cook Inlet beluga whale population from this class of chemicals are justified (Wetzel et al. 2010).

Sediment and surface water samples have been collected from various locations in ERF since 1989. Samples have been analyzed for volatile organic compounds, semi-volatile organic compounds, polychlorinated biphenyls, and inorganic compounds (metals and other). Trace amounts of several organic compounds have been detected in sediment, but not at concentrations that are deemed harmful to humans or wildlife (CH2M Hill 1997). None of the water samples have contained elevated levels of any contaminants, including traditional munitions constituents. The wetland environment of ERF functions as a uniquely effective mechanism for water treatment, and repeated testing indicates that munitions constituents are neither accumulating in nor migrating off the wetlands (CH2M Hill 1997).

In addition to chemical contaminants, runoff from natural and urban areas around Cook Inlet can introduce potential pathogens, or disease-causing agents, to the inlet. Infection and disease are of particular concern for Cook Inlet belugas and every effort is made to test tissues and lesions from stranded whales for potential viruses such as herpesvirus and brucella (NMFS 2022b). The following pathogenic groups have been identified as being of probable concern for the health and reproductive success of the Cook Inlet beluga whale: bacteria (e.g., *Vibrio* spp., *Brucella,* and *Enterococcus*), viruses (e.g., influenza A virus, herpes virus, morbillivirus, and norovirus), protozoans (e.g., *Toxoplasma gondii, Cryptosporidium* spp., and *Giardia* spp.), and parasites (e.g., nematodes, helminths, and trematodes) (URS Corporation 2011). A study of the occurrence and extent of fecal pathogens in Upper Cook Inlet found *Giardia* spp., *Vibrio* spp.,

[10] Becker et al. (2000) did find that copper levels in Cook Inlet beluga whale liver samples were two to three times higher than in other arctic beluga whales but concluded that these levels were not high enough to pose a known health risk.

[11] Chemical classes included chlorinates pesticides; chlorinated dielectric fluids, transformer oils; chlorinated dibenzo-p-dioxins and furans; metals; PAHs; polybrominated flame retardants; hexabromocyclododecanes; perfluorinated compounds; phthalates/phthalate esters/alkylated phthalates; prescription and over-the-counter drugs; alkylphenols, alkylphenol ethoxylates; consumer plastics; natural and synthetic hormones; surfactants; pesticides; organochlorines; organophosphates/carbamates; triazines; and synthetic pyrethroids.

Cryptosporidium spp.,[12] and norovirus present in water and sediment samples from seven sites in Knik Arm (Norman et al. 2013). Water from Eagle River tested positive for *Giardia* spp., *Vibrio* spp., and norovirus Group I. Burek and Goertz (2010) conducted a mortality and morbidity study on 34 Cook Inlet beluga whale carcasses and found that disease was the primary cause of death in two cases[13] and was a contributor to death in 31 cases.[14]

[12] *Cryptosporidium* spp. were only detected in water samples.
[13] Systemic infection (n=1) and systemic herpesvirus (n=1).
[14] Cardiomyopathy (n=3), lungworm pneumonia (n=11), *Crassicauda* pyelonephritis (n=14), Misc (n=3).

5.0 EFFECTS ANALYSIS

This section analyzes direct and indirect effects of the project on listed species and their habitats, together with the effects of other activities that are interrelated or interdependent with the action that are added to the environmental baseline (50 CFR 402.12(f)). This analysis includes the potential for the proposed action to result in take, or "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" of listed species (16 U.S.C. 1532(19)).

For listed species, the potential for an individual to be exposed to a stressor was evaluated in conjunction with the severity of the stressor and the status of existing baseline conditions. A conclusion about the effect was made for each listed species based on the analysis using the following terms: beneficial, insignificant, discountable, and destruction or adverse modification, as defined by NMFS:

- Beneficial effects have an immediate positive effect without any adverse effects to the species or habitat.
- Discountable effects are those that are extremely unlikely to occur. For an effect to be discountable, there must be a plausible effect (i.e., a credible effect that could result from the action and that will be an adverse effect if it did impact a listed species), but it is very not likely to occur.
- Insignificant effects relate to the size or severity of the impact and should never reach the scale where take occurs.

Potential direct effects of the project action on ESA-listed species marine mammals and their habitats include: 1) injury or mortality as a result of an errant round landing in or near the water; 2) primary blast injury or mortality as a result of detonation of a HE round in the target area; 3) noise-induced effects, including auditory injury, auditory fatigue, auditory masking, behavioral and physiological responses; and 4) changes in the availability of prey for ESA-listed marine mammals due to mortality, injury, or decreased fitness of fish. Potential indirect effects include the degradation of water quality due to munitions residues, which could potentially lead to toxicity in whales and their prey, as well as the possibility of increased sediment loads due to habitat disturbance.

The effects analysis, which is presented in detail in Sections 5.1 through 5.9 considers the potential effects of the proposed action with implementation of the measures presented in Section 2.4.

5.1 NOISE

An explosion is a chemical reaction that rapidly (on the order of milliseconds) converts a substance into gaseous products at very high temperature and pressure. In the case of HE rounds, this steep-fronted pressure wave (called a shock wave) travels with a speed exceeding the speed of sound in the medium through which it is propagating (e.g., air, water, rock). The amplitude and speed—and therefore destructive power—of this wave decay rapidly with increasing distance from its explosive origin, gradually becoming a sound wave. Airborne noise does not readily propagate into water, a portion of the sound is reflected off the water surface, with greater reflection occurring at shallow incidence angles (JASCO 2022).

5.1.1 General Effects of Underwater Noise

The effects of underwater noise on marine mammals depends on several factors, including the species, size of the animal, and proximity to the source; the depth, intensity, and duration of the sound; the depth of the water column; the substrate; the distance between the source and the animal; and the sound propagation properties of the environment. Therefore, the degree of effect is intrinsically related to the received level and duration of the sound exposure, which are in turn influenced by the distance between the animal and the source. In general, sound exposure is less intense farther away from the source. The substrate and depth of the habitat affect the sound propagation properties of the environment. Shallow environments are typically more structurally complex, which leads to more rapid sound attenuation. In addition, substrates that are soft (e.g., sand) absorb sound more readily than hard substrates (rock), which may reflect the acoustic wave.

Potential impacts to marine species can be caused by physiological responses to both the type and strength of the acoustic signature (Viada et al. 2008). Behavioral impacts may also occur, although the type and severity of these effects are more difficult to define because studies addressing the behavioral effects of impulsive sounds on marine mammals are limited. Potential effects from impulsive sound sources can range from Level B effects (e.g., behavioral disturbance, tactile perception, and physical discomfort) to Level A impacts, which may include injury to the internal organs and the auditory system and possible death of the animal (Yelverton et al. 1973; O'Keeffe and Young 1984).

5.1.1.1 Physiological Responses

The term "stressor" can be defined as an internal or external perturbation that challenges an organism's ability to survive or reproduce or results in the perception of such a challenge (U.S. Navy 2009). Stressors can be physical (e.g., anoxia, hypoglycemia, injury, cold, exertion), psychological (e.g., social interaction, fear of predation, or novel stimulus like an abrupt noise), or both (Reeder and Kramer 2005). Marine mammals experience a variety of stressors throughout their lives and must constantly adjust their internal environment and often their behavior to adapt to—or overcome—these challenges, thereby restoring homeostasis. These physiological and behavioral responses to a stressor are often collectively categorized as the "stress response."

The mammalian physiological stress response is thought to be mediated by two major systems, the sympathetic nervous system and the hypothalamic-pituitary-adrenal axis, both of which are activated rapidly in response to a stressor and work in concert to prepare an organism to respond. Activation of both pathways is mediated by the hypothalamus.

The immediate hypothalamic response to a stressor is a release of catecholamine neurohormones, epinephrine, and norepinephrine across sympathetic postganglionic neural synapses at the target organs themselves. Norepinephrine has dual roles as a hormone and a neurotransmitter, both of which act to increase the rate of contractions in the heart. The hypothalamus also initiates nerve impulses that pass through the brain stem into the spinal cord and then through sympathetic preganglionic fibers to sympathetic postganglionic fibers ending at the adrenal gland. This sympathetic nervous reaction ultimately stimulates the adrenal medulla to secrete epinephrine and norepinephrine into the bloodstream, where—in this case—they act as hormones, increasing heart rate, triggering release of glucose from the liver and muscles, and increasing blood flow to the skeletal muscles.

Concurrent with stressor-induced sympathetic nervous system activation, the hypothalamus also activates the hypothalamic-pituitary-adrenal axis via secretion of corticotropin-releasing hormone, which in turn stimulates the nearby pituitary gland to release adrenocorticotropic hormone into the bloodstream. Adrenocorticotropic hormone binds to and stimulates the cortex of the adrenal gland to release glucocorticoid steroids, including cortisol and corticosterone. Cortisol increases blood pressure and mobilizes energy via stimulation of gluconeogenesis in the liver, leading to an increase in blood sugar levels. Cortisol also suppresses components of the immune system, freeing up energy that can be used to address the acute stress. Once the stressor disappears, cortisol levels in the blood normally return to baseline levels via negative feedback on the pituitary gland and hypothalamus.

The physiological stress response prepares the body for direct action, in part by increasing heart rate and blood pressure and by mobilizing energy reserves for immediate use. These conditions are often key to the immediate survival of an animal. In cases of extreme or prolonged stress (e.g., predation or a stranding event), marine mammals may exhibit an exaggerated stress response that can cause physiological deterioration or even death.

Different types of stressors have been shown to produce variable stress responses in beluga whales. In one study, beluga whales demonstrated no catecholamine response to the playback of oil drilling sounds (Thomas et al. 1990) but showed an increase in catecholamines following exposure to impulsive sounds produced from a seismic water gun (Romano et al. 2004). Pursuit, capture, and short-term holding of beluga whales have been observed to result in a decrease in thyroid hormones (St. Aubin and Geraci 1988) and an increase in epinephrine (St. Aubin and Dierauf 2001).

In a study that measured cardiorespiratory changes in a recently captured captive beluga whale calf in response to noise at various frequencies (19 to 27 kilohertz [kHz], 27 to 38 kHz, 38 to 54 kHz, and 54 to 108 kHz), SPLs (140, 150, and 160 dB re 1 µPa), and durations (1, 3, and 10 minutes), presentation of noise elicited a sharp increase—up to 208 percent of the control rate—in heart rate (tachycardia) (Lyamin et al. 2011). Tachycardia was found to increase with SPLs and decrease with removal of the noise. The magnitude of tachycardia decreased with increasing sound bandwidth and was greatest in the 19 to 27 kHz range. Observed age-related differences in response to noise may be at least partially explained by a limited ability in young to control heart rate as a function of the dive response, which improves with maturation (Noren et al. 2004).

It is assumed that a physiological stress response must exist to cause a behavioral response. An animal that alters key natural behaviors (e.g., feeding, breeding, or sheltering) may incur a biologically significant cost. Another behavioral reaction that could lead to significant biological cost is a fleeing response that results in stranding or separation of a cow and calf, especially a newborn calf. Costs resulting from other reactions like altered surfacing rates, decreased vocalization, or temporary avoidance of an area are much less clear.

Many examples of feeding behavior disruption by anthropogenic sound have been reported for cetaceans (Nowacek et al. 2004; Dans et al. 2008; Arcangeli and Crosti 2009). Examples where noise does not have an effect have also been noted (Croll et al. 2001; Madsen et al. 2006; Yazvenko et al. 2007). Researchers have noted changes in resting and surface behavior states of cetaceans in proximity of whale-watching vessels (Arcangeli and Crosti 2009; Noren et al. 2009). Short-term avoidance of seismic surveys, low-frequency emissions, and acoustic deterrents have also been noted in wild populations of odontocetes (Bowles et al. 1994; Goold 1996; Stone et al. 2000; Morton and Symonds 2002).

Regardless of whether an animal displays a behavioral reaction, a physiological stress response can incur a biological cost to the animal. Reactive oxygen species produced during normal physiological processes are generally counterbalanced by enzymes and antioxidants; however, excess stress can result in an excess production of reactive oxygen species, leading to damage of lipids, proteins, and nucleic acids at the cellular level (Berlett and Stadtman 1997; Sies 1997; Touyz 2004). Prolonged or repeated exposure to stressors (i.e., chronic stress) can also result in elevated levels of stress-related hormones, which can lead to detrimental physiological effects over time, such as immune suppression, reproductive malfunction, accelerated aging, and gradual disintegration of body condition (Wright et al. 2007). Chronic stress is also thought to lead to morphological changes in the adrenal gland of odontocetes, resulting in the increased capacity for catecholamine production and storage (Clark et al. 2006). In addition, exposure to an acute stressor that is severe or prolonged (e.g., a predatory attempt or stranding event) is thought to sometimes result in an exaggerated stress response (massive release of catecholamines) in cetaceans, which can lead to physiological deterioration or even death (Cowan and Curry 2008). It has been theorized that expression of this exaggerated response in chronically stressed animals with the aforementioned adrenal changes and consequent increased capacity for catecholamine production could result in death via heart failure because is sometimes observed in stranded odontocetes (Clark et al. 2006).

Both the expression of a physiological stress response and a consequent behavioral response to a stressor may exact a biological cost to an animal. The magnitude of this response can differ greatly depending on interactions between multiple variables, including the type of stressor (e.g., injury, predation event, social interaction, noise), characteristics of the stressor (e.g., magnitude, novelty, duration, suddenness of onset, significance of stimulus), and the physiological (e.g., health status, sex, age) and psychological (e.g., social status, habituation, sensitization, group versus solo) status of the affected animal. The context in which the stressor is experienced and the animal's motivation to respond (or not) to a stressor may also greatly affect the magnitude of response. For social animals such as beluga whales, an additional complication is that animals in a group that would not normally respond to a given stressor may instead respond to another beluga whale's response to that stressor. This highly variable nature of the mammalian response to stressors complicates efforts to predict how a particular action might affect a particular individual or group on any given day.

5.1.1.2 Behavioral Responses

Behavioral responses to sound can be highly variable. NMFS has established reasonable noise thresholds based on the best available science. To assess marine mammal behavioral response to noise accumulating from multiple individual detonations within a 24 h period, JASCO applied the behavioral disturbance criteria for marine mammals used by the US Navy (Finneran et al. 2017). For multiple explosions, these behavioral thresholds correspond to levels 5 dB below the TTS onset thresholds (JASCO 2020). This report also presents the NMFS (2013) 160 dB re 1 μPa SPL threshold for behavioral response for impulsive sounds for all marine mammal species. For each potential behavioral change, the magnitude of the change ultimately determines the severity of the response. Factors that may influence an animal's response to noise include its previous experience, auditory sensitivity, biological and social status (including age and sex), and behavioral state and activity at the time of exposure (Southall et al. 2021). Habituation occurs when an animal's response to a stimulus wane with repeated exposure, usually in the absence of unpleasant associated events (Wartzok et al. 2003). Animals are most likely to habituate to sounds that are predictable and unvarying. The opposite process is sensitization—when an unpleasant experience leads to subsequent responses, often in the form of avoidance—at a lower level of exposure.

Behavioral state or differences in individual tolerance levels may affect the type of response as well. For example, animals that are resting may show greater behavioral change in response to disturbing noise levels than animals that are highly motivated to remain in an area for feeding (Richardson 1995; National Research Council 2003; Wartzok et al. 2003; Southall et al. 2007). Indicators of disturbance may include sudden changes in the animal's behavior or avoidance of the affected area. A marine mammal may show signs that it is startled by the noise and/or may swim away from the sound source and avoid the area. Increased swimming speed, increased surfacing time, and cessation of foraging in the affected area indicate disturbance or discomfort (Southall et al. 2021).

Controlled experiments with captive marine mammals have shown pronounced behavioral reactions, including avoidance of loud sound sources (Ridgway et al. 1997; Finneran et al. 2003, Southall et al. 2021) and an increase in the respiration rate of harbor porpoises (Kastelein et al. 2013). Observed responses of wild marine mammals to loud pulsed sound sources (typically seismic guns or acoustic harassment devices and pile driving) have been varied, but these responses often consist of avoidance behavior or other behavioral changes that suggest discomfort (Wartzok et al. 2003; Nowacek et al. 2007).

A comprehensive review of acoustic and behavioral responses to noise exposure by Nowacek et al. (2007) concluded that one of the most common behavioral responses is displacement. To assess the significance of displacements, it is necessary to know the areas that the animals relocate to, the quality of that habitat, and the duration of the displacement in the event that they return to the pre-disturbance area.

Natural and artificial sounds can disrupt behavior through auditory masking or interference with a marine mammal's ability to detect and interpret other relevant sounds, such as communication and echolocation signals (Wartzok et al. 2004). Masking occurs when both the signal and masking sound have similar frequencies and either overlap or occur very close to each other in time. A signal is very likely to be masked if the noise is within a certain "critical bandwidth" around the signal's frequency and its energy level is similar or higher (Holt et al. 2008). Noise within the critical band of a marine mammal signal will show increased interference with detection of the signal as the level of the noise increases (Wartzok et al. 2004).

For example, in delphinid subjects, relevant signals needed to be 17 to 20 dB louder than masking noise at frequencies below 1 kHz to be detected and 40 dB greater at approximately 100 kHz (Richardson 1995). Noise at frequencies outside of a signal's critical bandwidth will have little to no effect on the detection of that signal (Wartzok et al. 2004).

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

5.1.2 General Effects of Airborne Noise

ESA-listed species near ERF-IA could be exposed to airborne sounds associated with indirect live-fire training, which have the potential to cause behavioral disturbance depending on their distance from the target array and detonation point.

Airborne noise is a potential issue for Steller sea lions that are swimming or hauled out within the range of effect as defined by the acoustic criteria discussed in Section 5.1.3. However, there are no known haul out locations within the action area, reducing the chances of exposure. Airborne sound is most likely to cause behavioral responses such as changes in their normal behavior (e.g., reduction in vocalizations), or could cause them to temporarily abandon their usual or preferred locations and move farther from the noise source. Steller sea lions swimming in the vicinity of training activities may avoid or withdraw from the area or may show increased alertness or alarm (e.g., heading out of the water and looking around). ESA-listed species in the affected zones may exhibit temporary behavioral reactions to airborne detonation. These exposures may have a temporary effect on individual animals or groups of animals.

Demarchi et al. (2012), for example, found that hauled-out Steller sea lions subjected to in-air noise from military high explosive detonations displayed short term effects (e.g. significant increase in activity level with some animals leaving haul-out but with sharp decline in activity shortly after detonation). Activity levels were similar to pre-detonation levels on the day following detonation. From this and from the documented local increase in peak Steller sea lion numbers despite multiple decades of training with military high explosives in the area, auditory injury and injury from annoyance to Steller sea lions from in-air explosive noise are both unlikely.

Airborne noise could also affect cetaceans such as beluga whales. There currently are no in-air disturbance thresholds for cetaceans. However, when pressure waves from a detonation of HE munitions in air meet the water surface, the pressure can be transmitted across the air-water boundary and would likely be perceived by surfacing beluga whales. Reactions to in-air noise may be similar to behavioral disturbances described for underwater noise.

5.1.3 Applicable Acoustic Criteria[15]

For underwater impulsive sound, the Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts (NMFS, 2018) were used for this analysis. This technical guidance covers assessment of the onset of temporary threshold shifts (TTS) for Level B harassment or permanent threshold shifts (PTS) for Level A harassment (NMFS 2018). Subsequently, in October 2024, NMFS released updated guidance

[15]The terms, "Level A" and "Level B" are specific to the MMPA and are not typically used when discussing harassment under the ESA. Level A acoustic harassment under the ESA is often termed Auditory Injury while Level B harassment is often termed Behavioral Disturbance.

for assessing the effects of anthropogenic sound on marine mammals hearing, which includes updated underwater and in-air criteria for auditory injury[16] and TTS (NMFS 2024). This new guidance provides minor updates to auditory weighting and exposure function parameters for marine mammal hearing groups and revises TTS and auditory injury criteria for both impulsive and non-impulsive noise, compared to what is presented here. After considering these new thresholds, it was determined that while some of the new thresholds are slightly more protective and others are slightly less protective, they would not change the results of noise impact analysis for marine mammals.

Under this guidance, marine mammals are separated into five functional hearing groups based on hearing ranges (Table 5-1). Underwater TTS and PTS thresholds are set for the peak received sound pressure level (SPL; Lpk) and 24-hour cumulative sound exposure level (SEL_{24h}). The Level B (disturbance) underwater threshold for non-explosive impulsive sound is 160 decibels referenced to 1 microPascal (dB re 1 µPa) root mean square (rms) for all marine mammals, based on NMFS (2018). However, the 2018 NMFS guidance available when modeling for the proposed action was conducted did not include behavioral thresholds appropriate to assess potential Level B harassment from noise from explosive detonations. The Navy has developed criteria and thresholds specific for acoustic and explosive effects on marine mammals (Finneran et al. 2017). The 2017 Navy guidance for behavioral response for multiple impulses from explosives includes the following:

- If more than one explosive or explosive cluster is detonated within any given 24-hour period during a training or testing activity, criteria are applied to predict the number of animals that may have a behavioral reaction. For events with multiple explosions, the behavioral threshold used in this analysis is 5 dB less than the TTS onset threshold.
- Some multiple explosive events, such as certain naval gunnery exercises, may be treated as a single event because a few explosions occur closely spaced within a very short time (a few seconds). For single explosions at received sound levels below hearing loss thresholds, the most likely behavioral response is a brief alerting or orienting response. Because no further sounds follow the initial brief impulses, significant behavioral reactions would not be expected to occur. This reasoning was applied to previous shock trials (66 FR 87; 73 FR 143) and is extended to the criteria used in this analysis.

A summary of underwater harassment thresholds is provided in Table 5-2. For these criteria, all underwater SPLs are reported as dB re 1 µPa. The aforementioned thresholds are used to establish incidental take of marine mammals per the requirements of the MMPA.

For airborne impulsive sound, Southall et al. (2019) provided recommendations for assessing the onset of TTS and PTS for phocids and other marine carnivores using Lpk and SEL_{24h} metrics for Level A harassment. The Level B airborne threshold for sound is 90 dB re 20 µPa rms for harbor seals and 100 dB re 20 µPa rms for otariids (Steller sea lions). Table 5-3 provides a summary of the airborne harassment thresholds. For these criteria, all airborne SPLs are reported as dB re 20 µPa.

Table 5-1 Marine Mammal Functional Hearing Groups and Species Potentially Exposed to Live-fire Training Noise

Functional Hearing Group	Species in Geographic Region	Functional Hearing Range
Mid-frequency cetaceans*	Beluga whale	150 Hz to 160 kHz

[16] In the updated technical guidance (NMFS 2024), thresholds for auditory injury (AUD INJ) replace thresholds for PTS. Auditory injury is defined as "damage to the inner ear that can result in destruction of tissue, such as the loss of cochlear neuron synapses or auditory neuropathy. Auditory injury may or may not result in a PTS." While the thresholds and terminology from the 2018 technical guidance were used in the acoustic modeling reports and Noise Technical Report (Appendix C), changes resulting from the 2024 technical guidance have been reviewed and are considered in the analysis of impacts in this EIS.

Functional Hearing Group	Species in Geographic Region	Functional Hearing Range
Otariids	Steller sea lion	In-water: 60 Hz to 39 kHz In-air: 50 Hz to 75 kHz

Key: Hz = hertz; kHz = kilohertz.
Source: NMFS 2018
* The NMFS 2024 updated thresholds (NMFS 2024) now classify belugas as High-Frequency Cetaceans.

Table 5-2 Summary of Underwater Acoustic Criteria for Marine Mammals*

Marine Mammals	Auditory Injury Threshold[1]		Behavioral Disturbance Threshold [2,3]		
	PTS Thresholds		TTS Threshold		Behavioral
	Lpk	SEL_{24h}	Lpk	SEL_{24h}	SEL_{24h}
Beluga whale (Mid-frequency cetacean)**	230 [230]	185 [193]	224 [224]	170 [178]	165
Steller sea lion (Otariid pinniped)	232 [230]	203 [185]	226 [224]	188 [170]	183
Harbor seal (Phocid pinniped)	218 [223]	185 [183]	212 [217]	170 [168]	165

Notes:
* The NMFS 2024 updated thresholds (NMFS 2024b) are presented in bracketed superscript for comparison to the thresholds used in this analysis.
**Note that the hearing groups for the updated thresholds, while not changed in this analysis, have changed such that belugas are now considered High-Frequency Cetaceans

[1]Auditory injury thresholds: Lpk reported as dB re 1 µPa; SEL reported as dB re 1 µPa2·s.

[2]Behavioral disturbance threshold: reported as dB re 1 µPa2·s.

[3]JASCO 2022; Behavioral SEL_{24h} from Finneran et al. 2017 (Table 7 in JASCO 2022)

Key: dB re 1 µPa = decibel referenced to 1 microPascal; Lpk = peak sound pressure level; PTS = permanent threshold shift; s = second; SEL_{24h} = sound exposure level over 24 hours; TTS = temporary threshold shift.

Source: Finneran et al. 2017; NMFS 2018, 2024.

Table 5-3 Summary of Airborne Acoustic Criteria for Marine Mammals*

Functional Hearing Group or Species	Auditory Injury Threshold[1]		Behavioral Disturbance Threshold[2]		
	PTS Threshold		TTS Threshold		Behavioral rms
	Lpk	SEL_{24h}	Lpk	SEL_{24h}	
Steller sea lion (Otariid pinniped)	176 [177]	161 [163]	170 [171]	146 [148]	100
Harbor seal (Phocid pinniped)	161 [162]	138 [140]	155 [156]	123 [125]	90

Notes:

* The NMFS 2024 updated thresholds (NMFS 2024b) are presented in bracketed superscript for comparison to the thresholds used in this analysis, 2018 NMFS technical guidance, which provides thresholds for PTS.

[1]Auditory injury thresholds: Lpk reported as dB re 20 µPa; SEL_{24h} reported as dB re 20 µPa2·s.

[2]Behavioral disturbance threshold: reported as dB re 20 µPa rms.

Key: dB re 20 µPa = decibel referenced to 20 microPascals; Lpk = peak sound pressure level; PTS = permanent threshold shift; rms = root mean square; s = second; SEL_{24h} = sound exposure level over 24 hours; TTS = temporary threshold shift.

Source: Southall et al. 2019; NMFS 2024b.

The Navy's 2017 guidance also includes criteria and thresholds for mortality and injury (non-auditory) for explosives. The criterion for mortality is based on severe lung injury (derived from Goertner 1982), and the criteria for non-auditory injury are based on slight lung injury or gastrointestinal (GI) tract injury. These criteria take into account the animal mass and depth in water. See Appendix B for more information on the impulse criteria for non-auditory injury. Again, these criteria were not applied in the take calculations presented in this document. However, in general, the highest order effect is mortality > non-auditory injury > PTS > TTS > behavioral response; therefore, monitoring and mitigation designed around PTS thresholds would also be conservatively protective for non-acoustic injury.

In October 2024, NMFS released updated guidance for assessing the effects of anthropogenic sound on marine mammal hearing, which includes updated underwater and in-air criteria for PTS and TTS (NMFS 2024b). This new guidance provides minor updates to auditory weighting and exposure function parameters for marine mammal hearing groups, and revises TTS and auditory injury (PTS) criteria for both impulsive and non-impulsive noise. The new thresholds that are relevant to this analysis are provided in bracketed superscript in Tables 6-2 and 6-3.

With regard to PTS thresholds for impulsive underwater noise, all of the new peak thresholds are unchanged or greater than the thresholds utilized in this analysis and, with the exception of the threshold for phocid and otariid pinnipeds, all of the new thresholds for 24-hour SEL are also higher. For phocids, the new underwater 24-hour SEL PTS threshold (183 dB) for phocid pinnipeds is 2 dB lower than used in this analysis (185 dB). For otariids, the new underwater 24-hour SEL PTS threshold of 185 dB is 18 dB lower than the threshold utilized in this analysis. Even with this lower threshold, however, otariids are still considered less sensitive to underwater noise than the other hearing groups analyzed, none of which would be exposed to underwater noise above PTS thresholds, as discussed in Section 6.3.2. Even with application of the new thresholds, the protective habitat buffers described in Section 1.5.2.1 would still be adequate to prevent PTS of phocids (harbor seal) and otariids (Steller sea lion) from underwater noise.

With regard to TTS thresholds for impulsive underwater noise, the new peak and 24-hour SEL thresholds for beluga whale and harbor porpoise are higher or equal to what are used in this analysis, and the new peak thresholds for phocids are higher than what are used in this analysis. The new 24-hour TTS SEL threshold for otariid pinnipeds is lower than what is used in this analysis (170 versus 188 dB); this analysis also considered a 24-hour SEL behavioral threshold of 183 dB, which is closer to but still higher than the new 24-hour SEL threshold of 170 dB. However, with regard to the proposed action, underwater noise is not a significant factor in potential Level B exposures of otariids when compared to the much greater extent of in-air noise threshold exceedance, so application of this new threshold, if it were done, would have a discountable impact on this analysis. Similarly, the 2 dB decrease in the TTS SEL threshold for phocids and TTS peak threshold for otariids would not meaningfully affect the Level B exposure estimate for harbor seal or Steller sea lion.

With regard to impulsive in-air noise, the new PTS (AUD INJ) and TTS thresholds for both phocid and otariid pinnipeds are slightly higher than the thresholds used in this analysis.

5.1.4 Description of Acoustic Modeling

JASCO (2020) conducted numerical modeling to evaluate the potential impacts to marine mammals and fish due to underwater and in-air noise from mortar and artillery firing at ERF-IA. The Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts (NMFS, 2018) were used for this analysis. JASCO also conducted a supplemental analysis in 2022 to evaluate additional training scenarios, analyze non-auditory effects (for marine mammals), and estimate areas where detonations should be avoided to reduce underwater noise effects to marine mammals and fish. Multiple training scenarios were analyzed involving explosive ammunition fired by 105-mm and 155-mm howitzers and by 60-mm, 81-mm, and 120-mm mortars during both summer and winter scenarios to reflect representative training sessions and firing locations (JASCO 2020, 2022). For this analysis, the TNT-equivalent explosive mass for the ammunition is indicated as NEW. This modeling considers environmental parameters such as water sound speed profile, bathymetry, seabed geoacoustics, atmospheric conditions, and soil flow resistivity in winter and summer.

The modeling included the use of a pre-determined firing point (FP3) and several detonation points (AF1, DP2, and DP3) of several training event scenarios (Figure 5-1). Detonation points DP2 and DP3 are located approximately 100 meters from Eagle River. AF1 represents an accidental firing scenario where a round is inadvertently fired into Eagle River near the mouth of Eagle Bay. These points were chosen by the Army as representative locations to inform how sound would propagate throughout ERF-IA and firing areas. Note that the modeled detonation points were target arrays that were chosen based on historical firing and are not the only areas that the Army could fire into. Targets could be placed outside of these traditional target arrays as long as they are situated outside of the established buffers.

In the supplemental analysis (JASCO 2022), distance to effect (DTE) modeling was performed by simulating potential firing scenarios at six representative locations along Eagle Bay, Eagle River, and Otter Creek complex (Figure 5-1.) during typical high tide conditions to determine minimum impact distances from the waterbody required to avoid exceeding underwater noise thresholds for marine mammals and fish (JASCO 2022). DTE modeling used an iterative process where the ground impact point was shifted away from the edge of the nearest waterbody until thresholds were no longer exceeded in the water.

For underwater sound propagation, it was concluded that the coupling of acoustic energy from the air-ground-water pathway has the greatest potential to affect marine mammals and fish (JASCO 2020, 2022). The modeling considered typical high tide events as well as typical inundating tide events that may occur in ERF-IA during summer, although DTE modeling only considered typical high tide conditions. During lower tide conditions, there would be an even greater pathway for ground-detonation noise to propagate into the water column, further reducing noise levels. For this reason, typical high tide conditions represent a conservative scenario for firing, outside of the infrequent periods of inundation, which have been modeled separately.

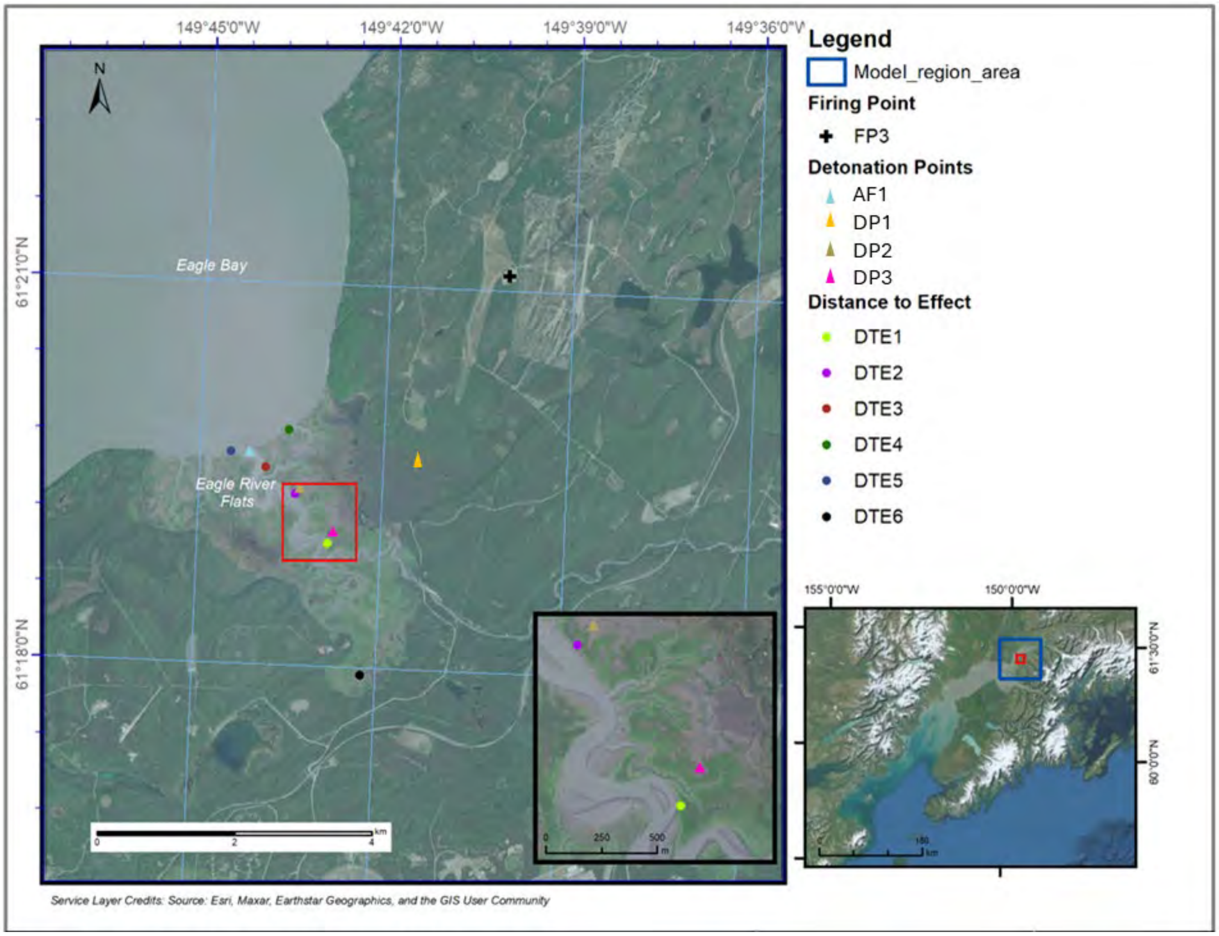


Figure 5-1 Firing and Detonation Points Analyzed at ERF-IA

5.1.4.1 Sound Propagation

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water. The disturbed particles of the media move against undisturbed particles, causing an increase in pressure. This increase in pressure causes adjacent undisturbed particles to move away, spreading the disturbance away from its origin. This combination of pressure and particle motion makes up the acoustic wave. As sound propagates out from the source, there are many factors that change the amplitude, including the spreading of sound over a wide area (spreading loss), loss to friction between particles that vibrate (absorption), and scattering and reflections from objects in the path (including surface or seafloor). The total propagation including these factors is called the transmission loss (TL). For in-air sound, TL parameters vary with frequency and type of source, temperature, wind, source and receiver height, and ground type. For underwater sound, TL parameters vary with frequency and type of source, temperature, wind, sea conditions, source and receiver depth, water chemistry, and bottom composition and topography.

To estimate distances to the in-air sound exposure level (SEL) and SPL thresholds from aboveground detonation, JASCO (2020 and 2022) used an Impulse Noise Propagation Model. The modeling assumed zero wind speed, that the heads of marine mammals would be 0 to 15 centimeters above the water, and the worst-case summer (April) and winter (January) periods for a conservative approach.

To estimate distances to the underwater SEL and SPL thresholds from on-ground detonation, JASCO considered two methods for propagation: 1) coupling of acoustic energy from the air into the water; and

2) coupling of acoustic energy from the air, through the ground, and into the water. For underwater sound propagation, JASCO concluded that the coupling of acoustic energy from the air-ground-water pathway has the greatest potential to affect marine mammals and fish (JASCO 2020, 2022). The modeling considered typical high tide events as well as typical inundating tide events that may occur in ERF-IA during summer, although DTE modeling only considered typical high tide conditions. During lower tide conditions, there would be an even longer pathway for ground-detonation noise to propagate into the water column, further reducing noise levels. For this reason, typical high tide conditions represent a conservative scenario for firing, outside of the infrequent periods of inundation, which have been modeled separately.

To estimate distances to the underwater SEL and SPL thresholds from in-water detonation during typical inundating tide events, JASCO used the Full Waveform Range-Dependent Acoustic Model.

5.1.4.2 In-Air Noise

The in-air noise generated by the detonation of the explosive ammunition was modeled using the Airblast module in ConWep, as described in the modeling reports (JASCO 2020, 2022). ConWep generates time-dependent waveforms of the detonation and accounts for scenario-specific parameters, such as type and size of the explosive, charge height above ground, and distance from the firing point. The ConWep model considers the NEW for each weapon size, as the different training scenarios use different ammunition sizes. The frequency spectra in-air source levels for each NEW are provided in Figure 5-2.The charges were all modeled at 3 meters height above the ground. A summary of the source SEL and peak source level used for in-air detonation for each ammunition size and corresponding NEW is provided in Table 5-4.

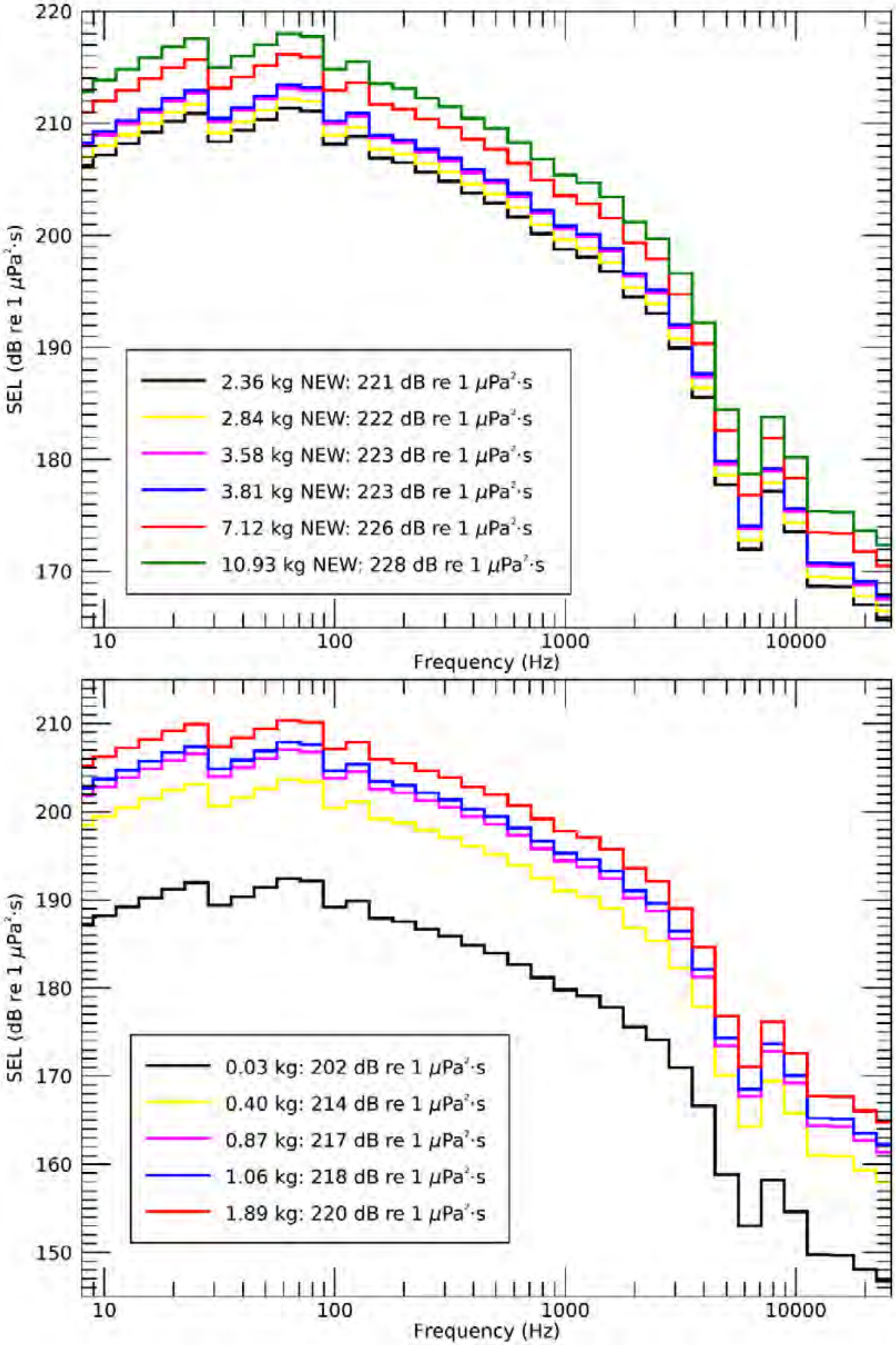


Figure 5-2 Airborne Frequency-Dependent Source Levels by NEW in 1/3 Octave Bands

Note: The top chart displays ammunition with explosive weight greater than 2 kg; while the bottom chart displays ammunition with explosive weight less than 2 kg.

Source: JASCO 2022

5.1.4.3 Underwater Noise

The underground noise generated by detonation of an explosive ammunition on contact with the ground was modeled using the Shockwave module in ConWep. The frequency spectra for underwater source levels for each ammunition size and NEW are provided in Figure 5-3. Charges were modeled as detonation on contact with the ground, and coupling into the water was considered by applying the parabolic equation. The charges were all modeled at 1 meter below the ground. A summary of the SEL source level used for each ammunition size is provided in Table 5-4.

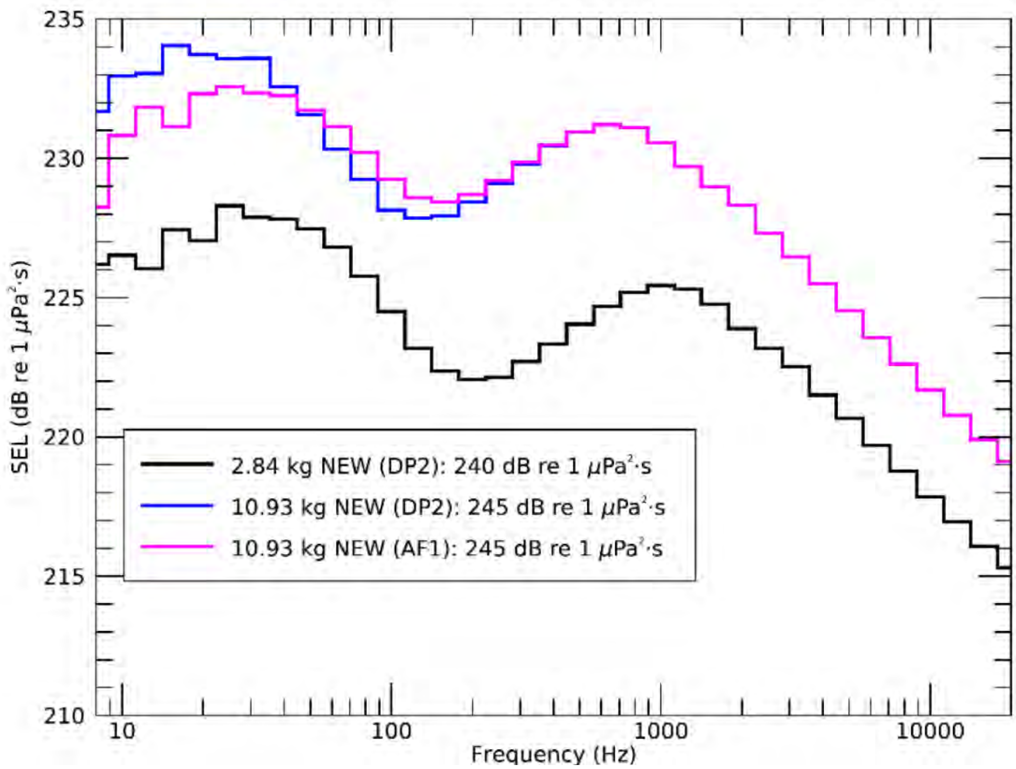


Figure 5-3 Underwater Frequency-Dependent Source Levels by NEW in 1/3 Octave Bands

Note: The legend indicates whether the signature corresponds to the inundated site DP2, or site AF1. Note that the waveforms are identical at site DP2 and DP3; the DP2 waveforms were applied to both locations.

Source: JASCO 2022

Table 5-4 Acoustic Modeling Specifications for the Artillery and Mortar Weapons Muzzle Blast Detonation Points

Ammunition Size	Net ExplosiveWeight	In-Air Detonation Point		Underground Detonation Point		Underwater Detonation Point	
		SEL Source Level[1]	Height Above Ground (m)	SEL Source Level[1]	Height Below Ground (m)	SEL Source Level[1]	Water Depth (m)
60-mm	0.03 kg	148	3	202	-1	221	0.5
60-mm	0.17 kg	158	3	210	-1	—	0.5
60-mm	0.40 kg	161	3	214	-1	232	0.5
81-mm	0.87 kg	164	3	217	-1	235	0.5
81-mm	1.06 kg	164	3	218	-1	236	0.5

Ammunition Size	Net ExplosiveWeight	In-Air Detonation Point		Underground Detonation Point		Underwater Detonation Point	
		SEL Source Level[1]	Height Above Ground (m)	SEL Source Level[1]	Height Below Ground (m)	SEL Source Level[1]	Water Depth (m)
155-mm[2]	1.28 kg	165	3	219	-1	—	0.5
120-mm	1.89 kg	170	3	220	-1	238	0.5
105-mm	2.33 kg	171	3	221	-1	—	0.5
105-mm	2.36 kg	171	3	221	-1	239	0.5
155-mm	2.84 kg	172	3	222	-1	240	0.5
120-mm	3.58 kg	173	3	223	-1	241	0.5
105-mm	3.81 kg	173	3	223	-1	241	0.5
155-mm	7.12 kg	175	3	226	-1	244	0.5
155-mm	10.93 kg	177	3	228	-1	245	0.5

Notes:

[1] SEL reported as dB re 20 µPa2 s for in-air and dB re 1 µPa2 s for underground and underwater.

[2] Round is comparable to the 155-mm training round (1.3 kg NEW).

Key: µPa = microPascal; dB = decibel; kg = kilogram; HE = high-explosive; m = meter; mm = millimeter; NEW = net explosive weight; re = referenced to; SEL = sound exposure level.

Source: JASCO 2020.

The underwater noise generated by in-water detonation during typical inundating tide events was modeled using spherical spreading and the Full Waveform Range-Dependent Acoustic Model over the frequency range of 10 to 2,048 hertz (Hz) with 1-second sources. For underwater propagation during typical inundating tide events, ammunition was assumed to detonate upon impact with the submerged ground (0.5-meter water depth). Inundating tide events are unlikely to last for an entire 24-hour period, and modeling of underwater acoustic noise during these events was performed assuming that half the typical number of rounds would be detonated (JASCO 2022). A summary of the SEL source level used for underwater detonation of each ammunition size and NEW is provided in Table 5-4. The duration of the individual blast for each ammunition size is provided in Figure 5-4. All airborne waveforms are less than 1 second.

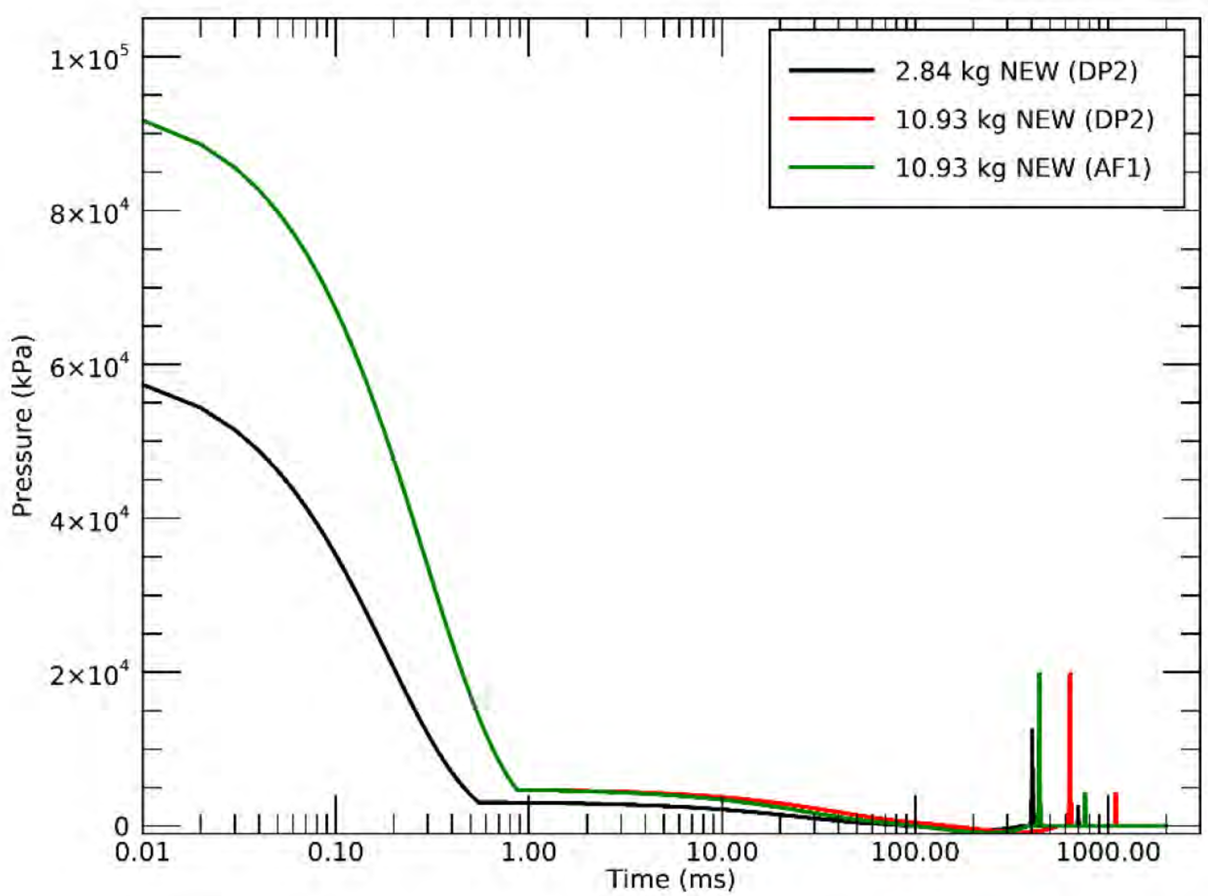


Figure 5-4 Underwater Time-Dependent Source Waveforms by NEW in 1/3 Octave Bands

Note: The legend indicates whether the signature corresponds to the inundated site DP2, or site AF1. Note that the waveforms are identical at site DP2 and DP3; the DP2 waveforms were applied to both locations.

Source: JASCO 2022

5.1.4.4 Scenarios Modeled

Army and Air Force personnel developed multiple summer and winter scenarios to evaluate the cumulative noise generated within a 24-hour period of training exercises. The "summer" period (or open water) was defined as April through October, and the "winter" period (or ice season) was defined as November through March (JASCO 2020, 2022). The scenarios modeled only include rounds containing HE because rounds that do not contain HE (such as FRPC, smoke, and ILLUM rounds) are not expected to produce significant levels of noise.

Although flooding may also occur during other periods of the year, typical inundating tide events that may occur at ERF during spring/summer (April to October) were modeled to represent the "worst-case" scenario for effects to marine mammals and fish because saturated soils do not attenuate sound propagation as well as ice cover and frozen ground conditions. Modeling showed that a key aspect to minimize underwater noise is keeping a buffer distance between detonation points and waterbodies because sound undergoes strong attenuation as it propagates underground to reach the water (JASCO 2020, 2022).

The presence of snow on the ground would result in less energy coupling into the ground-to-water path. In addition, the ice coverage expected during the winter would introduce additional acoustic losses to the propagation of sound underwater (Thiele et al. 1990) due to scattering loss.

Summer flooding events may coincide with periods of rain or snow/glacial melt or moderate to strong southerly winds (10+ knots), resulting in higher-than-predicted water elevations (Lawson et al. 1996b). During these events, shallow water can cover certain areas of the flats surrounding Eagle River and Otter Creek not normally inundated during high tide, and munition rounds could detonate upon impact with the ground in the submerged (0.5-meter depth) target array locations. This would lead to detonation sound propagating through ground in addition to water and potentially into Eagle River, Otter Creek, or Eagle Bay, if these areas are hydrologically connected.

Extreme maximum tide events (theoretical inundation of 6.4 feet) were not modeled because they are very rare and produced by a combination of high astronomical tide height, extremely high discharge from Eagle River, and a strong storm surge from the south. While possible, it is unlikely that all of these factors would converge during a firing event, so the more typical inundating tide event was modeled instead to provide a more representative characterization of what may be expected during a typical flooding event in the adjacent flats.

The analysis in this report references various combined (COMB) live-firing scenarios modeled by JASCO (2020, 2022) that may be used at JBER. Where applicable, the nomenclature from the acoustic modeling reports (e.g., COMB5, COMB21) is used.

Scenario	Scenario with Equivalent DTE Parameters	Round Characteristics	
		Total Maximum # of Rounds/Day	NEW of Ammunition (kg)
CALFEX 7 (summer)	--	84	1.89
COMB5 (summer)	COMB7 (summer)	47	1.06
		186	0.87
COMB9 (summer)*	COMB11 (summer)*	75	3.58
		179	1.89
COMB13 (summer)	COMB15 (summer)	212	3.81
		40	2.36
COMB18 (winter)	--	36	7.12
		262	2.84
COMB21 (summer)	COMB23 (summer)	36	10.93
		262	2.84

Table 5-5 Summary of Modeled Firing Scenarios Used in This Analysis

Notes: *These scenarios are used as a proxy for the firing of 155-mm training rounds (1.3 kg NEW) only. CALFEX 7 scenario represents in-air muzzle noise from training rounds, COMB9 and COMB11 scenarios represent 120-mm mortars; COMB13 and COMB15 scenarios represent 105-mm howitzers; and COMB18, COMB21 and COMB23 scenarios represent 155-mm howitzers.

Key: -- = not applicable; CALFEX = Combined Arms Live Fire Exercise; COMB = combined; DTE = Distance to Effect; kg = kilogram; NEW = Net Explosive Weight.
Source: JASCO Applied Sciences 2020, 2022.

contains a summary of the firing scenarios used in this analysis, which are the subset of the scenarios modeled by JASCO that were selected to evaluate the most conservative effects on sensitive fish and wildlife receptors. Additional details about these scenarios can be found in the acoustic modeling reports (JASCO 2020, 2022).

Scenario	Scenario with Equivalent DTE Parameters	Round Characteristics	
		Total Maximum # of Rounds/Day	NEW of Ammunition (kg)
CALFEX 7 (summer)	--	84	1.89
COMB5 (summer)	COMB7 (summer)	47	1.06
		186	0.87
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Key: -- = not applicable; CALFEX = Combined Arms Live Fire Exercise; COMB = combined; DTE = Distance to Effect; kg = kilogram; NEW = Net Explosive Weight.

Source: JASCO Applied Sciences 2020, 2022.

The 155-mm training rounds, which have a small explosive component of 1.3 kg NEW, were not specifically modeled. Assessment of underwater noise impacts for these rounds were based on results for the most similar HE weight round (1.89 kg) and number of rounds fired per day (179) (scenarios COMB9 and COMB11). For the seasonal closure period when only training rounds without HE would be used in ERF (9 August through 18 October), scenario CALFEX 7 was used, as it is the best fit for representing in-air noise from the muzzle blast of 120-mm mortar training shells.

5.1.5 Modeling Results

Sound propagation results using reasonably conservative input parameters were provided for the following conditions:

- For in-air sound from aboveground detonation (muzzle blast and detonation point), distances were modeled to the airborne thresholds for pinnipeds in both summer and winter. Contour maps indicating the corresponding thresholds of these criteria are provided in Appendix E of both the 2020 and 2022 modeling reports that are provided as part of Appendix B. When HE rounds are being detonated, muzzle blast contours are not used in the exposure estimates because the detonation contours are larger. Muzzle blast contours are used for the seasonal closure period, when no full HE rounds or 155-mm training rounds would be detonated at ERF-IA (9 August through 18 October).
- For underwater sound from on-ground detonation, distances were modeled to the underwater thresholds for all marine mammals. None of the thresholds for PTS, TTS, or behavioral disturbance

were exceeded anywhere in the water from on-ground detonation, and they are not used in the exposure estimates.

- For underwater sound from in-water detonation, distances were modeled to the underwater thresholds for all marine mammals during typical high tide conditions as well as typical inundating tide events. These results are used in the exposure estimates.

Detailed results of the modeling for each scenario and figures for all modeled scenarios are provided in the acoustic modeling reports (JASCO 2020, 2022). The results presented in the following subsections present a summary of the modeling results that represent the firing scenarios that generate the largest areas of threshold exceedance.

For non-auditory injury from in-water detonation, distances were modeled to the underwater thresholds for all marine mammals during typical inundating tide events. Detailed results of the modeling for each scenario are provided in the JASCO 2020 and 2022 modeling.

5.1.5.1 In-Air Noise

In-air noise has the potential to impact pinnipeds when they are hauled out or have their heads above water while swimming. For in-air propagation with no-wind conditions, the largest spatial extent for behavioral disturbance was reached for scenarios that include detonating the largest ammunition type in this study (155-mm HE round with 10.93 kg NEW).

Distances to acoustic harassment criteria for Steller sea lion during summer are provided in Table 5-6 and visualized in Figure 5-5. For the summer scenario, the greatest distance modeled was 39.1 kilometers from DP2. Distances to acoustic harassment criteria for Steller sea lion during winter are provided in Table 5-6 and visualized in Figure 5-6. For the winter period, the greatest distance modeled was 20.9 kilometers from DP2. For the summer period during the beluga HE closure (9 Aug-18 Oct), when HE rounds could still be fired into the CALFEX, the greatest distance modeled was 23.8 km for the behavioral disturbance threshold resulting from the detonation of a 105mm HE round detonating at DP1. Much of the area over which airborne noise thresholds may be exceeded are upland areas where pinnipeds would not be present. For a representation of the maximum water and shoreline area over which airborne noise thresholds may be exceeded, see Figure 1-4.

Table 5-6 Maximum Distances (from DP1 and DP2) Over Which Acoustic Harassment Criteria for In-Air Noise May Be Exceeded

Season	Species	Auditory Injury Criteria		Behavioral Disturbance Criteria		
		PTS SEL	PTS Peak	TTS SEL	TTS Peak	Behavioral RMS*
Summer	Steller sea lion	23 m	13 m	48 m	22 m	39,100 m**
Winter	Steller sea lion	23 m	13 m	38 m	22 m	20,900 m**
Summer (9 Aug-18 Oct)	Steller sea lion	<20 m	11 m	27 m	15 m	23,800 m

Notes: * NMFS-established threshold of 100 dB rms for non-phocid pinnipeds, referenced to 20 µPa. **SPL threshold reached beyond the 25 × 25 km modeled area. Reported distance corresponds to the radii along an azimuth of 242 degrees, which was modeled as far as 50 km.

Key: µPa = microPascal; dB = decibel; km = kilometer; m = meter; NMFS = National Marine Fisheries Service; PTS = permanent threshold shift; rms = root mean square; SEL = sound exposure level; SPL = sound pressure level; TTS = temporary threshold shift.

Source: JASCO 2020 modeled scenario CALFEX 4 Summer for “Summer (9 Aug-18 Oct)” and JASCO 2022, modeled scenario COMB23 Summer for “Summer” and “Winter”.

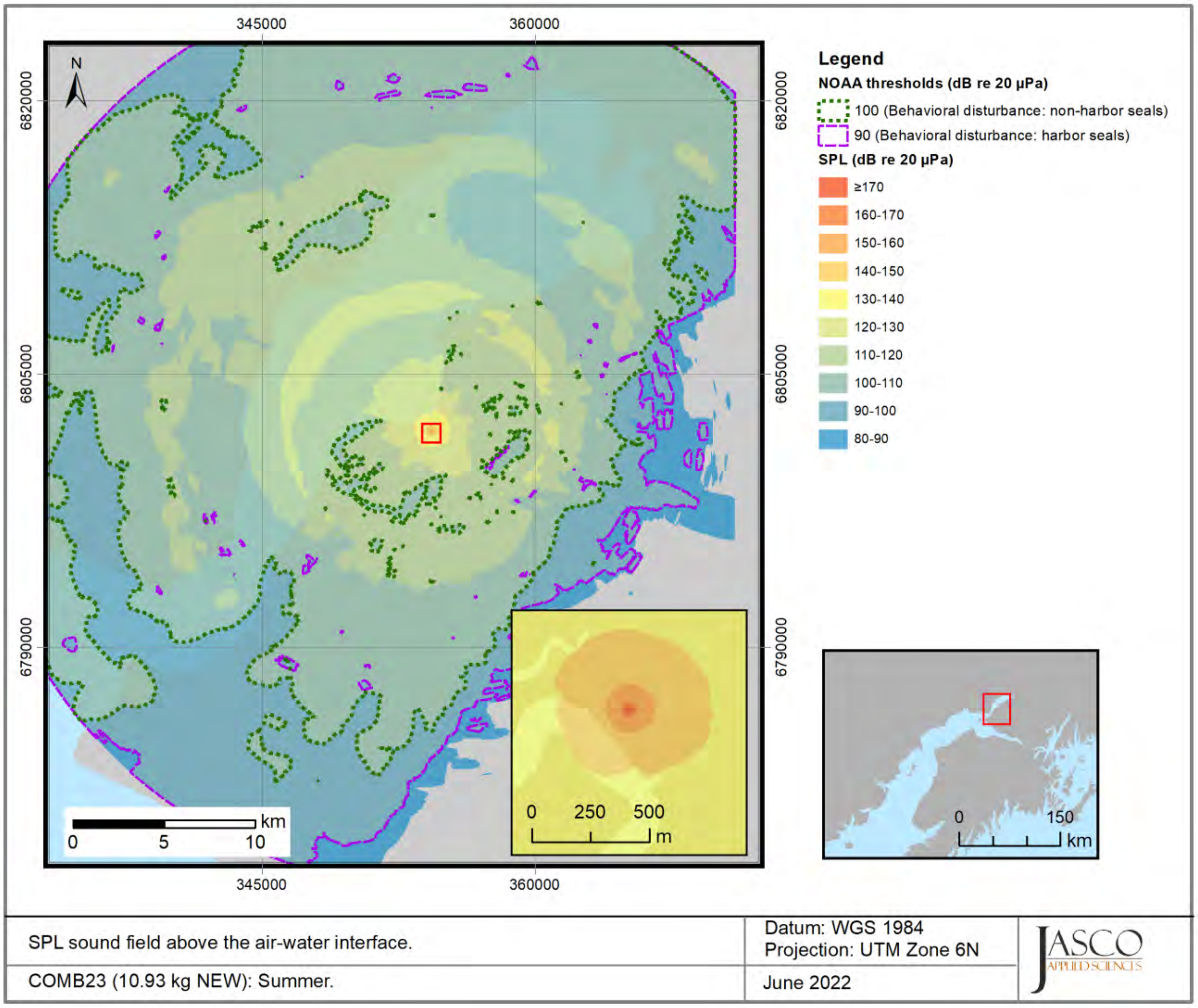

Figure 5-5 In-Air Noise Behavioral Disturbance Threshold for Pinnipeds during Summer Firing of 155-mm HE Rounds (NEW 10.93 kg)

Source: JASCO 2022

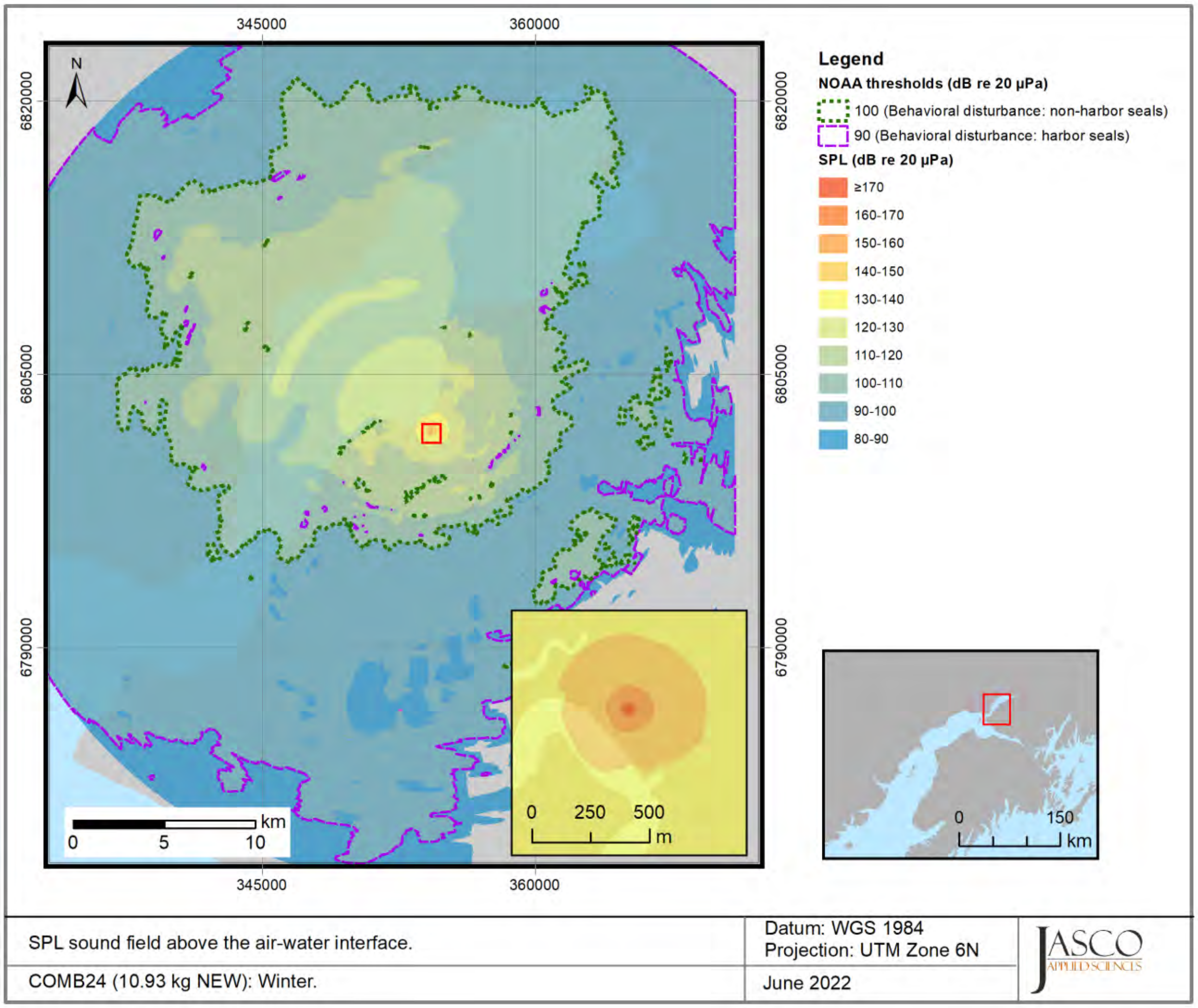

Figure 5-6 In-Air Noise Behavioral Disturbance Threshold for Pinnipeds during Winter Firing of 155-mm HE Rounds (NEW 10.93 kg)

Source: JASCO 2022

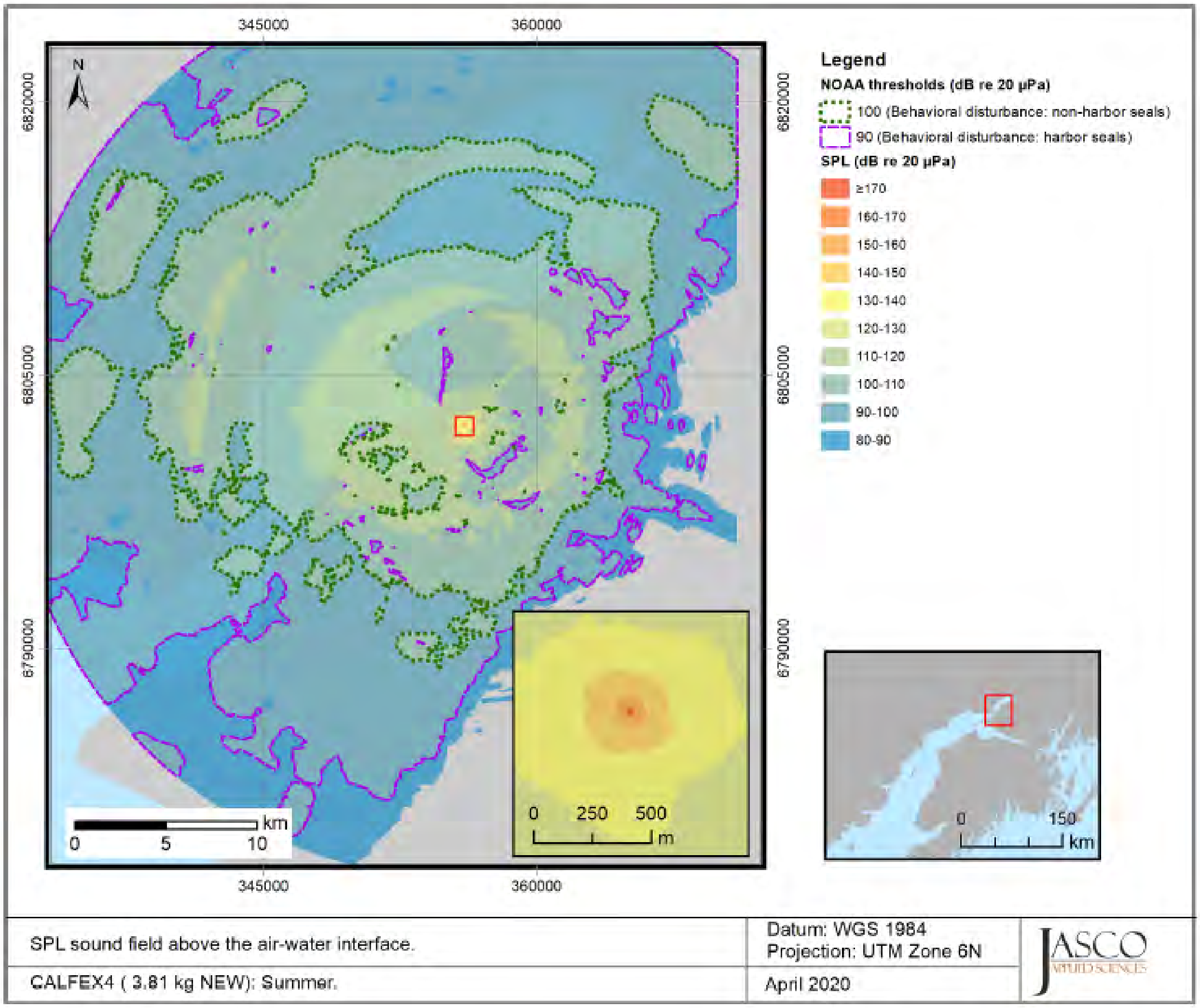

Figure 5-7 In-Air Noise Behavioral Disturbance Threshold for Pinnipeds during Summer Firing of 105mm HE Rounds (NEW 3.81 kg) at DP1

Source: JASCO 2020

5.1.5.2 Underwater Noise

For analysis of underwater noise impacts, the DTE modeling establishes the minimum buffers needed to prevent the exceedance of marine mammal thresholds during typical high tide conditions, when detonations would only occur on land. Typical high tide conditions reflect the vast majority of time when ERF is not inundated. Table 5-7 provides a summary of the distances over which noise thresholds may be exceeded in nearby waters from a detonation point on land. For reference, the proposed habitat buffers, as described in Section 2.4.4.1, are also provided in Table 5-7. With implementation of these buffers, underwater noise thresholds would not be exceeded within any adjacent waterways during typical high tide conditions.

Table 5-7 Maximum Distances from Detonation Point Where Underwater Noise Threshold Exceedances for Marine Mammals when Rounds are Detonated on Land

Threshold	Eagle River (LF Cetaceans Not Present)		Eagle Bay (All Species May Be Present)			Otter Creek (LF Cetaceans Not Present)
	DTE 1	DTE 2	DTE 3	DTE 4	DTE 5	DTE 6
All PTS Thresholds	6 m or less	10 m or less	20 m or less	24 m or less	24 m or less	12 m or less
MF Cetacean (beluga whale) TTS	2 m	6 m	6 m	4 m	4 m	8 m
Otariid (Steller sea lion) Behavioral SEL	Not Exceeded	Not Exceeded	Not Exceeded	Not Exceeded	Not Exceeded	Not Exceeded
MF Cetacean (beluga whale) Behavioral SEL	4 m	8 m	8 m	6 m	6 m	10 m
Otariid (Steller sea lion) Behavioral SEL	Not Exceeded	Not Exceeded	Not Exceeded	Not Exceeded	Not Exceeded	2 m
Proposed Habitat Protective Buffers	**130 m**		**500 m**			**50 m**

Key: DTE = distance to effect; LF = low frequency; m = meter; MF = mid-frequency; PTS = permanent threshold shift; SEL = sound exposure level; TTS = temporary threshold shift.

Source: JASCO 2022, modeled scenario COMB 21 and COMB 23.

During a typical inundating tide event, water partially floods ERF-IA around Eagle River, and shallow water may be present at target areas above the typical high tide level. When ammunition detonation takes place under these circumstances, sound can propagate directly through the water column to include Eagle River and Eagle Bay more easily than during typical high tide conditions. During a typical inundating tide event, the largest spatial extent for marine mammal PTS, TTS, and behavioral disturbance for underwater noise would be reached when detonating a 155-mm HE round, as summarized in Appendix C. After careful analysis, JBER has decided not to fire any rounds containing HE (including the 155-mm training round) during inundated tidal conditions in order to reduce the potential impacts of underwater noise on marine mammals and fish (see the mitigation measures in Section 2.4).

Table 5-8 Maximum Distances from Detonation Point Where Acoustic Harassment Criteria from Underwater Noise May Be Exceeded Due to 155-mm HE[1] Ammunition Detonation during a Typical Inundating Tide Event

Functional Hearing Group	Species	Level A Criteria		Level B Criteria		
		PTS SEL	PTS Peak	TTS SEL	TTS Peak	Behavioral SEL
Mid-frequency cetaceans	Beluga whale	600 m	150 m	1,340 m	250 m	2,080 m
Otariid pinnipeds in water	Steller sea lion	450 m	130 m	850 m	220 m	1,250 m

Note:

[1]155-mm HE rounds modeled have a maximum NEW of 10.93 kg.

Key: HE = high-explosive; kg = kilogram; m = meter; mm = millimeter; NEW = net explosive weight; PTS = permanent threshold shift; SEL = sound exposure level; TTS = temporary threshold shift.

Source: JASCO 2022, modeled scenario COMB23.

Implementation of the protective measures described in Section 2.4.4 would limit the type of rounds used at ERF-IA during typical inundating tide events to only training rounds. Additionally, the Army has identified an additional avoidance and minimization measure to expand this protective measure by including a

restriction on firing 155-mm training rounds into inundated areas during inundating tide events, as described in Section 2.4. The 155-mm training round is the only training round containing HE (1.3 kg NEW). The avoidance and minimization measure was identified based on the 2020 acoustic modeling results for similar training scenarios with rounds with somewhat larger NEW (Scenarios COMB5 and COMB9; see

Scenario	Scenario with Equivalent DTE Parameters	Round Characteristics	
		Total Maximum # of Rounds/Day	NEW of Ammunition (kg)
CALFEX 7 (summer)	--	84	1.89
COMB5 (summer)	COMB7 (summer)	47	1.06
		186	0.87
COMB9 (summer)*	COMB11 (summer)*	75	3.58
		179	1.89
COMB13 (summer)	COMB15 (summer)	212	3.81
		40	2.36
COMB18 (winter)	--	36	7.12
		262	2.84
COMB21 (summer)	COMB23 (summer)	36	10.93
		262	2.84

Table 5-5 Summary of Modeled Firing Scenarios Used in This Analysis

Notes: *These scenarios are used as a proxy for the firing of 155-mm training rounds (1.3 kg NEW) only. CALFEX 7 scenario represents in-air muzzle noise from training rounds, COMB9 and COMB11 scenarios represent 120-mm mortars; COMB13 and COMB15 scenarios represent 105-mm howitzers; and COMB18, COMB21 and COMB23 scenarios represent 155-mm howitzers.

Key: -- = not applicable; CALFEX = Combined Arms Live Fire Exercise; COMB = combined; DTE = Distance to Effect; kg = kilogram; NEW = Net Explosive Weight.

Source: JASCO Applied Sciences 2020, 2022.

). Training rounds that do not contain HE (such as FRPCs) are not expected to produce underwater noise in excess of the thresholds provided in Table 5-7, if fired during typical high tide or typical inundating tide events.

5.1.5.3 Non-Auditory Injury

Due to the increased hazard that a shock wave associated with underwater detonations presents to animals, physiological effects including auditory effects (PTS and TTS; discussed in Section 5.1.3) as well non-auditory effects (mortality and direct tissue damage known as primary blast injury) were modeled by JASCO for typical inundating tide events (JASCO 2022). During typical high tide events, rounds would not be detonating in water and thus the pathway for direct exposure to the shockwave of an underwater detonation does not exist.

The magnitude of an acoustic impulse (integral of the instantaneous sound pressure) from an underwater blast causes the most common injuries; therefore, its value is used to determine whether mortality or slight lung injury is likely to occur (Finneran et al. 2017). Mortality and slight lung injury depend on an animal's mass and the water depth it is located at during exposure. Potential for GI tract injury is assessed relative to the peak instantaneous sound level.

For training exercises during a typical inundating tide event, the greatest distances to mortality and slight lung injury thresholds correspond to scenarios involving detonation of 155-mm HE rounds. Slight lung injury thresholds are the lowest for the smallest animal species; therefore, these thresholds would be reached at the greatest distance for the smallest species (in this case, juvenile Steller sea lion). Slight lung injury thresholds were reached at modeled distances of 14 and 11 meters from the sound source for Steller sea lion juveniles and adults, respectively, while mortality thresholds for Steller sea lions were reached as far as 9.6 and 7.4 meters for juveniles and adults, respectively. Thresholds for larger animals were exceeded at shorter distances, if at all. All of these distances are substantially smaller than the proposed habitat buffers; therefore, no takes related to mortality or slight lung injury would occur as a result of the proposed training.

The greatest modeled distance to the GI tract injury threshold during a typical inundating tide event was 80 meters, for detonation of a 155-mm HE round. For smaller charges, the distances would be less. This distance is substantially smaller than the proposed habitat buffers (with the exception of the 50-meter buffer around the uppermost reach of Eagle River) of the areas that may be occupied by marine mammals (Eagle Bay and Eagle River).

5.1.5.4 Accidental Firing Scenario

Modeling (JASCO 2022) was conducted to determine the maximum distances where mortality or injury thresholds would be exceeded under an accidental firing scenario (rounds would never be intentionally fired into Eagle Bay, Eagle River, or Otter Creek, or other waterbodies that are identified as containing water during firing activities). The modeled scenario involved accidental detonation of one 155-mm HE round (10.9 kg NEW) in Eagle River at location AF1 (Figure 5-1) during typical high tide conditions. This modeled scenario is highly unlikely because the round would impact outside the SDZ; statistically, the chance is no greater than 1:1,000,000. The maximum distances over which PTS, TTS, and behavioral thresholds may be reached for accidental firing at location AF1 are provided in Table 5-9.

Table 5-9 Maximum Distances from Detonation Point where Acoustic Harassment Criteria from Underwater Noise May Be Exceeded Due to Accidental Detonation of a 155-mm HE Round[1] in Eagle River during a Typical Inundating Tide Event

	MF Cetaceans[2] (Beluga Whale)	Otariid Pinnipeds (Steller Sea Lion)
PTS SEL	330 m	160 m
PTS Peak	500 m	350 m
TTS SEL	2,560 m	1,400 m
TTS Peak	1,010 m	740 m
Behavioral SEL	9,400 m	3,350 m

Notes:
[1] 155-mm round modeled have a maximum NEW of 10.93 kg.
[2] These functional hearing groups/species are expected to occur in the area that includes Eagle River, Eagle Bay, and Knik Arm. Other species are considered to be rare in this area.
Key: HE = high-explosive; kg = kilogram; LF = low frequency; MF = mid-frequency; mm = millimeter; NEW = net explosive weight; PTS = permanent threshold shift; SEL = sound exposure level; TTS = temporary threshold shift.
Source: JASCO 2022, modeled scenario AF1.

In the case of accidental firing into the mouth of Eagle River, the modeling predicted that slight lung injury thresholds would be reached at distances of 151 and 102 meters from the sound source for Steller sea lion juveniles and adults, respectively, and mortality thresholds for Steller sea lion would be reached as far as 78.8 and 49 meters for juveniles and adults, respectively (JASCO 2022). The GI tract injury threshold would be reached at a distance of 240 meters from the sound source (JASCO 2022).

5.1.5.5 Duration of Activities

The duration of proposed live-fire activities is separated into typical high tide conditions (when HE rounds may be used) and typical inundating tide events (when HE rounds would not be used). For typical high tide conditions, the number of days of firing by month ranged from 3 to 15 days. JBER is assuming the maximum duration of 15 days per month, 12 months per year for the effects analysis of this BA. With implementation of the avoidance and minimization measures in Section 2.4, only training rounds that do not contain HE would be fired into potentially inundated areas. For typical inundating tide events, the maximum number of days of firing by month was based on an approximately 31-foot-high tide for inundation threshold and 44 tides (22 days) during the open water season (May–October). This yields approximately 3.7 days per month of typical inundating tide events. Additionally, during the peak Cook Inlet beluga whale upriver visitation period of 9 August to 18 October, the use of rounds containing HE (including 155-mm training rounds) would be restricted.

The duration of an individual detonation for purposes of in-air noise is approximately 0.04 seconds; the duration of the individual detonation for underwater modeling is approximately 1 second. The maximum number of rounds detonated in a 24-hour period in the combination scenarios was 298 (for the 155-mm howitzer). Assuming a 1-second duration of ensonification from each detonation, the total number of seconds of sound is 298 seconds or 0.0828 hours in a 24-hour period (298 seconds/60 seconds in a minute/ 60 minutes in an hour). Table 5-10 provides a summary of the maximum daily duration of noise for a variety of firing scenarios.

Table 5-10 Maximum Daily Duration of Airborne and Underwater Noise by Ammunition Type

Ammunition	Max # Detonations[1]	Total Airborne Duration (sec) (0.04 per round)	Total Underwater Duration (sec) (1 per round)	In-Air Duration (hrs)	Underwater Duration (hrs)
60-mm HE Mortar Rounds	223	8.92	223	0.000103	0.0619
81-mm HE Mortar Rounds	233	9.32	233	0.000108	0.0647
120-mm HE Mortar Rounds	254	10.16	254	0.000118	0.0706
105-mm HE Howitzer Rounds	252	10.08	252	0.000117	0.0700
155-mm HE Howitzer Rounds	298	11.92	298	0.000138	0.0828

[1]None of these rounds would be detonated in or over inundated areas.

Key: HE = high-explosive; hrs = hours; mm = millimeter; sec = seconds.

5.1.5.6 Ensonification Area

For the NMFS-established noise thresholds (Level A and Level B), the area of ensonification falls entirely within the habitat protective buffers described in Section 2.4.4.1 and includes areas that are not inundated or covered by very shallow water thus not available for marine mammals to be exposed to sound from the activities. The maximum distances for each of the thresholds for each of the functional hearing groups (Section 5.1.4) were used to estimate the potential for ESA-listed species to be exposed. A summary of the maximum distance for underwater ensonification is provided in Table 5-11. A summary of the maximum distance for in-air ensonification is provided in Table 5-12. For in-air noise, the maximum overwater and shoreline area over which the behavioral RMS threshold may be exceeded is 1,121.7 square kilometers, representing the in-air action area shown in Figure 1-4. Rounds that do not contain HE (i.e., smoke, ILLUM, and training rounds [apart from the 155-mm training round]) are not expected to exceed any of the in-air or underwater thresholds outside of the habitat protective buffers described in Section 2.4.4.1.

Table 5-11 Underwater Ensonification Maximum Distance by Functional Hearing Group

Functional Hearing Group	Species	Level A PTS SEL (m) Typical High Tide[1,2]	Level B[1] TTS SEL (m) Typical High Tide[1,2]	Level B[1] Behavioral 24-hour SEL (m) Typical High Tide[1,2]
Mid-frequency cetaceans	Beluga whale	4	8	10
Otariid pinnipeds in water	Steller sea lion	4	10	12

Notes:

[1] Maximum distances during typical high tide are based on 155-mm HE rounds with a maximum NEW of 10.93 kg. All distances fall within the protective habitat buffers applicable for those species.

[2] During typical inundating tide events, no rounds containing HE would be used where standing water may be present, and no thresholds would be exceeded in inundated areas.

Key: HE = high-explosive; kg = kilogram; m = meter; mm = millimeter; NA = not applicable; NEW = net explosive weight; PTS = permanent threshold shift; SEL = maximum sound level, TTS = temporary threshold shift.

Table 5-12 In-Air Ensonification Maximum Distance or Area by Functional Hearing Group

Functional Hearing Group	Species	Level A PTS SEL (km)		Level B TTS SEL (km)		Level B Behavioral RMS In-Air Area (km)	
		Summer	Winter	Summer	Winter	Summer	Winter
Otariids	Steller sea lion	0.02	0.023	0.048	0.038	39.1	21.3

Key: km = kilometer; rms = root mean square; PTS = permanent threshold shift; SEL = maximum sound level; sq = square; TTS = temporary threshold shift.

For airborne noise, the ensonification area for the time period when HE rounds may be detonated in ERF (19 October to 8 August) is the estimated water surface area within 50 kilometers of JBER, a value of 1,563 square kilometers. During the seasonal HE closure period (9 August to 18 October), the estimated water surface area within 22.6 kilometer of JBER is 318 square kilometers.

5.1.6 Potential Injury

Through implementation of the conservation measures, avoidance, and minimization measures described in Sections 2.4 and 2.5, the proposed action is not expected to injure or cause the likelihood of injury toESA-listed marine mammals. This includes any injury from noise, fragments, or disturbance. In other words, neither Level A nor Level B take is reasonably likely to occur.

5.1.6.1 Cook Inlet Beluga Whale

As described in Section 4.1.3, the Eagle Bay/Eagle River area appears to be an important area for a substantial portion of the Cook Inlet beluga whale population during the open water months. Large groups of beluga whales, occasionally exceeding 100 animals at once, move into Eagle Bay/Eagle River, where they travel, mill, feed, and socialize. The most intensive use of Eagle Bay/Eagle River by beluga whales occurs between August and November (Figure 3-7 through Figure 3-9).

As previously described, based on acoustic modeling for underwater noise propagation during typical high tide conditions, none of the thresholds to underwater criteria (Level A or B) for marine mammals would be reached from the modeled detonation points. With implementation of the measures described in Sections 2.4 and 2.5, Level A and Level B thresholds would not be exceeded in areas where beluga whales may be present. Additionally, only training rounds that do not contain HE would be used in ERF during the peak beluga whale upriver visitation period (NMFS 2024a) of 9 August through 18 October (all rounds could still be fired in the upland expansion area during this period). However, it is important to recognize the limitations of the model and the proximity of the modeled detonation points to beluga whale habitat that may be occupied throughout the spring, summer, fall, and early winter months.

Underwater noise from live-fire training may still be audible to Cook Inlet beluga whales, even if it does not exceed thresholds. JBER could not find any peer reviewed literature discussing reactions to subthreshold underwater noise. Such noise is likely to occur but there is insufficient data to conclude it would cause physiological or behavioral disturbance. Cetaceans that have adapted strong antipredator behavior, such as cessation of foraging, have been shown to treat anthropogenic noise as a predation risk, thus indicating that such species (i.e., beluga) will be more sensitive to anthropogenic noise (Miller et al. 2022). It is unknown whether Cook Inlet beluga whale would become either habituated or sensitized to audible noise from live-fire training.

Behavioral reactions to underwater noise could incur energetic costs, especially those resulting in lost foraging opportunities such as increased alertness (i.e., leading to decrease in foraging efficiency), displacement, and cessation of echolocation (i.e., cessation of foraging). Modeling of impacts of anthropogenic disturbance on the survival and reproductive success of Cook Inlet beluga whale indicates that intermittent losses of foraging opportunities from anthropogenic sources during the summer and fall would likely have little effect on Cook Inlet beluga whale fitness if prey are abundant but may adversely affect fitness if prey are reduced (McHuron et al. 2023). Thus, reactions of belugas to intermittent detonations within ERF-IA could have little real biological consequence to individual belugas or the population as a whole, provided that prey remain abundant during the summer and fall. On the other hand, reductions in high-quality prey within Cook Inlet, such as has been observed for Chinook salmon populations in southcentral Alaska (Jones et al. 2020), combined with lost foraging opportunities could lead to reductions in individual beluga fitness and potential adverse consequences to the population as a whole. Conservation and mitigation measures (Sections 2.4) that would reduce the potential for impacts to beluga whales include the following:

- No firing of HE rounds into areas inundated by high tide events (predicted and observed) (protective measure included in the proposed action; Section 2.4).
- No firing of 155-mm training rounds (training rounds with HE) into areas inundated by high tide events (predicted and observed) (mitigation measure; Section 2.4).
- No firing of HE rounds into ERF during the peak beluga whale upriver visitation period (9 August through 18 October; HE rounds could still be fired into the proposed expansion area during this time) (protective measure included in the proposed action; Section 2.4).
- No firing of 155-mm training rounds (training rounds with HE) into ERF during the peak beluga whale upriver visitation period of 9 August through 18 October; 155-mm training rounds could still be fired into the proposed expansion area during this time) (mitigation measure; Section 2.4).

During ice-off conditions (ice proxy to be developed), the following measures would effectively afford marine mammals the same protections as personnel and would prohibit the firing of rounds into areas where hazardous fragments would have a 1 in 1,000,000 or greater chance of striking marine mammals:

- o Ensure that for each weapon fired (mortar and artillery), the weapon system impact area (target area, 8PE, and 12PE portions of SDZ) does not overlap habitat protective buffers, Eagle Bay, or Eagle River (mitigation measure; Section 2.4).
- o Ensure that for each weapon fired (mortar and artillery), Areas A, B, and C of the SDZ do not overlap portions of Eagle Bay, Eagle River, or Otter Creek that have 130- or 500-meter buffers (mitigation measure; Section 2.4).
- o For portions of Upper Eagle River, Otter Creek, and the Otter Creek complex that have a 50-meter buffer, ensure that for artillery, Areas A, B, and C of the SDZs do not overlap the river/creek (mitigation measure; Section 2.4).

During ice-off conditions, the following measure would apply to waterbodies with habitat protective buffers where marine mammals are less likely to occur:

- For portions of Upper Eagle River, Otter Creek, and the Otter Creek complex that have a 50-meter buffer, ensure that for mortars, Area B of the SDZ does not overlap the river/creek. For mortars that overfly the river/creek, ensure the minimum safety distances in DA Pam 385-63 are applied to areas that overlap the river/creek. In other words, while there is a greater than 1:1,000,000 chance for fragmentation to land in portions of the river/creek/complex where infrequent marine mammal visitation is expected, minimum human safety distances would still be applied to protect marine mammals in these areas (mitigation measure; Section 2.4).

As discussed above, with implementation of the mitigation discussed in Section 2.4, underwater noise take thresholds would not be exceeded in Eagle Bay or Eagle River. Therefore, the likelihood of a behavioral reaction of beluga as a result of the proposed project is so low as to be discountable.

5.1.6.2 Steller Sea Lion

As described in Section 3.2.3, small numbers of Steller sea lions have been infrequently present in Upper Cook Inlet in spring, summer, and fall. In 2009, a single Steller sea lion was observed in transit in Eagle Bay. During long-term, intermittent marine mammal monitoring at the Port of Alaska, small numbers of Steller sea lion were observed near the Port of Anchorage. All of the observations of Steller sea lion recorded during monitoring at the Port of Alaska were made when there was no active pile driving recorded, so no information is available regarding the species response to Port of Alaska–related project noise.

With implementation of the conservation measures described in Section 2.4, such as the implementation of habitat protective buffers, as well as the avoidance and mitigation measures, Level A and Level B thresholds for underwater noise would not be reached in areas where Steller sea lion may be present. Airborne behavioral noise thresholds, on the other hand, would be exceeded, as described in Section 5.1.2. The in-air noise modeling estimates that the Level B exposure threshold for otariids may be exceeded at a distance of up to 39.1 kilometers when 155-mm rounds are being detonated and up to 15.1 kilometers when training rounds are being fired (muzzle noise). Due the large area affected, Steller sea lions that are hauled out (there are no known haul out locations within the ensonification area), or above surface while transiting through or foraging in Knik Arm and the portions of Upper Cook Inlet in the vicinity of Anchorage and Fire Island, may be exposed to in-air noise at or above the current in-air behavioral threshold.

The general effects of airborne noise on pinnipeds are discussed in Section 5.1.2. Because very few Steller sea lion are expected to be exposed to project-related noise, and any exposures would be limited to potential behavioral response only, impacts to the Western Stock of Steller sea lion would be insignificant. Additionally, the area where exposures may occur is in an area already subject to in-air noise from commercial, private, and military aircraft, port operations, and commercial fishing, so the small number of Steller sea lion that frequent the area may already be habituated to anthropogenic in-air noise.

Given the low numbers of Steller sea lions in the proposed action area (including no known haul-out locations), and observations suggesting minimal reactions of pinnipeds to similar sound sources (e.g., Holst et al. 2005, Demarchi et al. 2012, U.S. Navy 2023, USSF 2024, Ugoretz and Greene Jr. 2012), the likelihood of behavioral patterns being abandoned or significantly altered is low and, therefore, any disturbance resulting from airborne noise exposure would not constitute harassment. For these reasons, NMFS has determined that take of Steller sea lions from airborne noise incidental to the specified training activities is not reasonably likely to occur (NMFS 2025a). While some effects that do not rise to the level of take are foreseeable, the rare co-incidence of the presence of Steller sea lions above the surface at the moment significant noise is audible above background, and the absence of data such exposure would result in behavior different than that observed as a result of other anthropogenic noise in the action area, indicates that such effects would be insignificant.

5.2 HAZARDOUS FRAGMENTS

When explosive munitions detonate, fragments of the weapon are thrown at high velocity from the detonation point and can injure or kill marine mammals if they are struck. Risk of fragment injury reduces exponentially with distance as the fragment density is reduced and the fragment velocity decreases due to air resistance. Underwater, the friction of the water would quickly slow these fragments to a point where they no longer pose a threat (85 FR 72312); therefore, hazardous fragments are only potentially injurious to animals at or near the surface of the water. Only detonation of regular HE rounds would result in fragmentation or shrapnel. The 155-mm training round is filled with non-fragmentation producing concrete to provide the same weight as an actual HE round in order to create similar ballistics (S. Tucker, personal communication, 1 May 2023). No other training rounds would cause fragmentation that could be dangerous to marine mammals.

Hazardous fragments could result in direct injury to marine mammals. The type of injury that a hazardous fragment may cause is dependent on many variables, including species, size of the animal, and proximity to the source; the trajectory, shape, size, and velocity of fragment; and the distance the fragment travels in water prior to striking the animal. The injuries resulting from a hazardous fragment strike could range from minor contusions to severe, life-threatening wounds. Resulting wounds could become infected or result in permanent physical impairment due to muscular or skeletal damage. Any animal that is struck would likely exhibit behavioral changes, such as fleeing, and the cessation of other activities, similar to the responses described in Section 5.1.1 for auditory disturbances.

There are no standards that document risks to marine mammals from munitions fragments and no publicly available method of predicting the behavior of fragments to determine distances from waterbodies where detonations could result in take of marine mammals. DA Pam 385-64, Safety Ammunition and Explosives Safety Standards (2013 Revision) (U.S. Army 2013), identifies human safety standards for hazardous fragments, which are defined as fragments that maintain an impact energy of at least 58 feet per pound and/or a weight of at least 2,700 grains (0.17 kg). The hazardous fragmentation distance (HFD) for human safety is the distance at which there is a 1 percent probability of experiencing a serious or lethal injury from a fragment. As the distance from the impact to the receiver decreases, the probability of injury increases.

Human-based safety standards can be used as a conservative method for determining risks to marine mammals for serious or lethal injury from fragmentation. The initial analysis of potential effects to marine mammals from fragmentation involved calculation of HFDs for all explosive rounds that would be used at ERF-IA, using the methodology provided in DA Pam 385-64, which is based on the NEW of each projectile, and doubling distances to account for airburst detonations information provided in Geneva International Centre for Humanitarian Demining (2017). While this approach allows for a general and conservative approach for identifying HFDs with the protection of human health in mind, DA Pam 385-64 does not provide the necessary information to calculate take from the proposed training at ERF-IA. The initial analysis found that the calculated HFDs for various weapon systems could extend beyond the habitat protective buffers listed in Section 2.4.4.1, particularly for airburst detonations.

Based on these findings, the Army developed avoidance and minimization measures to avoid hazardous fragmentation into waterways where beluga whales might be present, based on use of SDZs. As described in Section 2.1.2, the probability of hazardous fragments striking a human-sized target becomes 1:1,000,000 at the boundary of the SDZ under standard firing procedures. The SDZ is the standard for troop placement; Army safety standards do not allow personnel to stand inside of this SDZ boundary during live-fire events. The proposed approach is to apply the same safety standards to marine mammals. During ice-free periods, live-fire training at ERF-IA would occur such that SDZ areas that are off-limits to personnel would not overlap Eagle River and Otter Creek, as described in Section 2.4. The boundaries of an SDZ can never extend past the installation boundary and thus would never overlap Eagle Bay.

During training events, SDZs are established using the Army Range Managers Toolkit SDZ. Figure 5-8 illustrates an example SDZ for a 155-mm HE round. The proposed avoidance and minimization measure is to place targets so that the target area does not overlap habitat protective buffers or Eagle Bay or Eagle River, and so that Areas A, B, and C of the SDZ do not overlap Eagle River or Eagle Bay where there is a 130-m or 500-m habitat buffer. For artillery rounds, Area D can overlap the river because personnel are allowed in this area, which represents the high-altitude trajectory of the round prior to detonation and is not associated with fragmentation risk. Artillery fire at targets across Eagle River are allowed, while mortar fire at targets across Eagle River are not. Mortars are allowed to fire across portions of Eagle River and Otter Creek where only a 50-meter habitat buffer is located. This restriction for mortar rounds reduces the potential for accidental firing into Eagle River to a discountable level.

During iced-in conditions (ice proxy to be developed), SDZs may overlap Eagle River, provided the target area does not overlap the habitat protective buffers. Marine mammals have a minimal presence at ERF during iced-in conditions, so the risk of hazardous fragments strikes to marine mammals during that time is so low as to be discountable.

As summarized in Table 2-4, 5,128 HE rounds capable of producing hazardous fragments may be fired into ERF-IA on an annual basis, with an estimated 3,784 HE rounds fired into ERF (the remainder would be fired into the upland expansion). With repeated firing, the 1:1,000,000 fragment strike risk at the SDZ boundary would increase slightly, but this increase would be offset by the low likelihood of a marine mammal being present in the vicinity of an HE detonation over the nearly instantaneous duration of fragment strikes. Additionally, during most of the tidal stage, the water surface of the Eagle River is below the crest of its banks, which provides a barrier to straight-line high velocity fragments.

By providing Eagle River and Eagle Bay with the same protective measures as personnel, the potential risk of hazardous fragment strikes to marine mammals is reduced to a discountable level.

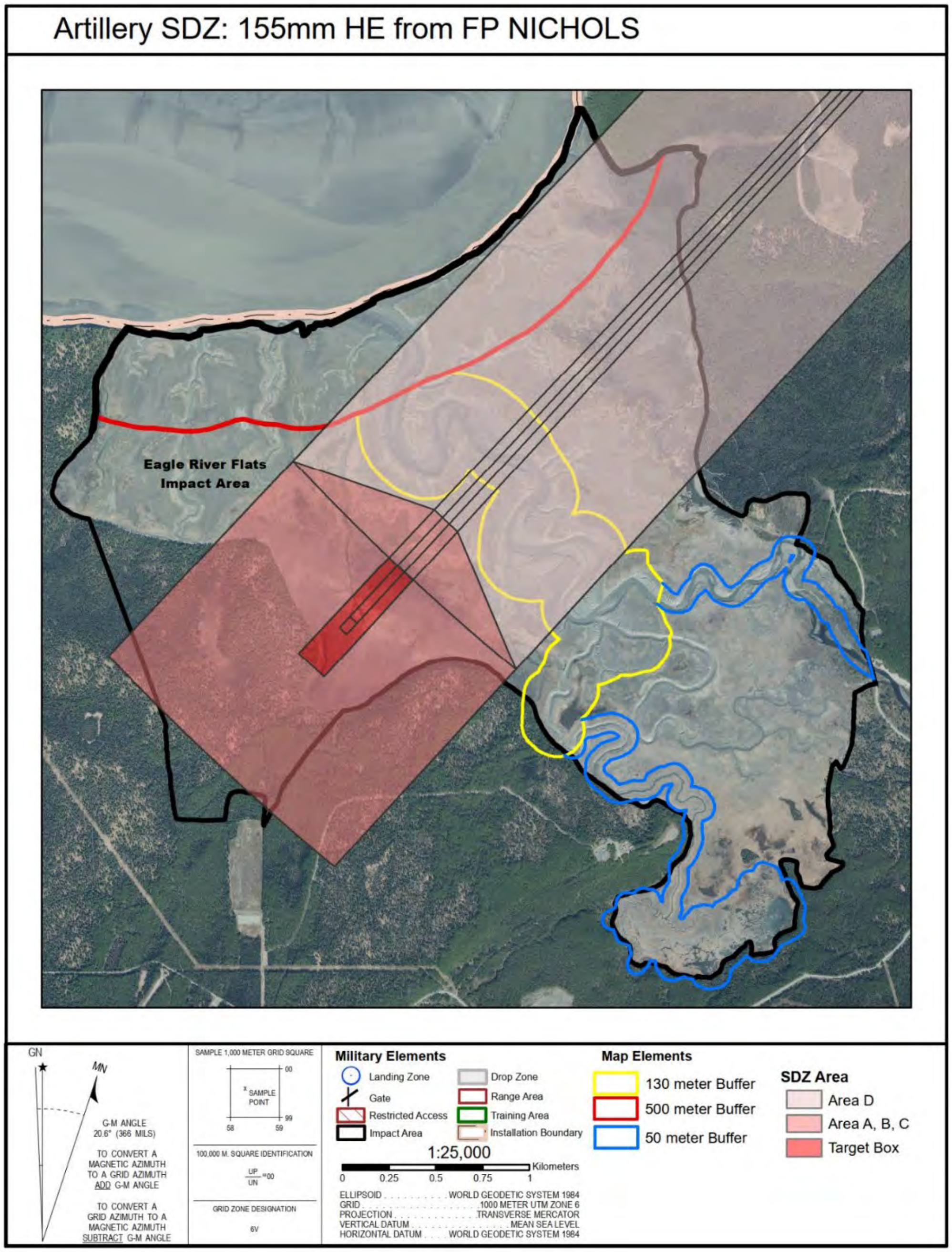

Figure 5-8 Example SDZ for a 155-mm HE Round

5.3 EROSION AND SEDIMENTATION

The following information on erosion and sedimentation effects on marine mammal prey species in ERF-IA was synthesized from the EFH Assessment (JBER 2023d). For a complete analysis of erosion and sedimentation effects on marine mammal habitat, please refer to that document.

5.3.1 Cratering and Sediment Transport in ERF

Weapons training can alter aquatic habitat through cratering, soil compaction, soil erosion, and vegetation removal, creating the potential for increased sediment runoff. Land detonations may generate craters that can erode or modify existing stream channels that provide rearing habitat for juvenile salmonids and thus reduce habitat connectivity. Detonations in ERF-IA may constitute an immediate change to sediments and habitat in waterbodies during each firing event, whereas construction and munitions detonations in the proposed expansion area could potentially cause erosion and sedimentation in ERF that would occur later than the actual firing event.

Sedimentation and turbidity are primary contributors to the degradation of habitat used by marine mammal prey species (Bash et al. 2001). Excess sediment loading and turbidity levels can clog fish gills, smother eggs, embed spawning gravels, disrupt feeding and growth patterns of juvenile salmonids, delay the upstream migration of adults, and scour nutrients from the stream substrate. This may temporarily cause fish to avoid the area, impede or discourage free movement through the proposed project area, prevent individuals from use of preferred habitats, and/or expose individuals to less favorable conditions. Excessive sediment deposition over benthic habitats can result in a reduced availability of macroinvertebrate prey for fish.

Erosion and sediment deposition are natural processes in ERF-IA. Aquatic organisms that occur in this area have adapted to a dynamic, highly turbid environment. Eagle River and other large rivers draining into Knik Arm carry massive quantities of naturally occurring silt and clay-sized particles. ERF is subject to strong tidal and river currents, which result in a constant fluctuation of erosion and sedimentation.

Researchers estimate that there is a net influx of sediment into ERF, which counteracts the effects of gully and river channel erosion (Racine et al. 1995). Sediments that settle out of floodwaters and are deposited in ponds and mudflats are important for maintaining the ERF ecosystem. Sediments are deposited into tidally affected waterbodies, ponds, mudflats, and wetland areas in ERF-IA during flood tides. A major source of sediment is the Knik Arm waters, which contain extremely high levels of total suspended solids (TSS); TSS levels measured in ERF-IA can be as high as 2,000 milligrams of sediment per liter of water. TSS levels in Knik Arm can be five times higher than levels found in Eagle River during the fall months (Racine et al. 1994); however, sedimentation can occur during flood events throughout the year.

Due to the net transfer of sediment into ERF, craters formed by live-fire training that are later subject to tidal inundation would eventually become filled with sediment. The process of sedimentation is evident from observations of old impact craters that have been completely filled with sediment over the past 33 years. Although munition-related cratering and resultant ponding in ERF-IA would occur in intertidal areas that may provide off-channel rearing for some juvenile fishes (such as salmonids) during certain periods of the year, scattered ponding within the mudflats is not anticipated to result in increased habitat for salmonids.

As part of the proposed action, live-fire training would occur during periods when ERF-IA is not covered with ice (for the first time since 1990) and would generate craters and create localized areas of reduced vegetative cover in the flats. The protective buffers applied for underwater noise (ranging from 50 to 500 meters) would reduce potential detonation-induced erosion and sedimentation from entering active channels. No firing of HE rounds would occur during typical inundating tide events, which would reduce sediment disturbance when the flats are flooded and connected to active channels, although some loose sediment caused by detonations could enter channels during subsequent inundating tide events.

It is estimated that crater sizes would be relatively small (i.e., 1 to 3 meters wide), and impacts would be localized to target areas, although repeat detonations in these areas could create larger craters. The potential for slumping or mass soil movements would be limited by the relatively flat topography of ERF-IA. Habitat protective buffers would reduce erosion and sedimentation impacts adjacent to Eagle River, Otter Creek, and the Otter Creek complex. However, some munitions detonations could occur in small waterbodies in unbuffered areas. Within these areas, targets would be placed on higher ground to avoid stream channels and low-lying areas that could be more susceptible to erosion. Although forward observers will monitor firing activities, as discussed in Section 2.4, it is possible that some detonation of rounds could occur in shallow areas of flowing or standing water that are obscured by vegetation and that are hydrologically connected to other surface water resources.

Habitat protective buffers would reduce erosion and sedimentation impacts adjacent to Eagle River, Otter Creek, and the Otter Creek complex where most juvenile salmonids rear in ERF-IA. However, some munitions detonations could occur in unbuffered areas that provide juvenile salmonid rearing habitat (e.g., the Eagle River relict channel complex). Targets would be placed in higher ground areas to avoid stream channels and low-lying areas that could generate erosion or result in loss of vegetation. However, it is likely that some munitions would detonate in stream habitats. This could impact local hydrology by opening new channels or closing off existing channels, which could alter juvenile salmonid access to connecting habitats, such as mainstem Otter Creek and Eagle River. Craters can be "self healing" in some situations as sediment settles back in after inundating tide events. Others could fill with tidal or freshwater and serve as pools, which could benefit rearing salmonids.

Sediment released into waterbodies and channels could result in loss or degradation of rearing habitat for juvenile salmonids, either by filling in channels or generating suspended sediment. This would indirectly result in some loss or disturbance to the macroinvertebrate prey base for juvenile salmonids. Existing vegetation would provide some sediment erosion control, and impacted vegetation would be expected to grow back if the same areas are not continually targeted. However, regrowth could be impeded if firing is concentrated within the unbuffered areas. Larger 155-mm HE rounds would not be fired into the Eagle River relict channel complex, which would reduce the potential for erosion caused by detonation of these rounds. The unbuffered area on the west side of ERF-IA would be subject to greater sediment disturbance and erosion because it could accommodate the full range of proposed rounds. However, this area is not known to provide the same high-quality rearing habitat that has been documented within the Eagle River relict channel complex. Macroinvertebrate recolonization is anticipated following each firing event, with the rate of recovery dependent on the frequency of firing. However, vegetation loss would reduce the availability of terrestrial prey organisms for juvenile salmonids.

The magnitude and scale of effects at the local level cannot be quantified, but it is anticipated that there would be some reduction in coho (and potentially Chinook and sockeye) escapement and productivity in Eagle River and Otter Creek, primarily due to loss or modification of habitat in unbuffered areas. Localized sediment increases, particularly within the unbuffered areas, could result in short-term loss or disturbance of some macroinvertebrates that comprise part of the prey base for fish species. Overall, the degree of effects to the unbuffered areas cannot be predicted, but it is expected that existing habitat would be altered, and the degree of effect would depend on detonation locations (buffered versus unbuffered areas). The full extent of impacts may not be observed for years after firing commences, through continued monitoring of adult escapement, juvenile outmigration surveys, and habitat evaluations of buffered and unbuffered areas of ERF-IA. The mitigation measures listed in Section 2.4 include use of ongoing salmon enumeration studies to obtain information on fish populations and determine whether additional measures are needed to prevent adverse impacts to marine mammal habitat.

It is estimated that individual crater sizes would be relatively small (i.e., 1 to 3 meters wide), and impacts would be localized to target areas, although repeat detonations in these areas could create larger craters. The potential for slumping or mass soil movements would be limited by the relatively flat topography of ERF-IA. The distance between detonation points and Eagle River/Otter Creek afforded by proposed protective buffers would limit the potential for erosion and sedimentation impacts to terrestrial invertebrates (or associated riparian habitat) that may provide a prey source for juvenile coho in these waterbodies.

Based on the site conditions and proposed protection measures, most sedimentation and turbidity effects caused by munition detonations in ERF-IA and the proposed expansion area are not expected to be significant, as the system already has a high baseline of suspended sediment/turbidity. However, it is likely that localized sediment increases, particularly within the unbuffered areas, could result in short-term loss or disturbance of some macroinvertebrates that comprise part of the prey base for juvenile salmonids in

ERF. As such, fish habitat alteration due to erosion and sedimentation could result in short-term, localized adverse impacts to EFH and managed species but would not cause long-term, adverse impacts due to existing and proposed protective measures and the dynamic sediment conditions at the site.

5.3.2 Construction of the Proposed Expansion Area

Ground disturbance associated with construction of the proposed expansion area would generate increased sediment in the proposed project area, although construction would be a short-term disturbance. Adherence to best management practices and conservation measures during construction activities, as outlined in the JBER INRMP (JBER 2023a) and a project-specific Construction General Permit *Storm Water Pollution Prevention Plan*, would minimize potential construction impacts from erosion and sedimentation.

Setbacks for vegetation clearing would prevent sedimentation into Clunie Creek and associated wetlands. Clunie Creek does not have a downstream surface water connection with Eagle River (the stream goes subterranean upstream from the confluence), although it may contribute sediments to ERF during infrequent periods of sheet flow flooding. Based on the erosion and sediment control measures that will be implemented, potential sedimentation in Clunie Creek from expansion of the impact area is not expected to result in any measurable effects to habitat for marine mammals in Eagle River, Otter Creek, or Eagle Bay. Should sedimentation occur, it is expected that suspended sediments would settle out quickly (or be flushed downstream) and that macroinvertebrates in the affected portions of the channel would recolonize the disturbed areas following construction activities. Therefore, no effects to marine mammal prey species are anticipated.

5.4 COOK INLET BELUGA WHALE CRITICAL HABITAT

The proposed action may affect Cook Inlet beluga whale critical habitat, primarily through noise from indirect live-firing of HE rounds during typical inundating tide events, potential release of contaminants, and effects to beluga whale prey base. Eagle Bay is designated as Area 1 habitat, the most valuable habitat, for the Cook Inlet beluga whale, and is used intensively from spring through fall for foraging and nursery habitat (76 FR 20180). As described in Section 3.1.1, designated critical habitat does not include ERF-IA. However, beluga whale prey species constitute an important component of critical habitat. Cook Inlet beluga whale seasonally occur in designated critical habitat near ERF-IA in Eagle Bay, particularly at the mouth of Eagle River and along the coast of ERF.

The Cook Inlet beluga whale critical habitat final rule (76 FR 20180) included designation of five PCEs. In 2016, the final rule revising critical habitat regulations (81 FR 7414) replaced the term PCE with PBF. The shift in terminology does not change the approach used in conducting a “destruction or adverse modification” analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features.

The five PBFs are deemed essential to the conservation of the Cook Inlet beluga whale (50 CFR 226.220[c]). The status of each PBF is summarized in Table 5-13.

Table 5-13 Status of Physical or Biological Features for the Cook Inlet Beluga Whale

PBFs	PBF is Present and “Healthy”	Potential Impacts to PBF
1. Intertidal and sub-tidal waters of Cook Inlet with depths less than 30 feet MLLW and within 5 miles of high and medium flow of anadromous fish streams	Intertidal and sub-tidal areas within 5 miles of anadromous fish streams would generally remain intact and undisturbed.	—
2. Primary prey species: Four species of Pacific salmon (Chinook, sockeye, coho, and chum), Pacific eulachon, Pacific cod, walleye, pollock, saffron cod, yellowfin sole	—	There is a risk for mortality, injury and behavioral disturbance to primary prey species from underwater noise, chemical contaminants, erosion/sedimentation, and direct

PBFs	PBF is Present and "Healthy"	Potential Impacts to PBF
		strikes from munitions and shrapnel in waterways of ERF-IA, but particularly within unbuffered areas. There is likely to be some reduction in salmon escapement and productivity in Eagle River and Otter Creek. However, the scale of effects would not affect fish at the population-scale for Upper Cook Inlet.
3. Waters free of toxins or other agents of a type and amount harmful to Cook Inlet beluga whales	Waters flowing from ERF-IA into Eagle Bay would not contain toxic levels of contaminants likely to harm beluga whales. Release of munitions constituents at levels that would affect beluga whales, or their prey base is low.	—
4. Unrestricted passage in or between the critical habitat areas	—	Underwater noise is limited to a small area and not expected to affect passage within critical habitat area.
5. Waters with underwater noise below levels resulting in abandonment of critical habitat areas by Cook Inlet beluga whales	—	There may be a risk of short-term avoidance of areas of critical habitat or movement away from the portion of Eagle Bay where underwater noise from live-fire may be above background levels.

Key: — = status does not apply; ERF-IA = Eagle River Flats Impact Area; MLLW = mean lower low water; PBF = physical or biological feature.

5.4.1 PBF 1: Intertidal and Subtidal Waters of Cook Inlet with Depths Less than 30 Feet MLLW and within 5 Miles of High and Medium Flow of Anadromous Fish Streams

Eagle Bay is in the action area and includes intertidal and subtidal waters within 5 miles of high and medium flow anadromous fish streams. Designated anadromous fish streams and foraging areas within 5 miles of the Eagle Bay portion of the action area include Eagle River, Fish Creek, Goose Creek, and Sixmile Creek (ADF&G 2022a). Garner Creek is also known to support salmonids, although it has not been identified as such by the Anadromous Waters Catalog (ADF&G 2022a). Noise levels may temporarily increase in Eagle Bay and may potentially affect beluga whales and prey species if they are present during firing activities. Potential impacts from noise on beluga whales and their prey species are described in Section 5.1.1 and 5.5, respectively. In ERF-IA, there is a low risk of exposure of marine mammal prey to underwater noise above NMFS-established thresholds, and any impacts would likely be limited to behavioral disturbances, as protective buffers and other measures would be implemented to reduce risk of injury and mortality to prey species.

As described in Section 5.3, any increase in sediment load in the Eagle River watershed associated with the proposed action could have short-term, localized adverse impacts to marine mammal prey (fish) or their habitat. No fill, removal, or physical habitat modifications are proposed in Eagle Bay.

As described further in Section 4.6, there is potential for the degradation of water quality, which could affect beluga whale prey from the introduction of munitions constituents into the environment as a result of firing munitions into ERF-IA.

With implementation of conservation measures and avoidance measures, the overall potential impacts of the proposed action on PBF 1 may affect, but are not likely to adversely affect, designated critical habitat for Cook Inlet beluga whale.

5.4.2 PBF 2: Primary Prey Species Consisting of Four Species of Pacific Salmon (Chinook, Sockeye, Coho, and Chum), Pacific Eulachon, Pacific Cod, Walleye Pollock, Saffron Cod and Yellowfin Sole

The primary prey species listed under PBF 2 that may be present in the action area during firing activities include all four salmon species, eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole. Although pink salmon are not included in this PBF, beluga whales may opportunistically feed on adult pink salmon during peak spawning periods so they are included in this BA (Castellote et al. 2021).

Pacific Salmon: As described in Section 4.1, the four Pacific salmon species listed under PBF 2 all occur in the action area. Information on the seasonality and migratory patterns of adult and juvenile salmon in ERF-IA and Eagle Bay is provided in Table 4-1 and Table 4-2. The ADF&G reviews annual escapement goals and makes management recommendations to the BOF on a 3-year cycle that corresponds to the BOF schedule for evaluating regulatory proposals (Otis et al. 2016). Escapement goals are only based on anadromous streams surveyed by ADF&G (e.g., foot and aerial surveys, mark-recapture, weir counts, hydroacoustics, or sonar) and do not reflect other streams in Cook Inlet where salmon may return (Otis et al. 2016). If there are stocks of concern, ADF&G identifies these stocks and lists the criteria in their report to the BOF. There are currently no stocks of concern that spawn in the vicinity of the action area (ADF&G 2022a). It is likely that fewer salmon are available to beluga whales in Upper Cook Inlet than in the past due to anthropogenic activity. Threats to salmon in Upper Cook Inlet include overfishing, dams, habitat loss, habitat degradation, stormwater runoff, variable ocean conditions, and climate change (ADF&G n.d.-a; Beamesderfer et al. 2015).

Eulachon: Eulachon return to spawning areas in Upper Cook Inlet from April through June. Particularly large runs of eulachon are found in the Susitna, Kenai, and Twentymile Rivers (Shields and Dupuis 2017). A total of 40 eulachon were captured during the 2017 Eagle Bay fish study, all in mid-May. All fish captured were assumed to be adults returning to spawn, although it was unclear whether their target was Eagle River or one of the larger glacial rivers at the head of Knik Arm (Schoofs et al. 2018). In mid-May to early June 2021, large numbers (n = 3,174) of small-sized fish (<25.4 centimeters) were detected during adult salmon monitoring in Eagle River (AERC 2022), and it was surmised that these fish were eulachon given the size class and run timing (C. Brandt, personal communication, 9 March 2023). This marked the first time that eulachon have been observed at the Eagle River sonar weir assembly site (6.4 kilometers upstream from river mouth), an observation made possible because the sonar devices were installed earlier than in previous years. No recent information is available on eulachon abundance within Upper Cook Inlet. Throughout the GOA, abundance and biomass estimates of eulachon during 2021 were higher than in 2019, but lower than those observed from 2001–2015 (NPFMC 2022).

Groundfish Species: Pacific cod, walleye pollock, and yellowfin sole are groundfish species managed by NMFS and the NPFMC under the GOA Groundfish Management Plan (NPFMC 2022). While not a federally managed species, saffron cod is a groundfish species that constitutes an important part of this PBF. The presence of these species in the GOA and its estuaries and relationship and movement between marine and nearshore processes have been well documented (NPFMC 2020). Larval forms of each species are transported and concentrated in nutrient-rich nearshore habitat from winter through summer (depending on species). Although different groundfish life stages (larvae, juveniles, and adults) may be present in Eagle Bay, few groundfish species are known to use ERF-IA, so use of this area is likely limited to groundfish larvae that enter Eagle River during incoming tides during the summer months. Groundfish species migrate to open waters to assume their late juvenile and adult life stages in open pelagic waters or on benthic substrates (Windward 2014; NPFMC 2020).

As discussed in Section 4.1.6, low abundances of groundfish species have been documented in Knik Arm (Schoofs et al. 2018).

The NPFMC provides North Pacific Groundfish Stock Assessment and Fishery Evaluation (SAFE) Reports on groundfish species by region (i.e., Bering Sea, Aleutian Islands, and GOA). Although the SAFE Reports discuss a much larger area than the action area (which is located within the GOA region), they provide information on status and trends of the population within the region. The SAFE Reports compare the previous year's assessment to the current year's assessment and project the future status of these species on a 1- to 2-year basis (NPFMC 2020). The most recent SAFE Reports for groundfish EFH species within the GOA region were issued in 2022 (NPFMC 2022), and species status information is incorporated by reference below. Additionally, the ADF&G opportunistically samples these species while conducting surveys on other fish species in Cook Inlet and their findings are described below where available.

- *Pacific Cod*: Pacific cod is not overfished and is not approaching an overfished condition in the GOA Management Area (NPFMC 2022). According to ADF&G's most recent (2016–2018) groundfish management report, Pacific cod abundance in the GOA and surrounding areas experienced a drastic decline in 2018, which resulted in a 77 percent reduction in guideline harvest levels (Rumble et al. 2019). This reduction was attributed to an ocean condition called the "warm blob," a marine heat wave that negatively affected some marine species, including Pacific cod. Two Pacific cod fishery seasons, the "parallel" and the "state-waters," occur within Cook Inlet Area state waters. Guideline harvest levels for these seasons have increased over the past few years due to increases in abundance (ADF&G 2023d).
- *Walleye Pollock*: Pollock are not subject to overfishing and are not being overfished in the GOA Management Area (NPFMC 2022). The GOA pollock stock is currently estimated to be at relatively high abundance; however, due to a decline in biomass in 2015 and 2016 during ADF&G surveys, there is uncertainty regarding future abundance trends (Rumble et al. 2019). There is a noticeable decline in pollock weight at age and a lack of recruitment to the stock for 3 years, and most of the stock consists of a single very strong year class. Currently, there is no directed fishery for pollock in Cook Inlet, so any fish captured by commercial vessels are limited to bycatch associated with other groundfish fisheries (ADF&G 2022e).
- *Yellowfin Sole*: In the GOA Management Area, yellowfin sole is managed as part of the shallow-water flatfish complex, which also includes northern rock sole (*Lepidopsetta polyxystra*), southern rock sole (*L. bilineata*), butter sole (*Isopsetta isolepis*), starry flounder, English sole (*Parophrys vetulus*), sand sole (*Psettichthys melanostictus*), and Alaska plaice (*Pleuronectes quadrituberculatus*) (NPFMC 2022). Yellowfin sole is not subject to overfishing and is not being overfished in the GOA (NPFMC 2022). There is no directed fishery for yellowfin sole in Cook Inlet (ADF&G 2022e).
- *Saffron Cod*: Saffron cod are not discussed in the SAFE Reports because they are not covered under the GOA Fishery Management Plan. There is no directed fishery for saffron cod in Cook Inlet (ADF&G 2022e). Juvenile and adult saffron cod may be present at various times in Eagle River and Eagle Bay, as discussed in Section 4.1.3.

As described further in Section 5.5, detonation of HE rounds during typical inundating tide events could potentially affect fish species that may be present in portions of ERF or the adjacent Eagle River, Otter Creek (and its tributaries), or Eagle Bay if they are within the noise threshold distances. There is a low risk of exposure of marine mammal prey to underwater noise above thresholds that may adversely affect the prey base for ESA-listed marine mammals. Any impacts would likely be limited to behavioral disturbances, as protective buffers and other measures would be implemented to reduce risk of injury and mortality. As previously described, impacts to primary prey species may also occur through erosion and sedimentation (Section 5.3), direct munition strikes (Section 5.6),and munitions residue (Section 5.7).

It is anticipated that potential project effects to beluga primary prey species would be localized to the local run or watershed level. Although unquantifiable, some mortality and injury are anticipated for juvenile salmonids that rear in unbuffered areas. Effects to adult salmon, eulachon, saffron cod, and other groundfish species that use ERF-IA would be generally limited to temporary behavioral modifications. With the implementation of avoidance and minimization measures and other conservation measures, it is not anticipated that the project would result in an attributable reduction of any beluga primary prey species at the population scale (within Upper Cook Inlet).

With implementation of avoidance and minimization measures and other conservation measures, the overall potential impacts of the proposed action on PBF 2 may affect, but are not likely to adversely affect, designated critical habitat for Cook Inlet beluga whale in Eagle Bay and Upper Cook Inlet. Critical habitat has not been designated in ERF-IA.

5.4.3 PBF 3: Waters Free of Toxins or Other Agents of a Type and Amount Harmful to Cook Inlet Beluga Whales

Water quality in the Knik Arm is expected to be similar to water quality in other parts of Upper Cook Inlet. The Alaska Department of Environmental Conservation has listed Upper Cook Inlet as a Category 3 waterbody, indicating that there is insufficient data to determine whether the waterbody meets water quality standards (ADEC 2022).

Quality and chemical composition of water in the impact area varies seasonally based on factors such as snowmelt, precipitation, and tidal fluctuations/inundation. Salinity varies seasonally and spatially throughout ERF waterbodies, with the highest concentrations tending to be in shallow intermittent ponds and during warmer dry summers. Between May and July, salinity in ponds has been measured at 4 to 38 parts per thousand, with higher salinities occurring in shallow mudflat ponds (Racine and Brouillette 1995).

Prior to cleanup in 1996, 60 acres of ERF-IA was placed on the Section 303(d) list for non-attainment of the criteria for toxic and other deleterious organic and inorganic substances. Specifically, ERF-IA was flagged for contamination with WP and was designated as a Category 4b waterbody. The site was treated by pumping water out and allowing soils and sediments to dry, providing an environment for WP to sublimate. Active treatment ceased in 2005, and in 2008 the site was redesignated as a Category 2 waterbody. The latest water quality assessment found good conditions for aquatic life and wildlife at ERF-IA (ADEC 2022).

Other portions of Eagle River are not water quality limited (USARAK 2004). The U.S. Geological Survey monitored the water quality of Eagle River until 1981 and concluded that Eagle River was, in terms of water quality, similar to other glacially fed rivers, with no exceedances of water quality standards (USARAK 2004). Between 1970 and 1981, the pH of Eagle River ranged between 6.6 and 8.0. Dissolved oxygen levels measured in 1981 were found to range between 11.8 mg/L and 12.9 mg/L (USGS 2020b).

In 2007, in support of the ongoing EIS to reinstate all-season indirect live-fire training at JBER, water quality samples were collected during three separate sampling events from areas along Eagle River, including areas upriver from ERF and at the river's mouth. Samples were analyzed for the presence of metals, explosives, and polychlorinated biphenyls. No explosive residues or compounds (including High Melting Explosive, Royal Demolition Explosive, TNT, or polychlorinated biphenyls) were detected in the river. In addition, none of the samples contained metals in excess of drinking water maximum contaminant levels. This suggests that munition contaminants and residues from winter firing activities are either breaking down or not being released into waterbodies where they could be exposed to beluga prey species.

Between 2007 and 2011, Army personnel collected 102 tissue samples from 15 fish species captured in the tidally influenced portions of Eagle River (Garner et al. 2008; USACHPPM 2008a, 2008b, 2009; USAPHC 2011). These samples were taken from all five Pacific salmon species, eulachon, starry flounder, and Pacific staghorn sculpin. The concentration of munitions residues in the samples did not exceed the detection limit in any of the fish tissue samples (Garner et al. 2008; USACHPPM 2008a, 2008b, 2009; USAPHC 2011). The results of this study indicate that munitions residues are not bioaccumulating in the fish that use the tidally influenced portions of Eagle River. Many of these fish were captured in the mouth of Eagle River, at its juncture with the waters of Knik Arm. This, taken with the fact that several of the analyzed species were primarily marine species (e.g., saffron cod, starry flounder), suggest that fish in Knik Arm are also not bioaccumulating munitions residues.

There is a potential for degradation of water quality from introduction of munitions constituents into the environment as a result of firing rounds into ERF-IA, which could affect beluga whale habitat and prey (Section 5.4.2). However, testing has consistently shown that traditional munitions constituents are not accumulating in or migrating out of ERF-IA. The presence of munitions-related compounds has been studied at 31 military ranges in the United States and in Canada, including at ERF-IA (Jenkins et al. 2007; Walsh et al. 2010). Lotufo et al. (2013) reviewed the fate and effects of several munitions constituents used at JBER and found that most constituents rapidly degraded in aqueous exposure systems, showed a significant binding affinity with organic matter, and were unlikely to result in biological effects to fish; however, the study states that verification of this conclusion should be pursued by determining site-specific exposure risk.

Live firing would discharge metal shrapnel fragments into ERF waterbodies, either during munition detonation or by tidal flushing events. As discussed in Section 2.1, projectile bodies are most often made of steel or iron, with copper alloy rotating bands and trace amounts of zinc. Therefore, shrapnel could contain a small percentage of copper and zinc, which could dissolve in the estuarine waters and become bioavailable to fish and aquatic organisms (see Section 5.7 for additional discussion of munitions constituents). Studies of sites impacted by munitions constituents generally only find trace amounts of copper and zinc (Rectanus et al. 2015). Considering the site characteristics and the small amounts of these metals that comprise munitions at JBER, the bioavailability of copper and zinc to beluga prey species is expected to be low. The proposed habitat protective buffers would prevent most shrapnel from directly entering waterbodies, so shrapnel is most likely to enter ERF waterbodies after flooding events.

Because these studies were conducted when firing was limited to periods of ice cover, the results may not be the same as for firing during other periods of the year, as proposed by this action. It is possible that some of the munition residues had degraded by various processes, such as photodegradation and dissolution, before entering site soils and the water column. However, any munitions residues deposited after ice has thawed would be subject to all degradation pathways, including biodegradation and sorption, which would increase probability for contaminant breakdown before they could be exposed to beluga prey species.

No studies specific to ERF were found that discuss accumulation or transport rates of IM, but recent investigations at ERF-IA indicate that 3 nitro-1,2,4 triazol-5 one (NTO) and nitroguanidine (NQ) are highly water soluble and likely to migrate with surface water or into groundwater. As described further in Section 5.7.3 and the EFH Assessment (JBER 2023d), these IM compounds and their breakdown products have been identified as limiting growth in aquatic organisms and causing behavioral abnormalities, with ultraviolet light potentially causing increased toxicity to aquatic organisms if these constituents are mobilized into waterbodies (Moores et al. 2021). These compounds appear to have low bioaccumulation and biomagnification potential, which would reduce risk of transferring toxicity from fish to marine mammals. More persistent IM compounds would be subject to soil breakdown pathways likely accelerated by presence of anaerobic soils and organic matter at ERF-IA. It is possible that degradation may occur even more rapidly because ERF-IA is a tidal estuary. Many residues are likely to be flushed out of the impact area and into Eagle Bay in runoff and subsequently diluted, with a flushing of residues deposited during the winter in spring snowmelt. It is possible that salmonids near a low-order (LO) detonation (i.e., partial detonation) crater or degrading UXO could experience adverse effects, particularly if they consume contaminated prey items within these areas. There is a low risk of munition contaminants entering Eagle River, Otter Creek, or associated wetland complexes at levels that could result in sublethal effects to juvenile salmonids.

The predominantly anaerobic environment at ERF-IA and various breakdown pathways (e.g., soil sorption, dissolution, photo-transformation, and biodegradation) are expected to reduce exposure of munition contaminants to aquatic species. However, site-specific sampling would be needed to further evaluate the potential for newer IM constituents to exhibit bioaccumulation at ERF-IA. The proposed all-season firing would result in an increased risk of exposure of munitions residue to beluga prey species, but the protective and avoidance and minimization measures described in Section 2.4(e.g., habitat protective buffers, seasonal and tidal firing restrictions, avoiding ground penetration in areas where WP contamination has been capped, and selective targeting within unbuffered areas) would reduce risk of contaminants entering waterbodies where they could potentially be consumed or accumulate in tissues of beluga prey species.

The risk of munitions contaminants to affect beluga prey species would be low to moderate due to 1) contradictory study results and uncertainty about breakdown efficiencies and toxicological effects from IM on fish and aquatic invertebrates, and 2) dynamic processes in ERF that could mobilize and transport IM and other traditional munitions into year-round rearing habitats for sensitive juvenile coho and other salmonids. It is possible that juvenile salmon that ingest invertebrates that have been exposed to munition residues could experience toxicological effects. However, it is impossible to predict potential exposure and effects on managed fish species and their prey base without water quality monitoring, fish tissue sampling, or a site-specific ecotoxicology study.

With implementation of avoidance and minimization measures and other conservation measures, the overall potential impacts of the proposed action on PBF 3 may affect, but are not likely to adversely affect, designated critical habitat for Cook Inlet beluga whale.

5.4.4 PBF 4: Unrestricted Passage in or between the Critical Habitat Areas

Although designated critical habitat in Eagle Bay may be affected by intermittent noise from live-fire above background conditions, Cook Inlet beluga whales are unlikely to be physically restricted from passing through critical habitat since the area affected is limited to a portion of Eagle Bay and would not extend across Knik Arm.

With implementation of avoidance and minimization measures and other conservation measures, the overall potential impacts of the proposed action on PBF 4 may affect, but are not likely to adversely affect, designated critical habitat for Cook Inlet beluga whale.

5.4.5 PBF 5: Waters with Underwater Noise Below Levels Resulting in Abandonment of Critical Habitat Areas by Cook Inlet Beluga Whales

As described in Section 5.5, live-fire training could result in temporary increases in underwater noise in critical habitat (where the underwater noise action area intersects with Eagle Bay). Temporary movement away from the action area to other feeding areas is possible during these training exercises. Beluga whales may avoid portions of the action area during firing exercises but may resume using those habitat areas once the most intense noise subsides. Alternatively, beluga whales may become habituated to underwater noise produced during live-fire training, and only a small portion of Critical Habitat Area 1 (Figure 3-4) may be affected by underwater noise above background conditions.

With implementation of avoidance and minimization measures and other conservation measures, the overall potential impacts of the proposed action on PBF 5 may affect, but are not likely to adversely affect, designated critical habitat for Cook Inlet beluga whale.

5.5 UNDERWATER NOISE EFFECTS ON PREY (FISH)

5.5.1 Fish Hearing Capabilities

Designated anadromous fish streams and foraging areas within 5 miles of ERF-IA include Eagle River, Fish Creek, Goose Creek, and Sixmile Creek (ADF&G 2022a). Garner Creek is also known to support salmonids, although it has not been identified as such by the Anadromous Waters Catalog (ADF&G 2022a).

Noise levels may temporarily increase in Eagle River potentially affect beluga whales prey species if they are present during firing activities.

All fishes have two sensory systems that can detect sound in the water: the inner ear, which functions similarly to the inner ear in other vertebrates, and the lateral line, which consists of a series of receptors along the body of a fish (Popper 2008).

Fish have historically been categorized as either hearing specialists or generalists based largely on their hearing range and sensitivity (Fay and Popper 2012); however, Popper and Fay (2011) determined that this classification system is poorly and inconsistently defined and likely too simplistic. Therefore, fish hearing groups now tend to be defined by species that possess a similar continuum of anatomical features, which result in varying degrees of hearing sensitivity (Popper and Hastings 2009; Popper and Fay 2011). Categories and descriptions of hearing sensitivities are further defined in this document (based on guidelines from Popper et al. 2014 and Popper et al. 2019 as follows:

- Fishes without a swim bladder (Group I) – Hearing capabilities are limited to particle motion detection and are best at frequencies less than 300 Hz (e.g., flatfishes, eulachon, sculpin).
- Fishes with a swim bladder not involved in hearing (Group II) – Species lack notable anatomical specializations and show sensitivity only to a narrow band of frequencies (e.g., salmonids).
- Fishes with a swim bladder involved in hearing (Group III) – Species can detect frequencies up to about 500 Hz and possess anatomical specializations to enhance hearing and are capable of sound pressure detection up to a few kHz (e.g., saffron cod).
- Fishes with a swim bladder and high-frequency hearing (Group IV) – Species can detect frequencies below 1 kHz and possess anatomical specializations and are capable of sound pressure detection at frequencies up to 5 kHz (e.g., Pacific herring) and higher in some species (e.g., American shad).

Fishes from these different groups not only vary in their hearing abilities but also in their susceptibility to hearing loss, physical injury, and physiological damage from exposure to sound. They may also vary in their behavioral responses to sound. Fish could potentially be injured or killed if they are present in the immediate vicinity of a munition detonation. Further, hearing loss may result from exposure to intense sounds. The loss may be permanent or temporary. PTS is a loss of hearing that never recovers. In contrast, TTS is a relatively short-lived reduction in hearing sensitivity due to changes in the sensory cells of the ear, generally resulting from exposure to intense sounds for short periods of time, or longer exposure to lower sound levels.

Most often, PTS is associated with the death of sensory hair cells in the ear and/or damage to the nerves innervating the ear (Liberman 2016). To date, there is no evidence of PTS in fishes, and it is considered unlikely to occur because fishes can replace lost or damaged hair cells, precluding any permanent hearing loss (Smith 2016; Smith and Monroe 2016). However, it is also possible that damage to the swim bladder or other organs involved in the detection of sounds might result in permanent changes to the hearing abilities of some fishes, although this would not be called PTS (Popper et al. 2019).

Fish that experience hearing loss as a result of exposure to explosions and impulsive sound sources may have a reduced ability to detect relevant sounds such as predators, prey, or social vocalizations. Sound detection impairment for fish can result in a decreased ability to forage or avoid predators, thereby reducing overall fitness; however, termination of exposure for fish that experience TTS eventually leads to the return of normal hearing ability (Popper et al. 2019). The length of time required for recovery varies as a function of the frequency of the sound and duration of the exposure (Scholik and Yan 2001).

All fishes have two sensory systems that can detect sound in the water: the inner ear, which functions similarly to the inner ear in other vertebrates, and the lateral line, which consists of a series of receptors

along the body of a fish (Popper 2008). The pressure component of sound is represented by sound waves, which are characterized by the medium compressing and expanding as sound energy moves through it. At the same time, the particles that form the medium move back and forth (particle motion). All fish directly sense the particle motion component of sound (Fay 1984), although relatively few fish sense both the particle and pressure components (Popper et al. 2003). The ears of all fish consist of otolith- (or otoconia-) containing end organs that function as inertial accelerometers. Fish that sense pressure have additional morphological adaptations that allow them to detect acoustic pressure (e.g., Popper et al. 2003; Popper and Hawkins 2019). In these fish, gas-filled bladders such as the swim bladder, which is near the ear, or mechanical connections such as Weberian ossicles, which are between the gas-filled bladder and the ear, convey sound pressure from the water to the ear when pressure deforms the bladder (JASCO 2020, 2022).

Fish have all of the basic acoustic processing capabilities of other vertebrates (Popper et al. 2003; Ladich and Popper 2004). Fish can discriminate between sounds of different magnitudes or frequencies, detect specific sounds when other signals are present, and determine the direction of a sound source (JASCO 2020). However, in contrast to marine mammals, which appear to have a limited ability to detect particle motion (Finneran et al. 2002), fish are well adapted to detect the particle motion component of an acoustic stimulus using sensory cells in the inner ear and lateral line (Popper 1996). Although such detection of sound is not considered hearing, it is likely that responses from the ear and lateral line are integrated into a single response to an acoustic stimulus (Higgs and Radford 2013). Fish hearing groups are defined by species that possess a similar continuum of anatomical features, which result in varying degrees of hearing sensitivity (Popper and Hastings 2009; Popper and Fay 2011).

5.5.2 Underwater Noise Effects Criteria

Numerical acoustic propagation modeling for in-air and underwater sound generated by mortar and artillery firing was conducted, as described in Section 5.2. This modeling utilized the mortality and impairment criteria for fish recommended by the Fisheries Hydroacoustic Working Group (Popper et al. 2014), shown in Table 5-14. For underwater noise in relation to fish, results were presented in terms of the following noise criteria:

- Peak sound pressure level (PK or Lpk) and unweighted SEL for mortality or potential mortal injury and hearing impairment for fish based on Popper et al. (2014). The PK refers to the maximum instantaneous sound pressure level in a stated frequency band during a stated period and is considered the most conservative and protective threshold for fish.

SEL_{24h} is a cumulative measure of sound related to the sound energy in one or more pulses that could be emitted in a 24-hour period.

Table 5-14 Mortality and Impairment Criteria for Sound From Impulsive Sources, as Proposed by the Fisheries Hydroacoustic Working Group

Fish Group		Mortality and Potential Mortal Injury		Impairment		
				Recoverable Injury		Temporary Threshold Shift
		SEL (24 hr) (dB re 1 $\mu Pa^2 \cdot s$)	PK (dB re 1 μPa)	SEL (24 hr) dB re 1 $\mu Pa^2 \cdot s$)	PK (dB re 1 μPa)	SEL (24 hr) (dB re 1 $\mu Pa^2 \cdot s$)
I	No swim bladder (particle motion detection)	> 219	> 213	> 216	> 213	> 186
II	Swim bladder not involved in hearing (particle motion detection)	210	> 207	203	> 207	> 186

Fish Group		Mortality and Potential Mortal Injury		Impairment		
				Recoverable Injury		Temporary Threshold Shift
		SEL (24 hr) (dB re 1 µPa^2·s)	PK (dB re 1 µPa)	SEL (24 hr) dB re 1 µPa^2·s)	PK (dB re 1 µPa)	SEL (24 hr) (dB re 1 µPa^2·s)
III and IV	Swim bladder involved in hearing (primary pressure detection)	207	> 207	203	> 207	186

Key: dB re 1 µPa2·s = decibels referenced to 1 microPascal; hr = hour; PK = peak sound pressure; s = second; SEL = sound exposure level.
Source: Popper et al. 2014; Popper et al. 2019.

Evidence has demonstrated that Lpk and SEL are better predictors of injury for fishes and most groups of marine life (Southall et al. 2007; Popper et al. 2014; Southall et al. 2019 in Martin et al. 2019). PK level is associated with immediate physiological injury to fish tissues (Halvorsen et al. 2012, cited in Martin et al. 2019). SEL is associated with fish fatigue injury through the equal energy hypothesis, which states that the effects on hearing are the same for the same total energy (Eldredge and Covell 1958, cited in Martin et al. 2019).

For this analysis, Lpk metrics are used to evaluate noise for a single detonation, whereas SEL metrics are used to evaluate noise from the total maximum number of rounds per day for each charge. Although peak values provide more representative thresholds for mortality or injury of fish (and are more conservative than SEL values), SEL metrics are more representative of ERF live-fire training scenarios and thus provide more appropriate underwater noise thresholds for fish. Accordingly, JBER considered these values when determining potential effects to fish species.

5.5.3 Potential for Mortality, Injury, and Behavioral Effects to Fish Species

Most training activities are not expected to introduce firing noise directly into the aquatic environment; during typical high tide conditions, noise would be attenuated by air and sediment before exposure to fish or other aquatic organisms. Direct coupling of airborne sound into the water is not a major contributor of underwater noise due to the sound wave impinging the water at grazing angles shallower than the critical angle (77 degrees) (JASCO 2022). Although very high airburst detonations at close distances to the water could exceed the critical angle, these scenarios would not occur during the proposed training. JASCO (2022) acknowledged that strong air-to-water coupling may be possible in some conditions, but for the purposes of their modeling, it was not assumed to be a dominant effect because the scenarios considered were on the flats rather than the surrounding bluffs. JASCO (2022) suggested that further intensive studies at ERF-IA would be needed to confirm whether a strong air-to-water coupling exists but assumed that it was not a dominant effect based on the location of the firing events.

Most of the proposed habitat buffers were identified based on acoustic modeling results to minimize noise exposures to endangered beluga whales, which generally require a larger protective buffer than fish. Therefore, these buffers would minimize impacts to fish as well. The buffer of the Otter Creek complex was identified based on modeling results for fish, which provide the most conservative estimate for this location.

The resumption of all-season mortar and artillery firing at ERF-IA would increase the potential for mortality, injury, or behavioral effects of/to fish due to underwater noise and vibrations from live-fire training activities. Currently, firing is limited to the winter months when fish abundance and diversity is generally lower in ERF-IA than it is during ice-free periods. During winter firing, the primary concern to fish species involves land detonations that transfer noise directly from the ice and snow-covered ground and into the water, but DTE thresholds can be much larger if detonations occur in water when there is a direct underwater pathway into waters that support fish. Under the proposed action, live-fire training could occur at any time during the year, including when juvenile salmonids may be present and when adult salmon may be holding in Eagle River or Otter Creek channels or actively migrating to spawning grounds upstream of ERF-IA. In addition, adult and juvenile salmon from other systems may rear in or migrate through the shallow and deep water areas just offshore in Eagle Bay or in Lower Eagle River from spring through fall (C. Garner, personal communication, 23 October 2020).

Under the proposed action, live-fire training activities may occur during the upstream migration of all four salmon species listed under PBF 2, which generally occurs from May through September. Although salmon spawning is not known to occur in ERF-IA, juvenile salmonids are known to seasonally rear in Eagle River, Otter Creek, and associated intertidal/backwater channels in ERF-IA; however, abundance is greatest from spring through fall, when they are rearing or outmigrating to marine areas. Note that although there are many gullies, intertidal channels, and ponds adjacent to Eagle River and Otter Creek, many of these areas go dry on a regular basis due to the dynamic and high ebb and flood tidal cycles in the project area, which limits the rearing habitat potential for juvenile salmonids and other marine mammal prey species.

Juvenile salmonid concentrations are likely greater in the main channels themselves because Eagle River and Otter Creek are fairly channelized and provide a constant source of water with good foraging opportunities. However, the inter-tidal channels and backwater ponds connected to Otter Creek at the southern portion of ERF-IA provide high-quality rearing and refugia habitat for juvenile coho (and likely other salmonids and forage fishes) throughout the year. Juvenile coho, sockeye, and Chinook salmon may overwinter in open water areas—and to a lesser degree under ice cover—in ERF-IA. Forage fishes may be present in Eagle Bay throughout the year, with the exception of eulachon that return to estuarine waters in the spring.

For analysis of underwater noise impacts, the DTE modeling establishes the minimum buffers needed to prevent the exceedance of fish acoustic effects thresholds during typical high tide conditions, when detonations would only occur on land. Table 5-15 provides a summary of the distances over which noise thresholds in nearby water may be exceeded from a detonation point on land. For reference, the proposed habitat buffers, as described in Section 2.4.4.1, are also provided in Table 5-15. With implementation of these buffers, underwater noise thresholds would not be exceeded within any adjacent waterways during typical high tide conditions when HE munitions would be used.

Table 5-15 Maximum Distances from Detonation Point where Threshold Exceedances to Fish May Occur when Rounds are Detonated on Land

Effect	Species	Threshold (dB re 1 µPa2 s)	Eagle River		Eagle Bay			Otter Creek Complex
			DTE1	DTE2	DTE3	DTE4	DTE5	DTE6
Recoverable injury; SEL	Fish with no swim bladder	216 dB	—	—	—	—	—	—
	Fish with swim bladder	203 dB	—	2 m	—	2 m	—	6 m
Mortality and potential mortal injury; SEL	Fish with no swim bladder	219 dB	—	—	—	—	—	—
	Fish with swim bladder involved in hearing	210 dB	—	—	—	—	—	4 m
	Fish with swim bladder not involved in hearing	207 dB	—	—	—	—	—	4 m

Effect	Species	Threshold (dB re 1 µPa2 s)	Eagle River		Eagle Bay			Otter Creek Complex
			DTE1	DTE2	DTE3	DTE4	DTE5	DTE6
TTS; SEL	All fish	186 dB	18 m	26 m	22 m	26 m	26 m	20 m
Proposed Buffers	—	—	**50 to 130 m**		**500 m**			**50 m**

Notes: For a discussion of the proposed buffers, see Section 2.4.
Key: dB = decibel; ; dB re 1 µPa^2·s = decibels referenced to 1 microPascal; DTE = distance to effect; m = meters; SEL = sound exposure level; TTS = temporary threshold shift.
Source: JASCO 2022, modeled scenario COMB21.

During a typical inundating tide event, water partially floods ERF-IA around Eagle River, and target areas that are normally land (no surface water) can be covered by water, including densely vegetated areas. If ammunition detonation takes place in flooded areas, sound can propagate directly through the water column, resulting in higher underwater noise levels. Firing into areas known to be inundated would be avoided, but ERF-IA has areas that frequently contain shallow vegetated waters. Forward observers will look for observable open water; if no such waters are observed in the intended target area, the live-fire training will proceed. It is possible that the target area will contain areas of flowing or standing water, fully covered by vegetation (typically tall grasses). As long as all rounds are visually observed impacting or bursting, and not landing in water that is too deep to mask impacts/effects, firing will continue as intended. It is possible that small fish, including juvenile salmon, may be present in these shallow wetlands. Training rounds without HE are not expected to result in underwater noise above NMFS thresholds for fish because they contain only a small pyrotechnic charge that discharges out the back of the round casing. However, 155-mm training rounds contain some HE, and use of these rounds during typical inundating tide events could result in adverse noise-related effects to marine mammal prey, as discussed in more detail in Appendix C. After careful analysis, JBER has decided not to fire any rounds containing HE (including the 155-mm training round) into inundated areas during inundating tide events in order to reduce the potential impacts of underwater noise on marine mammals and fish (see the mitigation measures in Section 2.4).

Implementation of the conservation measures described in 2.4 would reduce the potential for noise to impact fish, although some effects may still occur if smaller rounds are fired during inundated conditions. Additionally, because 155-mm rounds would not be fired into the unbuffered portions of the Eagle River relict channel due to space limitations, impacts to fish from these larger rounds in this unbuffered area would be avoided. Although open channels would not be targeted, it is likely that some rounds would land in or near unbuffered channels that support juvenile rearing salmonids, which could lead to acoustic impacts to fish that could adversely affect coho, Chinook, and sockeye salmon at the watershed scale. Selective targeting and other protective measures would be conducted when firing into unbuffered areas. Proposed mitigation described in Section 2.4 includes salmon enumeration studies to obtain information on fish populations and determine whether additional protective measures are needed.

ERF is a dynamic tidal estuary, and areas of shallow inundation may change over time or be obscured by vegetation as described above. In the rare event that rounds are unintentionally detonated in areas of shallow inundation, underwater noise may propagate directly through areas of connected shallow water and exceed the established thresholds over the distances presented in Table 5-16 and Table 5-17.

Table 5-16 Maximum Distances (From the Detonation Point) to Fish Mortality, Potential Mortal Injury, and Impairment (Using $SEL_{24\text{-}hr}$ Thresholds) Due to 155-mm Round[1] Detonation in an Area of Shallow Inundation

Mortality and Potential Mortal Injury Thresholds (dB re 1 µPa2 s)			Impairment Thresholds (dB re 1 µPa2 s)[2]		
			Recoverable Injury		Temporary Threshold Shift
Fish with no swim bladder: >219	Fish with swim bladder not involved in hearing: 210	Fish with swim bladder involved in hearing: 207	Fish with no swim bladder: >216	Fish with swim bladder: 203	All fish: >186
140 m	300 m	370 m	190 m	480 m	1,140 m

Notes:
[1]155-mm rounds have a maximum NEW of 10.93 kg.
[2] Thresholds provided are $SEL_{24\text{-}hr}$ values with units of dB re 1 µPa^2·s.

Key: dB re 1 µPa^2·s = decibels referenced at 1 microPascal; kg = kilogram; m = meter; mm = millimeter; NEW = Net Explosive Weight; $SEL_{24\text{-}hr}$ = sound exposure level 24-hour period.

Source: Popper et al. 2014; JASCO 2022, modeled scenario COMB23.

Table 5-17 Maximum Distances (From the Detonation Point) to Fish Mortality, Potential Mortal Injury, and Recoverable Injury (Using Peak Thresholds) Due to 155-mm Round[1] Detonation in an Area of Shallow Inundation

Mortality, Potential Mortal Injury, and Recoverable Injury Thresholds[2]	
Fish with no swim bladder: >213 (dB re 1 µPa2 s)	Fish with swim bladder: >207 (dB re 1 µPa2 s)
490 m	610 m

Notes:
[1] 155-mm rounds have a maximum NEW of 10.93 kg.
[2] Thresholds provided are unweighted peak thresholds (dB re 1 µPa).

Key: dB re 1 µPa^2·s = decibels referenced at 1 microPascal; kg = kilogram; m = meter; mm = millimeter; NEW = Net Explosive Weight.

Sources: Popper et al. 2014; JASCO 2022, modeled scenario COMB23.

Based on the modeled distances to thresholds, which extend as far as 1,140 meters in the case of the TTS threshold, the proposed habitat protective buffers around Eagle River, Otter Creek, and Eagle Bay would not be adequate to completely protect all fish (marine mammal prey) from effects due to underwater noise propagation in other inundated portions of ERF-IA. In addition, because there are no existing habitat protection buffers around the Garner Creek or Eagle River relict channel complex, fish in these waterbodies would be at risk for adverse noise-related effects. This risk is lower during typical tidal conditions when inundated areas are more easily avoided, but increases during inundating tide events, when much of ERF may be flooded, including areas not known to be inundated. Typical inundating tide events are more common during the summer but may occur throughout the year (Lawson et al. 1995). During these events, fish would be exposed for a temporary period of time (likely a few hours) when the detonation areas are hydraulically connected to waterbodies or flats where they may be present (Taylor et al. 1994; Lawson et al. 1996a, 1996b). The risk during inundated conditions is alleviated through the restriction to only use training rounds that do not contain HE in ERF at those times.

Although implementation of the conservation measures and avoidance and minimization measures described in Section 2.4 would reduce the potential for noise to impact fish, the potential for adverse effects to occur would still exist if rounds are accidentally inundated in shallow waters that contain fish.

There is a low to high risk of exposure of marine mammal prey to underwater noise above thresholds that may have local adverse effects on the prey base for ESA-listed marine mammals, with higher risk present in unbuffered areas that support juvenile salmonid rearing habitat. Most impacts are expected to be limited to behavioral disturbances, that may affect, but are not likely to adversely affect marine mammals, as protective buffers and other measures would be implemented to reduce risk of injury and mortality and confine effects to a limited area of the watershed.

5.6 DIRECT STRIKES TO MARINE MAMMAL PREY (FISH)

The increased numbers of munitions fired into ERF-IA, and training during the spring and summer months when salmonids and groundfish are more likely to be present in ERF waterbodies, would increase the risk of direct impacts to these prey species for ESA-listed marine mammals from an accidental direct strike by a munition and from weapons debris following detonation. Although the risk of direct strike would be relatively low and further minimized by existing and proposed protective measures, some suitable juvenile rearing habitats would not be buffered. A direct hit or shock waves from a munition detonation would likely cause fish mortality or severe injury resulting from damage or rupture of the swim bladder or other internal organs.

There would be no intentional firing into open waterbodies (rivers, streams, intertidal channels, gullies, lakes, ponds, or other areas that may contain water), so there would be a very low risk of rounds landing directly in fish habitat, particularly within buffered areas.

As discussed in Section 5.2, fragments of explosive rounds are thrown at high velocity from the detonation point. Therefore, they have the potential to cause injury or mortality if they enter the water and strike fish. Underwater, the friction of the water would quickly slow these fragments to a point where they no longer pose a threat (85 FR 72312). Only detonation of full HE rounds would result in high-velocity fragmentation or shrapnel. Because firing will be restricted to the use of training rounds during inundating tide events, there is no risk of hazardous fragments striking fish during inundating tide events.

During typical high tide conditions, most fish tend to remain in Eagle River, Garner Creek, Otter Creek, and the Otter Creek intertidal channels, and fish use of gullies or tidal channels associated with Eagle River is low. The identified avoidance and minimization measure that pertains to SDZs (Section 2.4) would avoid the risk of fragment strikes to fish in Eagle Bay, Eagle River, and Otter Creek. In the other waterways of ERF-IA (e.g., Upper Otter Creek, Eagle River relict channel, and Upper Garner Creek), proposed habitat protective buffers (ranging from 50 to 500 meters, depending on location) would help minimize effects to managed fish species from munition fragment strikes, although the HFD for various weapon systems can extend beyond the buffers, particularly for airburst detonations. Water tends to recede slowly in ERF after flooding (allowing fish to escape the flats back into the channels), so the risk of strikes to fish temporarily stranded in ponds in the mudflats would be low.

The likelihood that fish species that serve as prey for marine mammals would be present in the waterbodies in ERF-IA would be highest during the spring and summer months. For salmonids, peak use periods include April to July for juveniles and June to August for adults. It is anticipated that the risk of strikes would be higher for pelagic fish closer to the water's surface (e.g., eulachon) than for benthic groundfish species that are prominently found along the river bottom. Adult salmon tend to migrate along deeper portions of the water column; juveniles may vary, and subyearlings are generally found in deeper waters than yearlings (Carter et al. 2009; Eiler et al. 2022). Thus, the risk of shrapnel striking adult salmonids is expected to be negligible. Although risk of fish species being struck by high velocity fragments is expected to be low, it may occur with a low frequency in inundated areas outside of the main channel of Eagle River and Otter Creek. The occasional event where a fish is struck by a fragment is expected to occur so rarely that fish species that may be marine mammal prey would not experience any population-level effects.

Despite the safeguards that are in place during live-fire training and proposed avoidance and minimization measure to use SDZs to place targets, there may be a low to moderate risk of direct strike of munitions or hazardous fragments to fish, with a higher risk present within unbuffered areas that support salmonid rearing habitat. However, any impacts from direct strikes may affect, not likely to adversely affect overall populations of fish that may serve as prey for marine mammals.

5.7 EFFECTS OF MUNITIONS RESIDUE

5.7.1 Types of Detonations and Munitions Constituents

Munitions that are fired during live-fire training may detonate as intended (high-order [HO] detonation), undergo LO detonation, or become duds (i.e., UXO). HO detonations are the typical outcome of firing weapon systems, leaving only trace amounts of munitions residues at the detonation site (Walsh et al. 2007; Walsh et al. 2011). On impact areas, the greatest quantities of residues are produced by rounds that fail to detonate as designed (Hewitt et al. 2007). LO detonations and duds have the greatest potential to release munitions constituents into waterbodies that may affect marine mammal habitat.

Both traditional munitions and IMs may be used during training activities at JBER. The analysis of potential impacts to marine mammal prey species from munitions constituents is based largely on deposition rates for detonations of traditional munitions rather than IMs. Traditional munitions that have historically been used at ERF-IA, which include explosives such as Composition B, TNT, Research Department Explosive (RDX), and 1,3,5,7-octahydro-1,3,5,7-tetranitrotetrazocine (High Melting Explosive, or HMX), are being phased out in favor of explosives such as Insensitive Munitions Explosives (IMX)-101 and IMX-104, which are more resistant to shock than current formulations and are therefore less prone to unplanned detonations (Walsh et al. 2017).

Studies conducted by CRREL have found that the more insensitive the munitions are, the less efficient they become and the more they deposit residues. Thus, IMs are expected to result in a greater amount of residue from HO and LO detonations, and potentially UXOs, than traditional munitions. Consequently, if IM constituents are toxic, live firing IM rounds into training areas represents a potential environmental risk (Walsh et al. 2017). While HO detonations of traditional munitions only result in trace amounts of residue, HO residue deposition of IMs has been found to equate to approximately 1 percent of the total energetic mass of the projectile (Walsh et al. 2018; Beal et al. 2023). The ratio of traditional munitions to IMs that would be fired at JBER is unknown, and IM residue deposition rates as well as fate and transport processes are still being studied. Therefore, this analysis considers these limitations in assessing potential impacts to marine mammal prey species.

Testing conducted at Alaska military ranges has shown that LO detonations (in addition to UXO) are the major contributor of explosives residues on impact areas (Walsh et al. 2005a, 2005b). However, residue deposition is limited by their rare occurrence. Testing conducted at sites outside of Alaska that used traditional munitions estimate that the rate of LO detonation, or partially exploded ordnance, is very low (between 0.1 and 0.3 percent) (Dauphin and Doyle 2000, 2001), with LO detonations of HE munitions observed at an extremely low frequency of 0.09 percent (Dauphin and Doyle 2000). Although no site-specific data are available, it is anticipated that LO detonation rates at ERF-IA for both traditional explosives and IMs would be similar to these documented rates (B. Hubbard, U.S. Army, personal communication, 28 March 2024). UXO events are more common than LO detonations but occur much less frequently than HO detonations. Contaminant deposition rates from UXOs are comparatively slow, with time frames ranging from years to decades to centuries.

Historical studies have estimated an approximate dud rate for HE rounds during live-fire exercises to be 3.37 percent (Dauphin and Doyle 2000). Although the IM dud rate is not publicly available, it is expected to be lower than that of traditional munitions (<1 percent dud rate) due to recent improvements in munition manufacturing and quality control processes. Dud rates are known to increase as munitions age and are higher for detonations under extreme cold conditions and when delay fuzes (which will not be used at ERF-IA) are used (B. Hubbard, U.S Army, personal communication, 28 March 2024). The 3.37 percent dud rate is also substantially higher than the dud rate observed at ERF-IA at JBER and other ranges in Alaska over the past 20 years. During USACE WP cleanup efforts, a much lower number of UXOs was observed than anticipated by the assumed dud rate (USACE 2005). Additionally, during training, JBER requires units to observe all rounds, to cease fire if a round is not observed, and to report all rounds not observed exploding to Range Control. Incidents with unobserved rounds are investigated. Across the Army, units are required to report UXO during artillery and mortar training. Ammunition lots with reported UXOs are typically pulled from training accounts, which tends to lower the rate of UXOs in training. The 3.37 percent dud rate cited by Dauphin and Doyle (2000) has been used to estimate residue deposition in this analysis because it is an overestimate that considers variability in dud rates from use of IMs.

Munitions constituents include all materials originating from fired munitions, UXO, and discarded or other military munitions, including explosives, propellants, and metals. Munitions constituents also include a variety of secondary explosives, such as pyrotechnics (e.g., smoke-producing agents) (Rectanus et al. 2015). Both HE and non-HE munitions contain a variety of chemical compounds (Table 5-18), as well as metals. However, HE munitions contribute the majority of energetic material into the environment. Both conventional munitions and IMs may be used during training activities at JBER. IMs are explosive weapons or devices that are intentionally designed to be less sensitive to unplanned heat, shock, or impact events in order to reduce the risk of damage to equipment, facilities, and people (Crick 2014). As such, conventional munitions are being phased out in favor of IMs at military installations, including JBER. Although IMs have been approved and deployed in recent years, the literature on the fate and transport of IMs in the environment is rather limited. IMs are expected to result in a greater amount of residue from HO and LO detonations, and potentially UXOs. Studies conducted by CRREL have found that the more insensitive the munitions are, the less efficient they become and the more they deposit residues. In the case where IM constituents are toxic, the live firing of IM rounds into training areas represents an environmental risk (Walsh et al. 2017). As IM formulations continue to replace legacy explosives, the inadvertent release of their chemical compositions into the environment is inevitable where these chemicals will become emerging contaminants (Stein et al. 2023).

Table 5-18 Mortar and Artillery Rounds Proposed for Use at ERF-IA, with Filler Constituents

Caliber	Type	Cartridge	Department of Defense Ammunition Code No.	Filler
Mortar				
60-mm	HE	M720A2	BA44	IMX-104
		M768A1 w/M783 PD fuze	BA45	IMX-104
	ILLUM	M721 w/M766 MTSQ fuze	B647	Illuminant
		M767 w/M776 MTSQ fuze	BA04	Illuminant, Infrared
	FRPC	M769 w/M775 PD fuze	BA15	None (hollow body)
81-mm	HE	M889A4 w/M783 fuze	CA63	IMX-104
		M821A1 w/M734 MOF	C868	Comp B
	ILLUM	M816 w/M772 MTSQ	C484	Illuminant, Infrared
		M853A1 w/M772 MTSQ	C871	Illuminant
	FRPC	M879 w/Practice fuze M751	C875	Hydrocal (inert) (gypsum cement)
120-mm	HE	M934A1 W/MOF M734A1	CA04	Comp B

Caliber	Type	Cartridge	Department of Defense Ammunition Code No.	Filler
		M933A1 w/PD fuze M783	CA44	Comp B
	ILLUM	M930 w/M776 MTSQ	C625	Illuminant
		M983 w/M776 MTSQ	CA07	Illuminant, Infrared
	FRPC	M931 w/Practice fuze M781	CA09	None (hollow body)
Howitzer				
105-mm	HE	M1	C445	Comp B or TNT
		M1 w/o fuze	CA59	IMX-101
	ILLUM	M314 w/o fuze	C541	Illuminant
		M1064 w/o fuze	CA53	Illuminant, Infrared
	Smoke	M84A1 w/o fuze	C479	HC
155-mm	HE	M795	DA54	IMX-101
		M795	D529	TNT
	ILLUM	M1066	DA49	Illuminant, Infrared
		M485	D505	Illuminant
		M1123	DA56	Illuminant, Infrared
		M1124	DA57	Illuminant
	HE Training Projectile	M1122	DA51	Concrete + IMX-101
		M1122A1	DA68	Concrete + IMX-104

Key: Comp B = Composition B; ERF-IA = Eagle River Flats Impact Area; FRPC = Full Range Practice Cartridge; HC = hexachloroethane; HE = high-explosive; ILLUM = Illuminant; IMX = insensitive munitions explosives; mm = millimeter; MOF = Multi-Option Fuze; MTSQ = Mechanical Time Superquick; PD = Point Detonating; TNT = trinitrotoluene.

Source: U.S. Army 2017; S. Tucker, personal communication, 23 January 2023.

5.7.2 Deposition of Munitions Constituents and Breakdown Pathways

Ongoing live-fire training can deposit munitions constituents at the site of detonation, and sediments displaced from craters following detonation may contain munition residues (Walsh et al. 2008). These constituents have potential to result in changes to water and sediment quality if they enter waterbodies, which could affect fish species if present at or near the detonation site. Table 5-19 provides estimates of the total annual deposition of energetic residues (in grams) from HE munitions based on the annual number of rounds that would be fired under the proposed action (see Table 2-2 and Table 2-3).

Calculations that incorporate these assumptions estimate that a total of approximately 226.1 kg of HE munitions residue would be deposited annually at target sites as a result of live-fire training. Residue deposition would occur in both the existing ERF-IA (211.3 kg) and the proposed expansion area (14.8 kg), as shown in Table 5-19. Targets would be placed in locations outside of and away from proposed protective buffers (Section 2.4.4.1). It was assumed that the total area in the existing ERF-IA where munitions could detonate would encompass 1,568 acres (outside of the buffers), as well as approximately 350 acres of the proposed expansion area. It is estimated that most of this munitions residue would be contributed by UXOs (216 kg), with lesser amounts from LO detonations (10.4 kg) and HO detonations (0.021 kg). This is an estimated increase of approximately 79.5 kg over deposition under current firing conditions.

Several factors must be considered when evaluating these deposition rates. First, the residue estimates were developed based on use of traditional munitions. Secondly, the analysis incorporates the approximate dud rate for traditional HE rounds (3.37 percent) (Dauphin and Doyle 2000), which is higher than the anticipated dud rate during live-firing activities at JBER. Lastly, the total masses in Table 5-19 do not account for biodegradation or natural attenuation (i.e., flushing) of residues. Thus, the residue deposition values presented should be used to compare the proposed action to baseline conditions rather than predicting deposition quantities that would occur following resumption of all-season live firing in ERF-IA.

From 2012–2017, the Strategic Environmental Research and Development Program (SERDP) conducted research at various firing ranges in cold weather climates in the United States and Canada, including ERF-IA, to evaluate deposition of HE residues and dissolution of HE compounds from the detonation of IMs (Walsh et al. 2017). CRREL has also conducted research at JBER to evaluate IM residue deposition from 2017–2022 (Walsh et al. 2018; Beal et al. 2023). Sampling on snow has proven to be the most reproducible method for energetics residues characterization research because residues are more easily detected. Four IM HE formulations were tested: Piccatinny Arsenal Explosive (PAX)-21, PAX-48, IMX-101, and IMX-104; the latter two are proposed for use at ERF-IA. Walsh et al. (2017) found that detonation of IMX-101 and IMX-104 rounds resulted in high-residue deposition of 3-nitro-1,2,4-triazol-5-one (NTO) and nitroguanidine (NQ), which are both highly soluble compounds. The PAX-21 research indicated significant deposition of ammonium perchlorate; however, use of these munitions is now restricted, and they would not be used at ERF-IA under the proposed action.

Residue deposition rates from HO detonations of IMX mortar cartridges are greater than their traditional counterparts, which typically deposit less than 1–9 milligrams per cartridge each of RDX and TNT (Beal et al. 2023). While NTO has relatively low toxicity, the high water solubility and low soil affinity of NTO and NQ, along with high deposition rates from the studied mortar munitions, make it likely that NTO will reach ground and surface water at detectable concentrations around where IMX cartridges are detonated (Beal et al. 2023). Deposition rates of RDX and 2.4-dinitroanisole (DNAN) are generally minor (12–60 milligrams per cartridge), and improved fuze performance (i.e., decreased LO rates) for newer munitions may lead to an overall decrease in deposition of these compounds relative to older traditional munitions (Beal et al. 2023). A full summary of study findings for characterization of residues from the detonation of IMs is available in the EFH Assessment (JBER 2024b).

Table 5-19 Estimated Total Annual Munitions Use and Failure Rate at ERF-IA under Proposed Action

Munitions Information			Munitions Residue Impacts							
			Number of Rounds/Detonations				Munitions Residue Deposition (grams)			
HE Munitions Type[1]	Total Energetic Mass per Round[2]	Total Energetic Residue per HO Detonation[3]	Annual Number of Rounds Fired[4]	Annual Anticipated Number of LO Detonations[5]	Annual Anticipated Number of Dud Detonations[6]	Annual Anticipated Number of HO Detonations[7]	Annual Residue Deposition from HO Detonations[8]	Annual Residue Deposition from LO Detonations[9]	Annual Residue Deposition from Dud Detonations[10]	Total Annual Deposition of Energetic Residues[11]
Existing ERF-IA										
60-mm Mortar	370	0.000076	700	2	74	624	0.05	370	27,380	27,750
81-mm Mortar	969	0.0094	400	1	25	374	3.52	485	24,225	24,713
120-mm Mortar	2,960	0.021	552	1	19	532	11.17	1,480	56,242	57,734
105-mm Howitzer	2,086	0.00027	1,988	1	35	1,952	0.53	1,043	73,010	74,054

155-mm Howitzer Training Round	808	0.000036	900	1	3	896	0.03	404	2,424	2,828
155-mm Howitzer	6,936	0.00031	144	1	3	140	0.04	3,468	20,808	24,276
ERF Total	14,129	0.031	4,684	7	159	4,518	15.34	7,250	204,089	211,354
Proposed Expansion Area										
60-mm Mortar	370	0.000076	336	1	15	320	0.024	185	5,550	5,735
81-mm Mortar	969	0.0094	192	1	1	190	1.79	485	969	1,455
120-mm Mortar	2,960	0.021	192	1	1	190	3.99	1,480	2,960	4,444
105-mm Howitzer	2,086	0.00027	624	1	1	622	0.168	1,043	2,086	3,129
155-mm Howitzer Training Round	808	0.000036	0	1	3	0	0	0	0	0
155-mm Howitzer	6,936	0.00031	0	1	3	0	0	0	0	0
Expansion Area Total	14,129	0.031	1,344	6	24	1,322	5.97	3,193	11,565	14,764
Proposed Project Totals										
Totals	NA	NA	6,028	13	183	5,840	21.31	10,442	215,654	226,118

Notes: Mass and residue in grams.
[1] All munitions in this analysis used Comp B as filler.
[2] Walsh 2007, Table 1.
[3] Walsh 2007, Table 3.
[4] Section 2.0 provides estimated annual rounds and munitions that would be fired.
[5] LO rounds estimated to be 0.09 percent of total round fired, following observations from Dauphin and Doyle 2000.
[6] Dud rounds estimated to be 3.37 percent of total rounds fired, following observations from Dauphin and Doyle 2000.
[7] Annual anticipated number of HO detonations is assumed to be the total allotted rounds minus the anticipated LO and dud rounds.
[8] Estimated as the product of anticipated HO detonations and the observed resultant energetic residue from Walsh 2007, Table 3.
[5] Residue from LO rounds assumes 50 percent of energetic mass is consumed and 50 percent is deposited as residue.
[10] Dud rounds assume 100 percent of energetic mass is deposited as residue.
[11] Total residue is estimated as the sum of residue from HO, LO, and dud rounds.

Key: Comp B = Composition B; ERF-IA = Eagle River Flats Impact Area; HE = high-explosive; HO = high-order; LO = low-order; mm = millimeter; NA = not applicable.

Following the initial discharge of munition contaminants into the environment, their fate and degradation in soil and groundwater are dependent on a variety of environmental factors and conditions, including the contaminant characteristics, subsurface geochemistry, and microbial community. Fate and transport processes link the deposition of contaminants at a source with the resultant environmental concentrations to which fish and other receptors can be exposed. In the absence of modeling to predict exposure concentrations, information about transport and transformation of contaminants can provide information about their fate following deposition.

Attenuation processes cause the bioavailability of a given contaminant to decrease over time, reducing its potential to harm fish and other organisms. Attenuation processes can be divided into three main categories: physical, chemical, and biological pathways (Table 5-20). Major breakdown pathways for various munition constituents include biodegradation, photodegradation, dissolution, and sorption. Munition constituents are subject to breakdown pathways at different rates depending on their properties. Further, environmental conditions at ERF-IA influence breakdown processes. For example, much of ERF supports an anaerobic environment (with organic matter) that can help break down munitions constituents. Photodegradation can be a significant attenuation pathway for explosives and propellants (Rectanus et al. 2015) but would play a larger role during summer than winter due to seasonal light fluctuations at the site. IM compounds may undergo phototransformation, but it is not a significant pathway due to faster dissolution processes Predominant breakdown processes for various munitions constituents used at ERF-IA are summarized in Table 5-20.

Table 5-20 Attenuation Pathways Applicable to Munitions Contaminants in Soil and Groundwater

Pathway	Mechanism	Description
Physical	Advection	Movement of contaminant within groundwater
	Diffusion	Mass transfer of contaminant into or out of matrix due to concentration gradient
	Phase Transfer (Dissolution)	Dissolution (solid to aqueous phase) and/or volatilization
Chemical	Sorption	Reversible interactions between aquifer matrix and contaminant
	Abiotic Transformation	Reactions between mineral and contaminant
	Photodegradation (Photolysis)	Transformation of contaminant due to sunlight exposure in surface soils only
Biological	Biodegradation (Microbial Processes)	Biotically mediated reactions
	Biogeochemical Transformation	Coupled biotic and abiotic reactions

Source: Rectanus et al. 2015.

The solubility of most IM constituents is higher than that of TNT and cyclotrimethylenetrinitramine (Research Department Explosive, or RDX), increasing the likelihood that they could reach groundwater (Dontsova et al. 2014, 2022). Further, residues deposited on ERF may be transported in the water column or by sediment transport into Eagle River and Eagle Bay during ERF typical inundating tide events.

For metals, sorption is a significant attenuation pathway. Sorption takes place when a metal is attracted electrically to charged groups in minerals or solid organic materials. Copper has a strong affinity for the surfaces of iron oxides and hydroxides, clays, sulfides, and organic matter, and is more strongly sorbed to mineral substrates than zinc, nickel, and cadmium. Zinc readily sorbs to sediments and suspended solids such as hydrous iron and manganese oxides, clay minerals, and organic matter. The sorption affinity of zinc increases with increasing pH and decreasing salinity. Thus, zinc is expected to sorb better to sediments in groundwater than to tidally influenced sediments.

This analysis assumes that all residue is deposited onto soils and remains in the environment. However, degradation of munitions residue is expected to occur and is dependent on a variety of environmental factors and conditions. Due to the variety of breakdown pathways and anaerobic environment (with organic matter) that can help degrade munitions constituents, it is anticipated that many residues will break down in a matter of days to months after environmental exposure (Ringelberg et al. 2003). However, some LO and UXO residues are not available for degradation until dissolved, which may range from days to years depending on particle size (Beal and Bigl 2022), explosive solubility, and exposure to water; breached UXO can continue to leak for decades or centuries (Taylor et al. 2011). Due to the uncertainties and complexities associated with munition detonations, breakdown pathways, and site conditions, it is impossible to know how much munitions residue would be bioavailable at any given time and then apply half-life estimates to determine when residue would degrade over time. It is conceivable that degradation of residues occurs more rapidly than assumed by the analysis, and it is likely that many residues are flushed out into Eagle Bay and diluted to non-toxic levels. However, the amount of residue flushed out and contaminant concentration levels anticipated in Eagle Bay cannot be determined without a comprehensive ecotoxicological analysis.

5.7.3 Exposure and Toxicity of Munitions Constituents to Marine Mammal Prey Species

Fish may be exposed to contaminants in munitions residues by direct or incidental ingestion and by dermal contact (USEPA 2021). Exposure to contaminants in the water column could occur via direct uptake from water through gills and accumulation in muscle, fat, and other tissues. Bottom-dwelling species (i.e., groundfish) can be directly exposed to contaminants in sediments, or species may ingest contaminated benthic prey items. If fish species consume contaminated prey, there is a potential for contaminants to be transferred up the food chain. While it is possible that salmonids could access areas adjacent to an LO crater or leaching UXO residue when the flats are flooded after a firing event has concluded, fish species could be exposed to munition residues (originating anywhere on the flats) that enter waterbodies through surface water or sediment after flooding events or through groundwater migration.

A substantial body of sediment and water quality data has been collected at ERF-IA over the past 40 years that provides information on presence of munitions constituents with the potential to affect fish. Past studies of environmental fate and toxicity of munitions at JBER have focused on traditional explosives, rather than the newer IMs. Initial studies in the 1980s and early 1990s focused on identifying the cause of waterfowl mortality (which turned out to be WP), and much of the sampling was limited to ponds, marshes, craters, and areas near the OB/OD pad, which was a known source of contamination. However, sampling in craters can provide a good indication of contaminant presence in ERF-IA because these areas are directly impacted by HE and other munitions. Environmental samples typically show low concentrations of munitions compounds in water and sediments (on the order of nanograms/liter and micrograms per kilogram, respectively), and ecological risk appears generally low. Nonetheless, recent work demonstrates the possibility of sub-lethal genetic and metabolic effects (Beck et al. 2018). It is possible that some energetic munitions compounds that would be used during live-fire training, such as TNT, RDX, 1,3,5,7-octahydro-1,3,5,7-tetranitrotetrazocine (High Melting Explosive), and NQ (and their degradation products), may be harmful to fish and macroinvertebrates at high concentrations (Pichtel 2012; Lotufo et al. 2013; Koske et al. 2020).

Past soil and water testing have not detected conventional munitions residues at significant levels in ERF-IA. With the exception of WP (which is no longer being used at JBER), munitions constituents have only been detected at low levels at firing points (where large quantities of propellant has been burned) or in the immediate vicinity of LO munition (generally explosives) impact sites in ERF-IA (Racine et al. 1992; USAEHA 1994; CH2M Hill 1997; Walsh et al. 2006, 2008). These findings are consistent with studies that have found generally low numbers of munitions residues at military weapon and training installations in the U.S. and throughout the world (Lotufo et al. 2017). However, it should be noted that these studies were completed before IMs were being used at JBER.

The presence of munitions-related compounds has been studied at 31 military ranges in the U.S. and in Canada, including at ERF-IA (Jenkins et al. 2007; Walsh et al. 2010). Lotufo et al. (2013) reviewed the fate and effects of several munitions constituents used at JBER and found that most constituents rapidly degraded in aqueous exposure systems, showed a significant binding affinity with organic matter, and were unlikely to result in biological effects to fish; however, the study states that verification of this conclusion should be pursued by determining site-specific exposure risk.

Rounds containing IMX-101 or IMX-104 have not historically been fired onto ERF-IA as part of training activities, and therefore the environmental fate of those compounds and their associated transformation products in this environment is not well known. IMs were constructed to resist external stimuli such as bullet impact or fire, and because of that, they resist unintentional detonation. This insensitivity has resulted in a less-efficient detonation, differential performance among the formulation components, and increased residues caused by disposal of UXO by a blow-in-place procedure (Walsh et al. 2017).

Ecotoxicology assays for toxicity effects of the IM constituents and various breakdown products on aquatic receptors (fish and invertebrates) are summarized in the EFH Assessment. Compounds identified as having a moderate or high toxicity rating to fish include 2,4-dinitrophenol, nitrite, ammonia, and cyanamide. Additionally, 2,4-dinitroanisole (DNAN), nitrate, and guanidine are moderately toxic to fish food/prey. The dose needed to kill 50 percent of *Daphnia pulex* is far lower for TNT than other IM constituents, which suggests that some IM compounds may be less toxic than TNT (Moores et al. 2021; JBER 2024b).

Other ecotoxicity studies suggest that the parent compound DNAN, 19 methoxy-nitrophenols, methoxy-nitroanilines, and the other two products (2,4-dinitrophenol and 20 methoxy-dinitrophenol) could be harmful to fish and daphnids if present in high concentrations (Qin et al. 2021). NTO and its breakdown product 3-amino-1,2,4-triazol-5-one have been found to cause swimming behavior abnormalities at low concentrations; the reductive biotransformation of NTO could enhance or lower its toxicity according to the target organism (Madeira et al. 2018). Quick dissolution behavior of NTO and NQ indicates that these water-soluble constituents could easily migrate with rainfall. Because they have extremely low affinity for soil particles, these constituents have a tendency to reach groundwater, raising concerns for potential environmental contamination. Further studies are needed to evaluate both dissolution and toxic effects to better understand the environmental behavior of IMX and other IM constituents.

As described above, previous testing has shown that constituents of traditional munitions are not accumulating in or migrating out of ERF-IA into local waterbodies in measurable quantities. However, it is possible that degradation occurs more rapidly than predicted because ERF-IA is a tidal estuary. Many residues are likely to be flushed out of the impact area and into Eagle Bay in runoff and subsequently diluted. However, it should be noted that firing during ice-free months is expected to result in more rapid removal of munitions constituents from the environment. When ice is not present, munitions residues have potential for more rapid transport out of the estuary than during conditions when residues are deposited on top of ice surfaces. This is particularly the case when residue deposition areas are hydrologically connected to Eagle River and Eagle Bay because constituent residence times would be reduced on the surface of the flats. Residue deposited on ice/snow during winter training does not all flush away to Knik Arm when spring arrives (as the thaw occurs slowly) and may adhere to sediments; therefore, it is likely to be retained in the estuary for longer periods than residue deposited during ice-free conditions.

It is possible that salmonids in close proximity to an LO crater or degrading UXO could experience adverse effects, particularly if they consume contaminated prey items within these areas. There is a low risk of munition constituents entering Eagle River or Otter Creek at levels that could result in sublethal effects to juvenile salmonids. Adult salmon move through ERF-IA via Eagle River and Otter Creek channels to upstream spawning destinations outside of ERF-IA and are not known to spawn in the ERF portion of either Eagle River or Otter Creek. Juvenile salmonids that use Eagle River, the Otter Creek complex, or intertidal channels and backwater ponds for rearing could temporarily migrate onto mudflats and wetlands adjacent to the river and stream channels for brief periods when the flats are inundated. However, flooding is more likely to occur during August–October when fewer juvenile salmonids are present, and they are not expected to linger within a crater for extended periods because flooding conditions are ephemeral.

Protective buffers and selective targeting will also reduce the potential for munitions contaminants to enter waterbodies where marine mammal prey species could be exposed. The protective buffers shown in Figure 2-4 would prevent release of munitions directly into most ERF-IA waterbodies, although chemical constituents could still enter buffered waterbodies through surface water runoff or groundwater infiltration. The Army would place targets on higher ground within sensitive unbuffered areas, such as the Eagle River relict channel complex and Upper Garner Creek, to reduce risk of munition detonation in these stream channels. However, target areas would still overlap small tributaries, so it is likely that some munitions and contaminants would be released either directly into channels or indirectly through transport and migration pathways. Avoidance and minimization measures (Section 2.4) would be implemented to further reduce risk of contaminant exposure to managed species.

Based on a review of previous studies, the anticipated low percentage of LO and UXO events, the large firing area (existing ERF-IA and the proposed expansion area), the variety of contaminant breakdown pathways that are expected to occur, and the intermittent flushing of munitions residues from ERF-IA, it is anticipated that even with increased firing under the proposed action, the risk of munitions contaminants to affect prey species would be low due to 1) the uncertainty and often contradictory results about breakdown efficiencies and toxicological effects from IM on fish and aquatic invertebrates, and 2) dynamic processes in ERF that could mobilize and transport IM and other conventional munitions into year-round rearing habitats for sensitive juvenile coho and other salmonids. It is impossible to predict potential exposure and effects on managed fish species and their prey base without water quality monitoring, fish tissue sampling, or a site-specific ecotoxicology study. An adverse effect to a juvenile salmon could result if it ingests a single invertebrate that has consumed munition residues, and that possibility exists under the proposed action.

5.7.4 Bioaccumulation of Contaminants in Marine Mammal Prey (Fish)

Bioaccumulation is the process in which a chemical substance is taken up by an organism by all routes of exposure (e.g., from diet and across membranes like the gills). Biomagnification refers to an increase in the concentration of a substance up the food chain (e.g., fish to marine mammals). There would be a potential for bioaccumulation of munition constituents in marine mammal prey species under the proposed action. Beluga whales are opportunistic feeders known to prey on a wide variety of animals (NMFS 2008a), including many species of fish found in Eagle Bay and Eagle River. The bioaccumulation potential of munitions constituents and their transformation products are summarized in Table 5-21.

Between 2007 and 2011, Army personnel collected 102 tissue samples from 15 fish species captured in the tidally influenced portions of Eagle River, and they were analyzed for the presence of munitions residues. (Garner et al. 2008; USACHPPM 2008a, 2008b, 2009; USAPHC 2011). The concentration of munitions residues in the samples did not exceed the detection limit in any of the fish tissue samples.[17] In other words, no munitions residues were detected. The results of this study indicate that munitions residues are not bioaccumulating in the fish that use the tidally influenced portions of Eagle River. Many of these fish were captured in the mouth of Eagle River, at its juncture with the waters of Knik Arm. Given that several of the analyzed species were primarily marine species (e.g., saffron cod, starry flounder), the results suggest that fish in Knik Arm are also not bioaccumulating munitions residues. Additionally, CH2M Hill (1998) found no significant accumulations of WP in fish during sampling conducted as part of the initial CERCLA investigations at ERF. However, it should be noted that these previous studies were conducted when seasonal firing restrictions were in place. Thus, they do not account for exposure to fish species during all-season live firing scenarios or the use of IMs, which may present an increased toxicity and bioaccumulation risk to marine mammal prey species. Further, emerging research has shown that some toxic explosive compounds (e.g., TNT and degradation products) from underwater munitions disposal sites are accumulated by flatfish and other aquatic organisms in the Baltic Sea (Koske et al. 2020; Beck et al. 2018, 2021; Barbosa et al. 2023). Thus, there remains some uncertainty about ecotoxicity risk and bioaccumulation potential from underwater exposure to munitions constituents.

Because WP munitions are no longer being used in ERF-IA and WP cleanup efforts and capping are complete, the potential for future impacts to fish from WP contamination is low. There would be a very low risk of a gravel cap being struck by an errant round. The locations of gravel caps have been mapped and would not be intentionally targeted during firing outside of winter ice conditions. Most gravel-capped areas are underwater during months when ERF is not frozen, and no targets would be placed on them. If a gravel-capped area were struck during a misfire, it is expected that the risk of releasing sequestered WP

[17] One sample of juvenile coho muscle did show elevated levels of RDX; however, a duplicate sample from the same fish was sent to the lab and returned with levels of RDX below the detection limit. The assumption was made that the initial sample had been contaminated sometime between the field and the lab.

would be low, as WP is generally not known to still exist throughout the impact area. In addition to avoiding gravel caps during training, mitigation has been identified in the Draft EIS (JBER 2024a) to prevent exposure of any WP that may be present, including no use of delay fuzes to minimize ground penetration, making GIS-based tables and a map of remediated areas available to the units that train at ERF-IA, and if an errant round strikes a gravel cap, assuming that damage has occurred and placing gravel in the affected area when practicable. Additionally, it is unlikely that WP exposures would affect fish because they rarely use the flats and ponded areas where the caps are situated. Although some reports have indicated that WP can moderately bioaccumulate in fish (Davidson et al. 1987; Rivera et al. 1996; Sciences International 1997a), studies at ERF have not detected it in high concentrations in fish, likely because there is not a strong mechanism for exposure.

Based on the low bioaccumulation potential for most munitions residues (Table 5-21) and the highly reducing conditions present in ERF, as well as evidence from the Eagle River fish tissue contamination studies that munitions residues are not entering the food chain, the risk of impacts to marine mammal prey species from bioaccumulation appears to be low. However, site-specific sampling would be needed to further evaluate the potential for bioaccumulation at ERF-IA (and has been proposed as a avoidance/minimization measure in Section 2.4). The proposed all-season firing would result in an increased risk of exposure of munitions residue to marine mammal prey species, but the protective measures described in Section 2.4.4 (e.g., habitat protective buffers, tidal firing restrictions, avoiding capped areas, and selective targeting within unbuffered areas) and the avoidance and minimization measures described in Section 2.4, would reduce risk of contaminants entering waterbodies where they could potentially accumulate in tissues of marine mammal prey species.

Based on a review of previous studies, the anticipated low percentage of LO and UXO events, the large firing area (existing ERF-IA and the expansion area), the variety of contaminant breakdown pathways that are expected to occur, the low risk of bioaccumulation, and the intermittent flushing of munitions residues from ERF-IA, it is anticipated that even with increased firing under the proposed action, the risk of munitions contaminants adversely affecting marine mammal prey species at a population scale is insignificant.

Table 5-21 List of Proposed Munitions Constituents, Transformation Products, Breakdown Pathways, and Chemical Properties Relevant to EFH and Federally Managed Fish Species

Munition Type	Chemical Name[1]	Transformation Products	Mechanism of Transformation	References	Water Solubility (Sw) @ 25°C in mg/L[2]	Soil Organic Carbon Partition Coefficient[3] Koc (L/kg)(log Koc)	Octanol-water Partition Coefficients (Kow) Log Kow at 25°C[4]	References[5]	Bioaccumulation Potential	References
Explosives	**DNAN (**2,4-dinitroanisole)	See breakdown products below	See below	Reviewed in Hawari et al. 2015	213±12	364±8	1.58 ± 0.01	Hawari et al. 2015	Although DNAN is more soluble than TNT, its lower hydrophobicity and tendency to form aminoderivatives that sorb irreversibly to soil contribute to make it less toxic than the traditional explosive TNT.	Hawari et al. 2015
		2,4-DNP (2,4-dinitrophenol)	Transiently formed by microbial transformation. Significant or complete biodegradation of DNAN after 9 days under aerobic conditions; microbial transformation under aerobic conditions.	Richard and Weidhaas 2014; Fida et al. 2014	2,790 at 20 °C (experimental)	363.8 (2.561)	1.67 (experimental)	Royal Society of Chemistry 2020		
		MENA (2-methoxy-5-nitroaniline)	Reductive anaerobic biotransformation with H2 added as co-substrate; microbial transformation by aerobic bacteria.	Olivares et al. 2013; Liang et al. 2013	252±8	316±32	1.47± 0.01	Hawari et al. 2015		
		DAAN (2,4-diaminoanisole)	Microbial transformation by anaerobic bacteria with ethanol as primary substrate; reductive anaerobic biotransformation with H2 added as co-substrate.	Platten et al. 2010; Olivares et al. 2013	>40,000	<0.5	< -1	Hawari et al. 2015		
		4-ANAN (4-amino-2-nitroanisole)	Nitroreduction of DNAN	Schroer 2018	4,430±60	240±12	0.80 ± 0.01	Hawari et al. 2015		
		Nitrate	Phototransformation under sunlight.	Rao et al. 2013	90,900	14.3 (1.155)	0.21	Royal Society of Chemistry 2022		
		Nitrite	Phototransformation under sunlight.	Rao et al. 2013	119,600	23.74 (1.376)	0.06	Royal Society of Chemistry 2022		
		8 additional breakdown products[6]	Reductive anaerobic biotransformation with hydrogen added as co-substrate.	Olivares et al. 2013	4,852[7]	44.85 (1.652)[4]	-0.30	Royal Society of Chemistry 2022		
	NTO (3-nitro-1,2,4-triazole-5-one)	See breakdown product below	See below	Richard and Weidhaas 2014	1,000,000	50.58 (1.704)	-2.99	Royal Society of Chemistry 2022		
		1,2-dihydro-3H-1,2,4-triazol-3-one	Transiently formed by microbial transformation. Complete biodegradation of NTO after 9 days under anaerobic conditions.	Richard and Weidhaas 2014	885,000	109.2 (2.038)	-2.52	Royal Society of Chemistry 2022		
	RDX (cyclotrimethylenetrinitramine)	N/A	May biodegrade in water and soil under anaerobic conditions. Not significantly retained by most soils and can leach to groundwater from soil. Photolysis tends to degrade RDX relatively quickly in surface waters.	USEPA 2017a	59.7	1.80	0.87	USEPA 2017a	RDX has a low bioconcentration potential in aquatic organisms.	USEPA 2017a
	HMX (cyclotetramethylene-tetranitramine)	Nitrite, nitrate, formaldehyde, l,l-dimethylhydrazine	HMX does not evaporate or bind to sediments to any large extent. Sunlight breaks down most of the HMX in surface water into other compounds, usually in a matter of days to weeks. A small amount of HMX may also be broken down by bacteria in the water.	Sciences International 1997	5	30-290	0.16	NCBI n.d.-a	Tissue residues found to be lower than environmental concentrations. Elimination half-lives for marine species are relatively low, indicating that release from exposure would result in fast depuration and likely recovery from toxic effects.	Lotufo et al. 2013

Munition Type	Chemical Name[1]	Transformation Products	Mechanism of Transformation	References	Water Solubility (Sw) @ 25°C in mg/L[2]	Soil Organic Carbon Partition Coefficient[3] Koc (L/kg)(log Koc)	Octanol-water Partition Coefficients (Kow) Log Kow at 25°C[4]	References[5]	Bioaccumulation Potential	References
	TNT (2,4,6-Trinitrotoluene)	1,3,5-Trinitrobenzene (1,3,5-TNB) via photolysis; various other products via biological degradation.	Soils have a high capacity for rapid sorption of TNT. Under anaerobic conditions, TNT is usually transformed rapidly into its degradation byproducts. Once released to surface water, TNT undergoes rapid photolysis.	USEPA 2017b	130 at 20°C	300 (est.)	1.6	USEPA 2017b	TNT is not expected to bioconcentrate to high levels in the tissues of exposed aquatic organisms or bioaccumulate in fish.	Houston and Lotufo 2005; USEPA 2017b
	Ammonium Picrate	Picric acid and derivatives	Very soluble in water. Like TNT, degrades through reduction and microbes and biodegradation, with transformation rates highest in fine-grained sediment.	Lotufo et al. 2013	200,000	N/A	N/A	Clausen et al. 2006	No data for the bioaccumulation of picric acid in marine fish and invertebrates were found; however, based on the low log 5-59las the potential for bioconcentration in aquatic organisms is considered low.	Lotufo et al. 2013
Propellants	**DNT** (2,4-Dinitrotoluene)	N/A	Slight tendency to sorb to sediments based on relatively low organic-carbon partition coefficients; unless broken down by light, oxygen, or biota, expected to remain in water for long periods of time because of its relatively low volatility and moderate water solubility.	USEPA 2017c	270	1.65 (log)	1.98	USEPA 2017c	Not expected to bioaccumulate significantly in animal tissue.	ATSDR 2016, cited in USEPA 2017c
	NQ (Nitroguanidine)	See breakdown products below	See below	Reviewed in Mirecki et al. 2006	4,000	25.7 (1.41)	-0.83 to 0.156	Reviewed in Mirecki et al. 2006	No data for bioaccumulation of NQ in marine fish and invertebrates were found; however, based on the low log 5-59las, the potential for bioconcentration in aquatic organisms is considered low.	Lotufo et al. 2013
		Nitrourea	Transiently formed by aerobic microbial transformation. Microbial transformation by aerobic bacteria (*Variovorax* strain VC1). Nitrourea is unstable in water and degrades to ammonia, nitrous oxide, and carbon dioxide.	Richard and Weidhaas 2014; Perreault et al. 2012	140,900	5.392 (0.732)	-1.65	Royal Society of Chemistry 2022		
		Nitrosguanidine	Photolysis	Reviewed in Mirecki et al. 2006	1,000,000	70.48 (1.848)	-1.76	Royal Society of Chemistry 2022		
		Hydroxyguanidine	Photolysis	Reviewed in Mirecki et al. 2006	1,000,000	38.21 (1.582)	-2.72	Royal Society of Chemistry 2022		
		Guanidine	Photolysis	Reviewed in Mirecki et al. 2006	1,840 at 20°C (experimental)	19.78 (1.296)	-1.630	Royal Society of Chemistry 2022		
		Nitrite	Photolysis – end product	Reviewed in Mirecki et al. 2006	119,600	23.74 (1.376)	.06	Royal Society of Chemistry 2022		
		Nitrate	Photolysis – end product	Reviewed in Mirecki et al. 2006	90,900	14.3 (1.155)	0.21	Royal Society of Chemistry 2022		
		Ammonia	Photolysis – end product	Reviewed in Mirecki et al. 2006	482,000 at 24°C (experimental)	14.3 (1.155)	-1.38 (experimental)	Royal Society of Chemistry 2022		
		Cyanamide	Microbial transformation under microaerophilic conditions.	Spanggord et al. 1987	500,000 (experimental)	4.5 (0.653)	-0.82 at 20 °C (experimental)	Royal Society of Chemistry 2022		
	NG (Nitroglycerin)	Calcium nitrate and calcium nitrite	Moderate aqueous solubility. Alkaline hydrolysis by calcium hydroxide. NG	Reviewed in Mirecki et al. 2006	1,950	1.6-2.8 (log)	1.6-2.8	Reviewed in Mirecki et al. 2006	Although no data for the bioaccumulation of NG in marine or	Lotufo et al. 2013

Munition Type	Chemical Name[1]	Transformation Products	Mechanism of Transformation	References	Water Solubility (Sw) @ 25°C in mg/L[2]	Soil Organic Carbon Partition Coefficient[3] Koc (L/kg)(log Koc)	Octanol-water Partition Coefficients (Kow) Log Kow at 25°C[4]	References[5]	Bioaccumulation Potential	References
			disappeared within 1 week in sterile, anoxic solutions with mineral salts, presumably by an abiotic, aqueous reaction.						fish and invertebrates were found, based on the low log 5-60las the potential for bioconcentration in aquatic organisms is considered low.	
	NC (Nitrocellulose)	N/A	Will not dissolve or hydrolyze in aqueous solutions except with strong base (sodium hydroxide or ammonia) and high temperatures.	Reviewed in Mirecki et al. 2006	immiscible	N/A	N/A	Reviewed in Mirecki et al. 2006	Studies with NC indicated no toxicity at concentrations up to 1000 mg/L when tested with several species of fish and invertebrates. Lack of toxicity of NC is likely a result of its insolubility in water.	Lotufo et al. 2013
	Ammonium Perchlorate	Perchlorate anion	Highly soluble in water, and relatively stable and mobile in surface and subsurface aqueous systems.	USEPA 2014	200	N/A	-5.84	USEPA 2014	Bioconcentration of perchlorate appears to be low for aquatic and terrestrial species	ATSDR 2008
Pyrotechnics (Smoke agents)	**HC** (hexachloroethane)	N/A	Evaporation or broken down by microscopic organisms. Breakdown more quickly in anaerobic soils.	ATSDR 1997	50 @20°C	1,380 to 2,360	4.14	NCBI n.d-b	Slight tendency to build up in fish, but they tend to break it down quickly.	ATSDR 1997
Other	**HYDROCAL** (inert) (gypsum cement)	Calcium and sulfate ions	Calcium sulfate dissolves in water	USG 2017	1,500-4,000	N/A	N/A	USG 2017	Toxic to fish due to its high alkalinity (pH > 12). Discharge of large quantities directly into waterways could kill fish. Bioaccumulation not expected.	USG 2008

Notes:
[1] IMX-101 (TNT IM replacement) = DNAN, NTO, and NQ; IMX-104 (Comp B IM replacement) = DNAN, NTO, and RDX.
[2] Water solubility is measured in mg/L, the weight of constituent (in milligrams) that will dissolve in one liter of water (L).
[3] Koc = soil organic carbon distribution coefficient. Greater Koc values indicate the tendency for a hydrophobic organic solute to sorb to organic content in soil. Low Koc values indicate limited sorption (Mirecki et al. 2006).
[4] All 5-60las values from the Royal Society of Chemistry website (http://www.chemspider.com/) are estimated, unless otherwise noted.
[5] All data from the Royal Society of Chemistry website are generated using the U.S. Environmental Protection Agency's EPISuite™. Values are estimated using models unless otherwise noted.
[6] Additional DNAN breakdown products include: 3,3'-Diamino-4,4'dimethoxy-azobenzene, 3,3'-Diamino-4,4'dimethoxy-hydrazobenzene, N-(5-amino-2-methoxyphenyl) acetamide, 5-((3-Amino-4-methoxyphenyl)5-60iazinyl)-2-methoxy-N-methyleneaniline, 2-Methoxy-5-((4-methoxy-3-(methylamino)phenyl)5-60iazinyl)-methyleneaniline, 3,3'-Diamino-4-hydroxy-4'-methoxy-azobenzene, and 3,3'-Diamino-4-methoxy-hydrazobenzene.
[7] Value for N-(5-amino-2-methoxyphenyl) acetamide.
Key: °C = degrees Celsius; Comp B = Composition B; EFH = essential fish habitat; est. = estimated; kg = kilogram; L = liter; mg = milligram; N/A = not applicable; Sw = water solubility.

5.8 CUMULATIVE EFFECTS

As defined in the ESA, cumulative effects are future state, Tribal, local, or private activities—not involving federal actions—that are reasonably certain to occur in the action area (USFWS and NMFS 1998). Most future relevant activities in the action area and vicinity would have a clear federal nexus (such as facility expansion at the POA, oil and gas development activities, and ferry services) and thus are not included in this analysis. A common federal nexus of projects occurring within coastal waters is Rivers and Harbors Act and Clean Water Act permitting requirements, which essentially make any project involving excavation or removal of material (such as pile driving) a federal action. Many of these actions have potential to generate underwater and airborne noise in Upper Cook Inlet and the action area.

Because JBER is a controlled access facility, few private actions have the potential to occur in ERF. The primary mechanism by which the proposed action may contribute to cumulative effects is through noise that may emanate from the restricted area at JBER. Noise pollution may interrupt the normal behavior of beluga whales and other ESA-listed marine mammals, which rely on sound to communicate and echolocate. If loud enough, noise can cause permanent or temporary hearing loss or result in lost foraging opportunities. This is of particular concern for the Cook Inlet beluga whale population, which inhabits an area with high vessel traffic, oil and gas exploration and development, dredging and pile driving, military operations, and other noise-making anthropogenic activities. While many of these activities associated with maritime facilities described Section 4.4 are expected to occur into the future, most of these activities likely have a federal nexus and will require ESA Section 7 consultation so are not further described in this section.

Activities without a federal nexus that are expected to continue into the future include 1) vessel traffic and shipping, 2) State of Alaska-managed fisheries, 3) pollution, 4) tourism and recreational boating, and 5) Anchorage 2040 Land Use Plan actions (Table 5-22; AMATS 2020; NMFS 2020b, 2021b). These broad categories of activities were included in recent NMFS biological opinions in Upper Cook Inlet as they have potential to contribute to cumulative effects on beluga whale. These activities may affect beluga whales in Upper Cook Inlet but are less likely to affect belugas in the ERF-IA portion of the action area, unless an oil spill or pollutant release occurs.

Table 5-22 Future Non-Federal Actions that are Reasonably Certain to Occur in the Action Area.

Location	Project/Activity	Potential Effects
Upper Cook Inlet	Vessel Traffic and Shipping	Risk of ship strikes, exposure to vessel noise and presence, and small spills
	Fisheries (state of Alaska managed)	Risk to marine mammals of prey competition, ship strikes, harassment, and entanglement in fishing gear
	Pollution	Exposure to oil spills and other pollutants from marine, industrial, and municipal activities
	Tourism and Recreational Boating	Behavioral effects from vessel traffic
Matanuska-Susitna Borough/ Municipality of Anchorage	Anchorage 2040 Land Use Plan Actions (update to 2020 Anchorage Bowl Comprehensive Plan) will shape development for the next 20 years	Development, growth, pollution, climate change

The ESA-listed Cook Inlet beluga whale population is particularly at risk because it has experienced an ongoing decline for more than two decades. Beluga whales are vulnerable to current and future anthropogenic actions in Upper Cook Inlet such as habitat degradation, vessel transit, commercial and recreational fishing, oil and gas exploration, climate change, and other types of disturbance that may generate noise or interfere with prey availability and migration patterns. Many of these actions are currently present and are expected to increase in the future. The Cook Inlet beluga whale population faces additional threats because of its proximity to Anchorage, which is a regional center for shipping and other maritime activity, especially during the summer season. However, many of these actions already occur in Upper Cook Inlet and thus, comprise part of the environmental baseline (e.g., vessel traffic, fishing, pollution, and tourism). While the degree to which these actions in Upper Cook Inlet may change over time, it is unlikely that they will result in increased adverse cumulative effects to beluga whales in the action area.

There is low potential for adverse cumulative effects to ESA-listed marine mammals from any non-federal activities that are reasonably certain to occur in the action area.

5.9 INTERRELATED AND INTERDEPENDENT ACTIONS

Interrelated actions include actions that are part of a larger action and depend on the larger action for justification. Interdependent actions are defined as actions with no independent utility apart from the proposed action. Analysis of whether other activities are interrelated to, or interdependent with, the proposed project can be done by applying a "but for" test (USFWS and NMFS 1998). If another activity would not occur "but for" the proposed project, the activity should be analyzed as being interrelated to or interdependent with the proposed project. The proposed action, as described in Section 2.0, has independent utility and has no interdependent or interrelated activities associated with it.

6.0 EFFECTS DETERMINATION

This BA was written in accordance with the direction of the cooperating agency, NMFS (NMFS 2025). Using the NMFS Guidance on the Endangered Species Act Term "Harass", JBER has determined that the proposed action is not likely to cause injury to Cook Inlet beluga whales or Steller sea lions, or create the likelihood of injury by annoying ESA species to an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (NMFS 2016a).

The recommended determinations for ESA-listed species and critical habitats are summarized in Table 6-1.

Table 6-1 Recommended Effects Determination for ESA-listed Species and Critical Habitats

Common Name *Scientific Name* DPS	ESA Statua	Listing	Effects Determination for Species	Effects Determination for Critical Habitat
Beluga Whale *Delphinapterus leucas* Cook Inlet DPS	Endangered	73 FR 62919	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Steller Sea Lion *Eumetopias jubatus* Western DPS	Endangered	62 FR 24345	May affect, not likely to adversely affect	No effect; critical habitat is not designated in the action area

Key: DPS = distinct population segment, ESA = Endangered Species Act; FR = Federal Register.

6.1 COOK INLET BELUGA WHALE

6.1.1 Species Effects

A **may affect** determination is warranted for Cook Inlet beluga whale because:

- Beluga whales may be present in the action area during live-fire training.

With implementation of the full range of measures described in Section 2.4, a **not likely to adversely affect** determination is warranted and particularly based on the following:

- Implementation of a seasonal closure; prohibition on firing HE and 155-mm training rounds into ERF during the peak beluga whale upriver visitation period of 9 August through 18 October (except for potential firing into the proposed expansion area). This reduces the chances of belugas in the action area.
- Application of protective habitat buffers; spatial buffers along the Eagle Bay shoreline, Eagle River, Otter Creek, and selected tributaries and upstream locations that are larger than estimated ensonified harassment distances for which no rounds would be fired into. This reduces in-water noise below take thresholds.
- Prohibition on firing into inundated areas; implementation of a no-firing restriction for HE rounds (inclusive of the 155-mm training round) into areas inundated by high tide events, both predicted and observed. This measure prevents firing into open water or firing when protective habitat buffers or targets may be under water, to further ensure underwater noise thresholds are not exceeded.
- Application of minimum human safety stand-off distances to marine mammals; this measure overlays protective spatial buffers typically used for soldiers that could be in the area. In other words when plotting targets prior to live-fire, portions of Eagle River, Otter Creek and the Otter Creek Complex where whales could be, will be treated as though humans were present to reduce the chances of a whale being inadvertently struck by hazardous fragments to a less than 1 in 1,000,000 chance.

- Monitoring for marine mammals, which may include real time acoustic monitoring, will be conducted for a minimum of 30 minutes prior to firing, during firing, and for a minimum of 30 minutes after the end of the firing mission by at least two land-based marine mammal observers (MMOs).
- A cease-fire or delay of firing if marine mammals are detected in Eagle River or Otter Creek before or during a training event. Training would only resume after marine mammals are observed traveling into Eagle Bay or 15 to 30 minutes have passed without resighting (30 mins for beluga whales, 15 minutes for all other marine mammals).

The implementation of habitat buffers along many of the waterways in ERF-IA means that the underwater acoustic thresholds for non-auditory injury, auditory injury, or behavioral disturbance for beluga whales would not be reached, and that the likelihood of injury or mortality from shrapnel would be reduced to a less than 1:1,000,000 chance (i.e. discountable). Further, firing of HE rounds and 155-mm training rounds during inundating tides would be prohibited, reducing the likelihood that these rounds would detonate in water and that harassment thresholds would be met. While it is possible that individual animals may travel upstream undetected in the few unbuffered waterways within the target areas, it is not reasonably likely that they would be within the spatial and temporal proximity of a detonation that would be required to experience a temporary threshold shift (TTS) or behavioral disturbance (i.e., ≤ 10 meters; Level B harassment), or within the small ensonified Level A harassment radii (i.e., < 8 meters) for a period of time long enough to incur auditory injury (AUD INJ), which may include permanent threshold shifts (i.e., Level A harassment). Lastly, the implementation of the seasonal closure would eliminate any potential incidental harassment from HE rounds and 155-mm training rounds during the time period when beluga whales are most likely to be present in greatest numbers within ERF (NMFS 2024b). Slow start firing procedures and the measures to be implemented by forward observers and MMOs further reduce the likelihood of incidental take of this species such that take is not considered reasonably likely to occur (NMFS 2025a).

6.1.2 Critical Habitat Effects

A **may affect but is not likely to adversely affect** determination is warranted for beluga whale critical habitat because:

- While beluga whale critical habitat is not designated in ERF-IA, it is designated within the broader action area identified conceptually within Knik Arm and Upper Cook Inlet.

With implementation of the full range of measures described in Section 2.4, the following potential effects to the PBFs are expected to be insignificant in their magnitude:

- PBF 1 and 2: Fish species deemed to be the primary prey species of Cook Inlet beluga whale include Chinook salmon, sockeye salmon, chum salmon, coho salmon, Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole. These prey species may be affected through underwater noise, munitions contaminants, erosion and sedimentation, and direct strikes from munitions and fragmentation. The risk of mortality, injury, or behavioral effects is greatest to rearing salmonids in unbuffered areas, such as the Eagle River relict channel complex. The magnitude and scale of effects at the local level cannot be quantified, but there would be some reduction in coho (and potentially Chinook and sockeye) salmon escapement and productivity in Eagle River and Otter Creek that could affect abundance in designated critical habitat (Eagle Bay and Upper Cook Inlet). However, it is not expected that there would be a measurable reduction in beluga whale prey items within designated critical habitat at the species or population level.
- PBF 3: The probability of ingestion or bioaccumulation of munitions contaminants in prey species that would result in measurable reductions of prey species within designated critical habitat is discountable.

- PBF 4: Cook Inlet beluga whales are unlikely to be physically restricted from passing through critical habitat, as the affected area is limited to a portion of Eagle Bay and would not extend across Knik Arm.
- PBF 5: While there is the potential for underwater noise to be audible to Cook Inlet beluga whales within designated critical habitat in Eagle Bay, this noise will not exceed any NMFS-established thresholds. In addition, underwater noise would be limited to a small portion of the designated critical habitat in Upper Cook Inlet. Any changes to the utilization of critical habitat within Eagle Bay is expected to occur in short-term intervals during active live-fire training.

6.2 STELLER SEA LION WESTERN DPS

A **may affect** determination is warranted for Steller sea lions because:

- Low numbers of Steller sea lions may be present in the airborne noise action area during live-fire training.

With implementation of the full range of measures described in Section 2.4, a **not likely to adversely affect** determination is warranted based on the following:

- Proposed indirect live-fire training would occur during all seasons and would overlap with the times of the year that Steller sea lions may be present in the action area however Steller sea lion presence in the upper Cook Inlet is infrequent and there are no known haul-out or breeding sites.
- With protective habitat buffers, prohibition on firing into inundated areas; underwater noise during both typical high tide conditions and typical inundating tide events would not exceed PTS, TTS, or behavioral thresholds but still may be audible to Steller sea lions in Eagle River and Eagle Bay..
- Airborne noise above behavioral thresholds may be exceeded in Knik Arm, portions of Turnagain Arm, and portions of Upper Cook Inlet, including Fire Island and the Little Susitna River delta. Since Steller sea lion presence in the upper Cook Inlet is infrequent and there are no known haul-out or breeding sites, airborne noise is not likely to adversely affect or cause significant disruptions of natural behavior patterns.
- Marine mammal monitoring in the action area is difficult, and Steller sea lions have a chance to move into the action area undetected and be exposed to noise disturbance during live-fire training. Monitoring for marine mammals will be conducted for a minimum of 30 minutes prior to firing, during firing, and for a minimum of 30 minutes after the end of the firing mission by at least two land-based forward observers.
- Sufficient avoidance and minimization measures and other conservation measures would be implemented to ensure that marine mammals are not struck by hazardous fragments, that they are not exposed to noise above PTS thresholds, and that accidental detonation of rounds would not occur in Eagle River or Eagle Bay.

As a result of the mitigation measures (Section 2.4), it is concluded that the impacts of disturbance are expected to be insignificant given the low probability that the species will be in the action area and because the minimal disruption of normal behavior patterns anticipated is not expected to create the likelihood of injury to the exposed individuals. The underwater noise criteria and thresholds for PTS, TTS, and behavioral disturbance for Steller sea lions would not be met, and the likelihood of physical injury or mortality is expected to be discountable, due to the proposed mitigation and monitoring measures. Airborne noise thresholds would be exceeded; however, Steller sea lions are rare in upper Cook Inlet and there are no known haul-out or breeding sites. Monitoring data has suggested that Steller sea lion reactions to blasting or launch noise are variable, but are of minimal severity (e.g., alert behavior, entering water from haul out; Demarchi et al. 2012, USSF 2024), and that behavioral patterns are not abandoned or significantly altered or have any detectable effect on their health. Additionally, the area where exposures may occur is already subject to in-air anthropogenic noise as mentioned above, so the small number of Steller sea lions that frequent the area are likely already habituated to such noises. Given the low numbers of Steller sea lions in the proposed action area (including no known haul-out locations), and observations suggesting minimal reactions of pinnipeds to similar sound sources (e.g., Holst et al. 2005, Demarchi et al. 2012, U.S. Navy 2023, USSF 2024, Ugoretz and Greene Jr. 2012), the likelihood of behavioral patterns being abandoned or significantly altered is low and, therefore, any disturbance resulting from airborne noise exposure would not constitute harassment. For these reasons, NMFS has determined that, under the MMPA, take of Steller sea lions from airborne noise incidental to the specified training activities is not reasonably likely to occur (NMFS 2025a).

Conclusion

Our analysis, which utilized the best available scientific and commercial data, indicates that all potential effects of the proposed action (with mitigation measures) would be either insignificant or discountable. JBER has thus determined that the proposed project may affect but is not likely to adversely affect Cook Inlet beluga whales, Cook Inlet beluga whale designated critical habitat, or Steller sea lions.

In the event of an unlikely incidental take of marine mammal, JBER would contact NMFS immediately to provide notification of the incident and to work through the necessary steps to ensure MMPA and ESA compliance moving forward, which may include submitting a request for an ITA.

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APPENDIX E–ESSENTIAL FISH HABITAT ASSESSMENT

Essential Fish Habitat Assessment
For
Proposed Mortar and Artillery Training At
Richardson Training Area,
Joint Base Elmendorf-Richardson, Alaska

Submitted To:

NOAA Fisheries, Alaska Region
Habitat Conservation Division
222 West 7th Ave, Box 43
Anchorage, AK 99513

Prepared By:
JBER and AECOM

16 July, 2024

EXECUTIVE SUMMARY

Background

This Essential Fish Habitat (EFH) Assessment evaluates potential effects on EFH and federally managed species from Proposed Mortar and Artillery Training at Joint Base Elmendorf-Richardson (JBER), Alaska. This assessment supports EFH consultation with National Marine Fisheries Service (NMFS) pursuant to the Magnuson-Stevens Fishery Conservation and Management Act of 1972. EFH for Pacific salmon and groundfish has been designated in or near areas where proposed project activities would occur. The United States (U.S.) Air Force is the lead agency for the proposed project, and the U.S. Army and NMFS are cooperating agencies. The Air Force is concurrently preparing an Environmental Impact Statement for this project.

The Air Force proposes to remove existing winter firing restrictions to allow for all-season, indirect, live-fire mortar and artillery training in Eagle River Flats (ERF) Impact Area (ERF-IA), an existing 2,483-acre dedicated explosive munitions impact area on JBER that includes ERF, a large tidal salt marsh, associated upland buffer areas, Eagle River, and Otter Creek. This EFH Assessment considers two project alternatives: Alternative 1 (the Army's Proposed Action), which would also expand ERF-IA by approximately 585 acres into adjacent uplands, and Alternative 2, which would not change the existing impact area boundaries. All other aspects of the two alternatives would be the same.

The existing winter firing restrictions, which have been in place since 1991, limit use of ERF-IA to winter months, when established ice thickness requirements are met. The winter training window varies annually and does not allow units stationed at JBER to conduct the full range of training tasks at JBER. The proposed action is necessary to allow the Army to conduct frequent live-fire weapons training exercises under realistic conditions and standards throughout the year to prepare Soldiers for combat operations.

Proposed Project

Indirect-fire training at ERF-IA involves mortars (60-millimeter [mm], 81-mm, and 120-mm) and artillery (105-mm). The proposed project (both alternatives) would add use of 155-mm howitzers at ERF-IA. Types of rounds fired by these weapons systems include high explosive (HE), Illumination, smoke, and training rounds. White phosphorus rounds, which were previously linked to waterfowl mortality, are no longer fired at ERF-IA and would not be fired under either alternative. The two alternatives analyzed in the EFH Assessment are as follows:

- Alternative 1 – All-Season Live-Fire Training with Expanded Impact Area (Proposed Action)
- Alternative 2 – All-Season Live-Fire Training at Existing ERF-IA Only

Table ES-1 shows the maximum number of rounds that would be fired into ERF-IA under the alternatives annually, compared to baseline conditions. HE rounds have a much greater potential to impact EFH and managed species (relative to non-HE rounds) because they generate higher noise levels, can release munition residues, and produce shrapnel when they detonate in the impact area. Although 155-mm training rounds would also detonate in the impact area, they contain a lower amount of HE and do not produce shrapnel.

Under Alternative 1, expanding ERF-IA into 585 acres of adjacent uplands would entail clearcutting approximately 350 acres of vegetation and creating approximately 1.8 miles of gravel service roads and five vehicle gravel service pads inside the cleared area. The gravel service roads would be approximately 15 feet wide, and each service pad would be approximately 50 feet by 50 feet. A firebreak approximately 16 feet wide and 3 miles in length would be created along the boundary of the cleared area to contain wildland fires and prescribed burns. An approximately 230-acre vegetated buffer would remain to reduce potential sediment releases into Clunie Creek and Eagle River.

Table ES-1 Total Number of Rounds Allocated by Alternative

Munitions Type	Baseline (Current Conditions)	Alternative 1 (Proposed Action)	Alternative 2
60-mm Mortar HE Rounds	518	1,036	1,036
60-mm Mortar Other Rounds	1,645	3,290	3,290
81-mm Mortar HE Rounds	296	592	592
81-mm Mortar Other Rounds	940	1,880	1,880
120-mm Mortar HE Rounds	372	744	744
120-mm Mortar Other Rounds	1,296	2,592	2,592
105-mm Howitzer HE Rounds	1,306	2,612	2,612
105-mm Howitzer Other Rounds	714	1,334	1,334
155-mm Howitzer HE Rounds	N/A	144	144
155-mm Howitzer HE Training Rounds	N/A	900	900
155-mm Howitzer Other Rounds	N/A	146	146
Total Rounds	**7,087**	**15,270**	**15,270**

Key: HE = high explosive; mm = millimeter.

Under both alternatives, JBER and its contractors would comply with applicable laws, regulations, and policies, including those that are relevant to the protection and conservation of EFH. Additionally, protective measures that would benefit managed species are incorporated into the action and would be implemented under both alternatives. These measures include, but are not limited to, revised protective buffers based on acoustic modeling, limited fire periods for HE rounds, and redistribution of targets.

Essential Fish Habitat in the Proposed Project Area

Designated EFH waterbodies in the proposed project area include 1) the Eagle Bay portion of Knik Arm, 2) Eagle River, and 3) Otter Creek. EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (50 Code of Federal Regulations 600.10). ERF-IA consists of a tidally influenced estuary with flow from Eagle River and Otter Creek, both of which are anadromous fish streams. Otter Creek flows out of Otter Lake, which is spring fed and flows into tidally affected Eagle River and Eagle Bay. The lower reaches of Otter Creek and its tributaries in ERF have tidal influences as well. Both Eagle River and Otter Creek are partially in ERF-IA. Knik Arm is not in the project area, but it influences physical, chemical, and biological conditions in Eagle Bay. Clunie Creek flows through the proposed expansion area but has not been designated as EFH by the Alaska Department of Fish and Game (due to lack of a permanent hydrological connection to Eagle River). Although not designated as EFH, Garner Creek at the northwestern portion of ERF-IA is known to support salmonids. Designated EFH for federally managed species in Knik Arm and the proposed project area is listed in Table ES-2.

Table ES-2 Designated Essential Fish Habitat for Federally Managed Species Known to Occur in Knik Arm and Proposed Project Area

Species Management Unit	Lifestage(s) Found at Location	Management Council	Fisheries Management Plan
Groundfish			
Alaska plaice (GOA)	Egg and larvae (Summer)	North Pacific	Amendment 105 GOA Groundfish FMP
Yellowfin sole (GOA)	Egg (Summer)	North Pacific	Amendment 105 GOA Groundfish FMP
Dover sole (GOA)	Larvae (Summer)	North Pacific	Amendment 105 GOA Groundfish FMP
Flathead sole (GOA)	Larvae (Summer)	North Pacific	Amendment 105 GOA Groundfish FMP
Northern rock sole (GOA)	Larvae (Summer)	North Pacific	Amendment 105 GOA Groundfish FMP
Pacific cod (GOA)	Larvae (Summer)	North Pacific	Amendment 105 GOA Groundfish FMP
Rex sole (GOA)	Larvae (Summer)	North Pacific	Amendment 105 GOA Groundfish FMP
Starry flounder (GOA)	Juveniles and adults	North Pacific	Amendment 105 GOA Groundfish FMP
Forage fish complex	Adult eulachon; juvenile and adult longfin smelt	North Pacific	Amendment 105 GOA Groundfish FMP
Salmonids			
Chinook salmon	Marine juvenile, sub adult, and mature adult	North Pacific	Amendment 13 Salmon FMP
Chum salmon	Marine juvenile, sub adult, and mature adult	North Pacific	Amendment 13 Salmon FMP
Pink salmon	Marine juvenile, sub adult, and mature adult	North Pacific	Amendment 13 Salmon FMP
Sockeye salmon	Marine juvenile, sub adult, and mature adult	North Pacific	Amendment 13 Salmon FMP
Coho salmon	Marine juvenile, sub adult, and mature adult	North Pacific	Amendment 13 Salmon FMP

Key: GOA = Gulf of Alaska; FMP = Fishery Management Plan.

Potential Project Effects on EFH and Managed Species

Potential direct impacts from the proposed project on EFH and managed species include acoustic noise from live-firing events and injury or mortality from direct strike or fragmentation of munitions fired into ERF-IA. Potential indirect effects may include changes to water and sediment quality via introduction of munitions contaminants into ERF waterbodies and related bioaccumulation of contaminants to managed fish species. Erosion and sedimentation into aquatic systems from firing events may constitute a direct or indirect effect, depending on the location of the activity. Past, present, and reasonably foreseeable future development actions in the region could contribute to cumulative impacts, as could commercial fishing, pollution, shipping, underwater noise, disease, and climate change.

The Action Agency (Air Force) has determined that conducting all-season indirect live-fire mortar and artillery training at ERF-IA may adversely affect EFH and managed fish species, but the proposed protective measures under both alternatives (prohibiting firing into open water areas, restricting firing during typical inundating tide events,[1] and enhancing existing protective buffers) would reduce underwater noise effects to fish, including the potential for injury or mortality.

Table ES-3 summarizes potential impacts on EFH and managed species from the proposed action. In support of the analysis of impacts, acoustic modeling was conducted to determine potential noise exposures to fish at representative detonation sites as well as sites at various distances from waterbodies, under inundated and non-inundated conditions.

Table ES-3 Summary of Potential Impacts on EFH and Managed Species from Alternatives 1 and 2

Project Alternative	Potential Impacts
Direct Acoustic Impacts	
Alternative 1 (Proposed Action)	No direct acoustic impacts to fish anticipated in Eagle Bay, Eagle River, and the Otter Creek complex from any firing scenarios during typical high tide conditions due to implementation of protective buffers. Habitat buffers and firing restrictions during typical inundating tide events would limit risk of mortality or injury of managed species from underwater noise. Potential moderate to high risk of acoustic effects to fish from munition detonations in unbuffered ERF waterbodies, but risk would be moderated by protective measures. Use of larger 155-mm HE rounds could result in greater noise impacts than existing conditions, but habitat buffers and other firing restrictions would prevent adverse effects, except in the case of 155-mm training rounds fired during inundated conditions. No acoustic effects to managed species are anticipated from use of proposed expansion area. Fewer munition detonations in the ERF portion of ERF-IA relative to Alternative 2 would result in a lower potential for impacts to fish.
Alternative 2	Same effects to EFH and managed species due to underwater noise from munition detonations. More concentrated munition firing in ERF would result in a greater potential for effects to EFH and managed species than the Proposed Action.
Direct Erosion and Sedimentation Impacts	
Alternative 1 (Proposed Action)	Low to high potential for erosion and sedimentation effects from munition detonations in ERF-IA and proposed expansion area. Potential long-term adverse impacts from live-fire training during ice-free conditions through alteration of habitat in unbuffered areas. Effects likely to be greatest in unbuffered areas that support salmonid rearing habitat. No firing of HE rounds would occur during typical inundating tide events, which would reduce potential for sedimentation increases. Potential for short-term erosion and sedimentation effects from construction of the proposed expansion area.
Alternative 2	Same effects to EFH and managed species due to erosion and sedimentation from munition detonations in ERF-IA. More concentrated munition firing in ERF would result in a greater potential for erosion and sedimentation and habitat alteration effects in areas used by fish. No potential construction-related sedimentation effects because the impact area would not be expanded.

[1] A note on terminology in this EFH Assessment: "Inundated" and "inundated conditions" refer to the tidal inundation that occurs when higher tides cause flooding outside the banks of Eagle River into the surrounding floodplain at ERF. The magnitude of inundation varies depending on the height of the tide and the ice cover (in winter), discharge from Eagle River, and wind direction. For the acoustic modeling completed in support of this EFH Assessment, conditions during "typical inundating tide events" were assumed. An inundation level of 0.5 meters (the typical inundation peak of a maximum tide event) was assumed for submerged detonation points during these events. "Typical high tide" conditions are equivalent to mean higher-high water. During typical high tide conditions, all detonation points are on dry ground and are not submerged.

Project Alternative	Potential Impacts
Direct Strikes to Managed Fish Species	
Alternative 1 (Proposed Action)	Low to moderate potential for direct munition and fragment strikes to managed fish in unbuffered areas, and low risk of fragment strikes to fish in Eagle River and Otter Creek even with habitat protective buffers in place. Buffers would prevent munition and fragment strikes to fish in Eagle Bay. Risk of fragment strikes would be reduced by restrictions on firing rounds that produce shrapnel (HE) during typical inundating tide events.
Alternative 2	Same effects from direct strikes to managed fish species as Alternative 1. More concentrated munition firing in ERF would result in a greater potential for direct strikes to fish.
Indirect Impacts – Munition Contaminant Exposure	
Alternative 1 (Proposed Action)	Low to moderate but unquantifiable potential for exposure of managed species to munitions constituents through ingestion or diet within water column or sediments. Exposure limited to releases of traditional and insensitive munitions residue (particularly NTO and NQ) from LO or UXO detonations.
Alternative 2	Same effects from exposure of managed species to munitions constituents. Potential for exposure would be greater than under Alternative 1 because there would be more concentrated firing into ERF.
Cumulative Impacts	
Alternative 1 (Proposed Action)	No anticipated adverse effects.
Alternative 2	No anticipated adverse effects.

Key: EFH = Essential Fish Habitat; ERF = Eagle River Flats; ERF-IA = Eagle River Flats Impact Area; HE = high explosive; LO = low-order; mm = millimeter; NQ = nitroguanidine; NTO = 3-nitro-1,2,4-triazol-5-one; UXO = unexploded ordnance.

Minimization and Mitigation Measures

The impact analysis has determined that the habitat buffers and other planned protective measures incorporated into the alternatives are unlikely to be sufficiently protective of EFH and managed species. Some sensitive habitats would remain unbuffered, and there is uncertainty about fate and transport pathways, as well as potential for exposure and bioaccumulation of contaminants (particularly insensitive munitions [IM]) to salmonids and groundfish within ERF-IA. The following mitigation measures were developed based on site-specific knowledge from JBER biologists and review of project site conditions; they would be refined and modified as needed, in coordination with NMFS.

- JBER will expand the protective measure that specifies limited fire periods for HE rounds to include 155-mm training rounds.
- The Army will follow the most recent guidance and recommendations on using types of munitions that will minimize impacts to aquatic receptors to the maximum extent practicable. This involves coordination with other military firing ranges and research institutions (e.g., Strategic Environmental Research and Development Program and Cold Regions Research and Engineering Laboratory) that have been conducting studies on fate, transport, and toxicity of IMs and traditional explosives over the past several decades.
- JBER will consider opportunities to protect, enhance, and/or restore salmon habitat in the affected area, including within and outside the JBER installation boundary.
- As part of an *Adaptive Monitoring and Management Plan*, JBER will develop and implement appropriate efforts for comparative sampling and monitoring of hydrologic and biometric conditions in areas within and adjacent to the proposed project area. The practicability of these efforts is dependent on safe access to relevant areas, since much of the ERF-IA is a dudded impact area. Hydrologic monitoring may include water quality sampling as well as biometric sampling of fish tissue and characterization of invertebrate communities in relevant areas. Data will be used to

monitor changes in the condition of EFH, with appropriate consideration to all other potential confounding factors in the environment. Adaptive management measures may be considered where metrics indicate action-related degradation to EFH.

- JBER will consider the practicability of acoustic testing on the effects of managed fish species within the proposed project area. While there are several potential confounding factors that may influence the acoustic measurements in the proposed project area, pilot studies may be developed to evaluate the range of noise inputs within ERF-IA and within various channel morphologies (e.g., primary, tributary, relict). These sound verification experiments and studies may use live species to validate acoustic modeling used in the development of the EFH analysis. Data may be used to monitor changes in the condition of EFH, with appropriate consideration to all other potential confounding factors in the environment. Adaptive management measures may be considered where metrics indicate action-related degradation to EFH. The practicability of these efforts is dependent on safe access to relevant areas, since much of ERF-IA is a dudded impact area.
- JBER will continue to evaluate rearing and residency of juvenile salmon and/or other managed fish species using trap surveys and/or eDNA (or other methods as appropriate) to monitor productivity in and adjacent to the action area. The practicability of these studies is dependent on safe access to relevant areas within ERF-IA.
- JBER will continue fisheries harvest management, population studies (annual salmon enumeration studies), and habitat protection efforts at Sixmile Lake, Eagle River, and Otter Creek, among others, which are currently prescribed within the most current JBER Integrated Natural Resource Management Plan (INRMP) to ensure fish resources are effectively managed on JBER. These programs can be incorporated into an *Adaptive Monitoring and Management Plan*, which may be contained as an appendix within the INRMP (updated annually). Data will be used to monitor changes in the condition of EFH and with appropriate consideration to all other potential confounding factors in the environment. Adaptive management measures may be considered where metrics indicate action-related degradation to EFH.

Additionally, The Army will consider redirection of appropriate training and operational firing into the proposed expansion area, rather than areas where juvenile fish may be present and during the height of salmon runs (mid-June through August), as appropriate. The practicality of trajectory adjustments depends on the type of round necessary to train and the location of appropriate firing points relative to the expansion area. The Army intends to maximize use of the expansion area to reduce impacts to areas where juvenile fish may be present and during the height of salmon runs (mid-June through August), as appropriate. Since these actions are subject to practicability based on the training events or currently unknown circumstances, these is not considered guaranteed mitigation, however, actions to meet these efforts will be documented as required.

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°C	degrees Celsius
µg	microgram
µg cm/hr^2	microgram centimeter per hour squared
µg/g	micrograms per gram
ADF&G	Alaska Department of Fish and Game
AWC	Anadromous Waters Catalog
CALFEX	Combined Arms Live Fire Exercise
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
COMB	combined (used to refer to acoustic modeling scenarios)
Comp B	Composition B
CPUE	catch per unit effort
CRREL	Cold Regions Research and Engineering Laboratory
Cu	copper
DA Pam	Department of the Army Pamphlet
dB	decibel
DIDSON	Dual Frequency Identification Sonar
DNAN	dinitroanisole
DNP	dinitrophenol
DNT	dinitrotoluene
DTE	Distance to Effect
EC_{50}	median effective concentration
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EPT	Ephemeroptera, Plecoptera, and Trichoptera
ERF	Eagle River Flats
ERF-IA	Eagle River Flats Impact Area
FMC	Fishery Management Council
FMP	Fishery Management Plan
FR	Federal Register
FRTR	Full Range Training Rounds
GOA	Gulf of Alaska
GOA Groundfish FMP	*Fishery Management Plan for Groundfish of the Gulf of Alaska*
HAPC	Habitat Area of Particular Concern
HC	hexachloroethane
HE	high explosive
HFD	hazardous fragmentation distance
HMX	1,3,5,7-octahydro-1,3,5,7-tetranitrotetrazocine (aka High Melting Explosive)
HO	high-order
HUC	Hydrologic Unit Code
Hz	Hertz
IBCT	Infantry Brigade Combat Team
ILLUM	Illumination
IM	insensitive munitions
IMX	Insensitive Munitions Explosives
INRMP	Integrated Natural Resource Management Plan
JASCO	JASCO Applied Sciences

JBER	Joint Base Elmendorf-Richardson
Kd	soil sorption distribution coefficient
kg	kilogram
kHz	kilohertz
K_{OC}	organic-carbon partition coefficient
K_{OW}	octanol/water partition coefficient
LC_{50}	amount of substance required to kill half of test animals during a predetermined observation period
LO	low-order
Lpk	peak sound pressure levels
mg/L	milligrams per liter
MLLW	mean lower low water
mm	millimeter
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NEW	Net Explosive Weight
NMFS	National Marine Fisheries Service
NQ	nitroguanidine
NTO	3-nitro-1,2,4-triazol-5-one
NTU	nephelometric turbidity unit
OB/OD	Open Burn/Open Demolition
PAX-21	Piccatinny Arsenal Explosive 21
PCE	primary constituent element
PK	peak sound pressure
PMART	Proposed Mortar and Artillery Training
ppb	parts per billion
PTS	permanent threshold shift
RDX	cyclotrimethylenetrinitramine (aka Research Department Explosive)
RTA	Richardson Training Area
Salmon FMP	*Fishery Management Plan for the Salmon Fisheries in the EEZ Off Alaska*
SDZ	Surface Danger Zone
SEL	sound exposure level
SEL_{24h}	cumulative measure of sound related to sound energy in one or more pulses that could be emitted in a 24-hour period
SERDP	Strategic Environmental Research and Development Program
TNT	trinitrotoluene
TSS	total suspended solids
TTS	temporary threshold shift
U.S.	United States
U.S.C.	United States Code
USACE	U.S. Army Corps of Engineers
USACHPPM	U.S. Army Center for Health Promotion and Preventative Medicine
USARAK	U.S. Army Alaska
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UV	ultraviolet
UXO	unexploded ordnance
WP	white phosphorus

1.0 INTRODUCTION

This Essential Fish Habitat (EFH) Assessment evaluates potential effects on EFH and federally managed species from Proposed Mortar and Artillery Training (PMART) at the Richardson Training Area (RTA) on Joint Base Elmendorf-Richardson (JBER), in Southcentral Alaska. This assessment supports EFH consultation pursuant to the Magnuson-Stevens Fishery Conservation and Management Act of 1972 (MSA), as amended by the Sustainable Fisheries Act of 1996 (16 United States Code [U.S.C.] 1801 *et seq*.). The MSA established procedures designed to identify, conserve, and enhance EFH for those species regulated under a federal Fishery Management Plan (FMP). Section 305(b)(2) of the MSA requires federal agencies to consult with National Marine Fisheries Service (NMFS) on all actions or proposed actions authorized, funded, or undertaken by the agencies that may adversely affect EFH.

The United States (U.S.) Air Force proposes to remove existing winter firing restrictions to allow for all-season, indirect, live-fire mortar and artillery training in the Eagle River Flats (ERF) portion of the RTA. This EFH Assessment considers two action alternatives for the proposed project. Alternative 1, the U.S. Army's Proposed Action,[2] would also expand ERF Impact Area (ERF-IA) by approximately 585 acres, while Alternative 2 would not. The Army needs to conduct frequent live-fire weapons training exercises under realistic conditions and standards throughout the year to prepare Soldiers for combat operations. This EFH Assessment is a supplement to the Environmental Impact Statement (EIS) for the proposed action. Project information provided in this EFH Assessment was developed in tandem with the draft EIS, which is in preparation and will be submitted after this EFH Assessment. Management of JBER is the responsibility of the Air Force, and the Army retains operational responsibility for training areas and ranges. The Air Force is the lead agency for the proposed project, and the Army and NMFS are cooperating agencies.

The EFH Guidelines, 50 Code of Federal Regulations (CFR) 600.05–600.930, outline procedures that federal agencies must follow to satisfy MSA consultation requirements. Federal agencies must provide NMFS with an EFH Assessment if the federal action may adversely affect EFH. An EFH Assessment is to include the following contents (50 CFR 600.920[e](3)): 1) a description of the action; 2) an analysis of the potential adverse effects of the action on EFH and the managed species; 3) the federal agency's conclusions regarding the effects of the action on EFH; and 4) proposed mitigation, if necessary.

The objective of this EFH Assessment is to describe how the two action alternatives analyzed in the EIS may affect EFH for federally managed fisheries species in the proposed project area. It also describes conservation measures proposed to avoid, minimize, or otherwise offset potential adverse effects to designated EFH resulting from the proposed project alternatives. EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (50 CFR 600.10). The following waterbodies in the proposed project area are designated as EFH: Eagle River, Otter Creek, and Knik Arm of Cook Inlet, which encompasses Eagle Bay. The assessment focuses on Pacific salmon EFH (Chinook [*Oncorhynchus tshawytscha*], chum [*O. keta*], coho [*O. kisutch*], pink [O. *gorbuscha*], and sockeye [*O. nerka*]), as defined in the *Fishery Management Plan for the Salmon Fisheries in the EEZ* [Economic Exclusion Zone] *Off Alaska* (NPFMC et al. 2021) but also addresses potential effects to groundfish EFH defined in the *Fishery Management Plan for Groundfish of the Gulf of Alaska* (GOA) (NPFMC 2020). This EFH Assessment was prepared following the MSA regulations and EFH Assessment guidance developed in NMFS 2004 and based on additional guidance received from the NMFS Alaska Region Habitat Conservation Division in 2022 and 2023 during cooperating agency meetings.

[2] In this document, capitalized "Proposed Action" is synonymous with Alternative 1, the preferred alternative. Lowercase "proposed action" and "proposed project" refer more generally to the proposed mortar and artillery training.

1.1 PROPOSED PROJECT BACKGROUND

1.1.1 Proposed Project Area

JBER is a 73,014-acre[3] military installation in Southcentral Alaska, adjacent to Anchorage and the town of Eagle River (Figure 1-1). Knik Arm borders JBER to the west and north for approximately 20 miles, Chugach State Park lies to the south and southeast, the town of Eagle River lies along the northeast border, and Anchorage forms the southwestern boundary. Knik Arm includes Eagle Bay, which lies outside the installation boundary. The proposed project area is in a portion of the Eagle River watershed (5th field Hydrologic Unit Code [HUC] #1902080000) and the Lower Eagle River subwatershed (6th field HUC #190204010305), as well as the City of Anchorage-Frontal Cook Inlet (5th field HUC #1902040105) and Knik Arm-Frontal Cook Inlet (6th field HUC #190204010507). All of these drainages are in the Anchorage sub-basin (4th field HUC #19020401).

The proposed project area includes all areas where proposed project actions may affect EFH (Figure 1-2). This includes existing ERF-IA, a proposed expansion area, and Eagle Bay. ERF-IA is an existing 2,483-acre dedicated explosive munitions impact area on JBER. It encompasses approximately 2,092 acres of ERF, a large tidal salt marsh. The rest of the acreage is primarily contained in upland area near the western boundary and bluffs along its northern and southern boundaries. Throughout this EFH Assessment, the term "ERF-IA" is used to denote the entire 2,483-acre explosive munitions impact area, while the term "ERF" is used to denote the overlapping 2,092-acre estuarine salt marsh area. ERF is surrounded on the northern and southern sides by steep bluffs vegetated with upland spruce and birch forest. The eastern side is lowland marsh with thick vegetation. Eagle River flows into ERF from the east, meanders through the middle of the impact area, and discharges into Eagle Bay. The Eagle River delta extends approximately 1.6 miles along the coast of Eagle Bay; the width of ERF gradually narrows inland for approximately 2.6 miles upriver from the mouth.

Under Alternative 1, ERF-IA would be expanded into 585 acres of adjacent land to the northeast (referred to as the "proposed expansion area" in this document). The proposed expansion area is predominantly upland forested habitat, with limited wetlands and a minor waterbody (Clunie Creek) that supports a narrow riparian corridor (Figure 1-2). The portion of Clunie Creek in the proposed expansion area is an intermittent stream that drains Clunie Lake and other small ponds. Prior to reaching ERF, the creek becomes subterranean, reemerging at a small pond at the edge of ERF. While Clunie Creek does not have a permanent surface water connection to Eagle River, it does effectively drain into the river via groundwater, subsurface flow, and overland sheet flow after the stream channel dissipates approximately 1.3 miles prior to reaching ERF (JBER 2023a). Clunie Creek has been found to support slimy sculpin (*Cottus cognatus*) but no salmonids or other fish species (Schoofs and Zonneville 2016).

1.1.2 Past Military Training and Remediation at ERF-IA

The military has fired munitions into ERF-IA since the 1940s, and it is currently the only dedicated impact area at JBER. These munitions possibly included mortars, howitzers, missiles, rockets, grenades, illumination flares, smoke rounds, and small arms (20-millimeter [mm] caliber and smaller) (CH2M Hill 1994). This impact area supported heavy all-season use until February 1990, when the U.S. Army Alaska (USARAK) implemented a temporary firing suspension due to a suspected correlation between munitions used during training at ERF-IA and a high rate of waterfowl mortality.

Prior to 1990, range records show that roughly 12,000 artillery and mortar rounds were fired into ERF-IA each year, which included about 9,000 high explosive (HE) rounds and 440 white phosphorus (WP) rounds. Additionally, the Alaska Army National Guard has historically used ERF-IA to conduct required proficiency training. Prior to 1990, the most heavily used areas were in the center part of the impact area (along the northeast and southwest sides of Eagle River). Aerial imagery of ERF-IA from prior to 1990 shows distinct impact craters in these heavily used target areas.

[3] Throughout this document, imperial (English) units of measure are generally used for areas, elevations, and distances. Metric units are used for all other measurements, including descriptions of species, noise thresholds, and other specific project details. Where data from studies and/or scientific reports have been cited, the units used in those studies have been retained.

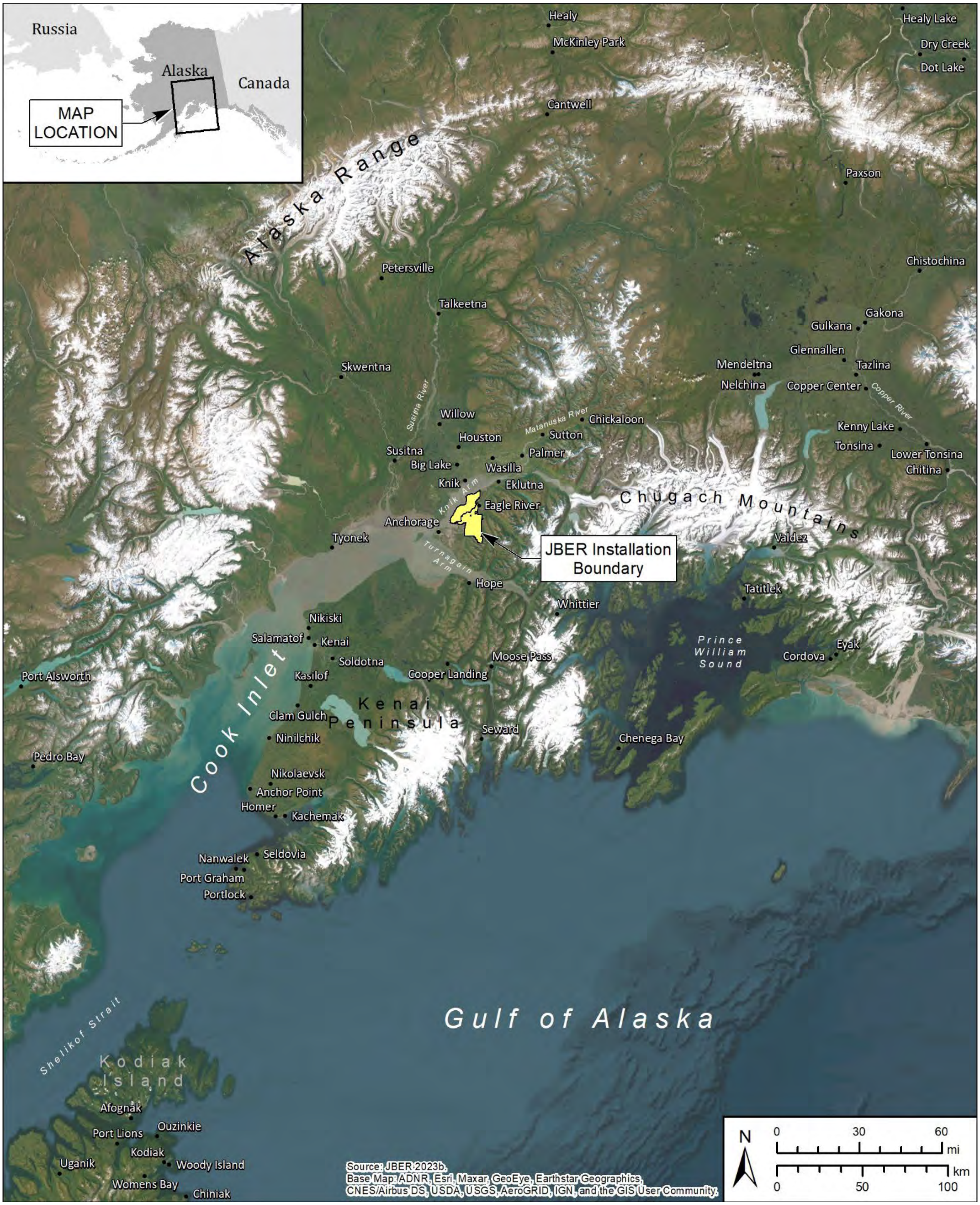

Figure 1-1 JBER and Vicinity, Southcentral Alaska

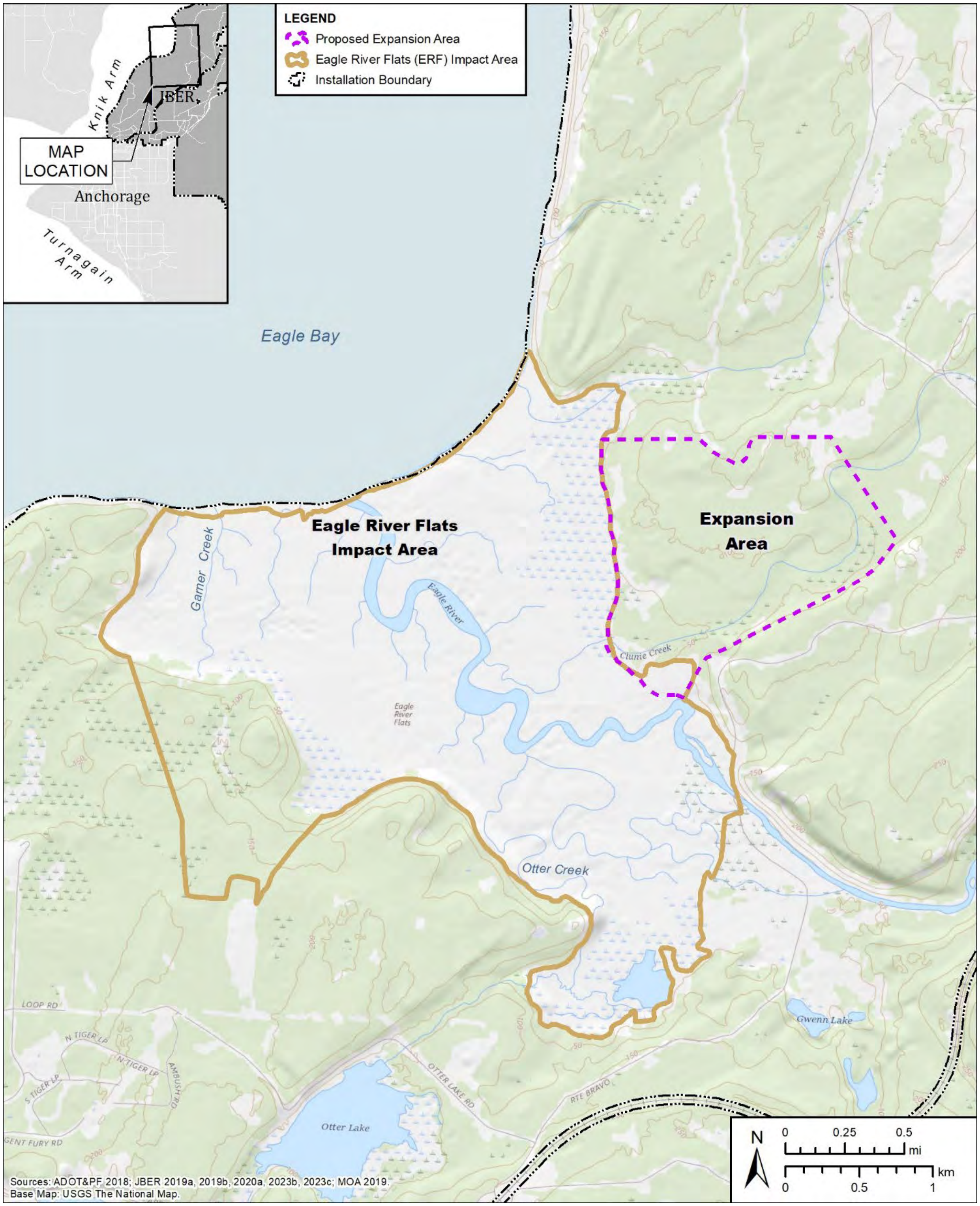

Figure 1-2 Proposed Project Area at Eagle River Flats, JBER, Alaska

In 1994, JBER (formerly Fort Richardson) was placed on the U.S. Environmental Protection Agency's (USEPA) National Priorities List and designated as a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Superfund site. ERF was given the identifier "Operable Unit C," which includes ERF and an associated gravel pad where historical destruction of military ordnance was conducted (Open Burn/Open Demolition Pad [OB/OD]). A comprehensive remedial investigation completed in 1996 concluded that the primary chemical of concern in the unit was WP and recommended that remedial action concentrate on hot ponds and be driven by waterfowl mortality (CH2M Hill 1997). The CERCLA Record of Decision in 1998 specified the process for remediating the WP contamination. The remedial action objectives were first met in 2006 and have been maintained since. Long-term monitoring continues as directed in the 1998 Record of Decision. The Army now prohibits WP from being fired into open waterbodies or wetlands, as specified in Department of the Army Pamphlet (DA Pam) 385-63 (U.S. Army 2014). WP would not be fired into ERF-IA or the proposed expansion area under any of the alternatives for this project.

In 2001, a notice of intent to sue was filed against the Army for activities in ERF-IA. This resulted in a settlement agreement in 2004. The Army fulfilled the requirements of the settlement agreement, which expired without protest in 2014. A timeline of actions pertaining to ERF-IA is presented in Figure 1-3.

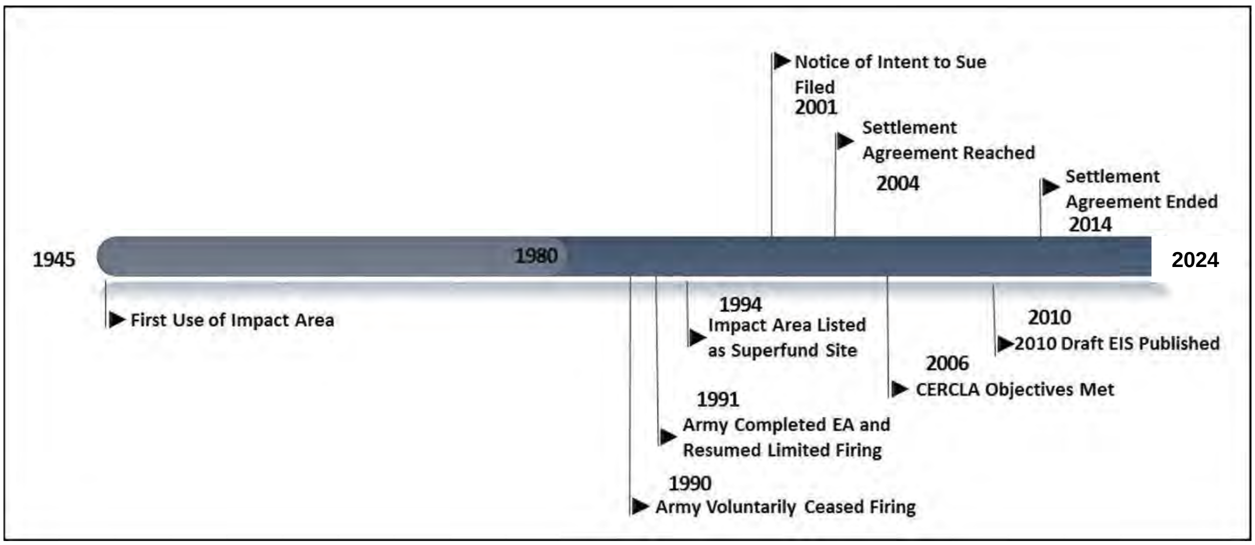

Figure 1-3 Historical Timeline for ERF-IA

1.1.3 Consultation History

During the time from the seasonal firing suspension to the present, units stationed at JBER have not been able to conduct the full range of training tasks at JBER. Current restrictions limiting the use of ERF-IA to winter months were initiated by the Army to prevent WP in underlying sediments from being released into standing water. Because the temporal onset and duration of these specific ice conditions vary annually, it is difficult to precisely predict when and for how long firing into ERF-IA would be allowed each year. During warm winters, units may not be able to begin indirect-fire weapons training until late November and may be forced to stop training in early March, affording a short window of opportunity to conduct required training and qualification. Even with favorable conditions, the winter season is too short to fulfill quarterly and semi-annual standardized training and qualification requirements or to fulfill newly assigned Soldier training and qualification requirements. Based on the completion of CERCLA remediation and attainment of the CERCLA remedial action objectives, the Army decided to seek expansion of the capability to conduct mortar and artillery training.

This EFH Assessment provides supporting documentation on potential effects on EFH and managed species from the proposed project alternatives. EFH for Pacific salmon and groundfish has been designated in or near areas where proposed project activities would occur.

1.2 ARMY TRAINING OBJECTIVES AND STANDARDS

1.2.1 Army Training Objectives

JBER currently supports Alaskan Command, 11th Air Force, 11th Airborne Division (U.S. Army), and more than 90 supported and tenant organizations. 11th Airborne Division is the proponent of the proposed project. Based on the training doctrine described in Section 1.2.2, 11th Airborne Division has formulated the following objectives to meet the intent of the Army Training Standards:

- Optimize the ability to train units to a proficiency level in accordance with Army standards, including use of a full array of indirect-fire (the impacts of rounds are not seen from the firing location [e.g., mortars and artillery]) and direct-fire (the impact of rounds is observed from the firing position [e.g., small arms/machine guns]) weapons and munitions at home station.
- Optimize opportunities for live-fire weapons training at JBER to ensure Soldiers achieve and maintain individual and crew proficiency, qualify newly assigned Soldiers throughout the year, train prior to deployments, and continually qualify weapons system crews in accordance with the Army training model requiring repetitive training.
- Ensure long-term, realistic training at JBER that will provide Soldiers opportunities to practice their skills in combat-like conditions in accordance with the Army Integrated Weapons Training Strategy (TC-3-20-0), Army Doctrine Publication 7-0, and other applicable regulations and doctrine.
- Improve Soldier quality of life and family stability by minimizing the need for travel to other installations for small unit training (company/battery/troop and below).
- Minimize overall training costs and lost time as a result of repetitive travel to other installations.
- Avoid land use conflicts.

1.2.2 Army Training Standards

Live-fire artillery/mortar training is required at all levels (section, platoon, company, and battalion) on a recurring basis, and live-fire training and qualification is a key component of the Army Integrated Weapons Training Strategy. DA Pam 350-38 (U.S. Army 2018) provides standardized training strategies for weapons training, identifies the amount of ammunition required to execute standardized training, and specifies the required frequency of repetitive training (i.e., quarterly, semi-annually, annually, and as required). The required intervals vary by unit based on the last time the unit, as a whole, qualified for the specific requirement. The qualifications cycle starts over if a Soldier who has not met the qualifications joins the unit.

Training standards for the 2nd Infantry Brigade Combat Team (IBCT), 11th Airborne Division include proficiency training using the following major weapon systems: 60-mm mortar, 81-mm mortar, 120-mm mortar, 105-mm howitzer, and 155-mm howitzer.

Figure 1-4 provides a visualization of the established training infrastructure at JBER that supports indirect live fire. Though firing points are identified, it should be noted that depending on the mission objective, a unit may use any open area for indirect live fire.

Under U.S. Army Forces Command regulation, units participating in a Combat Training Center rotation must complete all prerequisites at home station prior to the start of the rotation, which includes the participation of artillery crews, mortar crews, and infantry Soldiers in a company Combined Arms Live Fire Exercise (CALFEX). Under the current seasonal restrictions (see Section 1.1.3), units stationed at JBER must travel to Fort Wainwright to conduct indirect live-fire qualification and training whenever ice cover requirements are not met at ERF-IA. Removing seasonal restrictions would allow live-fire training (including CALFEX) to occur at JBER at the required frequency to allow Soldiers to maintain critical combat skills.

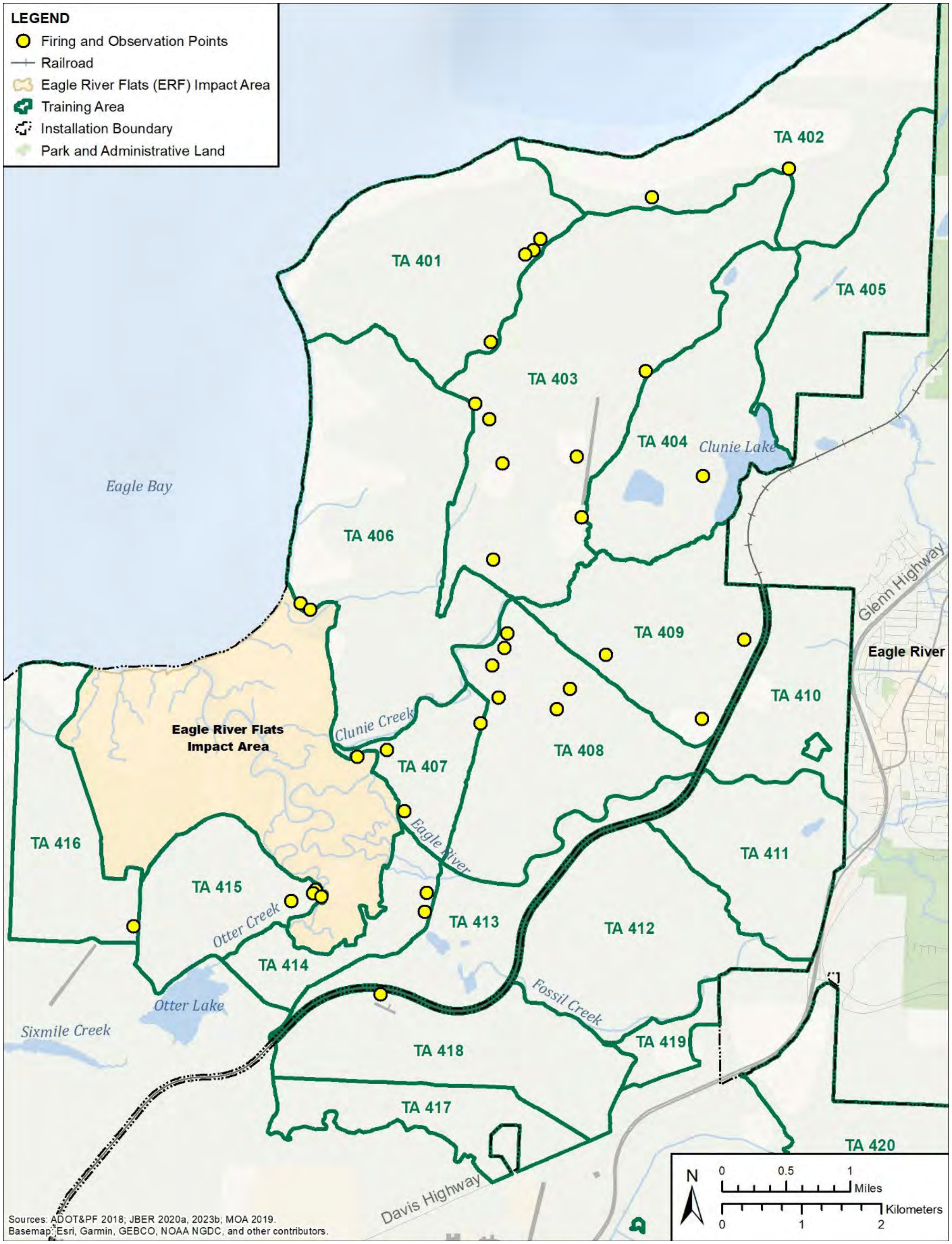

Figure 1-4 Indirect Live-Fire Training Infrastructure at JBER

2.0 DESCRIPTION OF THE PROPOSED PROJECT

The proposed project consists of modifying training conditions in which indirect live-fire weapons qualification, certification, and training can be conducted to meet Army training objectives and reinstating all-season live fire to meet Army regulatory and doctrinal standards. The action focuses on live-fire mortar and artillery training, which requires a dedicated impact area to contain explosive munitions, fragments, and debris. Current live-fire restrictions limit training on JBER's only dedicated impact area, with the result that units stationed at JBER must travel in excess of 700 miles (to Fort Wainwright) to train and qualify individual Soldiers and weapon system crews. Reinstating all-season live-fire training would enhance small-unit and live-fire training opportunities, avoid land use conflicts, and allow units stationed at JBER to attain mandatory Army qualification, certification, and training standards in an efficient manner. Additionally, it would provide a long-term local training solution, provide Soldiers a more stable family environment, and limit costly and time-consuming movement of equipment and personnel to and from Fort Wainwright.

2.1 WEAPON SYSTEMS AND MUNITIONS

Units stationed at JBER must train on direct-fire (e.g., small arms/machine guns) and indirect-fire (e.g., mortars and artillery) weapon systems. The proposed project would not modify current use of direct-fire weapon systems at JBER. Indirect-fire weapon systems currently at JBER are listed in Table 2-1. The proposed project would reinstate indirect-fire weapon systems use of ERF-IA during all four seasons, and 155-mm howitzers, which currently travel to Fort Wainwright to fire, would be incorporated into home station training and qualification on JBER.

Mortar and howitzer ammunition consists of a fuze, a projectile body, and propellant charges. Projectile bodies can be filled with varying materials (described below) and are commonly referred to as rounds or munitions. Mortars and howitzers use the same basic types of fuzes and munitions. With each indirect-fire weapon system, several types of fuzes and munitions can be used.

Table 2-1 Assigned Indirect Weapon Systems and Frequency of Training

Weapon System	Number of Weapon Systems Assigned at JBER	Frequency of Qualification and Live-Fire Training
60-mm Mortar	14	Quarterly
81-mm Mortar	8	Quarterly
120-mm Mortar	12	Quarterly
105-mm Howitzer	12	Semi-annually
155-mm Howitzer	6	Semi-annually

Key: JBER = Joint Base Elmendorf-Richardson; mm = millimeter.

Mortar and howitzer ammunition incorporates a variety of fuze types, all of which could be used under the proposed action as training requirements dictate. These fuze types include the following:

- Point-detonating, impact, or super quick fuzes, which detonate the cartridge on impact with the ground
- Near-surface burst fuzes, which explode on or near the ground

- Proximity (mechanical or variable time) fuzes, which explode above the ground
  - Mechanical time fuzes, which explode after a preselected time has elapsed from the round being fired
  - Variable time fuzes, which explode at a predetermined height and are not based on time
- Delay fuzes, which explode 0.05 seconds after impact
- Multi-option fuzes, which combine two or more of the other modes into one fuze

The cartridge, or projectile body of the round, may contain HE, Illumination (ILLUM), smoke, or inert[4] materials. The function of each is described below. All of these types of materials could be used under the proposed action.

- HE is used against enemy combatants and light-materiel targets. An explosive, when reacted, produces a sudden expansion of the material, usually accompanied by the production of heat and large changes in pressure. This rapid expansion and change in pressure produce noise and fractures the metal casing, resulting in shrapnel.
- ILLUM is used in missions requiring illumination for assistance in observation or as a spotting or marking round. ILLUM rounds are classified as non-explosive pyrotechnic rounds and contain chemical compounds (typically magnesium and sodium nitrate) that produce heat, light, smoke, and/or sound. None of the ILLUM rounds for the mortar systems or artillery used by units stationed at JBER contain phosphorus.
- Smoke is used as a screening, signaling, spotting, marking, casualty-producing, or incendiary agent. Smoke rounds are also pyrotechnic rounds. Three types of smoke-producing agents are used in Army mortar and howitzer munitions: WP, red phosphorus, and hexachloroethane (HC). Rounds including WP or red phosphorus as the primary constituent are prohibited from use in wetlands or other waterbodies per Army regulation (U.S. Army 2014; USARAK 2020). Neither are used currently in ERF-IA, and neither will be used in the future at ERF-IA (including in the upland expansion area) under the action alternatives. Thus, only HC smoke munitions are currently specified for use at ERF-IA.
- Full Range Training Rounds (FRTRs; for mortars only) are generally inert. Each round is fitted with a point-detonating practice fuze that simulates the multi-option fuze and provides a flash, bang, and smoke (typically through the ignition of a small black powder charge) but does not produce shrapnel. FRTRs are essentially the same as their HE counterparts except that they contain an inert filler material such as gypsum or plaster of Paris.
- The primary training round[5] for the 155-mm howitzer weapon system consists of a metal projectile casing filled mostly with high-density concrete. A small charge of HE (1.3 kilograms [kg]) is positioned in the nose of the round just beneath the fuze. The fuze is made up of metals or metal alloys and contains a pyrotechnic charge used to detonate the HE filler.

The term "munitions constituent" refers to any material originating from unexploded ordnance (UXO), discarded military munitions, or other military munitions; this includes explosive and non-explosive materials and emission, degradation, or breakdown elements of such ordnance or munitions (10 U.S.C. 2710[e][3]). The primary components (about 97 percent by weight) of mortar and howitzer munitions are explosives, iron (in the form of steel), copper, and aluminum (see Section 4.4.2). The projectile body is the only part of the round that lands in the impact area and is most often made of steel or iron. Many of the rounds have copper alloy rotating bands, and the fuzes and fins are typically made of aluminum. The

[4] Note that inert rounds may contain a negligible amount of HE.

[5] The term "training rounds" refers to rounds used during training that are similar to their HE counterparts but with no or much reduced HE. Depending on the caliber of the weapon and the manufacturer of the round, these can also be called "practice rounds." "Training rounds" is used for both in this report.

remaining components (2 to 3 percent) consist of trace amounts of numerous other compounds that can include metals (e.g., zinc, manganese, nickel, chromium, and cadmium), waxes, silicon, and pyrotechnics.

2.1.1 Total Live-Fire Ammunition Use for Mortars and Howitzers

Tables 2-2 and 2-3 collectively list the maximum number of mortar and artillery (howitzer) rounds (all indirect-fire weapon systems) that could be fired annually at ERF-IA by the IBCT currently stationed at JBER (excluding WP, which can only be fired at other installations). These numbers are based on the allocation specified in the 2018 version of DA Pam 350-38 (U.S. Army 2018). While the number of rounds allotted varies annually, the number fired at ERF-IA in a given year would not exceed the numbers shown in Tables 2-2 and 2-3 under either of the alternatives considered in this EFH Assessment. Larger unit exercises, which are included in these numbers, are likely to be conducted at other installations, which would decrease the total number of rounds expended at ERF-IA. Similarly, some smaller unit exercises may still be conducted at other installations, depending on training objectives and scenarios. The total number of rounds expended would also be reduced when units are called upon to deploy for overseas contingencies.

Table 2-2 Mortar Standard Training Munitions as Allotted Annually (Fiscal Year) by DA Pam 350-38

Mortar Type	HE	SMOKE	ILLUM	FRTR
60-mm Mortar	1,036	0	490	2,800
81-mm Mortar	592	0	280	1,600
120-mm Mortar	744	0	360	2,232
Total Annual Rounds	2,372	0	1,130	6,632

Key: DA Pam = Department of the Army Pamphlet; FRTR = Full Range Training Rounds; HE = high explosive; ILLUM = illumination; mm = millimeter.

Table 2-3 Howitzer Standard Training Munitions as Allotted Annually (Fiscal Year) by DA Pam 350-38

Howitzer Type	HE	SMOKE[1]	ILLUM	BLANK	FRTR/ Training[2]
105-mm Howitzer	2,612	144	282	908	0
155-mm Howitzer	144	62	84	0	900
Total Annual Rounds	2,756	206	366	908	900

Notes:

[1] Howitzer smoke rounds approved for use on JBER are non-phosphorus rounds that contain HC.
[2] For 155-mm howitzers, these are training rounds that contain a small amount (2.8 pounds) of HE material.

Key: DA Pam = Department of the Army Pamphlet; FRTR = Full Range Training Rounds; HC = hexachloroethane; HE = high explosive; ILLUM = illumination; JBER = Joint Base Elmendorf-Richardson; mm = millimeter.

Although the standard Army ammunition allotment includes WP smoke munitions, these rounds would not be used at ERF-IA, and they are not included in Tables 2-2 and 2-3. Although rocket-assisted projectile rounds are also allocated by DA Pam 350-38, they are not used at JBER and are not included in these tables. Blank rounds are training rounds without actual projectiles that are used during non-firing exercises to simulate the noise and effect of live fire and do not require the use of a dedicated impact area. FRTRs have been developed for the 105-mm howitzer; however, they have never been funded for production and thus are not resourced under DA Pam 350-38. As discussed in Section 2.1, 155-mm training rounds contain a small charge of HE (1.3 kg) that detonates in the impact area.

Although the number of training days varies annually, the total average number of indirect-fire training days scheduled by all units stationed at JBER is 134 days, at ranges on either JBER or Fort Wainwright. Although some training is likely to occur at Fort Wainwright, the analysis in this EFH Assessment conservatively assumes that all firing would occur at ERF-IA. The number of rounds fired per hour or day is highly variable depending on the unit, the qualification table, the training objectives, and the current conditions. However, numerous representative firing combinations were developed for the detailed acoustic studies referenced in Section 4.1 of this EFH Assessment.

2.1.2 Other Operational Assets

The following sections describe other operational assets required for Soldiers to conduct indirect live-fire training and fulfill their training requirements. Many of these features are shown in Figure 1-4.

2.1.2.1 Firing Points and Observation Points

Firing points are designated areas from which weapon systems fire munitions into an impact area. Indirect-fire weapons are fired from points that are not in the line-of-sight of targets in the impact area. Mortar firing points tend to be closer to the impact area than howitzer firing points, as the howitzer is a long-range indirect-fire weapon that can be fired from greater distances. In general, howitzers would be fired from locations at least 2.5 to 3.1 miles from the target area (which is in the impact area).

A forward observer is an observer operating with front line troops and trained to adjust ground or naval gunfire and pass back battlefield information. In the absence of a forward air controller, the observer may control close air support strikes (U.S. Army 2016). Platoon forward observers are assigned to the fire support team supporting each infantry company or cavalry troop in the Brigade Combat Team and to the battlefield surveillance brigade. During live-fire training, observation points are located in close proximity to impact areas to allow a forward observer to see and direct artillery and mortar fire onto a target (defined in Section 2.1.2.2). At ERF-IA, forward observers are located at one of the observation points that surround ERF.

When units fire at night, forward observers identify and observe targets either through visible light illumination or infrared illumination. For visible light, units fire visible-light ILLUM rounds just prior to firing HE rounds, which allows the forward observers to observe targets relative to where rounds are impacting. Alternatively, forward observers can also use night vision equipment to see in the dark; infrared ILLUM rounds are often used to enhance night vision capability and target observation. In both scenarios, units would continually intermix ILLUM rounds with the HE until the training is complete.

2.1.2.2 Impact Areas, Target Areas, Surface Danger Zones

Indirect-fire weapons are fired into a selected impact area. An impact area is a designated site used for training with live munitions. An explosive munitions impact area is a site used for training with live-fire munitions (e.g., mortars or howitzers) that could result in UXO. UXO is a term for munitions that do not explode as designed when employed and therefore pose a risk of future detonation.

Army Techniques Publication 3-09.42 defines a “target” as an entity or object that performs a function for the adversary considered for possible engagement or other action (U.S. Army 2016). Targets may be static or moving and may either occur as a single point/object or as an array. Within ERF-IA, an example of a target array is six vehicles grouped together in a line just west of Observation Point Fagan; any one of those vehicles would represent a point target.

A target area is the zone inside an impact area into which a weapon is fired. In DA Pam 385-63, Range Safety (U.S. Army 2014), a target area is defined as the point or location within a Surface Danger Zone (SDZ, defined later in this section) where targets (static/moving, point/array) are emplaced for weapon system engagement. For demolitions, it is the point or location where explosive charges are emplaced. Target areas in ERF-IA are limited by environmental restrictions set forth in USARAK Regulation 350-2 (USARAK 2020). Additionally, each installation may designate exclusion zones inside its impact areas, in which the placement of targets is prohibited, in order to avoid damage to specific areas or to ensure that the impact area adequately contains the effects of live-fire training.

An SDZ is defined as the ground and airspace designated in the training complex (to include associated safety areas) for vertical and lateral containment of projectiles, fragments, debris, and components resulting from the firing of weapons systems. SDZs are munition and weapons system specific, are developed to ensure personnel safety during training exercises, and are calculated to contain effects of the given munitions. The probability of hazardous fragments leaving the SDZ may not exceed 1:1,000,000. The SDZ essentially delineates a safety boundary that surrounds the firing point, the target area, and all points in between. DA Pam 385-63, Range Safety (U.S. Army 2014), provides a standard methodology to construct SDZs. Figure 2-1 illustrates an SDZ for indirect artillery fire; similar diagrams exist for mortars and other weapon systems. The boundaries of the SDZ cannot extend past the installation boundaries per Army regulation (U.S. Army 2014). Personnel, including forward observers, are not allowed to enter an SDZ during training exercises, except under special circumstances (U.S. Army 2014).

An SDZ consists of several areas, the dimensions of which are specific to each weapons system and munitions type. The target area is the point or location in the SDZ in which targets are placed for weapon system engagement (U.S. Army 2014). The smaller box in the hatched area in Figure 2-1 defines the target area. The weapon system impact area (larger hatched area in Figure 2-1) consists of the target area plus an additional containment zone designed to contain fired or launched ammunition and explosives. The weapon system impact area is constructed such that there is a 1 in 1,000,000 probability that a round would land outside of this containment zone under standard firing procedures. Firing procedures are established in regulations, field manuals, and training circulars; adherence is required. Failure to adhere would result in a formal investigation.

Areas A and B are the secondary danger areas (buffer zones) that laterally parallel the impact area or ricochet area (depending on the weapon system) and contain fragments, debris, and components from frangible or explosive projectiles and warheads functioning on the right or left edge of the impact area or ricochet area. Area C is the secondary danger area (buffer zone) on the up-range side of the impact area and parallel to Area B, which contains fragments, debris, and components from frangible or exploding projectiles and warheads functioning on the near edge of the impact area. Area D is the safety area in which personnel are allowed, provided that ammunition certified for overhead fire is used during the exercise. Area E is the danger area directly in front of the weapon system, inside of which there is danger from muzzle debris, overpressure, blast, and hazardous impulse noise. Because firing is directed at individual and grouped targets, the actual area impacted by munitions is generally only a small part of the overall impact area.

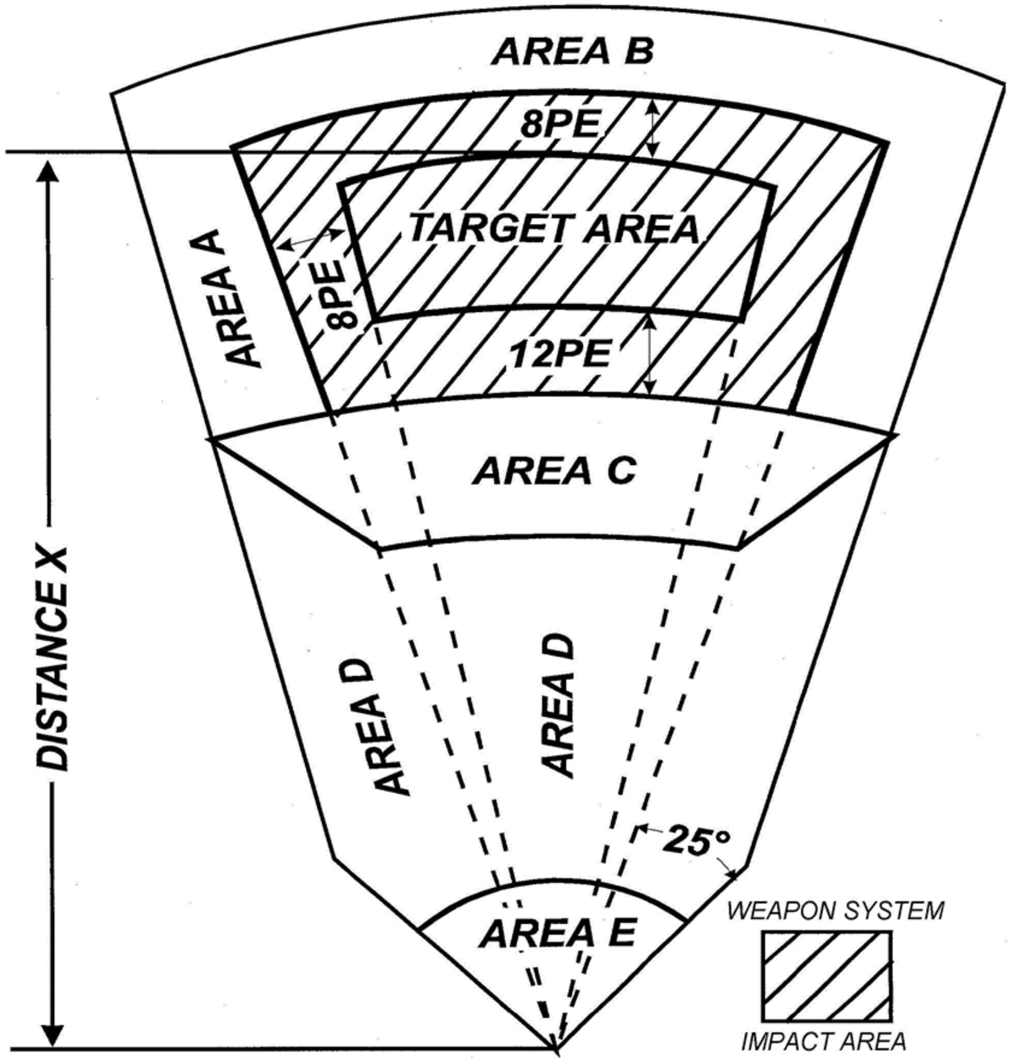

Figure 2-1 Surface Danger Zone for Indirect Artillery Fire

Note: PE = probable error in range or deflection.
Adapted from U.S. Army 2014.

Figure 2-2 provides an overview of where the targets for various munition types would be placed at ERF-IA under Alternative 1. Under Alternative 2, the expansion area would not be available.

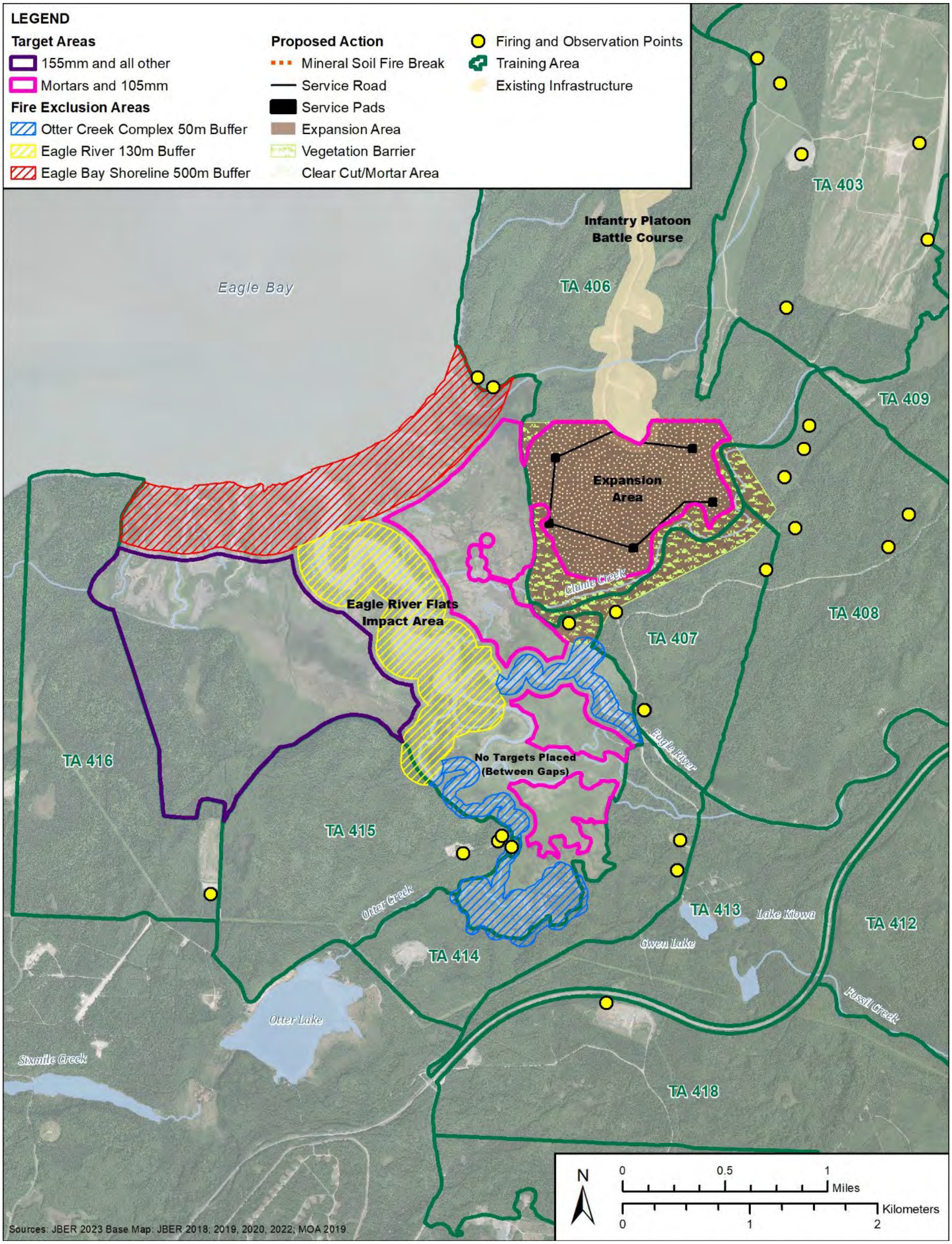

Figure 2-2 Target Areas for Artillery and Mortars at ERF-IA

2.2 PROJECT ALTERNATIVES

This EFH Assessment analyzes two alternatives for the proposed mortar and artillery training. Both alternatives remove winter firing restrictions and reinstate all-season indirect live-fire training and qualification at ERF-IA. Both alternatives also modify habitat protective buffers and implement additional protective measures to reduce noise impacts (Section 5.1). Alternative 1 (the Army's Proposed Action) differs from Alternative 2 in that it also expands ERF-IA (into an upland area) by approximately 585 acres. The maximum number of mortar and howitzer rounds that could be fired into ERF-IA annually under both alternatives is shown in Tables 2-2 and 2-3. There is no difference between alternatives as far as the total number of rounds allotted to JBER units that train in ERF-IA, although proportionally fewer rounds would be fired into ERF under Alternative 1 because of the new upland expansion area. Under both alternatives, 155-mm rounds would be added to the list of weapons available for use in ERF-IA. Currently, 155-mm rounds are not fired into ERF-IA.

Figure 2-3 shows how the proposed project would allow the Army to meet its indirect live-fire training requirements at JBER, with the full circle representing the total rounds needed. Under both alternatives, the Army would be unable to fire some smoke rounds; the hatched areas represent WP smoke rounds that are allocated to JBER units but would not be fired in ERF-IA (in either wetland or upland areas).

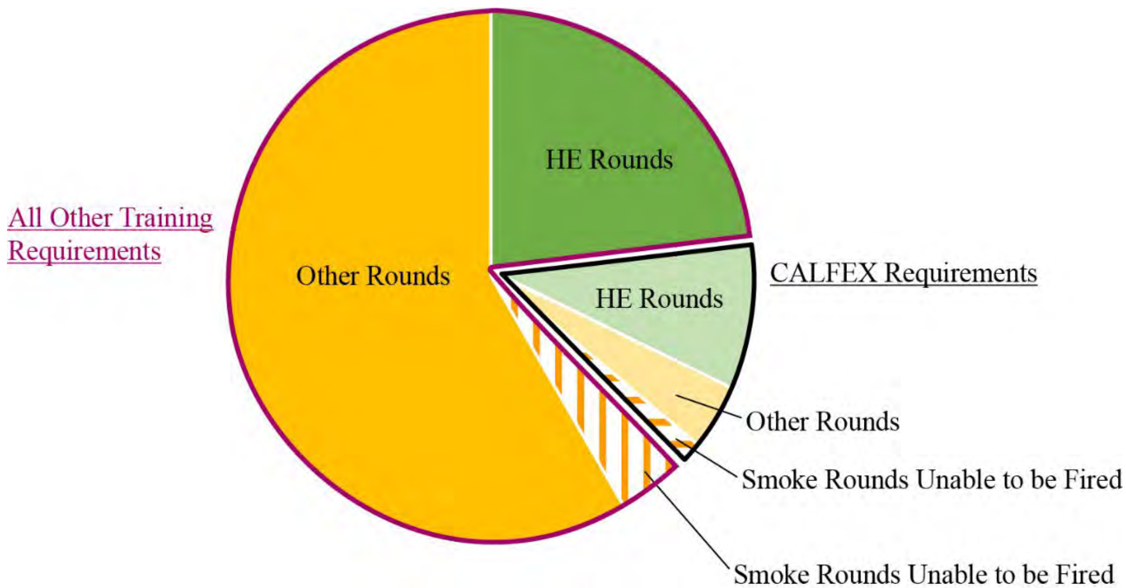

Figure 2-3 Indirect Live-Fire Training at JBER Under Alternatives 1 and 2

Under both alternatives, the protective measures discussed in Section 5.1 would be implemented to help protect EFH and managed species from noise impacts associated with live-fire training. These buffers would also provide additional benefits by reducing potential for erosion/sedimentation, release of contaminants into waterbodies, and risk of direct strike of munition fragments (shrapnel) to managed species. These protective measures are incorporated into the alternatives for the purpose of impact analysis in this report. They include habitat buffers based on the results of acoustic modeling (JASCO 2020, 2022) and expanded further through coordination with JBER planners and natural resource specialists to provide an additional level of protection. Other protective measures that would help protect managed species include prohibition of live firing during typical inundating tide events,[6] new target placement, "No Fire

[6] A note on terminology in this EFH Assessment: "Inundated" and "inundated conditions" refer to the tidal inundation that occurs when higher tides cause flooding outside the banks of Eagle River into the surrounding floodplain at ERF. The magnitude of inundation varies depending on the height of the tide and the ice cover (in winter), discharge from Eagle River, and wind direction. For the acoustic modeling completed in support of this EFH Assessment, conditions during "typical inundating tide events" were assumed. An inundation level of 0.5 meters (the typical inundation peak of a maximum tide event) was assumed for submerged detonation points during these events. "Typical high tide" conditions are equivalent to mean higher-high water. During typical high tide conditions, all detonation points are on dry ground and are not submerged.

Areas" along streams and shorelines, and no live firing during a seasonal window developed for the Cook Inlet beluga whale (*Delphinapterus leucas*) (see Section 5.1.2 for additional information).

2.2.1 Alternative 1—All-Season Live-Fire Training That Meets Training and Certification Requirements with Expanded Impact Area in Order to Fully Meet CALFEX Live Fire Proficiency in Accordance with Army Training Strategy (Proposed Action)

2.2.1.1 Impact Area Expansion

Figure 2-4 provides a visualization of the proposed expansion area to support indirect live-fire training. Construction would occur entirely in the 585-acre site and would entail clear cutting approximately 350 acres of vegetation and creating approximately 1.8 miles of gravel service roads and five vehicle gravel service pads inside the cleared area. The gravel service roads would be approximately 15 feet wide, and each service pad would be approximately 50 feet by 50 feet. In addition, a 3-mile firebreak would be created along the boundary of the cleared area to contain wildland fires and prescribed burns. The firebreak would be approximately 16 feet wide. An approximately 230-acre vegetated buffer would remain, as shown in Figure 2-4. This area would not be cleared but would be thinned to increase foot maneuverability and improve line of sight for training. To reduce the risk of wind throw, no more than one-third of the basal area of trees would be removed from the buffer.

Construction equipment would have access to the proposed expansion area to execute the design. Construction equipment (masticating hydro-axes, excavators, skidders, and feller bunchers) would clear vegetation, and salvageable trees would be disposed of in accordance with JBER forestry policy. Following clearing, the site would be reseeded with a native grass seed mix to revegetate and stabilize the cleared area.

The footprint of the service roads and pads would be grubbed and contoured to desired design prior to gravel installation. The firebreak would be constructed using a reciprocating Fecon machine to churn up the surface of the earth, creating a barrier of mineral soil that fire cannot spread through. Construction of the expansion area would take approximately 4 months to complete. The cleared portion of the expansion area would be maintained with controlled burning each year.

2.2.1.2 Training Under Alternative 1 (Proposed Action)

Under Alternative 1, Soldiers would gain the ability to conduct all-season live-fire qualification training using ERF-IA. Additionally, with the impact area expansion into upland to the east (Figure 2-4), a CALFEX live-firing proficiency exercise using a full array of weapons systems and munitions could be conducted. Table 2-4 provides an estimate of how many munitions would be fired in ERF (within the existing ERF-IA boundary) and how many would be fired in the upland expansion area under this alternative.

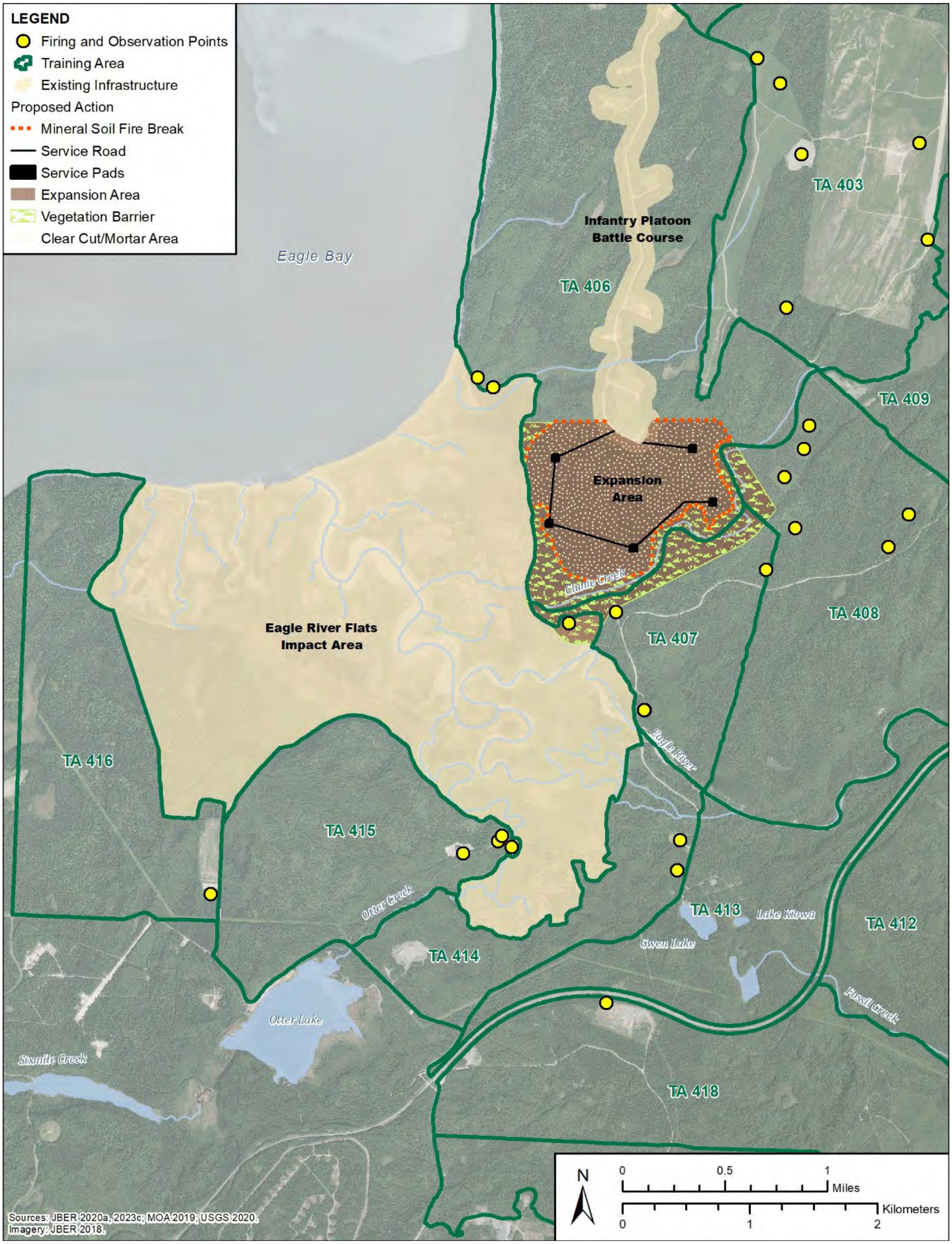

Figure 2-4 Proposed Impact Area Expansion under Alternative 1

Table 2-4 Munitions Fired into ERF and Proposed Expansion Area Annually under Alternative 1

Weapon System	HE	SMOKE	ILLUM	FRTR/Blanks Training Rounds
60-mm Mortar Rounds (total)	1,036	0	490	2,800
ERF	700	0	448	2,800
Expansion Area	336	0	42	0
81-mm Mortar Rounds (total)	592	0	280	1,600
ERF	400	0	256	1,600
Expansion Area	192	0	24	0
120-mm Mortar Rounds (total)	744	0	360	2,232
ERF	552	0	264	1,992
Expansion Area	192	0	96	240
105-mm Howitzer Rounds (total)	2,612	144	282	908
ERF	1,988	90	204	908
Expansion Area	624	54	78	0
155-mm Howitzer Rounds (total)	144	62	84	900
ERF	144	62	84	900
Expansion Area	0	0	0	0
TOTAL ANNUAL ROUNDS	**5,128**	**206**	**1,496**	**8,440**

Key: ERF = Eagle River Flats; FRTR = Full Range Training Rounds; HE = high explosive; ILLUM = illumination; mm = millimeter.

Table 2-4 shows the maximum annual potential munitions usage for Alternative 1. The focus of the proposed action is to meet Army training objectives for small unit training; however, because JBER has some capability to support larger unit exercises, the ammunition resources allocated by DA Pam 350-38 for those exercises are included in this analysis. Ultimately, it would be up to unit commanders to determine the specifics of each training exercise, including where to conduct that exercise.

2.2.2 Alternative 2—All-Season Live-Fire Training at Eagle River Flats Impact Area Only That Meets Training and Certification Requirements and Marginally Meets CALFEX Live Fire Proficiency in Accordance with Army Training Strategy

Under Alternative 2, all-season indirect live-fire proficiency training could be conducted at the existing ERF-IA. The full number of mortar and artillery rounds listed in Tables 2-2 and 2-3 could be fired annually, but the key difference between this alternative and Alternative 1 is that no additional acreage would be added to the current impact area (i.e., there would be no upland expansion area). Therefore, all mortar and artillery rounds would be fired into ERF, which would result in greater potential impacts to EFH and managed species, as described in the effects analysis (Chapter 4.0).

Live-fire training capabilities at JBER under Alternative 2 would fulfill Army training requirements for CALFEX certification; however, Soldiers would not receive the full benefit of a CALFEX because they would not experience the impacts of mortar and artillery rounds in close proximity. Due to its distance from ERF-IA, the maneuver portion of the CALFEX would be conducted parallel rather than perpendicular to the indirect-fire operations in ERF-IA. Some training would likely occur at Fort Wainwright under this alternative; however, the analysis in this EFH Assessment conservatively assumes that the maximum number of rounds would be fired in ERF-IA.

2.3 NUMBER OF ROUNDS FIRED BY ALTERNATIVE

Table 2-5 provides a summary of the total number of rounds that could be fired under each alternative, in comparison to the number of rounds fired under current conditions. As reflected in this table, the maximum total number of rounds fired at JBER would increase from baseline levels and would be the same for both Alternatives 1 and 2.

Table 2-5 Total Number of Rounds Allocated by Alternative

Munitions Type	Baseline (Current Conditions)	Alternative 1 (Proposed Action)	Alternative 2
60-mm Mortar HE Rounds	518	1,036	1,036
60-mm Mortar Other Rounds	1,645	3,290	3,290
81-mm Mortar HE Rounds	296	592	592
81-mm Mortar Other Rounds	940	1,880	1,880
120-mm Mortar HE Rounds	372	744	744
120-mm Mortar Other Rounds	1,296	2,592	2,592
105-mm Howitzer HE Rounds	1,306	2,612	2,612
105-mm Howitzer Other Rounds	714	1,334	1,334
155-mm Howitzer HE Rounds	N/A	144	144
155-mm Howitzer HE Training Rounds	N/A	900	900
155-mm Howitzer Other Rounds	N/A	146	146
Total Rounds	**7,087**	**15,270**	**15,270**

Note: Munitions containing phosphorus as a primary constituent would not be used in ERF or the upland expansion area.

Key: ERF = Eagle River Flats; HE = high explosive; mm = millimeter; N/A = not applicable.

2.4 EXISTING CONSERVATION MEASURES

The Army, JBER (Air Force, supported components, and tenant organizations), and contractors are required to comply with applicable laws, regulations, and policies.

Standard best management practices used at JBER include rigorous training by Soldiers to avoid errors when firing munitions, use of SDZs for personnel and protective redundancies in firing protocol, marine mammal observation, and cease-fire protocols.

USARAK Regulation 350-2 prohibits firing into or over any open navigable waterbody unless specific coordination with the U.S. Army Corps of Engineers (USACE) occurs**.** Navigable waterbodies of the U.S. are those waters that are subject to the ebb and flow of the tide and/or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. A determination of navigability, once made, applies laterally over the entire surface of the waterbody and is not extinguished by later actions or events which impede or destroy navigable capacity (33 CFR 329.4). DA Pam 385-63 defines a navigable waterway as any body of water open to the free movement of marine vessels. Eagle River is determined to be a navigable waterway from its mouth upstream to just west of Glenn Highway.

For the Army, firing into or over a navigable waterbody is prohibited unless specific coordination with the U.S. Army Corps of Engineers (USACE) occurs. Each Service has procedures in place to fire into and over navigable waterways, such as the Army's action locally at JBER firing across Eagle River, the U.S. Navy's Point Magu Sea Range in California's Channel Islands, and the Air Force's Eglin Gulf Test and Training Range in the Gulf of Mexico. In accordance with DA Pam 385-63, USARAK requested that Eagle River be restricted where it flows through the impact area so units could fire over the river. USACE issued a final rule establishing a restricted area for the portion of Eagle River between its mouth and Bravo Bridge (87 Federal Register [FR] 58452). The effective date of the rule was 27 October 2022. The rule indicates that, "Establishment of the restricted area will prevent all vessels, watercraft, and individuals from entering an active military range munitions impact area at all times, except for authorized vessels, watercraft, and individuals engaged in support of military training and management activities." The authority to allow entry lies with the USARAK Commander. As a result of the USACE decision to close Lower Eagle River to the public, USARAK Regulation 350-2 will be updated to allow firing over (but not into) Eagle River where it flows through the area closed to the public. Additionally, Range personnel will post large, highly visible signage at the mouth of Eagle River and upstream of Bravo Bridge to inform the public of the closure.

Open water has multiple definitions and must be read in context. Open water generally refers to water not frozen. JBER's training protocols clearly state that there would be no intentional firing into open waterbodies and that targets would not be placed in open waterbodies. In this context, open waterbodies are defined as rivers, streams, intertidal channels, gullies, lakes, ponds, or other areas that contain water. That said, ERF has areas that frequently contain vegetated waters of varying depths. Forward observers would look for observable open water; if no such waters are observed in the intended target area, the live-fire training would proceed. It is possible that the target area could contain areas of flowing or standing water, fully covered by vegetation (typically tall grasses) where small fish, including juvenile salmon, may be present. USARAK Regulation 350-2 requires all rounds to be visually observed impacting or bursting. This restriction leads to not firing into water bodies that are deep enough that the impacts/effects of rounds cannot be observed. So long as all rounds are visually observed impacting or bursting, which would indicate that they have not landed in water, firing will continue as intended. In this EFH Assessment, the word "inundated" is used specifically to refer to the tidal inundation that occurs when higher tides cause flooding outside the banks of Eagle River and into the surrounding floodplain.

The following additional requirements are relevant to the protection and conservation of EFH and would occur under all alternatives:

- Adherence to the Department of Defense Instruction 4715.03, Natural Resources Conservation Program (Department of Defense 2011).
- JBER Integrated Natural Resource Management Plan (INRMP) (JBER 2023a). Note: INRMP projects are ranked and funded by priority. Completion of projects in past years does not guarantee continued implementation in future years.
- Harassment of fish and wildlife is prohibited. Any action that disturbs fish and wildlife is considered harassment by federal and Alaska State law. Examples of harassment include pursuit with vehicles or aircraft, feeding, and shooting of wildlife. Vehicles, watercraft, and aircraft (including helicopters) may not be used to herd/chase wildlife off ranges or training areas.

- Adherence to spill prevention and cleanup procedures outlined in the most current INRMP (JBER 2023a) and JBER Spill Prevention, Control, and Countermeasures Plan (JBER 2023e).
- Adherence to the most current JBER Industrial Storm Water Pollution Prevention Plan (JBER 2022a).

Existing seasonal restrictions and habitat protective buffers that are currently in place are not included as part of Alternatives 1 and 2. Instead, protective measures (Section 5.1) developed specifically to protect managed species and other species are incorporated into the alternatives for the purpose of impact analysis in this document. These include revised protective buffers based on acoustic modeling, limited fire periods for HE rounds (during inundating tide events, during the peak Cook Inlet beluga whale visitation period), and redistribution of targets. In addition, JBER has identified some reasonable and prudent mitigation measures (Section 5.2) based on the analysis that are expected to provide additional protections for EFH and managed species as well as ensure through monitoring and adaptive management that the proposed project is sufficiently protective of EFH and managed species. JBER would work with NMFS (cooperating agency) to refine the mitigation measures, as needed, to obtain concurrence and ensure compliance with the MSA.

3.0 ESSENTIAL FISH HABITAT IN THE PROPOSED PROJECT AREA

3.1 INTRODUCTION

The 1996 amendments to the MSA set forth a mandate for NMFS, regional Fishery Management Councils (FMCs), and other federal agencies to identify and protect EFH of economically important marine and estuarine fisheries. A provision of the MSA requires that FMCs identify and protect EFH for every species managed by an FMP (16 U.S.C. 1853[a][7]).

In Alaska, NMFS works with the Alaska Department of Fish and Game (ADF&G) and other agencies to identify and protect EFH for federally managed fish species. EFH is designated by FMCs in FMPs based on best available scientific information (NMFS 2005). EFH is implemented by NMFS. In addition, specific locations have been defined as Habitat Areas of Particular Concern (HAPCs), which are areas “with extremely important ecological function and/or areas that are especially vulnerable to human-induced degradation” (NMFS 2021). Because no HAPCs would overlap with proposed project components, they are not discussed further in this EFH Assessment.

EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (16 U.S.C. 1802 [10]). For the purposes of this definition,

- “Waters” means aquatic areas and their associated physical, chemical, and biological properties;
- “Substrate” includes sediment, hard bottom, structures underlying the water surfaces, and associated biological communities;
- “Necessary” means the habitat required to support a sustainable fishery and healthy ecosystem; and
- “Spawning, feeding, and breeding” are terms used to encompass the complete life cycle of a species. (50 CFR Part 600).

The proposed project has the potential to affect EFH in marine and freshwater waterbodies. EFH for Pacific salmon and groundfish has been designated under the following FMPs in or near areas where proposed project activities would occur:

- *Fishery Management Plan for the Salmon Fisheries in the EEZ Off Alaska* (Salmon FMP) (NPFMC et al. 2021)
- *Fishery Management Plan for Groundfish of the Gulf of Alaska* (GOA Groundfish FMP) (NPFMC 2020)

Designated EFH for federally managed species in Knik Arm and the proposed project area is listed in Table 3-1. EFH is designated based on the best available scientific information and the levels defined by the MSA, including the following levels and corresponding information (NMFS 2005):

- Level 1—general distribution
- Level 2—density or relative abundance
- Level 3—growth, reproduction, or survival rates
- Level 4—production rates

Table 3-1 Designated Essential Fish Habitat for Federally Managed Species Known to Occur in Knik Arm and Proposed Project Area

Species Management Unit	Lifestage(s) Found at Location	Management Council	Fisheries Management Plan
Groundfish			
Alaska plaice (GOA)	Egg and larvae (Summer)	North Pacific	Amendment 105 GOA Groundfish FMP
Yellowfin sole (GOA)	Egg (Summer)	North Pacific	Amendment 105 GOA Groundfish FMP
Dover sole (GOA)	Larvae (Summer)	North Pacific	Amendment 105 GOA Groundfish FMP
Flathead sole (GOA)	Larvae (Summer)	North Pacific	Amendment 105 GOA Groundfish FMP
Northern rock sole (GOA)	Larvae (Summer)	North Pacific	Amendment 105 GOA Groundfish FMP
Pacific cod (GOA)	Larvae (Summer)	North Pacific	Amendment 105 GOA Groundfish FMP
Rex sole (GOA)	Larvae (Summer)	North Pacific	Amendment 105 GOA Groundfish FMP
Starry flounder (GOA)	Juveniles and adults	North Pacific	Amendment 105 GOA Groundfish FMP
Forage fish complex	Adult eulachon; juvenile and adult longfin smelt	North Pacific	Amendment 105 GOA Groundfish FMP
Salmonids			
Chinook salmon	Marine juvenile, sub adult, and mature adult	North Pacific	Amendment 13 Salmon FMP
Chum salmon	Marine juvenile, sub adult, and mature adult	North Pacific	Amendment 13 Salmon FMP
Pink salmon	Marine juvenile, sub adult, and mature adult	North Pacific	Amendment 13 Salmon FMP
Sockeye salmon	Marine juvenile, sub adult, and mature adult	North Pacific	Amendment 13 Salmon FMP
Coho salmon	Marine juvenile, sub adult, and mature adult	North Pacific	Amendment 13 Salmon FMP

Key: GOA = Gulf of Alaska; FMP = Fishery Management Plan.

Source: NMFS 2022a, b.

Many managed species are particularly important in Eagle Bay and ERF because they comprise an important part of the diet for endangered Cook Inlet beluga whales. Managed Pacific salmon (*Oncorhynchus* spp.) and several forage fish species (e.g., eulachon [*Thaleichthys pacificus*]) constitute one of the five primary constituent elements (PCEs) in the survival and recovery of Cook Inlet beluga whales (76 FR 20179).

Over the past decade, JBER has monitored salmon species in Eagle River to provide key insights to the state of natural resources, support management decisions, and ensure sustainable practices (AERC 2021). The Eagle River salmon monitoring data collected as part of this program are summarized in Section 3.4.2.

3.2 SALMON FISHERY MANAGEMENT PLAN

The proposed project is within the jurisdiction of the Salmon FMP (NPFMC et al. 2021), which lists five species of Pacific salmon that are known to occur in the proposed project area: Chinook, sockeye, coho, chum, and pink. Federally listed Evolutionarily Significant Units and Distinct Population Segments of Pacific Salmon from the U.S. West Coast (Washington, Oregon, and California) may range throughout the North Pacific. However, the specific occurrence of listed salmonids in close proximity to JBER is highly unlikely (NMFS 2011). Therefore, the salmon species described under this plan only include non-listed stocks that originate in Alaska.

The Salmon FMP (NPFMC et al. 2021) provides EFH descriptions for the five Pacific salmon species in the marine environment. For these salmon species, marine EFH includes the waters in the 200-mile EEZ around Alaska; all five salmon species are found in Eagle Bay (NMFS 2022a, b). Pacific salmon populations in Eagle Bay are in the West Management Area, which includes all federal waters west of Cape Suckling in the GOA to Demarcation Point in the Beaufort Sea.

NMFS is proposing an amendment to the Salmon FMP that would establish federal management for the salmon fisheries in the federal (EEZ) waters of Upper Cook Inlet (88 FR 25382). The Upper Cook Inlet EEZ is located between Clam Gulch and Anchor Point, or approximately 100 miles southwest of the proposed project area. Public comments were accepted through 25 May 2023. After the public hearing, NMFS will develop an FMP amendment and request additional public comments before issuing a final FMP amendment.

The Salmon FMP indicates that EFH for freshwater phases of each species are listed in the *Catalog of Waters Important for the Spawning, Rearing or Migration of Anadromous Fishes* (also referred to as the "Anadromous Waters Catalog" [AWC]) and its associated atlas (ADF&G 2022a). The catalog lists waterbodies where Pacific salmon species and their habitat uses have been documented in field studies, but it is not a comprehensive list; therefore, additional field studies may be required to identify EFH for Pacific salmon life stages that are not listed in the catalog. Salmon life stages expected to be present in marine and freshwater portions of the proposed project area are shown in Table 3-2.

Table 3-2 Pacific Salmon EFH Life Stages Present in the Proposed Project Area

Waterbody/ Anadromous Waters Catalog No.	Salmon Species				
	Chinook	Chum	Coho	Pink	Sockeye
Knik Arm (Eagle Bay)	(J), I, (M)	J, I, M	J, (I), M	J, (I), M	J, I, M
Eagle River 247-50-10110	P, R	P	P	P	P, R
Otter Creek 247-50-10110-2010	P, R	P, S	P, S, R	P	P, S
Otter Creek North Intertidal Channel 247-50-10110-2010-3007	R, (J)	-	R	-	-
Otter Creek South Intertidal Channel 247-50-10110-2010-3009	-	-	R	-	-
Otter Lake 247-50-10110-2010-0010	(M, P)	-	S, R	P	P, (S)

Notes:

[1] Life stages in parentheses have been observed at JBER but have not been formally designated as EFH in NMFS 2022a or ADF&G 2022a.

[2] Lateral extent of EFH extends up to Mean Higher Tide Line for estuarine waters and Ordinary High Water Elevation for fresh waters ((NPFMC et al. 2021).

Key: "-" = Presence or life stages not identified in AWC Catalog or Atlas (ADF&G 2022a); EFH = Essential Fish Habitat; J = juveniles; JBER = Joint Base Elmendorf-Richardson; I = immature adults; M = mature adults; P = documented presence; R = documented rearing; S = documented spawning.

Sources: ADF&G 2022a; Giefer and Graziano 2022; NMFS 2022a, b.

The generalized life history of Pacific salmon in Alaska involves adult salmon migrating into and spawning in fresh water. Fertilized eggs are deposited in a prepared redd (nest), and after a period of incubation, fry emerge from the redd. Once emerged, some species spend up to 2 years rearing in fresh water, while others migrate directly to the marine environment, where they feed and grow for up to 7 years before returning to their natal freshwater streams to spawn. Therefore, Pacific salmon may have EFH in both freshwater and marine environments.

Many estuaries in southcentral Alaska, such as ERF, provide important nursery habitat for juvenile salmonids, particularly coho. sockeye, and Chinook (ARRI 2013; Pierce 2017). Estuaries tend to be shallow, protected, nutrient rich, and biologically productive areas, where a high diversity of species can flourish. Because of tidal cycles and freshwater runoff, salinity varies within estuaries and results in a variety of freshwater, brackish, and marine habitats that may be used by numerous species.

Adult and juvenile salmonid rearing and migration timing patterns vary by species, but regionally speaking, the peak adult salmon migration generally runs from early July through August. Juvenile abundance is greatest during the peak outmigration period (April through July), although some juvenile salmonids may be present in ERF waterbodies throughout the year (Moulton 1997; Schoofs et al. 2018; Bogan et al. 2018, 2019; AERC 2021). Information on the seasonality and migratory patterns of adult and juvenile salmon in ERF-IA and Eagle Bay is provided in Tables 3-3 and 3-4.

Table 3-3 Summary of Adult Salmon Migration Timing in the Proposed Project Area

Species	Time of Year					
	May	Jun	Jul	Aug	Sep	Oct
Chinook						
Sockeye						
Pink						
Chum						
Coho						

Notes: Dark bars indicate peak migration periods; light bars represent estimated total period of occurrence. Timing is based on Eagle River data.
Sources: Johnson et al. 2015; Johnson and Bottom 2016; Schoofs et al. 2018; Weber and Seigel 2020a, b; JBER 2023a.

Table 3-4 Summary of Juvenile Salmon Rearing and Migration in the Proposed Project Area

Species	Time of Year											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chinook												
Sockeye												
Coho												
Chum												
Pink												

Note: Dark bars indicate peak presence, which includes emigration and rearing, while lighter-colored bars represent general rearing presence. This table incorporates general and site-specific information and applies to all waterways within the project area.
Sources: Moulton 1997; Schoofs et al. 2017, 2018; Bogan et al. 2018, 2019; JBER 2019c; NPFMC et al. 2021.

3.2.1 Chinook Salmon

3.2.1.1 Life History and Distribution

Chinook salmon are the largest and least abundant of the Pacific salmon in Alaska. In Alaska, they are distributed from the Chukchi and Beaufort coasts to Southeast Alaska (Groot and Margolis 1998; Mecklenburg et al. 2002). Larger rivers (e.g., Yukon River) generally tend to support larger Chinook runs.

Chinook may spawn up to 2,000 miles upstream from the ocean, or they may use short tributaries just above tidewater (NPFMC et al. 2021). Threats to Chinook salmon in Upper Cook Inlet include overfishing, dams, habitat loss, habitat degradation, stormwater runoff, variable ocean conditions, and climate change (ADF&G n.d.-a; Beamesderfer et al. 2015).

Chinook salmon exhibit high variability within and among populations in length and timing of freshwater, estuarine, and oceanic residency. They have two basic life history types: stream and ocean-type fish (Quinn 2005). Stream-type fish have long freshwater residence as juveniles (1 to 2 years), migrate rapidly to oceanic habitats, and return to their natal river in the spring or summer, several months prior to spawning.

Ocean-type fish have a short freshwater residency (lasting up to 1 year), extensive estuarine residency, a more coastal-oriented ocean distribution, and return to their natal river in the fall to spawn (NPFMC et al. 2021). In Alaska, the stream-type life history is predominant, although both stream and ocean-type life histories have been documented in northern Cook Inlet (ARRI n.d.). Based on the spring timing of adult returns to Eagle River and documentation of large juveniles (greater than 100 mm) at the mouth of Eagle River, Chinook salmon in the proposed project area appear to be stream-type fish (Schoofs et al. 2018).

Chinook salmon are highly piscivorous (i.e., feed on fish) and are also distributed deeper in the water column than other species of Pacific salmon. While other species of salmon generally are surface oriented, primarily using the upper 20 meters of the water column, Chinook salmon tend to be at greater depths (30 to 70 meters) and typically remain at sea for 1 to 6 years before returning to their natal streams to spawn (NPFMC et al. 2021). Fish make up the largest component of the Chinook salmon diet at sea, although squid, pelagic amphipods, copepods, and euphausiids are also important prey species.

Chinook salmon typically return to Alaska streams to spawn from May through July (ADF&G n.d.-a). In Eagle River, the Chinook spawning run is usually completed by early July (JBER 2023a). Chinook may spawn in water ranging in depth from a few centimeters to several meters, with velocities typically ranging from 40 to 60 centimeters per second. Females bury their eggs in clean gravel, 20 to 36 centimeters deep. Because of their large size, Chinook salmon are able to spawn in higher water velocities and use coarser substrates than other salmonid species. Once fertilized, Chinook females remain on their redds for 6 to 25 days after spawning. Fertilized eggs begin their 5- to 8-month period of embryonic development and growth in gravels. Threats to eggs, alevins (hatchlings), and pre-emergent fry include freezing, desiccation, stream bed scouring or shifting, and predators. Stream-type juveniles are dependent on freshwater ecosystems because of their extended residence in these areas. Their principal freshwater prey consist of larval and adult insects. The seaward migration of smolts is timed so that the smolts arrive in the estuary when food is plentiful and consists of epibenthic organisms, insects, and zooplankton (NPFMC et al. 2021).

3.2.1.2 EFH Description

Freshwater EFH has been designated for rearing juvenile Chinook salmon in Eagle River and Otter Creek, as identified in the AWC (Giefer and Graziano 2022; ADF&G 2022a). EFH includes contiguous rearing areas in the boundaries of ordinary high water throughout the year. Juvenile Chinook salmon outmigrate from freshwater areas in April toward the sea and may spend up to a year in Eagle River and Otter Creek and their tributaries. Chinook salmon smolts and post-smolt juveniles may be present in estuarine habitats from April through September. EFH for adult Chinook salmon spawning has been designated in upper Eagle River tributaries (e.g., South Fork Eagle River) but not in the proposed project area.

Marine EFH for immature and maturing adult Chinook salmon includes Eagle Bay and Knik Arm of Cook Inlet. EFH for this life stage includes all marine waters off the coast of Alaska from the mean higher tide line to the 200 nautical mile limit of the U.S. EEZ. Marine mature Chinook salmon inhabit pelagic marine waters from January to September, by which time the mature fish have migrated out of marine waters.

3.2.2 Chum Salmon

3.2.2.1 Life History and Distribution

Chum salmon are very widely distributed throughout Alaska (including in Cook Inlet drainages) and range throughout the state as the third most abundant species after pink and sockeye (ADF&G n.d.-b; Quinn 2005). Chum salmon usually spawn at the mouth or in the lower sections of rivers, although in Alaska's largest river systems, some travel great distances (up to 2,000 miles to the upper Yukon River in Canada) upriver to spawn (ADF&G n.d.-b). Although generally regarded as one of the less desirable species of salmon, in arctic, northwestern, and Interior Alaska, chum salmon are highly prized as a traditional source of dried winter food. Potential future threats to chum salmon in Alaska include habitat loss, climate change, overfishing, and competition from hatchery fish (ADF&G n.d.-b).

Like other Pacific salmon species, chum salmon usually spawn in the fall. Chum salmon comprise two distinct stocks based on spawning-run timing: summer and fall chum salmon. In the proposed project area, chum are considered fall-run fish because they return between July and September (JBER 2023a). Most chum spawning is completed by early November. Preferred spawning areas include small-to-medium, slow-flowing, spring-fed side channels with groundwater upwelling, but chum salmon will also spawn in intertidal portions of streams and rivers (ADF&G n.d.-b; NPFMC et al. 2021). Chum salmon are known to migrate through Eagle River and Otter Creek. Spawning has been documented in Otter Creek upstream of ERF (ADF&G 2022a; JBER 2023a).

The depth that eggs are deposited in streams varies according to the gravel size, current, and size of the female, but the range is about 8 to 50 centimeters. Chum salmon embryos hatch from eggs after 3 to 4 months, depending on water temperature. Alevins remain in the gravel for an additional 60 to 90 days before emerging. They begin their migration to the sea within days or weeks (ADF&G n.d.-b).

Chum salmon fry do not overwinter in streams but migrate (mostly at night) out of streams directly to the sea shortly after emergence. The range of this outmigration is from February to June, but most fry leave streams during April and May. Chum salmon do tend to linger and forage in the intertidal areas at the head of bays during the spring and summer months. Chum can use these intertidal wetlands and eelgrass beds for several months before actively migrating toward outside waters (ADF&G n.d.-b; NPFMC et al. 2021). Chum salmon consume a wide variety of food items, including mostly invertebrates (including insects), and gelatinous species. Offshore movement of larger juveniles occurs mostly from July to September. At sea, juvenile chum salmon spend several months near shore then disperse into the open ocean, where they can be found at depths of up to 61 meters (Mecklenburg et al. 2002). Adults consume a variety of foods during their ocean life, including invertebrates, fish, and squid larvae.

3.2.2.2 EFH Description

Freshwater EFH has been designated for Eagle River and Otter Creek due to documented presence of chum salmon, as identified in the AWC (Giefer and Graziano 2022; ADF&G 2022a). EFH for adult spawning chum salmon includes Otter Creek, as identified in the AWC (Giefer and Graziano 2022; ADF&G 2022a), wherever spawning substrates consist of clean, medium-to-coarse gravel containing less than 15 percent fine sediment (less than 2 mm diameter). Finer substrates can be used in upwelling areas of streams and sloughs from June through January (NPFMC et al. 2021).

Marine EFH has been designated for juvenile, immature, and maturing adult chum salmon in Eagle Bay and Knik Arm of Cook Inlet. EFH for juvenile chum salmon includes estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line within nearshore waters. Chum salmon juveniles are generally present in this area from late April through June. Marine EFH for juvenile chum salmon includes all marine waters off the coast of Alaska from the mean higher tide line to the 200 nautical mile limit of the U.S. EEZ, and to depths of up to 50 yards. Marine EFH for immature and maturing adult chum salmon includes all marine waters off the coast of Alaska from the mean higher tide line to the

200 nautical mile limit of the U.S. EEZ, and to depths of up to 200 yards (NPFMC et al. 2021). This includes Eagle Bay and Knik Arm.

3.2.3 Coho Salmon

3.2.3.1 Life History and Distribution

Coho salmon are widely distributed in Alaska, ranging from Southeast to Point Hope on the Chukchi Sea and in the Yukon River to the Alaska-Yukon border (ADF&G n.d.-c). They are extremely adaptable and use more diverse habitats than other salmon. Coho are most abundant in coastal areas from central Oregon north through Southeast Alaska.

Coho salmon typically return to Eagle River around the end of July to access spawning grounds in upper portions of the river system and in Otter Creek and Otter Lake (upstream of the project area) (ADF&G 2022a; JBER 2023a). Spawning may occur from September through January (NPFMC et al. 2021; JBER 2023a). Preferred spawning sites have relatively silt-free gravels ranging from 2 mm to 10 centimeters in diameter, well-oxygenated intra-gravel flow, and nearby cover (NPFMC et al. 2021). The eggs develop during the winter and hatch in early spring, and the embryos remain in the gravel until they emerge in May or June. The emergent fry occupy ponds, lakes, and pools in streams and rivers, usually among woody debris and slow-velocity, calm waters. During the fall, juvenile coho locate off-channel habitat to overwinter.

Recent research has found that estuaries play a crucial role in the growth and development of juvenile coho and are considered to be an important life strategy mechanism (Koski 2009; Hoem Neher 2012; Hoem Neher et al. 2013, 2014). Studies have found that juvenile coho move great distances to opportunistically feed and then retreat and rest (Armstrong et al. 2013). Evidence of coho rearing and overwintering in estuarine habitats suggests that estuaries function as much more than just staging or transitional habitats (Koski 2009; Hoem Neher 2012; Hoem Neher et al. 2013, 2014; Hughes et al. 2014). Coho have been found to use these types of habitats within the Otter Creek and Eagle River wetland complexes (Bogan et al. 2018, 2019; JBER 2019c; JBER unpublished data 2023). Documented use of rearing and overwintering habitat by coho at JBER is described in Section 3.4.3.2.

Juvenile coho salmon require year-round rearing habitat and also migration habitat from April to November to provide access to and from the estuary (NPFMC et al. 2021). Some fish leave fresh water in the spring and rear in brackish estuarine areas, then migrate back to fresh water in the fall. They spend one to three winters in streams and may spend up to five winters in lakes before migrating to the sea in the spring (Mecklenburg et al. 2002; NPFMC et al. 2021).

Coastal residence time varies. Some males mature and return after only 6 months at sea, while most fish stay between 18 months to 3 years before returning as full-size adults (ADF&G n.d.-c; Mecklenburg et al. 2002). Juvenile coho may be found at depths of up to 50 meters. In fresh water, coho fry feed voraciously on a wide range of aquatic insects and plankton. They also consume eggs deposited by adult spawning salmon. Their diet at sea consists mainly of fish and squid (ADF&G n.d.-c).

3.2.3.2 EFH Description

Freshwater EFH has been designated for Eagle River due to documented presence of migrating and spawning coho salmon, as identified in the AWC (ADF&G 2022a; Giefer and Graziano 2022). EFH for adult spawning coho salmon includes Otter Creek and Otter Lake, as identified in the AWC (ADF&G 2022a; Giefer and Graziano 2022), wherever spawning substrates consisting mainly of gravel containing less than 15 percent fine sediment (less than 2 mm diameter) from July to December (NPFMC et al. 2021). Because Otter Creek and Otter Lake support coho spawning, they also are designated as EFH for eggs in gravel substrates, as well as for freshwater larvae and juvenile life stages, which include contiguous rearing areas within the boundaries of ordinary high water. Fry generally migrate to a lake, slough, or estuary and rear in these areas for up to 2 years (NPFMC et al. 2021).

Marine EFH has been designated for juvenile and maturing adult coho salmon in Eagle Bay and Knik Arm. EFH for juvenile coho salmon includes marine waters off the coast of Alaska from the mean higher tide line to the 200 nautical mile limit of the U.S. EEZ. Marine juvenile coho salmon inhabit these marine waters from June to September. Marine EFH for maturing adult coho salmon includes marine waters off the coast of Alaska to 200 meters in depth and ranges from the mean higher tide line to the 200 nautical mile limit of the U.S. EEZ. Marine mature coho salmon inhabit pelagic marine waters in the late summer, by which time the mature fish tend to migrate out of marine waters, such as Eagle Bay and Knik Arm (NPFMC et al. 2021).

3.2.4 Pink Salmon

3.2.4.1 Life History and Distribution

Pink salmon, the most abundant of the Pacific salmon species, range from as far north as the Arctic Ocean south to Puget Sound, Washington (ADF&G n.d.-d; Mecklenburg et al. 2002). Pink salmon have the shortest lifespan of any Pacific salmon. They mature and complete their life cycle in 2 years, with approximately 18 months of that period spent foraging at sea (ADF&G n.d.-d; Mecklenburg et al. 2002). Pink salmon also have two genetically distinct odd- and even-year populations, which do not interbreed, with abundance shifting between the populations depending on the year and stream (ADF&G n.d.-d; Mecklenburg et al. 2002; Quinn 2005).

Pink salmon generally spawn in small coastal rivers and estuaries, and most do not travel more than 40 miles upstream, with some exceptions for larger river systems such as the Susitna, Yukon, and Mulchatna Rivers (ADF&G n.d.-d). Presence of pink salmon has been documented in Eagle River, Otter Creek, and Otter Lake (ADF&G 2022a; JBER 2023a). Pink salmon run timing begins at the end of July, with the run complete by the end of August (JBER 2023a). Pink salmon spawning has not been documented in Eagle River or its tributaries; however, it is assumed that spawning areas could occur in Eagle River upstream of ERF-IA. Pink salmon typically spawn between late June and mid-October.

Pink salmon fry begin swimming to the ocean as soon as they emerge from the gravel and therefore generally do not eat as they leave fresh water. Once at sea, they begin feeding on plankton, larval fishes, and occasional aquatic insects. After 18 months of feeding and growing in salt water, they reach maturity and return to their natal river to spawn (ADF&G n.d.-d). The eggs incubate over winter and hatch in late winter or early spring. Eggs are laid in high densities due to food constraints rather than space for incubation constraints (Quinn 2005). Fry emerge from eggs prepared for the sea with adaptations for movement and countershading to stay protected during their marine life (Quinn 2005). After young pink salmon emerge from the gravel and migrate to salt water, they gather in schools and remain in estuaries and along beaches. They are generally present within estuarine areas from late April through June (NPFMC et al. 2021). Eventually, they begin spending more time feeding in the deeper offshore waters (ADF&G n.d.-d). In the ocean, pink salmon feed on plankton, marine crustaceans, other smaller fish, squid, and the occasional aquatic insect.

3.2.4.2 EFH Description

Freshwater EFH has been designated for Eagle River, Otter Creek, and Otter Lake due to documented presence of migrating pink salmon, as identified in the AWC (ADF&G 2022a; Giefer and Graziano 2022); however, EFH for pink salmon spawning has not been designated in Eagle River or its tributaries.

Marine EFH for juvenile pink salmon is in marine waters off the coast of Alaska from the mean higher tide line to the 200 nautical mile limit of the U.S. EEZ, which includes Eagle Bay and Knik Arm. Juvenile pink salmon distribute in coastal waters along the entire shelf (0 to 200 meters) from mid-summer until December, then migrate to pelagic waters (upper 50 meters) off the slope (200 to 3,000 meters). Marine EFH for maturing adult pink salmon is in marine waters off the coast of Alaska to depths of 200 meters and ranges from the mean higher tide line to the 200 nautical mile limit of the U.S. EEZ, including Eagle Bay and Knik Arm of Cook Inlet. Mature adult pink salmon are present from fall through the mid-summer in pelagic waters (upper 50 meters) off the slope (0 to 200 meters) before returning to spawn in intertidal areas and coastal streams.

3.2.5 Sockeye Salmon

3.2.5.1 Life History and Distribution

Alaska is home to the largest sockeye salmon fishery in the world (Bristol Bay) and supports numerous populations throughout the state. In good years, these runs can number in the tens of millions of fish. In Alaska, their range extends from Point Hope south to Bristol Bay. Freshwater lakes, streams, and estuaries provide important habitat for spawning and rearing sockeye. There are hundreds of stocks of sockeye salmon throughout the state of Alaska, and their population trends are diverse; some stocks are in decline, while others are at equilibrium or increasing. Potential future threats include habitat loss, habitat degradation, climate change, and overfishing (ADF&G n.d.-e).

Sockeye salmon spend 1 to 4 years in fresh water and 1 to 3 years in the ocean. Sockeye typically return to Eagle River between early July and the end of August to access spawning habitats in upper portions of the river system and in Otter Creek/Otter Lake (ADF&G n.d.-e; JBER 2023a). Spawning generally occurs during late summer and autumn. Eggs hatch during the winter, and fry emerge from the gravel in the spring and move to rearing areas. In systems with lakes, juveniles usually spend 1 to 3 years in fresh water, feeding on zooplankton and small crustaceans, before migrating to the ocean in the spring as smolts. However, in systems without lakes, sockeye fry may feed in streams or low-salinity estuaries for several months before migrating to offshore ocean areas. Smolts grow quickly during their 1 to 3 years in the ocean, feeding on plankton, insects, small crustaceans, and occasionally squid and small fish.

3.2.5.2 EFH Description

Freshwater EFH has been designated for Eagle River and Otter Creek due to documented presence and rearing of sockeye salmon and for Otter Creek (and potentially Otter Lake) for spawning, as identified in the AWC (Giefer and Graziano 2022; ADF&G 2022a; JBER 2023a). EFH for sockeye salmon adults includes spawning substrates consisting of medium to coarse gravel containing less than 15 percent fine sediment (less than 2 mm diameter) and finer substrates, which can be used in upwelling areas of streams and sloughs from June through September. Sockeye often spawn in lake substrates, as well as in streams (NPFMC et al. 2021). Smolts outmigrate through estuaries from March through early August.

Marine EFH has been designated for juvenile, immature, and maturing adult sockeye salmon in Eagle Bay and Knik Arm. EFH for juvenile sockeye includes marine waters off the coast of Alaska up to depths of 50 meters and ranging from the mean higher tide line to the 200 nautical mile limit of the U.S. EEZ from mid-summer until December of the juvenile's first year at sea. EFH for immature and maturing adult sockeye salmon is in marine waters off the coast of Alaska up to depths of 200 meters and ranging from the mean higher tide line to the 200 nautical mile limit of the U.S. EEZ (NPFMC et al. 2021). This includes Eagle Bay and Knik Arm.

3.3 GROUNDFISH FISHERY MANAGEMENT PLAN

Eagle Bay is in the purview of the GOA Groundfish FMP, which governs more than 20 species of groundfish, skates, squid, sculpins, sharks, octopus, grenadiers, a shallow water flatfish management complex, and nine forage fish complexes (NPFMC 2020). EFH is described for FMP-managed species by life stage as general distribution using guidance from the EFH Final Rule (50 CFR 600.815), including the EFH Level of Information definitions. New analytical tools are used and recent scientific information from updated scientific habitat assessment reports is incorporated for each life history stage (NPFMC 2020). This information is incorporated into the Alaska EFH Online Mapper, which was used to identify EFH in the proposed project area for species managed by the North Pacific FMC (Table 3-5) (NMFS 2022b). EFH has not been identified for some managed species due to insufficient information (e.g., forage fish complex) but has been designated by extension in some cases (e.g., shallow water flatfish complex) when EFH has been identified for certain similar species in the proposed project area (NPFMC 2020).

EFH has not been defined for forage fish species in Knik Arm or the proposed project area. However, EFH for all life stages of some forage fish can be assumed. Forage fish species identified in the GOA Groundfish FMP such as walleye pollock, eulachon, longfin smelt (*Spirinchus thaleichthys*), and sculpin (*Cottus* sp.) provide prey species for salmonids in Knik Arm and Eagle Bay (Pentec Environmental 2005). Life history and EFH descriptions for various GOA groundfish species that have EFH designated in the proposed project area are further described in NPFMC 2020. Sections 3.3.1 and 3.3.2 provide general information on documented and potential EFH species presence in the proposed project area.

3.3.1 Groundfish Species

The relationship and movement between marine and nearshore processes and species presence in GOA and its estuaries have been well documented in the life histories of species such as walleye pollock, Pacific cod, yellowfin sole, and northern rock sole (*Lepidopsetta polyxystra* and *Lepidopsetta bilineata*) (NPFMC 2020). Larval forms of each species are transported and concentrated in nutrient-rich nearshore habitat from winter through summer (depending on species) (Table 3-5). Later, many of these species migrate to open waters to assume their late juvenile and adult life stages in open pelagic waters or on benthic substrates (NMFS 2013; Windward 2014; NPFMC 2020).

Table 3-5 Groundfish EFH Life Stages Identified in the Proposed Project Area

Waterbody	Life Stage/ Timing/ Documented	Groundfish Species								
		Pacific Cod	Deep-Water Flatfish Complex	Shallow-Water Flatfish Complex[1]				Other Flatfish		Forage Fish Complex[2]
			Dover sole	Alaska Plaice	Northern Rock Sole	Starry Flounder	Yellowfin Sole	Flathead Sole	Rex Sole	Various Fishes
Knik Arm (Eagle Bay)	Life Stage	Larvae	Larvae	Eggs Larvae	Larvae	-	Eggs	Larvae	Larvae	-
	Timing[3]	Summer	Summer	Summer	Summer	-	Summer	Summer	Summer	-
	Documented	No	No	No	No	Yes	No	No	No	Yes, several
Eagle River	Life Stage/ Timing[3]	-	Larvae/ Summer	-	-	-	-	-	-	-
	Documented	-	No	-	-	-	-	-	-	Yes, several

Notes:
[1] EFH is designated in Knik Arm and Eagle Bay for all shallow-water complex species (e.g., starry flounder) due to EFH designation of rock sole eggs and yellowfin sole larvae.
[2]The forage fish complex (eulachon, capelin, sand lance, sand fish, euphausiids, myctophids, pholids, gonostromatids, etc.) is included in the GOA groundfish FMP; however, no EFH description is determined due to insufficient information (NPFMC 2020).
[3]Timing represents general periods when life stages are known to use particular habitats as described in NPFMC 2020. All life stages have been designated EFH in the proposed project area during summer, which is the only time period when data were available.

Key: "-" = EFH not identified in NMFS EFH Mapper (NMFS 2022a); EFH = Essential Fish Habitat; FMP = Fishery Management Plan; GOA = Gulf of Alaska; NMFS = National Marine Fisheries Service.

Sources: NPFMC 2020; NMFS 2022b.

The shallow-water flatfish management complex in the GOA consists of eight species: southern rock sole, northern rock sole, yellowfin sole, starry flounder (*Platichthys stellatus*), butter sole (*Isopsetta isolepis*), English sole (*Parophrys vetulus*), Alaska plaice (*Pleuronectes quadrituberculatus*), and sand sole (*Psettichthys melanostictus*). The two species of rock sole and yellowfin sole are the most abundant and commercially important species of this management complex in the GOA, and the description of their habitat and life history best represents the shallow-water complex species (NPFMC 2020). Because EFH for northern rock sole larvae extends into Knik Arm, EFH for the shallow-water flatfish complex extends into Knik Arm as well (S. MacLean [NPFMC], personal communication, 24 June 2020). Therefore, Knik Arm is considered EFH for the entire shallow water flatfish complex, including starry flounder.

Several species of groundfish move into Knik Arm nearshore or estuarine waters when conditions are favorable. Among them are saffron cod, Pacific tomcod (*Microgadus proximus*), ringtail snailfish (*Liparis rutteri*), Pacific staghorn sculpin (*Leptocottus armatus*), starry flounder, walleye pollock, and snake prickleback (*Lumpenus sagitta*). USACE (2008) reported that most of these species were collected in relatively small numbers and were most abundant during the winter or after sediment loads had begun to drop in early autumn.

The 2017 Eagle Bay beach seine study documented low abundances of managed fish species in Knik Arm (Schoofs et al. 2018; Table 3-6). EFH groundfish species captured included juvenile walleye pollock, Pacific staghorn sculpin, and starry flounder. Upper Cook Inlet fish surveys conducted by Moulton (1997) found that walleye pollock juveniles were the most abundantly captured juvenile groundfish. Although rare, juvenile yellowfin sole were documented in Knik Arm by Dames & Moore (1983); therefore, it is possible that they could be present in Eagle Bay. This also applies to the other EFH species in Table 3-5 that were not identified in previous Knik Arm surveys.

Table 3-6 Documented Fish Presence and Designated EFH in the Proposed Project Area

Common Name (*Scientific Name*)	CSU 2017 Eagle Bay Fish Presence[1,a]		Pentec 2004-2005 Eagle Bay Fish Presence[2,b]		D&M 1983 Knik Arm Study[3]	Fish Presence at JBER[4]	Designated EFH[5]	
	No.	%	Beach Seine[c]	Tow Net[d]			Knik Arm	Eagle River/ Otter Creek
Juvenile Salmonids								
Chinook salmon (*Oncorhynchus tshawytscha*)	31	1.2	X	X	X	X	X	X
Chum salmon (*O. keta*)	90	3.5	X	X	X	X	X	X
Coho salmon (*O. kisutch*)	62	2.4	X	X	X	X	X	X
Pink salmon (*O. gorbuscha*)	265	10.4	X	X	X	X	X	X
Sockeye salmon (*O. nerka*)	14	0.6	X	X	X	X	X	X
Unknown salmonid	15	0.6						
Total Juvenile Salmon	477	18.8						
Adult Salmonids								
Chinook salmon (*O. tshawytscha*)	3	0.1				X	X	X
Chum salmon (*O. keta*)	29	1.1				X	X	X
Coho salmon (*O. kisutch*)	2	0.1	X			X	X	X
Pink salmon (*O. gorbuscha*)	8	0.3				X	X	X
Sockeye salmon (*O. nerka*)	30	1.2	X			X	X	X
Rainbow trout (*O. mykiss*)	2	0.1			X	X		
Dolly Varden (*Salvelinus malma*)	21	0.8	X		X	X		
Total Adult Salmon	95	3.7						

Common Name (*Scientific Name*)	CSU 2017 Eagle Bay Fish Presence[1,a]		Pentec 2004-2005 Eagle Bay Fish Presence[2,b]		D&M 1983 Knik Arm Study[3]	Fish Presence at JBER[4]	Designated EFH[5]	
	No.	%	Beach Seine[c]	Tow Net[d]			Knik Arm	Eagle River/ Otter Creek
Groundfish								
Walleye pollock (*Gadus chalcogrammus*)	3	0.1				X		
Starry flounder (*Platichthys stellatus*)	36	1.4			X	X	X[e]	
Saffron cod (*Eleginus gracilis*)	12	0.5	X		X	X		
Pacific tomcod (*Microgadus proximus*)	-	-				X		
Pacific staghorn sculpin (*Leptocottus armatus*)	4	0.2	X		X	X		
Unknown juvenile gadid	4	0.2						
Slimy sculpin (*Cottus cognatus*)	-	-				X		
Alaska plaice (*Pleuronectes quadrituberculatus*)	-	-					X	
Dover sole (*Solea solea*)	-	-					X	X
Flathead sole (*Hippoglossoides elassodon*)	-	-					X	
Northern/Southern rock sole (*Lepidopsetta polyxystra/ L. bilineata*)	-	-					X	
Pacific cod (*Gadus macrocephalus*)	-	-					X	
Rex sole (*Glyptocephalus zachirus*)	-	-					X	
Yellowfin sole (*Limanda aspera*)	-	-			X		X	
Forage Fishes								
Eulachon (*Thaleichthys pacificus*)	40	1.6	X		X	X	X	
Longfin smelt (*Spirinchus thaleichthys*)	67	2.6	X		X	X	X	
Pacific herring (*Clupea pallasi*)	2	0.1	X		X	X		
Snake prickleback (*Lumpenus sagitta*)	1	0.0				X	X	
Other Fishes								
Threespine stickleback (*Gasterosteus aculeatus*)	1,125	44.3	X	X	X	X		
Ninespine stickleback (*Pungitius pungitius*)	659	25.9	X		X	X		
Snailfish (*Liparis spp.*)	15	0.6	X		X	X		

Common Name (*Scientific Name*)	CSU 2017 Eagle Bay Fish Presence[1,a]		Pentec 2004-2005 Eagle Bay Fish Presence[2,b]		D&M 1983 Knik Arm Study[3]	Fish Presence at JBER[4]	Designated EFH[5]	
	No.	%	Beach Seine[c]	Tow Net[d]			Knik Arm	Eagle River/ Otter Creek
Bering cisco (*Coregonus laurettae*)	1	0.0			X	X		
Grand Total	***2,541***	***100***						

Notes:
[a] Beach seine surveys from May–November 2017 at mouth of Eagle River in Eagle Bay.
[b] Fish presence based on sampling sites in or adjacent to Eagle Bay.
[c] Beach seine surveys from July-November 2004 and April-July 2005.
[d] Tow net surveys from April-July 2005.
[e] Starry flounder EFH is part of the shallow water flatfish complex, which has designated EFH in Knik Arm.

Key: CSU = Colorado State University; D&M = Dames & Moore; EFH = Essential Fish Habitat; JBER = Joint Base Elmendorf-Richardson.

Sources**:** [1]Schoofs et al. 2018; [2]Pentec Environmental 2005; [3]Dames & Moore 1983; [4]ADF&G 2022a; Schoofs et al. 2018; JBER 2023a; Weber and Seigle 2020a, b; [5]NMFS 2022a, b; NPFMC 2020; NPFMC et al. 2021.

3.3.2 Forage Fish Complex

Forage fishes are a critical food source for marine mammal, seabird, and fish species in the proposed project area. The forage fish species category in the GOA Groundfish FMP was established to allow for management of these species in a manner that prevents the development of a commercial directed fishery for forage fish (NPFMC 2020). Insufficient information is available to determine EFH for life stages of the forage fish complex. Forage fish species known to occur in Knik Arm, Eagle Bay, and intertidal areas in Eagle River and Otter Creek include eulachon, longfin smelt, Pacific herring (*Clupea pallasii*), and snake prickleback (Dames & Moore 1983; Pentec Environmental 2005; JBER 2023a); however, other forage fishes may also occur in this area. The most frequently caught members of the GOA forage fish complex in Eagle Bay include eulachon and longfin smelt (Pentec Environmental 2005; Schoofs et al. 2018). Further details on these species are provided below.

3.3.2.1 Eulachon

Eulachon generally spawn in the lower reaches of rivers or streams, broadcasting their eggs over stream bottoms where the eggs attach to sand, gravel, or woody debris. Eggs hatch in 3 to 6 weeks, and the young are carried to the sea with the current where they feed mainly on copepod larvae and other plankton (ADF&G 2008). Both juvenile and adult eulachon feed primarily on plankton. After 3 to 5 years at sea, they return to their spawning grounds. In Southcentral Alaska, eulachon typically gather in April in large schools at the mouths of spawning streams (ADF&G 2008). A total of 40 eulachon were captured during the 2017 Eagle Bay fish study, all in mid-May. All fish captured were assumed to be adults returning to spawn, although it was unclear whether their target was Eagle River or one of the larger glacial rivers at the head of Knik Arm (Schoofs et al. 2018). In mid-May to early June 2021, AERC (2022a) detected large numbers (n = 3,174) of small-sized fish (<25.4 centimeters) traveling up-river during adult salmon monitoring in Eagle River and surmised that these fish were eulachon given the size class and run timing (C. Brandt, personal communication, 9 March 2023). This marked the first time that eulachon have been observed at the Eagle River sonar weir assembly site (6.4 kilometers upstream from river mouth), an observation made possible because the sonar devices were installed earlier than in previous years.

3.3.2.2 Longfin Smelt

Longfin smelt are anadromous and spawn in freshwater streams. In Southcentral Alaska, longfin smelt have been observed returning in late November through early December (ADF&G n.d.-f). As the spawning season approaches, longfin smelt gather in large schools off the mouths of their spawning streams and rivers. They typically spawn in slow-moving waterways because they are weak swimmers. Spawning sites are in the lower elevations of the river or stream, but in some rivers with long flat deltas, spawning sites may be many miles upstream. Eggs are "broadcast" over sandy gravel bottoms, and they attach to sand particles. After emerging from the eggs, young longfin smelt migrate downstream to salt water to grow to maturity in the sea. After 2 to 3 years at sea, they return as adults to spawn. After spawning, the majority of longfin smelt die. A total of 67 longfin smelt were captured during the 2017 Eagle Bay fish study, with the majority captured in June and July (Schoofs et al. 2018). Longfin smelt were present during all months of the study except November. Both adult and juvenile longfin smelt have been captured in Knik Arm and Eagle Bay (Pentec Environmental 2005; Schoofs et al. 2018). No longfin smelt have been captured in Eagle River, and it is unlikely that spawning occurs in the proposed project area.

3.4 HABITAT AND FISH USE OF EFH WATERBODIES IN THE PROPOSED PROJECT AREA

Designated EFH waterbodies in the proposed project area include 1) the Eagle Bay portion of Knik Arm, 2) Eagle River, and 3) Otter Creek. Watersheds and waterbodies in the proposed project area and vicinity are shown in Figure 3-1. Fish existing conditions in the proposed project area are shown in Figure 3-2. ERF-IA consists of a tidally influenced estuary with flow from two anadromous fish streams: Otter Creek and Eagle River. Otter Creek flows out of Otter Lake, which is spring fed and flows into tidally affected Eagle River and Eagle Bay. The lower reaches of Otter Creek and its tributaries in ERF have tidal influences as well. Both Eagle River and Otter Creek are partially in ERF-IA. Additional baseline information has been provided on Knik Arm because it influences physical, chemical, and biological conditions in Eagle Bay. Habitat conditions and fish use are described in each subsequent section, with the focus on EFH and managed species. Clunie Creek flows through the proposed expansion area but has not been designated as EFH by ADF&G (due to lack of a permanent hydrological connection to Eagle River) (ADF&G 2022a); therefore, it is not described in further detail. Although not designated as EFH, Garner Creek at the northwestern portion of ERF-IA is known to support salmonids. The creek originates in the lowland gravelly moist needleleaf forest ecotype, northwest of ERF, and empties into Eagle Bay.

3.4.1 Knik Arm and Eagle Bay

3.4.1.1 Habitat Conditions

Knik Arm represents the northernmost extension of Upper Cook Inlet, and its waters bound approximately 20 miles of the northwestern portion of JBER. Knik Arm is typified by high turbidity, extreme tidal variation, strong tidal currents, expansive mudflats exposed at low tides, and high winter ice scour. Knik Arm is approximately 31 miles long by 5 miles wide and is highly variable in depth, with a central trench in the southernmost part of the arm reaching depths of -160 feet mean lower low water (MLLW). This trench eventually splits into two shallower channels that follow both coasts around a large mudflat centered between Goose and Eagle Bays.

Eagle Bay is at the convergence of Knik Arm and Eagle River. The channel in Eagle Bay reaches depths of -30 feet MLLW and is closely associated with the shoreline of JBER, a nearly contiguous stretch of eroding bluffs reaching elevations of 150 feet. The bathymetry adjacent to Eagle Bay is dominated by mudflats exposed at MLLW and intersected by shifting networks of narrow tidal channels. Tidal activity in Eagle Bay has created an estuarine salt marsh encompassing ERF. Numerous ponds dot the marsh. Many are shallow mudflat ponds, less than 6 inches deep, that often dry up during summer. Others are more permanent, with depths over 20 inches. These deeper ponds often are fed by freshwater streams and springs.

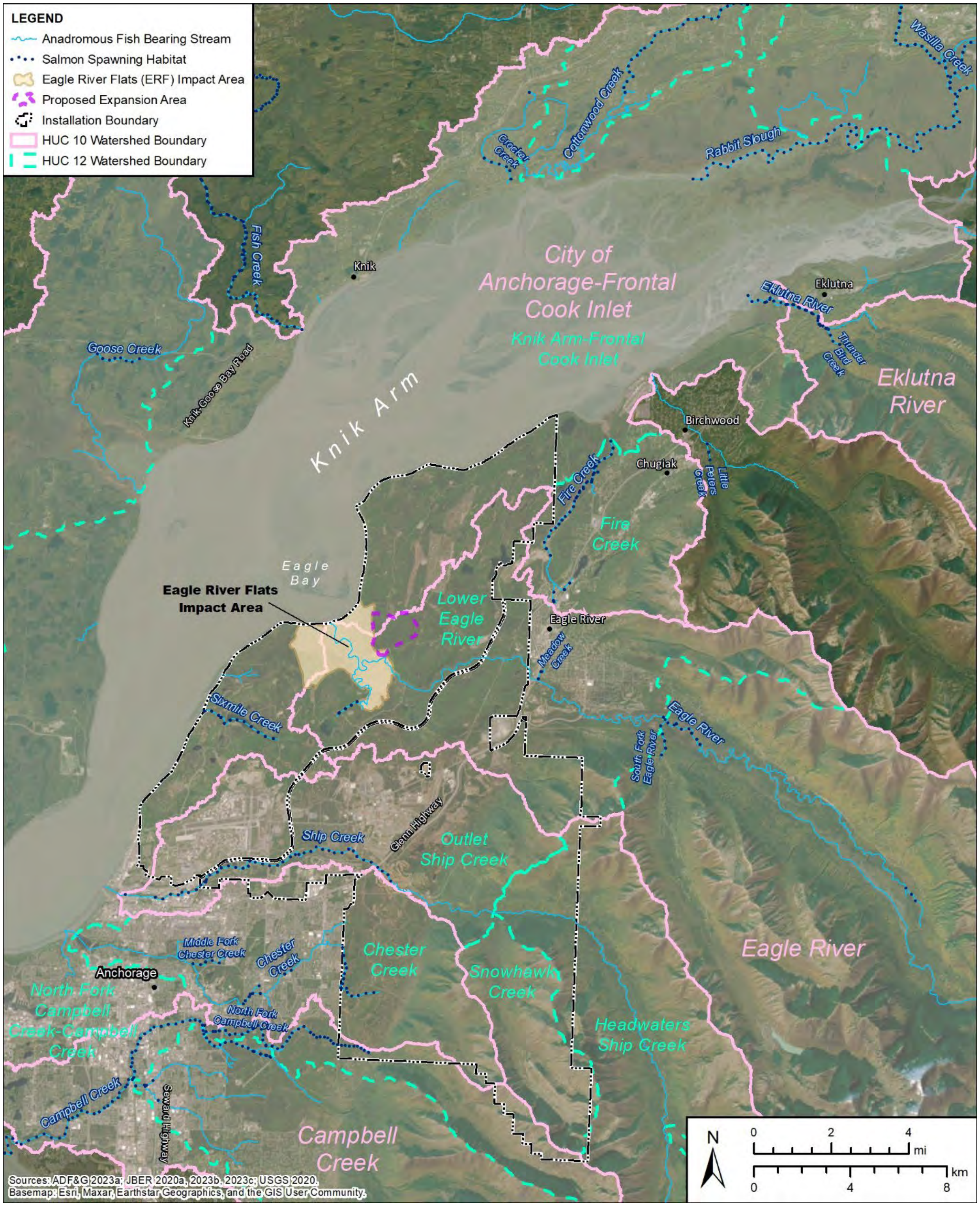

Figure 3-1 Watersheds and Major Waterbodies in the Proposed Project Area and Vicinity

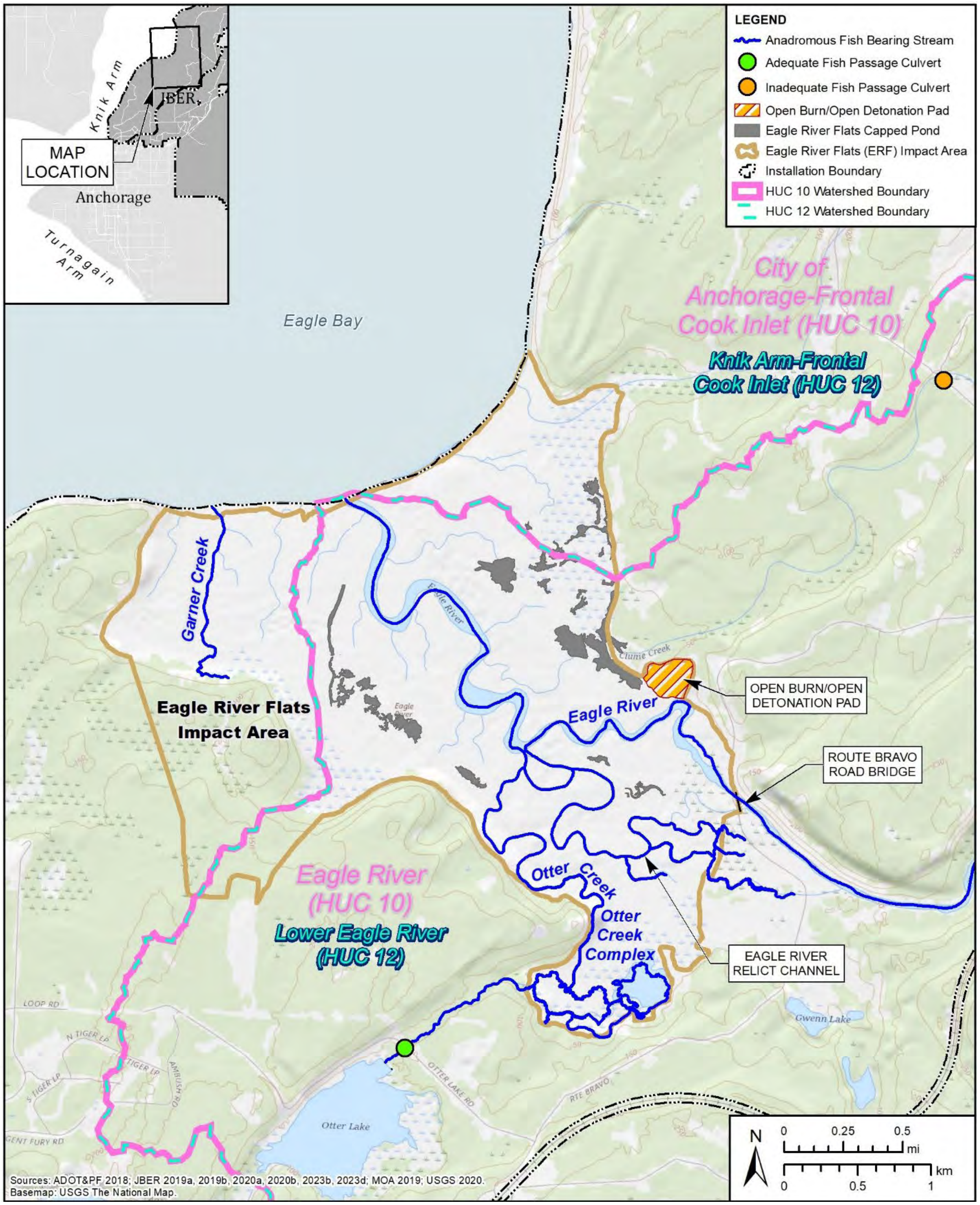

Figure 3-2 Fish Existing Conditions in the Proposed Project Area

Knik Arm receives much of its fresh water from eight rivers and streams (Ship Creek, Eagle River, Peters Creek, Eklutna River, Knik River, Matanuska River, Little Susitna River, and Chester Creek), with additional freshwater systems also contributing. The glacial Knik and Matanuska Rivers contribute by far the most suspended sediment (Smith 2004). This suspended sediment, combined with glacial till eroding from high bluffs lining the arm, as well as sediment resuspended by turbulent conditions, contribute greatly to the high prevailing turbidity of the water in Knik Arm. The average natural turbidity of Knik Arm typically ranges from 400 to 600 nephelometric turbidity units (NTUs) (USACE 2017); higher turbidity is generally associated with the upper arm. In 2004–2005, between April and July, turbidity near Eagle Bay was 629 NTU (Pentec Environmental 2005). The turbulent nature of the system mixes the water and maintains relatively high dissolved oxygen concentrations throughout the entire water column. During periods of low wave activity, and in areas lacking vertical turbulence, a thin surface layer (4 to 10 centimeters) may be clear at times. However, overall high suspended sediment loads inhibit light penetration beyond the surface layer, which contributes to low water column primary productivity.

Nearshore estuaries such as Eagle Bay are rich in organic and detrital material that provide energy and essential nutrients to algae, plankton, and invertebrate species such as polychaete worms, mysids, and amphipods. These species provide the foundation for estuarine and nearshore trophic interactions that benefit forage fish, flatfish, groundfish, and invertebrates during larval and juvenile life stages, including several of the species identified in this assessment (Table 3-6). The presence, abundance, and biodiversity of Alaskan fish species in nutrient-rich, nearshore nursery habitats are well documented (Norcross et al. 1995; Abookire et al. 2000; Abookire and Piatt 2005; Johnson et al. 2012, cited in Windward 2014).

3.4.1.2 Tidal Conditions and Flooding

Tides in Knik Arm are semi-diurnal (two high and low tide events per lunar day [24.8 hours]) with a maximum tidal range (difference between high and low water events) approaching 40 feet. Tidal velocities vary greatly depending on the location in Knik Arm but often exceed 7 knots during the ebb tide, with flooding velocities measuring somewhat less (Smith 2004). Strong horizontal and vertical current shears exist throughout Knik Arm, most likely combining with the strong tidal flux to create a well-mixed, brackish water column. From April to November (2004–2005), salinities at Eagle Bay ranged from 0.3 to 18.9 parts per thousand (average of 12.0), and water temperatures during this period ranged from 0.1 degrees Celsius (°C) to 16.6°C (average of 8.2°C) (Pentec Environmental 2005).

Tidal flooding of ERF infuses ponds with salt water and sediments from Eagle Bay (Figure 3-3). Elevation, varying from mean sea level to 18 feet above mean sea level, determines frequency of floods. Flooding may occur daily during high tides in areas less than 12 feet above mean sea level (JBER 2023a). In areas 12 to 13 feet above mean sea level, flooding occurs only with the highest tide each month, and in areas above 13 feet, flooding occurs only during extremely high tides (JBER 2023a). Cold Regions Research and Engineering Laboratory (CRREL) measurements of water levels in the mud flats indicate that "typical inundating tidal events" may cause flooding up to 0.5 meters in ERF (reviewed in JASCO 2020), with more infrequent, maximum tide events occurring during the summer (C. Garner, personal communication, 14 September 2020) (Figure 3-4).

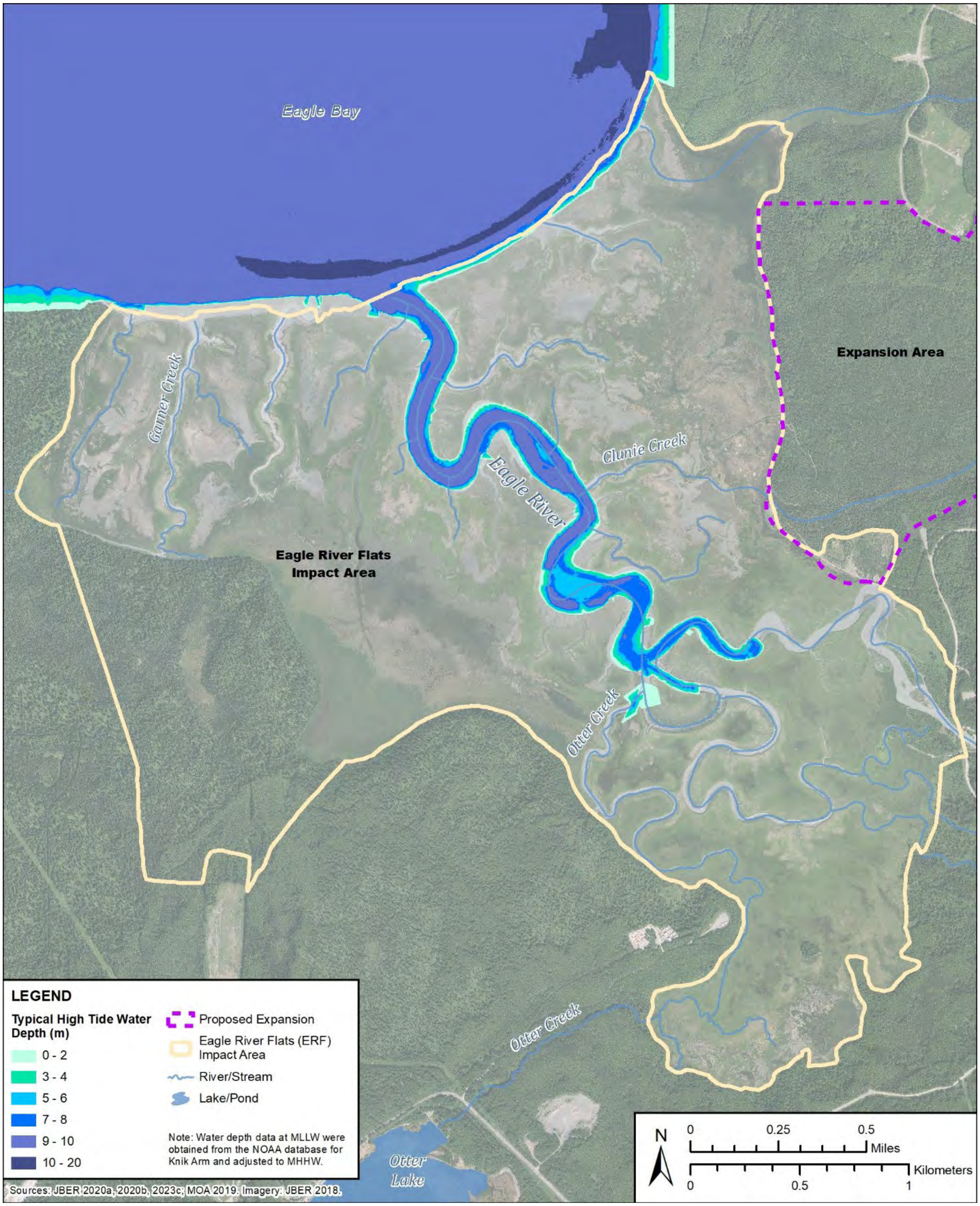

Figure 3-3 Water Depth of Nearshore Eagle Bay and Eagle River, Alaska, during Typical High Tide Conditions

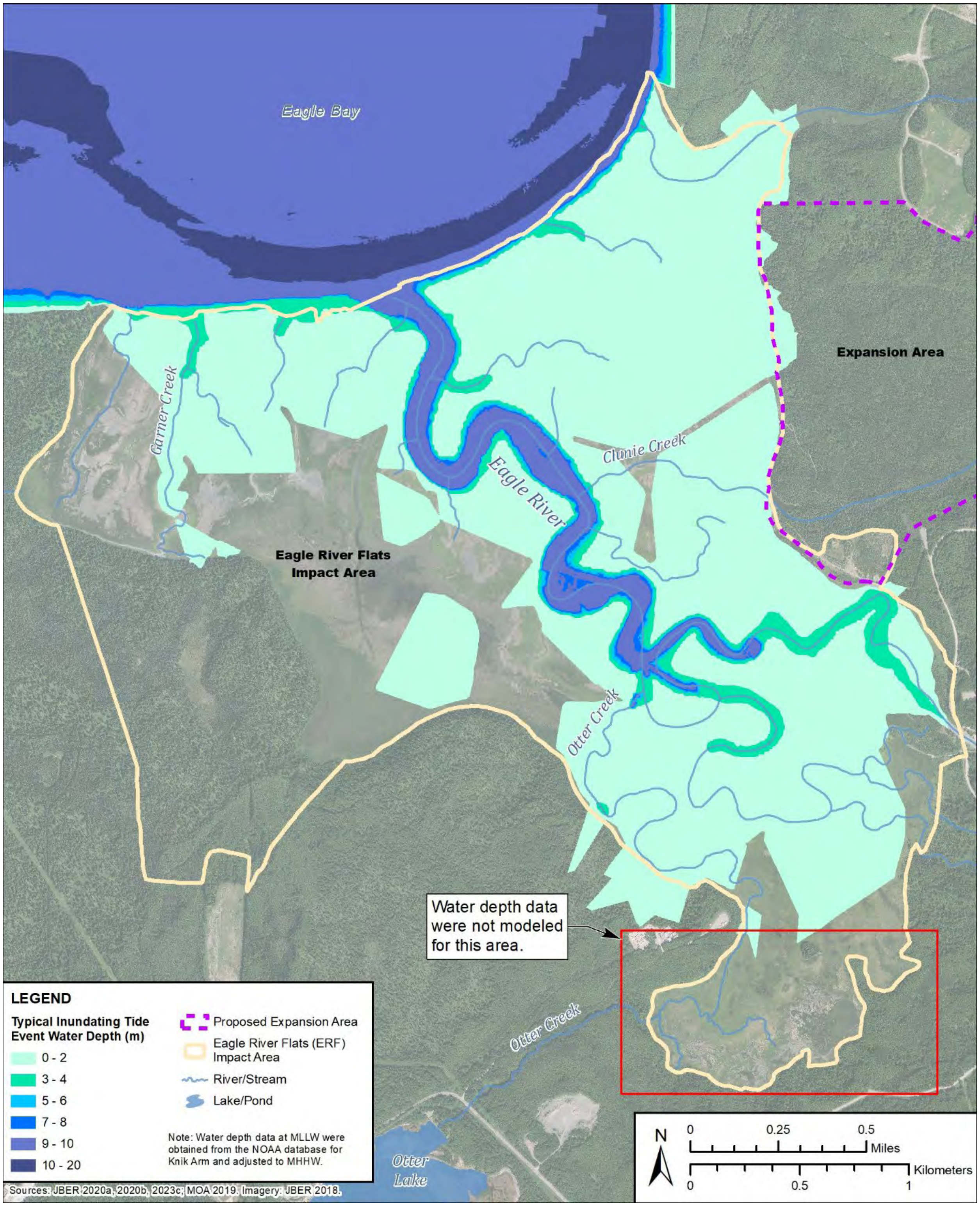

Figure 3-4 Water Depth of Nearshore Eagle Bay and Eagle River, Alaska, during Typical Inundating Tide Events

ERF inundating tide events may occur at any time of the year but occur most frequently during the summer (August/September), coinciding with periods of high discharge. ERF can experience more than 60 flood events on an annual basis (Lawson et al. 1995). Flood events due to rainfall typically occur from August to October (Papineau and Holloway 2011). Lawson et al. (1995) noted that every predicted tide exceeding 30 feet between 16 August and 21 September 1994 resulted in flooding of the flats. For that same time frame in 2020, there were 32 tides over 30 feet (C. Garner, personal communication, 8 October 2020). If inundations in 2020 were similar to those in 1994 during that same seasonal range (16 August to 21 September), then 32 out of 72 high tides (44 percent) would have resulted in inundated conditions (C. Garner, personal communication, 8 October 2020).

Flooding typically begins in the coastal mudflats on Knik Arm and progressively moves inland up the Eagle River channel, backing river waters up each gully, and causing them to spill onto the inner mudflats. Water levels rise initially at a steady rate but rapidly decrease as the water crests the gullies and spills out over the mudflats. Water levels decline first in the coastal zone while tidal flood waters are still moving up Otter Creek and into the southwestern corner of the flats (Lawson et al. 1995). During flooding events, some juvenile salmonids and other fishes may use the flats for rearing but are expected to move out during the ebb tide as the water slowly recedes.

Flooding duration may vary, but ERF likely takes several hours to drain after typical inundating tide events. Lawson et al. (1996a) show an inundation event with approximately 0.45 meters of water on 14 June 1995 (predicted tide height of 32.4 feet) that took approximately 2.5 hours to drain. This is consistent with Taylor et al. (1994), who reported that summer flood waters drained within “a few hours” after the high tide (some time would need to be added to this estimate to account for the time between inundation and slack high). Lawson et al. (1996b) observed that higher tides attributable to wind surge increase the height and volume of flood water and prolong the period of runoff during the ebb tide. In addition, it is likely that the same factors that are known to increase the height of the tide at ERF, such as winds from the south and increased discharge from Eagle River, would also lead to increased drain time. Extreme “maximum” tide events may cause more flooding of ERF (over 0.5 meters depth) during the summer months, but they are very infrequent, as they are likely produced by a combination of high astronomical tide height, increased discharge from Eagle River, and mid/strong southerly winds.

3.4.1.3 Sea Ice Conditions

Winter sea ice coverage varies on an annual basis. Large masses of ice are transported up and down Knik Arm, and consequently Eagle River, in accordance with the semi-diurnal, hypertidal regime of Upper Cook Inlet. In general, Eagle Bay hosts moving pan ice that can be inches to feet thick and from 10 to 90 percent ice cover (i.e., no shore-fast ice sheets as seen in Eagle River) (C. Garner, personal communication, 20 March 2020). Mean sea ice concentration (relative measure of the surface area of water that is covered with ice) in Knik Arm was 70 to 80 percent between 1 December and 28 February (from 1986 to 1999) and 30 to 60 percent in March (Mulherin et al. 2001). The dates of first significant ice and ice-out for Upper Cook Inlet (defined as 10 percent ice concentration at the Phillips Platform) were documented in the 1970s and 1980s and varied widely, with a median “first ice” date of 23 November and a median ice-out date of 9 April (Mulherin et al. 2001). The amount of ice measured in Knik Arm in February 2020 was the most significant sea ice coverage in the past 7 years (Solina 2020).

No studies of juvenile salmonid use of ice-covered areas have been conducted at ERF. However, other studies have reported mixed results regarding juvenile salmonid use and condition in these areas. Juvenile salmonids (predominantly coho salmon) are known to rear throughout the year in ERF (Eagle River, Otter Creek, and its interconnected intertidal channels) as well as adjacent Eagle Bay. Although juvenile salmon may overwinter under ice and may use ice as cover in areas where there are open leads (Jakober et al. 1998), they generally select habitats with low water velocity, cover, and relatively warmer water from springs or upwelling groundwater (Hillman et al. 1987; Cunjak 1996; Giannico and Hinch 2003; Davis and Davis 2015). Groundwater refugia in tributary streams or in the main river channels provide protection against ice and critically low temperatures and allow fish to remain mobile (Cunjak 1984). Overwintering sites were previously undocumented on JBER, but sampling in 2019 documented presence of juvenile coho in intertidal channels and backwater ponds connected to Otter Creek (JBER 2019c). These small channels have the greatest potential to support overwintering coho salmon in ERF-IA.

One study found that salmonids grow more and use a broader range of habitats in the presence of surface ice than in its absence (Watz 2015). Results from laboratory experiments suggests that the presence of surface ice may increase food intake rates and reduces stress; however, high densities of frazil ice (a type of slushy, particulate ice that freezes to surfaces either in the riverbed or on the underside of ice cover) can create adverse conditions for fish and force them to move away (Jakober et al. 1998; Simpkins et al. 2000) or suffer increased mortality (Maciolek and Needham 1952). When frazil ice sticks to the streambed, it becomes anchor ice. Anchor ice that fills the interstitial spaces in the stream bottom and blankets the stream floor excludes fish from their winter refuges (Jakober et al. 1998; Brown 1999). Conversely, patchy, unconsolidated anchor ice does not seem to have negative consequences for overwintering fish (Roussel et al. 2004; Linnansaari et al. 2009) and may even be used as cover (Stickler et al. 2008).

An overwintering study of kokanee (*O. nerka*) (landlocked sockeye) in ice-covered lakes in Idaho found that winter conditions limit zooplankton density as compared to ice-free periods. Although some kokanee actively foraged during winter, condition factors declined significantly, and ice cover may have restricted kokanee foraging ability to such an extent that they were unable to meet their daily nutrition requirements on some days (Steinhart and Wurtsbaugh 1999). EFH Species Use

To evaluate fish use by EFH species in the proposed project area, commercial and scientific reports and data were reviewed, as well as information provided by NMFS in July 2022. Online databases, mappers, and repositories were also reviewed, including NMFS' Alaska ShoreZone Mapping Website (2023), which catalogs the distribution, relative abundance, and habitat use of nearshore fishes in Alaska. All information was compiled and reviewed for applicability and relevance with respect to EFH species presence, abundance, distribution, and habitat use within the proposed project area.

NMFS classifies Knik Arm as EFH for all five Pacific salmon species as well as several groundfish species (NMFS 2022b) (Table 3-6). Previous studies in Upper Cook Inlet found all five species of Pacific salmon in both shoreline and open water areas, with higher abundances near large river mouths (Moulton 1997).

Salmon escapement estimates for Knik Arm tributaries have fluctuated widely over the last decade, as summarized in Table 3-7 (Marston and Frothingham 2019, 2022; ADF&G 2022b). Recent adult return estimates for Eagle River and Otter Creek are included for comparison purposes (Weber and Seigle 2020a, b; AERC 2020, 2021, 2022a, b, 2023a, b). ADF&G has conducted Chinook salmon spawning surveys in South Fork Eagle River during most years from 1999 to 2018 (Table 3-8) (Baumer and Blaine-Roth 2020). Spawning surveys were also conducted in Meadow Creek (tributary of Eagle River) from years 2004 to 2011. Since 1999, Chinook spawning counts (for both South Fork Eagle River and Meadow Creek) have ranged from 7 (2011) to 224 (1999), with an average of 99 spawners. Fewer Chinook salmon spawning fish have been documented in recent years (average of 57 spawners from 2016 to 2018) (Table 3-8).

Table 3-7 Salmon Escapement Estimates for Various Knik Arm Tributaries (including Eagle River and Otter Creek), 2010 to 2022

Year	Little Susitna River[1]					Fish Creek[1,2]					Jim Creek[1]		Eagle River[3]	Otter Creek[4]
	Chinook	Chum	Coho	Pink	Sockeye	Chinook	Chum	Coho	Pink	Sockeye	Coho	Sockeye	All Adults Combined	
2010	ND	ND	9,214	ND	ND	ND	ND	7,034	ND	126,836	ND	ND	ND	ND
2011	ND	ND	4,826	ND	ND	ND	ND	1,428	ND	66,678	ND	ND	ND	ND
2012	ND	23,846	6,770	ND	ND	ND	ND	1,237	ND	18,813	ND	ND	1,646	ND
2013	2,383	18,943	13,583	1,155	358	ND	ND	7,593	ND	18,912	ND	ND	ND	ND
2014	3,135	21,731	24,211	16,002	900	ND	ND	10,283	9,198	43,915	ND	ND	3,600	ND
2015	5,026	56,850	12,756	1,314	1,506	1	64	7,912	507	102,309	3,476	4,916	12,755	ND
2016	4,964	52,873	9,998	3,649	3,110	29	90	2,483	93	46,202	1,206	5,027	5,778	ND
2017	2,525	89,597	17,781	3,563	1,191	4	128	8,966	788	61,469	5,646	4,769	12,824	ND
2018	549	26,227	7,583	8,420	335	1	37	5,023	494	71,556	5,514	2,275	1,336	ND
2019	3,659	21,806	4,226	9,008	1,366	13	48	3,158	582	76,031	3,770	1,743	1,103	514[5]
2020	2,424	16,145	10,765	23,618	365	0	79	4,559	1,985	64,243	735	ND	2,415	721[6]
2021	3,121	18,952	10,923	11,491	2,176	0	0	0	5	22,271	ND	ND	14,007	1,811[7]
2022	2,237	12,605	3,162	14,978	1,286	0	0	36	0	58,351	ND	ND	5,654	2,300[8]
AVG	3,002	32,689	10,446	9,320	1,259	6	56	4,976	1,517	59,814	3,922	3,746	6,116	N/A

Notes:
[1] Based on weir counts.
[2] In 2021 and 2022, weir was removed in late July so did not capture fall returning fish (e.g., chum, coho, or pink salmon).
[3] Based on Dual Frequency Identification Sonar (DIDSON) weir counts (may include all five Pacific salmon species).
[4] Spawning survey counts
[5] 2019 Otter Creek adult salmon species counts for 2019 based on stream walks: coho = 356, sockeye = 155, pink = 1, and unknown = 2.
[6] 2020 Otter Creek adult salmon species counts for 2020 based on Vaki counts: coho = 145, sockeye = 575, and pink = 1.
[7] 2021 Otter Creek adult salmon species counts for 2021 based on Vaki counts: coho = 1,080, sockeye = 713, and pink = 18.
[8] 2022 Otter Creek adult salmon species counts for 2022 based on Vaki counts: coho = 2,003, sockeye = 263, pink = 7, chum=1, Chinook= NA, and unknown = 23.

Key: AVG = average; N/A = not applicable; ND = no data.

Sources: Marston and Frothingham 2019, 2022; Weber and Seigle 2020a, b; AERC 2020, 2021, 2022a,b, 2023a,b; ADF&G 2022b.

Table 3-8 Salmon Escapement Estimates for South Fork Eagle River and Meadow Creek, 1999-2018

Year	Chinook	Pink
1999	224	ND
2000	[a,b]	ND
2001	77[a]	19
2002	27[a]	ND
2003	167[a]	ND
2004	157[c]	ND
2005	122[c]	ND
2006	101[c]	ND
2007	117[c]	ND
2008	156[c]	ND
2009	152[c]	ND
2010	10[c]	ND
2011	7[c]	ND
2012	[b]	ND
2013	[b]	ND
2014	[b]	ND
2015	[b]	ND
2016	34	ND
2017	75	ND
2018	61	ND
Average		
1999-2018	99	ND
2016-2018	57	ND

Notes:
Estimates are from foot surveys designed for Chinook salmon only; pink salmon catches were incidental.
[a] High water and poor visibility.
[b] No survey conducted.
[c] Surveys include Meadow Creek.

Key: ND = no data.

Source: Baumer and Blain-Roth 2020.

Total salmon returns in Eagle River have exceeded 12,000 fish in recent years, but the average is relatively small compared to nearby Knik Arm tributaries. Although the Little Susitna River technically flows into Upper Cook Inlet (and not Knik Arm), it has been included based on proximity to the site and the historical and ongoing collection of salmonid escapement data.

Over the past 40 years, various studies have been conducted to document fish presence and assemblages in Knik Arm and Eagle Bay (Dames & Moore 1983; Pentec Environmental 2005; Schoofs et al. 2018). Dames & Moore (1983) sampled fish from May to June 1983 primarily using a beach seine at nine stations on both the east and west shores of Knik Arm, from Point Woronzof north to Fish Creek (including two sites in Eagle Bay). They captured a total of 5,455 fish representing 18 species. The vast majority were threespine stickleback (*Gasterosteus aculeatus*) (85 percent of total), followed distantly by all salmon species combined (5 percent of total), eulachon (4 percent), saffron cod (3 percent), and Bering cisco (*Coregonus laurettae*) (2 percent). The study documented a single-size group of chum salmon in the catch, with multiple age groups evident for coho salmon and possibly for sockeye and Chinook salmon.

Marine fish communities were sampled in the nearshore and offshore waters of Knik Arm (both sides) from Point Woronzof north to Fire Creek (near Birchwood) during the ice-free months (April to November) of 2004 and 2005. The study captured approximately 7,200 fish, representing 18 species, in Knik Arm (all sites combined), including 7 species of adult and juvenile salmonids (Pentec Environmental 2005) (Table 3-6). Juvenile salmonids were a substantial component of the beach seine and tow net catch (28.4 and 24.4 percent, respectively). The beach seine catch also contained large abundances of stickleback (threespine and ninespine), longfin smelt, saffron cod, and eulachon. Most of the tow net catch was dominated by stickleback (Pentec Environmental 2005).

In these studies, juvenile salmon collectively were the most dominant taxon present throughout the summer and fall in Knik Arm shoreline habitats, but only coho and Chinook salmon seemed able to orient and remain along shoreline areas. The smaller species were more likely to be entrained in the strong currents and carried out of Knik Arm (Pentec Environmental 2005; ARRI 2013). While a single cohort of juvenile chum and pink salmon were captured—predominantly in late spring—multiple year-classes of juvenile coho, sockeye, and Chinook salmon were captured in late spring to early summer, with some presence of coho and Chinook salmon into late fall. The low number of fish caught in the estuary during mid-summer is consistent with previous studies of estuaries in Knik Arm that report most juvenile salmon have likely already left the upper estuary by mid-summer for either the lower estuary or the marine environment (ARRI 2013). There appeared to be a general seasonal trend of fish movement out of Knik Arm with the onset of winter (Pentec Environmental 2005). Adult Chinook salmon were captured in May, and several adult coho, sockeye, pink, and chum salmon were captured in July of both years. Only coho adults were captured in August. Analysis of the catch data did not show a significant east versus west shore preference for any species of fish.

From 2015 to 2018, JBER implemented a 3-year stream and lake habitat project that gathered fisheries, habitat, and benthic macroinvertebrate data to contribute to the baseline inventory of current aquatic resources on JBER (Schoofs et al. 2018). During beach seining at the mouth of Eagle River between early May and November 2017, a total of 2,541 individual fish representing 19 species were captured (Table 3-9). The majority of fish were captured in spring and early summer (May through July), with the highest abundance, diversity, and catch per unit effort (CPUE) observed during the month of July. The most numerous species captured were threespine stickleback and ninespine stickleback (combined 70 percent), followed distantly by juvenile pink, coho, and chum salmon (combined 16 percent) and longfin smelt (2.6 percent). Juvenile salmon were present during all 7 months of the study, while adults were present during most months from June to October (Schoofs et al. 2018).

The species assemblage cataloged in the Schoofs et al. (2018) study was similar to that of both Dames & Moore (1983) and Pentec Environmental (2005), each of which cataloged 18 species of fish in Knik Arm. The 2018 study, in conjunction with studies conducted by military biologists between 2005 and 2011, expands the number of species known to use Eagle Bay from 16 to 19 species. Overall, this study demonstrated that a wide variety of potential prey items are available to marine mammals in Eagle Bay throughout the open water season, but that as winter approaches, there is an apparent decline in species diversity and abundance. Fall and spring surveys are needed to further characterize potential prey base during these periods (Schoofs et al. 2018).

Past studies have documented adult coho salmon, chum salmon, and Dolly Varden (*Salvelinus malma*) in Garner Creek (C. Garner personal communication, 3 February 2016, cited in Schoofs and Zonneville 2016). Due to the extreme marine environment of ERF and the location of the sampling site in ERF-IA, sampling could not be conducted as planned. Minnow traps were chosen for fisheries sampling at Garner Creek due to the unwadeable stream conditions, brackish water, and potential presence of UXO. No fish were caught in any of the minnow traps, and no macroinvertebrates were collected during sampling in 2016 (Schoofs and Zonneville 2016).

Table 3-9 Number and CPUE (Fish per Set) of Juvenile Salmon Captured Using a Beach Seine between 2 May and 9 November 2017 at the Mouth of Eagle River

SPECIES CAPTURED	MAY	JUN	JULY	AUG	SEP	OCT	NOV	TOT	% TOT	CPUE
Juvenile salmon										
Chinook *(Oncorhynchus tshawytscha)*	3	25	2	0	0	1	0	31	1.2	0.22
Coho *(Oncorhynchus kisutch)*	0	55	19	3	0	11	2	90	3.5	0.63
Chum *(Oncorhynchus keta)*	51	6	5	0	0	0	0	62	2.4	0.44
Pink *(Oncorhynchus gorbuscha)*	38	213	14	0	0	0	0	265	10.4	1.87
Sockeye *(Oncorhynchus nerka)*	0	2	7	2	1	2	0	14	0.6	0.10
Total juvenile salmon	*92*	*301*	*47*	*5*	*1*	*14*	*2*	*462*	*18.2*	*3.25*
Adult salmon										
Chinook *(Oncorhynchus tshawytscha)*	0	1	2	0	0	0	0	3	0.1	0.02
Coho *(Oncorhynchus kisutch)*	0	0	17	11	0	1	0	29	1.1	0.20
Chum *(Oncorhynchus keta)*	0	0	1	1	0	0	0	2	0.1	0.01
Pink *(Oncorhynchus gorbuscha)*	0	0	7	1	0	0	0	8	0.3	0.06
Sockeye *(Oncorhynchus nerka)*	0	0	25	5	0	0	0	30	1.2	0.21
Total adult salmon	0	1	52	18	0	1	0	72	2.8	0.51
Dolly Varden *(Salvelinus malma)*	1	9	10	1	0	0	0	21	0.8	0.15
Rainbow trout *(Oncorhynchus mykiss)*	0	0	1	0	0	1	0	2	0.1	0.01
Bering Cisco *(Coregonus laurettae)*	0	0	0	0	1	0	0	1	0.0	0.01
Threespine stickleback *(Gasterosteus aculeatus)*	429	251	248	12	9	175	1	1125	44.3	7.92
Ninespine stickleback *(Pungitius pungitius)*	45	14	365	113	76	43	3	659	25.9	4.64
Starry flounder *(Platichthys stellatus)*	1	7	20	8	0	0	0	36	1.4	0.25
Saffron cod *(Eleginus gracilis)*	0	8	2	0	0	2	0	12	0.5	0.08
Walleye pollock *(Gadus chalcogrammus)*	0	0	0	0	2	1	0	3	0.1	0.02
Pacific staghorn sculpin *(Leptocottus armatus)*	0	3	1	0	0	0	0	4	0.2	0.03
Longfin smelt *(Spirinchus thaleichthys)*	3	24	27	3	4	6	0	67	2.6	0.47
Eulachon *(Thaleichthys pacificus)*	40	0	0	0	0	0	0	40	1.6	0.28
Pacific herring *(Clupea pallasii)*	2	0	0	0	0	0	0	2	0.1	0.01
Snailfish *(Liparidae spp.)*	2	0	0	0	1	12	0	15	0.6	0.11
Snake prickleback *(Lumpenus sagitta)*	0	0	1	0	0	0	0	1	0.0	0.01
Unknown juvenile salmonid	0	8	2	1	1	2	1	15	0.6	0.11
Unknown juvenile gadid	0	0	0	0	3	1	0	4	0.2	0.03
Grand Total	*615*	*626*	*776*	*161*	*98*	*258*	*7*	*2541*	*100.0*	
% of Grand Total	*24.2*	*24.6*	*30.5*	*6.3*	*3.9*	*10.2*	*0.3*	*100.0*		
Beach seine sets	*28*	*35*	*28*	*15*	*5*	*26*	*5*	*142*		
CPUE (fish per set)	*22.0*	*17.9*	*27.7*	*10.7*	*19.6*	*9.9*	*1.4*	*17.9*		
Number of species	*11*	*12*	*14*	*9*	*7*	*10*	*3*	*19*		

Key: CPUE = catch per unit effort.

Source: Schoofs et al. 2018

3.4.1.4 Macroinvertebrates

A 2017 Colorado State University study opportunistically captured several taxa of macroinvertebrates, including *Crangon* spp., polychaetes, amphipods, and isopods, during beach seining at the mouth of Eagle River (Table 3-10; Schoofs et al. 2018). A total of 7,843 macroinvertebrates were captured, including crangonid shrimp (83.4 percent), amphipods (13.9 percent), polychaete worms (2.5 percent), and isopods (0.1 percent). In general, macroinvertebrate abundance increased to a maximum in July and then gradually decreased throughout the late summer and fall, with a notable increase in October (Table 3-10). As a comparison, benthic sampling in Eagle Bay by Dames & Moore (1983) captured seven species of epibenthic invertebrates by beach seine, with the overall catch also dominated by crangonid shrimp (93 percent). Mobile epibenthic crustaceans such as crangonid shrimp, mysids, and gammarid amphipods moved into intertidal habitats when immersed during higher tides.

Pentec Environmental (2005) found that invertebrates typical of shorelines in central and lower Cook Inlet are largely absent on the beaches of Knik Arm. Density of invertebrates (mostly amphipods, mysids, and crangonids) taken in the beach seine was very low in late fall and early spring but increased steadily during the open water season, remaining high from August through October. These same species also dominated in the surface tow net samples, showing that the high degree of turbulence in Knik Arm brings these mostly bottom-dwelling species up to the surface.

Table 3-10 Number and CPUE (Invertebrate per Set) of Macroinvertebrate Taxa Captured Using a Beach Seine between 2 May and 9 November 2017 at the Mouth of Eagle River

Taxa captured	May	June	July	Aug	Sept	Oct	Nov	Total	% Total
Crangon spp.	776	1184	2257	1192	223	909	3	**6544**	**83.4**
Polychaete spp.	23	0	3	7	0	20	143	**196**	**2.5**
Amphipod spp.	83	301	130	166	59	326	29	**1094**	**13.9**
Isopod spp.	0	4	3	1	0	1	0	**9**	**0.1**
Grand Total	882	1489	2393	1366	282	1256	175	**7843**	**100.0**
% of Grand Total	11.2	19.0	30.5	17.4	3.6	16.0	2.2	**100.0**	
Beach Seine sets	28	35	28	15	5	26	5	**142**	
CPUE (Invert per set)	31.5	42.5	85.5	91.1	56.4	48.3	35.0	**55.2**	

Key: % = percent; CPUE = catch per unit effort; spp. = species.

Source: Schoofs et al. 2018.

3.4.2 Eagle River

3.4.2.1 Habitat Conditions

Eagle River (ADF&G Catalog No. 247-50-10110) drains an area of approximately 123,550 acres, starting at its headwaters in the Chugach Mountains and terminating in Eagle Bay in Upper Cook Inlet. The river flows 8.5 river miles through JBER property, with roughly the last 4.1 river miles passing through ERF-IA (Figure 3-2). The upper extent of tidal influence extends upstream to about Bravo Bridge. Once Eagle River passes Bravo Bridge into ERF-IA, the river is characterized as intertidal, and the dominant substrate is silt with few rocks.

Otter Creek is Eagle River's major tributary on JBER, although Clunie Creek flows through the proposed expansion area and contributes subterranean flow to the river. The mean flow volume in Eagle River is greatly decreased in the frozen months, from a low of 58 cubic feet per second (cfs) in March to a high of 1,730 cfs in July (Figure 3-5; USGS 2022). Periods of heavy rainfall or rapid melting from Eagle Glacier can generate water flow in excess of 10,300 cfs (NOAA 2014, cited in JBER 2023a).

Eagle River flows are primarily from Eagle Glacier (13 percent), which is the major source of flow during the warm months of the year, along with Eagle Lake and Symphony Lake. Groundwater and surface/overland sheet flow from small tributaries also contribute to flows. The river is generally clear in the winter, with higher visibility than during the spring and summer when glacial ice melts and contributes flow to the river, resulting in high suspended sediment loads; however, overall sediment loads are fairly low in comparison with other glacially fed streams in Alaska (CH2M Hill 1994).

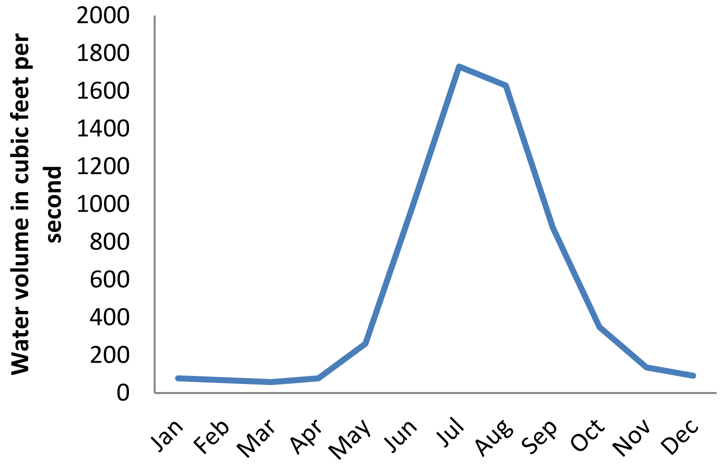

Figure 3-5 Monthly Mean Discharge of Water (1965-1981) in Cubic Feet per Second from Eagle River, Alaska (upstream from Glenn Highway)

Source: USGS 2022

Eagle River is surrounded by various habitats including alpine meadow, high shrub, mixed broadleaf forest, urban areas, and an estuary tidal marsh. Natural levees occur along the edge of Eagle River and the larger tributary streams near Eagle River. The combination of tides and river discharge cause variable levels of flooding across the flats. In some cases, areas behind the levees flood less frequently than nearby ponds because of their higher elevations (CH2M Hill 1997). However, flooding can occur from farther upstream, which would lead to flooding of the adjacent flats bypassing areas with levees, which would not actually reduce the potential for flooding (C. Brandt, personal communication, 6 October 2020).

Juvenile salmonid concentrations are likely greater in the main channels themselves because Eagle River and Otter Creek are fairly channelized and provide a constant source of water with good foraging opportunities. However, juvenile salmonids may be present in small concentrations throughout the entire tidal marsh complex if hydrology and water quality conditions are suitable (as described further in Section 3.4.2.2). Juvenile coho and other salmonids may overwinter in open water areas—and to a lesser degree under ice cover—in ERF-IA (JBER 2019c). Groundfish eggs and larvae may be present from winter through summer in Eagle Bay and Eagle River (NPFMC 2020) (Table 3-5). Forage fishes may be present in Eagle Bay throughout the year, with the exception of eulachon, which return to estuarine and fresh waters in the spring (Table 3-6).

Eagle River and the shallow ponds and creeks in the southern portion of the flats (where juvenile salmonids likely overwinter) experience different ice conditions. Eagle River ice accumulation is influenced by Eagle Bay. Ice pans migrate through Eagle River (laterally and vertically) along the tidally influenced portion of the river. At a critical date (which differs annually and geographically), sections of Eagle River ice become shorefast and begin to accumulate vertically (ranging from 2 to 3 feet thick depending on the year and location) (C. Garner, personal communication, 20 March 2020). JBER remote imaging has indicated that the upper river typically freezes in mid to late November in cold years and not until mid-December in warmer years. The mid-river generally does not freeze until late November in cold years and mid-January in warmer years. The lower river and mouth freeze by late November to early December in cold years and do not exhibit shorefast ice in warmer years (C. Garner, personal communication, 20 March 2020). Ice in the lower river tends to break up first (shorefast until at least mid-March in cold years), and the lower river does not have shorefast ice at all in warm years. Ice in the mid-river is generally shorefast until late January to mid-March, and upper river ice is shorefast from early to late March (C. Garner, personal communication, 20 March 2020).

Ice thickness is measured at the Explosive Ordnance Disposal pad on the eastern side of ERF-IA to determine when firing activities may commence. These data are used as a proxy to estimate thickness and timing of ice onset and breakup in the southern ponds and creeks in the southern portion of ERF. Over the past several years, shorefast ice has been found to form as early as 31 October, and sediments may remain frozen through 30 March and beyond. Ice thickness has been shown to vary between 1 and 32 inches (C. Garner, personal communication, 20 March 2020).

3.4.2.2 EFH Species Use

Eagle River is known to support all five Pacific salmon species (Chinook, chum, coho, pink, and sockeye salmon) (ADF&G 2022a; JBER 2023a). Adult salmon migrate upriver in Eagle River to spawning areas outside of ERF-IA (e.g., upper Otter Creek and Eagle River tributaries). Adult salmon migration and juvenile rearing have been observed in Eagle River, but spawning has not been documented in ERF-IA (ADF&G 2022a; JBER 2023a). The lower portion of Eagle River in ERF-IA consists of silt substrate and does not provide suitable spawning habitat.

JBER personnel sampled portions of Eagle Bay, the tidally influenced reaches of Eagle River, Otter Creek, and Garner Creek in the northwestern portion of ERF between 2007 and 2011 (unpublished data, cited in Schoofs et al. 2018). Although a few groundfish species were collected, salmonids were the only EFH species documented in the survey. Gill nets and minnow traps captured a total of 703 fish that represented nine different species and three developmental stages. The majority of fish captured were adult salmon species (n = 483 adult; 68.7 percent of total catch): coho salmon (28.3 percent), sockeye salmon (24.2 percent), chum salmon (8.5 percent), and pink (7.7 percent). Juvenile coho were the next most abundant species/developmental stage captured, with a total of 204 individuals (29 percent). Lesser numbers of other fish captured included Chinook salmon, Dolly Varden, threespine stickleback, slimy sculpin, and starry flounder. Additional species caught included saffron cod, eulachon, snailfish, and sand shrimp.

Since 2012, JBER has conducted annual salmon enumeration studies on Eagle River to establish a baseline for salmon escapement and run timing (Weber and Seigle 2020a; AERC 2021, 2022a). From 2012 to 2015, a Dual Frequency Identification Sonar (DIDSON) and fish wheel were used to estimate salmon escapement and to document species run timing. The studies were conducted from mid-May to mid-October just upstream from ERF and were designed to encompass the majority of the run timing for adult salmonids. Species timing data for the last year (2015) that the fish wheel was deployed in Eagle River are provided in Figure 3-6 (Johnson and Bottom 2016).

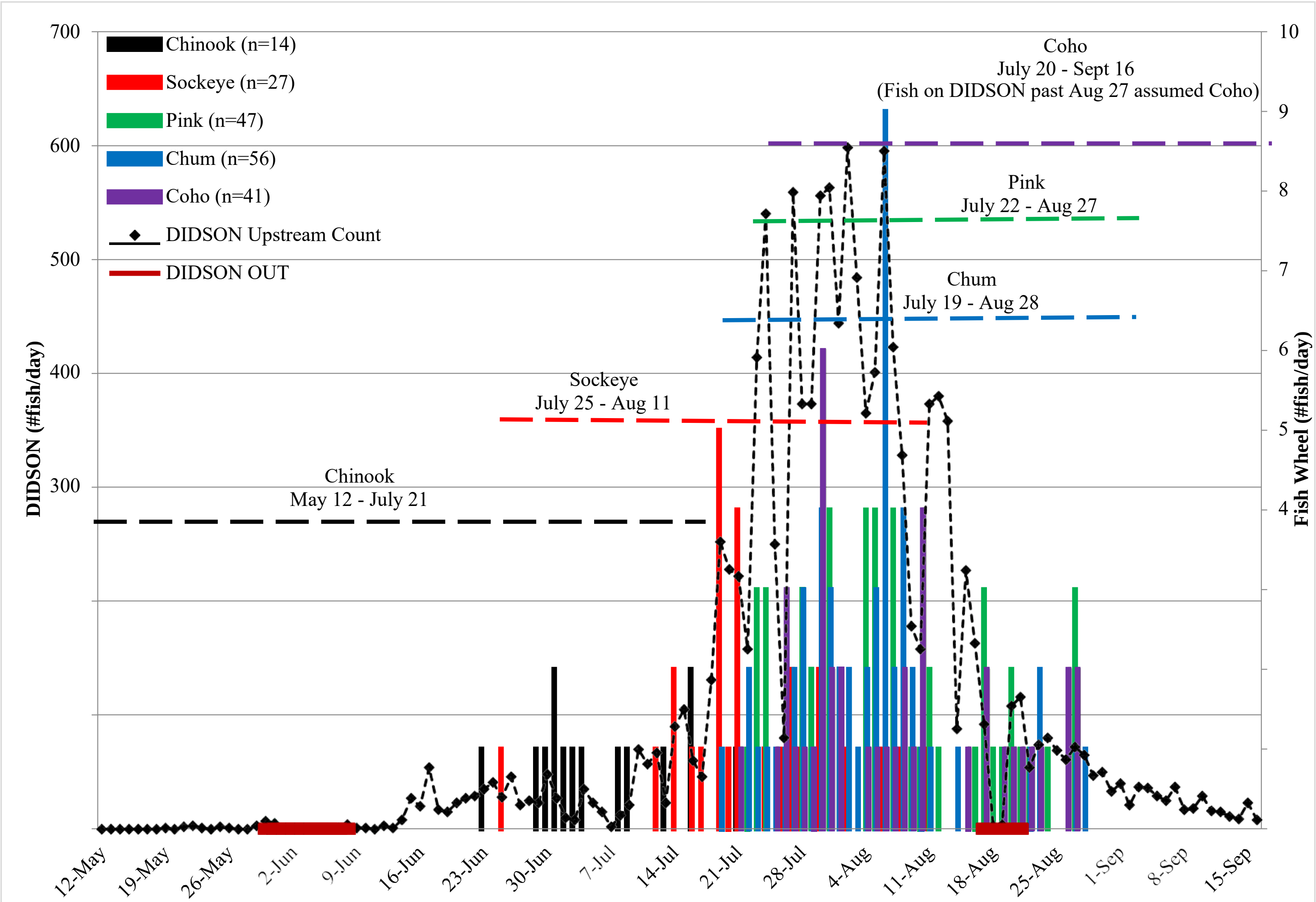

Figure 3-6 2015 Daily DIDSON Upstream Count (n = 12,755) and Fish Wheel Catch (n = 184) by Species in Eagle River

Source: Johnson and Bottom 2016

Chinook salmon are the first and least abundant salmon species to return to Eagle River each year. The Chinook run generally occurs from mid-May and is completed by early July. Sockeye are the second salmon species to return, with run timing from late June through August. Adult chum and pink salmon tend to return at the end of July, with the pink run complete by the end of August and the chum run ending in the first part of September. Coho salmon return to Eagle River around the end of July, and the run continues through September (Johnson and Bottom 2016; JBER 2023a) (Table 3-3).

Adult run timing (for all salmonids) from 2012 to 2021 is compared in Figure 3-7. The highest cumulative counts were recorded in 2021 (n = 14,007) and 2017 (n = 12,824) and lowest counts in 2018 (n = 1,336) and 2019 (n = 1,103) (Weber and Seigle 2020a; AERC 2021, 2022a). A review of daily escapement among years indicates that the adult salmon run in Eagle River typically begins in late May, with modest escapement spikes during June and early July. Historically, the bulk of escapement occurs from mid-July through late August. Adult salmon runs steadily decrease from mid-to-late August through September and typically terminate by early October. However, peak escapement varies considerably by year (Figure 3-7). In 2021, diurnal patterns of fish movement past the sonar assembly indicate that more than 50 percent of observed fish migrated over a 9-hour period between late afternoon and late evening, consistent with the long-term patterns in Eagle River (Weber and Seigle 2020a; AERC 2022a). The study also documented large numbers of smaller sized fish (<25.4 centimeters) in early May (as shown in Figure 3-7). It was hypothesized that these fish were eulachon rather than juvenile salmonids based on the size lengths and run timing.

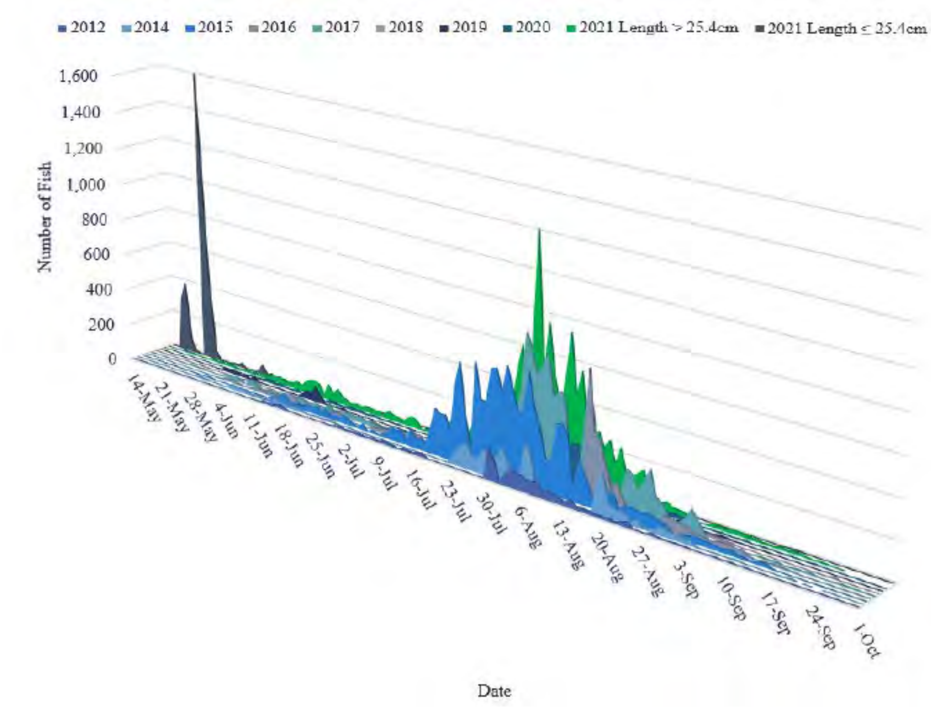

Figure 3-7 Total Daily Contribution of Salmonid Escapement, Plotted Cumulatively to Show Relative Year-by-Year Difference, at the DIDSON Weir on Eagle River, JBER, Alaska (2012-2021)

Source: AERC 2022a

Juvenile salmonids are typically concentrated within the Eagle River channel, although they may use intertidal areas during high tides and adjacent mudflats during flooding conditions (ADF&G 2022a; JBER 2023a). Tidal flooding moves progressively up the Eagle River channel and gullies and then spills across the inner mudflats into the ponds. The water level drops first at the coastal mudflats during the ebb, then progresses into the gullies (CH2M Hill 1997). Therefore, although not designated as EFH, flats and wetland areas adjacent to Eagle River may have year-round, seasonal, or diurnal (tidal) ponded areas that may connect to receiving waters and provide rearing for various fish species during flooding events. For example, threespine stickleback are commonly observed in the shallow mudflat ponds at ERF.

In addition, Eagle River side channels, tributaries, and adjacent wetlands may directly or indirectly provide habitat for juvenile salmonids. The Eagle River relict channel is a historical channel that connects with Eagle River in the vicinity of Bravo Bridge, extends through the southcentral portion of the impact area, and re-enters Eagle River near the Otter Creek confluence. Water depth data collected at two locations within the first 1.2 miles of its downstream confluence with Eagle River indicate that the lower half of the channel, at least, experiences tidally driven, bidirectional flow of brackish water per the semi-diurnal tidal regime of Cook Inlet (i.e., two floods per tidal day [JBER unpublished data]). Upstream from the buffered area, the channel becomes increasingly shallow and narrow.

The relict channel connects to a large complex of small tributaries and vegetated wetlands that have been recently found to provide off-channel rearing habitat for juvenile salmonids (JBER unpublished data). These findings have been documented as part of a multi-year ongoing study (April 2023 to December 2024) to investigate potential year-round residency and overwintering of juvenile salmonids within the eastern portion of ERF where habitat use was previously unknown. The study area extends between Eagle River mainstem to the north and the Otter Creek complex to the south and encompasses several small channels connected to the Eagle River relict channel and Otter Creek (JBER unpublished data).

Preliminary results suggest that the study area is more likely to support rearing from late spring to fall than during the winter, although further study is needed. During June 2023, subyearling coho were captured in small tributaries near the relict channel and treeline. Juvenile coho, Chinook, and sockeye salmon were also found within the study area in August 2023. These findings are not surprising since portions of the study area provide year-round hydrology (freshwater and brackish water) and vegetated cover that provide refugia and foraging opportunities for young juvenile salmon. This was also documented during a previous Alaskan estuary study, which found that coho abundance was greater in deeper channels with cooler and less variable temperatures and that variability in channel depth and water temperature was negatively associated with fish abundance (Hoem Neher et al. 2014). Because the study is ongoing, this EFH Assessment assumes that rearing salmonids could be present in all connected channels; however, presence and abundance of fish during specific firing activities cannot be determined.

Eagle River is managed to allow limited Chinook salmon fishing opportunities while ensuring wild populations are not impacted. In addition, the fishery is managed to maintain historical Chinook salmon escapement levels, continue natural production, and provide viewing opportunities. Access to Eagle River from the mouth upstream to Bravo Bridge, approximately 4.1 river miles, is restricted by the military due to the presence of UXO, and this reach of river is closed to all sport fishing year-round (Baumer and Blain-Roth 2020). Eagle River no longer has a sustainable escapement goal threshold for Chinook salmon (Munro and Volk 2010, cited in Baumer and Blain 2016).

3.4.2.3 Macroinvertebrates

Limited information is available regarding benthic macroinvertebrate communities in large and unaltered rivers, particularly in those involving glacial-fed rivers at northern latitudes (Schoofs et al. 2018). In sub-arctic regions, variation in lotic systems commonly relates to differing hydrological patterns. In the summer, stream types are affected by increased turbidity, suspended sediment load, bed-load transport, and velocity. During the winter, many streams and rivers are fed primarily by groundwater inputs, resulting in less variation. Additionally, the extent of snow and ice coverage affects the degree of incident solar radiation, water temperature, and primary production (Schütz et al. 2001, cited in Schoofs et al. 2018). Glacial-fed systems also experience changes in latitude, affecting riparian vegetation and instream conditions; these environmental gradients in turn reflect the composition of benthic fauna (Schoofs et al. 2018).

The combination of these habitat characteristics in glacial streams constrain the diversity and abundance of aquatic organisms that are able to persist in them (Milner and Petts 1994, cited in Schoofs et al. 2018). A study in Southeast Alaska investigated macroinvertebrate communities in hyporheic and benthic habitats in relation to glacial, clearwater, and brownwater stream types and their physiochemical properties (Wesener et al. 2011, cited in Schoofs et al. 2018). The study found the glacial system to have lower taxa richness and density than the clearwater and brownwater streams. Fauna from both benthic and hyporheic habitats were dominated by collector-gatherers, with the hyporheic zone being functionally more diverse. The taxa composition was similar across both habitats and all stream types (Wesener et al. 2011, cited in Schoofs et al. 2018).

The study of aquatic ecosystems in relatively undisturbed regions at higher latitudes is incredibly important, as these studies provide critical data for future management decisions in the face of anthropogenic change. As part of the 2017 stream and lake habitat study, the Hester-Dendy sampling method was employed on Eagle River to assess the presence/absence of macroinvertebrate species and infer the overall health of benthic communities, which provide important prey species for juvenile salmonids (Schoofs et al. 2018). Three sites were situated in the tidally influenced portion of Eagle River in ERF (ER1, ER3, and ER5), and three sites were situated upstream of tidal influence (ER7, ER8, and ER9).

The benthic invertebrates collected at all sites belonged to nine families and genera, from the orders Plecoptera, Ephemeroptera, Diptera, and Amphipoda. More taxa were collected at the upper sites, above ERF and tidally influenced stations (Figure 3-8). All macroinvertebrate species collected in the lower sites of the tidal flats belonged to the orders of Diptera and Amphipoda. Overall, taxa consisted of Chironomidae, Simuliidae *Simulium*, Baetidae *Baetis*, Heptageniidae *Cinygma*, Ephemerellidae *Ephemerella*, Cholorperlidae *Neaviperla*, Perlodidae *Isoperla*, Tipulidae *Pedicia*, and Gammaridae (in order of abundance, from greatest to least) (Schoofs et al. 2018).

Common metrics for assessing macroinvertebrate data evaluate the presence of families in the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT). EPT tend be sensitive to pollution, disturbance, and other environmental changes and serve as indicators of stream health. An EPT index was calculated based on the relative abundances of the EPT orders divided by the total number of individuals in the sample (Plafkin et al 1989; Goncalves and Menezes 2011, cited in Schoofs et al. 2018). The accumulative EPT percentage of Eagle River was 18 percent. The sensitivity of taxa in Eagle River reflected a healthy, unpolluted lotic system, with no highly tolerant taxa collected at any station (Figure 3-9). Functional feeding groups consisted of predominantly collectors (85 percent), with some predators (10 percent), and a small percentage of scrapers and shredders (3 percent and 2 percent, respectively) (Schoofs et al. 2018) (Figure 3-10).

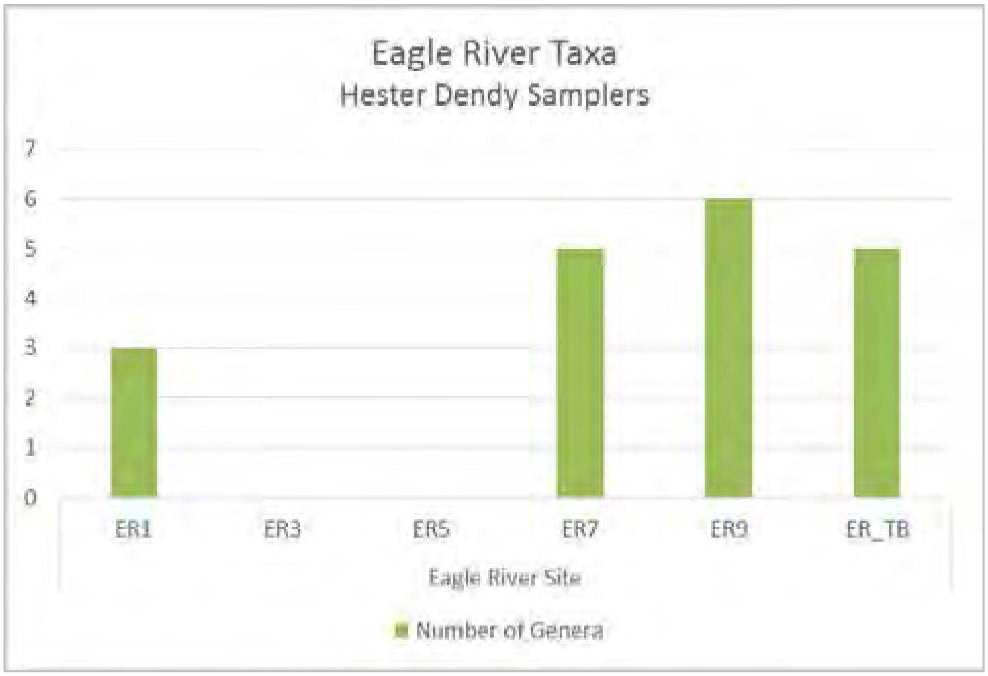

Figure 3-8 Taxa Richness of Macroinvertebrate Sites on Eagle River

Source: Schoofs et al. 2018

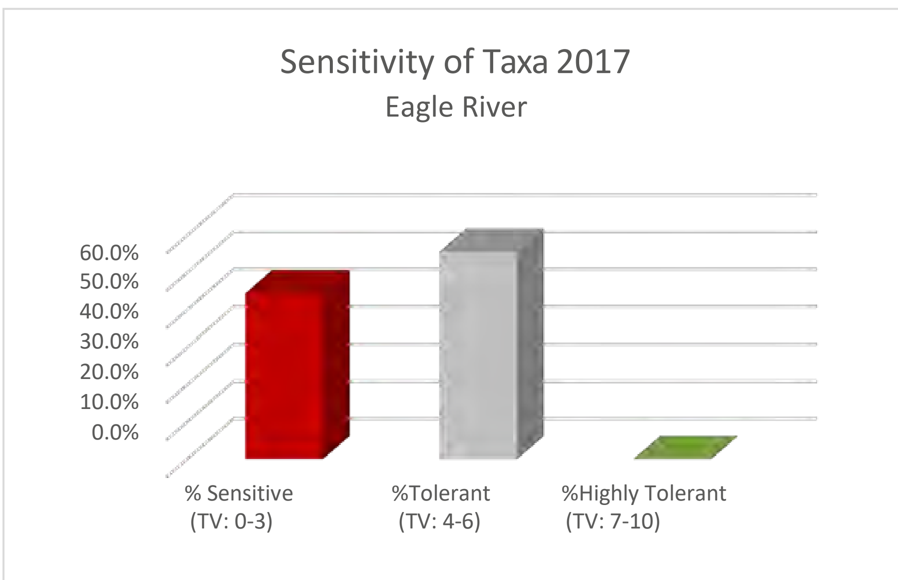

Figure 3-9 Accumulative Functional Feeding Groups Recovered in Study Sites on Eagle River

Source: Schoofs et al. 2018

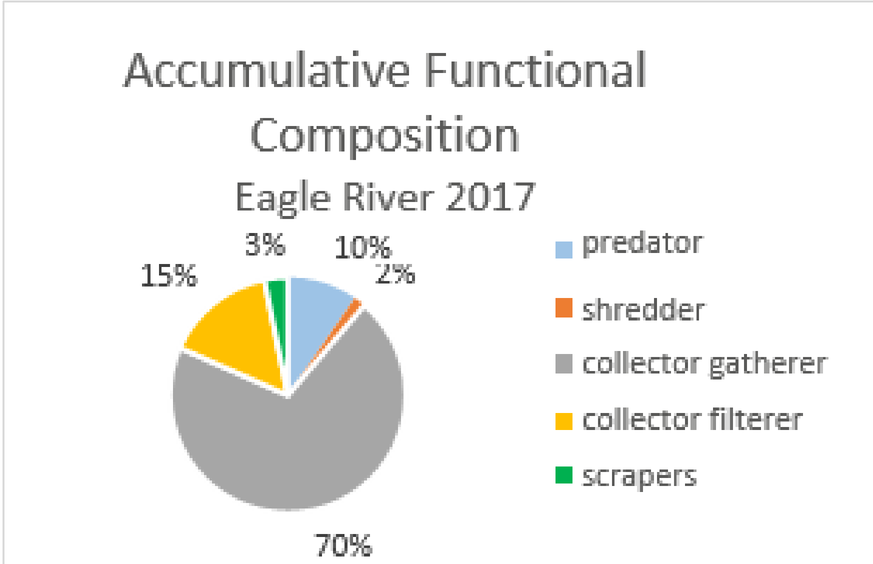

Figure 3-10 Percentage of Taxa Across All Sites in Eagle River, According to Their Tolerance Range

Source: Schoofs et al. 2018

3.4.3 Otter Creek and Otter Lake

3.4.3.1 Habitat Conditions

Otter Creek (ADF&G Catalog No. 247-50-10110-2010) originates in Otter Lake, which is spring fed and flows into Eagle River in ERF-IA. Two intertidal Otter Creek channels were recently added to the ADF&G AWC catalog: Otter Creek North Inter-tidal Channel (247-50-10110-2010-3007) and Otter Creek South Inter-tidal Channel (247-50-10110-2010-3009). Otter Creek flows through lowland and rocky broadleaf and needleleaf forests before entering the silt flats (JBER 2023a). Its substrate is composed of mostly fines and gravel (sizes 0.625 to 64 mm) until the flats, where it becomes more silt dominated. Otter Creek is characterized as a riffle-run system with dense vegetation prior to entering ERF-IA, at which point the vegetation changes to estuarine grasses and sedges, and the creek is tidally influenced. The lower portion of Otter Creek was dammed by beaver for several decades, which inhibited fish from entering the lake. Recent natural deterioration of the dam, reconstruction of a portion of the stream channel, and replacement of a culvert under Otter Lake Road has restored anadromy to this system. The return of adult salmon to Otter Lake was first recorded in 2017.

Otter Lake (ADF&G Catalog No. 247-50-10110-2010-0010) is a natural lake that was historically enhanced to increase its size and that discharges to Otter Creek (Weber and Seigle 2020b). The lake is outside of ERF-IA but provides spawning habitat for coho and sockeye salmon that migrate through Eagle River and Otter Creek (ADF&G 2022a; JBER 2023a). Otter Lake is an important recreational area serving both military and civilian residents in Anchorage (see Section 3.7).

3.4.3.2 EFH Species Use

Adult salmon historically used Otter Creek to migrate into Otter Lake, but access was impeded starting in the 1960s by a series of beaver dams in Otter Creek, a culvert beneath Otter Lake Road with insufficient flow for fish passage, and a concrete weir that blocked fish passage at the lake outlet. ADF&G stocked Otter Lake with rainbow trout (*O. mykiss*) until 2006 and resumed stocking the lake in 2016 (Schoofs et al. 2017). Northern pike (*Esox lucius*) was illegally introduced into the lake in around 2000 (POA 2011, cited in Weber and Seigle 2020b).

From 2015 to 2017, JBER and ADF&G conducted the Otter Lake/Creek Restoration Project to remove northern pike, remove obstructions to salmon passage, enhance spawning habitat, and reintroduce salmon to the system. The return of adult salmon to Otter Lake was first recorded in 2017. Coho salmon were observed in Otter Lake in 2017, as well as both coho and sockeye in 2018, suggesting that habitat restoration efforts were successful (Weber and Seigle 2020b). Over the past 2 years, stream surveys have been supplemented with autonomous fish counting equipment to estimate spawner escapement to Otter Lake. In 2022, it was estimated that 2,300 adult salmon (primarily coho) migrated into Otter Lake to spawn (AERC 2023b).

Adult coho, sockeye, and chum have been observed spawning in the upper reaches of Otter Creek as well (ADF&G 2022a; JBER 2023a). Rearing juvenile salmonids have been found in Otter Creek, from the lower tidally influenced reaches (in ERF-IA) to as far upstream as Otter Lake (Weber and Seigle 2020b; ADF&G 2022a; JBER 2023a). Other fish species documented in Otter Creek include threespine and ninespine stickleback, slimy sculpin, Dolly Varden, and rainbow trout. These species are presumed to migrate upstream from Eagle River and possibly pass rainbow trout from Otter Lake.

As part of a May to October 2018 juvenile salmonid dietary investigation in Otter Creek, juvenile rearing coho salmon in freshwater and intertidal areas of Otter Creek and intertidal tributaries to Otter Creek were documented (Table 3-11; Bogan et al. 2019). This study expanded on work that began in 2017 (Bogan et al. 2018). Since then, the intertidal channels and backwater ponds connected to Otter Creek at the southern portion of ERF-IA have been found to provide high-quality rearing and refugia habitat for juvenile coho salmon throughout the year.

Table 3-11 Juvenile Coho Caught, Lavaged, and Catch Rates at the Three Otter Creek Sites in 2018

	Otter Creek (Reference)					Lower Otter Creek (Intertidal)					Intertidal Tributaries to Otter Creek				
	5/30	7/3	8/16	9/6	10/17	5/31	7/2	8/15	9/5	10/17	6/1	7/3	8/16-18	9/5	10/16-18
Coho caught	34	46	64	73	37	22	31	49	103	30	9	9	36	110	26
Coho lavaged	28	30	30	30	30	20	30	30	29	29	9	9	30	28	16
Catch rate (Coho/trap hour)	0.5	1.8	0.8	2.2	1.1	0.3	0.8	0.9	3.5	0.9	0.2	0.1	0.5	2.1	0.6

Source: Bogan et al. 2019.

Catch rates were generally low at all sites in late May/early June but increased in July and peaked in September. Catch rates were always lower in the intertidal tributaries. Coho smolts were detected at all sites throughout the study, comprising 47 percent of the catch at the Otter Creek reference site, 69 percent of the catch in lower Otter Creek, and 86 percent of the catch in the intertidal tributaries.

To further assess the effectiveness of habitat restoration, visual adult salmon surveys were conducted in six Otter Creek stream reaches between ERF and Otter Lake from July to October 2019 (Weber and Seigle 2020b). The survey team observed a total of 433 adult salmon in Otter Creek, along with 4 post-spawn fish and 77 carcasses along the shoreline. Adult coho and sockeye were first observed in late July throughout the entire survey area. Fish counts remained at low levels until early September when observations started to increase, with sockeye counts peaking at 53 individuals on 13 September, and coho counts reaching 244 fish on 19 September. Coho and sockeye spawners were observed on 5 September in the upper reaches near Otter Lake (Weber and Seigle 2020b). The 2019 survey efforts confirmed that recent restoration activities in Otter Lake and Otter Creek have led to a substantial escapement of sockeye and coho salmon into the drainage (Weber and Seigle 2020b).

Based on the results of a 2018 investigation of overwintering habitat use by juvenile salmonids, the intertidal, backwater areas connected to Otter Creek in ERF provide EFH during a critical developmental period when there is low food availability and reduced dissolved oxygen (JBER 2019c). Surveys conducted in early March 2019 documented the presence of 59 juvenile coho, with the majority of fish captured in a beaver pond area that flows into the south intertidal connector channel. Although juvenile and smolt coho salmon had been observed throughout the summer in the intertidal channels of Otter Creek (Bogan et al. 2018, 2019), this was the first study that documented juvenile salmonids overwintering in the backwater and beaver pond areas of the Otter Creek complex. Further study is necessary to determine other areas that may provide overwintering habitat for juvenile salmonids.

3.4.3.3 Macroinvertebrates

Aquatic biotic abundance and diversity of macroinvertebrates are indicators of stream and lake health, as they are affected by physical, chemical, and biological conditions. In 2015–2016, benthic macroinvertebrate surveys were conducted in streams and lakes throughout JBER, including Otter Creek and Otter Lake (Schoofs and Zonneville 2016; Schoofs et al. 2017).

Two sampled Otter Creek stream sites outside of ERF showed relatively low EPT percent (less than 10 percent) and moderate EPT richness (4 to 5) compared to other JBER stream sites. The Otter Creek sites also had a very low percentage of both sensitive and tolerant taxa. Low percentages of tolerant taxa generally are indicative of beneficial habitat for macroinvertebrates, but the results are confounded by the low percentages of sensitive taxa. Alpine and sub-alpine sites tended to have a greater abundance of EPT taxa than sites farther downstream.

In 2016, three additional lower Otter Creek sampling sites were established in ERF-IA (Schoofs et al. 2017). Although no ground-disturbing macroinvertebrate sampling could be conducted at any of the three sites due to the potential for UXO presence, a Hester-Dendy sampler was deployed at the Lower Cole Point Bridge for approximately 4 weeks as a surrogate for the likely suite of macroinvertebrates in the lower Otter Creek sites (Schoofs et al. 2017). Macroinvertebrates collected at this site included Gammeridae (order Amphipoda), which are commonly referred to as “scuds,” and Isopoda (genus *Asellidae,* a common aquatic crustacean). Total counts were not conducted, but these organisms may be consumed by juvenile salmonids. Polychaetes have also been found in the tidally influenced areas of Eagle River and its tributaries (JBER 2023a).

In 2018, a juvenile coho dietary study was conducted to document the type and quantity of food that juvenile coho are consuming in lower Otter Creek at a lower intertidal reach, two intertidal tributaries, and a reference reach (outside of ERF-IA) (Bogan et al. 2019). The prey base for coho in the intertidal reaches includes organisms drifting downstream, as well as organisms originating in the water and riparian vegetation. In addition, organisms from the estuarine environment are transported into these reaches during high incoming tides, providing additional food resources for rearing coho (Bogan et al. 2019). The 2018 study results indicated a more even distribution of prey taxa groups than in previous studies, with no one taxa group accounting for more than 20 percent of the number of prey organisms in coho diets (Table 3-12). While prey of aquatic origin were generally more abundant in coho diets in all three reaches, prey biomass of terrestrial origin was greater in the reference reach and in lower Otter Creek in July and August, indicating the importance of terrestrial invertebrates to coho diets.

Table 3-12 Juvenile Coho Prey Group Statistics for Top 20 Prey Groups at Three Otter Creek Sites

Prey Group	Otter Creek (Reference)				Lower Otter Creek (Intertidal)				Otter Creek Tributaries (Intertidal)			
	% Freq	% No.	% Mass	% IRI	% Freq	% No.	% Mass	% IRI	% Freq	% No.	% Mass	% IRI
Chironomidae	63.5	39.4	2.3	35.9	53.3	16.8	1.1	17.1	72.2	30.3	1.2	38.1
Non-Chironomid Aquatic Diptera	67.6	21.1	14.7	29.8	49.6	17.2	6.8	19.5	47.2	9.3	7.3	10.6
Hymenoptera	31.1	10.0	16.3	11.1	13.1	2.9	5.2	1.9	17.5	1.3	1.8	0.9
Trichoptera	37.2	4.7	13.2	9.0	12.4	0.8	5.2	1.3	29.9	2.2	9.1	5.6
Plecoptera	31.1	5.0	5.2	4.3	9.5	0.8	0.3	0.2	6.2	1.0	0.5	0.2

Prey Group	Otter Creek (Reference)				Lower Otter Creek (Intertidal)				Otter Creek Tributaries (Intertidal)			
	% Freq	% No.	% Mass	% IRI	% Freq	% No.	% Mass	% IRI	% Freq	% No.	% Mass	% IRI
Terrestrial Diptera	25.7	2.9	2.7	2.0	28.5	4.2	7.8	6.1	32.0	3.2	1.9	2.7
Pisces	5.4	2.3	16.4	1.4	1.5	0.1	1.9	0.1	7.2	1.2	27.9	3.5
Terrestrial Mollusca	8.1	0.6	11.6	1.4	14.6	1.8	21.6	6.1	7.2	0.5	10.3	1.3
Araneae	19.6	1.7	3.0	1.2	19.7	1.7	5.2	2.4	27.8	2.0	7.1	4.2
Terrestrial Hemiptera	20.3	2.1	2.1	1.1	37.2	14.8	7.0	14.5	42.3	6.4	3.9	7.2
Ephemeroptera	21.6	3.3	0.5	1.1	0.7	0.0	0.0	0.0	4.1	0.4	0.2	0.0
Oligochaeta	12.8	1.6	1.5	0.5	N/A	N/A	N/A	N/A	7.2	0.4	0.7	0.1
Terrestrial Coleoptera	8.8	0.8	2.7	0.4	32.1	3.4	10.8	8.2	30.9	2.8	9.1	6.2
Aquatic Coleoptera	9.5	0.7	0.5	0.2	9.5	4.3	1.4	1.0	26.8	7.6	5.7	6.0
Lepidoptera	3.4	0.2	3.3	0.2	0.7	0.0	0.1	0.0	1.0	0.0	0.7	0.0
Aquatic Collembola	7.4	0.6	0.0	0.1	17.5	6.5	0.0	2.0	26.8	23.9	0.0	10.7
Terrestrial Collembola	6.8	0.7	0.2	0.1	12.4	2.2	0.0	0.5	15.5	2.0	0.0	0.5
Isopoda	0.7	0.0	0.1	0.0	35.0	18.0	8.5	16.6	17.5	2.5	2.6	1.5
Amphipoda	1.4	0.1	0.6	0.0	10.9	1.7	8.1	1.9	6.2	0.3	1.1	0.1
Aquatic Mollusca	4.1	0.5	0.4	0.0	4.4	0.9	3.3	0.3	10.3	0.7	0.3	0.2

Key: % Frequency = percent of coho stomachs prey taxa group was found; % Number = percentage of the total prey organism count; % Mass = percentage of the biomass of coho stomach contents; % IRI = percentage of the Index of Relative Importance of each taxa; N/A = not applicable.

Source: Bogan et al. 2019.

3.5 ESSENTIAL FISH HABITATS OF PARTICULAR CONCERN

No HAPCs overlap with the proposed project area. HAPCs are not discussed further in this EFH Assessment.

3.6 SUBSISTENCE FISHERY

The practice of subsistence take for food and resources is regulated and protected by federal and state law. The harvest and processing of wild resources for food, raw materials, and other traditional uses have been a central part of the customs and traditions of many cultural groups throughout Alaska. Subsistence consists of more than harvesting food. It is a system of cultural practice, resource distribution, and community connections that extend beyond the boundaries of the household and community. Many Alaskans depend heavily on subsistence-caught salmon for food and cultural purposes, including the aboriginal inhabitants, the Upper Cook Inlet Dena'ina, whose principal communities today include Knik and Eklutna (Fall 1981).

ADF&G defines subsistence fishing as the taking of, fishing for, or possession of fish, shellfish, or other fisheries resources by a resident of the state for subsistence uses with gill net, seine, fish wheel, long line, or other means defined by the Board of Fisheries (ADF&G n.d.-g). Title VIII of the Alaska National Interest Lands Conservation Act applies to federal public lands in Alaska. As a result, some subsistence hunting and fishing in Alaska are regulated by the federal government. Alaska state law (Alaska Statute 16.05.940[32]) and federal law currently differ in who qualifies for participation in subsistence fisheries and hunts. Under federal law, rural Alaska residents qualify for subsistence harvesting. Since 1989, all Alaska residents are entitled to participate in state-administered subsistence hunts and fisheries outside nonsubsistence use areas (ADF&G 2022c). Subsistence fisheries include salmon, halibut, herring, bottomfish, and shellfish. Today, the use of fish for subsistence—with the exception of salmon and halibut—is considerably less than during the period prior to the establishment of local retail stores and easily accessible packaged foods. Of the groundfish species, cod and rockfish are the most extensively used, with flounder and greenling as lesser contributors. Southcentral Alaska has a much lower level of subsistence use than other areas of the GOA (NMFS 2004, cited in NPFMC 2020). The Anchorage-Matanuska-Susitna-Kenai Peninsula Nonsubsistence Area, as designated by the Joint Boards of Fisheries and Game, is not considered a subsistence area. Alaska Statute 16.05.258c states that subsistence is not permitted in this area under state law.

While there are several subsistence salmon fisheries in Upper Cook Inlet and Knik Arm, subsistence harvest of fish does not occur on JBER at present. However, under the North Anchorage Land Use Agreement, Eklutna Inc. is not precluded from conducting any future subsistence activities should the federal government ever declare JBER lands excess to military requirements. As described in the INRMP (JBER 2023a) JBER "*consists of mostly public domain federal land withdrawn for military purposes. Federal regulations do not provide for subsistence priority on lands withdrawn for military use. 50 CFR 100.3(d), published 27 December 2005, in the Federal Register states: (d) The regulations contained in this part apply on all other public lands, other than to the military, U.S. Coast Guard, and Federal Aviation Administration lands that are closed to access by the general public, including all non-navigable waters located on these lands.*" No locations within ERF-IA are currently used for subsistence, and the area has been restricted from traditional activities and subsistence use since the establishment of Fort Richardson. JBER is within the traditional territory of the Dena'ina, who occupied the area and harvested resources. Dena'ina people are members of the Federally Recognized Tribes of Native Village of Eklutna, Knik Tribe, and Native Village of Tyonek. The people of Chickaloon Village Traditional Council also occupied JBER. They are collectively referred to as the Dene. According to ethnographic and archaeological data, Upper Cook Inlet Dene harvested all five species of salmon, eulachon, stickleback, and saffron cod in the area. Otter Lake and Otter Creek are known subsistence areas, and there are archaeological sites around ERF that demonstrate people harvested salmonids and groundfish there for at least the last 250 years. The Native Village of Eklutna is the closest of the Upper Cook Inlet Tribes to JBER. For centuries the Dene peoples inhabited what are now the installation's lands, hunting, fishing, gathering and establishing seasonal settlements. In addition, all of the Dena'ina Tribes of the Upper Cook Inlet used these same lands to differing degrees during seasonal subsistence rounds and trading excursions (Bancroft 1970; Fall 1981; Townsend 1981; Kari 1988; Davis and the Dena'ina Team 1994; Yarborough 1996; Fall et al. 2003; Hedman et al. 2003; Stone 2008; Kari and Fall 2016). Based on data from 1982, Chickaloon Native Village also harvests salmon as a primary resource, with chum, coho, Chinook, pink, and sockeye being the most harvested (ADF&G 2023b).

Subsistence harvest data for communities of Upper Cook Inlet for Native Village of Tyonek and Chickaloon Native Village were reviewed in the Community Subsistence Information System, a database maintained by ADF&G. There is no community summary information available from this source for Eklutna or Knik (ADF&G 2023b). The 2013 ADF&G data for Tyonek reports that Tyonek harvested an estimated 24,248 pounds of subsistence resources, predominantly multiple salmon species (i.e., Chinook, pink, coho), herring, cod, and halibut (ADF&G 2022d). In the 2013 summary data by ADF&G, Tyonek harvested an estimated 16,765 pounds of salmon and 1,863 pounds of non-salmon fish.

More recent (2018) subsistence salmon harvest data for a community near the proposed project area were obtained from the salmon fisheries in the Tyonek Subdistrict in Upper Cook Inlet (Jones and Fall 2020). The 2018 estimated harvest of 1,649 salmon was lower than the 2017 harvest of 2,089 salmon and the historical (1980–2018) average of 1,825 salmon. Of the total estimated subsistence salmon harvest in 2018, 1,308 were Chinook salmon (79 percent), 188 were sockeye salmon (11 percent), 136 were coho salmon (8 percent), 10 were chum salmon (1 percent), and 7 were pink salmon (1 percent) (Jones and Fall 2020). Due to a low preseason Chinook salmon forecast for the 2019 season, the Tyonek subsistence fisheries were restricted by emergency order from 3 days per week to 2 days per week (Jones and Fall 2020).
Impacts of the proposed action on subsistence resources are discussed in the project EIS.

3.7 RECREATIONAL FISHERY

Freshwater and saltwater recreational fishing is permitted on JBER, provided harvest rates are sustainable and accordant with the carrying capacity of fish habitats. Recreational fishing is extremely popular year-round on JBER and is centered primarily on stocked lakes. JBER is part of the ADF&G Anchorage Management Area for sport fisheries and fishing regulations for permitted fishing areas on JBER are provided in ADF&G 2023c. These regulations specify harvest limits for Chinook and other salmon, rainbow/steelhead trout, and Arctic char (*S. alpinus*)/Dolly Varden.

Eleven of the 30 stocked lakes in Anchorage Management Area occur on JBER. Stocking numbers are based on ADF&G-estimated carrying capacity and estimates of fishing pressure. The stocking program has changed greatly over the years. Although past stocking programs released Arctic char, Arctic grayling (*Thymallus arcticus*), lake trout (*Salvelinus namaycush*), and steelhead trout, the program currently stocks only rainbow trout, lake trout, Arctic char, and landlocked salmon. Ice fishing is allowed on most JBER lakes from mid-November through late-March (JBER 2023a).

Fishing at the mouth of Sixmile Creek is legal up to the high-water marker. Fishing at this location is popular, although exact numbers of salmon harvested here are unknown (JBER 2023a). Fishing opportunities are available along Eagle River within and outside of the JBER boundary, but there is no access to ERF-IA for recreational fishing (JBER 2023a). ADF&G has limited information on fish populations in this system. Two sections of Ship Creek and upstream of Bravo Bridge on Eagle River are also open to fishing under state regulations and bag limits. Sixmile (upstream of mouth), Otter, and EOD Creeks are closed to fishing. To better estimate fishing pressure, users can self-report their fish harvest through creel surveys conducted through iSportsman. In 2020 and 2021, an average of approximately 10,000 fish (90 percent of which were rainbow trout) were reported harvested from JBER (JBER 2023a). The 2021 total included 8,345 rainbow trout, 461 Chinook salmon, 158 coho salmon, 127 Dolly Varden/Arctic char, 20 sockeye salmon, and 2 lake trout at Clunie Lake (JBER 2023a).

In 1990, an annual stocking program was initiated in Eagle River with approximately 105,000 Chinook salmon smolt of Ship Creek origin (Stratton and Cyr 1995, cited in Baumer and Blain-Roth 2020). Due to poor returns and difficult fishing conditions, the stocking program was discontinued in 1995. Chinook salmon capture and harvest data for Eagle River are available from 1999 to 2018 (Baumer and Blaine-Roth 2020). Over this time period, the number of Chinook captured ranged from zero to 251 fish, and the number harvested ranged from zero to 109 fish. From 2012 to 2015, no Chinook salmon were reported caught or harvested in Eagle River. From 2016 to 2018, an average of 12 Chinook salmon were caught and harvested (Baumer and Blain-Roth 2020). The failure to enhance the fishery with hatchery releases, and typically poor fishing conditions with high, fast water during the season open to Chinook salmon fishing, probably contributed to low angler effort and success. Anecdotal information and observations of fishery performance in-season suggest that the catch and harvest numbers will continue to remain low.

Impacts of the proposed action on recreation are discussed in the project EIS.

4.0 ANALYSIS OF EFFECTS ON EFH AND MANAGED SPECIES

This chapter addresses direct, indirect, and cumulative effects of Alternatives 1 and 2 on EFH and managed species in the proposed project area. Acoustic noise from live-firing events is the primary direct effect analyzed. Risk of serious or lethal injury from direct strikes to managed species or fragmentation of munitions fired into ERF is also analyzed as a potential direct effect. Indirect effects to EFH may include changes to water and sediment quality via introduction of munitions contaminants and related bioaccumulation of contaminants to managed fish species. Erosion and sedimentation into aquatic systems from firing events may constitute a direct or indirect effect, depending on the location of the activity. This section also analyzes whether proposed conservation measures would be protective of EFH and managed species. Sections 6.2 to 6.4 provide an analysis of the potential duration, extent, magnitude, and scale (e.g., run, watershed, population) of potential project effects from the proposed action.

4.1 DIRECT ACOUSTIC IMPACTS

Noise does not impact EFH through a physical modification of the water column and sediments. Rather, impacts are manifested through changes in fish behavior, injury, or mortality. Exposure to high-intensity underwater noise may result in fish mortality, external and internal injury (such as damage to swim bladders), reduction to fitness due to physiological/behavioral stress, increased predation, reduced feeding efficiency, and avoidance of preferred habitats (Wright and Hopky 1998; Hastings and Popper 2005; Popper and Hastings 2009; Halvorsen et al. 2012; Buehler et al. 2015; Popper and Hawkins 2019; Popper et al. 2019). Although EFH analyses are meant to primarily focus on habitat components (e.g., sediment, water quality, prey base) (NOAA 2021), potential acoustic effects to the managed species themselves are also evaluated, as the noise may interrupt key life behaviors important for reproduction and growth.

There is limited information on the impacts to fish from detonation of explosives that travel through air and sediments before entering water. Studies and investigations on construction impacts from pile-driving and other activities have shown that direct ensonification in aquatic systems can generate underwater sound pressure levels that can injure and/or kill fish or cause alterations in behavior (Wright and Hopky 1998; Hastings and Popper 2005; Halvorsen et al. 2012). Most of the proposed mortar and artillery training activities are not expected to introduce firing noise directly into the aquatic environment but would be attenuated by air and sediment first before exposure to any fish or other aquatic organisms.

Proposed habitat protection buffers and other protective measures (e.g., no intentional firing or placement of targets into open waterbodies) would avoid or reduce acoustic impacts to fish species under most firing scenarios. However, these measures are not completely protective because there is a moderate to high risk that live firing of HE munitions could occur in waterbodies that support fish during typical inundating tide events or in unbuffered areas that are hydrologically connected to the Eagle River relict channel complex and upper Garner Creek. Firing in these areas could result in acoustic impacts (mortality, injury, or behavioral changes) to fish.

While there is potential for direct firing into unbuffered stream channels that may provide rearing habitat for juvenile salmonids, the risk of acoustic impacts would be reduced, as targets would be strategically placed to avoid these areas. However, there is potential for detonations to inadvertently occur in existing channels because the target areas may overlay and encompass portions of some stream channels, tributaries, gullies, or other fish habitats, and it may not be possible to identify the presence of open water prior to firing.

To evaluate potential effects from these acoustic transmission pathways, JASCO Applied Sciences (JASCO) performed site-specific acoustic modeling (Section 4.1.3) to evaluate noise propagation pathways for the specific munitions that would be used at JBER.

4.1.1 Fish Hearing Capabilities

All fishes have two sensory systems that can detect sound in the water: the inner ear, which functions similarly to the inner ear in other vertebrates, and the lateral line, which consists of a series of receptors along the body of a fish (Popper 2008). The pressure component of sound is represented by sound waves, which are characterized by the medium compressing and expanding as sound energy moves through it. At the same time, the particles that form the medium move back and forth (particle motion). All fish directly sense the particle motion component of sound (Fay 1984), although relatively few fish sense both the particle and pressure components (Popper et al. 2003). The ears of all fish consist of otolith- (or otoconia-) containing end organs that function as inertial accelerometers. Fish that sense pressure have additional morphological adaptations that allow them to detect acoustic pressure (e.g., Popper et al. 2003; Popper and Hawkins 2019). In these fish, gas-filled bladders such as the swim bladder, which is near the ear, or mechanical connections such as Weberian ossicles, which are between the gas-filled bladder and the ear, convey sound pressure from the water to the ear when pressure deforms the bladder (JASCO 2020, 2022).

Most fish detect only particle motion, not pressure, and their hearing frequency range is typically limited to frequencies below 1 kilohertz (kHz). Pressure-sensing fish tend to have extended hearing bandwidth and lower detection thresholds. They are often capable of detecting signals up to 3–4 kHz, with thresholds that may be at least 20 decibels (dB) lower than pressure-insensitive fish (Hastings and Popper 2005). Fish hearing groups tend to be defined by species that possess a similar continuum of anatomical features, which result in varying degrees of hearing sensitivity (Popper and Hastings 2009; Popper and Fay 2011). Hearing capabilities between different fish species, especially those that are taxonomically or geographically distant, must be extrapolated with caution.

Fish have all of the basic acoustic processing capabilities of other vertebrates (Popper et al. 2003; Ladich and Popper 2004). Fish can discriminate between sounds of different magnitudes or frequencies, detect specific sounds when other signals are present, and determine the direction of a sound source (JASCO 2020). However, in contrast to marine mammals, which appear to have a limited ability to detect particle motion (Finneran et al. 2002), fish are well adapted to detect the particle motion component of an acoustic stimulus using sensory cells in the inner ear and lateral line (Popper 1996). Although such detection of sound is not considered hearing, it is likely that responses from the ear and lateral line are integrated into a single response to an acoustic stimulus (Higgs and Radford 2013).

Fish have historically been categorized as either hearing specialists or generalists based largely on their hearing range and sensitivity (Fay and Popper 2012); however, Popper and Fay (2011) determined that this classification system is poorly and inconsistently defined and likely too simplistic. Therefore, fish hearing groups now tend to be defined by species that possess a similar continuum of anatomical features, which result in varying degrees of hearing sensitivity (Popper and Hastings 2009; Popper and Fay 2011). Categories and descriptions of hearing sensitivities are further defined in this document (based on guidelines from Popper et al. 2014 and Popper et al. 2019) as follows:

- Fishes without a swim bladder (Group I) – hearing capabilities are limited to particle motion detection and are best at frequencies less than 300 Hertz (Hz) (e.g., flatfishes, eulachon, sculpin).
- Fishes with a swim bladder not involved in hearing (Group II) – species lack notable anatomical specializations and show sensitivity only to a narrow band of frequencies (e.g., salmonids).
- Fishes with a swim bladder involved in hearing (Group III) – species can detect frequencies up to about 500 Hz and possess anatomical specializations to enhance hearing and are capable of sound pressure detection up to a few kHz (e.g., saffron cod).
- Fishes with a swim bladder and high-frequency hearing (Group IV) – species can detect frequencies below 1 kHz and possess anatomical specializations and are capable of sound pressure detection at frequencies up to 5 kHz (e.g., Pacific herring) and higher in some species (e.g., American shad).

Mechanisms for auditory detection of sound (i.e., hearing) vary widely among fish (Ladich and Fay 2013; Popper et al. 2014); however, hearing capability data only exist for just over 100 of the currently known 34,000 marine and freshwater fish species (Eschmeyer and Fong 2016). Consequently, for this analysis JBER has applied the results of research on species that are closely related or that share similar morphology (e.g., lacking a swim bladder) and life history (e.g., bottom dwelling) where appropriate (Table 4-1).

Table 4-1 Fish Species Used as Proxies for EFH-Managed Species in Eagle Bay and ERF, Alaska

Hearing Group	EFH-Managed Species Found in Knik Arm and ERF		Species Used as Proxy		Justification
	Common Name	Scientific Name	Common Name	Scientific Name	
Group I	Starry flounder	*Platichthys stellatus*	Common dab	*Limanda limanda*	Same family
Group I	Pacific staghorn sculpin	*Leptocottus armatus*	Spoonhead sculpin	*Cottus ricei*	Same family
Group II	Pacific salmon	*Oncorhynchus* spp.	Atlantic salmon	*Salmo salar*	Same family and subfamily
Group III	Walleye pollock	*Gadus chalcogrammus*	Atlantic cod	*Gaddus morhua*	Same family
Group IV	Pacific herring	*Clupea pallasii*	N/A	N/A	N/A

Key: EFH = Essential Fish Habitat; N/A = not applicable; spp. = species.

4.1.1.1 Fish without Swim Bladders—Flatfish, Eulachon, Sculpin

Hearing abilities for fish without a swim bladder are limited to detection of the particle displacement component of an acoustic stimulus. For EFH-managed species, this includes various flatfish (Family Pleuronectidae), such as starry flounder, as well as eulachon and sculpin species. Chapman and Sand (1974) (summarized in Nedwell et al. 2004) tested two flatfish—the common dab (*Limanda limanda*) and the European plaice (*Plueronectes platesa*)—and found that their hearing range is between 30 and 270 Hz, with best sensitivity at about 100 Hz. Mean hearing thresholds (i.e., the mean sound level below which a common dab and spoonhead sculpin are unable to detect any sound at various frequencies) are provided in Tables 4-2 and 4-3.

Table 4-2 Hearing Threshold Levels for Common Dab (*Limanda limanda*)

Frequency (Hz)	30	40	60	80	110	160	200
Mean threshold (dB re 1 μPa)	95	93.8	91.7	89.8	89	95.9	104.9

Key: dB re 1 μPa = decibels referenced to 1 microPascal; Hz = hertz.

Source: Chapman and Sand 1974.

Table 4-3 Hearing Threshold Levels for Spoonhead Sculpin (*Cottus ricei*)

Frequency (Hz)	100	200	400	800	1600
Mean threshold (dB re 1 μPa)	88	87	121	128	124

Key: dB re 1 μPa = decibels referenced to 1 microPascal; Hz = hertz.

Source: Mann et al. 2007.

4.1.1.2 Fish with Swim Bladders Not Involved in Hearing—Salmonids

The hearing capability of Atlantic salmon (*Salmo salar*) indicates a rather low sensitivity to sound, with primary sensitivity to particle motion at frequencies below 200 Hz and to sound pressure above 200 Hz (Hawkins and Johnstone 1978; audiogram obtained from Nedwell et al. 2004). The mean threshold levels measured per frequency for Atlantic salmon are provided in Table 4-4. Salmon's poor hearing is likely due to the lack of a link between the swim bladder and inner ear (Jørgensen et al. 2004).

Table 4-4 Hearing Threshold Levels for Atlantic Salmon (*Salmo salar*)

Frequency (Hz)	32	60	110	160	250	310	380
Mean threshold (dB re 1 μPa)	107.5	105	97.5	95.2	106	112.5	131.5

Key: dB re 1 μPa = decibels referenced to 1 microPascal; Hz = hertz.

Source: Hawkins and Johnstone 1978.

4.1.1.3 Fish with Swim Bladders Involved in Hearing—Walleye Pollock

Hearing thresholds of walleye pollock are generally similar to those of other gadidae fishes, such as Atlantic cod. Gadidae species are most sensitive to sounds from 30 to 500 Hz (Hawkins and Picciulin 2019). Atlantic cod was found to respond to particle motion at frequencies below 50 Hz and to sound pressure at all other frequencies in its range (Chapman and Hawkins 1973; Nedwell et al. 2004; Hawkins and Popper 2020). The mean threshold levels measured per frequency for Atlantic cod are provided in Table 4-5.

Table 4-5 Hearing Threshold Levels for Atlantic Cod (*Gadus morhua*)

Frequency (Hz)	30	40	50	60	100	160	200	300	400	450
Mean threshold (dB re 1 μPa)	90	90.4	83.1	79.8	77.3	75.3	81.6	81.2	84.7	110.2

Key: dB re 1 μPa = decibels referenced to 1 microPascal; Hz = hertz.

Source: Chapman and Hawkins 1973.

4.1.1.4 Fish with Swim Bladders and High-Frequency Hearing Capabilities—Pacific Herring

Pacific herring and other clupeids are considered specialists because they possess anatomical structures joining the swim bladder to the ear, leading to an expanded hearing range (both in frequency and relative sensitivity) aided by sound pressure detection capabilities (Enger 1967; Popper et al. 2003). Herring use sound to communicate and are more sensitive to anthropogenic noise than salmon (Van der Knaap et al. 2022). Pacific herring have low-frequency thresholds typical of other clupeids and can detect frequencies of up to 5 kHz but with higher thresholds than at lower frequencies. Unlike other clupeids, including sardines and anchovies, herring cannot detect ultrasound (sound with frequencies higher than 20 kHz) (Mann et al. 2005). The mean threshold levels measured per frequency for the Pacific herring are provided in Table 4-6.

Table 4-6 Hearing Threshold Levels for Pacific Herring (*Clupea pallasii*)

Frequency (Hz)	200	300	400	600	800	1000	2000	4000	5000
Mean threshold (dB re 1 μPa)	104	109	108	109	118	123	136	129	137

Key: dB re 1 μPa = decibels referenced to 1 microPascal; Hz = hertz.

Source: Mann et al. 2005.

4.1.2 Underwater Noise Modeling and Noise Effects Criteria

JASCO (2020) conducted numerical modeling to evaluate the potential impacts to marine mammals and fish due to underwater and in-air noise from mortar and artillery firing at ERF-IA. Multiple training scenarios were analyzed involving explosive ammunition fired by 105-mm and 155-mm howitzers and by 60-mm, 81-mm, and 120-mm mortars during both summer and winter scenarios to reflect representative training sessions and firing locations (JASCO 2020). These multiple scenarios allow the potential acoustic impacts on fish in ERF waterbodies such as Eagle River, Otter Creek, and Eagle Bay to be assessed. For this analysis, the trinitrotoluene (TNT)-equivalent explosive mass for the ammunition is indicated as Net Explosive Weight (NEW). The following information is summarized from the report (JASCO 2020).

The modeling methodology considered the following:

- Each weapon's caliber, azimuth, angle of declination, height above the ground, and spectral properties and directionality of the noise generated by muzzle blast upon shooting
- The amount of explosive in each type of ammunition and height above ground where detonation occurs
- The impact of environmental parameters, such as water sound speed profile, bathymetry, seabed geoacoustics, atmospheric conditions, and soil flow resistivity in winter and summer
- The cumulative effect of multiple rounds fired in a 24-hour period
- The impact of tides, including typical inundating tide events

JASCO also conducted a supplemental analysis in 2022 to evaluate additional training scenarios, analyze non-auditory effects (for marine mammals), and estimate areas where detonations should be avoided to prevent underwater noise effects to marine mammals and fish. Distance to Effect (DTE) modeling was performed by simulating potential firing scenarios at a pre-determined firing point (FP3) and several detonation points (AF1, DP2, and DP3) along Eagle Bay, Eagle River, and Otter Creek complex during typical high tide conditions (Figure 4-1). DTE modeling utilized an iterative process where the ground impact point was shifted away from the edge of the nearest waterbody until thresholds were no longer exceeded in the water.

Detonation points DP2 and DP3 are located approximately 100 meters from Eagle River. AF1 represents an accidental firing scenario where a round is inadvertently fired into Eagle River near the mouth of Eagle Bay (although the risk of such an occurrence is low). These points were chosen by the Army as representative locations to inform how sound would propagate throughout ERF-IA and firing areas. Note that the modeled detonation points were target arrays that were chosen based on historical firing and are not the only areas that the Army could fire into. Targets could be placed outside of these traditional target arrays as long as they are situated outside of the established buffers.

For underwater sound propagation, it was concluded that the coupling of acoustic energy from the air-ground-water pathway has the greatest potential to affect marine mammals and fish (JASCO 2020, 2022). The modeling considered typical high tide conditions as well as typical inundating tide events that may occur in ERF-IA during summer, although DTE modeling only considered typical high tide conditions. During lower tide conditions, there would be an even longer pathway for ground-detonation noise to propagate into the water column, further reducing noise levels. For this reason, typical high tide conditions represent a conservative scenario for firing, outside of the infrequent periods of inundation, which have been modeled separately.

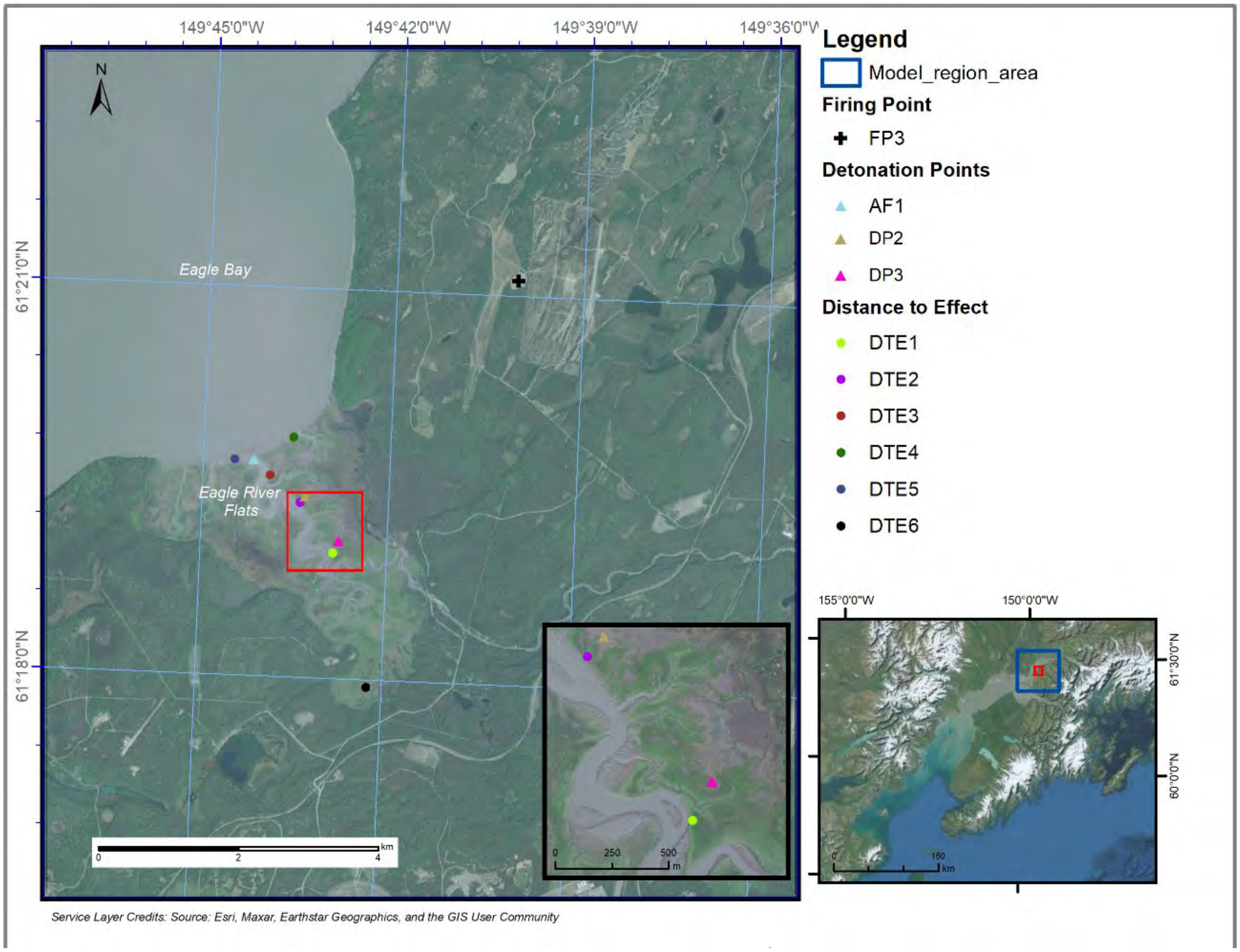

Figure 4-1 Firing and Detonation Points Analyzed at ERF-IA

Although flooding may also occur during other periods of the year, typical inundating tide events that may occur at ERF-IA during spring/summer (April to October) were modeled to represent the "worst-case" scenario for effects to marine mammals and fish because because saturated soils do not attenuate sound propagation as well as ice cover and frozen ground conditions. Modeling showed that a key aspect to minimize underwater noise is keeping a buffer distance between detonation points and waterbodies because sound undergoes strong attenuation as it propagates underground to reach the water (JASCO 2020, 2022). The presence of snow on the ground would result in less energy coupling into the ground-to-water path. In addition, the ice coverage expected during winter would introduce additional acoustic losses to the propagation of sound underwater (Thiele et al. 1990) due to scattering loss.

Summer flooding events may coincide with periods of rain or snow/glacial melt or moderate to strong southerly winds (10+ knots), resulting in higher-than-predicted water elevations (Lawson et al. 1996b). During these events, shallow water can cover certain areas of the flats surrounding Eagle River and Otter Creek not normally inundated during high tide, and munition rounds could detonate upon impact with the ground in the submerged (0.5-meter depth) target array locations. This would lead to detonation sound propagating through ground in addition to water and potentially into Eagle River, Otter Creek, or Eagle Bay, if these areas are hydrologically connected.

Extreme maximum tide events (theoretical inundation of 6.4 feet) were not modeled because they are very rare and produced by a combination of high astronomical tide height, extremely high discharge from Eagle River, and a strong storm surge from the south. While possible, it is unlikely that all of these factors would converge during a firing event, so the more typical inundating tide event was modeled instead to provide a more representative characterization of what may be expected during a typical flooding event in the adjacent flats.

This analysis references various combined (COMB) live-firing scenarios modeled by JASCO (2020, 2022) that may be used at JBER. Where applicable, the nomenclature from the acoustic modeling reports (e.g., COMB5, COMB21) is used. Table 4-7 contains a summary of the firing scenarios used in this analysis, which are the subset of the scenarios modeled by JASCO that were selected to evaluate the most conservative effects on sensitive fish and wildlife receptors. Additional details about these scenarios can be found in JASCO's acoustic modeling reports (JASCO 2020, 2022).

Table 4-7 Summary of Modeled Firing Scenarios Used in This Analysis

Scenario	Scenario with Equivalent DTE Parameters	Round Characteristics	
		Total Maximum # of Rounds/Day	NEW of Ammunition (kg)
COMB5 (summer)	COMB7 (summer)	47	1.06
		186	0.87
COMB9 (summer)	COMB11 (summer)	75	3.58
		179	1.89
COMB13 (summer)	COMB15 (summer)	212	3.81
		40	2.36
COMB18 (winter)	--	36	7.12
		262	2.84
COMB21 (summer)	COMB23 (summer)	36	10.93
		262	2.84

Key: -- = not applicable; COMB = combined; DTE = Distance to Effect; kg= kilogram; NEW = Net Explosive Weight.
Source: JASCO 2020, 2022.

The 155-mm training rounds, which have a small explosive component of 1.3 kg NEW, were not specifically modeled. Assessment of underwater noise impacts for these rounds were based on results for the most similar HE weight round (1.89 kg) and number of rounds fired per day (179) (scenarios COMB9 and COMB11).

The models were used to estimate sound levels over a large area around the firing and detonation points. While all live-firing activities generate noise, HE rounds contain an explosive component that can result in greater effects to fish present in the impact radius than other firing activities (e.g., training rounds, ILLUM, and smoke rounds). Therefore, the detonation of HE near fish-bearing waters is more prone to result in physical injury or mortality to various life stages of fish (including eggs and larvae) that may be present during live-firing activities than detonation of other munitions.

In all cases, the noise footprint due to ammunition detonation was larger than the footprint due to muzzle blast. Scenarios with a conservative maximum number of shots per day were simulated to calculate the per-shot and the cumulative sound energy that could be emitted in a 24-hour period (denoted SEL_{24h}). For fish, distances to thresholds were computed for the following potential effects—mortality, potential mortal injury, and hearing impairment—using the mortality and impairment criteria recommended by the Fisheries Hydroacoustic Working Group (Popper et al. 2014), shown in Table 4-8. For underwater noise in relation to fish, results were presented in terms of the following noise criteria:

- Peak sound pressure level (PK or *Lpk*) and unweighted sound exposure level (SEL) for mortality or potential mortal injury and hearing impairment for fish based on Popper et al. (2014). The PK refers to the maximum instantaneous sound pressure level in a stated frequency band during a stated period and is considered the most conservative and protective threshold to protect fish.
- SEL_{24h} is a cumulative measure of sound related to the sound energy in one or more pulses that could be emitted in a 24-hour period.

Table 4-8 Mortality and Impairment Criteria for Sound from Impulsive Sources, as Proposed by the Fisheries Hydroacoustic Working Group

Fish Group		Mortality and Potential Mortal Injury		Impairment		
				Recoverable Injury		Temporary Threshold Shift
		SEL (24 h) (dB re 1 μPa^2·s)	PK (dB re 1 μPa)	SEL (24 h) dB re 1 μPa^2·s)	PK (dB re 1 μPa)	SEL (24 h) (dB re 1 μPa^2·s)
I	No swim bladder (particle motion detection)	> 219	> 213	> 216	> 213	> 186
II	Swim bladder not involved in hearing (particle motion detection)	210	> 207	203	> 207	> 186
III and IV	Swim bladder involved in hearing (primary pressure detection)	207	> 207	203	> 207	186

Key: dB re 1 μPa^2·s = decibels referenced to 1 microPascal; PK = peak sound pressure; s = second; SEL = sound exposure level.

Source: Popper et al. 2014; Popper et al. 2019.

Evidence has demonstrated that Lpk and SEL are better predictors of injury for fishes and most groups of marine life (Southall et al. 2007; Popper et al. 2014; Southall et al. 2019). PK level is associated with immediate physiological injury to fish tissues (Halvorsen et al. 2012). SEL is associated with fish fatigue injury through the equal energy hypothesis that states the effects on hearing are the same for the same total energy (Eldredge and Covell 1958, cited in Martin et al. 2019).

For this analysis, Lpk metrics are used to evaluate noise for a single detonation, whereas SEL metrics are used to evaluate noise from the total maximum number of rounds per day for each charge. Although peak values provide more representative thresholds for mortality or injury of fish (and are more conservative than SEL values), SEL metrics are more representative of ERF live-firing scenarios and thus provide more appropriate underwater noise thresholds for fish. As such, JBER considered these values when determining potential effects to EFH and managed fish species.

Most training activities are not expected to introduce firing noise directly into the aquatic environment; noise would be attenuated by air and sediment before exposure to fish or other aquatic organisms. Direct coupling of airborne sound into the water is not a major contributor of underwater noise due to the sound wave impinging the water at grazing angles shallower than the critical angle (77 degrees) (JASCO 2022). Although very high airburst detonations at close distances to the water could exceed the critical angle, these scenarios would not occur during the proposed training.

Acoustic measurements collected during previous 2013 land detonations on the surrounding bluffs around ERF suggested a strong air-to-water coupling pathway (Henderson et al. 2013; BAART 2019). During the 2020 JASCO study, this effect was only observed for detonations at the farthest measurement range. Snell’s law can be used to determine how the path of a sound wave changes when it enters a new medium, and thus how sound from air could be transmitted into water. While Snell's law should apply in a controlled environment, the range of variables demonstrated in the JASCO study resulted in some inconsistent acoustic responses and confounding variables that resulted in outlier results that did not reflect the vacuum required by the law. JASCO (2022) concluded that the strong air-to-water coupling may be possible in some conditions, but for the purposes of their modeling, it was not assumed to be a dominant effect because the scenarios considered were on the flats rather than the bluffs. JASCO (2022) suggested that further intensive studies at ERF-IA would be needed to confirm whether a strong air-to-water coupling exists.

Most of the proposed habitat buffers (see Section 5.1.1) were identified based on acoustic modeling results to protect endangered beluga whales, which generally require a larger protective buffer than fish. Therefore, these buffers would be protective of fish in the buffered streams as well. The buffer of the Otter Creek complex was identified based on modeling results for fish, which provide a conservative estimate for this location.

4.1.3 Mortality or Injury of EFH-Managed Species Due to Primary Blast Trauma

Detonation of explosives produces a compression shock wave that expands rapidly outward from the detonation point. This pressure wave is characterized by a rapid compression of the transmitting media to a high peak pressure, followed by an equally rapid rarefaction of the media to below ambient hydrostatic pressure. Physical damage to organs of vertebrates exhibiting a gas/tissue interface (e.g., intestines, swim-bladders) due to the rapid changes in pressure is thought to be the primary cause of injury to fish exposed to underwater noise (Popper et al. 2019). In-water explosions have a steeper rise time than terrestrial explosions do and therefore are typically more lethal to fish (ADF&G 1991).

This analysis focuses on underwater sound propagation only. In-air sound propagation from muzzle blast or from detonations above water are not expected to affect managed fish species because sound levels would attenuate between the muzzle blast or detonation point and the water, and the air-water sound propagation pathway is not expected to affect managed fish species (JASCO 2020).

4.1.3.1 Alternative 1: All-Season Live-Fire Training with Expanded Impact Area (Proposed Action)[7]

Training sessions generally involve multiple firings of HE and training rounds aimed at designated impact locations (or targets), where the artillery rounds can detonate above the ground or on impact with the ground, which may be submerged during flooding events (JASCO 2020). The resumption of all-season mortar and artillery firing at ERF-IA would increase the potential for mortality, injury, or behavioral changes of fish due to underwater noise and vibrations from live-firing activities. Currently, firing is limited to the winter months, when fish abundance and diversity is generally lower in the proposed project area than it is during ice-free periods. During winter firing, the primary concern to EFH and managed fish species involves land detonations that transfer noise directly from the ice and snow-covered ground and into the water, but DTE thresholds can be much larger if detonations occur in water when there is a direct underwater pathway into waters that support fish. Under Alternative 1, the winter-only firing would be lifted, and live-fire training could occur at any time during the year, including when juvenile salmonids are more likely to be present and when adult salmon may be holding in Eagle River, Eagle Bay, or Otter Creek channels or actively migrating to spawning grounds upstream of ERF-IA. Additionally, firing could occur when adult and juvenile salmon from other systems rear in or migrate through the shallow and deep-water areas just offshore in Eagle Bay or in the mouth of Eagle River from spring through fall (C. Garner, personal communication, 23 October 2020).

Firing activities would be of relatively short duration (each event less than 24 hours; with events ranging from 7 to 14 days), with variable intervals between training events (determined based on qualification cycles), which would limit durations of exposure to managed fish species. Firing may occur during three different situations that could result in mortality or injury of fish due to underwater noise propagation: 1) typical tide conditions (normal low to high tide ranges) throughout ERF-IA where detonations take place on land; 2) typical tide conditions in unbuffered areas where detonations inadvertently occur in water and there exists a hydrological connection with stream channels where fish are present, and 3) typical inundating

[7] In Chapters 4 and 6, alternatives are referenced using shortened versions of the names given in Section 2.2.

tide events (when the adjacent flats are flooded and hydrologically connected). The probability for mortality or injury is greater under Scenarios 2 and 3 because these events involve detonation targets in water (where presence of standing water cannot be observed) in or adjacent to areas where juvenile salmonids are present. In Scenario 3, detonation noise could propagate through the shallow water of the flats (up to 0.5 meters deep) and impact fish that may be present in the main channels if these areas are hydrologically connected.

Although there is a potential for underwater detonations if firing occurs during winter flooding events, the probability of typical inundating tide events is much greater from spring through fall, and particularly during the months of August and September, which coincides with periods when adult and juvenile salmonids may be present in accessible waterbodies throughout ERF-IA. In addition, EFH-managed groundfish and forage fishes (e.g., starry flounder) and various groundfish larvae (e.g., Dover sole, which has EFH designated in Eagle River) may be present during any time of the year but are expected to be most abundant from winter through summer in Eagle River and Eagle Bay. Therefore, managed fish species would be present in greater abundance during ice-free periods when land and underwater detonations could have a greater effect on them in ERF-IA.

Under Alternative 1, live-firing activities may occur during the upstream spawning migration of all five adult EFH-managed salmon species, which generally occurs from May through mid-October. Although salmon spawning is not known to occur in ERF-IA, juvenile salmonids are known to rear in Eagle River, Otter Creek, and associated intertidal/backwater channels and ponds in ERF-IA; however, abundance is greater from spring though fall, when they may be rearing or outmigrating to marine areas.

Distances to thresholds were computed for the following potential effects to fish: mortality, potential mortal injury, and hearing impairment (JASCO 2020) using the mortality and impairment criteria recommended by the Fisheries Hydroacoustic Working Group (Popper et al. 2014). The supplemental DTE modeling was performed to determine how close to a waterbody the target arrays could be located before underwater noise thresholds would be exceeded for typical high tide conditions (JASCO 2022). As described in Section 2.2, HE rounds would not be fired during typical inundating tide events to avoid exceeding acoustic effects thresholds for fish. Thus, the actual worst-case firing scenarios considered included 1) firing of HE rounds during typical high tide conditions, 2) firing of training rounds during typical inundating tide events, and 3) accidental firing into a waterbody during training exercises. Potential impacts to managed fish species from these scenarios are described below.

Firing of HE Rounds during Typical High Tide Conditions

DTE modeling was performed for a live-firing scenario involving the largest HE munition type during summer (COMB21) to determine how close target arrays could be located near waterbodies before underwater noise thresholds for fish would be exceeded for the typical high tide condition (JASCO 2022). This scenario (155-mm howitzer; 10.93 kg NEW) was chosen because it represents the worst-case scenario with respect to acoustic impacts from land detonations near waterbodies. However, this provides a conservative estimate of potential impacts to fish because this round would only be fired into the portion of ERF-IA adjacent to Training Areas 415 and 416 (Figure 2-2). Typical high tide conditions are appropriate because HE rounds would not be fired during inundating tide events. Maximum distances from the edge of waterbodies in ERF-IA where mortality and injury threshold exceedances to fish may occur are provided in Table 4-9.

Table 4-9 Maximum Distances from Edge of Waterbody Where Threshold Exceedances to Fish May Occur (Typical High Tide)

Effect	Species	Threshold (dB re 1 μPa2·s)	Eagle River		Eagle Bay			Otter Creek Complex
			DTE1	DTE2	DTE3	DTE4	DTE5	DTE6
Recoverable injury; SEL	Fish with no swim bladder	216 dB	-	-	-	-	-	-
	Fish with swim bladder	203 dB	-	2 m	-	2 m	-	6 m
Mortality and potential mortal injury; SEL	Fish with no swim bladder	219 dB	-	-	-	-	-	-
	Fish with swim bladder involved in hearing	210 dB	-	-	-	-	-	4 m
	Fish with swim bladder not involved in hearing	207 dB	-	-	-	-	-	4 m
TTS; SEL	All fish	186 dB	18 m	26 m	22 m	26 m	26 m	20 m
Proposed Buffers	**-**	**-**	**50-130 m**		**500 m**			**50 m**

Notes: For a discussion of the proposed buffers, see Section 2.1.
Key: dB = decibel; ; dB re 1 μPa^2·s = decibels referenced to 1 microPascal; DTE = Distance to Effect; m = meters; SEL = sound exposure level; TTS = temporary threshold shift.
Source: JASCO 2022, modeled scenario COMB21.

See Figure 4-2 for a representative map of the sound field modeled for scenario COMB 21. Based on the information presented in this table, the proposed protective buffers along Eagle Bay, Eagle River, and the Otter Creek complex (as described in Section 5.1.1) are more than sufficient to protect fish in these waterbodies from all firing scenarios under Alternative 1 during typical high tide conditions. Existing buffers have been adjusted based on noise modeling results to provide adequate noise protection along the Eagle River main channel and Otter Creek complex. The potential for HE rounds to cause acoustic effects to fish during inadvertent water detonations in unbuffered areas is described later in this section.

For modeled detonations above typical maximum high tide level when the target locations are not inundated and hydrologically connected to adjacent waterbodies, none of the underwater noise thresholds for fish mortality, potential mortal injury, or impairment were reached for any of the potential firing scenarios at the representative detonation points (DP2 or DP3) throughout the year. This only applies to buffered areas.

For land detonations during typical high tide conditions, with implementation of the conservation measures proposed under Alternative 1, there is no potential for mortality or injury to various life stages of managed fish from primary blast trauma caused by underwater noise, based on modeling results. Additionally, as shown in Table 2-4, 26 percent of the total HE rounds would be fired into the proposed expansion area under this alternative, an area where there would be no risk of noise impacts to managed fish species. The lower concentration of munitions fired into ERF-IA for Alternative 1 (3,784 HE rounds) compared to Alternative 2 (5,128 HE rounds) would result in a lower risk of impacts to fish and a lower likelihood of errant rounds affecting fish and their habitat. Note that 155-mm training rounds (total of 900 rounds annually) would only be fired into ERF (not the expansion area) so there would be no difference between Alternatives 1 and 2 in terms of the number of these rounds fired.

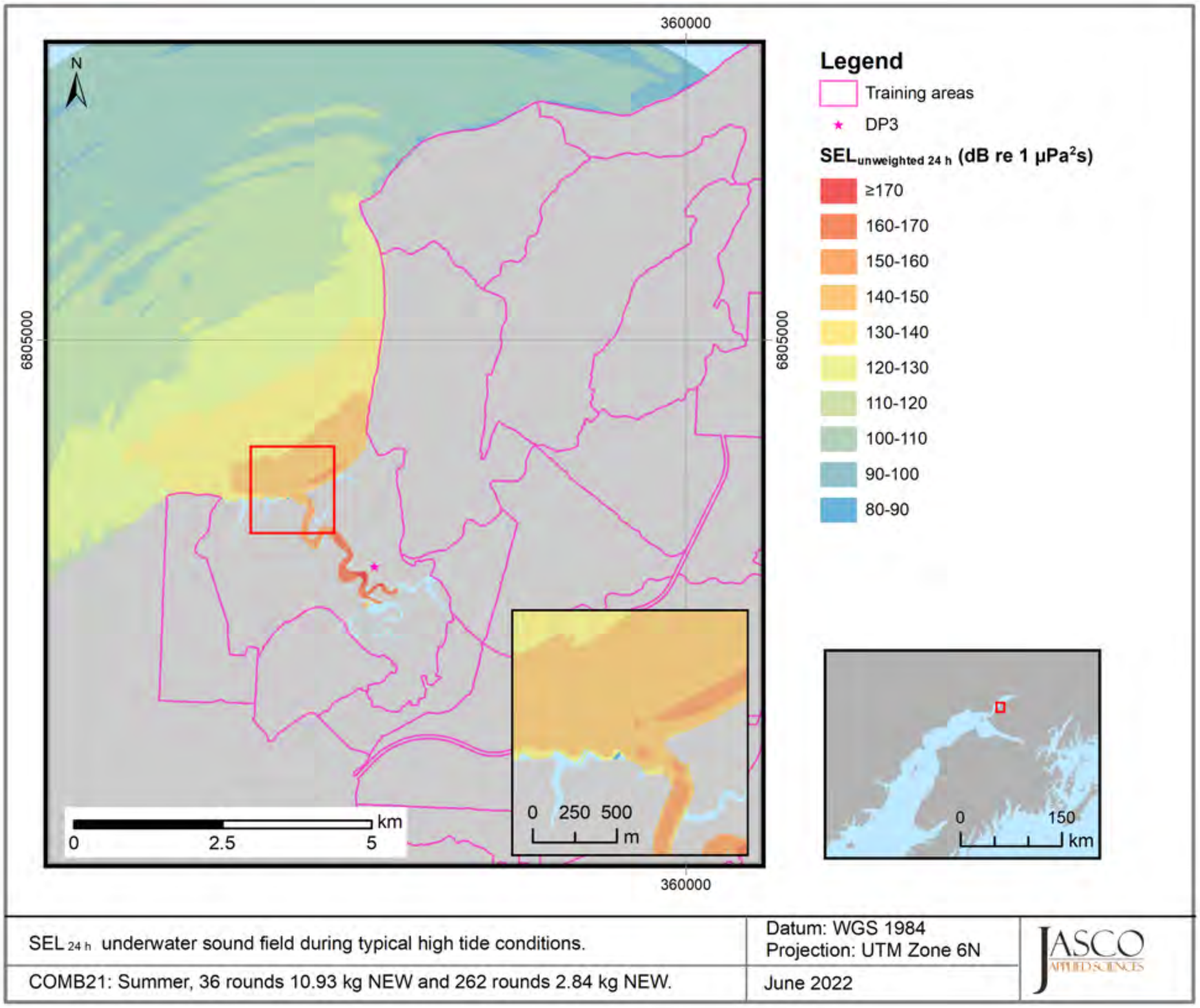

Figure 4-2 Modeled Fish TTS SEL_{24h} Underwater Sound Field for COMB 21 Scenario during Typical High Tide Conditions

Source: JASCO 2022

Some training rounds are fitted with a point-detonating practice fuze that simulates the multi-option fuze and provides a flash, bang, and smoke (typically through the ignition of a small black powder charge). The pyrotechnic smoke composition charge ranges from 12-16 grams, of which roughly a third (4-6 grams) is explosive (potassium perchlorate). The projectile bodies are hollow and do not fragment. Because the FRTRs do not yield HE and fragmentation effects and their pyrotechnic effects cannot be observed if they are fired into water, they must be fired at targets on solid ground in order to have training value.

There is an unquantifiable risk (potentially ranging from moderate to high) that firing at targets in unbuffered areas, particularly the Eagle River relict channel complex, during typical high tide conditions could result in mortality or injury to juvenile salmonids if they are present within a stream channel where a water detonation occurs. This is the case for two reasons: 1) targets would not be intentionally placed in wetted channels but the entire target area and weapon system impact area (hatched areas in Figure 2-1) within the SDZ may overlap channels that support juvenile salmonids, and 2) juvenile salmonids could potentially occupy any wetted channels in unbuffered areas throughout the year. Although the majority of the target area would not encompass a channel feature, and forward observers would monitor for presence of standing water prior to firing, there is a risk that an HE round could potentially land within a wetted channel while fish are present. This could occur if open water is not able to be observed at the target site due to presence of heavy vegetation or light-limited conditions. If this occurs, the maximum distances for mortality and injury effects on fish would likely be similar to those described in Section 4.1.3.3 for typical inundating tide events, although type of rounds fired as well as presence of vegetation and other site-specific factors would influence and potentially reduce maximum distances to effect for fish.

The particular risk of acoustic impacts to juvenile salmonids in the Eagle River relict channel complex is due to the affinity for salmonids to rear within shallow, vegetated areas, which are prevalent within this portion of ERF-IA. The Army would employ several protective measures to reduce this risk, including the following: 1) no firing will be permitted within any wetted stream channels per restrictions in USARAK 350-2 (Section 2.4); 2) firing will only target higher elevation areas to protect fish that may be rearing in vegetated low-lying ponds or depressions that cannot be easily observed; 3) no firing of 155-mm rounds will occur within the Eagle River relict channel complex due to space limitations; and 4) forward observers will monitor for observable open water and also ensure that rounds are visually observed impacting or bursting. If forward observers identify any site or detonation conditions that could potentially result in harm to salmonids, firing will immediately cease and a different target will be selected to ensure that salmonids are not subject to further auditory harm or injury from live firing within these unbuffered area. As described in Section 2.1.2.2, the probability of an errant round landing outside of the designated impact area is approximately one in a million, provided standard firing procedures are followed (U.S. Army 2014). If a round does land outside of the weapon system impact area, a check fire is called and all firing immediately stops; firing does not resume until a full investigation is completed to determine the cause of the errant round.

Firing of Training Rounds during Typical Inundating Tide Events

The Army proposes to only use training, ILLUM, and smoke rounds during typical inundating tide events. These rounds do not contain HE and would not generate explosive forces in the impact area. The 155-mm training round, however, contains a small HE component of 1.3 kg NEW and therefore has the potential to result in acoustic effects. As previously noted, some FRTRs contain a small pyrotechnic charge, but these rounds must be fired on dry ground to have training value.

To evaluate potential impacts to fish from detonation of the 155-mm training round in water, underwater noise impacts for the most similar HE weight round (NEW 1.9 kg) and number of rounds fired per day (179) modeled in JASCO (2020, 2022) are summarized in Tables 4-10 and 4-11. These scenarios (COMB 9 and 11) involve indirect live firing at two representative locations (DP2 and DP3) during typical inundating tide events. See Figure 4-3 for a representative map of the sound field modeled for scenario COMB 9. As shown in Tables 4-10 and 4-11, maximum distances for mortality and injury effects on fish with swim bladders (e.g., salmonids) may extend up to 320 meters (mortality) and 410 meters (injury) from the source (using $SEL_{24\text{-hr}}$ values) and up to 490 meters from the source (using Lpk values). This scenario would also exceed mortality and injury acoustic thresholds for fish without a swim bladder (e.g., eulachon and groundfish). Although the 500-meter Eagle Bay buffer would be protective of fish mortality and injury, the proposed buffers at Eagle River (range from 50-130 meters) and Otter Creek complex (50 meters) would not be adequately protective for most managed fish species when firing training rounds during a typical inundating tide event. Firing of 155-mm training rounds during flooded conditions would present a risk of mortality or injury to juvenile salmonids if they are present in unbuffered areas of ERF-IA. Because these rounds would not be fired into the Eagle River relict channel complex (see Figure 2-2), impacts to fish in this unbuffered area would be avoided.

Table 4-10 Maximum Distances (from the Detonation Point) to Fish Mortality, Potential Mortal Injury, and Impairment (using $SEL_{24\text{-}hr}$ Thresholds) Due to 155-mm Training Round[1] Detonation Noise during Typical Inundating Tide Events

Mortality and Potential Mortal Injury Thresholds (dB re 1 μPa2·s)			Impairment Thresholds (dB re 1 μPa2·s)[2]		
			Recoverable Injury		Temporary Threshold Shift
Fish with no swim bladder: >219	Fish with swim bladder not involved in hearing: 210	Fish with swim bladder involved in hearing: 207	Fish with no swim bladder: >216	Fish with swim bladder: 203	All fish: >186
110 m	260 m	320 m	150 m	410 m	850 m

Notes:
[1]155-mm training rounds have 1.3 kg NEW.
[2] Thresholds provided are $SEL_{24\text{-}hr}$ values with units of dB re 1 $\mu Pa^2 \cdot s$.
Key: dB re 1 $\mu Pa^2 \cdot s$ = decibels referenced at 1 microPascal; HE = high explosive; kg = kilogram; km = kilometer; m = meter; mm = millimeter; NEW = Net Explosive Weight; $SEL_{24\text{-}hr}$ = sound exposure level 24-hour period.
Source: Popper et al. 2014; JASCO 2020, modeled scenario COMB9.

Table 4-11 Maximum Distances (from the Detonation Point) to Fish Mortality, Potential Mortal Injury, and Recoverable Injury (Using Peak Thresholds) Due to 155-mm Training Round[1] Detonation Noise during Typical Inundating Tide Events

Mortality, Potential Mortal Injury, and Recoverable Injury Thresholds[2]	
Fish with no swim bladder: >213 (dB re 1 μPa)	Fish with swim bladder: >207 (dB re 1 μPa)
350 m	490 m

Notes:
[1] 155-mm training rounds modeled have 1.3 kg NEW.
[2] Thresholds provided are unweighted peak thresholds (dB re 1 μPa).
Key: dB re 1 μPa= decibels referenced at 1 microPascal; HE = high explosive; kg = kilogram; m = meter; mm = millimeter; NEW = Net Explosive Weight.
Sources: Popper et al. 2014; JASCO 2020, modeled scenario COMB9.

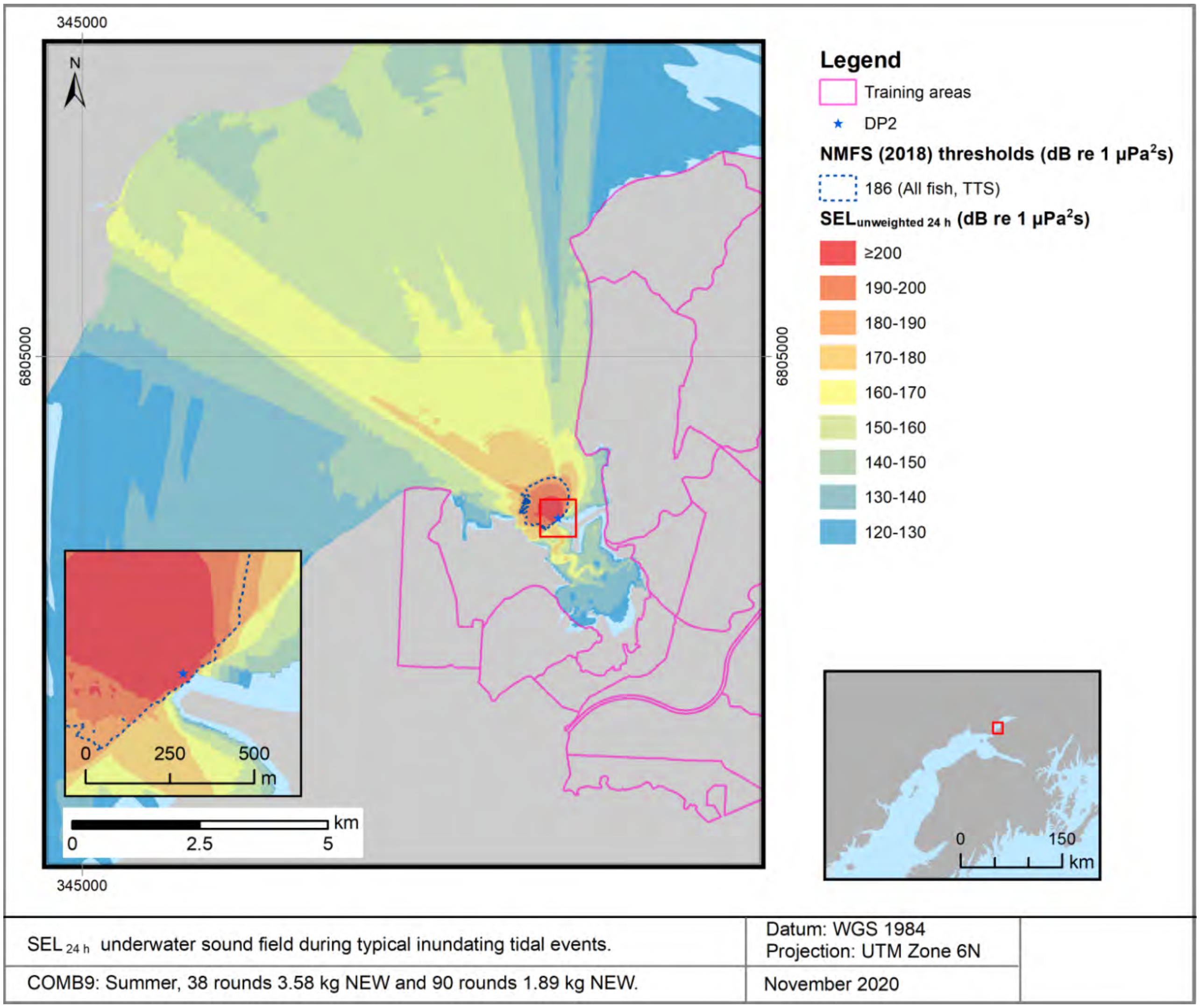

Figure 4-3 Modeled Fish TTS SEL$_{24h}$ Underwater Sound Field for COMB 9 Scenario during Typical Inundating Tide Events

Source: JASCO 2020

Although fish may currently be exposed to acoustic disturbance when live-firing activities occur during periods when soils and water are covered with ice, the resumption of all-season firing has the greatest potential to cause acoustic-related mortality or injury to juvenile salmonids if they are present at or in the vicinity of in-water detonations. The most likely effect scenarios include 1) inadvertent firing in water within certain unbuffered areas (e.g., upper Garner Creek) and 2) firing during intermittent periods of flooding that may occur during ice-free periods when managed species are more abundant and susceptible to direct impacts at ERF-IA. Although 155-mm training rounds would not be fired into the unbuffered Eagle River relict channel complex, juvenile salmonids may rear within other unbuffered areas where these rounds would be fired, such as the area around upper Garner Creek. Potential effects to fish from firing in unbuffered areas during typical high tide conditions were previously described in Section 4.1.3.2. During typical inundating tide events, fish could potentially be present over a larger portion of the unbuffered area, which would increase the risk of acoustic impacts, although no HE rounds would be fired. The following focuses on potential impacts to fish during typical inundating tide events throughout the rest of ERF-IA.

Juvenile salmonids and other fishes in ERF-IA use the channelized portions of Eagle River and Otter Creek—and intertidal, backwater areas that are connected to Otter Creek and the Eagle River relict channel complex on the southern side of ERF—for rearing. Adults tend to use the main Eagle River and Otter Creek channels for transit to off-site spawning areas. Spawning of salmon is not known to occur in ERF-IA, with the closest known spawning area occurring in Otter Creek upstream of ERF. Natural levees occur along the edge of Eagle River and the larger tributary streams near Eagle River. The combination of tides and river discharge cause variable levels of flooding across the flats. In some cases, areas behind the levees flood less frequently than nearby ponds because of their higher elevations (CH2M Hill 1997); however, flooding can occur from farther upstream, which could then flood the adjacent flats, bypassing areas with levees (C. Brandt, personal communication, 6 October 2020). Existing and proposed conservation measures, including prohibitions on intentional firing into open waterbodies and the all-season buffers around Eagle Bay, Eagle River, and Otter Creek complex (ranging from 50 to 500 meters wide depending on location), would make it unlikely that fish at any developmental stage would be injured or die as a result of live firing when munitions strike dry ground.

HE munition detonations that occur when the flats are tidally inundated could potentially affect fish species (including prey species) that may be present in the flats or the adjacent Eagle River, Otter Creek (and its tributaries), or Eagle Bay if they are within the effects threshold distances. Sound propagation could cause mortality/injury if fish happen to be present in adjacent waterbodies, including off-channel ponds, gullies, or over the mudflats, particularly if these areas are hydrologically connected to detonation locations and are within the distance thresholds. Because only certain areas of the flats would be flooded for relatively short periods of time (i.e., a few hours) during particularly high tide events, underwater detonations could affect juvenile salmonids or groundfish if they are present within the threshold distances. Although these events would be intermittent and infrequent, they could occur at any time throughout the year, including during the spring when juvenile salmonids are abundant.

During typical inundating tide events, direct impacts to fish may occur if they are exposed to underwater noise above threshold levels during the temporary periods of time (likely a few hours) when the detonation areas are hydraulically connected to waterbodies or flats in which fish may be present (Taylor et al. 1994; Lawson et al. 1996a, b). Therefore, potential acoustic impacts to adult and juvenile salmonids (and other fishes) would only occur during active firing events that coincide with these short, typical inundating tide events. Typical inundating tide events are more common during the summer but may occur throughout the year (Lawson et al. 1995). The proposed protective measure of restricting the use of ammunition type to training rounds during typical inundating tide events would reduce the potential that acoustic impacts would occur. However, use of 155-mm training rounds could still result in acoustic-related mortality or injury to managed fish species in Eagle River and Otter Creek complex, even with the proposed protective buffers in place.

Extreme flooding events may occur and inundate larger areas in ERF, but these events are very rare and produced by a combination of high astronomical tide height, extremely high discharge from Eagle River, and a strong storm surge from the south. Lawson et al. (1996b) observed that "higher tides attributable to wind surge increase the height and volume of flood water and prolong the period of runoff during ebb." Although the maximum flooding event was not modeled, the effects threshold distances are expected to be greater than those modeled for the typical inundating tide event. Proposed firing restrictions on HE rounds during flooding events would help prevent mortality or injury of fish and reduce potential for behavioral effects, but use of 155-mm training rounds could result in acoustic impacts to managed fish species beyond those discussed above for typical inundating tide events.

Accidental Firing into a Waterbody or Protective Buffer During Training Exercises

Modeling was also conducted to determine the maximum distances where mortality or injury thresholds would be exceeded under an accidental firing scenario into a waterbody or protective buffer during training exercises. The modeled scenario involved accidental detonation of one 155-mm HE round (10.9 kg NEW) in Eagle River at location AF1 (Figure 4-1). Maximum distances for mortality or injury effects on fish with swim bladders may extend up to 360 meters from the source (using $SEL_{24\text{-hr}}$ values) and up to 9,130 meters from the source (using Lpk values) (Tables 4-12 and 4-13). The modeled scenario is highly unlikely because the round would impact outside the SDZ; statistically the chance is no greater than 1:1,000,000.

Table 4-12 Maximum Distances Where Fish Mortality, Potential Mortal Injury, and Impairment Thresholds May Be Exceeded Due to 155-mm HE[1] Ammunition Detonation Noise from Accidental Detonation in Eagle River during Typical Inundating Tide Events

Mortality and Potential Mortal Injury Thresholds (dB re 1 µPa2·s)			Impairment Thresholds (dB re 1 µPa2·s)		
			Recoverable Injury		Temporary Threshold Shift
Fish with no swim bladder: >219	Fish with swim bladder not involved in hearing: 210	Fish with swim bladder involved in hearing: 207	Fish with no swim bladder: >216	Fish with swim bladder: 203	All fish: >186
30 m	140 m	240 m	50 m	360 m	4,140 m

Notes:
[1] 155-mm HE rounds modeled have 10.93 kg NEW.
[2] Thresholds provided are $SEL_{24\text{-}hr}$ values with units of dB re 1 $\mu Pa^2 \cdot s$ (decibels referenced to 1 microPascal).
Key: HE = high explosive; kg = kilogram; m = meter; mm = millimeter; NEW = Net Explosive Weight; $SEL_{24\text{-}hr}$ = 24-hour sound exposure level.
Source: Popper et al. 2014; JASCO 2022, modeled scenario AF1.

Table 4-13 Maximum Distances Where Fish Mortality, Potential Mortal Injury, and Recoverable Injury Peak Thresholds May Be Exceeded Due to 155-mm HE[1]Ammunition Detonation Noise from Accidental Detonation in Eagle River during Typical Inundating Tide Events

Mortality, Potential Mortal Injury, and Recoverable Injury PeakThresholds[2]	
Fish with no swim bladder: >213 (dB re 1 µPa)	Fish with swim bladder: >207 (dB re 1 µPa)
3,640 m	9,130 m

Notes:
[1] 155-mm HE rounds modeled have 10.93 kg NEW.
[2] Thresholds provided are unweighted peak thresholds (dB re 1 µPa).
Key: dB re 1 µPa = decibels referenced to 1 microPascal; HE = high explosive; kg = kilogram; m = meter; mm = millimeter; NEW = Net Explosive Weight.
Sources: Popper et al. 2014; JASCO 2022, modeled scenario AF1.

Underwater noise thresholds could also be exceeded if an errant round were to inadvertently be detonated within a buffered area during typical inundating tide events. In such an accidental scenario, sound propagation could cause mortality/injury or behavioral effects if fish are present in adjacent waterbodies, including off-channel ponds, gullies, or over the mudflats. As described previously, the risk of such an occurrence is very low and in such a circumstance, a check fire would be called.

4.1.3.2 Alternative 2: All-Season Live-Fire Training at Existing ERF-IA Only

Similar to Alternative 1, live-fire training under Alternative 2 could occur at ERF-IA during any season, including the period of upstream migration of adult salmon, and during higher periods of use by rearing juvenile salmonids and other managed fish species. Buffers and other protective measures would be the same for both alternatives. Although the buffers would protect against acoustic-related mortality and injury during typical high tide conditions, and no firing of HE rounds would occur during typical inundating tide events, there would be an increased risk for mortality or injury of fish relative to Alternative 1; because the impact area would not be expanded into adjacent uplands, a greater concentration of munitions (36 percent more HE rounds) would be fired into ERF.

The proposed protective measures would not completely protect all fish from impacts during training with 155-mm training rounds during typical inundating tide events. Further, unbuffered waterbodies such as the Eagle River relict channel and upper Garner Creek that may seasonally support managed fish species would not be protected from acoustic impacts (mortality or injury). Although the Army would not fire into these waterbodies when they are observed to contain water, nearby detonations could potentially harm fish if 1) target areas are located in close proximity (within 6 meters) of waterbodies during typical high tide conditions, or 2) target areas are located in unbuffered areas that are hydrologically connected to waterbodies that support fish.

4.1.4 Decreased Fitness of EFH-Managed Species Due to Auditory Fatigue or Injury

In addition to the potential for direct mortality or injury, hearing loss may result from exposure to intense sounds. The loss may be permanent or temporary. Permanent threshold shift (PTS) is a loss of hearing that never recovers. In contrast, temporary hearing loss, termed "temporary threshold shift" (TTS) is a relatively short-lived reduction in hearing sensitivity due to changes in the sensory cells of the ear, generally resulting from exposure to intense sounds for short periods of time or longer exposure to lower sound levels.

Most often, PTS is associated with the death of sensory hair cells in the ear and/or damage to the nerves innervating the ear (Liberman 2016). To date, there is no evidence of PTS in fishes, and it is considered unlikely to occur because fishes can replace any lost or damaged hair cells, precluding any permanent hearing loss (Smith 2016; Smith and Monroe 2016). However, it is also possible that damage to the swim bladder or other organs involved in the detection of sounds might result in permanent changes to the hearing abilities of some fishes, although this would not be called PTS (Popper et al. 2019); this type of injury for managed fish species is described in Section 4.1.3.

Fish that experience temporary hearing loss as a result of exposure to explosions and impulsive sound sources may have a reduced ability to detect relevant sounds such as predators, prey, or social vocalizations. Sound detection impairment for fish can result in a decreased ability to forage or avoid predators, thereby reducing overall fitness; however, termination of exposure for fish that experience TTS eventually leads to the return of normal hearing ability (Popper et al. 2019). The length of time required for recovery varies as a function of the frequency of the sound and duration of exposure (Scholik and Yan 2001).

Managed fish species in the proposed project area consist of generalist hearing fish (e.g., salmonids, eulachon, starry flounder, and Pacific staghorn sculpin) (Fish Hearing Groups I and II) and specialist hearing fish (e.g., walleye pollock and Pacific herring) (Fish Hearing Groups III and IV); however, the same TTS SEL_{24h} effects threshold (less than 186 dB referenced to 1 microPascal) apply to all fish, regardless of species or hearing capabilities. TTS thresholds are not provided in terms of PK.

4.1.4.1 Alternative 1: All-Season Live-Fire Training with Expanded Impact Area (Proposed Action)

Based on acoustic modeling results for Alternative 1, SEL_{24hr} thresholds for TTS would be reached at distances of up to 850 meters from the detonation point of the loudest type of round that would be fired during typical inundating tide events (155-mm training round; Table 4-10). This distance substantially exceeds all of the proposed protective buffers, including Eagle Bay (500 meters), Eagle River (50–130 meters), and Otter Creek complex (50 meters). This represents a conservative estimate because the 900 155-mm training rounds could be fired throughout the year (during a variety of conditions), but it was modeled to provide a worst-case scenario for TTS impacts to managed fish species.

During typical high tide conditions, TTS thresholds for managed fish species would be exceeded at 18–26 meters away from the detonation point (Table 4-9). No TTS impacts to fish are anticipated within the Eagle Bay, Eagle River, or Otter Creek buffered areas. However, firing outside of these buffered areas (e.g., upper Eagle River relict channel complex, upper Garner Creek) during any conditions could cause TTS effects to fish if detonations occur within stream channels that support fish or within the modeled threshold distances shown in Table 4-9. Targets would not be placed in open water or within these threshold distances to reduce risk of TTS effects to fish. However, it is possible that a target area could overlap an unbuffered stream channel that supports juvenile salmon, which could result in TTS effects if an HE munition or 155-mm training round unintentionally detonates within the channel. As shown on Figure 2-2, 155-mm rounds would not be targeted at the unbuffered areas near the Eagle River relict channel complex. Additionally, expanding the impact area under Alternative 1 would result in a lower concentration of HE munitions fired into ERF than under Alternative 2 (26 percent fewer HE rounds), which in turn would result in reduced risk of impacts to fish fitness during typical high tide conditions.

Any potential short-term effects to fitness associated with TTS are expected to be limited to live-fire training during 1) typical inundating tide events that involves use of 155-mm training rounds and 2) typical high tide conditions in unbuffered areas. Effects from accidental detonations outside of target areas are discounted due to the extremely low probability of occurrence. Given that TTS effects are generally considered temporary (i.e., fish can recover within a relatively short time frame), occasional behavioral reactions to intermittent land-based explosions during typical high tide conditions are unlikely to cause long-term consequences for individual fish or populations in ERF-IA.

4.1.4.2 Alternative 2: All-Season Live-Fire Training at Existing ERF-IA Only

Potential decreased fitness effects to fish would be similar to those under Alternative 1, with potential TTS effects occurring at distances of up to 850 meters from the detonation point of 155-mm training rounds during typical inundating tide events. This would exceed all proposed buffer widths for Eagle Bay, Eagle River, and Otter Creek. The same number (900) of 155-mm training rounds would be fired into ERF-IA under both alternatives.

Because Alternative 2 would not expand ERF-IA into adjacent uplands, all munitions would be fired into the lowland areas of ERF. As a result, there would be a greater risk for decreased fitness effects from temporary hearing loss from live-fire training in unbuffered areas during typical high tide conditions compared to Alternative 1 because a greater concentration of HE munitions would be fired into ERF. However, targets would be placed outside of the TTS threshold distances to reduce risks.

4.1.5 Decreased Fitness of EFH-Managed Species Due to Physiological/Behavioral Responses and Habitat Avoidance

Anthropogenic noise may deter fish from important feeding or spawning areas, may interfere with other vital activities like foraging and predator detection, and may add to chronic stress levels, which may adversely affect fitness (Hawkins and Popper 2017; Popper et al. 2019). The type, magnitude, and significance of behavioral and physiological responses of fish to noise appears to vary significantly depending on multiple factors that likely include sound properties (e.g., spectral characteristics, source level, duration, rise and fall times, repetition rate), background noise (masking properties), properties of the sound as received by the fish (e.g., sound level, duration, spectral characteristics), hearing ability of the species, and species or individual specific variation in responses to sound (Kastelein et al. 2008). Context of the exposure (e.g., location, temperature, physiological state, age, body size, and school size) also likely affects the type or magnitude of response (Kastelein et al. 2008). Kastelein warned that differing fish species react quite differently to sound and that generalizations about the expected reactions of a given species to a given noise should be made with care.

Little is known about the threshold for noise-induced behavioral effects on fish. Therefore, a weight of evidence approach has been used to analyze potential fish behavioral and physiological response as a result of terrestrial explosions. Pacific salmon (all five species) make up most of the managed fish biomass in the proposed project area. Salmon predominantly sense the particle motion component of a sound source with limited ability to detect pressure. Starry flounder, sculpin, and eulachon are limited to detection of particle displacement only. Of the EFH-managed species in the proposed project area, walleye pollock and Pacific herring have the greatest hearing sensitivity and can detect both particle displacement and pressure components of sound. Very few of these fish were found during previous surveys in Eagle Bay and they are not expected to move upstream into Eagle River. The following evaluates how managed species in Eagle Bay, Eagle River, and Otter Creek may be able to detect the particle and pressure components of detonation explosions in ERF-IA.

- **Eagle Bay:** The theoretical acoustic near-field (i.e., the region where particle displacement predominates the acoustic signal generated by an explosion [predominant energy below 500 Hz]) is between 1 and 240 meters from the center of detonation, depending on the frequency. Given this limited range where particle motion predominates the signal (maximum 240 meters) relative to the proposed protective buffer along Eagle Bay (500 meters), it is highly unlikely that the acoustic signal entering Eagle Bay from an explosion in ERF-IA would contain significant particle motion. Therefore, it is not anticipated that fish species in Eagle Bay that are sensitive to only particle motion (e.g., starry flounder, eulachon, sculpin) would be able to detect the explosions. Salmon may be able to detect the pressure component of the explosion, although the detection in Eagle Bay is likely to be weak. Walleye pollock and Pacific herring may be able to detect both the pressure and particle components of the signal, although it would be weakened as it passes through the ground within the 500-meter-wide protective buffer. It should be noted that the theoretical acoustic signal distance for particles (240 meters) is between the TTS thresholds (proxy for behavioral response thresholds) modeled by JASCO for Eagle Bay: 26 meters for typical high tide detonations and 850 meters for 155-mm HE round detonation during a typical inundating tide event.
- **Eagle River:** Eagle River is approximately 1 to 12 meters deep, depending on tidal stage and location, which means that the lowest frequency theoretically able to propagate in the river is between 30 Hz at high tide and 400 Hz at low tide. Because both particle displacement and pressure attenuate rapidly in shallow water, the near-field region (where particle displacement is predominant) of an explosion would likely be effectively reduced to a maximum range of less than 10 meters (transition point of 30 Hz signal is 8 meters) during all stages of the tide. Given the proposed 50- to 130-meter buffers around the river, it is unlikely that fish in the river would be able to detect particle displacement from an explosion; however, salmonids may be able to detect the pressure component. The TTS thresholds modeled by JASCO for Eagle River ranged from 18–26 meters for typical high tide detonations and were 850 meters for 155-mm HE round detonation during a typical inundating tide event.
- **Otter Creek:** Otter Creek ranges from approximately 0.5 to 7 meters in depth depending on tidal stage and location, which means that the lowest frequency theoretically able to propagate in the river is between 50 Hz at low tide and 800 Hz at high tide. As both particle displacement and pressure attenuate rapidly in shallow water, the near-field region (where particle displacement is predominant) of an explosion would likely be effectively reduced to a maximum range of less than 10 meters (transition point of 30 Hz signal is 8 meters) during all stages of the tide. Given the proposed 50-meter buffer around Otter Creek and the Otter Creek complex, it is unlikely that fish in the creek would be able to detect particle displacement from an explosion; however, salmonids may be able to detect the pressure component of a nearby detonation if they are present within the threshold distance. The TTS thresholds modeled by JASCO for Otter Creek ranged from 20 meters for typical high tide detonations and 850 meters for 155-mm HE round detonation during a typical inundating tide event.

Salmon, walleye pollock, and Pacific herring are the only EFH-managed species likely to detect the sounds of a detonation in ERF-IA. Of these species, only salmonids are likely to migrate into ERF-IA and thus are more susceptible to exposure to acoustic impacts for live firing activities. Such a detection could result in a wide variety of responses, including no observable response, startle response with movement away from the sound, increased swimming speed with or without activation of anaerobic white muscle fibers, distraction from vital functions like foraging or monitoring for predators, and increases in release of primary stress hormones.

These types of responses are likely to have some unquantifiable energetic cost to a fish and may result in behavioral modifications that affect fitness. For example, migrations to spawning grounds may be delayed or prevented, with detrimental effects on growth, survival, and reproductive success (Hawkins and Popper 2017). For juvenile salmonids, displacement from preferred habitats may affect feeding, growth, predation, survival, and reproductive success. For example, anthropogenic noise could force juvenile coho away from preferred foraging areas in intertidal areas of Otter Creek if behavioral thresholds are exceeded. Juvenile salmonids foraging along the shallow water shoreline of Eagle River may be startled into the main channel where they could more likely be subject to predation. Further, masking of sounds made by prey organisms and predators may result in reduced feeding and reduced survival (Hawkins and Popper 2017). However, given that live-fire training events would be intermittent and of limited duration, and due to the habitat buffers in place, it seems unlikely that these costs would result in a substantial long-term decrease in fitness in juvenile salmon under most firing scenarios. However, localized behavioral effects could result when firing the 155-mm training round during typical inundating tide events or when firing in unbuffered areas when juvenile salmonids are present.

Distraction from monitoring for predators could result in fish injury or mortality from an undetected predatory attack, particularly for juvenile salmon. Such injury or death would certainly adversely affect individual fitness but would likely be limited because the bulk of the presumed predators of juvenile salmon in Eagle River and Otter Creek (e.g., birds, Dolly Varden, rainbow trout) would most likely also be similarly distracted by the explosion (e.g., decreased foraging efficiency). Other fish found in Eagle River that are likely to prey on juvenile salmon include starry flounder and Pacific staghorn sculpin. These fish—thought to detect only the particle displacement component of sound—are unlikely to be distracted by the explosion; therefore, they could theoretically exploit the state of distraction in juvenile salmon to launch an attack. However, the importance of this theoretical advantage to the population of juvenile salmon in Eagle River is likely to be low given the relatively low numbers of mature individuals of these species (i.e., large enough to predate a juvenile salmon) presumed to be in Eagle River and Otter Creek (based on results of fish sampling). When considered alongside the ephemeral nature of training events with HE munitions, it is unlikely that distraction from explosions would result in a biologically significant number of juvenile salmon injured or removed due to undetected predatory attack.

Increases in primary stress hormones could occur in fish as a result of detection of an explosion and would theoretically represent a more substantial biological cost for juvenile salmon, as they spend the most time in Eagle River and Otter Creek relative to the other fish. The magnitude of this biological cost cannot be quantified. However, Wysocki et al. (2007) found no negative impacts to the growth, survival, stress, or disease susceptibility of rainbow trout exposed to long-term noise (8 months) with sound pressure levels up to 150 dB root mean square referenced to a pressure of 1 microPascal.

4.1.5.1 Alternative 1: All-Season Live-Fire Training with Expanded Impact Area (Proposed Action)

Annually, all-season live-fire training would occur during upstream migration of adult salmon, periods of year-round use by rearing juvenile salmonids, and periods of seasonal use by other managed fish species. Noise exposure to fish from live-fire training would be possible throughout the year when fish are present in nearby waterbodies. Land detonations during typical high tide conditions could pass through the ground and result in behavioral effects or habitat avoidance. However, any potential short-term behavioral changes or habitat avoidance are expected to be limited to live-fire training during 1) typical inundating tide events that involves use of 155-mm training rounds and 2) typical high tide conditions in unbuffered areas.

With protective buffers in place during live firing of HE munitions, most managed fish species would not be able to detect particle or pressure impacts from acoustic disturbance. There is potential for decreased fitness of juvenile salmonids due to physiological/behavioral responses as a result of firing HE munitions under Alternative 1, particularly during use of HE training rounds and live firing in unbuffered areas. Although targets would be placed to avoid inundated waterbodies in unbuffered areas (e.g., Eagle River relict channel complex), the target area or weapon system impact area could overlap channels that contain fish, which could then result in behavioral effects if fish are present. Overall, behavioral effects were modeled to range from distances of 18-26 meters for typical high tide detonations and up to 850 meters from the detonation point of 155-mm training rounds during typical inundating tide events (which would exceed all proposed buffer widths for Eagle Bay, Eagle River, and Otter Creek).

Occasional behavioral reactions to intermittent land-based explosions and impulsive sound sources during typical high tide conditions are unlikely to cause long-term effects for most fish in ERF-IA. Potential behavioral impacts to fish would be reduced because the largest round (155-mm) would only be fired into the portion of ERF-IA adjacent to Training Areas 415 and 416 and would not be fired into the unbuffered Eagle River relict channel complex where juvenile salmonids may be present (Figure 2-2). Therefore, most firing scenarios under Alternative 1 are not expected to adversely affect managed fish species or result in long-term behavioral effects or changes in habitat use. Additionally, expanding the impact area under Alternative 1 would result in a lower concentration of munitions fired into ERF than under Alternative 2 (26 percent fewer HE rounds), which in turn would result in lower risk of impacts to fish behavior.

4.1.5.2 Alternative 2: All-Season Live-Fire Training at Existing ERF-IA Only

Behavioral effects to fish would be similar to those under Alternative 1 because the same number of 155-mm training rounds would be fired. However, because ERF-IA would not be expanded into adjacent upland under Alternative 2, all munitions would be fired into the lowland areas of ERF. As a result, there would be a greater risk for behavioral effects and associated decreased fitness from live-fire training relative to Alternative 1 because a greater concentration of munitions would be fired into ERF (36 percent more HE rounds). However, intermittent detonations associated with other types of training during typical inundating tide events are unlikely to cause long-term consequences for individual fish or populations in ERF-IA.

4.2 DIRECT STRIKES TO MANAGED FISH SPECIES FROM LIVE FIRING ACTIVITIES

Use of explosive munitions during training has potential risk of direct impacts to managed fish species from an accidental direct strike by a munition and from weapons debris following detonation. Although the risk of direct strike would be relatively low and further minimized by existing and proposed protective measures, some suitable juvenile rearing habitats would not be buffered. A direct hit or shock waves from a munition detonation would likely cause fish mortality or severe injury resulting from damage or rupture of the swim bladder or other internal organs.

When explosives detonate, fragments of the weapon are thrown at high velocity from the detonation point and have the potential to cause injury or mortality if they enter the water and strike fish. This risk is directly related to the distance of separation between the location of the explosion, presence of obstructions, and the location of managed fish species. Underwater, the friction of the water would quickly slow these fragments to a point where they no longer pose a threat (85 FR 72312).

While there are no standards that document risks to fish from munitions fragments, DA Pam 385-64 *Ammunition and Explosives Safety Standards (2013 Revision)* (U.S. Army 2013) identifies human safety standards for hazardous fragments, which are defined as fragments that maintain an impact energy of at least 58 feet per pound and/or a weight of at least 2,700 grains (0.17 kg). The hazardous fragmentation distance (HFD) for human safety is the distance at which there is a 1 percent probability of experiencing a serious or lethal injury from a fragment. This equates to a density of 1 hazardous fragment per 600 square feet (0.01 acre) (U.S. Army 2013). As the distance from the impact to the receiver decreases, the probability of injury increases. For the purposes of this EFH Assessment, the human-based safety standards have been used as a conservative method for determining risks to EFH-managed species for serious or lethal injury from fragmentation.

HFDs for all explosive rounds that would be used at ERF-IA were calculated (based on ground detonations) using the methodology provided in DA Pam 385-64 (U.S. Army 2013), which is based on the NEW of each projectile (Table 4-14). Based on information provided in the Geneva International Centre for Humanitarian Demining *Explosive Weapons Effects-Final Report* (GICHD 2017), an airburst can increase the detonation effect area by up to 100 percent, relative to a ground burst, which would double the HFD distance for lethality (Table 4-14). This is a conservative estimate, as it is highly dependent on detonation height; however, this airburst HFD conversion factor has been applied because airburst detonation heights are variable and generally only range from 0 to 1 meter above ground. It should be noted that there are many environmental factors that have an effect on this probability, such as wind, gravitation differences, and deflection. Further, only detonation of HE rounds would result in fragmentation or shrapnel. The HE 155-mm training round is filled with non-fragmentation producing concrete to provide the same weight of an actual HE round in order to create similar ballistics (S. Tucker, personal communication, 1 May 2023), and no other training rounds would cause fragmentation that could impact EFH-managed species.

Table 4-14 Estimated HFD for Weapon Systems at JBER

Weapon System	NEW (kg)	Annual Number of Rounds	HFD			
			Ground Burst		Airburst	
			Feet	Meters	Feet	Meters
155-mm Howitzer	10.9	144	543.3	165.6	1,086.6	331.2
105-mm Howitzer	3.8	2,612	459.9	140.2	919.7	280.3
120-mm Mortar	3.6	744	454.9	138.7	909.8	277.3
81-mm Mortar	1.0	592	358.5	109.3	717.1	218.6
60-mm Mortar	0.4	1,036	281.3	85.7	562.7	171.5

Key: HFD = hazardous fragmentation distance; JBER = Joint Base Elmendorf-Richardson; kg = kilogram; mm = millimeter; NEW = Net Explosive Weight.

Source: U.S. Army 2013.

4.2.1 Alternative 1: All-Season Live-Fire Training with Expanded Impact Area (Proposed Action)

Under Alternative 1, the increased numbers of munitions fired into ERF-IA, and training during the spring and summer months when salmonids and groundfish are more likely to be present in ERF waterbodies, would increase the risk of direct impacts to these species by a munition strike or from fragmentation debris. There would be no intentional firing into open waterbodies (rivers, streams, intertidal channels, gullies, lakes, ponds, or other areas that may contain water), which would reduce the risk of rounds landing directly in suitable fish habitat and striking a fish. However, there is a small potential for a direct munition strike when firing in unbuffered areas, firing of training rounds during typical inundating tide events, or as a result of an accidental firing event. While targets would not be placed in stream channels in unbuffered areas, the target area could overlap channels that support juvenile salmonids, which presents a risk of direct strike if a munition misses the target and lands in a nearby stream channel where a fish is present. The risk of direct strike would decrease when firing during typical inundating tide events because only training rounds would be fired, and because these events would only occur for brief intervals (a few hours) during certain times of the year (generally late summer when juvenile salmonids are less likely to be present). The risk of direct strike due to an accidental firing scenario would approach zero since there is a 1 in 1,000,000 probability that a round would land outside of the containment zone where it could strike a fish under standard firing procedures. Although smaller munitions would be fired in the unbuffered Eagle River relict channel complex, as previously mentioned, mortality is highly likely if a direct strike occurs.

Fragments from HE munitions detonated on/above land have the potential to land in nearby waterbodies where fish and their prey items may be present. As shown in Table 4-14, ground burst detonations occurring within 86 to 166 meters (depending on the weapon system) and airburst detonations occurring within 172 to 331 meters of a waterbody where managed fish species are present would have a low (1 percent) chance of causing serious or lethal injury to fish. At further distances, risks would be lower, and at closer distances risks would be higher.

During typical high tide conditions, most fish within ERF are expected to occur in Eagle River, Otter Creek, and the Otter Creek intertidal channels, although as discussed previously, some juvenile salmonids, especially coho, may be present in unbuffered areas associated with the Eagle River relict channel complex and upper Garner Creek. In such cases, the target area and weapon system impact area portion of the SDZ could overlap small stream channels used by rearing juvenile salmonids. Thus, there is a low to moderate risk of direct fragment strike of salmonids in these areas, with the level of risk dependent on fish presence, amount and density of vegetation, water levels, topography, and other site-specific factors near target areas at the time of firing.

Proposed protective measures (Section 5.1) would avoid or minimize risk of fragment strikes to managed species. The proposed habitat protective buffers (ranging from 50 to 500 meters depending on location) would help protect managed fish species from munition fragment strikes, although as shown in Table 4-14, the HFD for various weapon systems can extend beyond the buffers, particularly for airburst detonations. Water tends to recede slowly in the ERF after flooding (allowing fish to escape the flats back into the channels), so the risk of strikes to fish temporarily stranded in ponds within the mudflats would be low.

The greatest risk of direct munition or fragment strikes to managed species involves target areas along Eagle River and Otter Creek that are outside of the 50-150 meter buffers along these waterways, as well as unbuffered areas (e.g., Eagle River relict channel complex, upper Garner Creek) that may support fish. The likelihood that managed species would be present in Eagle River and other waterbodies in ERF-IA would be highest during the spring and summer months. For salmonids, peak use periods include June to August for adults and April to July for juveniles, although some juveniles may use off-channel areas associated with the Otter Creek and Eagle River relict channel complex throughout the year. It is anticipated that the risk of fragment strikes would be higher for pelagic fish located closer to the water's surface (e.g., eulachon) than for benthic groundfish species that are prominently found along the river bottom. Adult salmon tend to migrate along deeper portions of the water column, and juveniles may vary, with subyearlings generally found in deeper waters than yearlings (Carter et al. 2009; Eiler et al. 2022).

Juvenile salmonids present within vegetated wetlands in the Eagle River relict channel complex may face an increased risk of shrapnel strike since they could be present anywhere throughout the system and occupy shallow water depths. However, they are present in relatively low abundances, sparsely distributed, exhibit seasonally variability, and are often present in areas of high vegetative cover that would help attenuate effects. Thus, the risk of shrapnel striking salmonids is expected to range from low to moderate in unbuffered areas depending on location.

It should be noted that the HFDs were developed based on the 1 percent risk of striking a human on land. Underwater, the friction of the water would quickly slow these fragments to a point where they no longer pose a threat. The risk would be much smaller for a munitions fragment passing through an aqueous medium (as the impact speed would be reduced) and contacting an individual fish, which are much smaller in size than the average human. However, while risks for impacts to managed species from fragmentation strikes are expected to be low, they cannot be discounted.

4.2.2 Alternative 2: All-Season Live-Fire Training at Existing ERF-IA Only

The risk evaluation for direct or munition fragment strikes to managed fish species would be similar to that described for Alternative 1, except that the overall risk of strike would be slightly higher because the impact area would not be expanded into uplands, and all munitions would be fired into the ERF lowlands, where designated EFH and managed species occur.

4.3 EROSION AND SEDIMENTATION IMPACTS

Weapons training can alter aquatic habitat through cratering, soil compaction, soil erosion, and vegetation removal, creating the potential for increased sediment runoff. Land detonations may generate craters, which can erode or modify existing stream channels that provide rearing habitat for juvenile salmonids and thus reduce habitat connectivity. Erosion and sedimentation effects on EFH and managed species may constitute direct or indirect effects, depending on the location and timing of impact. For example, detonations in ERF-IA may constitute an immediate change to sediments and habitat in EFH waterbodies during each firing event, whereas construction and munitions detonations in the proposed expansion area could potentially cause erosion and sedimentation in ERF that would occur later than the actual firing event. Because some of these impacts may represent direct effects on EFH and managed species, they are included in this section.

Sedimentation and turbidity are primary contributors to the degradation of salmonid habitat (Bash et al. 2001). Excess sediment loading and turbidity levels can clog fish gills, smother eggs, embed spawning gravels, disrupt feeding and growth patterns of juveniles, delay the upstream migration of adults, and scour nutrients from the stream substrate. This may temporarily cause fish to avoid the area, impede or discourage free movement through the proposed project area, prevent individuals from use of preferred habitats, and/or expose individuals to less favorable conditions. Excessive sediment deposition over benthic habitats can result in a reduced availability of macroinvertebrate prey for fish.

Erosion and sediment deposition are natural processes in ERF-IA, and significant changes have occurred over the past 40 years. Eagle River basin is a naturally turbid, glacially influenced system with sediment from glacial deposition, glacial outwash, and still water deposition from lakes and estuaries (JBER 2023a). Aquatic organisms that occur in this area have adapted to a dynamic, highly turbid environment. Eagle River and other large rivers draining into Knik Arm carry massive quantities of naturally occurring silt and clay-sized particles. ERF is subject to strong tidal and river currents, which result in a constant fluctuation of erosion and sedimentation. Researchers found that the hydrology of the landward third of ERF is controlled or dominated by the dynamics of Eagle River, and that the seaward two-thirds of ERF are dominated by tidal inundation and ebb (Racine et al. 1994). The drop in water level during the ebb tide is slower than the rise during flooding. The difference indicates a temporary storage of tidal waters that allows sedimentation to occur in ERF. The slow ebb outflow also provides an opportunity for fish to escape and reduces the potential for stranding in the flats.

Researchers estimate that there is a net influx of sediment into ERF, which counteracts the effects of gully and river channel erosion (Racine et al. 1995). Sediments that settle out of floodwaters and are deposited in ponds and mudflats are important for maintaining the ERF ecosystem. Sediments are deposited into tidally affected waterbodies, ponds, mudflats, and wetland areas in ERF-IA during flood tides. The amount and frequency of tidal inundation, currents (both wind and water), topographic slope, and ice all interact to determine the flux of sediment and water within the flats. Although tides higher than 30 feet often inundate ERF, lower tides that are supplemented by river surge or high winds may also cause inundation of the flats. Ice damming can also cause flooding in ERF. A major source of sediment is the Knik Arm waters, which contain extremely high levels of total suspended solids (TSS); TSS levels measured in ERF-IA can be as high as 2,000 milligrams of sediment per liter of water. TSS levels in Knik Arm can be five times higher than levels found in Eagle River during the fall months (Racine et al. 1994); however, sedimentation can occur during flood events throughout the year.

Due to the net transfer of sediment into ERF, craters formed by live-fire training that are later subject to tidal inundation would eventually become filled with sediment. Sediment accumulation rates vary dramatically throughout ERF and are dependent on vegetative cover, distance from the sediment source (e.g., Knik Arm), and elevation. Sedimentation rates can vary from about 2 to 35 mm (0.08 to 1.38 inches) per year depending on the location in the flats, and data suggest that the largest net accumulation of sediment occurs in ponds (U.S. Army 2010). The rate of sedimentation tends to increase east from the Eagle River levees, across the mudflats, and into the ponds. Sedimentation in unvegetated mudflats that would typify conditions after detonation of HE munitions would be expected to average about 7 to 15 mm (0.28 to 0.59 inches) per year (U.S. Army 2010). Each successive flooding tide deposits new material, which eventually fills the ponds, marshes, and craters.

The process of sedimentation is evident from observations of old impact craters that have been completely filled with sediment over the past 33 years. Based on the length of time since munitions have been fired at ERF-IA during summer months (33 years) and the depth of a crater created by a 155-mm or 105-mm howitzer round (about 72 centimeters or 28.3 inches), the sedimentation rate could be as high as 40 mm (1.57 inches) per year in certain areas (U.S. Army 2010). Although munition-related cratering and resultant ponding in ERF-IA would occur in intertidal areas that may provide off-channel rearing for some juvenile fishes (such as salmonids) during certain periods of the year, scattered ponding within the mudflats is not anticipated to result in increased habitat for salmonids. It is possible that these areas could be used by stickleback, which is not a federally managed species.

4.3.1 Alternative 1: All-Season Live-Fire Training with Expanded Impact Area (Proposed Action)

There is potential for increased erosion and sedimentation into ERF waterbodies as a result of live firing during all seasons under Alternative 1. Live-fire training would occur during periods when ERF-IA is not covered with ice (for the first time since 1990) and would generate craters and create localized areas of reduced vegetative cover in the flats. The protective buffers applied for underwater noise (ranging from 50 to 500 meters) would also reduce potential detonation-induced erosion and sedimentation from entering active channels. No firing of HE rounds would occur during typical inundating tide events, which would reduce sediment disturbance when the flats are flooded and connected to active channels, although some loose sediment caused by detonations could enter channels during subsequent inundating tide events.

Habitat protective buffers would reduce erosion and sedimentation impacts adjacent to Eagle River, Otter Creek, and the Otter Creek complex. However, some munitions detonations could occur in unbuffered areas that provide juvenile salmonid rearing habitat (e.g., the Eagle River relict channel complex). Targets would be placed in higher ground areas to avoid stream channels and low-lying areas that could generate erosion or result in loss of vegetation. However, it is likely that some munitions would detonate in stream habitats. This could impact local hydrology by opening new channels or closing off existing channels, which could alter juvenile salmonid access to connecting habitats, such as mainstem Otter Creek and Eagle River. As previously mentioned, craters can be “self healing” in some situations as sediment settles back in after inundating tide events. Others could fill with tidal or fresh water and serve as pools, which could benefit rearing salmonids.

Sediment released into waterbodies and channels could result in loss or degradation of rearing habitat for juvenile salmonids, either by filling in channels or generating suspended sediment. This would indirectly result in some loss or disturbance to the macroinvertebrate prey base for juvenile salmonids. Existing vegetation would provide some sediment erosion control, and impacted vegetation would be expected to grow back if the same areas are not continually targeted. However, regrowth could be impeded if firing is concentrated within the unbuffered areas. As described previously, 155-mm rounds would not be fired into the Eagle River relict channel complex, which would reduce the potential for erosion in this area. The unbuffered area on the west side of ERF-IA would be subject to greater sediment disturbance and erosion because it could accommodate the full range of proposed rounds (Figure 2-2). However, the value of this area as rearing habitat for juvenile salmonids is unknown. because it has not been surveyed.

Macroinvertebrate recolonization is anticipated following each firing event, with the rate of recovery dependent on the frequency of firing. However, vegetation loss would reduce the availability of terrestrial prey organisms for juvenile salmonids. Overall, the extent and magnitude of impacts to the unbuffered areas cannot be predicted, but it is expected that existing habitat would be altered, with effects ranging from low to high depending on detonation locations (buffered versus unbuffered areas).

As munitions have never been fired into the proposed expansion area, Alternative 1 would result in potential erosion and sedimentation impacts in this area that could affect downstream waterbodies in ERF. Ground disturbance associated with construction of the proposed expansion area would also generate increased sediment in the proposed project area, although construction would be a short-term disturbance.

Under Alternative 1, gravel service roads, service pads, and a firebreak would be constructed in the 585-acre proposed expansion area. No stream crossings would be required. Construction activities in the expansion area are not anticipated to result in any direct impacts to aquatic resources or EFH. Clearing of approximately 350 acres of vegetation could destabilize soils and increase the potential for erosion during construction operations. The proposed expansion area consists of hilly undulating terrain sloping between 0 and 15 percent (USDA 2020). Following vegetation clearing, the area would be seeded with native grasses to stabilize soils and reduce potential for erosion. New service roads and pads would be cleared, grubbed, and then covered with gravel; firebreaks would expose mineral soils but would be surrounded by a vegetated buffer to trap sediments. Adherence to best management practices and mitigation measures during construction activities as outlined in the JBER INRMP and a project-specific Construction General Permit Storm Water Pollution Prevention Plan would minimize potential construction impacts from erosion and sedimentation (JBER 2023e).

Proposed setbacks for vegetation clearing within the proposed expansion area are 65 feet from Clunie Creek and 15 feet from wetlands associated with Clunie Creek. Adherence to these habitat buffers and setback requirements would prevent sedimentation into Clunie Creek and associated wetlands. Clunie Creek does not have a downstream surface water connection with Eagle River (the stream goes subterranean upstream from the confluence), although it may contribute sediments to ERF during infrequent periods of sheet flow flooding. Based on the erosion and sediment control measures that would be implemented, potential sedimentation in Clunie Creek from the proposed project is not expected to result in any measurable effects to Eagle River or ERF. Should sedimentation occur, it is expected that suspended sediments would settle out quickly (or be flushed downstream) and that macroinvertebrates in the affected portions of the channel would recolonize the disturbed areas following construction activities.

Under Alternative 1, sedimentation would increase, as the proposed all-season firing would result in changes to bathymetry and sediment transport within intertidal wetland habitat, which may affect macroinvertebrate productivity. It is estimated that individual crater sizes would be relatively small (i.e., 1 to 3 meters wide), and impacts would be localized to target areas, although repeat detonations in these areas could create larger craters. The potential for slumping or mass soil movements would be limited by the relatively flat topography of ERF-IA. The distance between detonation points and Eagle River/Otter Creek afforded by proposed protective buffers would limit the potential for erosion and sedimentation impacts to terrestrial invertebrates (or associated riparian habitat) that may provide a prey source for juvenile coho in these waterbodies.

Based on the site conditions and proposed protection measures, most sedimentation and turbidity effects caused by munition detonations in ERF-IA and the proposed expansion area are not expected to be significant, as the system already has a high baseline of suspended sediment/turbidity. However, it is likely that localized sediment increases, particularly within the unbuffered areas, could result in short-term loss or disturbance of some macroinvertebrates that comprise part of the prey base for juvenile salmonids in ERF. As such, fish habitat alteration due to erosion and sedimentation under Alternative 1 could result in short-term, localized adverse impacts to EFH and managed species but would not cause long-term, adverse impacts due to existing and proposed protective measures and the dynamic sediment conditions at the site.

4.3.2 Alternative 2: All-Season Live-Fire Training at Existing ERF-IA Only

Under Alternative 2, the potential for disturbance of soils and resuspension of sediment from munitions detonation in ERF intertidal wetland habitat would be as discussed for Alternative 1. Because ERF-IA would not be expanded, there would be no associated potential for sedimentation impacts related to construction under Alternative 2. The number of detonations and associated sedimentation in ERF would be greater than under Alternative 1, and there would be an associated greater potential for alterations to mudflats that may be used by salmon and other managed species during typical inundating tide events. However, due to the site conditions and proposed protective measures that would be implemented (Section 5.1.1), no long-term adverse impacts to EFH or managed species are anticipated.

4.4 INDIRECT IMPACTS FROM MUNITIONS CONSTITUENTS

The potential indirect effects of the proposed project on EFH and managed species as a result of all-season munitions use include 1) changes to water and sediment quality and resulting exposure of munitions residues to fish and their prey base, and 2) erosion and sedimentation effects (discussed as direct effects in Section 4.3). Munitions that are fired during military training experience one of several fates: detonate as intended, undergo a low-order (LO) or partial detonation, or become duds (also referred to as UXO). As described below, LO detonations and duds have the greatest potential to affect EFH. Managed species and aquatic invertebrate prey items may be exposed to contaminants in munitions residues by direct or incidental ingestion and by dermal contact (USEPA 2021). Exposure to contaminants in the water column could occur via direct uptake from water through gills and accumulation in muscle, fat, and other tissues. Bottom-dwelling species (i.e., groundfish) can be directly exposed to contaminants in sediments, or species may ingest contaminated benthic prey items. If managed species consume contaminated prey, there is a potential for contaminants to be transferred up the food chain.

This analysis includes potential impacts on EFH and managed species from both traditional (or conventional) munitions and insensitive munitions (IMs), although less information is available on IM constituents because they are relatively new. IMs are explosive weapons or devices that are intentionally designed to be less sensitive to unplanned heat, shock, or impact events in order to reduce the risk of damage to equipment, facilities, and people (Crick 2014). As such, traditional munitions are being phased out in favor of IMs at military installations, including JBER. Although IMs have been approved and deployed in recent years, the literature on the fate and transport of IMs in the environment is rather limited. As IM formulations continue to replace legacy explosives, the inadvertent release of their chemical compositions into the environment is inevitable where these chemicals will become emerging contaminants (Stein et al. 2023).

Sections 4.4.1 through 4.4.6 provide useful background information and context for the analysis of indirect effects to managed species as a result of munitions residues. The analysis of effects is presented in Section 4.4.7. The analysis of effects considers information about the chemical constituents found in munitions that have been and would be used in ERF-IA, methods by which these constituents could be released to the environment, and fate and transport processes. Additionally, information about the relative toxicity and bioaccumulation potential of individual munitions constituents, where available, is considered, along with relevant information from past studies at ERF-IA and various firing ranges. Due to dynamic hydrologic and sediment transport patterns; daily, seasonal, and interannual variation of fish presence in ERF waterbodies; and protective measures that would be implemented (Section 5.1), exposure concentrations of these chemicals to EFH and managed species cannot be quantified but are expected to be relatively low. Potential effects are described in this section to the maximum extent practicable without conducting a detailed site-specific ecotoxicological risk assessment.

4.4.1 Types of Detonations

4.4.1.1 High-Order Detonations

A high-order (HO) detonation occurs when at least 99.9 percent of the explosive mass is consumed (Walsh 2007). HO detonations are the typical outcome of firing rounds with traditional explosives. Studies have shown that HO detonations leave only trace amounts of munitions residues at the detonation site (Walsh 2007; Walsh et al. 2011). This finding is supported by other studies (Hewitt et al. 2003) that have shown munitions residues recovered after HO live-fire detonations represent a very small percent of the original mass of the explosive. HO detonation residues are slightly greater for IM than for traditional munitions (Walsh et al. 2014). When munitions detonate as designed, these HO detonations generally release only small quantities (less than 10 milligrams) of energetic compounds for traditional explosives and relatively minor quantities (1 to 4 grams) for some new IMs (reviewed in Bigl et al. 2021). Estimates of energetic residues that may be deposited by HO rounds in the proposed project area are described in Section 4.4.4.

4.4.1.2 Low-Order Detonations

An LO detonation occurs when there is either incomplete consumption of the explosive filler or a round is breached when the fuze functions properly but the filler fails to detonate. LO detonations may be caused by any one or a combination of the following factors: 1) initiator (blasting cap) of inadequate power; 2) deterioration of the explosive; 3) poor contact between the initiator and the explosive; 4) lack of continuity in the explosive (cracks or air space); and 5) dead pressing, where the initial shock may compress a portion of the HE filler so it does not detonate. LO detonations may result in distribution of particulate energetic residues at the impact site. Most residues are deposited on the surface, with the highest concentrations occurring near targets and areas where demolition activities are performed. In the case of impact and demolition ranges, the greatest quantities of residues are produced by rounds that fail to detonate as designed (Hewitt et al. 2007). Demolition activities would not be conducted at ERF-IA or the proposed expansion area.

Testing conducted at Alaska military ranges has shown that LO detonations (in addition to UXO) are the major contributor of explosives residues on impact areas (Walsh et al. 2005a, b). Testing conducted at sites outside of Alaska that used traditional munitions estimate that the rate of LO detonation, or partially exploded ordnance, is between 0.1 and 0.3 percent (Dauphin and Doyle 2000, 2001), with LO detonations of HE munitions observed at a frequency of 0.09 percent (Dauphin and Doyle 2000). Although no site-specific data are available, it is anticipated that these LO detonation rates would be similar to those occurring at ERF-IA for traditional explosives. Because the likelihood of IM rounds experiencing LO detonations is higher than for rounds with traditional explosives, it is likely that more IM explosives would be deposited on the ground than traditional explosives (Arthur et al. 2018). Most munitions residues for LO detonations are associated with HE rounds because inert rounds only contain a negligible amount of HE material. Estimates of energetic residues that may be deposited by LO rounds in the proposed project area are provided in Section 4.4.4.

4.4.1.3 Unexploded Ordnance—UXO

UXO is defined as military munitions that 1) have been primed, fuzed, armed, or otherwise prepared for action; 2) have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installations, personnel, or materiel; and 3) remain unexploded, whether by malfunction, design, or any other cause (10 U.S.C. 101[e][5]). UXOs, or duds, exist in ERF-IA. Because a variety of actions (including a change in pressure, weight, or heat) could trigger a detonation, UXO is a hazard wherever it occurs.

During a crater mapping exercise in 1990, it was estimated that more than 100,000 artillery rounds have been fired into ERF-IA since it was established in 1945 (Racine et al. 1992). Previous stated dud rates for artillery rounds used to calculate UXO at ERF-IA in the study were around 10 percent (range of 4 to 20 percent), which would equate to approximately 10,000 rounds of UXOs in ERF-IA. Subsequent estimates of numbers of dud rounds in ERF-IA have been calculated based on live-firing activities conducted over a 12-year period (October 2010–October 2022) (S. Tucker, personal communication, 27 October 2022). During this period, the total number of rounds fired into ERF-IA was 33,287. The Army is required to observe all rounds fired and determine whether they have functioned as intended. Of the total rounds fired, three duds were observed, which is a dud rate of less than 0.01 percent. Extrapolating back to estimate the number of duds since 1990 at the same rate would yield a total of less than 10 UXO rounds. Even assuming much higher dud rates, the amount of UXO is likely to be substantially less than the 10,000 rounds previously estimated since live-action firing began at JBER. It is unknown how many of the older

UXOs still exist at ERF-IA. Very few UXOs have been observed at or near the surface of ERF, although this is not necessarily an indication of the scarcity of UXOs.

Despite the low dud rates observed at ERF-IA, dud rounds appear to occur with greater frequency than LO rounds. Older studies (Dauphin and Doyle 2000, 2001) have estimated an approximate rate of munitions failure (i.e., ordnance that completely fail to detonate) for traditional mortar and howitzer ammunition of between 2.28 and 4.95 percent, and a 3.37 percent dud rate for HE rounds during live-fire exercises (Dauphin and Doyle 2000). The rate of IM explosives resulting in UXO was found to be 3 percent, so is within the range observed for traditional explosives (Dauphin and Doyle 2001). These rates may vary depending on a number of factors, such as age of the munitions being fired, variations in production, and ambient conditions. As discussed in the previous paragraph, the observed dud rate at ERF-IA over the last 10 years was substantially lower.

The fate of UXO is dependent on the conditions in the impact area. UXO may penetrate deep into the ground where soils are soft or have low penetrability coefficients. Military Munitions Response Program (USARAK 2008) researchers studying old SDZs found that fragments of rounds, which remain intact and are therefore comparable to UXO in shape and weight, typically penetrate about 1.2 to 2.0 meters below the surface, depending on the density of the soil. Where the ground is relatively hard, UXO may remain at the surface; therefore, it can be assumed that UXO landing on the ice during winter months at ERF-IA remains at the surface until the spring when it may settle on the ground or sink into the soft soils. The end destination of UXO plays a critical part in determining the environmental fate of the munitions. UXO that penetrates deep into the ground may be subject to either an aerobic or anaerobic environment, where release and degradation processes are very different from those at the ground surface.

Soils in ERF-IA are predominantly anaerobic, although the microtopographic (<1 meter) variation, combined with regular tidal fluctuations, creates a mosaic of soil conditions across ERF. ERF-IA is composed of over 90 percent wetlands, while the proposed expansion area contains less than 5 percent wetlands. The wetlands in the expansion area are mostly along Clunie Creek, outside the area where detonations would occur. There are two predominant soil types in ERF-IA that are both very poorly drained and combined cover 86.7 percent of the area (USDA NRCS 2022):

- Entisols and Inceptisols are mineral soils that have developed in recent silty marine sediments on tidal flats and beach terraces and typically only support salt marsh vegetation in ERF-IA. The predominant soil subgroups in ERF-IA are Typic Cryaquents and Typic Cryaquepts (USDA NRCS 1979). Soil laboratory data from the National Cooperative Soil Survey (2023) and Wells et al. (2021) indicate that percent organic matter in these soil subgroups in southcentral and southwest Alaska typically ranges from 2 to 12 percent in the upper 1 meter of the soil profile. Entisols and Inceptisols combined cover 78.6 percent of ERF-IA.
- Histosols cover 8.1 percent of ERF-IA and are wet, organic soil materials that have developed in peat and sedge materials in depressions on river terraces and abandoned tidal flats. Organic soil materials typically have approximately 20–60 percent organic matter (USDA NRCS 2022; NCSS 2023).

Anaerobic soils are dominant in ERF-IA due to its location near tidal and river flooding and high-water tables and its depositional setting. There may be both spatial and seasonal patterns to soil saturation and subsequent oxygen status. Some coarse alluvial soils may never be depleted of oxygen if they receive oxygenated river water, and the water moves quickly through the soil. Other soils have seasonal hydrology and may be anaerobic during the wet part of the year and aerobic during the dry part of the year. This would be more common in areas affected by seasonal river flooding. Areas influenced by tidal flooding would more likely be wet nearly year-round, and the water would more likely be depleted of oxygen. Approximately 8.1 percent of soils in ERF are organic; these soils may interact with contaminants differently than anaerobic mineral soils. However, the mineral soils that comprise the majority of the site support wetland habitats, which are typically characterized by high organic matter accumulation compared to adjacent upland soils. Organic matter acts as a binding agent for nutrients and potential contaminants, and therefore aids in reducing inputs of these contaminants to waterbodies. Breakdown processes for specific munitions in this environment and how contaminants interact with anaerobic and aerobic conditions are discussed in Section 4.4.3.

Energetic materials deposited in the form of UXO, which likely compose the bulk of deposited residue at ERF-IA, often remain inside the ordnance after landing in the impact area. There are several ways in which UXO can be exposed to the environment: it might be destroyed by Explosive Ordnance Disposal personnel during range clearance operations (blow-in-place); may undergo sympathetic detonation caused by another round exploding nearby or by some other event that causes a change in pressure, weight, or temperature; or may corrode. Sympathetic detonations are rare events, and the number of blow-in-place events depends on range management strategies. Both types of events generally result in LO detonations that distribute explosives in the impact area. IM-filled UXOs are less likely to undergo sympathetic detonation than traditional explosives because they are more resistant to detonation (Walsh et al. 2014). Larger amounts of donor explosives are required to initiate the munition detonation, and there is a larger risk of incomplete consumption of the explosive fill. Initial modifications of existing techniques required up to 400 percent more donor explosives to detonate UXOs and typically achieved only partial detonation (Bagley 2019).

Corrosion of UXO shell casing may result in the release of munitions constituents to the environment. Leaching of energetics from UXOs could result in changes in sediment and water quality that could affect EFH and managed fish species. The time to perforation due to corrosion of UXO casing, exposing contained energetic compounds to the environment, can range from years to several thousands of years (Packer 2004). Packer (2004) estimated the time to perforation due to corrosion of 0.25-inch metal casing of UXOs in ecosystems including desert, forest/grassland, and temperate forest, and modeled perforation times ranging from 8 to 760 years, depending on a variety of environmental variables. While no site-specific evidence is available for corrosion of UXO in ERF-IA, modeling indicated that UXO in temperate forest ecosystems (which have temperature and moisture levels most similar to ERF) would be expected to perforate in 30 to 170 years (Packer 2004). In highly reducing conditions found in wetlands and other anaerobic and flooded environments such as ERF-IA, small openings would probably start to appear in the casing within 10 to 40 years (Taylor et al. 2004). Brackish conditions at ERF-IA could increase corrosion rates of UXO casing.

While a timeline for corrosive perforation of UXOs is difficult to predict, observations from Taylor et al. (2011) indicated that corrosive perforation/pitting is not an important release route for HE, as iron oxides tend to quickly seal small holes. Instead, the primary route of release of HE from UXOs comes from cracked casings and larger perforations due to fragmentation hits. Taylor et al. (2011) investigated 42 UXO samples of calibers ranging from 60 to 150 mm at ERF-IA, San Luis Obispo in California, and Vieques in Puerto Rico. Observations indicate that only approximately 16 percent of UXOs were found to be leaking HE residue. The UXOs sampled at ERF-IA included nine 60-mm munitions, with two leaking HE residue. One of the UXOs had a failed fuse and was cracked on impact with the target (Jeep), and the other was punctured by fragment hits. The other seven UXOs were not found to be leaking HE residue.

Only small amounts of explosives in the UXO are exposed to the environment as the UXO corrodes over time. According to modeling conducted by CRREL researchers, corroding UXO contributes only a small proportion to the net change in overall dissolved HE residues in an impact area. Studies suggest that reducing conditions at ERF-IA could cause the explosives to break down as fast as they are released to the environment, and it is possible that reactive intermediates formed during metal corrosion may facilitate the degradation of cyclotrimethylenetrinitramine (Research Department Explosive, or RDX), TNT, and other explosives (Taylor et al. 2004). Singh et al. (1998) showed that the presence of iron can increase the rate and extent of RDX degradation. As the steel casing of a UXO corrodes, an iron-rich environment is created in soils around the UXO, potentially accelerating degradation of the explosive. It should be noted that these studies only pertain to traditional explosives. IM constituents differ in fate/transport pathways and toxicity; 3-nitro-1,2,4-triazol-5-one (NTO) and nitroguanidine (NQ) in particular pose a greater risk of release to the aquatic ecosystem due to their increased solubility and mobility, as described further in Section 4.4.3.

Table 4-15 Mortar and Artillery Rounds Proposed for Use at ERF-IA, with Filler Constituents

Caliber	Type	Cartridge	Department of Defense Ammunition Code No.	Filler
Mortar				
60-mm	HE	M720A2	BA44	IMX-104
		M768A1 w/M783 PD fuze	BA45	IMX-104
	ILLUM	M721 w/M766 MTSQ fuze	B647	Illuminant
		M767 w/M776 MTSQ fuze	BA04	Illuminant, Infrared
	FRTR	M769 w/M775 PD fuze	BA15	None (hollow body)
81-mm	HE	M889A4 w/M783 fuze	CA63	IMX-104
		M821A1 w/M734 MOF	C868	Comp B
	ILLUM	M816 w/M772 MTSQ	C484	Illuminant, Infrared
		M853A1 w/M772 MTSQ	C871	Illuminant
	FRTR	M879 w/Practice fuze M751	C875	Hydrocal (inert) (gypsum cement)
120-mm	HE	M934A1 W/MOF M734A1	CA04	Comp B
		M933A1 w/PD fuze M783	CA44	Comp B
	ILLUM	M930 w/M776 MTSQ	C625	Illuminant
		M983 w/M776 MTSQ	CA07	Illuminant, Infrared
	FRTR	M931 FRPC w/Practice fuze M781	CA09	None (hollow body)
Howitzer				
105-mm	HE	M1	C445	Comp B or TNT
		M1 w/o fuze	CA59	IMX-101
	ILLUM	M314 w/o fuze	C541	Illuminant
		M1064 w/o fuze	CA53	Illuminant, Infrared
	Smoke	M84A1 w/o fuze	C479	HC
155-mm	HE	M795	DA54	IMX-101
		M795	D529	TNT
	ILLUM	M1066	DA49	Illuminant, Infrared

Caliber	Type	Cartridge	Department of Defense Ammunition Code No.	Filler
		M485	D505	Illuminant
		M1123	DA56	Illuminant, Infrared
		M1124	DA57	Illuminant
	HE Training Projectile	M1122	DA51	Concrete + IMX-101
		M1122A1	DA68	Concrete + IMX-104

Key: Comp B = Composition B; ERF-IA = Eagle River Flats Impact Area; FRPC = Full Range Practice Cartridge; FRTR = Full Range Training Rounds; HE = high explosive; ILLUM = Illuminant; IMX = Insensitive Munitions Explosives; mm = millimeter; MOF = Multi-Option Fuze; MTSQ = Mechanical Time Superquick; PD = Point Detonating; TNT = trinitrotoluene.

Source: U.S. Army 2017; S. Tucker, personal communication, 23 January 2023.

4.4.2.1 Explosives

Explosive formulations historically used at ERF-IA include Comp B and 2,4,6-TNT. The chemical constituents of these formulations rely on combinations of TNT, RDX, and HMX. In general, these chemicals have been well characterized because of their prolific use in military and industrial explosives. In terms of toxicity, the three explosive compounds can be ranked as follows: TNT > RDX > HMX, with TNT having the largest potential impact to the environment (Rectanus et al. 2015). PAX-21 (Picatinny Arsenal Explosive 21) was a constituent of 60-mm HE mortars; it is primarily composed of the explosive 2,4-dinitroanisole (DNAN), RDX, and ammonium perchlorate. However, the Army has discontinued use of PAX-21 filled rounds during training because of the amount of ammonium perchlorate they deposit. The Army still uses traditional explosives at ERF-IA; however, as previously mentioned, many rounds have been replaced with IMs. IMX-101, the IM replacement for TNT, contains the explosives DNAN (40–45 percent), NTO (18–23 percent), and NQ (35–40 percent) (Richard and Weidhaas 2014a, b). IMX-104, the IM replacement for Comp B, contains the explosives DNAN (32 percent), NTO (53 percent), and RDX (15 percent) (Taylor et al. 2015). IMX-104 also contains HMX because technical grade RDX contains approximately 10 percent HMX (Arthur et al. 2018).

4.4.2.2 Illuminants

Illuminants and infrared illuminants are used for illuminating target areas. These devices use an illuminant mix that contains a small propellant charge that illuminates when ignited. Magnesium oxide and sodium nitrate are the primary constituents, although older formulations may contain other metal constituents (Hardt 2001, cited in Clausen et al. 2012). Metal residue deposition studies have found that illuminants do not contribute concentrations of metals to the environment above background levels (Clausen et al. 2012).

4.4.2.3 Propellants

Military propellants comprise part of the munitions used at JBER and can deposit residues on the ground like explosives. Propellants are designed to burn at a controlled rate and rapidly produce gases, thereby providing energy to deliver a munition to its target. The main difference between explosives and propellants is their reaction rate. While explosives react rapidly and result in the munition’s casing breaking apart, propellants react slowly, providing sustained energy to propel a munition. Propellants, such as nitrocellulose, nitroglycerin, NQ, 2,4-dinitrotoluene (DNT), and perchlorate, are found in cartridge cases (small arms, medium caliber munitions, some artillery), projectile externals (mortars, some artillery), rocket motors, and explosive charges. At JBER, they may be incorporated into devices such as signal flares, smoke-generating compounds, parachute flares, fuzes, and training simulators. Toxicity information for propellants used at ERF-IA is provided in Section 4.4.5.

4.4.2 Munitions Constituents

Munitions constituents have the potential to impact EFH and federally managed species. The term "munitions constituent" refers to any material originating from fired munitions; UXO; discarded military munitions or other military munitions, including explosive and non-explosive materials; and emission, degradation, or breakdown elements of such ordnance or munitions (10 U.S.C. 2710 [e][3]). Munitions constituents are typically divided into three main categories: explosives, propellants, and metals. Munitions constituents also include a variety of secondary explosives, such as pyrotechnics (e.g., smoke-producing agents) (Rectanus et al. 2015).

Both HE and non-HE munitions contain a variety of chemical compounds, as shown in Table 4-15. Primary munitions constituents (more than 97 percent by weight) of mortar and howitzer HE rounds are explosives, iron (steel), aluminum, and copper. The remaining 2 to 3 percent of the munitions' weight is characterized by other compounds consisting of trace amounts of other metals such as zinc, manganese, nickel, chromium, and cadmium, which are generally components of steel or iron alloys.

The proposed 155-mm training round also contains about 21.8 kg of concrete filler. Although concrete could result in localized increases in pH of surface water and sediments, the proposed protective measures described in Section 5.1.1 (e.g., habitat protective buffers, HE firing restrictions during inundated conditions, selective targeting in unbuffered areas) would reduce risk of concrete entering waterbodies. Highly alkaline water can not only cause fish injury or mortality but also increase the toxicity of other substances, such as munition residues, as described in Section 4.4.5.5. Although sediments and groundwater are likely to filter any residual concrete material that is deposited on the flats, and the training rounds would be dispersed throughout ERF-IA, some concrete filler could be flushed into waterways through runoff or typical inundating tide events. Based on natural attenuation processes and protective measures, the amount of concrete released in water is expected to be minimal, and the buffering capacity of the receiving saline waters would reduce potential toxicity to fish and aquatic organisms.

Other compounds, such as waxes and silicon, represent just a few grams of the overall weight of munitions. The projectile body, which is the only part of the munition that lands in the impact area, is typically made of steel or iron. Many of the rounds have copper alloy rotating bands; the fuzes and fins are made of aluminum. During an HO detonation, the metals are discharged as shrapnel and essentially everything else is consumed. As previously described in Section 4.2, only HE rounds are expected to generate shrapnel.

Traditional munitions that have historically been used at ERF-IA, such as Composition B (Comp B), TNT, RDX, and 1,3,5,7-octahydro-1,3,5,7-tetranitrotetrazocine (High Melting Explosive, or HMX), are being phased out in favor of IMs (Insensitive Munitions Explosives [IMX]-101 and IMX-104), which are more resistant to shock and have a higher detonation temperature than current formulations and are therefore less prone to unplanned detonations. IMs were constructed to resist external stimuli such as bullet impact or fire, and because of that, they resist unintentional detonation. This insensitivity has resulted in a less-efficient detonation, differential performance among the formulation components, and increased deposition of residues caused by sympathetic detonations of UXO (Walsh et al. 2017).

4.4.2.4 Metals

Metals are found in nearly all military munitions used at ERF-IA. Uses of metals in munitions include casings, bullets, projectile cases, projectiles, bomb bodies, and fillers. The most commonly occurring metals at JBER and other military training sites, along with their roles in munitions and toxicity, are presented in Table 4-16. In addition to these metals, the munitions casings used at JBER also contain iron, manganese, nickel, chromium, and cadmium. Although metals such as lead, antimony, copper, and zinc can be found in trace amounts, lead is often the primary metal contaminant of concern at munitions sites. However, lead is not a component of munitions used in live-fire training activities at JBER. Because aluminum, iron, magnesium, and other metals used in JBER munitions are not defined as CERCLA hazardous elemental metals, further discussion of metals is limited to copper and zinc, which present the greatest potential for impacts to fish and their habitat. A brief description from Rectanus et al. (2015) of natural physical attenuation pathways for copper and zinc is summarized below:

- **Copper:** Cu(II) is the most common soluble oxidation state of copper, which is more mobile at highly oxidizing acidic systems. However, in neutral to alkaline systems and sulfidic environments such as ERF, copper oxides are stable and highly insoluble, with low bioavailability.
- **Zinc**: Zn(II) is the most common state of zinc. Zinc is one of the most mobile heavy metals because many of its compounds are soluble in acidic and neutral pH waters. Zinc precipitates readily with hydroxide, carbonate, and sulfide, which are favored at basic, reducing conditions such as those at ERF, and co-precipitates with hydrous oxides of iron or manganese, which decreases mobility.

Table 4-16 Commonly Occurring Metals in Munitions Constituents at JBER and Other Training Facilities

Metal	Use	Toxicity	Component of JBER Munitions?
Aluminum (Al)	Incendiaries, composition explosives, propellants, pyrotechnics	Not a CERCLA hazardous elemental metal	**Yes**
Antimony (Sb)	Lead-based alloys in small arms bullets and pyrotechnics	Toxic metal that targets cardiovascular and respiratory systems	No
Copper (Cu)	Brass cartridge cases, bullet jackets, pyrotechnics and bronze gun barrels	Toxic metal that targets gastrointestinal, hematological, and hepatic systems	**Yes**
Iron (Fe)	Steel projectiles, incendiaries, and pyrotechnics	Not a CERCLA hazardous elemental metal	**Yes**
Lead (Pb)	Small arms bullets, primary explosives, primer compositions	Group B2 carcinogen, toxic metal that targets cardiovascular, developmental, gastrointestinal, hematological, musculoskeletal, neurological, ocular, renal, and reproductive systems	No
Magnesium (Mg)	Incendiaries, pyrotechnics (photoflash), tracers, and armor piercing bullets	Not a CERCLA hazardous elemental metal	No
Zinc (Zn)	Cartridge cases (brass), bullet jackets (e.g., gilding metal), hexachloroethane smoke-filled munitions, and pyrotechnics	Toxic metal that targets gastrointestinal, hematological, and respiratory systems	**Yes**

Key: CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; JBER = Joint Base Elmendorf-Richardson.

Source: Rectanus et al. 2015.

4.4.3 Munitions Breakdown Pathways

Following the initial release of munition contaminants into the environment, their fate and degradation in soil and groundwater are dependent on a variety of environmental factors and conditions, including the contaminant characteristics, subsurface geochemistry, and microbial community. Fate and transport processes link the release of contaminants at a source with the resultant environmental concentrations to which fish and other receptors can be exposed. In the absence of modeling to predict exposure concentrations, information about transport and transformation of contaminants can provide information about their fate following release.

Attenuation processes cause the bioavailability of a given contaminant to decrease over time, reducing its potential to harm fish and other organisms. Attenuation processes can be divided into three main categories: physical, chemical, and biological pathways (Table 4-17). Major breakdown pathways for various munition constituents include biodegradation, photodegradation, dissolution, and sorption and are described in more detail in the following subsections.

Table 4-17 Attenuation Pathways Applicable to Munitions Contaminants in Soil and Groundwater

Pathway	Mechanism	Description
Physical	Advection	Movement of contaminant within groundwater
	Diffusion	Mass transfer of contaminant into or out of matrix due to concentration gradient
	Phase Transfer (Dissolution)	Dissolution (solid to aqueous phase) and/or volatilization
Chemical	Sorption	Reversible interactions between aquifer matrix and contaminant
	Abiotic Transformation	Reactions between mineral and contaminant
	Photodegradation (Photolysis)	Transformation of contaminant due to sunlight exposure in surface soils only
Biological	Biodegradation (Microbial Processes)	Biotically mediated reactions
	Biogeochemical Transformation	Coupled biotic and abiotic reactions

Source: Rectanus et al. 2015.

4.4.3.1 Biodegradation and Photodegradation

Biodegradation is the process by which organic substances are decomposed by microorganisms. Aerobic, oxygenated soils allow for gas diffusion and plant respiration. When soils become saturated with water, gas diffusion slows because there are no open passageways for air to travel. When oxygen levels become limited, such as in ERF-IA, an anaerobic environment (no oxygen) develops, and different biological and chemical reactions begin to dominate. Sulfate-reducing bacteria produce hydrogen sulfide, which is prevalent in ERF. Hydrogen sulfide reacts with metals to form metal sulfides, which precipitate out of the soil-water solution. These metals can be broken down through consumption by microorganisms, which removes the organic compounds from water as they provide energy for the organisms.

Photodegradation (photolysis) is the process by which substances are broken down by light. Photons impart energy to chemical bonds upon striking a target molecule; specific wavelengths of light can provide the energy required to induce a chemical reaction resulting in photodecomposition. Photolysis can be a significant attenuation pathway for explosives and propellants (Rectanus et al. 2015). For solid explosives, photodecomposition reactions occur only on the surface, the products of which can be washed off—often producing a halo of reddish-brown residue on the soil surface surrounding the bulk particles. This pathway, like abiotic pathways, can lead to reduction of contaminant mass by degradation. Photolysis does not occur when the munitions contaminants are under soil surfaces and in groundwater due to the absence of light. It is anticipated that photolysis degradation at ERF is seasonal and primarily limited to suitable ambient light conditions from spring to fall. However, this pathway would help break down munition residues deposited at ERF and the expansion area during the resumption of all-season firing.

Available data indicate that TNT, RDX, and HMX undergo biodegradation under anaerobic conditions (McCormick et al. 1981; U.S. Army 1984; Walker and Kaplan 1992). These studies and others conducted in Alaska suggest that these explosive compounds biodegrade within days to months in anaerobic environments with sufficient organic matter content such as those found at ERF. Ringelberg et al. (2003) found that aerobic and anaerobic biodegradation of explosives can occur in cold region soils with high organic matter content, but biodegradation rates are much faster under anaerobic conditions, which are commonly found in ERF, than under aerobic conditions, which only comprise a small portion of ERF (although more prevalent in the expansion area).

In 2005, CRREL researchers performed assays using soil samples collected from locations in ERF-IA where cratering tests had been conducted using C4 explosives (RDX) (Ringelberg 2005). Samples were analyzed for microbial biomass, community composition, and RDX degradation capacity. After incubation, the samples contained hydrogen sulfide gas, suggestive of anaerobic respiration and sulfate reduction by bacteria. The soils also contained a substantial microbial biomass and showed that significant degradation of RDX had occurred. This work strongly suggests the role of sulfate-reducing bacteria in the biodegradation of RDX in soils at ERF-IA and suggests that anaerobic biodegradation is the primary mechanism for breakdown of RDX and potentially other explosive residues at the site.

Studies indicate that RDX is generally more persistent and mobile than TNT, which photodegrades rapidly and is aerobically biotransformed into 2-Am-DNT and 4-Am-DNT (McCormick et al. 1976). Esteve-Nunez et al. (2001) found that certain strains of microorganisms and fungi use the nitrogen from TNT to degrade or transform TNT under anoxic conditions as well. Alavi et al. (2011) observed similar results in volcanic soils of Hawaii, where TNT and DNT would not leach beyond a depth of 30 centimeters, unlike HMX and RDX, which were found to pass beyond this depth. This suggests that the risk of groundwater contamination is greater for HMX and RDX relative to TNT and DNT. However, anoxic soils at ERF-IA are not as porous as volcanic soils; therefore, it is likely that biodegradation processes would restrict migration of RDX into groundwater. It should be noted that when exposed to water, RDX undergoes photolysis and has a short half-life of 9 to 13 hours (Abadin et al. 2012). Phasing out of TNT (and DNT) and reduced use of RDX and HMX would minimize the potential amount of these contaminants that can enter waterbodies.

The additional munitions constituents in IMX-101 and IMX-104 (i.e., DNAN, NTO, and NQ) can undergo aerobic and anaerobic biotransformation, as well as phototransformation, to yield a variety of transformation products in the laboratory (Table 4-18). A study of the biodegradation potential of IMX-101 and IMX-104 on two training ranges (Camp Shelby, Mississippi, and Umatilla Chemical Depot, Oregon) found higher transformation rates for all IMX constituents under anaerobic conditions versus aerobic conditions (Indest et al. 2017). The most persistent compounds were the NQ component of IMX-101 and the RDX component of IMX-104. The study found that certain soil microbial communities associated with explosives degradation increased significantly in anaerobic soils, and supplemental carbon could be used to facilitate cleanup of these compounds (Indest et al. 2017). The relatively high presence of organic matter at ERF-IA would help break down these and other munitions residues deposited at the site.

IM compounds may undergo phototransformation, but it is not a significant pathway due to faster dissolution processes, as described in Section 4.4.3.2 (Dontsova 2018). NTO and DNAN phototransform when in solution, with NTO phototransformation rates three times greater than DNAN in the presence of organic matter (Dontsova et al. 2014). Other studies have concluded that DNAN, NTO, and NQ can be photodegraded in surface water (Halasz et al. 2018) and that the kinetics of biodegradation are comparable to those of nitroaromatic explosives (e.g., TNT) (Richard and Weidhaas 2014a). One study found that the photodegradation half-lives of NQ, DNAN, and NTO in a laboratory were 0.44 days, 0.83 days, and 4.4 days, respectively (Moores et al. 2021), although sunlight exposures were likely higher than those at ERF-IA. A strong correlation was found between salinity and the photolysis rate for DNAN, suggesting that saline waters from inundating tides may increase the degradation process of any DNAN residues deposited on the flats. The photolysis rate for TNT has shown a similar trend (O'Sullivan et al. 2011), which suggests that brackish waters in ERF would help break down these munition constituents, relative to freshwater conditions. Based on these studies, it is apparent that the biodegradation and photodegradation rates of IM explosives are relatively fast and comparable to those of traditional explosives, such as TNT.

Degradation of IM by ultraviolet (UV) light has become a topic of concern following observations that some UV-degradation products have increased toxicity relative to parent compounds in aquatic organisms (Moores et al. 2021). Lab studies exposed UV irradiated IMX-101 constituents to *Daphnia pulex* and found that UV-degraded NTO and NQ (and associated degradation products) increased mortalities by factors of 40.3 and 1,240, respectively (Moores et al. 2021). Additionally, for the first time, cyanide was detected during UV degradation of NQ. Among the analytically determined NQ UV-degradation products, cyanide was the most toxic, followed by guanidine, nitrite, and ammonia. However, further testing is needed because the individual concentrations of the products could not fully account for the observed toxicity of the UV-degradation product mixture. The study concluded that 1) other unidentified NQ degradation products contributed principally to toxicity and/or 2) synergistic toxicological interactions occurred among the NQ degradation product mixture that exacerbated toxicity (Moores et al. 2021). Regardless, the study suggests that UV exposure to IMX munition residues on ERF-IA could increase toxicity to aquatic organisms if these constituents are mobilized into waterbodies.

4.4.3.2 Dissolution and Sorption

Dissolution is the process by which a solid or solute (in this case an explosive fragment) dissolves into a solvent (in this case water) and allows transport and mobility of the contaminant into soil. Interactions between the compound and the soil particles can slow or even halt the movement of the contaminant through the soil, effectively removing it from the aqueous fraction. This removal of a compound from solution to a solid phase is called sorption. Chemical properties that influence dissolution and sorption are presented in Table 4-17. While volatilization is listed under phase transfer in Table 4-18 as a potential attenuation pathway, energetic compounds are classified as semi-volatile organics, and other common munitions constituents are classified as non-volatile inorganics. Therefore, volatilization is not a significant attenuation pathway for these munitions (Rectanus et al. 2015).

The mobility of a chemical in soil is often characterized by the soil sorption distribution coefficient (Kd), defined as the ratio of the compound concentration associated with the solid phase to the concentration of the compound in the aqueous phase when at equilibrium. This coefficient is often normalized for soil organic carbon content, as nonpolar organic compounds most often sorb to this component in the soil. The resulting organic-carbon partition coefficient (K_{OC}) indicates the tendency for a hydrophobic organic solute to partition into the nonpolar soil organic carbon fraction (i.e., sorb to organic content in soil). Greater K_{OC} values tend to indicate an increased tendency for a hydrophobic organic solute to sorb to organic content in soil. In situations where the solute is a polar ($\log K_{OW} < 0.5$)[8] or ionic compound, or when the organic content of the soil is low with a high clay content, the K_{OC} paradigm might not be adequate to estimate mobility (reviewed in Wen et al. 2012).

[8] The physico-chemical property K_{OW} (octanol-water partition coefficient) is the dimensionless ratio of the concentration of a chemical substance in octanol (non-polar solvent) and in water (polar solvent) at equilibrium and at a given temperature. This measure of the tendency of the substance to associate with either water or octanol (a lipid) is used to describe the hydrophobicity of the substance and is used as an indicator of the tendency of that substance to bioaccumulate (i.e., associate with non-polar organic tissue).

Table 4-18 List of Proposed Munitions Constituents, Transformation Products, Breakdown Pathways, and Chemical Properties Relevant to EFH and Federally Managed Fish Species

Munition Type	Chemical Name[1]	Transformation Products	Mechanism of Transformation	References	Water Solubility (Sw) @ 25°C in mg/L[2]	Soil Organic Carbon Partition Coefficient[3] Koc (L/kg)(log Koc)	Octanol-water Partition Coefficients (Kow) Log K_{OW} at 25°C[4]	References[5]	Bioaccumulation Potential	References
Explosives	**DNAN (**2,4-dinitroanisole)	See breakdown products below	See below.	Reviewed in Hawari et al. 2015	213±12	364±8	1.58 ± 0.01	Hawari et al. 2015	Although DNAN is more soluble than TNT, its lower hydrophobicity and tendency to form aminoderivatives that sorb irreversibly to soil contribute to make it less toxic than the traditional explosive TNT.	Hawari et al. 2015
		2,4-DNP (2,4-dinitrophenol)	Transiently formed by microbial transformation. Significant or complete biodegradation of DNAN after 9 days under aerobic conditions; microbial transformation under aerobic conditions.	Richard and Weidhaas 2014a; Fida et al. 2014	2,790 at 20 °C (experimental)	363.8 (2.561)	1.67 (experimental)	Royal Society of Chemistry 2020		
		MENA (2-methoxy-5-nitroaniline)	Reductive anaerobic biotransformation with H2 added as co-substrate; microbial transformation by aerobic bacteria.	Olivares et al. 2013; Liang et al. 2013	252±8	316±32	1.47± 0.01	Hawari et al. 2015		
		DAAN (2,4-diaminoanisole)	Microbial transformation by anaerobic bacteria with ethanol as primary substrate; reductive anaerobic biotransformation with H2 added as co-substrate.	Platten et al. 2010; Olivares et al. 2013	>40,000	<0.5	< -1	Hawari et al. 2015		
		4-ANAN (4-amino-2-nitroanisole)	Nitroreduction of DNAN.	Schroer 2018	4,430±60	240±12	0.80 ± 0.01	Hawari et al. 2015		
		Nitrate	Phototransformation under sunlight.	Rao et al. 2013	90,900	14.3 (1.155)	0.21	Royal Society of Chemistry 2022		
		Nitrite	Phototransformation under sunlight.	Rao et al. 2013	119,600	23.74 (1.376)	0.06	Royal Society of Chemistry 2022		
		8 additional breakdown products[6]	Reductive anaerobic biotransformation with hydrogen added as co-substrate.	Olivares et al. 2013	4,852[7]	44.85 (1.652)[4]	-0.30	Royal Society of Chemistry 2022		
	NTO (3-nitro-1,2,4-triazole-5-one)	See breakdown product below	See below.	Richard and Weidhaas 2014a	1,000,000	50.58 (1.704)	-2.99	Royal Society of Chemistry 2022		
		1,2-dihydro-3H-1,2,4-triazol-3-one	Transiently formed by microbial transformation. Complete biodegradation of NTO after 9 days under anaerobic conditions.	Richard and Weidhaas 2014a	885,000	109.2 (2.038)	-2.52	Royal Society of Chemistry 2022		
	RDX (cyclotrimethylenetrinitramine)	N/A	May biodegrade in water and soil under anaerobic conditions. Not significantly retained by most soils and can leach to groundwater from soil. Photolysis tends to degrade RDX relatively quickly in surface waters.	USEPA 2017a	59.7	1.80	0.87	USEPA 2017a	RDX has a low bioconcentration potential in aquatic organisms.	USEPA 2017a
	HMX (cyclotetramethylene-tetranitramine)	Nitrite, nitrate, formaldehyde, l,l-dimethylhydrazine	HMX does not evaporate or bind to sediments to any large extent. Sunlight breaks down most of the HMX in surface water into other compounds, usually in a matter of days to weeks. A small amount of HMX may also be broken down by bacteria in the water.	Sciences International 1997a	5	30-290	0.16	NCBI n.d.-a	Tissue residues found to be lower than environmental concentrations. Elimination half-lives for marine species are relatively low, indicating that release from exposure would result in fast depuration and likely recovery from toxic effects.	Lotufo et al. 2013

Munition Type	Chemical Name[1]	Transformation Products	Mechanism of Transformation	References	Water Solubility (Sw) @ 25°C in mg/L[2]	Soil Organic Carbon Partition Coefficient[3] Koc (L/kg)(log Koc)	Octanol-water Partition Coefficients (Kow) Log Kow at 25°C[4]	References[5]	Bioaccumulation Potential	References
	TNT (2,4,6-Trinitrotoluene)	1,3,5-Trinitrobenzene (1,3,5-TNB) via photolysis; various other products via biological degradation.	Soils have a high capacity for rapid sorption of TNT. Under anaerobic conditions, TNT is usually transformed rapidly into its degradation byproducts. Once released to surface water, TNT undergoes rapid photolysis.	USEPA 2017b	130 at 20°C	300 (est.)	1.6	USEPA 2017b	TNT is not expected to bioconcentrate to high levels in the tissues of exposed aquatic organisms or bioaccumulate in fish.	Houston and Lotufo 2005; USEPA 2017b
	Ammonium Picrate	Picric acid and derivatives	Very soluble in water. Like TNT, degrades through reduction and microbes and biodegradation, with transformation rates highest in fine-grained sediment.	Lotufo et al. 2013	200,000	N/A	N/A	Clausen et al. 2006	No data for the bioaccumulation of picric acid in marine fish and invertebrates were found; however, based on the low log Kow the potential for bioconcentration in aquatic organisms is considered low.	Lotufo et al. 2013
Propellants	**DNT** (2,4-Dinitrotoluene)	N/A	Slight tendency to sorb to sediments based on relatively low organic-carbon partition coefficients; unless broken down by light, oxygen, or biota, expected to remain in water for long periods of time because of its relatively low volatility and moderate water solubility.	USEPA 2017c	270	1.65 (log)	1.98	USEPA 2017c	Not expected to bioaccumulate significantly in animal tissue.	ATSDR 2016, cited in USEPA 2017c
	NQ (Nitroguanidine)	See breakdown products below	See below.	Reviewed in Mirecki et al. 2006	4,000	25.7 (1.41)	-0.83 to 0.156	Reviewed in Mirecki et al. 2006	No data for bioaccumulation of NQ in marine fish and invertebrates were found; however, based on the low log Kow, the potential for bioconcentration in aquatic organisms is considered low.	Lotufo et al. 2013
		Nitrourea	Transiently formed by aerobic microbial transformation. Microbial transformation by aerobic bacteria (*Variovorax* strain VC1). Nitrourea is unstable in water and degrades to ammonia, nitrous oxide, and carbon dioxide.	Richard and Weidhaas 2014a; Perreault et al. 2012	140,900	5.392 (0.732)	-1.65	Royal Society of Chemistry 2022		
		Nitrosguanidine	Photolysis.	Reviewed in Mirecki et al. 2006	1,000,000	70.48 (1.848)	-1.76	Royal Society of Chemistry 2022		
		Hydroxyguanidine	Photolysis.	Reviewed in Mirecki et al. 2006	1,000,000	38.21 (1.582)	-2.72	Royal Society of Chemistry 2022		
		Guanidine	Photolysis.	Reviewed in Mirecki et al. 2006	1,840 at 20°C (experimental)	19.78 (1.296)	-1.630	Royal Society of Chemistry 2022		
		Nitrite	Photolysis - end product.	Reviewed in Mirecki et al. 2006	119,600	23.74 (1.376)	.06	Royal Society of Chemistry 2022		
		Nitrate	Photolysis - end product.	Reviewed in Mirecki et al. 2006	90,900	14.3 (1.155)	0.21	Royal Society of Chemistry 2022		
		Ammonia	Photolysis - end product.	Reviewed in Mirecki et al. 2006	482,000 at 24°C (experimental)	14.3 (1.155)	-1.38 (experimental)	Royal Society of Chemistry 2022		
		Cyanamide	Microbial transformation under microaerophilic conditions.	Spanggord et al. 1987	500,000 (experimental)	4.5 (0.653)	-0.82 at 20 °C (experimental)	Royal Society of Chemistry 2022		
	NG (Nitroglycerin)	Calcium nitrate and calcium nitrite	Moderate aqueous solubility. Alkaline hydrolysis by calcium hydroxide. NG disappeared within 1 week in sterile,	Reviewed in Mirecki et al. 2006	1,950	1.6-2.8 (log)	1.6-2.8	Reviewed in Mirecki et al. 2006	Although no data for the bioaccumulation of NG in marine or fish and invertebrates were found, based	Lotufo et al. 2013

Munition Type	Chemical Name[1]	Transformation Products	Mechanism of Transformation	References	Water Solubility (Sw) @ 25°C in mg/L[2]	Soil Organic Carbon Partition Coefficient[3] Koc (L/kg)(log Koc)	Octanol-water Partition Coefficients (Kow) Log Kow at 25°C[4]	References[5]	Bioaccumulation Potential	References
			anoxic solutions with mineral salts, presumably by an abiotic, aqueous reaction.						on the low log Kow the potential for bioconcentration in aquatic organisms is considered low.	
	NC (Nitrocellulose)	N/A	Will not dissolve or hydrolyze in aqueous solutions except with strong base (sodium hydroxide or ammonia) and high temperatures.	Reviewed in Mirecki et al. 2006	immiscible	N/A	N/A	Reviewed in Mirecki et al. 2006	Studies with NC indicated no toxicity at concentrations up to 1000 mg/L when tested with several species of fish and invertebrates. Lack of toxicity of NC is likely a result of its insolubility in water.	Lotufo et al. 2013
	Ammonium Perchlorate	Perchlorate anion	Highly soluble in water, and relatively stable and mobile in surface and subsurface aqueous systems.	USEPA 2014	200	N/A	-5.84	USEPA 2014	Bioconcentration of perchlorate appears to be low for aquatic and terrestrial species	ATSDR 2008
Pyrotechnics (Smoke agents)	**HC** (hexachloroethane)	N/A	Evaporation or broken down by microscopic organisms. Breakdown more quickly in anaerobic soils.	ATSDR 1997	50 @20°C	1,380 to 2,360	4.14	NCBI n.d-b	Slight tendency to build up in fish, but they tend to break it down quickly.	ATSDR 1997
Other	**HYDROCAL** (inert) (gypsum cement)	Calcium and sulfate ions	Calcium sulfate dissolves in water.	USG 2017	1,500-4,000	N/A	N/A	USG 2017	Toxic to fish due to its high alkalinity (pH > 12). Discharge of large quantities directly into waterways could kill fish. Bioaccumulation not expected.	USG 2008

Notes:
[1] IMX-101 (TNT IM replacement) = DNAN, NTO, and NQ; IMX-104 (Comp B IM replacement) = DNAN, NTO, and RDX.
[2] Water solubility is measured in mg/L, the weight of constituent (in milligrams) that will dissolve in one liter of water (L).
[3] Koc = soil organic carbon distribution coefficient. Greater Koc values indicate the tendency for a hydrophobic organic solute to sorb to organic content in soil. Low Koc values indicate limited sorption (Mirecki et al. 2006).
[4] All Kow values from the Royal Society of Chemistry website (http://www.chemspider.com/) are estimated, unless otherwise noted.
[5] All data from the Royal Society of Chemistry website are generated using the U.S. Environmental Protection Agency's EPISuite™. Values are estimated using models unless otherwise noted.
[6] Additional DNAN breakdown products include: 3,3'-Diamino-4,4'dimethoxy-azobenzene, 3,3'-Diamino-4,4'dimethoxy-hydrazobenzene, N-(5-amino-2-methoxyphenyl) acetamide, 5-((3-Amino-4-methoxyphenyl)4-41iazinyl)-2-methoxy-N-methyleneaniline, 2-Methoxy-5-((4-methoxy-3-(methylamino)phenyl)4-41iazinyl)-methyleneaniline, 3,3'-Diamino-4-hydroxy-4'-methoxy-azobenzene, and 3,3'-Diamino-4-methoxy-hydrazobenzene.
[7] Value for N-(5-amino-2-methoxyphenyl) acetamide.
Key: °C = degrees Celsius; Comp B = Composition B; EFH = Essential Fish Habitat; est. = estimated; kg = kilogram; L = liter; mg = milligram; N/A = not applicable; Sw = water solubility.

Biodegradation and photodegradation are the primary degradation pathways for HMX, as it does not bind well to sediments. Jenkins et al. (2003) examined the stability of munitions residues in moist unsaturated soils and reported half-lives for RDX and HMX ranging from 94 to 154 days and 133 to 2,310 days, respectively. Ringelberg et al. (2003) conducted a similar analysis examining the stability of RDX in soil samples from Fort Greely, Alaska, and observed a half-life of approximately 1 month in unsaturated soils and 4 days in saturated soils, similar to what would be expected at ERF.

Dissolution rates of munitions residues can vary based on a variety of environmental conditions, including hydraulic conductivity of soils, temperature, and the presence of water (exposure via rainfall or submerged UXO). Taylor et al. (2010) reported dissolution rates of TNT to be 2.5 +/- 0.7 microgram (µg) centimeter per hour squared (µg cm/hr^2) and for C4 (91 percent RDX) to be 1.8 +/- 0.1 µg cm/hr^2, which indicates potential for these munitions residues to be mobilized into groundwater. Brannon et al. (2005) and Prak and O'Sullivan (2006) measured the dissolution rates in salt water and determined that the solubility of TNT and 2,4-DNT was lower than when exposed to fresh water. TNT has greater potential than RDX to sorb to soil (300 K_{OC} versus 1.8 K_{OC}), although biodegradation is likely the primary breakdown pathway for these residues.

For IM constituents, Richard and Weidhaas (2014b) investigated the dissolution rates of DNAN, NTO, and NQ under simulated rainfall and found that dissolution of the compounds was slow and followed the dissolution order NTO>NQ>DNAN, with NTO and NQ dissolving first, leaving DNAN crystals to dissolve more slowly. The study also investigated sorption of DNAN and NTO to soils and found that both compounds sorbed to and desorbed from soils to a limited extent. In soil, DNAN showed irreversible sorption and reduced bioavailability under oxic conditions (Hawari et al. 2015). Qin et al. (2021) suggested that slow dissolution processes for DNAN (and its breakdown products) could result in toxic effects to fish and macroinvertebrates in the absence of other breakdown pathways. Although DNAN is more soluble than TNT, its lower hydrophobicity and its tendency to form aminoderivatives that sorb irreversibly to soil contribute to make it less toxic than the traditional explosive TNT (Pichtel 2012; Hawari et al. 2015).

Both DNAN and NTO are subject to adsorption and transformation in soil (Dontsova et al. 2014). Dontsova et al. (2014) found that NTO was weakly adsorbed, with adsorption coefficients lower than those measured for RDX (the compound that it is replacing) and DNAN. The study suggested that an increase in transformation rates may occur if the soil is slightly anaerobic, such as in ERF-IA. DNAN is easily phototransformed and adsorbed in the soil, making it less mobile in the environment.

NQ and cyanamide are mobile in soil environments with limited sorption, as indicated by high solubility and low K_{OC} values (Mirecki et al. 2006). Given this paradigm, it seems likely that many of the transformation products of DNAN, NTO, and NQ would also experience limited sorption to soils and sediment (see Table 4-18). The solubility of most IM constituents is higher than that of TNT and RDX, increasing the likelihood that they could reach groundwater (Dontsova et al. 2014, 2022). Therefore, these compounds would likely remain bioavailable because sorption of compounds to soils reduces the rate or potential for biotransformation or other abiotic transformation.

Several studies have examined the dissolution, fate, and transport behavior of IMX-101 and IMX-104 in the environment (Arthur et al. 2018; Dontsova 2018; Qin 2021; Polyakov et al. 2023; Karls et al. 2023). Three primary pathways for rainfall-driven energetic transport were identified: subsurface infiltration, off-site transport in solution, and offsite transport in solid form (Polyakov et al. 2023). For IMX-104, the primary transport pathway for NTO was in solution, which could be either surface runoff or infiltration resulting in over 50 percent of NTO being transported off the surface. Energetic components with the exception of NTO and fine particles of DNAN, RDX, and HMX remained largely on-site, which would expose them to physical breakup, photodegradation, and dissolution and further transport by subsequent rainfall events (Polyakov et al. 2023). As flow rate increased, there was an increase in the percent mass found in solution and sediment and a decrease in the percent mass remaining on the surface. NTO fate was dominated by transport in solution, while DNAN, RDX and HMX were predominantly transported with the sediment (Karls et al. 2023). Although these studies were intended to understand how munition residues interacted with precipitation and runoff, it can be inferred that residues deposited on ERF may be transported in the water column or by sediment transport into Eagle River and Eagle Bay during ERF inundating tide events.

Qin (2021) suggested that IMX residues are consistently irradiated as solids under natural sunlight and then dissolved after rainfall. The study indicates that sunlight-induced direct photolysis would contribute significantly to the natural attenuation of IMX-101 and IMX-104 in the environment. DNAN transformed to 2-amino-4-nitroanisole and 4-amino-2-nitroanisole, while NTO concentrations also decreased due to transformation. Mark et al. 2017 found that NTO transformation rates increased (and less NTO was recovered) with increased soil organic carbon content. Although NTO has low adsorption in soils, high soil organic carbon content, breakdown by microorganisms, and hydraulic residence time at ERF-IA could reduce NTO concentrations. These studies indicate the potential for natural attenuation of IM constituents in soils through adsorption and transformation (Arthur et al. 2018).

For metals, sorption is a significant attenuation pathway. Sorption takes place when a metal is attracted electrically to charged groups in minerals or solid organic materials. Generally, high pH favors sorption of metal ions. Sorption capacity is dependent on pH and soil particle size distribution; fine soil particles have greater surface area than coarser material and therefore have a greater capacity for immobilizing metal contaminants. A brief description of attenuation by sorption for copper and zinc is included below, as summarized by Rectanus et al. (2015):

- **Copper:** ERF-IA sediments have pH values ranging from 7 to 8 (Racine et al. 1993). Neutral to alkaline soils are more effective in retaining Cu (II) compared to acidic soils. Copper has a strong affinity for the surfaces of iron oxides and hydroxides, clays, sulfides, and organic matter and is more strongly sorbed to mineral substrates than zinc, nickel, and cadmium.
- **Zinc:** Zinc readily sorbs to sediments and suspended solids such as hydrous iron and manganese oxides, clay minerals, and organic matter. The sorption affinity of zinc increases with increasing pH and decreasing salinity. Thus, zinc is expected to sorb better to sediments in groundwater than to tidally influenced sediments.

4.4.4 Deposition of Munitions Constituents

Ongoing live-fire training can deposit munitions constituents at the site of detonation, and sediments displaced from craters following detonation may contain munition residues (Walsh 2008). These constituents have potential to result in changes to water and sediment quality, which could affect EFH and managed species if present at or near the detonation site. Table 4-19 provides estimates of the total annual deposition of energetic residues (in grams) from HE munitions based on the annual number of rounds that would be fired under the alternatives (see Tables 2-4 and 2-5). The assumed number of HO/LO detonations and duds is based on the findings of Dauphin and Doyle (2000). Information provided by Walsh (2007) for traditional explosives was used to estimate the energetic residues for HO/LO detonations and duds for each munition type. The total annual deposition of energetic residues represents the sum of the residues for HO/LO detonations and duds.

Calculations that incorporate these assumptions estimate that a total of approximately 226.1 kg of HE munitions residue would be deposited annually at target sites as a result of live-fire training. Under Alternative 1, residue deposition would occur in both the existing ERF-IA (211.3 kg) and the proposed expansion area (14.8 kg), as shown in the table. Targets would be placed in locations outside of and away from proposed protective buffers (Section 5.1.1). It was assumed that the total area in the existing ERF-IA where munitions could detonate would be the 1,568 acres outside the buffers. It was assumed that munitions could detonate within approximately 350 acres of the proposed expansion area. Under Alternative 2, the entire project total (226.1 kg) would be deposited in the existing ERF-IA because this alternative does not include the expansion area. It is estimated that most of this munitions residue would be contributed by

UXOs (216 kg), with lesser amounts from LO detonations (10.4 kg) and HO detonations (0.021 kg). Note that this UXO deposition rate is very conservative as it assumes a 3.37 percent dud rate, which is much greater than the dud rate observed by JBER personnel (0.01 percent) over the past 12 years.

The aforementioned residue estimates were developed based on use of traditional munitions. IMs are expected to result in a greater amount of residue from HO and LO detonations, and potentially UXOs. Studies conducted by CRREL have found that the more insensitive the munitions are, the less efficient they become and the more they deposit residues. In the case where IM constituents are toxic, the live firing of IM rounds into training areas represents an environmental risk (Walsh et al. 2017).

From 2012–2017, the Strategic Environmental Research and Development Program (SERDP) conducted research at various firing ranges in cold weather climates in the United States and Canada, including ERF-IA, to evaluate deposition of HE residues and dissolution of HE compounds from the detonation of IM (Walsh et al. 2017). Sampling on snow has proven to be the most reproducible method for energetics residues characterization research because residues are more easily detected. Four IM HE formulations were tested: PAX-21, PAX-48, IMX-101, and IMX-104; the latter two are proposed for use at ERF-IA. The PAX-21 research indicated significant deposition of ammonium perchlorate. The use of these munitions is now restricted, and they would not be used at ERF-IA. Walsh et al. 2017 found that detonation of IMX-101 and IMX-104 rounds resulted in high residue deposition of NTO and NQ, which are both highly soluble compounds. Very high deposition rates of NTO and NQ from the IMX-101 rounds has led to a re-evaluation of the explosive load for these rounds (Walsh et al. 2017). A summary of study findings for characterization of residues from the detonation of IMs is provided in Tables 4-20 and 4-21.

Table 4-19 Estimated Total Annual Munitions Use and Failure Rate at ERF-IA under Alternative 1

Munitions Information			Munitions Residue Impacts							
			Number of Rounds/Detonations				Munitions Residue Deposition (grams)			
HE Munitions Type[1]	Total Energetic Mass per Round[2]	Total Energetic Residue per HO Detonation[3]	Annual Number of Rounds Fired[4]	Annual Anticipated Number of LO Detonations[5]	Annual Anticipated Number of Dud Detonations[6]	Annual Anticipated Number of HO Detonations[7]	Annual Residue Deposition from HO Detonations[8]	Annual Residue Deposition from LO Detonations[9]	Annual Residue Deposition from Dud Detonations[10]	Total Annual Deposition of Energetic Residues[11]
Existing ERF-IA										
60-mm Mortar	370	0.000076	700	2	74	624	0.05	370	27,380	27,750
81-mm Mortar	969	0.0094	400	1	25	374	3.52	485	24,225	24,713
120-mm Mortar	2,960	0.021	552	1	19	532	11.17	1,480	56,242	57,734
105-mm Howitzer	2,086	0.00027	1988	1	35	1952	0.53	1,043	73,010	74,054
155-mm Howitzer Training Round	808	0.000036	900	1	3	896	0.03	404	2,424	2,828
155-mm Howitzer	6,936	0.00031	144	1	3	140	0.04	3,468	20,808	24,276
ERF Total	14,129	0.031	4,684	7	159	4,518	15.34	7,250	204,089	211,354

Proposed Expansion Area										
60-mm Mortar	370	0.000076	336	1	15	320	0.024	185	5,550	5,735
81-mm Mortar	969	0.0094	192	1	1	190	1.79	485	969	1,455
120-mm Mortar	2,960	0.021	192	1	1	190	3.99	1,480	2,960	4,444
105-mm Howitzer	2,086	0.00027	624	1	1	622	0.168	1,043	2,086	3,129
155-mm Howitzer Training Round	808	0.000036	0	1	3	0	0	0	0	0
155-mm Howitzer	6,936	0.00031	0	1	3	0	0	0	0	0
Expansion Area Total	14,129	0.031	1,344	6	24	1,322	5.97	3,193	11,565	14,764
Proposed Project Totals										
Totals	NA	NA	6,028	13	183	5,840	21.31	10,442	215,654	226,118

Notes: Mass and residue in grams.
[1] All munitions in this analysis used Comp B as filler.
[2] Walsh 2007, Table 1.
[3] Walsh 2007, Table 3.
[4] Section 2.3 provides estimated annual rounds and munitions that would be fired.
[5] LO rounds estimated to be 0.09% of total round fired following observations from Dauphin and Doyle 2000.
[6] Dud rounds estimated to be 3.37% of total rounds fired following observations from Dauphin and Doyle 2000.
[7] Annual anticipated number of HO detonations is assumed to be the total allotted rounds minus the anticipated LO and dud rounds.
[8] Estimated as the product of anticipated HO detonations and the observed resultant energetic residue from Walsh 2007, Table 3.
[5] Residue from LO rounds assumes 50% of energetic mass is consumed and 50% is deposited as residue.
[10] Dud rounds assume 100% of energetic mass is deposited as residue.
[11] Total residue is estimated as the sum of residue from HO, LO, and dud rounds.

Key: % = percent; Comp B = Composition B; ERF-IA = Eagle River Flats Impact Area; HE = high explosive; HO = high-order; LO = low-order.

Table 4-20 Summary of Findings for Characterization of Residues from the Detonation of Insensitive Munitions (Walsh et al. 2017)

Formulation	Significant Findings	Outcomes
PAX-21	Significant (15%) mass of perchlorate deposition from HO detonations. Detonation efficiencies of PAX-21 components varied significantly.	Munitions reclassified. No longer used on test and training ranges. Canada also banned use on ranges.
IMX-104	Slight decrease in overall detonation performance compared to Comp B. Detonation efficiencies of IMX-104 components varied significantly and were affected by fuzing systems used. Aqueous fraction of samples were acidic (pH 4). High (rapid) dissolution rate for NTO.	Overall efficiency near 99.99%, customary efficiency for HO detonations.
IMX-101	Very poor detonation performance using both types of fuzing systems. Aqueous fraction of sample was very basic (pH 14) due to concrete filler. High dissolution rates for NTO and NQ.	Research findings recommended review of IMX-101 filled 155-mm training round and replacement of concrete filler with gypsum to moderate pH levels.

Notes:
PAX-21 is no longer used at ERF-IA but was included to present research findings.
For all formulations, finer residues resulted in accelerated dissolution rates.

Key: % = percent; ERF-IA = Eagle River Flats Impact Area; HO = high-order; IMX = Insensitive Munitions Explosives; NQ = nitroguanidine; NTO = 3-nitro-1,2,4-triazol-5-one.

Table 4-21 Summary of Detonation Residues of IM from 2017 SERDP Research Studies (Walsh et al. 2017)

Round Characteristics	Analytes[1]	Estimated Total Mass[2] (g)	% Original Analyte Mass
IMX-104: 2013 (12 g C4 booster)	RDX+HMX DNAN AP Overall Efficiency	0.009 0.007 14 96%	0.007% 0.006% 15%
IMX-104: (12 g C4 booster)	RDX+HMX DNAN AP Overall Efficiency	0.009 0.007 3.8 97.9%	0.012% 0.006% 2.1%
IMX-104: 2013 (12 g C4 Booster)	RDX + HMX DNAN NTO Overall Efficiency	0.005 0.005 2.2 99.77%	0.006% 0.005% 1.2%
IMX-104: 2014 (18 g C4 Booster)	RDX + HMX DNAN NTO Overall Efficiency	0.008 0.008 0.54 99.93%	0.005% 0.003% 0.13%
IMX-104: 2015 (18 g C4 Booster)	RDX + HMX DNAN NTO Overall Efficiency	0.004 0.013 1.2 99.93%	0.003% 0.005% 0.27%
IMX-104: 2015 (18 g C4 Booster)	RDX + HMX DNAN NTO Overall Efficiency	0.004 0.017 0.72 99.91%	0.003% 0.007% 0.17%
IMX-104: 2017 (9 g C4 Booster)[4]	RDX + HMX DNAN NTO Overall Efficiency	0.011 0.048 1.7 99.8%	0.007% 0.018% 0.40%
IMX-101: 2015 (50 g C4 Booster)	RDX + HMX DNAN NTO NQ Overall Efficiency	0.012 2.4 15 130 89%	0.0070% 0.49% 6.6% 31%

Notes:
[1]RDX includes some HMX as well (<9% of original mass).
[2]Based on mid-range value of formulation specifications. Includes 520 g RDX/HMX for blow-in-place donor block.

Key: % = percent; AP = Ammonium perchlorate; DNAN = dinitroanisole; g = gram; IM = insensitive munition; IMX = Insensitive Munitions Explosives; HMX = cyclotetramethylene-tetranitramine; NQ = nitroguanidine; NTO = 3-nitro-1,2,4-triazol-5-one, RDX = cyclotrimethylenetrinitramine; SERDP = Strategic Environmental Research and Development Program.

The study found that many of the IM rounds had overall efficiency less than 99.9 percent, which is characteristic of HO detonations. Five of the seven rounds were considered LO detonations and generated more residue deposition than one would expect with a HO detonation. The IMX-101: 2015 round was particularly ineffective (89 percent efficiency), which generated high amounts of residue. Low-efficiency IM rounds could present a residue deposition concern if they frequently occur during live firing activities (Walsh et al. 2017).

While HE munitions contribute the majority of energetic material into the environment, a smaller but non-zero (approximately 5 percent) contribution of energetic material would be contributed as a result of other types of rounds (Smoke and ILLUM). FRTR/Blank rounds are essentially inert. However, 155-mm and pyrotechnic training rounds do contain a small amount of HE material (see Section 2.1). While contributions from non-HE munitions were not considered in the calculations in Table 4-19, it is assumed that their contributions to the total accumulated energetic materials would not be significant.

AECOM performed a munitions residue accumulation analysis for traditional munitions to evaluate residue deposition patterns with the resumption of all-season live firing. Assuming a constant residue deposition rate and constant half-lives for munitions, the analysis showed that residue initially accumulates in the environment but eventually reaches a steady state, which suggests that there would be a limit to the amount of residue that would accumulate. Residue is expected to accumulate during the winter months, when the energetic mass is not breaking down as rapidly. After winter, when degradation rates increase, the environmental load of energetic mass in the environment begins to return to a steady state. The analysis assumed all residue is deposited into soils and remains in the environment. However, because ERF-IA is within a tidal estuary, it is likely that munitions residue degradation occurs more rapidly and that residues are flushed out of the impact area and into Eagle Bay in runoff and diluted. Munitions detonated during winter conditions may deposit all residues into snow and soils and be flushed out to Knik Arm with spring snowmelt. It is anticipated that the IM residue accumulation patterns would show a similar trend.

4.4.5 Toxicity of Munitions Constituents

A substantial body of sediment and water quality data has been collected at ERF-IA over the past 40 years that provides information on presence of munitions constituents with the potential to affect fish. Past studies of environmental fate and toxicity of munitions at JBER have focused on traditional explosives, rather than the newer IMs. Initial studies in the 1980s and early 1990s focused on identifying the cause of waterfowl mortality (which turned out to be WP), and much of the sampling was limited to ponds, marshes, craters, and areas near the OB/OD pad, which was a known source of contamination. However, sampling in craters can provide a good indication of contaminant presence in ERF-IA because these areas are directly impacted by HE and other munitions. Although low levels of WP have been found in plants, macroinvertebrates, and fish, existing data do not show that these populations have been significantly affected by the presence of WP in ERF-IA (CH2M Hill 1997). A study conducted by the U.S. Fish and Wildlife Service (USFWS) also found that impacts were not great enough for WP cleanup to be driven by fish or macroinvertebrate accumulation (CH2M Hill 1997).

Environmental samples typically show low concentrations of munitions compounds in water and sediments (on the order of nanograms/liter and μg/kg, respectively), and ecological risk appears generally low. Nonetheless, recent work demonstrates the possibility of sub-lethal genetic and metabolic effects (Beck et al. 2018). It is possible that some energetic munitions compounds that would be used during live-fire training, such as TNT, RDX, HMX, NG, NQ, and 2,4-DNT (and their degradation products), may be harmful to fish and macroinvertebrates at high concentrations (Pichtel 2012; Lotufo et al. 2013; Koske et al. 2020). See Appendix A for details regarding the toxicity of munitions and their degradation products.

Past soil and water testing have not detected traditional munitions residues at significant levels in ERF-IA. With the exception of WP (which is no longer being used at JBER), munitions constituents have only been detected at low levels at firing points (where large quantities of propellant has been burned) or in the immediate vicinity of LO munition (generally explosives) impact sites in ERF-IA (Racine et al. 1992; USAEHA 1994; CH2M Hill 1997; Walsh et al. 2006, 2008). These findings are consistent with studies that have found generally low numbers of munitions residues at military weapon and training installations in the United States and throughout the world (Lotufo et al. 2017). However, it should be noted that these studies were completed before IMs were being used at JBER.

In 2007, in support of the ongoing EIS to reinstate all-season indirect live-fire training at JBER, water quality samples were collected during three separate sampling events from areas along Eagle River, including areas upriver from ERF and at the river’s mouth. Samples were analyzed for the presence of metals, explosives, and polychlorinated biphenyls. None of the samples contained metals in excess of drinking water maximum contaminant levels. In addition, no explosive compounds were detected. This suggests that munition contaminants and residues from winter firing activities are either breaking down or not being released into waterbodies where they could be exposed to managed fish species or their prey.

The presence of munitions-related compounds has been studied at 31 military ranges in the United States and in Canada, including at ERF-IA (Jenkins et al. 2007; Walsh et al. 2010). Lotufo et al. (2013) reviewed the fate and effects of several munitions constituents used at JBER and found that most constituents rapidly degraded in aqueous exposure systems, showed a significant binding affinity with organic matter, and were unlikely to result in biological effects to fish; however, the study states that verification of this conclusion should be pursued by determining site-specific exposure risk. The studies of non-WP munition constituents used at ERF-IA are described below to evaluate potential toxicity risk to EFH and managed species.

4.4.5.1 Traditional Munitions

A total of 312 sediment and surface water samples were collected throughout ERF-IA from 1989 to 1993 to evaluate the potential for environmental contamination of non-WP munition constituents (CH2M Hill 1997). As previously described, this sampling was conducted in areas that may support waterfowl (e.g., ponds, marshes, craters) but was representative of water and sediments that may be exposed to managed fish species and their prey base. None of these studies detected munitions residues, except WP, at concentrations deemed to be harmful to fish species. The only detectable levels of munitions residues at ERF-IA consisted of 2,4-DNT, 2,6-DNT, and TNT (and their biotransformation products) associated with the OB/OD pad and in the salt marsh along the edge of the pad (Figure 3-2). Researchers suspected that the 2,4-DNT found near the OB/OD pad had either been dumped there or had been dispersed during a past demolition exercise and was not the result of mortar or artillery firing. Otherwise, the concentration levels of sediment residues throughout the site were only a few parts per million. The concentrations of detected organic analytes in surface water were only a few parts per billion (ppb) (CH2M Hill 1997). In 1993, surface water and sediment samples were collected in Eagle River and throughout ERF-IA. The samples were analyzed for metals, explosives, organics, and pesticides. Metals concentrations were within background levels for a glacially fed tidal wetland system and no other contaminants were detected (USAEHA 1994; CH2M Hill 1997).

Historical and recent research suggests that munitions constituents, while present at low levels in ERF-IA, are not migrating outside the impact area in measurable quantities (CH2M Hill 1997). In addition, explosive residues such as RDX, HMX, and TNT are not persistent in wetlands. In ERF-IA, natural processes such as tidal inundation, shallow groundwater, and dynamic surface conditions result in dilution/flushing and naturally reducing conditions, minimizing the potential for munitions residues to persist and accumulate in soils/sediments.

4.4.5.2 High-Order Detonations

Scientific data suggest that HO detonations do not present a substantial environmental hazard with regard to the release of munitions constituents. CRREL researchers sampled 56 HO detonation sites and grouped them into six munitions categories (Walsh et al. 2005b). The researchers reported that low concentrations of RDX were detected in all cases except one corresponding to the 155-mm HE howitzer rounds with TNT filler, a type of round not included in the proposed mortar and artillery training. Low levels of TNT were detected for all but two of the munitions categories: the 60-mm mortar and the 155-mm howitzer with TNT filler. Trace amounts of HMX were found for only one of the munitions categories: the 120-mm mortar. Based on these data, it is estimated that 50 HO detonations would result in less than 50 milligrams of un-reacted residues (Walsh et al. 2005b).

Live-fire munitions residue tests at ERF-IA examined explosive residues from live-fire exercises and observed consistent results. Following a live-fire HO test of 120-mm HE mortar munitions, concentrations of RDX, TNT, and HMX in displaced sediment were measured at 105, 64, and 15 micrograms per gram (µg/g) (equivalent to parts per million), respectively, on the day of detonation. Second measurements taken 82 days later yielded concentrations of 13, 5.2, and 2.0 µg/g, respectively, indicating a decrease in concentration over time and suggesting a similar half-life for HMX and TNT (Walsh et al. 2008). These levels are well below the threshold effects screening levels for fish and invertebrates cited by Lotufo et al. 2013 and provided in Appendix A.

4.4.5.3 Low-Order Detonations

LO detonations present a greater potential for deposition of munitions residues than HO detonations. Samples collected near an LO detonation crater during a 2007 field study at ERF-IA contained measurable amounts of energetic compounds. Residues consisting of RDX, TNT, and HMX were present, ranging from tens to thousands of parts per million in the soil samples. These residues were generally unreacted particles of explosives that may be 1 to 2 centimeters in diameter. Additional testing at the site showed that the concentration of TNT had decreased by about 40 percent in a span of 82 days (Walsh et al. 2008). In another study, an LO detonation of a 120-mm mortar produced concentrations of 15,000 µg/g of RDX, 8,300 µg/g of TNT, and 2,000 µg/g of HMX inside the crater 5 months after the firing event (Walsh et al. 2007). Three months later, concentrations in the same crater were reduced to 7,020 µg/g of RDX, 2,870 µg/g of TNT, and 950 µg/g of HMX. These levels are well below the threshold effects screening levels for fish and invertebrates cited by Lotufo et al. 2013 and provided in Appendix A.

CRREL researchers also conducted water and sediment sampling near two LO detonation sites at ERF-IA. In August 2007, water and sediment samples were collected during a series of flooding tides from a gully that was in the drainage path of the LO detonations. Energetic residues were not detected in sediment samples collected downstream from the detonations. Water samples collected from the head of the gully adjacent to the LO detonations contained low but detectable concentrations of RDX (6.47 ppb), HMX (1.2 ppb), and TNT (0.04 ppb). These concentrations were below provisional chronic water quality criteria presented by Lotufo et al. (2017); the lowest chronic criteria were 28.4 ppb for TNT, 329 ppb for HMX, and 186 ppb for RDX. The concentrations of these constituents decreased significantly downstream from the gully, and the constituents were undetectable about 24 meters from the source (Walsh et al. 2008).

Subsequent water quality testing conducted as part of the National Pollution Discharge Elimination System application process produced similar results. Water quality samples were collected annually from ERF-IA and a reference site (Goose Bay) for 6 years between 2002 and 2008. Samples were analyzed for energetic or explosive residues and metals. None of the munitions constituents of interest were detected at levels above background, and results showed that there were no differences in water quality parameters for metals between ERF-IA and Goose Bay. Results of these water quality monitoring events were submitted to USEPA for review.

4.4.5.4 Unexploded Ordnance

In areas with periodic flooding like ERF-IA, UXO munitions that settle below the water surface may become corroded or breach, causing the filler material to leak or dissolve into the surrounding environment, which could potentially adversely affect the exposed biota. Because of the high cost and complexity associated with sampling munitions constituents at these types of sites, detailed and reliable information about munitions constituents in water, sediment, and biota is available for only a few sites; therefore, temporal and spatial uncertainties persist.

The extent of soil contamination from explosive residues varies by site. Generally, concentrations of explosive residues in soils beneath and adjacent to UXOs range between <1 to 110 mg/kg (Taylor et al. 2011). Taylor et al. reported that in general, LO rounds or UXOs with damaged or cracked casings in which HE fill is exposed yield significantly higher concentrations of explosives in soils (reported up to 26,000 mg/kg being the greatest concentration detected).

A recent USACE study collected data for eight waterbodies from four countries associated with underwater military munitions sites and found much lower munition concentrations from UXOs (Lotufo et al. 2017). Concentrations of munitions constituents in water and sediment were largely below detection or were relatively low (e.g., ppb), with higher concentrations being highly localized and typically near a point source. These findings agreed with predictive modeling and with fate studies. Toxicity varied widely across a diversity of munitions constituents and species. The study concluded that based on the available evidence, there was a negligible risk to aquatic invertebrates and fish exposed to munitions constituents in sediment and the water column (Lotufo et al. 2017).

4.4.5.5 Insensitive Munitions

Rounds containing IMX-101 or IMX-104 have not historically been fired onto ERF-IA as part of training activities and therefore the environmental fate of DNAN, NTO, NQ, and associated transformation products in this environment is not well known. Various studies report mixed results on toxicological effects on EFH and managed species (Appendix A). Insensitive munitions were constructed to resist external stimuli such as bullet impact or fire, and because of that, they resist unintentional detonation. This insensitivity has resulted in a less-efficient detonation, differential performance among the formulation components, and increased residues caused by disposal of UXO by a blow-in-place procedure (Walsh et al. 2017).

Recent ecotoxicological assessments have identified that many of the chemical constituents of IM formulations exhibit toxic effects in soil microorganisms, aquatic organisms, and mammals (Stein et al. 2023). Very little information is available for IM contaminant concentrations at live-firing ranges; however, based on the comparatively high residue deposition for IM constituents versus those of traditional HE munitions (as shown in Tables 4-20 and 4-21), it is apparent that IM residues could present a contaminant concern to fish and their prey base if they are exposed to these residues at toxic levels.

One study found that DNAN was found to be more toxic than TNT to terrestrial receptors, whereas it was significantly less toxic to aquatic species (Monteil-Rivera et al. 2021). Studies have shown that three IM formulations caused strong inhibition to plant growth and high dissolution rates, and that solubility will lead to pulses of IM constituents into the environment (Walsh et al. 2018), compounding potential detrimental effects. However, IMs overall appear to have a less detrimental environmental impact than traditional explosives (Monteil-Rivera et al. 2021).

Walsh et al. (2017) determined that IM toxicity is well established, with the exception of NTO. The high acidic solution of NTO was considered a potential concern, mostly because of NTO's high aqueous solubility. NTO within IMX-104 samples had low pH (3 to 4), which presents a corrosive concern. During testing at ERF-IA in 2017, the presence of concrete in the M1122 155-mm training round drastically changed the pH of the melted snow samples. The pH shifted from 4 to 12, resulting in a highly alkaline aqueous fraction of the sample. Leaching of IMX through the snow was observed following detonation of a round in ERF-IA. Whereas base hydrolysis of the aqueous sample transformed DNAN to dinitrophenol, it was surmised that rapid dissolution of the NTO out of the residues occurred, which likely led to a high concentration of contaminants in the soil column (Walsh et al. 2017).

Ecotoxicology assays for toxicity effects of the IM constituents and various breakdown products on aquatic receptors (fish and invertebrates) are provided in Appendix A, along with a discussion of these results. The assays summarize lethal concentration 50 (LC_{50}) values and toxicity ratings. LC_{50} is the amount of a substance required to kill 50 percent of test animals during a predetermined observation period. Compounds identified as having a moderate or high toxicity rating to fish include 2,4-dinitrophenol (DNP), nitrite, ammonia, and cyanamide. Additionally, DNAN, nitrate, and guanidine are moderately toxic to fish food/prey. The LC_{50} of *Daphnia pulex* is far lower for TNT than other IM constituents, which suggests that some IM compounds may be less toxic than TNT (Moores et al. 2021; Appendix A).

Other ecotoxicity studies suggest that the parent compound DNAN, 19 methoxy-nitrophenols, methoxy-nitroanilines, and the other two products (2,4-dinitrophenol and 20 methoxy-dinitrophenol) could be harmful to fish and daphnids if present in high concentrations (Qin et al. 2021). NTO and its breakdown product 3-amino-1,2,4-triazol-5-one have been found to cause swimming behavior abnormalities at low concentrations; the reductive biotransformation of NTO could enhance or lower its toxicity according to the target organism (Madeira et al. 2018). Quick dissolution behavior of NTO and NQ indicates that these water-soluble constituents could easily migrate with rainfall. Because they have extremely low affinity for soil particles, these constituents have a tendency to reach groundwater, raising concerns for potential environmental contamination. Further studies are needed to evaluate both dissolution and toxic effects to better understand the environmental behavior of IMX and other IM constituents.

4.4.5.6 Metals and Other Constituents

As stated previously, of all the metals that comprise detonation munitions at JBER, copper and zinc have the greatest potential to affect fish and aquatic organisms. Some metals bind to soils and organic matter and are transported in sediment, while other metals dissolve in water. Dissolved nutrients have a higher bioavailability factor than particulate forms, and metals in the dissolved form are more readily absorbed by aquatic species. Rainwater is naturally slightly acidic, which increases its ability to dissolve heavy metals. Although most copper present in munitions is not bioavailable, it is the dissolved portion that is the most toxic and pervasive in aquatic ecosystems (Nason et al. 2011). Even at relatively low concentrations, dissolved copper can inhibit salmonid olfactory systems, which can impede predator detection and avoidance, social interaction, prey detection, and homing, thereby affecting survival, distribution, and reproductive success (NMFS 2016). Zinc can be dissolved or attached to soil particles. Zinc washed off from galvanized surfaces is almost entirely in dissolved form. Potential adverse effects to salmonids from dissolved zinc may include altered behavior, changes to blood chemistry, impaired reproduction, and reduced growth (NMFS 2009).

As previously mentioned in Section 4.4.2.3, copper sulfides are stable and highly insoluble in highly reducing and sulfidic environments, such as ERF-IA. Zinc has the potential for increased mobility but precipitates readily with hydroxide, carbonate, and sulfide, which are favored at basic, reducing conditions, and co-precipitates with hydrous oxides of iron or manganese. Therefore, it is not likely to mobilize into soil and groundwater at high levels. As discussed in Section 4.2, live firing would discharge metal shrapnel fragments into ERF waterbodies, either during munition detonation or by tidal flushing events. Shrapnel could contain a small percentage of copper and zinc, which could dissolve in the estuarine waters and become bioavailable to fish and aquatic organisms. Considering the site characteristics and the small amounts of these metals that comprise munitions at JBER, the bioavailability of copper and zinc to EFH or managed species is expected to be low but not discountable. The proposed habitat protective buffers would prevent most shrapnel from directly entering waterbodies, so shrapnel is most likely to enter ERF waterbodies after flooding events.

4.4.6 Bioaccumulation Potential of Munitions Constituents

Bioaccumulation is the process by which a chemical substance is taken up by an organism by all routes of exposure (e.g., from diet and across membranes like the gills). The physico-chemical property K_{OW} (octanol-water partition coefficient) is the dimensionless ratio of the concentration of a chemical substance in octanol (non-polar solvent) and in water (polar solvent) at equilibrium and at a given temperature. This measure of the tendency of the substance to associate with either water or octanol (a lipid) is used to describe the hydrophobicity of the substance and is used as an indicator of the tendency of that substance to bioaccumulate (i.e., associate with non-polar organic tissue).

Bioaccumulated contaminants in fish can be transferred from mother to developing egg. This can result in high body burdens of contaminants in newly hatched larval fish even if the spawning area is pristine (i.e., mother accumulated contaminant in feeding area). A study of the effects of persistent organic pollutants on developing sole (*Solea solea*) found that the tissue concentration of persistent organic pollutants with log K_{OW} >5 peaked as the larvae switched from endogenous (absorption of yolk sac) to exogenous feeding (free-feeding) (Foekema et al. 2012). This further concentration of the maternally transferred contaminant in the newly free-feeding larvae could exceed the concentration in the spawning adult by 2 to 4 times and could be enhanced in species such as salmon, which migrate to spawning grounds without feeding. Such exposures during this critical developmental period could seriously affect larval survival, even if the eggs and larvae develop in an otherwise pristine environment (Foekema et al. 2012). The potential theoretically exists for the bioaccumulation of munitions constituents in managed species as a result of the proposed action and alternatives.

Table 4-18 provides the bioaccumulation potential of the munitions constituents that would be used in ERF-IA. Substances with log K_{OW} <3 can be characterized as non-bioaccumulating (Nendza and Herbst 2011). The only constituents/transformation products[9] with a log K_{OW} greater than 3 are WP (which is no longer used in ERF-IA) and HC, which has just a slight tendency to build up in fish (Table 4-18). Therefore, it is unlikely that munitions constituents, based on their physico-chemical properties, would bioaccumulate in fish in the proposed project area.

Between 2007 and 2011, Army personnel collected 102 tissue samples from 15 fish species captured in the tidally influenced portions of Eagle River (Garner et al. 2008; USACHPPM 2008a, 2008b, 2009; USAPHC 2011). These samples were taken from all five Pacific salmon species, eulachon, starry flounder, and Pacific staghorn sculpin and sent to the U.S. Army Center for Health Promotion and Preventative Medicine (USACHPPM) for analysis for the presence of munitions residues. USACHPPM tested for the following analytes: 1,2-dinitrobenzene, 1,3,5-trinitrobenzene, 1,3-dinitrobenzene, TNT, 2,4-dinitrotoluene, 2,6-dinitrotoluene, 2-amino-4,6-DNT, 2-nitrotoluene, 3-nitrotoluene, 4-amino-2,6-DNT, 4-nitrotoluene, RDX, methyl-2,4,6-trinitrophenylnitramine (tetryl), nitrobenzene, NG, HMX, and pentaerythritol tetranitrate. The concentration of munitions residues in the samples did not exceed the detection limit in any of the fish tissue samples (Garner et al. 2008; USACHPPM 2008a, 2008b, 2009; USAPHC 2011).[10] In other words, no munitions residues were detected. The results of this study indicate that munitions residues are not bioaccumulating in the fish that use the tidally influenced portions of Eagle River. Many of these fish were captured in the mouth of Eagle River, at its juncture with the waters of Knik Arm. This, taken with the fact that several of the analyzed species were primarily marine species (e.g., saffron cod, starry flounder) suggest that fish in Knik Arm are also not bioaccumulating munitions residues. Additionally, no significant accumulations of WP were found in fish during sampling conducted as part of the initial CERCLA investigations at ERF (Table 4-22) (CH2M Hill 1998). While WP would not be fired in ERF-IA under either alternative, information is included because WP is still present in the capped areas.

Table 4-22 White Phosphorus Impacts on EFH-Managed Species and Their Food Chain at ERF-IA

Managed Species and Food Chain	Impact of White Phosphorous
Fish and invertebrates in ERF-IA	No significant accumulations or adverse effects of WP to fish or invertebrates in ERF were identified.
Fish in Knik Arm	Adverse effects in Knik Arm are considered to be insignificant because only minimal transport of WP particles from ERF has been identified.
Plants in ERF and Knik Arm	Aquatic plants growing in contaminated sediments contained only low levels of WP, indicating that they do not create a risk through food-chain contamination.

Key: EFH = Essential Fish Habitat; ERF-IA = Eagle River Flats Impact Area; WP = white phosphorus.

Source: CH2M Hill 1998.

As described above, both fish tissue sampling and water quality sampling in Eagle River suggest that munitions use at ERF-IA is not contributing to detectable water quality changes in the river or entering the food chain. Because these studies were conducted when firing was limited to periods of ice cover, the results may not be the same as for firing during other periods of the year, as proposed by this action. UXO and other munitions residue could be deposited on soils when the ice thaws, so there would be potential for contaminants to be present when sampling was performed. It is possible that some of these munitions

[9] K_{ow} for the following transformation products could not be found: 3,3'-Diamino-4,4'dimethoxy-azobenzene; 3,3'-Diamino- 4,4'dimethoxy-hydrazobenzene; 5-((3-Amino-4-methoxyphenyl)diazenyl)-2-methoxy-N-methyleneaniline; 2-Methoxy-5-((4- methoxy-3-(methylamino)phenyl)diazenyl)-methyleneaniline; 3,3'-Diamino-4-hydroxy-4'-methoxy-azobenzene; 3,3'-Diamino- 4-methoxy-azobenzene; 3,3'-Diamino-4-methoxy-hydrazobenzene.

[10] One sample of juvenile coho muscle showed elevated levels of RDX. A duplicate sample from the same fish; however, was sent to the lab and returned with levels of RDX below the detection limit. The assumption was made that the initial sample had been contaminated sometime between the field and the lab.

residues had degraded by various processes, such as photodegradation and dissolution, before entering site soils and the water column. However, any munitions residues deposited after ice has thawed would be subject to all degradation pathways, including biodegradation and sorption, which would increase probability for contaminant breakdown before they could be exposed to EFH and managed species.

No significant accumulations of WP were found in fish during sampling conducted as part of the initial CERCLA investigations at ERF (CH2M Hill 1998), and past studies have not found significant accumulations of WP in macroinvertebrates (CH2M Hill 1997). Because WP munitions are no longer being used in ERF-IA and WP cleanup efforts and capping are complete, the potential for future impacts to fish from WP contamination is low. The Army would avoid targeting capped areas and the OB/OD pad during non-frozen conditions, which would reduce the risk of accidental release of WP into the environment. If any caps are compromised by munition detonations, it is unlikely that WP releases would affect fish because they rarely use the flats and ponded areas where the caps are situated. Although some reports have indicated that WP can moderately bioaccumulate in fish (Davidson 1987; Rivera et al. 1996; Sciences International 1997b), studies at ERF have not detected it in high concentrations in fish, likely because there is not a strong mechanism for exposure.

Based on the low bioaccumulation potential for most munitions residues (Table 4-18) and the highly reducing conditions present in ERF, as well as evidence from the Eagle River fish tissue contamination studies that munitions residues are not entering the food chain, the risk of impacts to EFH and managed species from bioaccumulation appears to be low. However, site-specific sampling would be needed to further evaluate the potential for bioaccumulation at ERF-IA. The proposed all-season firing would result in an increased risk of exposure of munitions residue to managed species, particularly in unbuffered areas, but the protective and mitigation measures described in Chapter 5 (e.g., habitat protective buffers, tidal firing restrictions, avoiding capped areas, and selective targeting in unbuffered areas) would reduce risk of contaminants entering waterbodies where they could be exposed to and potentially accumulate in tissues of managed species.

4.4.7 Analysis of Indirect Effects

4.4.7.1 Alternative 1: All-Season Live-Fire Training with Expanded Impact Area (Proposed Action)

Under Alternative 1, all-season live firing would increase the number of munitions fired annually into ERF-IA relative to baseline levels. This alternative would also introduce live-fire training into the adjacent upland expansion area. Although the total annual number of rounds (15,270) fired into ERF-IA and the expansion area would be greater than the annual total number of rounds (12,000) fired when all-season firing previously occurred in 1990, the number of HE rounds would be less (5,128 versus 9,000). However, this includes larger 155-mm HE rounds as well as an additional 900 155-mm training rounds, neither of which have been fired at ERF-IA previously. As discussed in Section 4.4.4 and shown in Table 4-19, the estimated annual deposition of traditional munitions residues into ERF-IA would be 226.1 kg. This includes 211.3 kg into existing ERF-IA and 14.8 kg into the expansion area. The amount of annual deposition into existing ERF-IA would be a 44 percent increase over the estimated annual deposition under current levels of training. Annual depositions of residues from IMs would likely be higher, as LO detonations are more likely than with traditional munitions.

The vast majority of new UXO and LO rounds would land at or near the targets, which would be situated landward of open waterbodies and outside of habitat protective buffers, although some rounds would land within or near unbuffered stream habitats. Some of the target areas may host shallow ephemeral puddles with potential to support bacteria, macroinvertebrates, plants, and small fish tolerant of large fluctuation in temperature and salinity (e.g., stickleback). Given the relatively high acute toxicity ratings of degradation products such as ammonia, cyanamide, nitrite, and 2,4-DNP, it is possible that organisms inhabiting puddles containing or closely adjacent to a degrading UXO or crater formed by an LO round could experience adverse effects, including mortality. Although HE rounds would not be fired during typical inundating tide events when managed fish species could use these areas, rounds could be fired in unbuffered areas where HE residue could eventually enter the Eagle River relict channel complex that may provide year-round rearing habitat for juvenile salmonids. While it is possible that salmonids could access areas adjacent to an LO crater or leaching UXO residue when the flats are flooded after a firing event has concluded, managed fish species could be exposed to munition residues (originating anywhere on the flats) that enter waterbodies through surface water or sediment after flooding events or through groundwater migration.

As discussed in Section 4.4.5, testing has consistently shown that traditional munitions constituents are not accumulating in or migrating out of ERF-IA into local waterbodies in measurable quantities. No studies specific to ERF were found that discuss accumulation or transport rates of IM, but recent investigations at ERF-IA indicate that NTO and NQ, in particular, are highly water soluble and likely to migrate with surface water or into groundwater. More persistent IM compounds would be subject to soil breakdown pathways likely accelerated by presence of anaerobic soils and organic matter at ERF-IA. It is possible that degradation may occur even more rapidly because ERF-IA is a tidal estuary. Many residues are likely to be flushed out of the impact area and into Eagle Bay in runoff and subsequently diluted, with a flushing of residues deposited during the winter in spring snowmelt. It is possible that salmonids in close proximity to an LO crater or degrading UXO could experience adverse effects, particularly if they consume contaminated prey items within these areas. There is a low but not discountable risk of munition contaminants entering Eagle River, Otter Creek, or associated wetland complexes at levels that could result in sublethal effects to juvenile salmonids. As discussed in Section 3.4, adult salmon move through ERF-IA via Eagle River and Otter Creek channels to upstream spawning destinations outside of ERF-IA and are not known to spawn in the ERF portion of either Eagle River or Otter Creek. Juvenile salmonids that use Eagle River, the Otter Creek complex, or intertidal channels and backwater ponds for rearing could temporarily migrate onto mudflats and wetlands adjacent to the river and stream channels for brief periods when the flats are inundated. However, flooding is more likely to occur during August–October when fewer juvenile salmonids are present, and they are not expected to linger within a crater for extended periods because flooding conditions are ephemeral. Proposed buffers in this area would also reduce risk of contaminant exposure. The Army would place targets on higher ground within sensitive unbuffered areas, such as the Eagle River relict channel complex and upper Garner Creek, to reduce risk of munition detonation in stream channels. However, target areas would still overlap small tributaries, so it is likely that some munitions and contaminants would be released either directly into channels or indirectly through transport and migration pathways. Additional protective measures (Chapter 5) would be implemented to reduce risk of contaminant exposure to managed species.

Water quality data collected over the past 30 years indicate that munitions-related compounds are not accumulating, nor are they migrating into local waterbodies. This is notable because even after 60 years of munitions training at ERF-IA, only low levels of munitions residues have been detected in ERF and only in the immediate vicinity of LO rounds or burn sites (Racine et al. 1992; USAEHA 1994; Walsh et al. 2008). Only small amounts of explosives in UXO are exposed to the environment as the UXO corrode over time. According to modeling conducted by CRREL researchers, corroding UXO contribute only a small proportion to the net change in overall dissolved HE residues in an impact area. At the calculated deposition rate of about 10.4 kg per year, it is possible that residues from LO rounds may impact EFH and some managed species. However, degradation processes in ERF-IA continually break down explosives and prevent a net buildup of toxic components.

Given the proposed buffer distances (50 to 500 meters) from the target areas (i.e., where deposition of the vast majority of UXO and LO rounds would occur) to Eagle Bay and Eagle River/Otter Creek channels (i.e., where salmonids are typically found), and given the CRREL study that failed to detect munitions constituents 24 meters downstream from an LO crater, it seems unlikely that the concentration of munitions constituents or their transformation products would be high enough to adversely affect fish either from acute or chronic toxicity. This seems especially true in light of the semi-diurnal tidal fluctuation present in Knik Arm, which brings a twice-daily influx of saline water to Eagle River, Otter Creek, and occasionally the flats themselves. The predominantly anaerobic environment at ERF-IA and various breakdown pathways (e.g., soil sorption, dissolution, phototransformation, biodegradation) are expected to reduce exposure of munition contaminants to EFH and managed species. The basic underlying reason that munitions residues are not detected at ERF-IA is the reducing environment found in soil and sediment, as well as the relatively high percentage of organic matter that facilitates breakdown processes. Organic compounds do not persist and are degraded quickly in the ERF environment. This is the same reason that human-made wetlands are commonly constructed to treat runoff from contaminated sites. Scientists have not been able to calculate the carrying capacity of ERF, but data collected to date suggest that the area has a high capacity to chemically reduce munitions-related constituents. If this were not the case, large quantities of residues would have been detected in ERF-IA during the extensive sampling that has been conducted since the early 1980s. The exception to this rule is WP, which is not broken down as readily in ERF-IA, but can no longer be fired into ERF-IA.

Potential exposure of contaminants to adult and juvenile salmonids depends on several factors, including run timing, migration rate, residence time, and access to habitats that contain contaminants. Adult salmon may migrate upstream through ERF to reach spawning habitats from May to October, although peak passage generally runs from early July through mid-August. Adults also tend to make directed migrations through ERF and are not expected to utilize tidal flats during inundated flooding conditions that may contain deposition of LO or UXO munition residue. Adult coho and sockeye have been found to migrate upstream at an average speed of 43 centimeters per second or 1.5 kilometers per hour, which is likely similar to speeds for other salmonids as well (Ellis 1966). At this rate, they would spend about 4–5 hours within ERF-IA before leaving the site to spawn upstream. However, documented travel time from the mouth of Eagle River through the flats has not been studied or documented. Although they could be exposed to contaminants in the water column or sediments during this period, they do not feed during their upstream migration, which would reduce exposure risk significantly.

Although juvenile salmonids (particularly coho and sockeye) could be present throughout the year in ERF, greatest juvenile presence coincides with the peak outmigration period (April through July). Chinook, chum, and pink salmon are expected to migrate through ERF relatively quickly en route to coastal waters. Juveniles may rear in the lower portion of Eagle River, but higher-quality rearing habitat is present further upstream within the intertidal channels in Eagle River and Otter Creek, at the southern portion of ERF-IA. Because rearing habitat is not as optimal in the lower reach of Eagle River, juvenile salmonids are not expected to spend as much time in this area, which would reduce potential contaminant exposure. Further, as described in Section 3.2, fewer juvenile salmonids are present in ERF during late summer (August to October), when typical inundating tide events most frequently occur. This would help reduce exposure to craters on the mudflats that may contain higher levels of munition residue. Eulachon may migrate upstream in the spring to spawn in Eagle River, but groundfish managed species are not likely to be present in ERF in large abundances. Fishes in Eagle Bay and Knik Arm are less likely to be affected due to dilution and breakdown processes prior to discharge of any contaminants to Eagle Bay.

Mortar and artillery training under Alternative 1 would also introduce munitions contaminants into the proposed expansion area; however, this area does not support any EFH-designated waterbodies, and Clunie Creek does not have a surface water connection with Eagle River. Because the only exposure pathway for munitions contaminants into ERF-IA from the expansion area would be through groundwater, the risk of contaminant exposure to EFH or managed species from firing into the proposed expansion area would be very low.

The increased quantity of munitions fired into ERF-IA and firing during all seasons would increase the risk to fish species and their prey base from exposure to contaminants. Protective buffers and strategic placement of targets on higher ground within sensitive unbuffered areas would reduce risk of munition detonation in stream channels. However, target areas would still overlap small tributaries, so it is likely that some munitions and contaminants would be released into stream channels. Additionally, throughout ERF, rounds may land in areas that contain standing or flowing water during inundated conditions where fish may be found.

Based on the large firing area (existing ERF-IA and the proposed expansion area), the variety of contaminant breakdown pathways that are expected to occur, the low risk of bioaccumulation, and the intermittent flushing of munitions residues from ERF-IA, it is anticipated that even with increased firing under this alternative, there would be a risk of munitions contaminants affecting habitat and managed fish species.. An adverse effect to a juvenile salmon could result if it ingests a single invertebrate that has consumed munition residues, and that possibility exists under both alternatives. Based on past studies at ERF-IA, it is not anticipated that live-fire training under Alternative 1 would result in significant impacts to fish from contaminant exposure; however, additional site-specific information on water quality and contaminant exposure pathways would provide a better understanding of potential toxicological effects, particularly newer IMs. Monitoring and sampling identified in an *Adaptive Monitoring and Management Plan* (see Fish *Mitigation* section) could allow JBER to obtain a better understanding of impacts to fish from munitions constituents and implement adaptive management as needed...

4.4.7.2 Alternative 2: All-Season Live-Fire Training at Existing ERF-IA Only

This alternative is expected to have slightly greater impacts to EFH and managed species than Alternative 1 because indirect live-fire training would be concentrated in the existing ERF-IA, rather than spread out over an expanded impact area. The total annual number of rounds (15,270) would be the same as the annual number fired under Alternative 1, but all of these rounds would be fired into the existing ERF-IA. The number of HE rounds (5,128) and 155-mm training rounds (900) fired under Alternatives 1 and 2 would be the same.

It is estimated that 226.1 kg of munitions residue would be deposited annually in ERF-IA by a combination of HO, LO, and UXOs, which is 14.8 kg more than under Alternative 1, because the impact area would not be expanded and all of the residue would be deposited in the ERF lowland areas. It is estimated that up to 24 more UXOs would land in ERF-IA under Alternative 2 than under Alternative 1, contributing 11.6 kg of the total munitions residue. The estimated annual deposition into ERF-IA would be a 54 percent increase over the estimated annual deposition under current levels of training.

Similar to Alternative 1, however, most of the residue from the UXOs would either degrade slowly over time or remain encased in the shell, therefore reducing the potential for impacts to EFH and managed fish species. The predominantly anaerobic environment at ERF-IA and various breakdown pathways are expected to help reduce exposure of munition contaminants to EFH and managed species. For the same reasons identified for Alternative 1, it is anticipated that even with increased firing under this alternative, the risk of munitions contaminants to affect EFH and managed species would be low to moderate but not discountable. The overall risk of an adverse effect would be greater in Alternative 2 than Alternative 1 because firing would only occur within the 1,568-acre ERF-IA (which supports EFH and managed fish species) instead of the total 1,918-acre area that includes the upland expansion area.

4.5 CUMULATIVE IMPACTS

The analysis presented in Sections 4.1 through 4.4 describes potential effects on EFH and managed species associated with the proposed mortar and artillery training. However, additional analysis is necessary to determine if the proposed project would add significantly to the cumulative effects of regional projects. Past, present, and reasonably foreseeable future actions that may interact with EFH are presented in Table 4-23. Many of these projects have or would construct or maintain infrastructure in Knik Arm or Upper Cook Inlet that have the potential to affect EFH and managed species through effects from noise, turbidity, contaminants, loss or conversion of physical habitat, loss or disturbance to prey base, or through other pathways.

Human-caused stressors on anadromous and marine fishes also include the introduction of non-native species (NMFS 2022c), climate change that shifts fish distribution from lower to higher latitudes (Myers et al. 2016), aquaculture (Mancuso 2015), energy production (USFWS 2018), vessel movement (Walker et al. 2018), and underwater noise (Slabbekoorn et al. 2010). The effects of organic and inorganic pollutants to marine fishes, including bioaccumulation of pollutants and behavioral, physiological, or genetic changes, are examples, as well as entanglement in abandoned commercial and recreational fishing gear. The introduction of plastics from oceanic and tidal circulation patterns represents a significant threat to fish diet and their physiology that has received recent attention, particularly in the GOA. Recent literature has also documented toxic stormwater runoff as a species-specific threat to coho salmon in urbanized areas (Feist et al. 2017; McIntyre et al. 2018).

Anadromous and marine fishes and their habitat will continue to be threatened by recreational and commercial fishing, pollution, shipping, underwater noise, oil and gas development, disease, and climate change (Norman 2011; Melnychuk et al. 2013; BOEM 2017; Wisniewska et al. 2018). Many of these threats are expected to increase in the future (USFWS 2016). The aggregate impacts of past, present, and reasonably foreseeable future actions may have a significant adverse effect on EFH.

Both action alternatives would result in a range of potential adverse impacts to fish that are expected to be localized in extent to a portion of individual runs but could potentially affect fish at the watershed scale. Impacts from both action alternatives have the potential to exceed applicable significance thresholds, even with the proposed protective and mitigation measures. Monitoring and sampling will be performed, as needed, to determine whether adaptive management measures are needed to reduce effects below significance thresholds. Other projects summarized in Table 4-23 could potentially have a significant adverse effect on fish, but it is anticipated that each permitting process will require the implementation of protective and mitigation measures to reduce impacts to less than significant. Injury and mortality that might occur as a result of the proposed action would be additive to injury and mortality associated with other actions. However, there is no evidence suggesting that the combined noise of either of the action alternatives and other anthropogenic noise-generating activities would result in harmful additive impacts on fish that could result in significant cumulative effects, or that ocean pollution (or other cumulative impacts) would increase the susceptibility of fish to stressors associated with the proposed action and result in significant cumulative effects. Continued fisheries harvest management, annual salmon enumeration studies, and habitat protection are important to effectively manage fish resources in ERF-IA and throughout JBER and would help offset any potential cumulative effects. Further, future restoration projects and fishery management actions by other private or public entities within Upper Cook Inlet would help offset these effects. Note that cumulative effects resulting from previous, current, and future habitat restoration on JBER and the surrounding watersheds, consistent with the INRMP and federal, state, and local management actions, may have significant beneficial effects on fish in ERF-IA. This includes the joint JBER and ADF&G Otter Lake/Creek restoration project, which was designed to remove pike and obstructions to salmon passage, enhance spawning habitat, and reintroduce salmon into the system. .

Table 4-23 Past, Present, and Reasonably Foreseeable Future Actions

Location	Project/Activity	Description	Time Frame
Port MacKenzie	Port MacKenzie Development	Development intended to increase use of Port MacKenzie for the transportation of goods that are currently transported through the POA or on the highway.	Ongoing

Location	Project/Activity	Description	Time Frame
Port MacKenzie	Alaska Railroad Port MacKenzie Rail Extension	Construction and operation of a new rail line to connect the Borough's Port MacKenzie to ARRC's rail system. The port lies about 30 miles southwest of Wasilla and about 5 miles due north of Anchorage, across Cook Inlet. The selected route involves 32 miles of new rail line extending from Port MacKenzie to the Alaska Railroad's mainline just south of Houston.	Ongoing
Port MacKenzie, Upper Cook Inlet	Port MacKenzie Tidal Project	Use tidal energy to power the cathodic protection systems that prevent metal structures at Port MacKenzie from corroding.	Future
Federally owned portion of Cook Inlet	Cook Inlet Planning Area Oil and Gas Lease Sale 258	Oil and gas exploration, development, and production.	Future
Point MacKenzie and POA/ Anchorage area	Knik Arm Crossing Project	Proposes to construct a new means of improved access between the Municipality of Anchorage and the Matanuska-Susitna Borough through an efficient and financially feasible crossing of Knik Arm, including adequate connections to the committed roadway network.	Ongoing
Knik Arm and Eagle River Watershed	Recreational and commercial fishing	Fisheries harvest for commercial or recreational purposes	Ongoing
POA	Increased cruise ship calls at POA	Cruise ship companies are expected to continue expansion and development at the POA and are expected to attract more major cruise companies.	Future
POA	POA Modernization Program	A series of infrastructure improvement projects at the POA to upgrade and replace aging infrastructure. A south floating dock was completed in 2022, and a petroleum and cement terminal was completed. The next phases of the program will include a new cargo terminal in 2024 and demolition of a remaining cargo terminal in 2025 and 2026.	Ongoing
Matanuska-Susitna Borough/ Municipality of Anchorage	Matanuska–Susitna Borough/Municipality of Anchorage Regional Land Use Planning Actions	Anchorage 2040 *Land Use Plan* was an update to the *Anchorage 2020—Anchorage Bowl Comprehensive Plan* and will shape development for the next 20 years. The Anchorage Metropolitan Area Transportation Solutions is in the process of updating its *Metropolitan Transportation Plan*, which will shape transportation development through 2050.	Ongoing
Matanuska–Susitna Borough/ Municipality of Anchorage	Matanuska–Susitna Borough/Municipality of Anchorage Regional Connecting Transportation Improvement Projects	The Municipality of Anchorage has identified several transportation improvement projects within the Matanuska–Susitna and Anchorage areas.	Ongoing
Northwest of Eagle River	Eklutna Inc. Commercial and Residential Development	Development of Eklutna landholdings is expected to occur within the next 15 years. Powder Reserve Tract 40A is located near ERF-IA.	Ongoing

Location	Project/Activity	Description	Time Frame
Downtown Anchorage	Alaska Railroad Ship Creek Intermodal Transportation Center	Construction of an Intermodal Transportation Center could cause impacts from construction and operation of the new transportation center.	Ongoing
Between Anchorage and Palmer	Alaska Railroad Bridge Replacement at ARRC Milepost 125.7 (Eagle River)	Bridge replacement project.	Ongoing
Palmer	Alaska Railroad Glenn Highway Rail Crossing Improvements	The ARRC and the Department of Transportation plan to build a frontage road and other infrastructure at railroad crossings along the Glenn Highway for increased safety and reduced traffic congestion.	Ongoing
Wasilla	Alaska Railroad Wasilla Intermodal Hub	Plan to build an intermodal hub in Wasilla.	Future
Wasilla	Alaska Railroad South Wasilla Rail Line Relocation (MP 154-156)	ARRC plans to straighten curves along the mainline track in South Wasilla.	Ongoing
JBER	JBER Training (e.g., demolition training/EOD activities)	The Army continues to make changes to the force structure at JBER in accordance with transformation initiatives. These changes in force generally mean changes to the training regime and not to the infrastructure at JBER.	Ongoing
JBER	Joint Base Installation Master Plan	Master plan providing a framework for future development to meet both Army and Air Force missions as a result of joint-basing.	Ongoing
JBER	Extension of North/South Runway	The U.S. Air Force is extending the North/South Runway at JBER to upgrade the airfield to enable full use of the North/South Runway by a variety of aircraft that presently exist at JBER. Estimated completion 2025.	Ongoing
BAAF, JBER	Implementation of a BASH program at BAAF	The Alaska Army National Guard is proposing to implement a BASH program at BAAF similar to what exists at the JBER airfield such that risks to pilots flying out of BAAF are avoided and/or minimized to the extent possible.	Ongoing
JBER	JBER Range Military Construction (e.g., new or upgrades to current range, course, and trailing facilities)	Includes Military Construction projects throughout JBER ranges to improve weapons and maneuver capabilities to meet training requirements. These projects include new or upgrades to the following current ranges and facilities: Known Distance Range, Light Demolition Range, Light Anti-Armor Range, Grenade Launcher Range, Urban Assault Course, Combines Arms Collective Training Facility, Tactical Unmanned Vehicle Facility, and the Convoy Live Fire Range, etc.	Future
JBER	JBER Cantonment Sustainment, Restoration, and Modernization Construction (e.g., infrastructure repairs, demolition, and minor construction)	Includes general construction and maintenance projects throughout JBER within cantonment. Projects vary in size and scope, including facility earthquake repairs, replacing water mains, resurfacing parking areas, and renovation. Projects may include demolition of current facilities.	Ongoing/ Future

Location	Project/Activity	Description	Time Frame
JBER	JBER ITAM program projects (e.g., trail maintenance and reconfiguration, land cleanup and repair)	Includes trail and vegetation maintenance and land cleanup and repair throughout JBER. Current and known future projects include hardening of trails to provide better access to areas of JBER, repair of trails and areas, vegetation maintenance, flattening and contours of an old berm, filling and contouring vehicle ruts, disposal of soil/wood debris piles, and disposal of scrap metal debris piles.	Ongoing/ Future
JBER	Range clearing	Army clearing projects include new range reconfiguration for AT4 range and construction of new towers at FP Cole and Eagle.	Ongoing/ Future
JBER	Construct Range Operations and Storage Building for the JBER Davis Range Shoot House	Construct a range operations and storage building in the vicinity of range control to allow for increased requirements of unit stationing and use of ranges.	Future
JBER	Construct Ammunition Break Down Facility at Zero Range, Sport Fire Range, Small Arms Complex Shoot House, Davis Range Shoot House, Statler Range, and Oates Range	Construct an Ammunition Breakdown Building to meet TC25-8 standards to allow the safe daily storage and issue of ammunition used on the range.	Future
JBER	Multipurpose Training Range Structural Repair	Replace target and PC pits, which are currently of Gabion basket design. Add defilade positions in accordance with TC25-8 to meet required training.	Ongoing
JBER	Grezelka 10-meter Baffle Range	Move current 10-meter range and construct a baffled range to eliminate deviation and road guard requirements.	Future
JBER	UAC Attack and Defend house	Construct an attack and defend house on the current UAC to meet TC 25-8 standards and all training requirements.	Future
JBER	Repair Infantry Squad Battle Course service road	Repair the Infantry Squad Battle Course service road on the ISBC. The current road along with several targets flood during winter warm-up conditions and spring break-up rendering the road and part of the range unusable.	Ongoing
JBER	Expand the Malemute FLS to meet C17 requirements	Expand the southern end of the Malemute Drop Zone FLS in accordance with Air Force regulations for safely landing, turning around, and taking off a C17 aircraft.	Ongoing
JBER	Joint Integrated Test and Training Center	Construct new 112,200 SF simulator building with training bays for integrated virtual training. Construction anticipated 2023. Project to be constructed in already developed cantonment area.	Ongoing
JBER	Camp Mad Bull Range Expansion	Expand capacity for Arctic Field training capabilities at Camp Mad Bull. Addition of storage facilities, latrine, office space, mock runway, and LZ capable.	Ongoing
JBER	Installation Security	Expand installation security infrastructure around boundary areas where trespassing occurs or where security is compromised from lack of security features.	Ongoing
JBER	Water Treatment Facility	Doyon to construct new water treatment facility at Ship Creek site; demolish old water treatment plant due to toxics.	Ongoing

Location	Project/Activity	Description	Time Frame
JBER	Combat Rescue Helicopter Simulator Building	8,500 SF building to be constructed near other simulator facilities by 176 Air National Guard. Project to be constructed in already developed cantonment area.	Ongoing
JBER	F-22 Fuel Dispensing Station	Construct new fuel dispensing station, new JP-8 fuel farm, and fuel connections to existing 15 bays.	Ongoing
JBER	Combat Alert Cell	Construct new 8-bay fighter aircraft hangar within existing airfield.	Future
JBER	Army National Guard Aircraft Maintenance Hangar	Construct new 54,250 SF aircraft maintenance hangar within existing BAAF.	Future
JBER	Additional Personnel	The Army will likely be adding personnel and support infrastructure for those personnel in support of potential new weapons systems and potential mission requirements. There will be no changes to indirect fire systems (artillery or mortar).	Future

Key: ARRC = Alaska Railroad Corporation; BAAF = Bryant Army Airfield; BASH = Bird/wildlife Airstrike Hazard; EOD = explosive ordnance disposal; FLS = flight landing strip; FP = Firing Point; ITAM = Integrated Training Area Management; JBER = Joint Base Elmendorf-Richardson; LZ = landing zone; MP = milepost; POA = Port of Alaska; SF = square foot; UAC = Urban Assault Course

5.0 MINIMIZATION AND MITIGATION MEASURES AND RECOMMENDATIONS

Minimization and mitigation measures are presented in two subsections: 1) planned protective measures, which are incorporated into the action and were assumed during the analysis of effects presented in Chapter 4, and 2) recommended mitigation measures, which are additional protections that have been identified to address impacts to EFH and managed fish species identified in the analysis of effects. These measures include some recommendations by NMFS (cooperative agency) that were identified during pre-consultation meetings.

5.1 PLANNED PROTECTIVE MEASURES

Best management practices currently integrated into management strategies, policies, and actions would be continued under both alternatives. Additional reasonable and practicable protective measures have been identified to protect EFH and managed fish from noise impacts associated with live-fire training. Measures have also been developed to protect Cook Inlet beluga whale and other marine mammals, which are not the focus of this document but are mentioned in the following subsections to provide context for how habitat protective buffers were established.

5.1.1 Protective Buffers

Distances of proposed habitat protective buffers were determined based on the results of the acoustic modeling for fish (and marine mammals) and through coordination with JBER. The acoustic modeling results are referenced in Chapter 4 of this document and described in detail in the acoustic modeling reports (JASCO 2020, 2022). Proposed protective buffer distances from the Knik Arm shoreline and the banks of Eagle River, Otter Creek, and the Otter Creek complex (Figure 5-1) have been slightly modified from the current protective buffers and would be finalized through consultation with NMFS. Protective buffers would be translated into No Fire Areas in artillery fire support computers and loaded as GIS layers into the Range Facility Management Support System for planning and tracking.

The buffer distances would be periodically reviewed and may be altered during updates to JBER's INRMP. No targets would be placed within the protective buffers, and no rounds would be intentionally fired into the buffer areas. Targets would be placed far enough outside the buffers to allow for adjustment of rounds without the rounds impacting the buffer areas. The following buffers and restrictions are proposed. All buffers were identified based on the 2020 and 2022 modeling of typical high tide conditions (JASCO 2020, 2022) and were prescribed to protect the most sensitive marine mammal and fish receptors at each river/stream reach:[11]

- Keep the current 500-meter shoreline habitat buffer along Eagle Bay, which exceeds the 254-meter protective buffer indicated by the acoustic modeling report for the highest explosive weight (155-mm) round.
- Keep the current 130-meter habitat buffer from each bank of Eagle River, beginning from the mouth at Eagle Bay and extending upstream to a point 100 meters above the confluence with Otter Creek. This protective buffer is more than triple the 36-meter buffer indicated by the acoustic modeling report.
- Extend the current 130-meter habitat buffer from either bank of Eagle River approximately 0.5 kilometers upstream to encompass the Eagle River/Otter Creek confluence area.
- Keep the current 50-meter habitat buffer from each bank of the main Eagle River channel beginning at the point 100 meters upstream from the Otter Creek confluence and extending further upstream

[11] Marine mammals were determined to be the most sensitive biological receptors at each river/stream reach except for Otter Creek, where fish TTS thresholds were more sensitive than marine mammals that could be present in this reach (JASCO 2022). Although most of the buffers are overly protective for fish with regard to underwater noise, they would provide additional habitat protections (e.g., reduced erosion and contaminant loading) that would benefit EFH and managed species.

to the Route Bravo Bridge. This protective buffer exceeds the 36-meter buffer indicated by the acoustic modeling report.

- Keep the current 50-meter habitat buffer from either bank of Otter Creek and the associated Otter Creek complex within 100 meters of its confluence with Eagle River. This protective buffer exceeds the 36-meter buffer indicated by the acoustic modeling report.
- Keep the current 50-meter habitat buffer from either bank of Otter Creek and the Otter Creek complex from 100 meters above its confluence with Eagle River to the impact area boundary. This protective buffer exceeds the 20-meter buffer indicated by the acoustic modeling report.
- Extend the 50-meter Otter Creek habitat buffer approximately 0.25 kilometers south and east to encompass the Otter Creek backwater channel complex.
- Eliminate the current 1,000-meter shoreline habitat buffer along Eagle Bay for 120-mm HE rounds. The acoustic modeling indicates only a 254-meter buffer is required for protection, and the 500-meter buffer will be nearly twice that distance.
- Prohibit firing into Eagle Bay, Eagle River, or Otter Creek. (Adherence to USARAK Regulation 350-2, which requires all rounds to be visually observed impacting or bursting, will result in numerous additional waterbodies receiving similar protection.)
- Restrict firing into the Otter Creek complex to the area outside of the established protective buffer areas to include its multiple small tributaries, branches, and connected open water.

5.1.2 Other Protective Measures

Alternatives 1 and 2 consider additional protections for areas within ERF immediately along Eagle River, Otter Creek, the Otter Creek complex, and the Eagle Bay shoreline. These protections include measures recommended by NMFS during coordination meetings and would include the following limited fire periods for HE rounds (training rounds could still be fired):

- During all inundating tide events as predicted by a 31-foot[12] or higher tide at the Goose Creek, Cook Inlet Tide Station (ID 9455963) or as observed on the ground. Inundated areas will become no-fire areas during predicted and actual flooding events. Inundation period closure was recommended by NMFS in an EFH Coordination Letter dated 26 July 2022.
- During inundating tide events, the closure period would begin at 1 hour before high tide and extend for 2.5 hours after high tide as determined by the Goose Creek, Cook Inlet Tide Station. The timing of high tide as predicted by this station is consistent with JBER's field observations and the tide tables account for tidal amplification.
- The proposed HE closure period, based on peak upriver CIBW visitation within Eagle River and Otter Creek, is currently 15 Aug – 30 Sept. This date range, during which time no HE containing munitions (to include the 155mm Training Round) may be fired into the ERF proper (but may be fired into the expansion area) may be expanded on either end by NMFS during the course of consultations under the MMPA and ESA. Such an expansion would be more protective of fish within the ERF but is not considered in this analysis since this consultation is occurring prior to completion of the other consultations.

The Installation Range Control Officer would redistribute targets within ERF-IA to support No Fire Areas established along the Knik Arm shoreline, Eagle River, Otter Creek, and the Otter Creek complex. Target redistribution may include siting new targets, moving existing targets, obscuring existing targets, highlighting existing targets, or removing existing targets. The end goal is to establish an array of targets to focus the indirect fire and to preclude inadvertent targeting of rounds inside the protective buffer areas.

[12] While tides exceeding 30 feet result in flooding of ERF, the 31-foot tide level at the Goose Creek, Cook Inlet Tide Station (nearest tide station) is used as a reference for this restriction because there are no tide tables for 30 feet.

5.2 MITIGATION MEASURES

In addition to the planned protective measures listed above, the following reasonable and prudent mitigation measures would be implemented to further protect EFH and managed species from all-season firing activities. These measures would be applied because this EFH Assessment has determined that the planned protective measures alone would likely not be sufficiently protective of EFH and managed species. Sensitive habitats associated with the seasonal Eagle River relict channel and associated waterbodies remain unbuffered, and there remains uncertainty about fate and transport pathways, as well as potential for exposure and bioaccumulation of contaminants (particularly IM) to salmonids within ERF-IA. These mitigation measures were developed based on site-specific knowledge from JBER biologists, review of project site conditions, and through coordination with NMFS as a cooperating agency; they will be refined and modified further, as needed, through consultation with NMFS.

- JBER will expand the protective measure that specifies limited fire periods for HE rounds (Section 5.1.2) to include 155-mm training rounds.
- The Army will follow the most recent guidance and recommendations on using types of munitions that will minimize impacts to aquatic receptors to the maximum extent practicable. This involves coordination with other military firing ranges and research institutions (e.g., SERDP and CRREL) that have been conducting studies on fate, transport, and toxicity of IMs and traditional explosives over the past several decades.
- JBER will consider opportunities to protect, enhance, and/or restore salmon habitat in the affected area, including within and outside the JBER installation boundary.
- As part of an Adaptive Monitoring and Management Plan, JBER will develop and implement appropriate efforts for comparative sampling and monitoring of hydrologic and biometric conditions in areas within and adjacent to the proposed project area. The practicability of these efforts is dependent on safe access to relevant areas since much of the ERF-IA is a dudded impact area. Hydrologic monitoring may include water quality sampling as well as biometric sampling of fish tissue and characterization of invertebrate communities in relevant areas. Data will be used to monitor changes in the condition of EFH, with appropriate consideration to all other potential confounding factors in the environment. Adaptive management measures may be considered where metrics indicate action-related degradation to EFH.
- JBER will consider the practicability of acoustic testing on the effects of managed fish species within the proposed project area. While there are several potential confounding factors that may influence the acoustic measurements in the proposed project area, pilot studies may be developed to evaluate the range of noise inputs within ERF-IA and within various channel morphologies (e.g., primary, tributary, relict). These sound verification experiments and studies may use live species to validate acoustic modeling used in the development of the EFH analysis. Data may be used to monitor changes in the condition of EFH, with appropriate consideration to all other potential confounding factors in the environment. Adaptive management measures may be considered where metrics indicate action-related degradation to EFH. The practicability of these efforts is dependent on safe access to relevant areas, since much of ERF-IA is a dudded impact area.
- JBER will continue to evaluate rearing and residency of juvenile salmon and/or other managed fish species using trap surveys and/or eDNA (or other methods as appropriate) to monitor productivity in and adjacent to the action area. The practicability of these studies is dependent on safe access to relevant areas within ERF-IA.
- JBER will continue fisheries harvest management, population studies (annual salmon enumeration studies), and habitat protection efforts at Sixmile Lake, Eagle River, and Otter Creek, among others, which are currently prescribed within the most current JBER INRMP to ensure fish resources are effectively managed on JBER. These programs can be incorporated into an Adaptive Monitoring and Management Plan, which may be contained as an appendix within the INRMP (updated annually). Data will be used to monitor changes in the condition of EFH and with appropriate

consideration to all other potential confounding factors in the environment. Adaptive management measures may be considered where metrics indicate action-related degradation to EFH.

Additionally, The Army will consider redirection of appropriate training and operational firing into the proposed expansion area, rather than areas where juvenile fish may be present and during the height of salmon runs (mid-June through August), as appropriate. The practicality of trajectory adjustments depends on the type of round necessary to train and the location of appropriate firing points relative to the expansion area. The Army intends to maximize use of the expansion area to reduce impacts to areas where juvenile fish may be present and during the height of salmon runs (mid-June through August), as appropriate. Since these actions are subject to practicability based on the training events or currently unknown circumstances, these is not considered guaranteed mitigation, however, actions to meet these efforts will be documented as required.

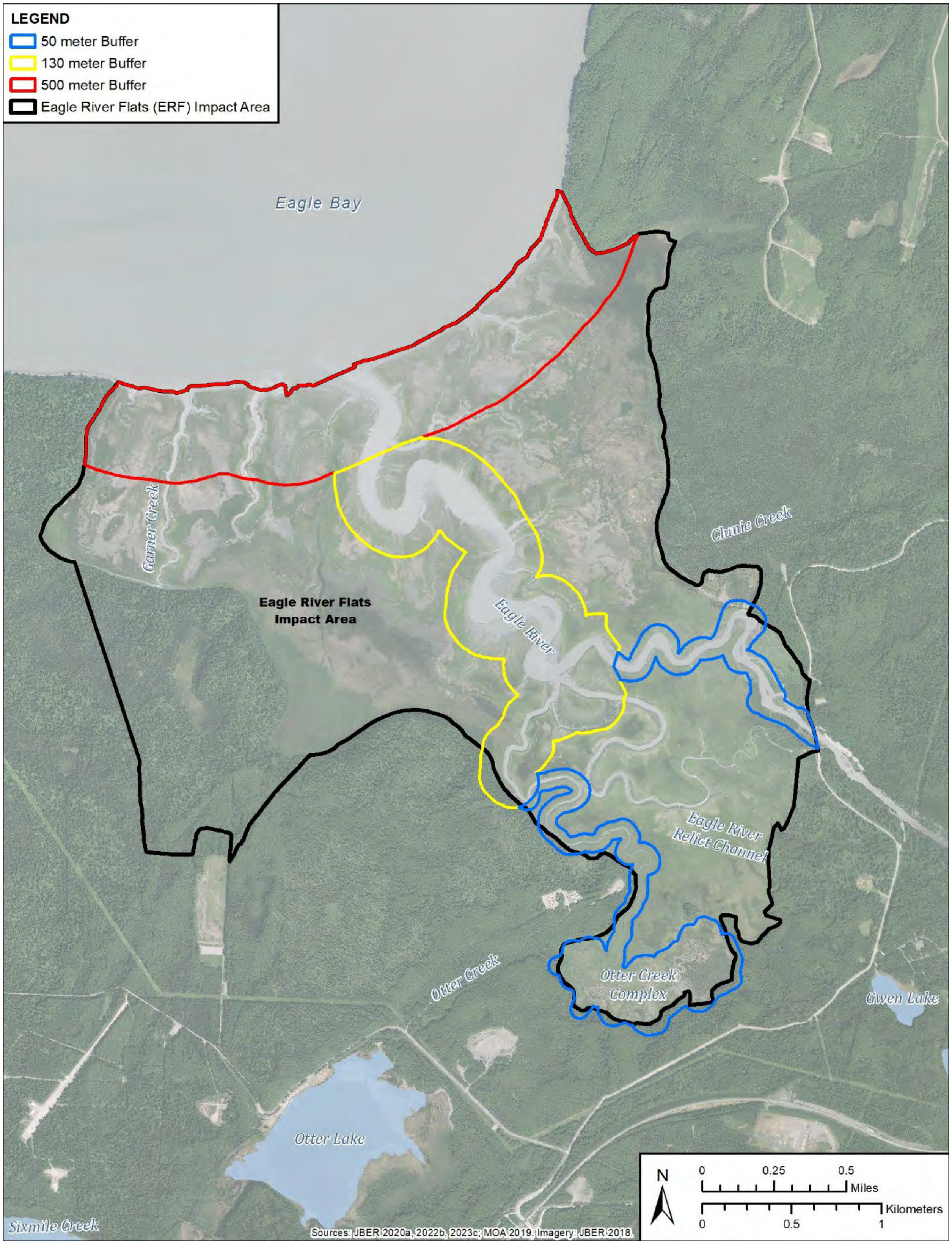

Figure 5-1 Proposed Habitat Protective Buffers at ERF-IA

6.0 ACTION AGENCY'S VIEW REGARDING EFFECTS OF PROPOSED ACTIONS ON EFH

6.1 EFFECTS DETERMINATION

It is the Action Agency's view that the proposed project of conducting all-season indirect live-fire mortar and artillery training at ERF-IA may adversely affect EFH and/or managed fish and their habitat at the watershed scale. It is anticipated that there would be some reduction in coho (and potentially Chinook and sockeye) escapement and productivity in Eagle River and Otter Creek primarily due to loss or modification of habitat in unbuffered areas. Underwater noise associated with live-fire training would increase the potential for mortality, injury, or behavioral effects of/to fish due to underwater noise and vibrations from live-fire training activities. The increased quantity of munitions fired into ERF-IA and firing during all seasons would increase the risk to fish species and their prey base from exposure to contaminants.

Protective measures to be executed under both alternatives would reduce underwater noise effects to fish, including the potential for injury or mortality. However, there is a risk that firing at targets in unbuffered areas, particularly the Eagle River relict channel complex, could result in mortality or injury to fish if they are present within a stream channel where a water detonation occurs. Although forward observers would monitor for presence of standing water prior to firing, there is a risk that an HE round could potentially land within a wetted channel while fish are present if open water cannot be observed.

In most areas that are known to support sensitive fish species, protective buffers would be implemented to reduce the risk of fish mortality, injury, and behavioral effects during other firing scenarios. Proposed buffers would provide additional benefits by reducing potential exposure of fish to munitions contaminants, sedimentation, and direct strikes from HE munition fragments.

Despite these protective buffers, there is still a low to high risk of adverse effects to EFH and managed species, particularly from acoustic impacts, contaminant exposure, erosion/sedimentation, and munition/fragment strikes that cannot be discounted. The buffers are not adequate to completely protect all inundated channels that are known to support rearing salmonids (e.g., Eagle River relict channel complex) or eliminate all risk of shrapnel strike to fish. The risk of mortality and injury as well as indirect effects from habitat loss/disturbance to juvenile salmonids (particularly coho and sockeye) is greatest in unbuffered areas, which provide crucial rearing and foraging habitat throughout the year.

Although any munitions contaminant residue deposited on-site is expected to degrade over time, there is potential for fish and their prey base to be exposed to low levels of contaminants through surface water transport, groundwater leaching, or shrapnel fragments entering waterbodies. Without conducting a detailed ecotoxicological risk assessment, there is a level of uncertainty that exists with respect to contaminant exposure. Due to the uncertainty of fate/transport processes and high solubility and potential toxicity of IM (particularly NTO and NQ) and contaminant degradation products to managed species and their prey base at ERF-IA, hydrologic and biometric monitoring has been included as a mitigation measure in Section 5.2.

The additional mitigation measures described in Section 5.2 are intended to help offset potential project impacts. Such measures include restricting firing of 155-mm training rounds during typical inundating tide events, acoustic testing, continued adult and juvenile salmon monitoring, firing adjustments, and implementing habitat restoration projects in the Eagle River watershed. Ongoing monitoring and adaptive management would be performed, as needed, to further minimize impacts to managed fish species.

6.2 DURATION, EXTENT, MAGNITUDE, AND SCALE

This section evaluates the Action Agency's view regarding duration, extent, magnitude, and scale of potential impacts that could reasonably be expected to occur as a result of the proposed action. This analysis is meant to be qualitative rather than quantitative, as it would be difficult to quantify impacts based on the numerous parameters, complicating factors, and dynamic natural processes involved in ERF-IA.

The impacts are described in terms of their anticipated duration (i.e., short-term or long-term), extent (geographic area), magnitude (i.e., negligible to high), and scale (i.e., run, watershed, population). For the purpose of this EFH assessment, the terms used to describe duration, magnitude, and scale are defined as follows:

- Duration
  - Short-term – Impacts last only for the duration of the firing activity or for less than a month beyond the cessation of the firing activity.
  - Long-term – Impacts last for more than a month beyond the cessation of the firing activity (including permanent impacts).
- Extent
  - Local – The area of ERF-IA and Eagle River watershed depending on the season and location in which the disturbance occurs (e.g., during salmon migrations).
  - Regional – Waters and watershed of Upper Cook Inlet.
  - Statewide – All fresh, estuarine and marine waters of Alaska.
- Magnitude
  - Negligible – No change in a managed species or resource (e.g., food, refuge, spawning habitat, migratory corridor) condition is anticipated.
  - Low – A change in a resource (e.g., food, refuge, spawning habitat, migratory corridor) condition is unlikely to result in measurable changes to EFH or managed species.
  - Moderate – A change in a resource (e.g., food, refuge, spawning habitat, migratory corridor) condition could result in some measurable change to EFH or managed species.
  - High – A change in a resource (e.g., food, refuge, spawning habitat, migratory corridor) condition is expected to result in measurable changes to EFH or managed species.
- Scale
  - Run – A group of fish of the same species that migrate together up a stream to spawn, usually associated with the seasons, e.g., fall, spring, summer, and winter runs. For ERF-IA, this would be localized to individual salmon runs in Eagle River and Otter Creek. Groundfish do not make spawning "runs" so they are evaluated at the watershed scale.
  - Watershed – Watershed-scale characteristics are defined as the physical and biological attributes of the entire 5th-field watershed. This includes the entire Eagle River watershed, including areas upstream from ERF-IA.
  - Population – A fish population is defined as a group of individuals of the same species or subspecies that are spatially, genetically, or demographically separated from other groups (Wells and Richmond 1995). For example, for this project, the Chinook salmon population would include all individual Chinook salmon that use rivers and streams in Upper Cook Inlet.

It is important to note that the proposed action would have a gradient of potential effects in terms of extent, duration, magnitude, and scale, depending on various factors such as the season and specific timing of the firing activity, type of rounds fired, location of the firing targets, river and tidal conditions, species and life stages of fish present, and habitat accessibility. However, it is anticipated that the scale of effects would be localized in extent to a portion of the run or watershed level. The magnitude and scale of effects at the local level cannot be quantified, but it is anticipated that there would be some reduction in coho (and potentially Chinook and sockeye) escapement and productivity in Eagle River and Otter Creek primarily due to loss or modification of habitat in unbuffered areas. Localized sediment increases, particularly within the unbuffered areas, could result in short-term loss or disturbance of some macroinvertebrates that comprise part of the prey base for fish species. Overall, the degree of effects to the unbuffered areas cannot be predicted, but it is expected that existing habitat would be altered, and the degree of effect would depend on detonation locations (buffered versus unbuffered areas). The full extent of impacts may not be realized for years after firing commences through continued monitoring of adult escapement, juvenile outmigration surveys, and habitat evaluations of buffered and unbuffered areas of ERF-IA..

The rationale for these determinations for both alternatives as well as individually for Alternatives 1 and 2 is described below. Table 6-1 summarizes potential impacts on EFH and managed species under Alternatives 1 and 2 and includes anticipated duration, extent, and magnitude of impacts, as well as proposed mitigation measures that would be implemented to further reduce potential impacts on EFH and managed species.

All-season live firing would occur indefinitely, so effects to EFH and managed species may result from intermittent active firing activities due to noise, munition strikes, sedimentation, and contaminant exposure. The Army plans to conduct all-season live firing training at ERF-IA for the foreseeable future, so one would expect that effects to EFH and managed species could occur at least over the next several decades or longer, unless management priorities or regulations change and all-season firing is suspended for some reason. Potential effects from noise and munitions strikes are only a concern for fish that are present in ERF-IA during or shortly after active firing at ERF-IA. Sedimentation effects could be either short or long term depending on firing location and timing of typical inundating tide events. If live firing ceases, low levels of contaminants could persist for weeks to years in ERF-IA depending on sediment transport patterns and breakdown rates of individual contaminants. Thus, contaminants could result in potential long-term effects to managed fish species.

Munition residue contaminants could enter waterbodies through either surface water or groundwater pathways (thus contributing to water quality degradation in ERF-IA at a three-dimensional level). NTO and NQ are particularly soluble and more likely to enter groundwater than other contaminants. However, as discussed in Section 4.4, it is not anticipated that firing at ERF-IA would result in a substantial net accumulation of contaminants at the site. Further, it is not expected that managed fish would be continuously exposed to high contaminant concentrations due to their migration patterns as well as tidal and riverine dilution and the continuous breakdown processes that are involved. The one exception would be if a LO or UXO detonation occurs in an unbuffered stream channel that supports year-round rearing by juvenile salmonids, and the contaminants are continuously exposed to fish or their prey base. However, the exposure risk would be limited due to salmonid movement patterns and contaminant breakdown pathways.

Localized water and sediment quality changes may result from munition contaminant deposition in the Eagle River watershed, but dilution and breakdown processes would reduce the risk of affecting other managed fish populations in Eagle Bay or Knik Arm (outside of ERF-IA). It is possible that some sub-lethal effects could result to managed fish through exposure to contaminated sediments or prey in both ERF-IA and Eagle Bay. The mitigation measures described in Section 5.2 (such as water quality sampling and continued adult salmon migration monitoring) would be conducted to evaluate the potential for effects on individual fish or salmon runs within the watershed. Depending on the sampling and monitoring results, adaptive management practices would be identified, evaluated, and implemented in coordination with NMFS to further reduce potential impacts to EFH and managed species within the Eagle River watershed.

Juvenile salmonids and other managed fish (such as eulachon) are more abundant in ERF waterbodies from spring to early summer, so there would be a greater risk of effect to these fish when firing during this time frame. However, most effects would be generally limited to juvenile coho salmon as well as some juvenile sockeye salmon, Chinook salmon, and groundfish (e.g., starry flounder) that may forage and rear for extended periods within ERF. These fish may seasonally utilize unbuffered areas as well as the flats when inundated and are more susceptible to acoustic disturbances or contaminant exposure due to their foraging behavior and longer residence time in ERF-IA. However, protective buffers, tidal flushing, and contaminant breakdown pathways would help reduce effects to these species. Mitigation beyond what is proposed in this assessment would be identified and implemented during monitoring and adaptive management, as needed.

Table 6-1 Summary of Potential Project Effects to EFH and Managed Species (Duration, Extent, and Magnitude/Scale) and Proposed Mitigation Measures

EFH and Managed Species	Potential Effect	Alternative	Potential Duration	Potential Extent	Potential Magnitude and Scale	Proposed Mitigation Measures
Pacific Salmon	Acoustic Disturbance from Munitions Detonations	1 (Proposed Action)	Short term during active firing events (each event less than 24 hours; with events ranging from 7 to 14 days). Live firing would be intermittent (average of up to 134 days per year) but could occur during any season, including both ice-covered and ice-free periods. Exposure duration for adults limited to migration periods (May-October); juveniles are more abundant during spring but may be present in ERF waterbodies throughout year (particularly coho and sockeye salmon). No HE munitions would be fired during typical inundating tide events (which may occur throughout year).	Acoustic effects limited to salmonids that rear and migrate within Eagle Bay and ERF-IA. Buffers for Eagle Bay, Eagle River, and Otter Creek complex would be adequately protective for salmonids during typical high tide conditions. Extension of existing buffers would increase protections of fish, including juvenile salmonids that may rear and overwinter in the Otter Creek complex. 155-mm training rounds could potentially detonate in water in unbuffered areas on the west side of the ERF-IA. Juvenile salmon are known to rear in unbuffered areas such as Eagle River relict channel complex and upper Garner Creek. Selective target placement and monitoring with forward observers would help avoid and reduce impacts.	The proposed project would increase the potential for mortality or injury of fish due to underwater noise and vibrations from live-firing activities, as these activities would occur when some fish species are more likely to be present in ERF-IA or actively migrating to spawning grounds upstream of ERF-IA Range from low to high in magnitude depending on conditions. Substantial risk of mortality, injury, and behavioral effects from firing of 155-mm training rounds during typical inundating tide events. Moderate to high risk of mortality, injury, and temporary behavioral effects during firing in unbuffered areas. The Army would not intentionally fire into open waterbodies. Selective targeting and other protective measures would be conducted when firing into unbuffered areas. 155-mm rounds would not be fired into the unbuffered Eagle River relict channel complex. Potential for acoustic impacts would be reduced when firing during ice-covered and frozen conditions.	Prohibit firing of 155-mm training rounds during typical inundating tide events, inter-agency coordination to evaluate munition options to reduce impacts, acoustic testing, continued adult and juvenile salmon monitoring, firing adjustments, habitat restoration, adaptive monitoring and management plan.

EFH and Managed Species	Potential Effect	Alternative	Potential Duration	Potential Extent	Potential Magnitude and Scale	Proposed Mitigation Measures
		2	Same as above.	Same as above.	Slightly greater than Alternative 1 because all firing concentrated in ERF.	Same as above.

Pacific Salmon	Erosion and Sedimentation	1 (Proposed Action)	Short-term impacts during construction of expansion area. Short- and long-term sedimentation impacts depending on location and timing of live-fire training events. Each firing event would be less than 24 hours; with events ranging from 7 to 14 days. Training would be intermittent (average of up to 134 days per year) but could occur throughout the year. Most sedimentation increases expected to occur when firing during ice-free periods.	Mostly limited to existing ERF-IA and proposed expansion area, with most disturbance concentrated in unbuffered areas. BMPs implemented during construction of the proposed expansion area would reduce potential for sedimentation into ERF-IA. Some sedimentation increases are anticipated in Eagle Bay, but they are not expected to be measurable due to existing high sediment load and sediment transport dynamics that result in a net increase of sedimentation into ERF-IA. The magnitude and scale of effects at the local level cannot be quantified, but it is anticipated that there would be some reduction in coho (and potentially Chinook and sockeye) escapement and productivity in Eagle River and Otter Creek primarily due to loss or modification of habitat in unbuffered areas. Localized sediment increases, particularly within the unbuffered areas, could result in short-term loss or disturbance of some macroinvertebrates that comprise part of the prey base for fish species. Overall, the degree of effects to the unbuffered areas cannot be predicted, but it is expected that existing habitat would be altered, and the degree of effect would depend on detonation locations (buffered versus unbuffered areas). The full extent of impacts may not be realized for years after firing commences through continued monitoring of adult escapement, juvenile	There is potential for increased erosion and sedimentation into ERF waterbodies as a result of live-fire training. Erosion and sedimentation into aquatic systems from firing events may constitute a direct or indirect effect, depending on the location of the activity. It is anticipated that there would be some reduction in coho (and potentially Chinook and sockeye) escapement and productivity in Eagle River and Otter Creek primarily due to loss or modification of habitat in unbuffered areas. Low to high. Dynamic tidal action constantly redistributes sediment in ERF waterbodies. No EFH or Pacific salmon are found in the proposed expansion area. Salmonid spawning does not occur in ERF-IA, so there would be no impacts to spawning habitat. Greatest potential for effects in unbuffered areas used by rearing salmonids. Although open channels would not be targeted, there is a high likelihood that munitions would detonate in or adjacent to unbuffered channels, which would result in habitat loss/modification, changes to vegetative cover, and loss of prey organisms. Connectivity to adjacent rearing habitats would be impacted through changes in topography and hydrology from ground disturbance. Macroinvertebrates and vegetation could recover over time, but recolonization would be dependent on frequency and concentration of firing in unbuffered areas.	Prohibit firing of 155-mm training rounds during typical inundating tide events, continued adult and juvenile salmon monitoring, firing adjustments, hydrologic and biometric monitoring, habitat restoration, adaptive monitoring and management plan.

EFH and Managed Species	Potential Effect	Alternative	Potential Duration	Potential Extent	Potential Magnitude and Scale	Proposed Mitigation Measures
				outmigration surveys, and habitat evaluations of buffered and unbuffered areas of ERF-IA.		
		2	Same as above.	Firing would be limited to a 1,568-acre area of ERF-IA and would not include the expansion area.	No impacts at expansion area. Slightly greater impacts at ERF due to concentrated firing.	Same as above.
Pacific Salmon	Munitions and Fragment Strikes	1 (Proposed Action)	Short term during active firing events (each event less than 24 hours; with events ranging from 7 to 14 days). Live firing would be intermittent (average of up to 134 days per year) but could occur during any season, including both ice-covered and ice-free periods. Potential for strikes only during ice-free periods.	ERF-IA only, with greatest potential for direct strikes by munitions and fragments in unbuffered areas. Very low potential for munition or fragment strikes in Eagle Bay due to protective buffers.	Low to moderate in magnitude. For munition strikes, buffers would be completely protective for fish in Eagle River, Otter Creek, and Otter Creek complex. Low to moderate potential for direct strikes in unbuffered areas but lethal effects anticipated if a munitions strike occurs. For fragment strikes, risk is greatest for juvenile salmonids in unbuffered areas, but buffers are not completely protective against fragment strikes for fish in Eagle River, Otter Creek, or Otter Creek complex. Any adults and juveniles present could be struck, although the risk is low in deeper water due to water attenuation. Potential effects would be slightly greater for adult salmonids due to their larger surface area. Training rounds do not cause release of shrapnel. Any fragment-strike effects would be limited to individual fish that happen to be present in ERF-IA during intermittent firing, so any effects would be localized to the run/watershed scale. Greatest potential for effect from airburst detonations, although risk is dependent on fish presence, vegetation, topography, and other site-specific factors.	Prohibit firing of 155-mm training rounds during typical inundating tide events, continued adult and juvenile salmon monitoring, firing adjustments, habitat restoration, adaptive monitoring and management plan.

EFH and Managed Species	Potential Effect	Alternative	Potential Duration	Potential Extent	Potential Magnitude and Scale	Proposed Mitigation Measures
		2	Same as above.	Same as above.	Slightly greater than Alternative 1 because all firing concentrated in ERF.	Same as above.

Pacific Salmon	Munition Contaminant Exposure	1 (Proposed Action)	Long term. Low levels of contaminants could persist for weeks to years in ERF-IA depending on sediment transport patterns and breakdown rates of individual contaminants. Live firing would be intermittent (average of up to 134 days per year) but could occur during any season. Salmonids are not likely to be continuously exposed to high levels of contaminants. Exposure would likely be limited to periods when juvenile salmonids can access the flats or after flooding events that deposit munitions residue into ERF-IA waterbodies.	ERF-IA and Eagle Bay. Firing could occur throughout ERF-IA (outside of buffered areas) and the proposed expansion area. Tidal flushing, dynamic sediment conditions, and various breakdown pathways would reduce contaminant concentrations, although high solubility and mobility of NTO and NQ and localized toxicity from munition residues and their degradation products could present risk to salmon in ERF-IA. Higher concentrations of munition residues may occur in localized areas on tidal flats that are infrequently occupied by juvenile salmonids. Contaminants that migrate into Eagle Bay likely dilute to low exposure levels, so they are not expected to affect adult salmon migrating through Eagle Bay from other watersheds.	The increased quantity of munitions fired into ERF-IA and firing during all seasons would increase the risk to fish species and their prey base from exposure to contaminants. Protective buffers and strategic placement of targets on higher ground within sensitive unbuffered areas would reduce risk of munition detonation in stream channels. However, target areas would still overlap small tributaries, so it is likely that some munitions and contaminants would be released into stream channels. Additionally, throughout ERF, rounds may land in areas that contain standing or flowing water during inundated conditions where fish may be found. Unknown but expected to be low to moderate. Only sub-lethal effects anticipated. Risk of exposure greater for juvenile salmonids (particularly coho and sockeye) that forage and rear year-round in ERF-IA, particularly in unbuffered areas. Protective buffers would help reduce contaminant releases, although some residues would enter waterbodies following flooding events. Dilution would help reduce toxicity. Low risk of exposure to adult salmonids because they do not forage or spawn in ERF-IA. IMs present potential increased risk of exposure over traditional munitions. Prohibiting firing at WP-capped ponds (when not ice-covered) would reduce potential contaminant exposure from WP releases.	Prohibit firing of 155-mm training rounds during typical inundating tide events, continued adult and juvenile salmon monitoring, firing adjustments, hydrologic and biometric monitoring, habitat restoration, adaptive monitoring and management plan.
		2	Same as above.	Firing would only be limited to a 1,568-acre area of ERF-IA and	Slightly greater than Alternative 1 because all firing concentrated in ERF.	Same as above.

EFH and Managed Species	Potential Effect	Alternative	Potential Duration	Potential Extent	Potential Magnitude and Scale	Proposed Mitigation Measures
				would not include the expansion area.		
Groundfish and Forage Fishes	Acoustic Disturbance from Munitions Detonations	1 (Proposed Action)	Short term during active firing events (each event less than 24 hours; with events ranging from 7 to 14 days). Live firing would be intermittent (average of up to 134 days per year) but could occur during any season, including both ice-covered and ice-free periods. Eulachon only migrate through Eagle River for brief periods during spring. Few groundfish species are known to use ERF-IA, but they are more likely to be present in ERF-IA during summer months. No HE munitions would be fired during typical inundating tide events (which may occur throughout year) when these fish could use flats.	Acoustic effects limited to few groundfish and forage fish species that rear and migrate in ERF-IA. Planned protective buffers for Eagle Bay, Eagle River, and the Otter Creek complex would provide adequate protection during typical high tide conditions. Use of 155-mm training rounds during typical inundating tide events could occur in unbuffered areas throughout ERF-IA. Groundfish and forage fish are not expected to use unbuffered off-channel and wetland complexes that can support salmonid rearing. No effects anticipated to groundfish and forage fishes in Eagle Bay due to habitat buffer.	Low to moderate. Substantial risk of mortality, injury, and behavioral effects to fish from firing of 155-mm training rounds during typical inundating tide events. Groundfish and forage fishes unlikely to use unbuffered areas of ERF-IA, so risk of acoustic effects is very low. The Army would not intentionally fire into open waterbodies, and targets would not be placed in open waterbodies. Selective targeting would be conducted when firing near these areas. Potential for acoustic impacts would be reduced when firing during ice-covered and frozen conditions. Potential effects limited to individual fish that happen to be present in ERF-IA during intermittent firing, so any effects would be localized to the watershed scale.	Prohibit firing of 155-mm training rounds during typical inundating tide events, inter-agency coordination to evaluate munition options to reduce impacts; acoustic testing, firing adjustments, adaptive monitoring and management plan.
		2	Same as above.	Same as above.	Slightly greater than Alternative 1 because all firing concentrated in ERF.	Same as above.

EFH and Managed Species	Potential Effect	Alternative	Potential Duration	Potential Extent	Potential Magnitude and Scale	Proposed Mitigation Measures
Groundfish and Forage Fishes	Erosion and Sedimentation	1 (Proposed Action)	Short-term impacts during construction of expansion area. Short- or long-term sedimentation impacts depending on location and timing of live-fire training events. Each firing event would be less than 24 hours; with events ranging from 7 to 14 days. Training would be intermittent (average of up to 134 days per year) but could occur throughout the year. Most sedimentation increases expected to occur when firing during ice-free periods.	Mostly limited to existing ERF-IA and proposed expansion area. BMPs implemented during construction would reduce potential for sedimentation into ERF-IA Groundfish and forage fish not expected to use off-channel and wetland complexes that can support salmonid rearing. Localized sediment increases, particularly within the unbuffered areas, could result in short-term loss or disturbance of some macroinvertebrates that comprise part of the prey base for fish species. Some sedimentation increases are anticipated in Eagle Bay but they are not expected to be measurable due to existing high sediment load and sediment transport dynamics that result a net increase of sedimentation into ERF-IA.	There is potential for increased erosion and sedimentation into ERF waterbodies as a result of live-fire training. Erosion and sedimentation into aquatic systems from firing events may constitute a direct or indirect effect, depending on the location of the activity. Negligible to low primarily because these managed species are not expected to use unbuffered areas. Dynamic tidal action constantly redistributes sediment in ERF waterbodies. Some prey items may be lost or disturbed by sedimentation increases. Macroinvertebrates are expected to recolonize disturbed areas relatively quickly. Any minor sedimentation effects would be limited to the watershed scale. Potential effects would be slightly greater for starry flounder, which may forage in ERF-IA, or any other adult groundfish.	Prohibit firing of 155-mm training rounds during typical inundating tide events, firing adjustments, hydrologic and biometric monitoring, adaptive monitoring and management plan.
		2	Same as above.	Firing would be limited to a 1,568-acre area of ERF-IA and would not include the expansion area.	No impacts at expansion area. Slightly greater impacts at ERF due to concentrated firing.	Same as above.

EFH and Managed Species	Potential Effect	Alternative	Potential Duration	Potential Extent	Potential Magnitude and Scale	Proposed Mitigation Measures
Groundfish and Forage Fishes	Munition and Fragment Strikes	1 (Proposed Action)	Short-term impacts during active firing events (each event less than 24 hours; with events ranging from 7 to 14 days). Live firing would be intermittent (average of up to 134 days per year) but could occur during any season, including both ice-covered and ice-free periods. Potential for strikes only during ice-free periods.	ERF-IA only. Very low potential for munition or fragment strikes in Eagle Bay due to protective buffers.	Negligible to low. Buffers not completely protective for fish in Eagle River and Otter Creek, particularly for airburst detonation strikes, but few groundfish and forage fish species use ERF-IA, especially unbuffered areas. Potential for mortality or injury from munition or fragments strikes. Low risk of fragment strike of eulachon due to brief migration periods and small surface area. Negligible risk of strike to starry flounder or other flatfish that use benthic substrates. Lethal effects unlikely but not discountable, particularly in unbuffered areas or during airburst detonations. Any adults and juveniles present could be struck by fragments, although the risk is low due to water attenuation. Training rounds do not cause release of shrapnel. Any fragment-strike effects would be limited to individual fish that happen to be present in ERF-IA during intermittent firing, so any effects would be localized to the watershed scale.	Prohibit firing of 155-mm training rounds during typical inundating tide events, firing adjustments, hydrologic and biometric monitoring, adaptive monitoring and management plan.
		2	Same as above.	Same as above.	Slightly greater than Alternative 1 because all firing concentrated in ERF.	Same as above.

EFH and Managed Species	Potential Effect	Alternative	Potential Duration	Potential Extent	Potential Magnitude and Scale	Proposed Mitigation Measures
Groundfish and Forage Fishes	Munition Contaminant Exposure	1 (Proposed Action)	Long term. Low levels of contaminants could persist for weeks to years in ERF-IA depending on sediment transport patterns and breakdown rates of individual contaminants. Live firing would be intermittent (average of up to 134 days per year) but could occur during any season. Groundfish are not likely to be continuously exposed to high levels of contaminants. Exposure would likely be limited to periods when groundfish and forage fishes can access the flats or after flooding events that deposit munitions residue into ERF-IA waterbodies.	ERF-IA and Eagle Bay. Firing could occur throughout existing ERF-IA and the proposed expansion area, so any munition residue deposition would not be localized in one area. Tidal flushing, dynamic sediment conditions, and various breakdown pathways would reduce contaminant concentrations although high solubility and mobility of NTO and NQ, and localized toxicity from munition residues and their degradation products could present risk to groundfish and forage fishes in ERF-IA. Higher concentrations of munition residues likely in localized areas on tidal flats that are infrequently occupied by these species. Contaminants that migrate into Eagle Bay likely dilute to low exposure levels so they are not expected to affect groundfish and forage fishes in Eagle Bay.	Unknown but expected to be low. Few groundfish and forage fishes use ERF-IA, including unbuffered areas. Only sub-lethal effects anticipated. Protective buffers would help reduce contaminant releases, although some residues would enter waterbodies following flooding events. Dilution would help reduce toxicity. Low risk of exposure to eulachon because they do not forage during their spawning migration in ERF-IA. IMs present potential increased risk of exposure over traditional munitions. Prohibiting firing at WP-capped ponds (when not ice-covered) would reduce potential contaminant exposure from WP releases. Most contaminants would be localized to the watershed scale and would break down over time. Some low levels of munition contaminants may enter Eagle Bay and Knik Arm but due to dilution and breakdown processes.	Prohibit firing of 155-mm training rounds during typical inundating tide events, firing adjustments, hydrologic and biometric monitoring, adaptive monitoring and management plan.
		2	Same as above.	Firing would only be limited to a 1,568-acre area of ERF-IA and would not include the expansion area.	Slightly greater than Alternative 1 because all firing concentrated in ERF.	Same as above.

Key: BMP = best management practice; EFH = Essential Fish Habitat; ERF = Eagle River Flats; ERF-IA = Eagle River Flats Impact Area; HE = high explosive; IM = insensitive munitions; mm = millimeter; NQ = nitroguanidine; NTO = 3-nitro-1,2,4-triazol-5-one; WP = white phosphorus.

Habitat protective buffers would reduce erosion and sedimentation impacts adjacent to Eagle River, Otter Creek, and the Otter Creek complex where most juvenile salmonids rear in ERF-IA. However, some munitions detonations could occur in unbuffered areas that provide juvenile salmonid rearing habitat (e.g., Eagle River relict channel complex). This could impact local hydrology by opening new channels or closing off existing channels, which could alter juvenile salmonid access to connecting habitats. Existing vegetation would provide some sediment erosion control, and impacted vegetation would be expected to grow back if the same areas are not continually targeted. However, regrowth could be impeded if firing is concentrated within the unbuffered areas. Overall, the extent and magnitude of impacts to the unbuffered areas cannot be predicted, but it is expected that existing habitat would be altered, with effects ranging from low to high depending on detonation locations (buffered versus unbuffered areas).

The risk of adverse effect to adult salmonids and eulachon is particularly low due to the protective buffers in place along their migration routes and the fact that they do not feed (and thus are unlikely to be exposed to sediment or prey base contaminants) during their upstream migration. The risk of munition strikes would be slightly greater for adult salmon than other managed species due to their larger body size but would still be low. It is anticipated that these aforementioned effects would be primarily localized to a small portion of the run (primarily coho and sockeye in unbuffered areas) or local watershed level, as the project could potentially affect fish within any ERF waterbodies.

6.3 ALTERNATIVE 1: ALL-SEASON LIVE-FIRE TRAINING WITH EXPANDED IMPACT AREA (PROPOSED ACTION)

Alternative 1 is the Proposed Action. Under Alternative 1, extended indirect live-fire training using a full array of weapons systems and munitions would be conducted at ERF-IA, subject to certain conditions designed to ensure safety and minimize environmental impacts. This alternative would also expand ERF-IA by 585 acres to allow Soldiers full access to training opportunities. Selection of this alternative would extend weapons training throughout the year for non-explosive munitions and explosive munitions to the extent practicable.

Alternative 1 would have direct and indirect, long-term, adverse impacts on fish resources. Although protective measures would be implemented to avoid and reduce potential impacts, this alternative would still result in mortality or injury of various fishes depending on type, location, and timing of live-firing activities at ERF-IA. Impacts from Alternative 1 would have the potential to exceed applicable significance thresholds, even with the proposed protective and mitigation measures, as fish could potentially be impacted at the watershed scale from rounds landing in or near channels that support juvenile rearing salmonids.

Under Alternative 1, live-fire exercises would be spread out over both existing ERF-IA and the proposed expansion area. Firing into the proposed expansion area, which is further away from fish-bearing waters than existing ERF-IA, would reduce the likelihood of errant rounds reaching fish habitat. Therefore, impacts under Alternative 1 would potentially be less than under Alternative 2, where firing would be concentrated in ERF-IA.

Proposed tidal firing restrictions and habitat protective buffers that would be incorporated into both alternatives would reduce risk of mortality or injury to managed fish species from underwater noise but are not adequate to completely protect against all potential acoustic impacts, such as behavioral modifications, or ensure protection from contaminant exposure or munition fragment strikes. Noise levels associated with firing 155-mm training rounds during inundated conditions would exceed key thresholds ($SEL_{24\text{-hr}}$ and PK mortality and injury for fish with and without swim bladders) for fish at distances larger than the proposed buffers. Thus, mitigation measures are proposed to further reduce potential long-term adverse effects to EFH and managed species.

Based on the large firing area (ERF-IA and expansion area), the variety of contaminant breakdown pathways that are expected to occur, the low risk of bioaccumulation, and the intermittent flushing of munitions residues from ERF-IA, it is anticipated that even with increased firing under this alternative, the risk of munitions contaminants to affect EFH and managed fish species would range from low to moderate but is not discountable. This is due to 1) the uncertainty and often contradictory results about breakdown efficiencies and toxicological effects from IM on fish and aquatic invertebrates and 2) dynamic processes in ERF that could mobilize and transport IM and other traditional munitions into year-round rearing habitats for sensitive juvenile coho and other salmonids. It is impossible to predict potential exposure and effects on managed fish species and their prey base without water quality monitoring, fish tissue sampling, or a site-specific ecotoxicology study. An adverse effect to a juvenile salmon could result if it ingests a single invertebrate that has consumed munition residues, and that possibility exists under the proposed alternative.

Minimization and mitigation measures would be implemented to reduce effects to EFH and managed species. The implementation of these proposed conservation measures would reduce the potential for adverse long-term consequences to EFH or managed fish populations in the proposed project area.

6.4 ALTERNATIVE 2: ALL-SEASON LIVE-FIRE TRAINING AT EXISTING ERF-IA ONLY

Under Alternative 2, the proposed mortar and artillery training would occur only in the existing ERF-IA, as the impact area would not be expanded. This alternative is expected to have a greater potential for impacts to EFH and managed species than Alternative 1 because munitions would be fired annually into the lowland areas of ERF where EFH and managed species occur. Many of the same effects described for Alternative 1 would also occur under Alternative 2, with slightly greater associated risk. Therefore, it was determined that Alternative 2 may adversely affect EFH and managed species. As with Alternative 1, conservation measures have been recommended to reduce effects to EFH and managed species. The implementation of these proposed conservation measures would reduce the potential for adverse long-term consequences to EFH or managed fish populations within the proposed project area.

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APPENDICES

APPENDIX A—ECOTOXICOLOGY ASSAYS

A-1: Ecotoxicology Assays for Insensitive Munitions Constituents

This appendix provides ecotoxicology assays for toxicity effects of IM munitions constituents and their various breakdown products on aquatic receptors (fish and invertebrates). The assays summarize LC_{50} values and toxicity ratings.

Acute Toxicity

Some of the transformation products of DNAN and NQ appear to be more acutely toxic to aquatic organisms than their parent compound. Biotransformation of DNAN under aerobic conditions, for instance, yielded the compound 2,4-DNP (Richard and Weidhaas 2014a). 2,4-DNP is a protonophore that collapses the mitochondrial proton gradient by transporting hydrogen ions across the inner mitochondrial membrane. This decrease in the proton motive force results in decreased adenosine triphosphate synthase activity and a consequent decrease in adenosine triphosphate formation with increased production of heat (reviewed in Marit and Weber 2011). This can lead to hyperthermia, hyperventilation, tachycardia, confusion, weakness, and even death in animals. Gao et al. (2011) found that 2,4-DNP photodegraded relatively easily under sunlight, with a half-life of 56 hours in June and 141 hours in September. Gao et al. (2011) hypothesized that the lower horizon of solar radiant intensity in fall led to slower photodegradation in September. Given that these experiments were conducted in China at approximately 44–46 North latitude, it is likely that the fall rate, in particular, would be lower in Alaska.

The USFWS developed a general (non-regulatory) ranking system, which characterizes the relative acute toxicity of a compound based on measured aquatic LC_{50} and median effective concentration (EC_{50}) endpoints (USFWS 1984) (Table A-1). Using this system, DNAN is classed as moderately toxic to algae and only slightly toxic to bacteria, macroinvertebrates, and fish, whereas 2,4-DNP is classed as moderately toxic to fish (e.g., rainbow trout). Exposure to 2,4-DNP also caused a significant decrease in the swimming performance of zebrafish (*Danio rerio*), as well as a significant increase in whole body triglyceride levels in exposed fish that also endured forced swimming tests (Marit and Weber 2011).

Table A-1 Acute-Toxicity Rating Scales

Relative Toxicity Category	Aquatic EC_{50} or LC_{50} (mg/L)
Super Toxic	<0.01
Extremely Toxic	0.01-0.1
Highly Toxic	0.1-1
Moderately Toxic	1-10
Slightly Toxic	10-100
Practically Nontoxic	100-1000
Relatively Harmless	>1000

Key: EC_{50} = concentration at which half of an exposed population exhibits an effect (often the endpoint) after a short-term exposure; LC_{50} = a concentration at which half of an exposed population dies after a short-term exposure; mg/L = milligrams per liter.

Source: USFWS 1984.

NQ is classed as relatively harmless to fish (fathead minnow [*Pimephales promelas*]) and macroinvertebrates (e.g., water fleas) (van der Schalie 1985), whereas one of the end-products of phototransformation of NQ is ammonia, which is classed as highly toxic to juvenile marine fish (pompano) (Costa et al. 2008) and shrimp larvae (whiteleg shrimp) (Lourdes Cobo et al. 2014), to include a decrease of fecundity in fathead minnows (Armstrong et al. 2012). Another biotransformation product of NQ formed under microaerophilic conditions is cyanamide (USEPA 2007), which is classed as highly toxic to blue green algae, moderately toxic to macroinvertebrates (mysid shrimp and water fleas), and slightly toxic to fish (USEPA 2007). Another transformation product of NQ, nitrite, is ranked as slightly to highly toxic to rainbow trout depending on the concentration of chloride present in the water (reviewed in Lewis and

Morris 1986). Therefore, the timing of nitrite exposure on a salmonid relative to the flood tide (with subsequent increase in salinity) could impact the relative toxicity of this chemical in ERF-IA, with less toxicity expected as salinity increases.

Chronic Toxicity

Long-term exposure to contaminants can adversely affect aquatic organisms, with effects most often manifesting at much lower contaminant concentrations than those observed in acute exposures. Table A-2 through Table A-7 include the results of chronic exposure assays for aquatic receptors exposed to munitions constituents. Chronic toxicity tests of DNAN-exposed fathead minnows yielded a 7-day LC_{50} of 10.0 milligrams per liter (mg/L; equivalent to parts per million), which was below the acute (48 hour) LC_{50} of 37 mg/L (Kennedy et al. 2013). Similarly, the DNAN LC50 values for water fleas were lower in a 6-day chronic toxicity test in which the LC50 was >24.2 mg/L versus the acute (48 hour) LC50 of 42 mg/L (Kennedy et al. 2013).

In a 42-day test of NQ chronic toxicity, early-life stage rainbow trout exposed to NQ exhibited significant differences in weight (16 percent below the control), length (3.7 percent below control), and incidence of deformation (increased deformities) from a control group only in the highest concentration tested (1,703 mg/L), which was nearly at the saturation point (van der Schalie 1985). Haley et al. (2009) conducted a 7-day toxicity test of NTO using water fleas and found a reproductive half maximal inhibitory concentration (IC_{50}) of 57 mg/L, which is much lower than the acute (48 hour) LC_{50} of 460 mg/L. Developing eggs and fry of rainbow trout and Chinook salmon exhibited significant increases in mortality when exposed to nitrate concentrations of 1.1-4.5 mg/L during a 30-day chronic toxicity test, compared to 96-hour acute LC_{50} for fingerlings of 1,355 and 1,310 mg/L, respectively (reviewed in Camargo et al. 2005). The eggs and fry of coho salmon, on the other hand, were much less sensitive to nitrate in the 30-day trial, with the highest concentration of nitrate (4.5 mg/L) failing to result in significantly altered survival (reviewed in Camargo et al. 2005). Rainbow trout exposed to concentrations of 0.04 mg/L of unionized ammonia for up to 52 months developed adverse alterations of gill and kidney tissues,[13] which were thought to potentially lead to organ dysfunction or behavioral alterations in a natural environment (Thurston et al. 1984).

Table A-2 Ecotoxicological Assays for DNAN

Compound	Organism	Effect	Effect Endpoint[1]	Level at Measured Effect	Toxicity Rating[2]	Reference
DNAN	Green algae (*Pseudokirch-neriella subcapitata*)	Decreased growth	EC_{50}	4.0 mg/L	Moderately Toxic	Dodard et al. 2013
	Bacteria (*Vibrio fischeri*)	Decreased bioluminescent activity	EC_{50}	60.3 mg/L (Microtox assay[3])	Slightly Toxic	Dodard et al. 2013
	Bacteria (*Aliivibrio fischeri*)	Decreased bioluminescent activity	IC_{50}	57 µM (Microtox assay)		Liang et al. 2013
	Bacteria (methanogens and nitrifying)	Decreased methane production and ammonium consumption	IC_{50}	41-49 µM		Liang et al. 2013
	Fish–fathead minnow (*Pimephales promelus*)	Combined decrease in survival and growth/reproduction (7-day exposure)	IC_{50}	15.2 mg/L		Kennedy et al. 2013

[13] Gill alterations include hypertrophy of gill lamellae, separation of epithelia from underlying basement membrane, necrosis, aneurysms, and mild to moderate lamellae fusion. Kidney alterations include nephrosis, degeneration of renal tubule epithelium, hyaline droplet degeneration, and partially obstructed tubule lumens.

Compound	Organism	Effect	Effect Endpoint[1]	Level at Measured Effect	Toxicity Rating[2]	Reference
	Fish–fathead minnow (*Pimephales promelus*)	Lethal	LC_{50}	41 mg/L (24 hr) 37 mg/L (48 hr)	Slightly Toxic	Kennedy et al. 2013
	Fish–fathead minnow (*Pimephales promelus*)	Lethal	LC_{50}	10.0 mg/L (7 d)		Kennedy et al. 2013
	Water flea (*Ceriodaphnia dubia*)	Combined decrease in survival and growth/reproduction (6-day exposure)	IC_{50}	10.6 mg/L		Kennedy et al. 2013
	Water flea (*Ceriodaphnia dubia*)	Lethal	LC_{50}	82 mg/L (24 hr) 42 mg/L (48 hr) 24.2 mg/L (6 d)	Slightly Toxic	Kennedy et al. 2013

Notes:
[1] LC_{50} = concentration at which half of an exposed population dies after a short-term exposure; EC_50 = concentration at which half of an exposed population exhibits an effect (often the endpoint) after a short-term exposure; IC_{50} = the concentration at which a 50% reduction (compared to control group) of a particular function occurs after a short-term exposure.
[2] Acute-toxicity rating scales: USFWS Research Information Bulletin. 1984. No. 84-78.
[3] Microx is a bioassay used to detect toxic substances in soil, air, water and sediment. Toxicity is indicated by the degree of disruption (percent inhibition) of bioluminescent activity in the bacterium *Vibrio fischeri*. Luminescence in this species is a by-product of cellular respiration and thus inhibition of luminescence is directly tied to disruption of cellular respiration, a critical life process.

Key: µM = micromole; d = day; DNAN = dinitroanisole; hr = hour; mg/L = milligram per liter.

Table A-3 Ecotoxicological Assays for MENA, DAAN and 2,4-DNP

Compound	Organism	Effect	Effect Endpoint[1]	Level at Measured Effect	Toxicity Rating[2]	Reference
MENA	Bacteria (*Aliivibrio fischeri*)	Decreased bioluminescent activity	IC_{50}	48 µM (Microtox assay)		Liang et al. 2013
	Bacteria (methanogens and nitrifying)	Decreased methane production and ammonium consumption	IC_{50}	48-175 µM		Liang et al. 2013
DAAN	Bacteria (methanogens)	Decreased methane production	IC_{50}	176 µM		Liang et al. 2013
	Bacteria (*Aliivibrio fischeri*)	Decreased bioluminescent activity	IC_{50}	155 µM (Microtox assay)		Liang et al. 2013
2,4-DNP	Fish–Japanese rice fish (*Oryzias latipes*)	Lethal. Did not accumulate in tissue or cause hemorrhage, behavior change or deformities	LC_{50}	1.48 mg/L (24 hr)	Moderately Toxic	Rice et al. 1997
				1.33 mg/L (48 hr)		
	Fish–rainbow trout (*Oncorhynchus mykiss*)	Lethal	LC_{50}	13.2 mg/L (24 hr)	Slightly Toxic	Reviewed in Rice et al. 1997
				10.36 mg/L (48 hr)		
	Fish–rainbow trout (*Oncorhynchus mykiss*)	Lethal	LC_{50}	2.07 mg/L (48 hr)	Moderately Toxic	Reviewed in Rice et al. 1997
	Fish–zebrafish (*Danio rerio*)	Significant decrease in tailbeat frequency and swim speeds after 24 hr exposure to 2,4-DNP (6-12 mg/L)				Marit and Weber 2011
	Fish–zebrafish (*Danio rerio*)	Significant increase in whole body triglyceride levels when fish exposed to both 2,4-DNP (for 24 hr) and swimming tests. Triglyceride increases was thought to be the result of interference of DNP with lipid catabolism.				Marit and Weber 2011

Notes:
[1] LC_{50} = concentration at which half of an exposed population dies after a short-term exposure; IC_{50} = the concentration at which a 50% reduction (compared to control group) of a particular function occurs after a short-term exposure.
[2] Acute-toxicity rating scales: USFWS Research Information Bulletin. 1984. No. 84-78.

Key: µM = micromole; 2,4-DNP = 2,4-dinitrophenol; DAAN = 2,4-diaminoanisole; hr = hour; MENA = 2-methoxy-5-nitroanilinel; mg/L = milligram per liter.

Table A-4 Ecotoxicological Assays for NTO, NQ and Ø-NQ (photolyzed NQ)

Compound	Organism	Effect	Effect Endpoint[1]	Level at Measured Effect	Toxicity Rating[2]	Reference
NTO	Green algae (*Selenastrum capricornutum*)	Inhibition of growth (pH buffered solution)	IC_{50}	3,465 mg/L		Haley et al. 2009
	Water flea (*Ceriodaphnia dubia*)	Inhibition of reproduction during 7-day exposure (pH buffered solution)	IC_{50}	57 mg/L		Haley et al. 2009
	Water flea (*Ceriodaphnia dubia*)	Lethal	LC_{50}	830 mg/L (24 hr) 460 mg/L (48 hr)	Practically Nontoxic	Haley et al. 2009
NQ	Fish–fathead minnow (*Pimephales promelus*)	Lethal	LC_{50}	>2,714 mg/L[3] (96 hr)	Relatively Harmless	van der Schalie 1985
	Water flea (*Ceriodaphnia dubia*)	Immobilization	EC_{50}	>2,838 mg/L[4] (48 hr)	Relatively Harmless	van der Schalie 1985
	Fish–rainbow trout (*Oncorhynchus mykiss*) early life stage	Decreased weight (16.3%below control Decreased length (3.7% below control) Increase deformation		1,703 mg/L (42 day)		van der Schalie 1985
Ø-NQ[5]	Fish–fathead minnow (*Pimephales promelus*)	Lethal	LC_{50}	34.5 mg/L (96 hr)	Slightly Toxic	van der Schalie 1985
	Water flea (*Ceriodaphnia dubia*)	Immobilization	EC_{50}	24.6 mg/L (48 hr)	Slightly Toxic	van der Schalie 1985

Notes:
[1] LC_{50} = concentration at which half of an exposed population dies after a short-term exposure; EC_{50} = concentration at which half of an exposed population exhibits an effect (often the endpoint) after a short-term exposure; IC_{50} = the concentration at which a 50% reduction (compared to control group) of a particular function occurs after a short-term exposure.
[2] Acute-toxicity rating scales: USFWS Research Information Bulletin. 1984. No. 84-78.
[3] There were no mortalities at the highest concentration.
[4] Immobilization was 16.7% at this concentration.
[5] Ø-NQ = This indicates photolyzed NQ. The increase in toxicity observed between NQ and Ø-NQ is presumably due to a photo-transformation product. No specific transformation product, however, was identified.

Key: hr = hour; mg/L = milligram per liter, NQ = nitroguanidine; NTO = 3-nitro-1,2,4-triazol-5-one.

Table A-5 Ecotoxicological Assays for Nitrate

Compound	Organism	Effect	Effect Endpoint[1]	Level at Measured Effect	Toxicity Rating[2]	Reference
Nitrate	Spotted caddis (*Hydropsyche accidentalis*) |Early instar larvae	Lethal	LC_{50}	4.5 mg/L (120 hr)	Moderately Toxic	Reviewed in Camargo et al. 2005
	Water flea (*Ceriodaphnia dubia*) Neonate (<24 hr)	Lethal	LC_{50}	374 mg/L (48 hr)	Practically Non- toxic	Reviewed in Camargo et al. 2005
	Asian tiger shrimp (*Penaeus monodon*)–Juvenile	Lethal	LC_{50}	1,449 mg/L (96 hr)	Relatively Harmless	Reviewed in Camargo et al. 2005
	Fish–rainbow trout (*Oncorhynchus mykiss*) Fingerling	Lethal	LC_{50}	1,355 mg/L (96 hr)	Relatively Harmless	Reviewed in Camargo et al. 2005
	Fish–rainbow trout (*Oncorhynchus mykiss*) Eggs (nonanadromous)	Lethal	LOEC	1.1 mg/L (30 d)		Reviewed in Camargo et al. 2005
	Fish–rainbow trout (*Oncorhynchus mykiss*) Fry (nonanadromous)	Lethal	LOEC	2.3 mg/L (30 d)		Reviewed in Camargo et al. 2005
	Fish–Chinook salmon (*Oncorhynchus tshawytscha*) Fingerling	Lethal	LC_{50}	1,310 mg/L (96 hr)	Relatively Harmless	Reviewed in Camargo et al. 2005
	Fish–Chinook salmon (*Oncorhynchus tshawytscha*) Fry	Lethal	LOEC	4.5 mg/L (30 d)		Reviewed in Camargo et al. 2005
Nitrate	Fish–Coho salmon (*Oncorhynchus kisutch*) Eggs and Fry	No Effect	NOEC	4.5 mg/L (30 d)		Reviewed in Camargo et al. 2005

Notes:

[1] LC_{50} = concentration at which half of an exposed population dies after a short-term exposure; LOEC = Lowest Observed Effect Concentration is the lowest tested concentration of a chemical in which a statistically significant response from the control response was observed; NOEC = No Observed Effect Concentration.

[2] Acute-toxicity rating scales: USFWS Research Information Bulletin. 1984. No. 84-78.

Key: d = day; hr = hour; mg/L = milligrams per liter.

Table A-6 Ecotoxicological Assays for Nitrite

Compound	Organism	Effect	Effect Endpoint[1]	Level at Measured Effect	Toxicity Rating[2]	Reference
Nitrite (expressed as mg NO_2-N/L)	Fish–pike-perch (*Sander lucioperca*) Juvenile	Lethal	LC_{50}	6.1 mg NO_2-N/L (120 hr)	Moderately Toxic	Wuertz et al. 2013
	Fish–pike-perch (*Sander lucioperca*) Juvenile	Increased tissue/plasma concentration NO_2-N. Addition of chloride decreased plasma and muscle accumulation of NO_2		0.44 mg NO_2- N/L (42 day)		Wuertz et al. 2013
	Fish–Topeka shiner (*Notropis topeka*) Juvenile	Decreased growth	LOEC	5.53 mg NO_2- N/L) (30 day)		Adelman et al. 2009
	Fish–fathead minnow (*Pimephales promelus*) Juvenile	Decreased growth	LOEC	4.06 mg NO_2- N/L) (30 day)		Adelman et al. 2009
	Fish–pompano (*Trachinotus marginatus*) Juvenile	Lethal	LC_{50}	39.94 mg/L (96 hr)	Slightly Toxic	Costa et al. 2008
	Fish–rainbow trout (*Oncorhynchus mykiss*)	Lethal Toxicity decreased with increasing Cl^- conc.	LC_{50}	0.24 mg/L (96 hr) at 0.35 mg/L Cl^-	Highly Toxic	Rev. in Lewis and Morris 1986
	Fish–rainbow trout (*Oncorhynchus mykiss*)	Lethal Toxicity decreased with increasing Cl^- conc.	LC_{50}	3 mg/L (96 hr) at 10 mg/L Cl^-	Moderately Toxic	Rev. in Lewis and Morris 1986
	Fish–rainbow trout (*Oncorhynchus mykiss*)	Lethal Toxicity decreased with increasing Cl^- conc.	LC_{50}	11 mg/L (96 hr) at 40 mg/L Cl^-	Slightly Toxic	Rev. in Lewis and Morris 1986
	Fish–Chinook salmon *(Oncorhynchus tshawytscha)*–Fry	Lethal No Cl^- conc. given	LC_{50}	0.88 mg/L (96 hr)	Highly Toxic	Rev. in Lewis and Morris 1986

Notes:

[1] LC_{50} = concentration at which half of an exposed population dies after a short-term exposure; LOEC= Lowest Observed Effect Concentration is the lowest tested concentration of a chemical in which a statistically significant response from the control response was observed.

[2] Acute-toxicity rating scales: USFWS Research Information Bulletin. 1984. No. 84-78

Key: Cl^- = chloride ion; hr = hour; mg = milligram; mg/L = milligrams per liter; N/L = Nitrite/liter; NO_2- = nitrite ion;

Table A-7 Ecotoxicological Assays for Ammonia, Cyanamide, and Guanidine[1]

Compound	Organism	Effect	Effect Endpoint[2]	Level at Measured Effect	Toxicity Rating[3]	Reference
Ammonia	Fish–pompano (*Trachinotus marginatus*)–Juvenile	Lethal	LC_{50}	0.66 mg/L (96 hr): UIA-N	Highly Toxic	Costa et al. 2008
	Fish–rainbow trout (*Oncorhynchus mykiss*)	Lethal	LC_{50}	207 mg/L TAN (96 hr): Resting	Highly Toxic	Wicks et al. 2002
	Fish–rainbow trout (*Oncorhynchus mykiss*)	Lethal	LC_{50}	32.38 mg/L TAN (96 hr) Swimming	Highly Toxic	Wicks et al. 2002
	Fish–rainbow trout (*Oncorhynchus mykiss*)	Organ dysfunction or behavioral alterations	Ucrit	0.04 mg/L (52 mo): UIA-N		Thurston et al. 1984
	Fish–Coho salmon (*Oncorhynchus kisutch*)	Decreased swimming performance with increasing concentration of water and plasma ammonia	Ucrit			Wicks et al. 2002
	Shrimp–whiteleg shrimp (*Litopenaeus vannamei*)–Larvae	Lethal	LC50	Zoea 1 0.6 mg/L (24 hr) UIA-N	Highly Toxic	Lourdes Cobo et al. 2014
	Shrimp–whiteleg shrimp (*Litopenaeus vannamei*)–Larvae	Lethal	LC_{50}	Postlarvae 1 9 mg/L (24 hr) UIA-N	Moderately Toxic	Lourdes Cobo et al. 2014
	Fish–fathead minnow (*Pimephales promelus*)	Fecundity was decreased by 29% at even the lowest concentration tested (unionized ammonia 0.06 mg/L)				Armstrong et al. 2012
Cyanamide	Fish–sheepshead minnow (*Cyprindon variegatus*)	Lethal	LC_{50}	58 mg/L (96 hr)	Slightly Toxic	Reviewed in USEPA 2007
	Fish–rainbow trout (*Oncorhynchus mykiss*)	Lethal	LC_{50}	46 mg/L (96 hr)	Slightly Toxic	Reviewed in USEPA 2007
	Fish–rainbow trout (*Oncorhynchus mykiss*)	Lethal	LC_{50}	11.8 mg/L (21 days)	Slightly Toxic	Reviewed in USEPA 2007
	Mysid shrimp (*Mysiodopsis bahia*)	Lethal	LC_{50}	6.3 mg/L (96 hr)	Moderately Toxic	Reviewed in USEPA 2007
	Water flea *(Ceriodaphnia dubia)*	Decreased growth	EC_{50}	3.3 mg/L (48 hr)	Moderately Toxic	Reviewed in USEPA 2007
	Blue-green algae (*Anabaena flos aquae*)	Decreased growth rate	EC_{50}	0.65 mg/L (72 hr)	Highly Toxic	Reviewed in USEPA 2007
Guanidine	Mayfly (*Cloeon dipterum*) nymphs	Lethal	LC_{50}	15 mg/L (6 hr)	Slightly Toxic	Reviewed in NIH n.d.
	Mayfly (*Cloeon dipterum*) nymphs	Lethal	LC_{50}	2 mg/L (48 hr)	Moderately Toxic	Reviewed in NIH n.d.

Notes:
[1] No aquatic toxicological studies were found for the following transformation products: Nitrosguanidine; Nitrourea; Hydroxyguanidine; 1,2-dihydro-3H-1,2,4-triazol-3-one; N-(5-amino-2-methoxyphenyl) acetamide; 3,3’-Diamino-4,4’dimethoxy-azobenzene; 3,3’-Diamino-

[2] LC_{50} = concentration at which half of an exposed population dies after a short-term exposure; EC_{50} = concentration at which half of an exposed population exhibits an effect (often the endpoint) after a short-term exposure; Ucrit = critical swimming velocity, a measure of swimming performance.
[3] Acute-toxicity rating scales: USFWS Research Information Bulletin. 1984. No. 84-78.
Key: hr = hour; mg/L = milligram per liter; mo = month; TAN = Total ammonia-Nitrogen; UIA-N = unionized ammonia-Nitrogen.

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A-2: Ecotoxicology Assays for TNT

The following is excerpted from the Summary Review of the Aquatic Toxicology of Munitions Constituents prepared for the U.S. Army Corps of Engineers (Lotufo et al. 2013)

Numerous aquatic toxicity studies have reported that TNT causes decreased survival in a number of aquatic invertebrate and fish species, typically at concentrations ranging from 1 to 10 mg L-1 (Nipper et al. 2009). The lethal toxicity of TNT to marine fish and invertebrates is summarized and compared using median lethal concentration (LC_{50}) values [Table A-8].

Exposure of the marine species *Sciaenops ocellatus* (redfish) to TNT for 2 days during the hatching period (Nipper et al. 2001) generated an LC_{50} value higher than that reported for *Cyprinodon variegatus* (sheepshead minnow) exposed for 5 days. Toxicity data for longer exposure duration is not available for redfish.

Most invertebrates investigated exhibited similar sensitivities to TNT and overall less sensitivity than fish [Table A-8]. Mysid shrimp were the most sensitive species, while adult mussels were the most tolerant among the invertebrate species investigated. The relative high tolerance of adult mussels has also been observed for other contaminant classes. For example, 96 h LC_{50} values for several organophosphorus pesticides ranged from 23 to >56 mg L-1 for *M. galloprovincialis*, while LC_{50}s were generally 3-4 orders of magnitude lower in comparable exposures with fish (Serrano et al. 1995).

The TNT acute toxicity values derived for marine fish and invertebrates are comparable to those reported for freshwater organisms [Table A-9], suggesting relatively similar sensitivity among all aquatic fish and invertebrates. The toxicity of TNT was compared to that of its major transformation products 1,3,5-TNB, 2-Am-DNT and 2,4-DANT using sheepshead minnows (Lotufo et al. 2010a). Nitro-reduction appears to decrease the toxicity of TNT to sheepshead minnows, as the LC_{50} for the mono-aminated compound 2-Am-DNT was approximately 4 times higher than that for TNT. Further amination appears to decrease toxicity even more dramatically, as the highest tested concentration for 2,4-DANT was 20 times higher than the LC_{50} for TNT and yet that concentration failed to promote significant mortality [Table A-8].

Freshwater species varied in their relative sensitivity to lethal toxicity of TNT and its major aminated transformation products [Table A-10]. The toxicity of 2-Am-DNT was lower than that of TNT for fathead minnows. For larvae of the frog *Xenopus laevis*, the toxicity of 2-Am-DNT and 4-Am-DNT were also lower than that of TNT. For invertebrates, 2-Am-DNT exhibited toxicity similar to that of TNT. The compound 2,4-DANT was more toxic than TNT for *Hyalella azteca* but substantially less toxic to *Chironomus dilutus* (formerly known as *C. tentans*). The compound 1,3,5-TNB was more toxic than TNT to sheepshead minnows and fathead minnows, as well as for the invertebrates *Daphnia magna* and *Hyalella azteca*, but was almost identically lethal as TNT to *Chironomus dilutus*.

Table A-8 Lethal Toxicity Data for Marine Fish and Invertebrates Exposed to TNT and Related Compounds

Species	MC	Duration (d)	LC_{50} (mg L^{-1})	Reference
Sheepshead minnow *Cyprinodon variegatus*	TNT	10	2.3	Lotufo et al. 2010a
	TNT	5	1.7	Lotufo et al. 2010a
	2-Am-DNT	5	8.6	Lotufo et al. 2010a
	2,4-DANT	5	No lethal effects at 50.3 mg L^{-1} [a]	Lotufo et al. 2010a
	1,3,5-TNB	5	1.2	Lotufo et al. 2010a
Redfish *Sciaenops ocellatus*	TNT	2	7.6	Nipper et al. 2001
	2,4-DNT	2	48	Nipper et al. 2001
	2,6-DNT	2	28	Nipper et al. 2001
	1,3,5-TNB	2	1.2	Nipper et al. 2001
Oyster (larvae) *Crassostrea gigas*	TNT	4	8.2	Won *et al.* 1976
Mussel (adult) *M. galloprovincialis*	TNT	4	19.5	Rosen and Lotufo 2007a
Mysid shrimp *Americamysis bahia*	TNT	4	0.98	Nipper et al. 2001
	2,4-DNT	4	4.4	Nipper et al. 2001
	2,6-DNT	4	5.0	Nipper et al. 2001
	1,3,5-TNB	4	0.74	Nipper et al. 2001
Copepod *Tigriopus californicus*	TNT	3	5.3	Won *et al.* 1976
	2-Am-DNT	3	No lethal effects at 50 mg L^{-1} [a]	Won *et al.* 1976
	2,4-DANT	3	No lethal effects at 50 mg L^{-1} [a]	Won *et al.* 1976
	2,6-DANT	3	No lethal effects at 50 mg L^{-1} [a]	Won *et al.* 1976
Copepod *Nitocra spinipes*	TNT	4	7.6	Dave et al. 2000
	2,4-DNT	4	17	Dave et al. 2000
Polychaete *Dinophilus gyrociliatus*	TNT	7	5.6	Nipper et al. 2001
	2,4-DNT	7	20	Nipper et al. 2001
	2,6-DNT	7	13	Nipper et al. 2001
	1,3,5-TNB	7	1.6	Nipper et al. 2001
Amphipod *Eohaustorius estuarius*	TNT	4	4.5	Rosen and Lotufo, unpublished
Amphipod *Leptocheirus plumulosus*	TNT	4	3.6	Rosen and Lotufo, unpublished

LC_{50} - Median lethal concentration, [a] Highest concentration tested.

(Excerpted from Lotufo et al. 2013)

Table A-9 Lethal Toxicity Data for Freshwater Fish, Amphibians, and Invertebrates Exposed to TNT

Species	Duration (d)	LC_{50} (mg L^{-1})	Reference
Bullfrog (tadpole) *Rana catesbeiana*	4	40.3	Paden et al. 2011
Frog (tadpole) *Xenopus laevis*	4	3.8	Saka et al. 2004
Fathead minnow *Pimephales promelas*	10	2.2	Yoo et al. 2006
Pimephales promelas	4	2.9	Liu et al. 1983a
Bluegill *Lepomis macrochirus*	4	2.6	Liu et al. 1983a
Rainbow trout *Oncorhynchus mykiss*	4	0.8	Liu et al. 1983b
Channel catfish *Ictalurus punctatus*	4	2.4	Liu et al. 1983a
Amphipod *Hyalella azteca*	4	3.6	Sims and Steevens 2008
Oligochaete *Lumbriculus variegatus*	2	5.2	Liu et al. 1983b
Oligochaete *Tubifex tubifex*	4	7.7 [a]	Conder et al. 2004c
Cladoceran *Daphnia magna*	4	5.1	Johnson et al. 1994
Cladoceran *Ceriodaphnia dubia*	7	No lethal effects at 6.1 mg L^{-1} [b]	Griest et al. 1998
Midge (larva) *Chironomus tentans*	4	1.9	Conder et al. 2004c
Rotifer *Branchionus calyciflorus*	1	5.6	Toussaint et al. 1995

LC_{50} - median lethal concentration, [a] Based on nominal concentrations, [b] Highest concentration tested.

(Excerpted from Lotufo et al. 2013)

Table A-10 Lethal Toxicity Data for Freshwater Fish, Amphibians, and Invertebrates Exposed to TNT

Species	Duration (d)	LC_{50} (mg L^{-1}) TNT	2-Am-DNT	4-Am-DNT	2,4-DANT	2,6-DANT	1,3,5-TNB	Reference
Marine species								
Sheepshead minnow *Cyprinodon variegatus*	5	1.7	8.6	ND	No effect at 50.3 mg $L^{-1\,a}$	ND	1.2	Lotufo et al. 2010a
Freshwater species								
Frog tadpole *Xenopus laevis*	4	3.8	32.7	22.7	ND	ND	ND	Saka et al. 2004
Fathead minnow *Pimephales promelas*	4	2.4	14.8	6.9	ND	ND	1.0	Pearson et al. 1979
Cladoceran *Daphnia magna*	2	11.9	4.5	5.2	ND	ND	2.7	Pearson et. al. 1979
	4	5.1	1.1	5.1	ND	ND	ND	Johnson et al. 1994
Cladoceran *Ceriodaphnia dubia*	7	No effect at 6.0 mg $L^{-1\,a}$	4.9	6.6	No effect at 0.2 mg $L^{-1\,a}$	No effect at 2.0 mg $L^{-1\,a}$	No effect at 2.0 mg $L^{-1\,a}$	Griest et al. 1998
Amphipod *Hyalella azteca*	4	3.6	3.8	9.2	1.7	ND	2.3	Sims and Steevens 2008
Midge (larva) *Chironomus dilutus*	4	1.9	3.3	ND	33.3	ND	2.2	Lotufo, unpublished

LC_{50} - median lethal concentration, ND - not determined, [a] Highest concentration tested, [b] The No observed effect concentration was 3.0 and lowest observed effect concentration was 6.0 mg L^{-1}.

(Excerpted from Lotufo et al. 2013)

A-3: Ecotoxicology Assays for RDX and HMX

The following is excerpted from the Summary Review of the Aquatic Toxicology of Munitions Constituents prepared for the U.S. Army Corps of Engineers (Lotufo et al. 2013)

RDX caused decreased survival of some fish and aquatic invertebrate species at concentrations similar to those reported as acutely toxic for TNT. Other fish species and aquatic invertebrates exhibited decreased survival in exposure to concentrations approaching or exceeding 40 mg L-1 [Table A-11], the approximate solubility limit for this compound in water. Lotufo et al. (2010b) and ENSR International (2005) reported similar toxicity values for RDX to sheepshead minnows [Table 4-9]. Test-organisms in both studies were approximately two-week-old juvenile fish. ENSR International (2005) reported 96-h LC50 values for two species of marine fish that were lower than that for sheepshead minnows [Table 4-11]. A saturated aqueous solution of RDX did not promote any effects on redfish during a 48-h embryo hatching and larval survival test (Nipper et al. 2001). The toxicity of RDX to 5 species of freshwater fish suggest they are similarly sensitive to the lethal effects of RDX as marine species (reviewed in Talmage et al. 1999 and Nipper et al. 2009; see also Muhki et al. 2005, Muhki and Patino 2008, and Warner et al. 2012).

A variety of aquatic invertebrate species, both marine and fresh water, were tolerant to the lethal effects of RDX (Peters et al. 1991; Burton et al. 1993; Dave et al. 2000; Nipper et al. 2001; ENSR International 2005; Rosen and Lotufo 2007a; Gust et al. submitted). Exposure to RDX at 28 mg L-1 or higher failed to elicit mortality in adult mussels, Dungeness crabs, mysid shrimp, polychaetes, amphipods and copepods, and failed to impair normal development of embryonic mussels and echinoderms (e.g., urchins) and exposure to RDX at 7.2 mg L-1 failed to elicit mortality of the coral *Acropora formosa* [Table 4-11].

Table A-11 Lethal and Sublethal Toxicity Data for Marine Fish and Invertebrates Exposed to RDX and HMX

Species	MC	Duration (d)	Effects Concentration (mg L^{-1})	Reference
Sheepshead minnow *Cyprinodon variegatus*	RDX	10	9.9 (LC_{50})	Lotufo et al. 2010b
	RDX	4	9.8 (LC_{50})	ENSR International 2005
	HMX	5	No lethal effects at 2 [a]	Lotufo et al. 2010b
Inland silverside *Menidia beryllina*	RDX	4	7.1 (LC_{50})	ENSR International 2005
Speckled sand dab *Citharichthys stigmaeus*	RDX	4	2.4 (LC_{50})	ENSR International 2005
Redfish *Sciaenops ocellatus*	RDX	2	No lethal effects at 68 [a, b]	Nipper et al. 2001
Mussel *Mytilus galloprovincialis* (adult)	RDX	4	No lethal effects at 28 [a]	Rosen and Lotufo 2007a
(embryo)	RDX	2	No developmental effects at 28 [a]	Rosen and Lotufo 2007a
(embryo)	RDX	2	No developmental effects at 47 [a]	ENSR International 2005
(adult)	HMX	4	No lethal effects at 2 [a]	Rosen and Lotufo 2007a
(embryo)	HMX	2	No developmental effects at 2 [a]	Rosen and Lotufo 2007a
Mysid shrimp *Americamysis bahia*	RDX	4	No lethal effects at 47 [a]	Nipper et al. 2001
	RDX	4	No lethal effects at 53 [a]	ENSR International 2005
Dungeness crab *Cancer magister*	RDX	4	No lethal effects at 41 [a]	ENSR International 2005
Sand dollar (embryo) *Dendraster excentricus*	RDX	3	No lethal effects at 41 [a]	ENSR International 2005
Sea Urchin *Arbacia punctulata*	RDX	2	No developmental effects at 75 [a,b]	Nipper et al. 2001
Polychaete *Dinophilus gyrociliatus*	RDX	7	No lethal effects at 49 [a]	Nipper et al. 2001
	RDX	7	26 Reproduction (EC_{50})	Nipper et al. 2001
Polychaete *Neanthes arenaceadentata*	RDX	4	No lethal effects at 43 [a]	ENSR International 2005
Copepod *Nitocra spinipes*	RDX	4	No lethal effects at 36 [a]	Dave et al. 2000
Amphipod *Eohaustorius estuarius*	RDX	4	No lethal effects at 39 [a]	Rosen and Lotufo, unpublished data

Species	MC	Duration (d)	Effects Concentration (mg L^{-1})	Reference
Amphipod *Leptocheirus plumulosus*	RDX	4	No lethal effects at 39 [a]	Rosen and Lotufo, unpublished
Coral *Acropora formosa*	RDX	g	No lethal effects at 7.2 [a]	Gust et al. (in preparation)
Alga *Ulva fasciata*	RDX	4	8.1 Germling length (EC_{50})	Nipper et al. 2001

EC_{50} - Median effective concentration, a - Highest concentration tested, [b] Reported as target concentrations exceeding the solubility limit of 56.3 mg L^{-1} (Table 3.1).

(Excerpted from Lotufo et al. 2013)

APPENDIX F–MUNITIONS CONSTITUENTS

Appendix F:

MUNITIONS CONSTITUENTS

PROPOSED MORTAR AND ARTILLERY TRAINING AT RICHARDSON TRAINING AREA, JOINT BASE ELMENDORF-RICHARDSON, ALASKA

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LIST OF ACRONYMS AND ABBREVIATIONS

µg cm^2/hr	microgram per square centimeter per hour
2,4-DNT	2,4-dinitrotoluene
2,6-DNT	2,6-dinitrotoluene
BCF	bioconcentration factor
BIP	blow-in-place
BMD	benchmark dose
Comp B	Composition B
CRREL	Cold Regions Research and Engineering Laboratory
DNAN	2,4-dinitroanisole
DNT	dinitrotoluene
EIS	Environmental Impact Statement
ERF	Eagle River Flats
ERF-IA	Eagle River Flats Impact Area
HC	hexachloroethane
HE	high explosive
HMX	High Melting Explosive
HO	high-order
IM	insensitive munitions
IMX	Insensitive Munitions Explosives
JBER	Joint Base Elmendorf-Richardson
Kd	soil sorption distribution coefficient
LANL	Los Alamos National Laboratory
LD_{50}	median lethal dose
LO	low-order
LOAEL	lowest observed adverse effect level
LOEC	lowest observed effect concentration
mg/kg	milligram per kilogram
mm	millimeter
NOAEL	no observed adverse effect level
NOEC	no observed effect concentration
NQ	nitroguanidine
NTO	nitrotriazolone
PAX-21	Picatinny Arsenal Explosive 21
PMART	Proposal for Mortar and Artillery Training
RDX	Research Department Explosive
SERDP	Strategic Environmental Research and Development Program
TF	transfer factor
TNB	trinitrobenzene
TNT	trinitrotoluene
TRV	toxicity reference value

U.S.C.	United States Code
USEPA	United States Environmental Protection Agency
UV	ultraviolet
UXO	unexploded ordnance
WP	white phosphorus

1. INTRODUCTION

This appendix provides information on the type, deposition, breakdown pathways, and potential toxicity of constituents associated with munitions that would be used under alternatives analyzed in the Joint Base Elmendorf-Richardson (JBER) Proposed Mortar and Artillery Training (PMART) Environmental Impact Statement (EIS). Munitions constituents including explosive materials and metal compounds may have deleterious effects on fish, wildlife, invertebrates, and plants. Consequently, it is important to identify constituent concentrations and doses that may elicit adverse responses from a receptor, be it an animal or plant, following exposure to the constituent. The purpose of this appendix is to present readily available scientific information that can be used to help evaluate potential toxicological impacts to sensitive ecological receptors under all alternatives analyzed in the EIS. This appendix references project details that are described in Chapter 2 of the EIS and provides supporting information for the effects analysis presented in Chapter 3 of the EIS.

Information provided in this appendix includes the following:

- Potential contaminants of concern associated with munitions that would be used under the alternatives
- Estimated deposition of munitions contaminant residues in Eagle River Flats (ERF) Impact Area (ERF-IA)
- Potential exposure pathways as well as fate and transport of contaminants
- Present benchmarks and exposure limits for various munition constituents for plant, invertebrate, fish, and wildlife receptors

The availability of toxicity data and benchmarks vary widely across both munition constituents and receptor type. Reviews of the available toxicity data for some munitions are available in the literature and have been used to derive media-specific benchmarks protective of particular receptors (e.g., fish, birds) and exposure pathways (e.g., direct contact, ingestion). For other munitions, toxicity data for some receptors are available in the literature, and additional studies are being published by active researchers.

2. MUNITIONS CONSTITUENTS

For the purpose of the EIS and pertinent supporting documents, the term “munitions constituent” refers to any material originating from unexploded ordnance (UXO), discarded military munitions, or other military munitions; this includes explosive and non-explosive materials and emission, degradation, or breakdown elements of such ordnance or munitions (10 United States Code [U.S.C.] § 2710[e][3]). Munitions constituents are typically divided into three main categories (explosives, propellants, and metals), but this appendix also considers illuminants. Munitions constituents also include a variety of secondary explosives, such as pyrotechnics (e.g., smoke-producing agents) (Rectanus et al. 2015).

Both high explosive (HE) and non-HE munitions contain a variety of chemical compounds, as shown in Table 1. Primary munitions constituents (more than 97 percent by weight) of mortar and howitzer HE rounds are explosives, iron (steel), aluminum, and copper. The remaining 2 to 3 percent of the munitions’ weight is characterized by other compounds consisting of trace amounts of other metals (e.g., zinc, manganese, nickel, chromium, and cadmium) that are generally components of steel or iron alloys, as well as propellants and pyrotechnics (e.g., hexachloroethane [HC], nitrocellulose, and nitroglycerine). In addition to other components, the 155-millimeter (mm) training round contains about 21.8 kilograms of concrete filler. While white phosphorus (WP) would not be fired in ERF-IA under any of the alternatives analyzed in the EIS, information is included because WP is still present in the capped areas and could be discharged if the caps are damaged. Table 1 lists the munition constituents by cartridge type.

Traditional munitions that have historically been used at ERF-IA, such as Composition B (Comp B), trinitrotoluene (TNT), Research Department Explosive (RDX), and 1,3,5,7-octahydro-1,3,5,7-tetranitrotetrazocine (High Melting Explosive, or HMX), are being phased out in favor of insensitive munitions (IMs), such as Insensitive Munitions Explosives (IMX)-101 and IMX-104, which are more resistant to shock than current formulations and are therefore less prone to unplanned detonations. IMs are constructed to resist external stimuli such as bullet impact or fire, and because of that, they resist unintentional detonation. This insensitivity results in less efficient detonation, differential performance among the formulation components, and increased deposition of residues caused by sympathetic detonations of UXO (Walsh et al. 2017).

While the primary HE compounds in IMs are different than those found in traditional munitions, many IMs have the same auxiliary components (e.g., fuzes, transfer charges, supplemental charges) or detonation composition as traditional munitions. For instance, IMX-104 is a mixture of 2,4-dinitroanisole (DNAN), nitrotriazolone (NTO), and RDX, and low levels of RDX and HMX are often present in munition fuzes and other components (Walsh et al. 2017). Other HE munitions used at ERF-IA also include mixtures: IMX-101 is a mixture of DNAN, NTO, and nitroguanidine (NQ), while Comp B is a mixture of RDX and TNT. Additionally, degradation products are of interest as well as they may result in different effects to organisms. Common TNT degradation products from HE munitions include 2-amino-4,6-dinitrotoluene and 4-amino-2,6-dinitrotoluene (Jenkins et al. 2006). Other TNT degradation products from propellants may include 2,4-dinitrotoluene (DNT), 2,6-DNT, and trinitrobenzene (TNB), but they are not likely to be present in HE munitions (Walsh et al. 2008; Walsh et al. 2010)..

Some possible breakdown products (e.g., cyanide) are more toxic than their derivative compound (e.g., NQ). In many cases, more toxicity information is available for the individual munition constituents rather than for the munition product mixture (e.g., IMX). In these instances, each of the individual compounds may be analyzed and evaluated individually to determine the ecological risks of introducing the mixture to ERF-IA, as each compound may affect plant and animal resources differently.

Other compounds, such as waxes and silicon, represent just a few grams of the overall weight of munitions. The projectile body, which is the only part of the munition that lands in the impact area, is typically made of steel or iron. Many of the rounds have copper alloy rotating bands. Fuzes and fins are made of aluminum. During a high-order (HO) detonation of an HE round, the metals are discharged as shrapnel and essentially everything else is consumed. Non-HE rounds are not expected to generate shrapnel, so the shell would remain intact in the impact area. Shrapnel from HE rounds would distribute metal fragments over a larger impact area, whereas contamination from non-HE rounds would be localized to the specific detonation site.

Table 1 Mortar and Artillery Rounds Proposed for Use at ERF-IA, with Filler Constituents

<table>
<tr><th>Caliber</th><th>Type</th><th>Cartridge</th><th>Department of Defense Ammunition Code No.</th><th>Filler</th></tr>
<tr><td colspan="5">Mortar</td></tr>
<tr><td rowspan="5">60-mm</td><td rowspan="2">HE</td><td>M720A2</td><td>BA44</td><td>IMX-104</td></tr>
<tr><td>M768A1 w/M783 PD fuze</td><td>BA45</td><td>IMX-104</td></tr>
<tr><td rowspan="2">ILLUM</td><td>M721 w/M766 MTSQ fuze</td><td>B647</td><td>Illuminant</td></tr>
<tr><td>M767 w/M776 MTSQ fuze</td><td>BA04</td><td>Illuminant, Infrared</td></tr>
<tr><td>FRTR</td><td>M769 w/M775 PD fuze</td><td>BA15</td><td>None (hollow body)</td></tr>
<tr><td rowspan="5">81-mm</td><td rowspan="2">HE</td><td>M889A4 w/M783 fuze</td><td>CA63</td><td>IMX-104</td></tr>
<tr><td>M821A1 w/M734 MOF</td><td>C868</td><td>Comp B</td></tr>
<tr><td rowspan="2">ILLUM</td><td>M816 w/M772 MTSQ</td><td>C484</td><td>Illuminant, Infrared</td></tr>
<tr><td>M853A1 w/M772 MTSQ</td><td>C871</td><td>Illuminant</td></tr>
<tr><td>FRTR</td><td>M879 w/Practice fuze M751</td><td>C875</td><td>Hydrocal (inert) (gypsum cement)</td></tr>
<tr><td rowspan="5">120-mm</td><td rowspan="2">HE</td><td>M934A1 W/MOF M734A1</td><td>CA04</td><td>Comp B</td></tr>
<tr><td>M933A1 w/PD fuze M783</td><td>CA44</td><td>Comp B</td></tr>
<tr><td rowspan="2">ILLUM</td><td>M930 w/M776 MTSQ</td><td>C625</td><td>Illuminant</td></tr>
<tr><td>M983 w/M776 MTSQ</td><td>CA07</td><td>Illuminant, Infrared</td></tr>
<tr><td>FRTR</td><td>M931 w/Practice fuze M781</td><td>CA09</td><td>None (hollow body)</td></tr>
<tr><td colspan="5">Howitzer</td></tr>
<tr><td rowspan="5">105-mm</td><td rowspan="2">HE</td><td>M1</td><td>C445</td><td>Comp B or TNT</td></tr>
<tr><td>M1 w/o fuze</td><td>CA59</td><td>IMX-101</td></tr>
<tr><td rowspan="2">ILLUM</td><td>M314 w/o fuze</td><td>C541</td><td>Illuminant</td></tr>
<tr><td>M1064 w/o fuze</td><td>CA53</td><td>Illuminant, Infrared</td></tr>
<tr><td>Smoke</td><td>M84A1 w/o fuze</td><td>C479</td><td>HC</td></tr>
</table>

Caliber	Type	Cartridge	Department of Defense Ammunition Code No.	Filler
155-mm	HE	M795	DA54	IMX-101
		M795	D529	TNT
	ILLUM	M1066	DA49	Illuminant, Infrared
		M485	D505	Illuminant
		M1123	DA56	Illuminant, Infrared
		M1124	DA57	Illuminant
	HE Training Projectile	M1122	DA51	Concrete + IMX-101
		M1122A1	DA68	Concrete + IMX-104

Notes: All rounds listed could be used under Alternatives 1 and 2. Under the No Action Alternative, all rounds except 155-mm rounds could be used.
Key: Comp B = Composition B; ERF-IA = Eagle River Flats Impact Area; FRTR = Full Range Training Rounds; HE = high explosive; ILLUM = illuminant; IMX = Insensitive Munitions Explosives; mm = millimeter; MOF = Multi-Option Fuze; MTSQ = Mechanical Time Superquick; PD = Point Detonating; TNT = trinitrotoluene.
Source: U.S. Army 2017; S. Tucker, personal communication, 23 January 2023.

2.1. EXPLOSIVES

Explosive formulations historically used at ERF-IA include Comp B and 2,4,6-TNT. The chemical constituents of these formulations rely on combinations of TNT, RDX, and HMX. In general, these chemicals have been well characterized because of their prolific use in military and industrial explosives. In terms of toxicity, the three explosive compounds can be ranked as follows: TNT > RDX > HMX, with TNT having the largest potential impact to the environment (Rectanus et al. 2015). PAX-21 (Picatinny Arsenal Explosive 21) was a constituent of 60-mm HE mortars; it is primarily composed of the explosive DNAN, RDX, and ammonium perchlorate. However, the Army has discontinued use of PAX-21-filled rounds during training because of the amount of ammonium perchlorate they deposit. The Army still uses traditional explosives at ERF-IA; however, as previously mentioned, many rounds have been replaced with IMs. IMX-101, the IM replacement for TNT, contains the explosives DNAN (40–45 percent), NQ (35–40 percent), and NTO (18–23 percent) (Richard and Weidhaas 2014a, 2014b). IMX-104, the IM replacement for Comp B, contains the explosives NTO (53 percent), DNAN (32 percent), and RDX (15 percent) (Taylor et al. 2015). IMX-104 also contains HMX because technical grade RDX contains approximately 10 percent HMX (Arthur et al. 2018).

2.2. ILLUMINANTS

Illuminants and infrared illuminants are used for illuminating target areas. These devices use a mix that contains a small propellant charge that illuminates when ignited. Magnesium oxide and sodium nitrate are the primary constituents, although older formulations may contain other metal constituents (Hardt 2001, cited in Clausen et al. 2012). Metal residue deposition studies have found that illuminants do not contribute concentrations of metals to the environment above background levels (Clausen et al. 2012).

2.3. PROPELLANTS

Like explosives, military propellants can deposit residues on the ground. Propellants are designed to burn at a controlled rate and rapidly produce gases, thereby providing energy to deliver a munition to its target. The main difference between explosives and propellants is their reaction rate. While explosives react rapidly and result in the munition's casing breaking apart, propellants react slowly, providing sustained energy to propel a munition. Propellants, such as nitrocellulose, nitroglycerin, NQ, 2,4-DNT, and perchlorate, are found in cartridge cases (small arms, medium caliber munitions, some artillery), projectile externals (mortars, some artillery), rocket motors, and explosive charges. At JBER, they may be incorporated into devices such as signal flares, smoke-generating compounds, parachute flares, fuzes, and training simulators.

2.4. METALS

Metals are found in nearly all munitions used during live-fire training at ERF-IA. Uses of metals in munitions include casings, bullets, projectile cases, projectiles, bomb bodies, and fillers. The most commonly occurring metals at JBER and other military training sites, along with their roles in munitions and toxicity, are presented in Table 2. In addition to these metals, the munitions used at JBER also contain iron, manganese, nickel, and chromium. Although metals such as lead, antimony, copper, cadmium, and zinc can be found in trace amounts (including in fuze primary charges), lead is often the primary metal contaminant of concern at munitions sites. However, lead is not a major component of munitions used in live-fire training activities at JBER. Because aluminum, iron, magnesium, and other metals used in JBER munitions are not defined as hazardous elemental metals under the Comprehensive Environmental Response, Compensation, and Liability Act, further discussion of metals is limited to antimony, copper, lead, and zinc, which present the greatest potential for ecotoxicological impacts. A brief description from Rectanus et al. (2015) of natural physical attenuation pathways for these compounds is summarized below:

- Antimony: Sb(V) is assumed to be favored in water, while Sb(III) is only stable in anaerobic or moderately reducing conditions. Soluble forms are assumed to be very mobile with basic, oxidizing conditions favoring increased mobility (in contrast with other metals). Insoluble forms tend to sorb to clay, soil, and sediments where they are bound to extractable iron and aluminum. The Sb(III) form is more toxic and expected to be more prevalent than Sb(V) in the anoxic flats at ERF-IA whereas the less toxic Sb(V) form is more likely to be present in water (Li et al. 2019).
- Copper: Cu(II) is the most common soluble oxidation state of copper, which is more mobile at highly oxidizing acidic systems. However, in neutral to alkaline systems and sulfidic environments such as ERF, copper oxides are stable and highly insoluble, with low bioavailability.
- Lead: While lead is increasingly mobile in low pH ranges and oxidizing conditions, its aqueous solubility at near neutral to alkaline pH such as at ERF is slow. Lead forms stable aqueous complexes with hydroxyl species, carbonate, sulfate, and sulfide. At neutral to moderately alkaline conditions such as at ERF, lead complexes with carbonate are stable and predominate. In sulfate-reducing conditions, lead sulfide will precipitate to form an insoluble complex.
- Zinc: Zn(II) is the most common state of zinc. Zinc is one of the most mobile heavy metals because many of its compounds are soluble in acidic and neutral pH waters. Zinc precipitates readily with hydroxide, carbonate, and sulfide, which are favored at basic, reducing conditions such as those at ERF, and co-precipitates with hydrous oxides of iron or manganese, which decreases mobility.

Table 2 Commonly Occurring Metals in Munitions Constituents at JBER and other Training Facilities

Metal	Use	Toxicity	Component of JBER Munitions?
Aluminum (Al)	Incendiaries, composition explosives, propellants, pyrotechnics	Not a CERCLA hazardous elemental metal	**Yes**
Antimony (Sb)	Lead-based alloys in small arms bullets and pyrotechnics, fuze primary charges	Toxic metal that targets cardiovascular and respiratory systems	**Yes**
Copper (Cu)	Brass cartridge cases, bullet jackets, pyrotechnics and bronze gun barrels	Toxic metal that targets gastrointestinal, hematological, and hepatic systems	**Yes**

Metal	Use	Toxicity	Component of JBER Munitions?
Iron (Fe)	Steel projectiles, incendiaries, and pyrotechnics	Not a CERCLA hazardous elemental metal	**Yes**
Lead (Pb)	Small arms bullets, primary explosives, fuze primary charges	Group B2 carcinogen, toxic metal that targets cardiovascular, developmental, gastrointestinal, hematological, musculoskeletal, neurological, ocular, renal, and reproductive systems	**Yes**
Magnesium (Mg)	Incendiaries, pyrotechnics (photoflash), tracers, and armor piercing bullets	Not a CERCLA hazardous elemental metal	No
Zinc (Zn)	Cartridge cases (brass) bullet jackets (e.g., gilding metal), hexachloroethane smoke-filled munitions and pyrotechnics	Toxic metal that targets gastrointestinal, hematological, and respiratory systems	**Yes**

Notes: Only trace amounts of these metals are present in fuze primary charges.
Key: CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; JBER = Joint Base Elmendorf-Richardson
Source: Rectanus et al. 2015.

3. DEPOSITION OF MUNITIONS CONSTITUENTS

The primary mode of contaminant loading into the environment is direct deposition from live-fire exercises. Munitions constituents, including metal casing and energetic materials, are deposited into the environment during detonation of munitions. For munitions energetics, environmental deposition may be variable as a function of detonation type. HE munition detonations can be characterized into three types:

- HO Detonations: An HO detonation has traditionally been used to describe an event in which at least 99.9 percent of the explosive mass is consumed for conventional munitions. However, for IMs, NATO's Type I Detonation definition tends to provide a more accurate description of HO detonations, as the explosive mass consumed may be less than 99.9 percent (NATO 2018). The Type I Detonation is the most violent type of munition reaction, where the energetic material is consumed and the reaction causes rapid deformation of the metal casing, causing extensive high shear rate fragmentation.

  HO detonations are the typical outcome of firing rounds with traditional and IM explosives (typically about 95 percent of all events). Studies have shown that HO detonations for traditional munitions leave only trace amounts of residues at the detonation site (Walsh 2007; Walsh et al. 2011), with IM HO detonations resulting in higher residue quantities (approximately 1 percent of total energetic mass) (Walsh et al. 2014; Walsh et al. 2018; Beal et al. 2023). When munitions detonate as designed, HO detonations generally deposit only small quantities (less than 10 milligrams) of energetic compounds for traditional explosives and typically minor quantities (1 to 4 grams) for IMs, although higher residue quantities (up to 100 grams) may be deposited in larger 155-mm rounds (Walsh et al. 2018).

- Low-Order (LO) Detonation: An LO (or partial) detonation occurs when there is either incomplete consumption of the explosive filler or a round is breached when the fuze functions properly, but the filler fails to detonate. These type of detonations were traditionally characterized as having a detonation efficiency of between 75 and 99.99 percent (Walsh et al. 2017). However, recent studies have found much lower efficiencies, ranging between 39 and 82 percent (Bigl et al. 2021; Beal and Bigl 2022; Bigl et al. 2022). These detonations may result in distribution of particulate energetic residues at the impact site. Most residues are deposited on the surface, with the highest concentrations occurring near target areas. Testing conducted at Alaska military ranges has shown that LO detonations (in addition to UXO) are the major contributor of explosives residues on impact areas (Walsh et al. 2005a, 2005b). However, residue deposition is limited by their rare occurrences.

- UXO: UXO is defined as military munitions that (1) have been primed, fuzed, armed, or otherwise prepared for action; (2) have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installations, personnel, or materiel; and (3) remain unexploded, whether by malfunction, design, or any other cause (10 U.S.C. § 101[e][5]). UXOs, or duds, exist in ERF-IA. Because a variety of actions (including a change in pressure, weight, or heat) could trigger a detonation, UXO is a hazard wherever it occurs. UXO events are more common than LO detonations but occur much less frequently than HO detonations. Contaminant deposition rates from UXOs are comparatively slow, with time frames ranging from years to decades to centuries.

While metal munitions components are deposited regardless of detonation type, energetic mass (explosives) is consumable, and the resultant residue deposited is a function of detonation type. Therefore, deposition of munitions residue is dependent on rates of HO/LO detonations and UXO and the annual number of rounds fired.

3.1. MASS LOADING OF MUNITIONS RESIDUES

This section provides an estimate of munitions residues resulting from the proposed resumption of all-season, indirect live-fire activities within ERF-IA (Alternatives 1 and 2), as well as expanding live-fire training into the proposed expansion area (Alternative 1). Table 3 provides estimates of the total annual deposition of energetic residues (in grams) from HE traditional munitions based on the annual number of rounds that would be fired under Alternative 1 (ERF-IA and proposed expansion area) and Alternative 2 (ERF-IA only). The same amount of munitions would be fired under Alternatives 1 and 2. The "Proposed Project Totals" row of the table represents estimated total residue deposition at ERF-IA, based on a worst-case scenario in which all annual training events occur at JBER. The total annual deposition of energetic residues represents the sum of the residues for HO/LO detonations and duds. For comparison purposes, the estimated totals for the No Action Alternative are provided in Table 4.

This analysis assumes that munitions detonated in ERF-IA and the proposed expansion area would result in munitions residue deposition, as well as LO and dud rates, consistent with observations made during detonations of both traditional munitions and IMs (Dauphin and Doyle 2000; Walsh 2007; Walsh et al. 2017, 2018; Bigl et al. 2021, 2022; Beal and Bigl 2022; Beal et al. 2023). For the purpose of this analysis, it is assumed that all LO detonations consume 50 percent of the energetic mass of the munition and deposit the remaining 50 percent as munitions residue (RDX, TNT, HMX, IMX constituents). While it is expected that consumption of energetics in LO detonations is variable, ranging from 1 to 99 percent consumption, 50 percent consumption of energetics was assumed as an estimated median deposition rate from all LO detonations over time. This analysis also assumes that dud rounds consume none of the energetic material and deposit 100 percent of the explosive mass into the environment over time.

It should be noted that because this analysis was based on detonations of traditional munitions rather than IMs, the residue quantities for HO detonations are likely to be underestimated. Whereas HO detonations of traditional munitions only result in trace amounts of residue, HO residue deposition of IMs has been found to equate to approximately 1 percent of the total energetic mass of the projectile (Walsh et al. 2018; Beal et al. 2023). For example, annual residue from HO detonation of 144 155-mm howitzer rounds is expected to only result in trace amounts of residue (15 grams) for traditional munitions whereas HO detonation residue from firing of IM rounds could result in 11 kg of residue, which is several orders of magnitude greater. Thus, if only IMs are used instead of traditional munitions, the amount of total residue deposition in ERF-IA may be up to 36 percent greater. However, the ratio of traditional munitions to IMs that would actually be fired at JBER is unknown and IM residue deposition rates are still being studied.

The LO and dud estimates are intended to be conservative (overestimate) and inclusive of IM rounds, which are constructed to resist external stimuli, potentially leading to a less-efficient detonation, differential performance among the formulation components, and increased deposition of residues caused by sympathetic detonations of UXO when compared to traditional explosives (Walsh et al. 2017). Based on recent studies that have found lower efficiencies for LO detonations (between 39 and 82 percent) (Bigl et al. 2021; Beal and Bigl 2022; Bigl et al. 2022), an assumption of 50 percent deposition for the median deposition for LO detonations and 100 percent deposition for duds was used for the analysis. This is likely a conservative estimate of deposition but since IMs are known to result in greater deposition during HO and LO events, these rates were used as a proxy to estimate total munitions residue deposition at ERF-IA since IMs were not included in the analysis.

The number of HO/LO detonations and duds is estimated based on the findings of Dauphin and Doyle (2000). Testing conducted at Alaska military ranges has shown that LO detonations (in addition to UXO) are the major contributor of explosives residues on impact areas (Walsh et al. 2005a, 2005b). However, the rate of LO detonation is typically very low (between 0.1 and 0.3 percent) (Dauphin and Doyle 2000, 2001), with LO detonations of HE munitions observed at an extremely low frequency of 0.09 percent (Dauphin and Doyle 2000). Although no site-specific data are available, it is anticipated that LO detonation rates at

ERF-IA for both traditional explosives and IMs would be similar to these documented rates (B. Hubbard, U.S. Army, personal communication, 28 March 2024).

UXOs tend to occur with greater frequency than LO rounds. Dauphin and Doyle (2000) estimated the approximate dud rate for traditional HE rounds during live-fire exercises to be 3.37 percent. Although the IM dud rate is not publicly available, it is expected be lower than that of traditional munitions (<1 percent dud rate) due to recent improvements in munition manufacturing and quality control processes. Dud rates are known to increase as munitions age and are higher for detonations under extreme cold conditions and when delay fuzes (which will not be used at ERF-IA) are used (B. Hubbard, U.S Army, personal communication, 28 March 2024). The 3.37 percent dud rate is also substantially higher than the dud rate observed at ERF-IA at JBER and other ranges in Alaska over the past 20 years. During USACE WP cleanup efforts, a much lower number of UXOs was observed than anticipated by the assumed dud rate (USACE 2005). Additionally, during training, units are required to observe all rounds, cease fire if a round is not observed, and report all rounds not observed exploding to Range Control. Incidents with unobserved rounds are investigated. Across the Army, units are required to report UXO during artillery and mortar training. Ammunition lots with reported UXOs are typically pulled from training accounts, which tends to lower the rate of UXOs in training. The 3.37 percent dud rate cited by Dauphin and Doyle (2000) has been used to estimate residue deposition in Tables 3 and 4 because it is an overestimate that considers variability in dud rates from use of IMs and other factors and provides a worst-case scenario for potential exposure to ecological receptors.

Corrosion of UXO shell casing may result in the deposition of munitions constituents to the environment. Leaching of energetics from UXOs could result in changes in sediment and water quality that could affect fish and wildlife species. The time to perforation due to corrosion of UXO casing, exposing contained energetic compounds to the environment, can range from years to several thousands of years (Packer et al. 2004). Packer et al. (2004) estimated the time to perforation due to corrosion of 0.25-inch metal casing of UXOs in ecosystems including desert, forest/grassland, and temperate forest and modeled perforation times ranging from 8 to 760 years, depending on a variety of environmental variables. While no site-specific evidence is available for corrosion of UXO in ERF-IA, modeling indicated that UXO in temperate forest ecosystems (which have temperature and moisture levels most similar to ERF) would be expected to perforate in 30 to 170 years (Packer et al. 2004). In highly reducing conditions found in wetlands and other anaerobic and flooded environments such as ERF-IA, small openings would probably start to appear in the casing within 10 to 40 years (Taylor et al. 2004). Brackish conditions at ERF-IA could increase corrosion rates of UXO casing.

While a timeline for corrosive perforation of UXOs is difficult to predict, observations from Taylor et al. (2011) indicated that corrosive perforation/pitting is not an important deposition route for HE, as iron oxides tend to quickly seal small holes. Instead, the primary route of deposition of HE from UXOs comes from cracked casings and larger perforations due to fragmentation hits. Taylor et al. (2011) investigated 42 UXO samples of calibers ranging from 60 to 150 mm at ERF-IA, San Luis Obispo in California, and Vieques in Puerto Rico. Observations indicate that only approximately 16 percent of UXOs were found to be leaking HE residue. The UXOs sampled at ERF-IA included nine 60-mm munitions, with two leaking HE residue. One of the UXOs had a failed fuse and was cracked on impact with the target (Jeep), and the other was punctured by fragment hits. The other seven UXOs were not found to be leaking HE residue.

Only small amounts of explosives in the UXO are exposed to the environment as the UXO corrodes over time. According to modeling conducted by Cold Regions Research and Engineering Laboratory (CRREL) researchers, corroding UXO contributes only a small proportion to the net change in overall dissolved HE residues in an impact area. Studies suggest that reducing conditions at ERF-IA could cause the explosives to break down as fast as they are discharged to the environment, and it is possible that reactive intermediates formed during metal corrosion may facilitate the degradation of RDX, TNT, and other explosives (Taylor et al. 2004). Singh et al. (1998) showed that the presence of iron can increase the rate and extent of RDX degradation. As the steel casing of a UXO corrodes, an iron-rich environment is created in soils around the

UXO, potentially accelerating degradation of the explosive. It should be noted that these studies only pertain to traditional explosives. IM constituents differ in fate/transport pathways and toxicity; NTO and NQ in particular pose a greater risk of discharge to the aquatic ecosystem due to their increased solubility and mobility, as described further in Section 4.2.

Information provided by Walsh (2007) was used to estimate the energetic residues for HO/LO detonations and duds for each munition type. The total annual deposition of energetic residues represents the sum of the residues for HO/LO detonations and duds. Consequently, it is estimated that a total of approximately 226.1 kilograms of HE munitions residue would be deposited annually at ERF-IA under Alternative 1, which includes 211.3 kilograms of residue in the existing ERF-IA and 14.8 kilograms of residue in the proposed expansion area (Table 3). Under Alternative 2, all residue would be deposited in the existing ERF-IA. Most of this munitions residue would be contributed by UXOs (215.7 kilograms), with lesser amounts from LO detonations (10.4 kilograms) and HO detonations (0.021 kilograms). This is an estimated increase of approximately 79.5 kilograms over deposition under current firing (the No Action Alternative; Table 4).

However, several factors must be considered when evaluating these deposition rates. First, the residue estimates were developed based on use of traditional munitions. Studies conducted by the CRREL have found that the more insensitive the munitions are, the less efficient they become and the more they deposit residues. Thus, IMs are expected to result in a greater amount of residue from HO and LO detonations, and potentially UXOs. Consequently, if IM constituents are toxic, the live firing of IM rounds into training areas represents a potential environmental risk (Walsh et al. 2017). Secondly, the analysis incorporates the approximate dud rate for traditional HE rounds (3.37 percent) (Dauphin and Doyle 2000), which is higher than the anticipated dud rate during live-firing activities at JBER. Lastly, the total masses in Tables 3 and 4 do not account for biodegradation or natural attenuation (i.e., flushing) of residues. Thus, the residue deposition values presented should be used for comparing alternatives rather than predicting deposition quantities that would occur following resumption of all-season live firing in ERF-IA.

From 2012–2017, the Strategic Environmental Research and Development Program (SERDP) conducted research at various firing ranges in cold weather climates in the United States and Canada, including ERF-IA, to evaluate deposition of HE residues and dissolution of HE compounds from the detonation of IM (Walsh et al. 2017). CRREL has also conducted research at JBER to evaluate IM residue deposition from 2017–2022 (Walsh et al. 2018; Beal et al. 2023). Sampling on snow has proven to be the most reproducible method for energetics residues characterization research because residues are more easily detected. Four IM HE formulations were tested: PAX-21, PAX-48, IMX-101, and IMX-104; the latter two are proposed for use at ERF-IA. The PAX-21 research indicated significant deposition of ammonium perchlorate; however, use of these munitions is now restricted, and they will not be used at ERF-IA under any of the alternatives.

Residue deposition rates from HO detonations of IMX mortar cartridges are greater than their conventional counterparts, which typically deposit less than 1–9 mg/cartridge each of RDX and TNT (Beal et al. 2023). HO detonations of IMX-104 cartridges can result in relatively high residue deposition rates, ranging between 4 and 8 g/cartridge, with this residue mass mostly from (>99%) NTO (Table 6; Walsh et al. 2017, 2018; Beal et al. 2023). While NTO has relatively low toxicity, the high water solubility and low soil affinity of NTO and NQ, along with high deposition rates from the studied mortar munitions, make it likely that NTO will reach ground and surface water at detectable concentrations around where IMX cartridges are detonated (Beal et al. 2023). Deposition rates of RDX and DNAN are generally minor (12–60 mg/cartridge), and improved fuze performance (i.e., decreased LO rates) for newer munitions may lead to an overall decrease in deposition of these compounds relative to older conventional munitions (Beal et al. 2023). A summary of study findings for characterization of residues from the detonation of various HE IMs proposed at ERF-IA is provided in Tables 5 and 6.

Table 3 Estimated Total Annual Munitions Use and Residue Deposition at ERF-IA under Alternatives 1 and 2

Munitions Information			Munitions Residue Impacts							
			Number of Rounds/Detonations				Munitions Residue Deposition (grams)			
HE Munitions Type[1]	Total Energetic Mass per Round[2]	Total Energetic Residue per HO Detonation[3]	Annual Number of Rounds Fired[4]	Annual Anticipated Number of LO Detonations[5]	Annual Anticipated Number of Dud Detonations[6]	Annual Anticipated Number of HO Detonations[7]	Annual Residue Deposition from HO Detonations[8]	Annual Residue Deposition from LO Detonations[9]	Annual Residue Deposition from Dud Detonations[10]	Total Annual Deposition of Energetic Residues[11]
Alternative 1: Existing ERF-IA										
60-mm Mortar	370	0.000076	700	2	74	624	0.05	370	27,380	27,750
81-mm Mortar	969	0.0094	400	1	25	374	3.52	485	24,225	24,713
120-mm Mortar	2,960	0.021	552	1	19	532	11.17	1,480	56,242	57,734
105-mm Howitzer	2,086	0.00027	1,988	1	35	1,952	0.53	1,043	73,010	74,054
155-mm Howitzer Training Round	808	0.000036	900	1	3	896	0.03	404	2,424	2,828
155-mm Howitzer	6,936	0.00031	144	1	3	140	0.04	3,468	20,808	24,276
Existing ERF-IA Total	14,129	0.031	4,684	7	159	4,518	15.34	7,250	204,089	211,354
Alternative 1: Proposed Expansion Area										
60-mm Mortar	370	0.000076	336	1	15	320	0.02	185	5,550	5,735

Munitions Information			Munitions Residue Impacts							
			Number of Rounds/Detonations				Munitions Residue Deposition (grams)			
HE Munitions Type[1]	Total Energetic Mass per Round[2]	Total Energetic Residue per HO Detonation[3]	Annual Number of Rounds Fired[4]	Annual Anticipated Number of LO Detonations[5]	Annual Anticipated Number of Dud Detonations[6]	Annual Anticipated Number of HO Detonations[7]	Annual Residue Deposition from HO Detonations[8]	Annual Residue Deposition from LO Detonations[9]	Annual Residue Deposition from Dud Detonations[10]	Total Annual Deposition of Energetic Residues[11]
81-mm Mortar	969	0.0094	192	1	1	190	1.79	485	969	1,455
120-mm Mortar	2,960	0.021	192	1	1	190	3.99	1,480	2,960	4,444
105-mm Howitzer	2,086	0.00027	624	1	1	622	0.17	1,043	2,086	3,129
155-mm Howitzer Training Round	808	0.000036	0	0	0	0	0	0	0	0
155-mm Howitzer	6,936	0.00031	0	0	0	0	0	0	0	0
Expansion Area Total	14,129	0.031	1,344	4	18	1322	5.97	3,193	11,565	14,764
Alternative 2: Existing ERF-IA										
60-mm Mortar	370	0.000076	1,036	3	89	944	0.07	555	32,930	33,485
81-mm Mortar	969	0.0094	592	2	26	564	5.30	969	25,194	26,168
120-mm Mortar	2,960	0.021	744	2	20	722	15.16	2,960	59,202	62,177
105-mm Howitzer	2,086	0.00027	2,612	2	36	2,574	0.69	2,086	75,096	77,183

Munitions Information			Munitions Residue Impacts							
			Number of Rounds/Detonations				Munitions Residue Deposition (grams)			
HE Munitions Type[1]	**Total Energetic Mass per Round[2]**	**Total Energetic Residue per HO Detonation[3]**	**Annual Number of Rounds Fired[4]**	**Annual Anticipated Number of LO Detonations[5]**	**Annual Anticipated Number of Dud Detonations[6]**	**Annual Anticipated Number of HO Detonations[7]**	**Annual Residue Deposition from HO Detonations[8]**	**Annual Residue Deposition from LO Detonations[9]**	**Annual Residue Deposition from Dud Detonations[10]**	**Total Annual Deposition of Energetic Residues[11]**
155-mm Howitzer Training Round	808	0.000036	900	1	3	896	0.03	404	2,424	2,828
155-mm Howitzer	6,936	0.00031	144	1	3	140	0.04	3,468	20,808	24,276
Existing ERF-IA Total	14,129	0.031	6,028	11	177	5,840	21.31	10,442	215,654	226,118
Proposed Project Totals (Alternatives 1 and 2)										
Totals	**N/A**	**N/A**	**6,028**	**11**	**177**	**5,840**	**21.31**	**10,442**	**215,654**	**226,118**

Notes: Mass and residue are given in grams. This table is based on traditional munitions rather than IMs, which tend to result in greater residue deposition during HO and LO detonation events. Although conservative assumptions were used to estimate residue deposition for traditional munitions, this table may underestimate total annual deposition for combined traditional munitions and IMs. Residue deposition mass was calculated by multiplying estimated number of detonation types (HO, LO, or UXO) by average residue mass for each munitions type based on the literature cited below. Deposition calculations assume UXOs will immediately discharge 100% of filler mass to the environment, which is a worst-case scenario, as leaching rates will vary depending on site-specific factors.

1 All munitions in this analysis used Comp B as filler.
2 Walsh 2007, Table 1.
3 Walsh 2007, Table 3.
4 Section 2.6 of the EIS provides estimated annual rounds and munitions that would be fired.
5 LO rounds estimated to be 0.09% of total round fired following observations from Dauphin and Doyle 2000.
6 Dud rounds estimated to be 3.37% of total rounds fired following observations from Dauphin and Doyle 2000.
7 Annual anticipated number of HO detonations is assumed to be the total allotted rounds minus the anticipated LO and dud rounds.
8 Estimated as the product of anticipated HO detonations and the observed resultant energetic residue from Walsh 2007, Table 3.
9 Residue from LO rounds assumes 50% of energetic mass is consumed and 50% is deposited as residue.
10 Dud rounds assume 100% of energetic mass is deposited as residue, although it is not expected that all residue will be immediately bioavailable. Dud residue exposure to ecological receptors will depend on deposition rates.
11 Total residue is estimated as the sum of residue from HO, LO, and dud rounds.

Key: % = percent; Comp B = Composition B; EIS = Environmental Impact Statement; ERF-IA = Eagle River Flats Impact Area; HE = high explosive; HO = high-order; IM = insensitive munition; LO = low-order; N/A= not applicable; UXO = unexploded ordnance

Table 4 Estimated Total Annual Munitions Use and Residue Deposition at ERF-IA under the No Action Alternative

Munitions Information			Munitions Residue Impacts							
			Number of Rounds/Detonations				Munitions Residue Deposition (grams)			
HE Munitions Type[1]	Total Energetic Mass per Round[2]	Total Energetic Residue per HO Detonation[3]	Annual Number of Rounds Fired[4]	Annual Anticipated Number of LO Detonations[5]	Annual Anticipated Number of Dud Detonations[6]	Annual Anticipated Number of HO Detonations[7]	Annual Residue Deposition from HO Detonations[8]	Annual Residue Deposition from LO Detonations[9]	Annual Residue Deposition from Dud Detonations[10]	Total Annual Deposition of Energetic Residues[11]
60-mm Mortar	370	0.000076	518	1	18	499	0.04	0.00	6,660	6,660
81-mm Mortar	969	0.0094	296	1	10	285	2.68	0.00	9,690	9,692
120-mm Mortar	2,960	0.021	372	1	13	358	7.52	0.01	38,481	38,489
105-mm Howitzer	2,086	0.00027	1,306	2	44	1,260	0.34	0.00	91,784	91,784
155-mm Howitzer	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Totals	**6,385**	**0.031**	**2,492**	**5**	**85**	**2,402**	**10.58**	**0.02**	**146,616**	**146,626**

Notes: Mass and residue are given in grams. This table is based on traditional munitions rather than IMs, which tend to result in greater residue deposition during HO and LO detonation events. Although conservative assumptions were used to estimate residue deposition for traditional munitions, this table may underestimate total annual deposition for combined traditional munitions and IMs. Residue deposition mass was calculated by multiplying estimated number of detonation types (HO, LO, or UXO) by average residue mass for each detonation type based on the literature cited below. Deposition calculations assume UXOs will immediately discharge 100% of filler mass to environment which is a worst-case scenario as leaching rates will vary depending on site-specific factors.

[1] All munitions in this analysis used Comp B as filler.
[2] Walsh 2007, Table 1.
[3] Walsh 2007, Table 3.
[4] Section 2.6 of the EIS provides estimated annual rounds and munitions that would be fired.
[5] LO rounds estimated to be 0.09% of total round fired following observations from Dauphin and Doyle 2000.
[6] Dud rounds estimated to be 3.37% of total rounds fired following observations from Dauphin and Doyle 2000.
[7] Annual anticipated number of HO detonations is assumed to be the total allotted rounds minus the anticipated LO and dud rounds.
[8] Estimated as the product of anticipated HO detonations and the observed resultant energetic residue from Walsh 2007, Table 3.
[5] Residue from LO rounds assumes 50% of energetic mass is consumed and 50% is deposited as residue.
[10] Dud rounds assume 100% of energetic mass is deposited as residue, although it is not expected that all residue will be immediately bioavailable. Dud residue exposure to biological receptors will depend on deposition rates.
[11] Total residue is estimated as the sum of residue from HO, LO, and dud rounds.

Key: % = percent; Comp B = Composition B; EIS = Environmental Impact Statement; ERF-IA = Eagle River Flats Impact Area; HE = high explosive; HO = high-order; IM = insensitive munition; LO = low-order; N/A= not applicable; UXO = unexploded ordnance

Table 5 Summary of Findings for Characterization of Residues from the Detonation of Insensitive Munitions

Formulation	Significant Findings	Outcomes
IMX-104	Slight increase in overall residue deposition compared to Comp B. Detonation efficiencies of IMX-104 components varied significantly and were affected by fuzing systems used. Aqueous fraction of samples were acidic (pH 4). High (rapid) dissolution rate for NTO.	Overall efficiency >98.8%, customary efficiency for HO detonations.
IMX-101	Very poor detonation performance (leading to high residue deposition) using both types of fuzing systems. Aqueous fraction of sample was very basic (pH 14) due to concrete filler. High dissolution rates for NTO and NQ.	Research findings recommended review of IMX-101 filled 155-mm training round and investigating use of gypsum to replace concrete filler and moderate pH levels.

Notes: For all formulations, finer residues resulted in accelerated dissolution rates.
Key: % = percent; ERF-IA = Eagle River Flats Impact Area; HO = high-order; IMX = Insensitive Munitions Explosives; NQ = nitroguanidine; NTO = 3-nitro-1,2,4-triazol-5-one.
Source: Walsh et al. 2017; Beal et al. 2023

Table 6 Summary of IM Detonation Residues for Various Munitions Proposed at JBER

Round Characteristics	Analytes	Estimated Total Residue Mass (g/projectile)
IMX-104: 2021–2022 (60 mm) HO detonation, mean deposition	NTO DNAN RDX HMX	3.8 0.034 0.012 0.0019
IMX-104: 2021–2022 (81 mm) HO detonation, mean deposition	NTO DNAN RDX HMX	8.0 0.060 0.020 0.002
IMX-104 (155 mm; M1122 with AFS fuze)	Has not been tested	N/A
IMX-101: 2017 (155 mm; M1122 with AFS fuze) HO detonation, mean deposition	NQ NTO DNAN RDX	44 32 2.3 -
IMX-101 155 mm; M795	Has been tested but data under review	N/A

Note: These values are for HO detonations, so LO detonations are expected to result in increased amounts of residue deposition.
Key: AFS = ARDEC Fuze Simulator; DNAN = dinitroanisole; g = gram; HMX = cyclotetramethylene-tetranitramine; HO = high-order; IM = insensitive munition; IMX = Insensitive Munitions Explosives; LO = low-order; mm = millimeter; NQ = nitroguanidine; N/A = not applicable; NTO = 3-nitro-1,2,4-triazol-5-one; RDX = cyclotrimethylenetrinitramine
Sources: Walsh et al. 2017; Walsh et al. 2018; Beal et al. 2023

While HE munitions contribute the majority of energetic material into the environment, a smaller but non-zero (approximately 5 percent) contribution of energetic material would be contributed by other types of rounds (Smoke and Illuminants). Full Range Training Rounds/Blank rounds are essentially inert. However, 155-mm and pyrotechnic training rounds do contain a small amount of HE material. While contributions from non-HE munitions were not considered in the calculations in Tables 3 and 4, it is assumed that their contributions to the total accumulated energetic materials would be negligible.

In the proposed expansion area, the Army would detonate all UXO after each training exercise with blow-in-place (BIP) methods to make the area safe for maneuver training. UXO detonation would substantially reduce the average contaminant residue from approximately 1 kilogram to 200 milligrams (or less) per dud (S. Beal, U.S. Army, personal communication, 28 March 2024; Walsh et al. 2011). BIP methods used would be at the discretion of the JBER explosives ordnance disposal commanding officer. While residues from BIP detonations of conventional munitions are fairly low (Walsh et al. 2011), BIP detonations of IMs have resulted in much higher residues deposition, indicating that a larger donor charge is required for efficient detonation. The highly soluble compound NTO was particularly problematic, with BIP deposition approaching 95 percent of the original load (Walsh et al. 2014). However, it should be noted that these detonations did not use the newer modified BIP procedures for IM. JBER will implement the latest methods recommended by U.S. Army research scientists to promote clean disposal to reduce residue deposition and associated exposure to wildlife resources in the expansion area.

3.2. CONTAMINANT DEPOSITION SUMMARY

The primary mode of contaminant loading into the environment is direct deposition from live-fire exercises. It is estimated that a total of approximately 226.1 kilograms of munitions residue would be deposited annually at ERF-IA from training activities under Alternatives 1 and 2. While the total maximum number of HE munitions detonated would be the same under both alternatives, under Alternative 1, 211.3 kilograms would be deposited in the existing ERF-IA and 14.8 kilograms would be deposited in the proposed expansion area (Table 3). Under Alternative 2, the total amount would be deposited in the existing ERF-IA (if all training occurs at JBER). Compared to the estimated 146.6 kilograms of munitions residues that would be deposited into ERF-IA under the No Action Alternative (Table 4), there would be an estimated increase of approximately 79.5 kilograms. Although these values are only intended to estimate residue deposition based on the stated assumptions, they are useful in providing a relative comparison of anticipated relative munition residue deposition levels under each alternative.

The total number of HE munitions detonated under Alternative 2 is anticipated to be the same as for Alternative 1, but they would all be detonated within the existing ERF-IA (under a worst-case scenario in which all live-fire training occurs on JBER) because the impact area would not be expanded into adjacent uplands. Consequently, the total estimated mass of explosive residues dispersed to soils via LO explosives and UXOs could also be the same as under Alternative 1. The total estimated residue deposition for the project, as presented in Table 3, would potentially apply to both alternatives, but it would occur over a smaller area than under Alternative 1. Under both action alternatives, the potential deposition of energetic residues would increase by 65 percent relative to the No Action Alternative. Under Alternative 1, some of this material (between 0 and 17 percent) would be deposited in the proposed expansion area.This analysis assumes that all residue is deposited onto soils and remains in the environment. However, degradation of munitions residue is expected to occur and is dependent on a variety of environmental factors and conditions, as described in the following section. It should be noted that some LO and UXO residues are not available for degradation until dissolved, which may take days to years depending on particle size (Beal and Bigl 2022), explosive solubility, and exposure to water; breached UXO can continue to leak for decades or centuries (Taylor et al. 2011). Due to the uncertainties and complexities associated with munition detonations, breakdown pathways, and site conditions, it is impossible to know how much munitions residue would be bioavailable at any given time and then apply half-life estimates to determine when residue would degrade over time. However, anticipated breakdown pathways are described for various munitions in the next section to convey that residues will eventually break down through environmental exposure. It is conceivable that degradation of residues occurs more rapidly than assumed by the analysis, and it is likely that many residues are flushed out into Eagle Bay and diluted to non-toxic levels. However, the amount of residue flushed out and contaminant concentration levels anticipated in Eagle Bay cannot be determined without a comprehensive ecotoxicological analysis.

4. MUNITIONS BREAKDOWN PATHWAYS

Following the initial discharge of munitions contaminants into the environment, their fate and degradation in soil and groundwater are dependent on a variety of environmental factors and conditions, including contaminant characteristics, subsurface geochemistry, and the microbial community. For example, the lithology of the site affects contaminant fate in the subsurface due to the contaminant's affinity for sorption with organic matter. Additionally, biological degradation pathways impact the fate of munitions, with the redox environment of the soil or groundwater contributing to the rate of biotransformation.

Fate and transport processes link the deposition of contaminants at a source with the resultant environmental concentrations to which ecological receptors can be exposed. In the absence of modeling to predict exposure concentrations, information about transport and transformation of contaminants can provide information about their fate following deposition.

Attenuation processes cause the bioavailability of a given contaminant to decrease over time, reducing its potential to harm organisms. Attenuation processes can be divided into three main categories: physical, chemical, and biological pathways (Table 7). Major breakdown pathways for various munition constituents include biodegradation, photodegradation, dissolution, and sorption and are reviewed below.

Table 7 Attenuation Pathways Applicable to Munitions Contaminants in Soil and Groundwater

Pathway	Mechanism	Description
Physical	Advection	Movement of contaminant within groundwater
	Diffusion	Mass transfer of contaminant into or out of matrix due to concentration gradient
	Phase Transfer (Dissolution)	Dissolution (solid to aqueous phase) and/or volatilization
Chemical	Sorption	Reversible interactions between aquifer matrix and contaminant
	Abiotic Transformation	Reactions between mineral and contaminant
	Photodegradation (Photolysis)	Transformation of contaminant due to sunlight exposure in surface soils only
Biological	Biodegradation (Microbial Processes)	Biotically mediated reactions
	Biogeochemical Transformation	Coupled biotic and abiotic reactions

Source: Rectanus et al. 2015

4.1. BIODEGRADATION AND PHOTODEGRADATION

Biodegradation is the process by which organic substances are decomposed by microorganisms. Aerobic, oxygenated soils allow for gas diffusion and plant respiration. When soils become saturated with water, gas diffusion slows because there are no open passageways for air to travel. When oxygen levels become limited, such as in portions of ERF-IA, an anaerobic environment (no oxygen) develops, and different biological and chemical reactions begin to dominate. Sulfate-reducing bacteria produce hydrogen sulfide, which is prevalent in the tidal salt marsh of ERF. Hydrogen sulfide reacts with metals to form metal sulfides, which precipitate out of the soil–water solution. These metals can be broken down through consumption by microorganisms, which removes the organic compounds from water as they provide energy for the organisms.

Photodegradation (photolysis) is the process by which substances are broken down by light. Photons impart energy to chemical bonds upon striking a target molecule; specific wavelengths of light can provide the energy required to induce a chemical reaction resulting in photodecomposition. Photolysis can be a significant attenuation pathway for explosives and propellants (Rectanus et al. 2015). For solid explosives, photodecomposition reactions occur only on the surface, and the reaction products can be washed off, often producing a halo of reddish-brown residue on the soil surface surrounding the bulk particles. This pathway, like abiotic pathways, can lead to reduction of contaminant mass by degradation. Photolysis does not occur when the munitions contaminants are under soil surfaces and in groundwater due to the absence of light. It is anticipated that photolysis degradation at ERF is seasonal and primarily limited to suitable ambient light conditions from spring to fall. However, this pathway would help break down munition residues deposited at existing ERF-IA and the proposed expansion area during the resumption of all-season firing.

Available data indicate that TNT, RDX, and HMX undergo biodegradation under anaerobic conditions (McCormick et al. 1981; U.S. Army 1984; Walker and Kaplan 1992). These studies and others conducted in Alaska suggest that these explosive compounds biodegrade within days to months in anaerobic environments with sufficient organic matter content such as those found at ERF. Ringelberg et al. (2003) found that aerobic and anaerobic biodegradation of explosives can occur in cold region soils with high organic matter content, but biodegradation rates are much faster under anaerobic conditions, which are commonly found in ERF, than under aerobic conditions, which are found over a smaller portion of ERF and in the proposed expansion area.

In 2005, CRREL researchers performed assays using soil samples collected from locations in ERF-IA where cratering tests had been conducted using C4 explosives (RDX) (Ringelberg 2005). Samples were analyzed for microbial biomass, community composition, and RDX degradation capacity. After incubation, the samples contained hydrogen sulfide gas, suggestive of anaerobic respiration and sulfate reduction by bacteria. The soils also contained a substantial microbial biomass and showed that significant degradation of RDX had occurred. This work strongly suggests the role of sulfate-reducing bacteria in the biodegradation of RDX in soils at ERF-IA and suggests that anaerobic biodegradation is the primary mechanism for breakdown of RDX and potentially other explosive residues at the site.

Studies indicate that RDX is generally more persistent and mobile than TNT, which photodegrades rapidly and is aerobically biotransformed into 2-Am-DNT and 4-Am-DNT (McCormick et al. 1976). Esteve-Nunez et al. (2001) found that certain strains of microorganisms and fungi use the nitrogen from TNT to degrade or transform TNT under anoxic conditions as well. Alavi et al. (2011) observed similar results in volcanic soils of Hawaii, where TNT and DNT would not leach beyond a depth of 30 centimeters, unlike HMX and RDX, which were found to pass beyond this depth. This suggests that the risk of groundwater contamination is greater for HMX and RDX relative to TNT and DNT. However, anoxic soils at ERF-IA are not as porous as volcanic soils; therefore, it is likely that biodegradation processes would restrict migration of RDX into groundwater. It should be noted that when exposed to water, RDX undergoes photolysis and has a short half-life of 9 to 13 hours (Abadin et al. 2012). The Army's plan to phase out TNT (and DNT) and reduce use of RDX and HMX would minimize the potential amount of these contaminants that can enter waterbodies.

The additional munitions constituents in IMX-101 and IMX-104 (i.e., DNAN, NTO, and NQ) can undergo aerobic and anaerobic biotransformation, as well as phototransformation, to yield a variety of transformation products in the laboratory (Table 8). A study of the biodegradation potential of IMX-101 and IMX-104 on two training ranges (Camp Shelby, Mississippi, and Umatilla Chemical Depot, Oregon) found higher transformation rates for all IMX constituents under anaerobic conditions versus aerobic conditions (Indest et al. 2017). The most persistent compounds were the NQ component of IMX-101 and the RDX component of IMX-104. The study found that certain soil microbial communities associated with explosives degradation increased significantly in anaerobic soils, and supplemental carbon could be used to facilitate cleanup of these compounds (Indest et al. 2017). The relatively high presence of organic matter at ERF-IA would help break down these and other munitions residues deposited at the site.

IM compounds may undergo phototransformation, but it is not a significant pathway due to faster dissolution processes (Dontsova 2018). NTO and DNAN phototransform when in solution, with NTO phototransformation rates three times greater than DNAN in the presence of organic matter (Dontsova et al. 2014). Other studies have concluded that DNAN, NTO, and NQ can be photodegraded in surface water (Halasz et al. 2018) and that the kinetics of biodegradation are comparable to those of nitroaromatic explosives (e.g., TNT) (Richard and Weidhaas 2014a). One study found that the photodegradation half-lives of NQ, DNAN, and NTO in a laboratory were 0.44 days, 0.83 days, and 4.4 days, respectively (Moores et al. 2021), although sunlight exposures were likely higher than those at ERF-IA. A strong correlation was found between salinity and the photolysis rate for DNAN, suggesting that saline waters from inundating tides may increase the degradation process of any DNAN residues deposited on ERF. The photolysis rate for TNT has shown a similar trend (O'Sullivan et al. 2011), which suggests that brackish waters in ERF would help break down these munition constituents to a greater degree than under freshwater conditions. Based on these studies, it is apparent that biodegradation and photodegradation rates of IM explosives are relatively fast and comparable to those of traditional explosives, such as TNT.

Degradation of IM by ultraviolet (UV) light has become a topic of concern following observations that some UV-degradation products have increased toxicity relative to parent compounds in aquatic organisms (Becher et al. 2019; Moores et al. 2021). The environmental half-lives of NQ and NTO in pure water are only estimated as 4 and 6 days, respectively (Becher et al. 2019). However, the ecotoxicities of NQ and NTO solutions are known to increase with UV exposure, with cyanide one of the degradation products for NQ. This could be of concern because NQ is one of the primary components of IMX-101 detonations. IMX-101 155-mm rounds have been shown to deposit 44 grams of NQ during HO detonations, with greater amounts anticipated during LO and UXO events (Table 6).

Lab studies exposed UV irradiated IMX-101 constituents to water flea (*Daphnia pulex*) and found that UV-degraded NTO and NQ (and associated degradation products) increased mortalities by factors of 40.3 and 1,240, respectively (Moores et al. 2021). Additionally, cyanide was detected during UV degradation of NQ. Among the analytically determined NQ UV-degradation products, cyanide was the most toxic, followed by guanidine, nitrite, and ammonia. However, further testing is needed because the individual concentrations of the products could not fully account for the observed toxicity of the UV-degradation product mixture. The study concluded that (1) other unidentified NQ degradation products contributed principally to toxicity and/or (2) synergistic toxicological interactions occurred among the NQ degradation product mixture that exacerbated toxicity (Moores et al. 2021). Regardless, the study suggests that UV exposure to IMX munition residues in ERF-IA could increase their ecotoxicity if these constituents are mobilized into waterbodies.

Table 8 List of Proposed Munitions Constituents, Transformation Products, Breakdown Pathways, and Chemical Properties Relevant to Ecological Receptors

Chemical Name[1]	Transformation Products	Mechanism of Transformation	References	Water Solubility (Sw) @ 25°C in mg/L[2]	Soil Organic Carbon Partition Coefficient[3] Koc (L/kg)(log Koc)	Octanol-water partition coefficients (Kow) Log Kow at 25˚C[4]	References[5]
Explosives							
DNAN (2,4-dinitroanisole)	See breakdown products below	See below.	Reviewed in Hawari et al. 2015	213±12	364±8	1.58 ± 0.01	Hawari et al. 2015
	2,4-DNP (2,4-dinitrophenol)	Transiently formed by microbial transformation. Significant or complete biodegradation of DNAN after 9 days under aerobic conditions; Microbial transformation under aerobic conditions.	Richard and Weidhaas 2014a; Fida et al. 2014	2,790 at 20 °C (experimental)	363.8 (2.561)	1.67 (experimental)	Royal Society of Chemistry 2022
	MENA (2-methoxy-5-nitroaniline)	Reductive anaerobic biotransformation with H_2 added as co-substrate; Microbial transformation by aerobic bacteria.	Olivares et al. 2013; Liang et al. 2013	252±8	316±32	1.47± 0.01	Hawari et al. 2015
	DAAN (2,4-diaminoanisole)	Microbial transformation by anaerobic bacteria with ethanol as primary substrate; Reductive anaerobic biotransformation with H_2 added as co-substrate.	Platten et al. 2010; Olivares et al. 2013	>40,000	<0.5	< -1	Hawari et al. 2015
	4-ANAN (4-amino-2-nitroanisole)	Nitroreduction of DNAN.	Schroer 2018	4,430±60	240±12	0.80 ± 0.01	Hawari et al. 2015
	Nitrate	Phototransformation under sunlight.	Rao et al. 2013	90,900	14.3 (1.155)	0.21	Royal Society of Chemistry 2022
	Nitrite	Phototransformation under sunlight.	Rao et al. 2013	119,600	23.74 (1.376)	0.06	Royal Society of Chemistry 2022
	8 additional breakdown products[6]	Reductive anaerobic biotransformation with H_2 added as co-substrate.	Olivares et al. 2013	4,852[7]	44.85 (1.652)[6]	-0.30	Royal Society of Chemistry 2022
NTO (3-nitro-1,2,4-triazole-5-one)	See breakdown product below	See below.	Richard and Weidhaas 2014a	1,000,000	50.58 (1.704)	-2.99	Royal Society of Chemistry 2022
	1,2-dihydro-3H-1,2,4-triazol-3-one	Transiently formed by microbial transformation. Complete biodegradation of NTO after 9 days under anaerobic conditions.	Richard and Weidhaas 2014a	885,000	109.2 (2.038)	-2.52	Royal Society of Chemistry 2022
RDX (cyclotrimethylenetrinitramine)	N/A	May biodegrade in water and soil under anaerobic conditions. Note significantly retained by most soils and can leach to groundwater from soil. Phototransformation tends to degrade RDX relatively quickly in surface waters.	USEPA 2017a	59.7	1.80	0.87	USEPA 2017a
HMX (cyclotetramethylene-tetranitramine)	Nitrite, nitrate, formaldehyde, l,l-dimethylhydrazine	HMX does not evaporate or bind to sediments to any large extent. Sunlight breaks down most of the HMX in surface water into other compounds, usually in a matter of days to weeks. A small amount of HMX may also be broken down by bacteria in the water.	Sciences International 1997a	5	30–290	0.16	NCBI n.d-a
TNT (2,4,6-Trinitrotoluene)	1,3,5-Trinitrobenzene (1,3,5-TNB) via photolysis; Various other products via biological degradation.	Soils have a high capacity for rapid sorption of TNT. Under anaerobic conditions, TNT is usually transformed rapidly into its degradation byproducts. Once discharged to surface water, TNT undergoes rapid photolysis.	USEPA 2017b	130 at 20°C	300 (est)	1.6	USEPA 2017b
NQ (Nitroguanidine)	See breakdown products below	See below.	Reviewed in Mirecki et al. 2006	4,000	25.7 (1.41)	-0.83 to 0.156	Reviewed in Mirecki et al. 2006
	Nitrourea	Transiently formed by aerobic microbial transformation; Microbial transformation by aerobic bacteria (*Variovorax* strain VC1). Nitrourea is unstable in water and degrades to NH_3, N_2O, and CO_2.	Richard and Weidhaas 2014a; Perreault et al. 2012	140,900	5.392(0.732)	-1.65	Royal Society of Chemistry 2022
	Nitrosoguanidine	Photolysis.	Reviewed in Mirecki et al. 2006	1,000,000	70.48 (1.848)	-1.76	Royal Society of Chemistry 2022
	Hydroxyguanidine	Photolysis.	Reviewed in Mirecki et al. 2006	1,000,000	38.21 (1.582)	-2.72	Royal Society of Chemistry 2022
	Guanidine	Photolysis.	Reviewed in Mirecki et al. 2006	1,840 at 20 °C (experimental)	19.78 (1.296)	-1.630	Royal Society of Chemistry 2022

Chemical Name[1]	Transformation Products	Mechanism of Transformation	References	Water Solubility (Sw) @ 25°C in mg/L[2]	Soil Organic Carbon Partition Coefficient[3] Koc (L/kg)(log Koc)	Octanol-water partition coefficients (Kow) Log K_{OW} at 25°C[4]	References[5]
	Nitrite	Photolysis – end product.	Reviewed in Mirecki et al. 2006	119,600	23.74 (1.376)	0.06	Royal Society of Chemistry 2022
	Nitrate	Photolysis – end product.	Reviewed in Mirecki et al. 2006	90,900	14.3 (1.155)	0.21	Royal Society of Chemistry 2022
	Ammonia	Photolysis – end product.	Reviewed in Mirecki et al. 2006	482,000 at 24 °C (experimental)	14.3 (1.155)	-1.38 (experimental)	Royal Society of Chemistry 2022
	Cyanamide	Microbial transformation under microaerophilic conditions.	Spanggord et al. 1987	500,000 (experimental)	4.5 (0.653)	-0.82 at 20 °C (experimental)	Royal Society of Chemistry 2022
	Cyanide	Phototransformation.	Moores et al. 2021	95,400	2.71 (0.433)	-0.69	Royal Society of Chemistry 2022
Propellants							
DNT (2,4-Dinitrotoluene)	N/A	Slight tendency to sorb to sediments based on relatively low organic-carbon partition coefficients; unless broken down by light, oxygen or biota, expected to remain in water for long periods of time because of its relatively low volatility and moderate water solubility.	USEPA 2017c	270	1.65 (log)	1.98	USEPA 2017c
NQ (Nitroguanidine)	See transformation products listed above under explosives	See above.	See above	See above	See above	See above	See above
NG (Nitroglycerin)	Calcium nitrate and calcium nitrite	Moderate aqueous solubility. Alkaline hydrolysis by calcium hydroxide. NG disappeared within 1 week in sterile, anoxic solutions with mineral salts, presumably by an abiotic, aqueous reaction.	Reviewed in Mirecki et al. 2006	1,950	1.6–2.8 (log)	1.6–2.8	Reviewed in Mirecki et al. 2006
NC (Nitrocellulose)	N/A	Will not dissolve or hydrolyze in aqueous solutions except with strong base (NaOH or NH_3) and high temperatures.	Reviewed in Mirecki et al. 2006	immiscible	N/A	N/A	Reviewed in Mirecki et al. 2006
Ammonium Perchlorate	Perchlorate anion	Highly soluble in water, and relatively stable and mobile in surface and subsurface aqueous systems.	USEPA 2014	200	N/A	-5.84	USEPA 2014
Pyrotechnics (Smoke Agents)							
WP (White Phosphorus)	Phosphine in water with low oxygen	WP reacts mainly with O_2 in water and may linger for hours to days, or in water/soil for years if O_2 levels are low. In water with low O_2, WP may react with water to form phosphine, a toxic gas and quickly moves from water to air. Phosphine in air is changed to less harmful chemicals in less than a day.	Sciences International 1997b	3 @15 °C	3.05 (log)	3.08	Reviewed in Sciences International 1997b
HC (hexachloroethane)	N/A	Evaporation or broken down by microscopic organisms. Breakdown more quickly in anaerobic soils.	ATSDR 1997	50 @20 °C	3.25 (log)	4.14	NCBI n.d.-b
Other							
HYDROCAL (inert) (gypsum cement)	Calcium and sulfate ions	Calcium sulfate dissolves in water	USG 2017	1,500–4,000	N/A	N/A	USG 2017

Notes:
[1] IMX-101 (TNT IM replacement) = DNAN, NTO, and NQ; IMX-104 (Comp B IM replacement) = DNAN, NTO, and RDX
[2] Water solubility is measured in mg/L, the weight of constituent (in milligrams) that will dissolve in 1 liter of water.
[3] K_{OC} = soil organic carbon distribution coefficient. Greater K_{OC} values indicate the tendency for a hydrophobic organic solute to sorb to organic content in soil. Low K_{OC} values indicate limited sorption (Mirecki et al. 2006).
[4] All Kow values from the Royal Society of Chemistry website (http://www.chemspider.com/) are estimated, unless otherwise noted.
[5] All data from the Royal Society of Chemistry website are generated using the U.S. Environmental Protection Agency's EPISuite™. Values are estimated using models unless otherwise noted.
[6] Additional DNAN breakdown products include: 3,3'-Diamino-4,4'dimethoxy-azobenzene, 3,3'-Diamino-4,4'dimethoxy-hydrazobenzene, N-(5-amino-2-methoxyphenyl) acetamide, 5-((3-Amino-4-methoxyphenyl)diazenyl)-2-methoxy-N-methyleneaniline, 2-Methoxy-5-((4-methoxy-3-(methylamino)phenyl)diazenyl)-methyleneaniline, 3,3'-Diamino-4-hydroxy-4'-methoxy-azobenzene, and 3,3'-Diamino-4-methoxy-hydrazobenzene.
[7] Value for N-(5-amino-2-methoxyphenyl) acetamide

Key: °C = degrees Celsius; CO_2 = carbon dioxide; Comp B = Composition B; est. = estimated; kg = kilogram; H_2 = hydrogen; Koc = organic-carbon partition coefficient; Kow = octanol-water partition coefficient; L = liter; mg = milligram; N_2O = nitrous oxide; N/A = not applicable; NaOH = sodium hydroxide; NH_3 = ammonia; O_2 = oxygen; Sw = water solubility.

4.2. DISSOLUTION AND SORPTION

Dissolution is the process by which a solid or solute (in this case an explosive fragment) dissolves in a solvent (in this case water) and allows transport and mobility of the contaminant into soil. Interactions between the compound and the soil particles can slow or even halt the movement of the contaminant through the soil, effectively removing it from the aqueous fraction. This removal of a compound from solution to a solid phase is called sorption. Chemical properties that influence dissolution and sorption are presented in Table 7. While volatilization is listed under “phase transfer” as a potential attenuation pathway, energetic compounds are classified as semi-volatile organics, and other common munitions constituents are classified as non-volatile inorganics. Therefore, volatilization is not a significant attenuation pathway for any munitions constituents (Rectanus et al. 2015).

The mobility of a chemical in soil is often characterized by the soil sorption distribution coefficient (Kd), defined as the ratio of the compound concentration associated with the solid phase to the concentration of the compound in the aqueous phase when at equilibrium. This coefficient is often normalized for soil organic carbon content, as nonpolar organic compounds most often sorb to this component in the soil. The resulting organic carbon partition coefficient (K_{OC}) indicates the tendency for a hydrophobic organic solute to partition into the nonpolar soil organic carbon fraction (i.e., sorb to organic content in soil). Greater K_{OC} values tend to indicate an increased tendency for a hydrophobic organic solute to sorb to organic content in soil. In situations where the solute is a polar ($\log K_{OW}$ <0.5) or ionic compound, or when the organic content of the soil is low with a high clay content, use of K_{OC} might not be adequate to estimate mobility (reviewed in Wen et al. 2012).

Biodegradation and photodegradation are the primary degradation pathways for HMX, as it does not bind well to sediments. Jenkins et al. (2003) examined the stability of munitions residues in moist unsaturated soils and reported half-lives for RDX and HMX ranging from 94 to 154 days and 133 to 2,310 days, respectively. Ringelberg et al. (2003) conducted a similar analysis examining the stability of RDX in soil samples from Fort Greely, Alaska, and observed a half-life of approximately 1 month in unsaturated soils and 4 days in saturated soils, similar to what would be expected at ERF.

Dissolution rates of munitions residues can vary based on a variety of environmental factors, including hydraulic conductivity of soils, temperature, and the presence of water (exposure via rainfall or submerged UXO). Taylor et al. (2010) reported dissolution rates of TNT to be 2.5 +/- 0.7 microgram per square centimeter per hour (µg cm^2/hr) and for C4 (91 percent RDX) to be 1.8 +/- 0.1 µg cm^2/hr, which indicates potential for these munitions residues to be mobilized into groundwater. Brannon et al. (2005) and Prak and O’Sullivan (2006) measured the dissolution rates in salt water and determined that the solubility of TNT and 2,4-DNT was lower than when exposed to fresh water. TNT has greater potential than RDX to sorb to soil (300 K_{OC} versus 1.8 K_{OC}), although biodegradation is likely the primary breakdown pathway for these residues.

For IM constituents, Richard and Weidhaas (2014b) investigated the dissolution rates of DNAN, NTO, and NQ under simulated rainfall and found that dissolution of the compounds was slow and followed the dissolution order NTO>NQ>DNAN, with NTO and NQ dissolving first, leaving DNAN crystals to dissolve more slowly. The study also investigated sorption of DNAN and NTO to soils and found that both compounds sorbed to and desorbed from soils to a limited extent. In soil, DNAN showed irreversible sorption and reduced bioavailability when oxygen is present (Hawari et al. 2015). Qin et al. (2021) suggested that slow dissolution processes for DNAN (and its breakdown products) could result in toxic effects to fish and macroinvertebrates in the absence of other breakdown pathways. Although DNAN is more soluble than TNT, its lower hydrophobicity and its tendency to form aminoderivatives that sorb irreversibly to soil help make it less toxic than the traditional explosive TNT (Pichtel 2012; Hawari et al. 2015).

Both DNAN and NTO are subject to adsorption and transformation in soil (Dontsova et al. 2014). Dontsova et al. (2014) found that NTO was weakly adsorbed, with adsorption coefficients lower than those measured for RDX (the compound that it is replacing) and DNAN. The study suggested that an increase in transformation rates may occur if the soil is slightly anaerobic, such as over much of the existing ERF-IA. DNAN is easily phototransformed and adsorbed in the soil, making it less mobile in the environment.

NQ and cyanamide are mobile in soil environments with limited sorption, as indicated by high solubility and low K_{OC} values (Mirecki et al. 2006). Therefore, it seems likely that many of the transformation products of DNAN, NTO, and NQ would also experience limited sorption to soils and sediment (see Table 8). The solubility of most IM constituents is higher than that of TNT and RDX, increasing the likelihood that they could reach groundwater (Dontsova et al. 2014, 2022). These compounds would likely remain bioavailable because sorption of compounds to soils reduces the rate or potential for biotransformation or other abiotic transformation.

Several studies have examined the dissolution, fate, and transport behavior of IMX-101 and IMX-104 in the environment (Arthur et al. 2018; Dontsova 2018; Qin 2021; Polyakov et al. 2023; Karls et al. 2023). Three primary pathways for rainfall-driven energetic transport were identified: subsurface infiltration, off-site transport in solution, and offsite transport in solid form (Polyakov et al. 2023). For IMX-104, the primary transport pathway for NTO was in solution, which could be either surface runoff or infiltration resulting in over 50 percent of NTO being transported off the surface. Energetic components, with the exception of NTO and fine particles of DNAN, RDX, and HMX, remained largely on-site, which would expose them to physical breakup, photodegradation, and dissolution and further transport by subsequent rainfall events (Polyakov et al. 2023). As flow rate increased, there was an increase in the percent mass found in solution and sediment and a decrease in the percent mass remaining on the surface. NTO fate was dominated by transport in solution, while DNAN, RDX, and HMX were predominantly transported with the sediment (Karls et al. 2023). Although these studies were intended to understand how munition residues interacted with precipitation and runoff, it can be inferred that residues in ERF may be transported in the water column or by sediment transport into Eagle River and Eagle Bay during inundating tide events.

Qin (2021) suggested that IMX residues are consistently irradiated as solids under natural sunlight and then dissolved after rainfall. The study indicates that sunlight-induced direct photolysis contributes significantly to the natural attenuation of IMX-101 and IMX-104 in the environment. DNAN transformed to 2-amino-4-nitroanisole and 4-amino-2-nitroanisole, while NTO concentrations also decreased due to transformation. Mark et al. 2017 found that NTO transformation rates increased (and less NTO was recovered) with increased soil organic carbon content. Although NTO has low adsorption in soils, high soil organic carbon content, breakdown by microorganisms, and hydraulic residence time at ERF-IA could reduce NTO concentrations. These studies indicate the potential for natural attenuation of IM constituents in soils through adsorption and transformation (Arthur et al. 2018).

For metals, sorption is a significant attenuation pathway. Sorption takes place when a metal is attracted electrically to charged groups in minerals or solid organic materials. Generally, high pH favors sorption of metal ions. Sorption capacity is dependent on pH and soil particle size distribution; fine soil particles have greater surface area than coarser material and therefore have a greater capacity for immobilizing metal contaminants. Brief descriptions of attenuation by sorption for antimony, copper, lead, and zinc are included below, as summarized by Rectanus et al. (2015):

- **Antimony**: Insoluble forms of antimony tend to sorb to clay, soil, and sediments, where they are bound to extractable iron and aluminum, and antimony readily adsorbs to iron oxides and oxihydroxides.
- **Copper:** ERF-IA sediments have pH values ranging from 7 to 8 (Racine et al. 1993). Neutral to alkaline soils are more effective in retaining Cu (II) compared to acidic soils. Copper has a strong affinity for the surfaces of iron oxides and hydroxides, clays, sulfides, and organic matter and is more strongly sorbed to mineral substrates than zinc, nickel, and cadmium.

- **Lead**: The adsorption of lead is highly dependent on pH, with increasing pH favoring sorption. Lead adsorbs more strongly than most divalent metal ions onto hydrous ferric oxide, other ferric oxides, hydrous oxides, aluminum oxides, oxyhydroxides, clay minerals, and iron and aluminum containing hydroxypolymer coatings on natural aquifer sediments. In reducing systems, lead adsorbs to and co-precipitates with iron sulfide. Uptake of lead in natural systems is irreversible due to its strong retention and small likelihood of transport to surface waters or groundwater.
- **Zinc:** Zinc readily sorbs to sediments and suspended solids such as hydrous iron and manganese oxides, clay minerals, and organic matter. The sorption affinity of zinc increases with increasing pH and decreasing salinity. Thus, zinc is expected to sorb better to sediments in groundwater than to tidally influenced sediments.

Although concrete could result in localized increases in pH of surface water and sediments, the proposed protective measures described in Section 2.4.1.3 of the EIS (e.g., habitat protective buffers, HE firing restrictions during inundated conditions, selective targeting in unbuffered areas) would reduce risk of concrete entering waterbodies. Highly alkaline water can not only cause fish injury or mortality but also increase the toxicity of other substances, such as munition residues. Although sediments and groundwater are likely to filter any residual concrete material that is deposited on the flats, and the training rounds would be dispersed throughout ERF-IA, some concrete filler could be flushed into waterways through runoff or typical inundating tide events. Based on natural attenuation processes and protective measures, the amount of concrete deposited in water is expected to be minimal, and the buffering capacity of the receiving saline waters would reduce potential toxicity to fish and aquatic organisms.

4.3. MUNITIONS BREAKDOWN PATHWAYS SUMMARY

Following the initial deposition of munition contaminants into the environment, their fate and degradation in soil and groundwater are dependent on a variety of environmental factors and conditions. When oxygen levels become limited, as they are in much of ERF-IA, an anaerobic (oxygen free) environment develops and different biological and chemical reactions begin to dominate. Organic compounds can be broken down for consumption by microorganisms in an anaerobic wetland system, or when they are taken up by plants. Studies conducted in Alaska suggest that these explosive compounds biodegrade within days to months in anaerobic environments with sufficient organic matter content. Ringelberg et al. (2003) found that aerobic and anaerobic biodegradation of explosives can occur in cold region soils with high organic matter content. However, aerobic biodegradation rates are much slower than those under anaerobic conditions. Studies indicate that RDX is generally more persistent and mobile than TNT, which photodegrades rapidly and is aerobically biotransformed into 2-Am-DNT and 4-Am-DNT (McCormick et al. 1976). However, when exposed to water, RDX undergoes photolysis and has a short half-life of 9 to 13 hours (Abadin and Smith 2012).

The extent of soil contamination with explosives from UXOs is variable. Generally, concentrations of explosives in soils beneath and adjacent to UXOs range from <1 to 110 milligrams per kilogram (mg/kg) (Taylor et al. 2011). Richard and Weidhaas (2014b) investigated the dissolution rates of DNAN, NTO, and NQ under simulated rainfall and found that dissolution of the compounds was slow and followed the dissolution order NTO>NQ>DNAN, with NTO and NQ dissolving first.

For metals, sorption is a significant attenuation pathway. Sorption of metals takes place when either a metal or a complexed ligand is attracted electrically to charged groups in minerals or solid organic materials. Adsorption is much more significant than absorption as an attenuation pathway. ERF-IA sediments have pH values ranging from 7 to 8 (or neutral to slightly alkaline) (Racine et al. 1993). Low pH soils are less effective in retaining Cu (II) compared to neutral and calcareous soils, with a high degree of reversibility of sorption processes at low pH. Zinc readily sorbs to sediments and suspended solids such as hydrous iron and manganese oxides, clay minerals, and organic matter. The sorption affinity of zinc increases with increasing pH and decreasing salinity. Thus, zinc is expected to sorb better to sediments in groundwater than to tidally influenced sediments.

5. TOXICITY OF MUNITIONS CONSTITUENTS

This section provides toxicological information for relevant munitions constituents, which may be used as a benchmark for environmental analysis. It discusses acute and chronic toxicity to plant and wildlife species.

5.1. EXPLOSIVE COMPOUNDS AND PROPELLANTS

Toxicity information for the constituents of munitions that would be used at ERF-IA under the alternatives was investigated; available information is summarized in Table 9. Information for aquatic and terrestrial receptors (including avian, mammalian, invertebrate, and plant species) were identified, where available. Occasionally, information was not identified for every receptor and munitions combination. Only receptor and munition combinations that are described in the available literature are included in this appendix. Table 9 identifies the analyte of interest (the munitions constituent), the exposure pathway (e.g., soil, air, diet), the receptor (e.g., bird, mammal, plant), the endpoint impacted (e.g., survival, growth, reproduction), the toxicity value type (dose or concentration-based toxicity values), and the numeric toxicity value with specified units. In general, preference was given to toxicity values identified as relevant benchmarks by the U.S. Environmental Protection Agency (USEPA) or other governmental entities. Applicable toxicity information was not identified in publicly available sources for components identified as inert (e.g., hydrocal) or as illuminants.

For ecological receptors, benchmarks and toxicity values for aquatic (e.g., algae, aquatic and benthic invertebrates, fish) and terrestrial (soil invertebrates, earthworms, plants) community receptors were reported based on media-specific exposure concentrations (milligrams per liter for water, mg/kg for soil or sediment exposures). Toxicity values include median lethal doses (LD_{50}s), typically based on short-term oral doses, or chronic toxicity reference values (TRVs) based on longer dietary exposures resulting in no observed adverse effect levels (NOAELs) and lowest observed adverse effect levels (LOAELs). Some wildlife TRVs identified in the literature were derived as a statistical benchmark dose (BMD) based on the distribution of the toxicity data (rather than the tested concentrations used to determine NOAELs and LOAELs). The BMD represents the modeled 10 percent level of a sublethal effect, and the lower 95 percent confidence limit on the mean 10 percent response is referred to as the benchmark dose limit. The USEPA has not derived the equivalent of regional screening levels for ecological receptors. Therefore, several sources were reviewed to identify toxicity information for munitions constituents and various ecological receptors. It was assumed that ecological exposures might occur some time following the deployment of munitions, so the review focused on direct exposures via constituent in soil, water and sediment, and via dietary exposures for ecological receptors. Inhalation-based toxicity information was investigated for the smoke-related constituents.

Several compilation documents are available that summarize the available toxicity and bioaccumulation data related to environmental exposures to munitions constituents. These documents include *Ecotoxicology of Explosives* (Sunahara et al. 2009), *Review and Synthesis of Evidence Regarding Environmental Risks Posed by Munitions Constituents (MC) in Aquatic Systems* (Lotufo et al. 2017), *Wildlife Toxicity Assessments for Chemicals of Military Concern* (Williams et al. 2015), and *Nitroaromatic Munition Compounds: Environmental Effects and Screening Values* (Talmage et al. 1999). Lotufo et al. (2017) includes an aquatic toxicity database containing nearly 700 toxicity results for algae, fish, invertebrates, and amphibians for a variety of munitions. These documents summarize the available data but may not derive benchmarks for use in evaluating environmental data. Given the large amount of information included in these documents, the information was not repeated in this appendix.

The primary resource for identification of ecological toxicity information was the Los Alamos National Laboratory (LANL) ECORISK Database (LANL 2017). This database functions as a screening tool to evaluate impacts from various chemicals, including several munitions of interest, present in the water, soil, air, and sediment on a variety of ecological receptors. The database incorporates a review of the available toxicological literature and derives applicable media-specific benchmarks and TRVs based on the acceptable datasets. Many of the constituents of interest for the PMART EIS are considered in this database, and both no effect and low effect toxicity values are provided in Table 9. Additionally, wildlife toxicity data for a variety of munitions constituents used by the U.S. Army has been compiled and reviewed in order to identify wildlife TRVs (Williams et al. 2015). Table 9 includes the no effect TRVs recommended by Williams et al. (2015). The benchmarks and TRVs identified in the LANL database and Williams et al. (2015) are more current than the screening values presented by Talmage et al. (1999), and more recent benchmarks were selected preferentially.

Despite these resources evaluating a wide variety of munition constituents, several constituents of interest for the PMART EIS are not included in these compilations, or toxicity data for the constituent were not identified for all of the potential ecological receptors of interest (aquatic community [algae, aquatic and benthic invertebrates, fish], benthic community [invertebrates], soil community [plants, invertebrates], birds, and mammals). For the outstanding constituents and receptors, brief individual literature reviews were conducted to identify relevant toxicity data or additional benchmarks and associated information, and sources are provided in Table 9. As indicated by the availability of multiple databases, compilation documents, and individual articles, the toxicological data available for munitions constituents are wide-ranging and cover a variety of receptors and environmental conditions in both the field and the laboratory. The benchmarks and toxicity data provided in Table 9 serve as a starting point for the assessment of environmental data. Additional review of the available toxicological data may be warranted to account for site-specific conditions.

Table 9 Toxicity Summaries and Benchmark Data for Explosives and Propellants

Analyte	Media	Receptor	Endpoint	Toxicity Value Type	Toxicity Value	Units	Details/Notes	Source
2,4-DNAN	Water	Aquatic community organism (aquatic invertebrates)	Reproduction	NOEC	6.2	mg/L	6-day NOEC for reproduction for *Ceriodaphnia dubia*; survival NOEC was 24.2 mg/L.	Johnson 2012
2,4-DNAN	Water	Aquatic community organism (fish)	Survival	NOEC	5.8	mg/L	7-day NOEC for survival for *Pimephales promelas*; growth NOEC was 11.6 mg/L.	Johnson 2012
2,4-DNAN	Oral / Diet	Birds	Survival	$BMDL_{10}$	151	mg/kgBW/day	The mean BMD of 348 mg/kg-day was calculated for male and female F_0 generation quail based on the results of the 5 BMDL models. This corresponded to a $BMDL_{10}$ of 151 mg/kg-day for male and female F_0 generation quail which can be used as a point of departure to develop a TRV for birds.	Johnson 2012
2,4-DNAN	Soil	Invertebrates	Survival	LC_{50}	98	mg/kg	7 day LC_{50} for Eisenia; 14 day LC_{50} was 47 mg/kg.	Hawari 2014
2,4-DNAN	Oral / Diet	Mammals	Extramedullary hematopoiesis (EMH) (spleen)	$BMDL_{10}$	0.93	mg/kgBW/day	EMH in female rats was selected as the critical effect, and a benchmark dose lower confidence limit for a 10% response ($BMDL_{10}$) of 0.93 mg/kgBW/day. Oral dosing via gavage.	Lent et al. 2016
2,4-DNAN	Soil	Plants	Seedling emergence, shoot wet mass, and shoot dry mass	EC_{50}	6	mg/kg	7-day emergence; 19-day shoot growth EC_{50} was 7 mg/kg.	Hawari 2014
2,4-DNT	Sediment	Aquatic community organism	Not specified	No effect SQT	0.29	mg/kg	Sediment quality benchmark (SQB) calculated by Equilibrium Partitioning (EqP) method using Tier II water quality value (USEPA Region 4) and TOC =1%.	LANL 2017
2,4-DNT	Sediment	Aquatic community organism	Not specified	Low effect SQT	2.9	mg/kg	SQB calculated by EqP method using Tier II water quality value (USEPA Region 4) and TOC =1%.	LANL 2017
2,4-DNT	Water	Aquatic community organism	Not specified	Chronic screening value	65	µg/L	Australian and New Zealand ECLs and Trigger Value (2008 NOAA SQuiRT).	LANL 2017
2,4-DNT	Water	Aquatic community organism	Not specified	Acute screening value	330	µg/L	Freshwater acute LOAEL (2008 NOAA SQuiRT).	LANL 2017
2,4-DNT	Oral / Diet	Birds	Kidney-to-body weight ratio	TRV (NOAEL-based)	0.01	mg/kgBW/day	Kidney-to-body weight ratio was the most sensitive endpoint and indicative of early onset of disease. Other endpoints (e.g., egg production and triglyceride levels) occurred at levels where mortality occurred. Bobwhite quail mortality occurred at doses of 15 mg/kgBW/day or greater.	Williams et al. 2015
2,4-DNT	Soil (aged)	Earthworms	Reproduction – cocoon production	NOEC	21.5	mg/kg	TNT breakdown compounds were analyzed to determine toxicity to earthworms. NOECs varied by breakdown compound and ecotoxicological parameter.	Kuperman 2003
2,4-DNT	Soil (aged)	Earthworms	Reproduction – juvenile production	NOEC	37.3	mg/kg	TNT breakdown compounds were analyzed to determine toxicity to earthworms. NOECs varied by breakdown compound and ecotoxicological parameter.	Kuperman 2003
2,4-DNT	Soil (fresh)	Earthworms	Reproduction – cocoon production	NOEC	20.3	mg/kg	TNT breakdown compounds were analyzed to determine toxicity to earthworms. NOECs varied by breakdown compound and ecotoxicological parameter.	Kuperman 2003
2,4-DNT	Soil (fresh)	Earthworms	Reproduction – juvenile production	NOEC	55	mg/kg	TNT breakdown compounds were analyzed to determine toxicity to earthworms. NOECs varied by breakdown compound and ecotoxicological parameter.	Kuperman 2003
2,4-DNT	Oral / Diet	Mammals	Survival	No effect TRV	2.68	mg/kgBW/day	Chronic NOAEL derived from an LD_{50}. The LD_{50} study was for the mouse and assumed to be oral and lasted for less than 1 week. No other study details were reported. The LD_{50} was extrapolated to a chronic NOAEL with a UF = 0.01.	LANL 2017
2,4-DNT	Oral / Diet	Mammals	Survival	Low effect TRV	26.8	mg/kgBW/day	LOAEL derived from the NOAEL with UF=10.	LANL 2017
2,4-DNT	Oral / Diet	Mammals	Neurological effects	TRV (BMDL)	0.67	mg/kgBW/day	Adverse neurological effects were used to calculate TRVs as these are most likely to be relevant to the health effects of wildlife species.	Williams et al. 2015

Analyte	Media	Receptor	Endpoint	Toxicity Value Type	Toxicity Value	Units	Details/Notes	Source
2,4-DNT	Soil	Plants	Germination (measured as the number of emerged seedlings), and growth (measured as both fresh and dry shoot mass).	NOEC	10 to 967	mg/kg	NOECs for plants varied by species; alfalfa NOEC of 95 mg/kg; corn, Japanese millet, ryegrass, and lettuce NOECs at or around 10 mg/kg, lettuce emergence NOEC of 967 mg/kg.	Kuperman 2003
2,4-DNT	Soil (aged)	Plants	Not specified	No effect Eco-SSL	6	mg/kg	Definitive studies used three terrestrial plants (alfalfa, barnyard grass, and ryegrass) exposed in weathered-and-aged Sassafras sandy loam soil.	LANL 2017
2,4-DNT	Soil (aged)	Plants	Not specified	Low effect Eco-SSL	60	mg/kg	Definitive studies used three terrestrial plants (alfalfa, barnyard grass, and ryegrass) exposed in weathered-and-aged Sassafras sandy loam soil.	LANL 2017
2,4-DNT	Soil	Soil and litter earthworms/invertebrates	Not specified	No effect Eco-SSL	18	mg/kg	Definitive studies used three soil invertebrate test species (earthworm, potworm, and collembola) exposed in sandy loam soils.	LANL 2017
2,4-DNT	Soil	Soil and litter earthworms/invertebrates	Not specified	Low effect Eco-SSL	180	mg/kg	Low effect derived from no effect with UF=10.	LANL 2017
2,6-DNT	Water	Aquatic community organism	Not specified	Chronic screening value	230	µg/L	NHDES, 1996 regulation chronic criterion.	LANL 2017
2,6-DNT	Water	Aquatic community organism	Not specified	Acute screening value	330	µg/L	NHDES, 1996 regulation acute criterion.	LANL 2017
2,6-DNT	Oral / Diet	Birds	Reproduction (egg production)	No effect TRV	60	mg/kgBW/day	Subchronic (60-day) study with bobwhite quail (*Colinus virginianas*) exposed to 2,6-DNT in corn oil via gavage daily at nominal concentrations of 5, 10, 40, or 60 mg/kg/day; subchronic NOAEL of 60 m/kg/day for egg production.	LANL 2017
2,6-DNT	Oral / Diet	Birds	Reproduction (egg production)	Low effect TRV	600	mg/kgBW/day	LOAEL derived from the NOAEL with UF=10.	LANL 2017
2,6-DNT	Oral / Diet	Birds	Hematology and blood plasma chemistry	TRV (NOAEL-based)	0.1	mg/kgBW/day	Hematology and blood plasma chemistry (most sensitive endpoints) were selected as relevant endpoints as they are considered early indicators of adverse hepatic and renal effects, which may contribute to gastrointestinal distress and mortality.	Williams et al. 2015
2,6-DNT	Soil (aged)	Earthworms	Reproduction – cocoon production	NOEC	18.1	mg/kg	TNT breakdown compounds were analyzed to determine toxicity to earthworms. NOECs varied by breakdown compound and ecotoxicological parameter.	Kuperman 2003
2,6-DNT	Soil (aged)	Earthworms	Reproduction – juvenile production	NOEC	13.9	mg/kg	TNT breakdown compounds were analyzed to determine toxicity to earthworms. NOECs varied by breakdown compound and ecotoxicological parameter.	Kuperman 2003
2,6-DNT	Soil (fresh)	Earthworms	Reproduction – cocoon production	NOEC	9.4	mg/kg	TNT breakdown compounds were analyzed to determine toxicity to earthworms. NOECs varied by breakdown compound and ecotoxicological parameter.	Kuperman 2003
2,6-DNT	Soil (fresh)	Earthworms	Reproduction – juvenile production	NOEC	20	mg/kg	TNT breakdown compounds were analyzed to determine toxicity to earthworms. NOECs varied by breakdown compound and ecotoxicological parameter.	Kuperman 2003
2,6-DNT	Oral / Diet	Mammals	Survival	No effect TRV	1.77	mg/kgBW/day	Chronic NOAEL derived from an LD_{50}. The LD_{50} study was for the mouse and assumed to be oral and lasted for less than 1 week. No other study details were reported. The LD_{50} was extrapolated to a chronic NOAEL with a UF=0.01.	LANL 2017
2,6-DNT	Oral / Diet	Mammals	Survival	Low effect TRV	17.7	mg/kgBW/day	LOAEL derived from the NOAEL with UF=10.	LANL 2017
2,6-DNT	Oral / Diet	Mammals	Body size	TRV (NOAEL-based)	0.7	mg/kgBW/day	Toxicity data were limited to one study, which showed that rats had reduced body sizes in response to oral dosing of 2,6-DNT for 1 year.	Williams et al. 2015
2,6-DNT	Soil	Plants	Germination (measured as the number of emerged seedlings), and growth (measured as both fresh and dry shoot mass).	NOEC	10 to 4,905	mg/kg	NOECs were all at 10 mg/kg for alfalfa, corn, Japanese millet, and ryegrass; lettuce had similar concentrations for wet and dry growth, but the seedling emergence NOEC was 4,905 mg/kg.	Kuperman 2003

Analyte	Media	Receptor	Endpoint	Toxicity Value Type	Toxicity Value	Units	Details/Notes	Source
Ammonium perchlorate	Water	Aquatic community organism (aquatic invertebrates)	Emergence	NOEC	59	mg/L	Various toxicity studies were conducted on aquatic invertebrates in an effort to develop freshwater water-quality criteria for perchlorate. Both acute and chronic tests were conducted using six test species (*Daphnia*, *Ceriodaphnia*, *Hyalella*, *Lumbriculus*, *Corbicula*, and *Chironimus*). The results suggest that aquatic invertebrates are not particularly sensitive to perchlorate exposure. The most conservative TRVs were a chronic NOEC and LOEC (59 and 118 mg/L) based on emergence of midges (*Chironomus*).	Yoo et al. 2007
Ammonium perchlorate	Water	Aquatic community organism (aquatic invertebrates)	Emergence	LOEC	118	mg/L	Various toxicity studies were conducted on aquatic invertebrates in an effort to develop freshwater water-quality criteria for perchlorate. Both acute and chronic tests were conducted using six test species (*Daphnia*, *Ceriodaphnia*, *Hyalella*, *Lumbriculus*, *Corbicula*, and *Chironimus*). The results suggest that aquatic invertebrates are not particularly sensitive to perchlorate exposure. The most conservative TRVs were a chronic NOEC and LOEC (59 and 118 mg/L) based on emergence of midges (*Chironomus*).	Yoo et al. 2007
Ammonium perchlorate	Oral / Diet	Birds	Tibia length	NOAEL	13	mg/kgBW/day	The NOAEL and LOAEL are based on an 8-week study of perchlorate effects on development (tibia length) in 3-4 day old post-hatch bobwhite quail. Three dose groups (0.00326, 130, and 261 mg/kg/d) plus a control were reported. Tibia length was significantly decreased at 261 mg/kg/d compared to control, while no effect was seen at 130 mg/kg/d. Authors note that tibia length has often been used as an indicator of growth rates in birds. Because the data set only consists of one species from a single taxonomic order, an UF of 10 was applied to the NOAEL and LOAEL to derive the selected TRVs.	LANL 2017
Ammonium perchlorate	Oral / Diet	Birds	Tibia length	LOAEL	26	mg/kgBW/day	The NOAEL and LOAEL are based on an 8-week study of perchlorate effects on development (tibia length) in 3-4 day old post-hatch bobwhite quail. Three dose groups (0.00326, 130, and 261 mg/kg/d) plus a control were reported. Tibia length was significantly decreased at 261 mg/kg/d compared to control while no effect was seen at 130 mg/kg/d. Authors note that tibia length has often been used as an indicator of growth rates in birds. Because the data set only consists of one species from a single taxonomic order, an UF of 10 was applied to the NOAEL and LOAEL to derive the selected TRVs.	LANL 2017
Ammonium perchlorate	Sediment	Earthworms	Cocoon production	NOAEL	3.5	mg/kg	Value is based on a chronic (28-day) study, in which mature earthworms were exposed to sodium perchlorate added to artificial soil at nominal dose levels of 0, 0.1, 10, 100 and 1,000 mg/kg soil. Chronic EC_{50} extrapolated to chronic NOAEL.	LANL 2017
Ammonium perchlorate	Sediment	Earthworms	Cocoon production	LOAEL	35	mg/kg	Value is based on a chronic (28-day) study, in which mature earthworms were exposed to sodium perchlorate added to artificial soil at nominal dose levels of 0, 0.1, 10, 100 and 1,000 mg/kg soil. Chronic EC_{50} extrapolated to chronic LOAEL.	LANL 2017
Ammonium perchlorate	Water	Aquatic community organism (fish)	Survival and reproduction	Chronic screening value	9.3	mg/L	Effects on fish exposed to perchlorate were highly variable, whether considered by effect endpoint, test duration, or by test species. A criterion continuous concentration (CCC) of 9.3 mg/L was derived which is generally protective of survival and reproductive endpoints, but is not always protective of thyroid effects.	Yoo et al. 2007
Ammonium perchlorate	Oral / Diet	Mammals	Survival	NOAEL	6.4	mg/kgBW/day	The NOAEL and LOAEL are based on most sensitive LD_{50} data (rabbit). Chronic NOAEL = 0.01(LD_{50}).	LANL 2017
Ammonium perchlorate	Oral / Diet	Mammals	Survival	LOAEL	32	mg/kgBW/day	The NOAEL and LOAEL are based on most sensitive LD_{50} data (rabbit). Chronic LOAEL = 0.2(LD_{50}).	LANL 2017
Ammonium perchlorate	Soil	Plants	Mean dry weight	NOEC	40	mg/kg	Value is based on mean dry weight of lettuce 28 days after exposure to perchlorate added to soil as sodium perchlorate resulting in concentrations of 10, 20, 40 80 and 160 mg/kg ClO_4.	LANL 2017
Ammonium perchlorate	Soil	Plants	Mean dry weight	LOEC	80	mg/kg	Value is based on mean dry weight of lettuce 28 days after exposure to perchlorate added to soil as sodium perchlorate resulting in concentrations of 10, 20, 40 80 and 160 mg/kg ClO_4.	LANL 2017

Analyte	Media	Receptor	Endpoint	Toxicity Value Type	Toxicity Value	Units	Details/Notes	Source
HC	Air	Birds	Body weight, gross organ and/or tissue changes at necropsy	NOEC	260	ppm	The subchronic inhalation toxicity for HC vapor was tested by exposing animals to control air and three concentrations of HC for 6 hours a day, 5 days a week for 6 weeks. The quail showed no signs, no effects in body weight and no gross organ or tissue changes at necropsy in the highest (260 ppm) exposure. Concentrations of 260 ppm HC vapor caused almost no response in quail. 40% of guinea pigs and 25% of dogs died following exposure to 260 ppm.	Weeks et al. 1979
HC	Oral / Diet	Mammals	Survival	LD_{50}	350	mg/kg (food)	HC smoke is considered potentially toxic to wildlife consuming vegetation that has been exposed to deposition from smoke munitions. FIQ was determined to be approximately 4.2. Compounds with FIQ values near or greater than 1 are considered potentially toxic to wildlife.	Shinn et al. 1985
HC	Oral / Diet	Mammals	Survival	LD_{50}	4,460 to 7,690	mg/kg (food)	14-day oral exposures for male and female rats and male guinea pigs.	Weeks et al. 1979
HC	Air	Mammals	Not specified	NOAEL	26.6	mg/m3	NOAEL for daily 1-hr exposure to HC smoke; LOAEL of 254 mg/m^3 for inflammatory changes in the lung and death.	National Research Council 1997
HC	Oral / Diet	Mammals	Hematological effects	LOAEL	25	mg/kgBW/day	Rats fed $ZnCl_2$ in their food ad libitum for 7 days per week for 4 weeks were reported to have a decrease in hemoglobin to 85% of control values. The LOAEL reported for such effects was calculated to be a dose of Zn at 12 mg/kg per day, equivalent to $ZnCl_2$ at 25 mg/kg BW/day.	National Research Council 1997
HC	Diet (plant matter)	Mammals	Not specified	General toxic limit	0.5	mg/g plant dry matter	Zinc chloride is the prime aerosol constituent of HC smoke. High zinc levels adversely affect appetite and growth in pigs, sheep, and cattle. Ingestion of grass containing 0.5 mg/g zinc was not toxic to cattle, but higher dietary levels caused abnormal appetite. Therefore, a general toxic limit for zinc in plant dry matter is estimated at 0.5 mg/g.	Cichowicz 1983
HC	Nutrient Solution	Plants	Germination and growth	General toxic limit	0.4	mg/g plant dry matter	Zinc chloride is the prime aerosol constituent of HC smoke. Zinc in low concentrations is necessary for the normal growth of plants; however, excess zinc may be toxic to plants. Delayed germination and severely retarded growth was observed in cress and mustard seeds grown In a nutrient solution containing 34-436 mg/L. Concentrations of 3, 5, and 10 mg/L were toxic to orange and mandarin seedlings, flax, and water hyacinths, respectively. A general toxic limit for zinc in plant dry matter Is estimated at 400-500 µg/gm (0.4 mg/g).	Cichowicz 1983
HMX	Sediment	Aquatic community organism	Survival and growth	NOAEL	130	mg/kg	Amphipod tests.	LANL 2017
HMX	Sediment	Aquatic community organism	Survival and growth	LOAEL	170	mg/kg	LOAEL extrapolated from NOAEL by multiplying by UF of 1.3.	LANL 2017
HMX	Oral / Diet	Birds	Egg production and body mass (possibly related to foraging frequency)	TRV (NOAEL-based)	0.1	mg/kgBW/day	The authors did not recommend a TRV for birds. This value is from the single study identified in the review. There is low confidence in this value as it is based on a single study where egg production and body mass reductions were observed but test organisms avoided HMX-contaminated feed, potentially reducing HMX exposure; however, since HMX tainted feed is unlikely to be consumed, actual risk from exposure is expected to be negligible.	Williams et al. 2015
HMX	Soil (aged)	Earthworms	Reproduction – cocoon production	NOEC	>561.7	mg/kg	NOEC values for HMX on cocoon production and juvenile production in earthworms varied between fresh and weathered soils.	Kuperman 2003
HMX	Soil (aged)	Earthworms	Reproduction – juvenile production	NOEC	>561.7	mg/kg	NOEC values for HMX on cocoon production and juvenile production in earthworms varied between fresh and weathered soils.	Kuperman 2003
HMX	Soil (fresh)	Earthworms	Reproduction – cocoon production	NOEC	15.6	mg/kg	NOEC values for HMX on cocoon production and juvenile production in earthworms varied between fresh and weathered soils.	Kuperman 2003
HMX	Soil (fresh)	Earthworms	Reproduction – juvenile production	NOEC	6.5	mg/kg	NOEC values for HMX on cocoon production and juvenile production in earthworms varied between fresh and weathered soils.	Kuperman 2003
HMX	Oral / Diet	Mammals (omnivores)	Mortality	TRV (NOAEL-based)	9	mg/kgBW/day	13-week exposure; low oral bioavailability of HMX noted; mice more sensitive than rats.	Williams et al. 2015

Analyte	Media	Receptor	Endpoint	Toxicity Value Type	Toxicity Value	Units	Details/Notes	Source
HMX	Oral / Diet	Mammals	Lack of convulsions	TRV (NOAEL-based)	0.5	mg/kgBW/day	Limited data available. NOAEL derived from rabbit study showing no convulsions at 5 mg/kg/day.	Williams et al. 2015
HMX	Oral / Diet	Mammals	Survival	NOAEL	75	mg/kgBW/day	13-week mouse study.	LANL 2017
HMX	Oral / Diet	Mammals	Survival	LOAEL	200	mg/kgBW/day	13-week mouse study.	LANL 2017
HMX	Soil	Plants	Germination (measured as the number of emerged seedlings), and growth (measured as both fresh and dry shoot mass).	NOEC	>10,373	mg/kg	Alfalfa, corn, Japanese millet, ryegrass, and lettuce all had NOECs over 10,373 mg/kg soil, and no toxic effects were observed at concentrations of up to 10,000 mg/kg.	Kuperman 2003
HMX	Soil	Plants	Reproduction	NOEC	2,740	mg/kg	Derived based on review of multiple studies.	LANL 2017
HMX	Soil	Plants	Reproduction	LOEC	3,560	mg/kg	Derived based on review of multiple studies.	LANL 2017
HMX	Soil	Soil and litter earthworms/invertebrates	Not specified	No effect Eco-SSL	16	mg/kg	Definitive studies used three soil invertebrate test species (earthworm, potworm, and collembola) exposed in sandy loam soils.	LANL 2017
HMX	Soil	Soil and litter earthworms/invertebrates	Not specified	Low effect Eco-SSL	160	mg/kg	Low effect derived from no effect with UF = 10.	LANL 2017
HMX	Water	Aquatic community organism	Not specified	Chronic screening value	150	µg/L	Screening values derived as USEPA water quality criteria, USEPA Region 3 screening benchmarks, and hazardous concentration 5% based on species sensitivity distribution.	Lotufo et al. 2017
Infrared Obscuring Agent (smoke)	Oral / Diet	Mammals	Survival	LD_{50}	800	mg/kg (food)	Oral LD_{50} for infrared obscuring agents EA-5763 and EA-5769 was estimated from by-products assumed to occur (e.g., copper and zinc in brass). FIQ was determined to be around 8.1. Compounds with FIQ values near or greater than 1 are considered potentially toxic to wildlife.	Shinn et al. 1985
NG	Oral / Diet	Birds	Body mass and feed consumption	None	--	--	Since adverse effects were not observed in northern bobwhites exposed to over 5,000 ppm NG in feed over 8 days, NG is considered non-toxic to birds in environmental settings.	Williams et al. 2015
NG	Oral / Diet	Mammals	Weight loss and hepatic lesions	TRV (NOAEL-based)	3	mg/kgBW/day	Chronic study with rat; no adverse effects in weight loss or hepatic lesions; other studies showed no effect at higher doses so true NOAEL for many species may be higher.	Williams et al. 2015
NG	Oral / Diet	Mammals	Body weight	No effect TRV	96.4	mg/kgBW/day	2-year mouse study; TRV based on changes in body weight.	LANL 2017
NG	Oral / Diet	Mammals	Body weight	Low effect TRV	1,020	mg/kgBW/day	2-year mouse study; TRV based on changes in body weight.	LANL 2017
NG	Soil (aged)	Plants	Seedling emergence, shoot wet mass, and shoot dry mass	NOEC	21	mg/kg	Testing with alfalfa, Japanese millet, and perennial ryegrass; exposed in weathered-and-aged natural soil; seedling emergence, shoot wet mass, and shoot dry mass.	LANL 2017
NG	Soil (aged)	Plants	Seedling emergence, shoot wet mass, and shoot dry mass	LOEC	210	mg/kg	Testing with alfalfa, Japanese millet, and perennial ryegrass; exposed in weathered-and-aged natural soil; seedling emergence, shoot wet mass, and shoot dry mass.	LANL 2017
NG	Soil	Soil and litter earthworms/invertebrates	Not specified	No effect Eco-SSL	13	mg/kg	Definitive studies used three soil invertebrate test species (earthworm, potworm, and collembola) exposed in sandy loam soils.	LANL 2017
NG	Soil	Soil and litter earthworms/invertebrates	Not specified	Low effect Eco-SSL	130	mg/kg	Low effect derived from no effect with UF = 10.	LANL 2017
NG	Water	Aquatic community organism	Not specified	Chronic screening value	6.8	µg/L	Screening values derived as USEPA water quality criteria, USEPA Region 3 screening benchmarks, and hazardous concentration 5% based on species sensitivity distribution.	Lotufo et al. 2017
NTO	Water	Aquatic community organism (microalgae)	Growth inhibition	NOEC	2,245	mg/L	Individual exposures of NTO, NQ, FOX-7, and FOX-12 inhibited *P. subcapitata* growth in the 96-hour exposure test.	Hawari 2014
NTO	Water	Aquatic community organism (microalgae)	Growth inhibition	LOEC	4,489	mg/L	Individual exposures of NTO, NQ, FOX-7, and FOX-12 inhibited *P. subcapitata* growth in the 96-hour exposure test.	Hawari 2014

Analyte	Media	Receptor	Endpoint	Toxicity Value Type	Toxicity Value	Units	Details/Notes	Source
NQ	Water	Aquatic community organism (microalgae)	Growth inhibition	NOEC	746	mg/L	Individual exposures of NTO, NQ, FOX-7, and FOX-12 inhibited *P. subcapitata* growth in the 96-hour exposure test.	Hawari 2014
NQ	Water	Aquatic community organism (microalgae)	Growth inhibition	LOEC	1,491	mg/L	Individual exposures of NTO, NQ, FOX-7, and FOX-12 inhibited *P. subcapitata* growth in the 96-hour exposure test.	Hawari 2014
NQ	Oral / Diet	Mammals	Reduced body weight and fetal malformations	TRV (NOAEL-based)	316	mg/kgBW/day	Mammalian TRV based on studies with rats and mice. NOAELs ranged from 316 to 1,000 mg/kgBW/day. Little research has been done on NQ and impacts to birds. TRVs for bird species cannot be summarized from current research.	Williams et al. 2015
NQ	Soil	Invertebrates	Survival	LC_{50}	>4,768	mg/kg	14-day LC_{50}.	Hawari 2014
NTO	Soil	Invertebrates	Survival	LC_{50}	2,768	mg/kg	14-day LC_{50}.	Hawari 2014
NQ	Soil	Plants	19-day growth inhibition (dry weight)	NOEC	4,768	mg/kg	Initial measured concentrations of NQ in soil ranged from 0 (control) to 4,768 mg/kg. Preliminary data indicated that NQ-amended soil did not inhibit ryegrass seedling emergence or growth.	Hawari 2014
NQ	Soil	Plants	19-day growth inhibition (dry weight)	LOEC	>4,768	mg/kg	Initial measured concentrations of NQ in soil ranged from 0 (control) to 4,768 mg/kg. Preliminary data indicated that NQ-amended soil did not inhibit ryegrass seedling emergence or growth.	Hawari 2014
NQ	Soil	Soil microorganisms	Not specified	NOEC	10	mg/kg	Concentrations ranging up to 10 mg/kg soil did not indicate apparent toxicity to soil microorganisms in 48-hour exposure.	Williams et al. 2015
NTO	Water	Aquatic community organism (aquatic invertebrates)	Not specified	NOEC	34	mg/L	The 7-day IC_{50} value for *Ceriodaphnia dubia* (water flea) was 57 mg/L. The NOEC and LOEC values were 34 and 66 mg/L, respectively.	NCBI 2020
NTO	Water	Aquatic community organism (aquatic invertebrates)	Not specified	LOEC	66	mg/L	The 7-day IC_{50} value for water flea was 57 mg/L. The NOEC and LOEC values were 34 and 66 mg/L, respectively.	NCBI 2020
NTO	Oral / Diet	Birds	Brain vacuoles and neuromuscular anomalies	$BMDL_{10}$	35	mg/kgBW/day	Vacuolization of cerebellum and/or the brainstem was observed on histopathologic examination in a dose-dependent manner. Therefore, brain vacuoles and neuromuscular anomalies were identified as critical endpoints in this study. A BMD for brain vacuoles of 62 mg/kg-day was derived for male and female F0-generation quail, which corresponded to a $BMDL_{10}$ of 35 mg/kg-day. Oral dosing via gavage.	Jackovitz et al. 2018
NTO	Oral / Diet	Mammals	Testes mass	$BMDL_{10}$	40	mg/kgBW/day	A 90-day study was conducted at doses of 0, 30, 100, 315, or 1000 mg/kgBW/day NTO. There was no effect on food consumption, body mass, or neurobehavioral parameters. Males in the 315 and 1,000 mg/kgBW/day groups had reduced testes mass with associated tubular degeneration and atrophy. The testicular effects were the most sensitive adverse effect and were used to derive a BMD of 70 mg/kgBW/day, with a $BMDL_{10}$ of 40 mg/kgBW/day.	Crouse et al. 2015
NTO	Soil	Plants	19-day growth inhibition (dry weight)	NOEC	1	mg/kg	NTO-amended soil inhibited ryegrass seedling emergence and the growth.	Hawari 2014
NTO	Soil	Plants	19-day growth inhibition (dry weight)	LOEC	2	mg/kg	NTO-amended soil inhibited ryegrass seedling emergence and the growth.	Hawari 2014
RDX	Sediment	Aquatic community organism	Survival and growth	NOEC	260	mg/kg	Chronic NOECs from 102 to 711 mg/kg; midge and amphipod tests.	LANL 2017
RDX	Sediment	Aquatic community organism	Survival and growth	LOEC	350	mg/kg	LOAEL extrapolated from NOAEL by multiplying by UF of 1.3	LANL 2017
RDX	Oral / Diet	Birds	Body weight, egg production, feed consumption, total plasma protein and packed cell volume	TRV (BMDL)	3.65	mg/kgBW/day	Decreased egg production was used to determine the TRV because it is an ecologically relevant parameter indicative of impaired reproduction performance, which can have direct impacts on population dynamics.	Williams et al. 2015

Analyte	Media	Receptor	Endpoint	Toxicity Value Type	Toxicity Value	Units	Details/Notes	Source
RDX	Oral / Diet	Birds	Reproduction, survival, body weight change	No effect TRV	2.36	mg/kgBW/day	Chronic NOAEL derived based on multiple studies; reproduction, survival, and adult body weight change.	LANL 2017
RDX	Oral / Diet	Birds	Reproduction, survival, body weight change	Low effect TRV	4.49	mg/kgBW/day	Chronic LOAEL derived based on multiple studies; reproduction, survival, and adult body weight change.	LANL 2017
RDX	Soil (aged)	Earthworms	Reproduction – cocoon production	NOEC	56.6	mg/kg	NOEC values for RDX on cocoon production and juvenile production in earthworms varied between fresh and weathered soils.	Kuperman 2003
RDX	Soil (aged)	Earthworms	Reproduction – juvenile production	NOEC	8.4	mg/kg	NOEC values for RDX on cocoon production and juvenile production in earthworms varied between fresh and weathered soils.	Kuperman 2003
RDX	Soil (aged)	Earthworms	Reproduction – juvenile production	NOEC	8.4	mg/kg	1.2% organic matter; multiple test species and endpoints considered; 56 days; tested concentrations 6.4–527 mg/kg.	LANL 2017
RDX	Soil (aged)	Earthworms	Reproduction – juvenile production	LOEC	15.7	mg/kg	1.2% organic matter; multiple test species and endpoints considered; 56 days; tested concentrations 6.4–527 mg/kg.	LANL 2017
RDX	Soil (fresh)	Earthworms	Reproduction – cocoon production	NOEC	8.6	mg/kg	NOEC values for RDX on cocoon production and juvenile production in earthworms varied between fresh and weathered soils.	Kuperman 2003
RDX	Soil (fresh)	Earthworms	Reproduction – juvenile production	NOEC	7.5	mg/kg	NOEC values for RDX on cocoon production and juvenile production in earthworms varied between fresh and weathered soils.	Kuperman 2003
RDX	Oral / Diet	Mammals	Body weight	TRV (BMDL)	1.19	mg/kgBW/day	Decreased body weight, an indication of lower growth rate or a reduction in energy allocation was used as an endpoint for TRV determination because this endpoint may be ecologically relevant through effects on fitness.	Williams et al. 2015
RDX	Oral / Diet	Mammals	Survival, body weight change	No effect TRV	8.94	mg/kgBW/day	Chronic NOAEL derived based on multiple studies; survival and adult body weight change.	LANL 2017
RDX	Oral / Diet	Mammals	Survival, body weight change	Low effect TRV	28.3	mg/kgBW/day	Chronic LOAEL derived based on multiple studies; survival and adult body weight change.	LANL 2017
RDX	Soil	Plants	Germination (measured as the number of emerged seedlings), and growth (measured as both fresh and dry shoot mass)	NOEC	>9,363	mg/kg	Alfalfa, corn, Japanese millet, ryegrass, and lettuce all had NOECs over 9,363 mg/kg soil, and no toxic effects were observed at concentrations of up to 10,000 mg/kg.	Kuperman 2003
RDX	Soil (aged)	Plants	Not specified	NOEC	36	mg/kg	Testing with alfalfa, Japanese millet, and perennial ryegrass; exposed in weathered-and-aged natural soil; seedling emergence, shoot wet mass, and shoot dry mass.	LANL 2017
RDX	Soil (aged)	Plants	Not specified	LOEC	360	mg/kg	Testing with alfalfa, Japanese millet, and perennial ryegrass; exposed in weathered-and-aged natural soil; seedling emergence, shoot wet mass, and shoot dry mass.	LANL 2017
RDX	Water	Aquatic community organism	Not specified	Chronic screening value	186	µg/L	Screening values derived as USEPA water quality criteria, USEPA Region 3 screening benchmarks, and hazardous concentration 5% based on species sensitivity distribution.	Lotufo et al. 2017
TNT	Sediment	Aquatic community organism	Not Specified	No effect TRV	25	mg/kg	NOAEL of 25 mg/kg reported in study.	LANL 2017
TNT	Sediment	Aquatic community organism	Not Specified	Low effect TRV	32.5	mg/kg	NOAEL of 25 mg/kg reported in study; UF of 1.3 used to derive LOAEL.	LANL 2017
TNT	Oral / Diet	Birds	Hemoglobin Levels	TRV (BMDL)	60	mg/kgBW/day	Changes in hemoglobin levels were used to model the benchmark dose.	Williams et al. 2015
TNT	Oral / Diet	Birds	Survival	NOAEL	9.75	mg/kgBW/day	Selected study reported a subchronic NOAEL of 97.5 mg/kgBW/day with an accompanying LOAEL of 178 mg/kgBW/day for survival (moribundity and mortality). An uncertainty factor of 0.1 was applied to derive the chronic NOAEL and LOAEL.	LANL 2017

Analyte	Media	Receptor	Endpoint	Toxicity Value Type	Toxicity Value	Units	Details/Notes	Source
TNT	Oral / Diet	Birds	Survival	LOAEL	17.8	mg/kgBW/day	Selected study reported a subchronic NOAEL of 97.5 mg/kgBW/day, with an accompanying LOAEL of 178 mg/kgBW/day for survival (moribundity and mortality). An uncertainty factor of 0.1 was applied to derive the chronic NOAEL and LOAEL.	LANL 2017
TNT	Soil	Earthworms	Reproduction, survival, and body weight/adult growth	NOEC	32.8	mg/kg	A TRV based on these characteristics is considered protective of natural invertebrate populations because it is intended to prevent potential adverse impacts of low-level, long-term chemical effects (i.e., adverse effects on ability of individuals to develop into viable organisms, search for mates, breed successfully, and produce live and equally viable offspring).	LANL 2017
TNT	Soil	Earthworms	Reproduction, survival, and body weight/adult growth	LOEC	58.8	mg/kg	A TRV based on these characteristics is considered protective of natural invertebrate populations because it is intended to prevent potential adverse impacts of low-level, long-term chemical effects (i.e., adverse effects on ability of individuals to develop into viable organisms, search for mates, breed successfully, and produce live and equally viable offspring).	LANL 2017
TNT	Oral / Diet	Mammals	Survival and body weight	NOAEL	34.7	mg/kgBW/day	Effects on the body weight of an organism may result in changes in behavior and/or physiology, and therefore reduce success in competing for mates, breeding, and producing viable offspring.	LANL 2017
TNT	Oral / Diet	Mammals	Survival and body weight	NOAEL	160	mg/kgBW/day	Effects on the body weight of an organism may result in changes in behavior and/or physiology, and therefore reduce success in competing for mates, breeding, and producing viable offspring.	LANL 2017
TNT	Oral / Diet	Mammals	Decreased weight gain and anemia	TRV (BMDL)	0.9	mg/kgBW/day	Since decreased gain of weight (an indicatory of reduced growth and/or energy efficiency) and anemia have potential to impact fitness, these endpoints were considered ecologically relevant.	Williams et al. 2015
TNT	Soil	Plants	Reproduction and development	NOEC	62.1	mg/kg	TRV is considered protective of plant populations and the more sensitive individuals of threatened and endangered species because it considers multiple ecologically relevant endpoints and thus provides a more comprehensive TRV than a single CS TRV.	LANL 2017
TNT	Soil	Plants	Reproduction and development	LOEC	126	mg/kg	TRV is considered protective of plant populations and the more sensitive individuals of threatened and endangered species because it considers multiple ecologically relevant endpoints and thus provides a more comprehensive TRV than a single CS TRV.	LANL 2017
TNT	Water	Aquatic community organism	Not specified	Chronic screening value	28.4	µg/L	Screening values derived as USEPA water quality criteria, USEPA Region 3 screening benchmarks, and hazardous concentration 5% based on species sensitivity distribution.	Lotufo et al. 2017
TNT (breakdown product; TNB)	Sediment	Aquatic community organism	Survival	NOAEL	1.1	mg/kg	Based on survival of *Chironomus tentans*, a sediment invertebrate.	LANL 2017
TNT (breakdown product; TNB)	Sediment	Aquatic community organism	Survival	LOAEL	1.5	mg/kg	Based on survival of *Chironomus tentans*, a sediment invertebrate.	LANL 2017
TNT (breakdown product; TNB)	Soil (aged)	Earthworms	Reproduction – cocoon production	NOEC	19.9	mg/kg	TNT breakdown compounds were analyzed to determine toxicity to earthworms. NOECs varied by breakdown compound and ecotoxicological parameter.	Kuperman 2003
TNT (breakdown product; TNB)	Soil (aged)	Earthworms	Reproduction – juvenile production	NOEC	19.9	mg/kg	TNT breakdown compounds were analyzed to determine toxicity to earthworms. NOECs varied by breakdown compound and ecotoxicological parameter.	Kuperman 2003
TNT (breakdown product; TNB)	Soil (fresh)	Earthworms	Reproduction – cocoon production	NOEC	13.6	mg/kg	TNT breakdown compounds were analyzed to determine toxicity to earthworms. NOECs varied by breakdown compound and ecotoxicological parameter.	Kuperman 2003

Analyte	Media	Receptor	Endpoint	Toxicity Value Type	Toxicity Value	Units	Details/Notes	Source
TNT (breakdown product; TNB)	Soil (fresh)	Earthworms	Reproduction – juvenile production	NOEC	13.6	mg/kg	TNT breakdown compounds were analyzed to determine toxicity to earthworms. NOECs varied by breakdown compound and ecotoxicological parameter.	Kuperman 2003
TNT (breakdown product; TNB)	Soil	Earthworms	Reproduction, development, and survival	NOEC	10.4	mg/kg	Endpoint categories included in the data set are reproduction and development and survival. The test exposure route/medium of soil matches the exposure route of concern for soil ESLs for invertebrates.	LANL 2017
TNT (breakdown product; TNB)	Soil	Earthworms	Reproduction, development, and survival	LOEC	28.4	mg/kg	Endpoint categories included in the data set are reproduction and development and survival. The test exposure route/medium of soil matches the exposure route of concern for soil ESLs for invertebrates.	LANL 2017
TNT (breakdown product; TNB)	Oral / Diet	Mammals	Survival	NOAEL	13.4	mg/kgBW/day	Survival was selected over body weight because effects on body weight were attributed to an aversion to the diet rather than to toxic effects of the diet. Survival among treated male and female rats was not significantly different from controls except for the low-dose males.	LANL 2017
TNT (breakdown product; TNB)	Oral / Diet	Mammals	Survival	LOAEL	134	mg/kgBW/day	Survival was selected over body weight because effects on body weight were attributed to an aversion to the diet rather than to toxic effects of the diet. Survival among treated male and female rats was not significantly different from controls except for the low-dose males.	LANL 2017
TNT (breakdown product; TNB)	Soil	Plants	Germination (measured as the number of emerged seedlings), and growth (measured as both fresh and dry shoot mass)	NOEC	12 to 116	mg/kg	NOECs varied between plant species; NOECs were 12 mg/kg for most endpoints and species; emergence NOEC for corn was 116 mg/kg.	Kuperman 2003
White Phosphorus	Water	Aquatic community organism (invertebrates)	Not specified	EC_{50}	30 to > 560	µg/L	48-hour LC_{50}s on eight species of freshwater invertebrates; marine species were no more sensitive than freshwater species.	Sullivan et al. 1979
White Phosphorus	Water	Aquatic community organism (fish)	Survival	LC_{50}	2 to 154	µg/L	96-hour LC_{50} values; fish appear to be the most sensitive aquatic organisms to white phosphorus; many LC_{50} values were less than 10 µg/L; life cycle tests showed adverse effects at 0.4 µg/L with a NOEC estimated to be ~0.1 µg/L.	Sullivan et al. 1979
White Phosphorus	Water	Aquatic community organism	Not specified	Water quality criteria	0.01	µg/L	Insufficient data exists to recommend final criteria for WP. However, available data indicate that a level equal to or less than 0.01 µg/L of WP should adequately protect aquatic organisms.	Sullivan et al. 1979
White Phosphorus	Oral / Diet	Birds	Fecundity	TRV (NOAEL-based)	0.0125	mg/kgBW/day	Decreased fecundity would likely contribute to population sustainability and growth. Uncertainty factor of 40 applied to acute LOAEL to obtain the NOAEL-based TRV. Study showed reduced reproduction and clutch size in mallards.	Williams et al. 2015
White Phosphorus	Oral / Diet	Mammals	Late gestational mortality	TRV (NOAEL-based)	0.015	mg/kgBW/day	Late gestational mortality would likely affect the survival and reproduction of a populations; studies with rats over 80 days to 30 weeks.	Williams et al. 2015
White Phosphorus	Oral / Diet	Mammals	Survival	LD_{50}	1,530	mg/kg (food)	Oral LD_{50} for all phosphorus smokes was estimated as that for orthophosphoric acid. FIQ was determined to be around 19. Compounds with FIQ values near or greater than 1 are considered potentially toxic to wildlife.	Shinn et al. 1985

Key: % = percent; µg/gm = microgram per gram; µg/L = microgram per liter; BMD = benchmark dose; BMDL = benchmark dose lower confidence limit for a 10% response; BW = body weight; ClO_4 = perchlorate; DNAN = dinitroanisole; DNT = dinitrotoluene; EC_{50} = half maximal effective concentration; Eco-SSL = Ecological Soil Screening Level; EMH = extramedullary hematopoiesis; ESL = environmental screening level; FIQ = foliage ingestion quotient; HC = hexachloroethane; HMX = High Melting Explosive; LC_{50} = median lethal concentration; LD_{50} = median lethal dose; LOAEL = lowest observed adverse effect level; LOEC = lowest observed effect concentration; mg/g = milligrams per gram; mg/kg = milligrams per kilogram; mg/kgBW/day = milligrams per kilogram of body weight per day; mg/L = milligrams per liter; mg/m3 = milligrams per cubic meter; NG = nitroglycerine; NHDES = New Hampshire Department of Environmental Services; NOAEL = no observed adverse effect level; NOEC = no observed effect concentration; ppm = parts per million; RDX = Research Department Explosive; NG = nitroglycerine; NOAA = National Oceanic and Atmospheric Administration; NQ = nitroguanidine; NTO = nitrotriazolone; SQB = sediment quality benchmark; SQT = sediment quality threshold; SQuiRT = Screening Quick Reference Tables; TNB = trinitrobenzene; TNT = trinitrotoluene; TOC = total organic carbon; TRV = toxicity reference value; UF = uncertainty factor; USEPA = United States Environmental Protection Agency; $ZnCl_2$ = zinc chloride

5.2. METALS

As with explosive and propellant munitions constituents, exposure to metals in the environment can be toxic to many receptors. A similar methodology to that used in the analysis of explosive compounds and propellant toxicities was used to analyze metal toxicity to the same receptors. In addition to information regarding the most stringent criteria for metals of interest (Table 10), information for aquatic and terrestrial receptors (including avian, mammalian, invertebrate, and plant species) was identified, where available. Information was not identified for every receptor and munitions combination. Table 11 identifies the analyte of interest (the metal), the media where exposure may occur (soil, air, diet, etc.), the receptor (birds, mammals, plants, etc.), the endpoint impacted (survival, growth, reproduction, etc.), the toxicity value type (dose or concentration-based toxicity values), and the numeric toxicity value with specified units. In general, preference was given to toxicity values identified as relevant benchmarks by the USEPA or other governmental entities.

Table 10 Most Stringent Water Quality and Sediment Criteria for Select Metals of Interest

Surface Water Quality				Marine Sediment Quality		Soil Screening Levels (mg/kg)
Parameter	**Unit**	**Most Stringent Criteria**	**Basis**	**TEL**	**PEL**	
Aluminum (total)	µg/L	87 (4-day average)	ALC-FW	-	-	50,000 (plants)
Antimony (total)	µg/L	500	ALC-M	-	-	142 (mammals)
Copper (total)	µg/L	3.1 (hardness dependent)	ALC-M	18,700	108,000	5,400 (mammals)
Iron (total)	µg/L	1,000	ALC-FW	-	-	200,000 (microbes)
Lead (total)	µg/L	8.1 (4-day average; hardness dependent)	ALC-M	30,240	112,000	53.7 (mammals)
Zinc (total)	µg/L	81 (4-day average; hardness dependent)	ALC-M	124,000	271,000	6,620 (invertebrates)

Key: µg/L = microgram per liter; ALC = Aquatic Life, Chronic; FW = freshwater; M = marine; mg/kg = milligram per kilogram; PEL = Probable Effects Level; TEL = Threshold Effects Level
Source: Buchman 2008; ADEC 2022, 2023

Table 11 Toxicity Summaries and Benchmark Data for Metals

Analyte	Media	Receptor	Endpoint	Toxicity Value Type	Toxicity Value	Units	Details/Notes
Antimony	Oral / Diet	Mammals	Effects on reproduction and growth	NOAEL/NOEC	0.059	mg/kg	The interim final Eco-SSL TRV of 0.059 mg/kg/d for antimony in mammals represents the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth, or survival endpoints. USEPA does not specifically select one study to represent the NOAEL but rather, the TRV is theoretically based on all of the studies and their associated data and is specific to the highest bounded NOAEL below the lowest bounded LOAEL.
Antimony	Sediment	Earthworms	Effects on reproduction	NOAEL/NOEC	78	mg/kg	The interim final, chronic geometric mean of 78 mg/kg for antimony in soil invertebrates is based on a geometric mean of three EC20 values. The GMM represents three test species (enchytraeid, *Enchytraeus crypticus*; springtail, *Folsomia candida*; and earthworm; *Eisenia fetida*) under similar test conditions. Soil pH ranges for the three studies are 4.08 to 5.29, 4.57 to 5.29, and 4.39 to 5.29. The soil organic matter in all studies was 1.2%. The GMM represents effects on reproduction.
Antimony	Soil	Plants	Effects on reproduction and development	NOAEL/NOEC	11.4	mg/kg	The GMM TRV for antimony in soil of plants is equal to a chronic NOEC of 11.4 mg/kg soil. This GMM TRV is derived from a data set of three PTVs representing three references, three experiments, three unique measurements, and one phylogenetic test organism order. Endpoint category included in the data set is reproduction/development only. One of the PTVs is associated with high confidence and two with medium confidence. The test exposure route/medium of uptake via seed and root matches the exposure route of concern for soil ESLs for plants.
Aluminum	Oral dose	Birds	Body weight and food consumption rate	NOAEL	109.7	mg/kgBW/d	This chronic NOAEL of 109.7 mg/kgBW/d is based on a dietary concentration of 1,000 ppm. Ringed turtle doves were exposed to the chemical in their diet for 4 months, including during a critical life stage (reproduction) at one dose level (1,000 ppm). No significant reproductive effects were observed with an exposure of 1,000 ppm.
Aluminum	Sediment	Aquatic community organism	Not specified	NOAEL/NOEC	25,500	mg/kg	--

Analyte	Media	Receptor	Endpoint	Toxicity Value Type	Toxicity Value	Units	Details/Notes
Aluminum	Oral dose	Mammals	Growth inhibition, litter number, and offspring number	NOAEL/NOEC	1.93	mg/kg/d	This chronic NOAEL of 1.93 mg/kg/d for reproductive effects is based on a chronic LOAEL of 19.3 mg/kg/d. Mice were exposed to the chemical in their drinking water for three generations, including during a critical life stage (reproduction) at one dose level (19.3 mg/kg/d). A significant reduction of growth in generations 2 and 3 was observed with an exposure of 19.3 mg/kg/d. No effects on number of litters or number of offspring per litter were observed at this same dose.
Copper	Oral Dose	Birds	Eggs per nest	Highest Bounded NOAEL	4.05	mg/kg/d	The interim final Eco-SSL TRV of 4.05 mg/kg/d for copper in birds is equal to the highest bounded NOAEL lower than the lowest bounded LOAEL for reproduction, growth or survival. This NOAEL represents a reproduction (eggs per nest) endpoint.
Copper	Sediment	Aquatic community organism	Not specified	NOAEL/NOEC	31.6	mg/kg	TEC from MacDonald et al. 2000, as cited in Buchman 2008.
Copper	Oral Dose	Mammals	Both growth and survival	NOAEL	5.6	mg/kg/d	The interim final Eco-SSL TRV of 5.60 mg/kg/d for copper in mammals is equal to the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth, or survival. This NOAEL represents a both growth (body weight changes) and survival (mortality) endpoints.
Copper	Sediment	Earthworms	Not specified	NOAEL	80	mg/kg	The interim final Eco-SSL TRV of 80 mg/kg dw for copper in soil invertebrates is equal to the geometric mean of the MATC and EC10 values for at least six test species under different test conditions (pH and OM%).
Copper	Soil	Plants	Not specified	NOAEL	70	mg/kg	The interim final Eco-SSL TRV of 70 mg/kg dw for copper in terrestrial plants is equal to the geometric mean of the MATC and EC10 values for four species under different test conditions (pH and OM%).
Iron	Sediment	Aquatic community organism	Not specified	NOAEL/NOEC	20,000	mg/kg	--
Iron	Water	Aquatic community organism	Not specified	NOAEL/NOEC	1,000	µg/L	--

Analyte	Media	Receptor	Endpoint	Toxicity Value Type	Toxicity Value	Units	Details/Notes
Lead	Oral / Diet	Birds	Reproduction, growth, or survival	NOAEL	1.63	mg/kg/d	The interim final chronic NOAEL of 1.63 mg/kg/d for lead in birds represents the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth, or survival endpoints. USEPA does not specifically select one study to represent the NOAEL but rather, the TRV is theoretically based on all of the studies and their associated data and is specific to the highest bounded NOAEL below the lowest bounded LOAEL.
Lead	Sediment	Aquatic community organism	Not specified	NOAEL/NOEC	35	mg/kg	TEC from MacDonald et al. 2000 as cited in Buchman, 2008.
Lead	Oral dose	Mammal	Reproduction, growth, or survival	NOAEL/NOEC	4.70	mg/kg/d	The interim final Eco-SSL TRV of 4.70 mg/kg/d for lead in mammals represents the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth, or survival endpoints.
Lead	Soil	Earthworm	Reproduction	NOAEL/NOEC	1,700	mg/kg	The interim final, chronic geometric mean of 1,700 mg/kg for lead in soil invertebrates is based on a geometric mean of four MATCs. The GMM represents four studies, three different test conditions (based on soil pH), and one test species (springtail, *Folsomia candida*). The soil organic matter in all studies was 10%. The GMM represents effects on reproduction.
Lead	Soil	Plants	Growth	NOAEL/NOEC	120	mg/kg	The interim final, chronic geometric mean of 120 mg/kg for lead in terrestrial plants is based on a geometric mean of five MATCs. The GMM data set includes four test species (Berseem clover, loblolly pine, red maple, and ryegrass). The soil organic matter in the data set ranges from 0.1 to 3.11%, and the pH ranges from 4 to 6.7. The GMM represents effects on growth.
Zinc	Oral dose	Birds	Effects on reproduction and growth	NOAEL/NOEC	66.1	mg/kg/d	The interim final Eco-SSL TRV of 66.1 mg/kg/d for zinc in birds is equal to the geometric mean of the NOAEL values for reproduction (progeny counts/numbers, testes weight, reproductive organ histology) and growth (body weight changes). This value is lower than the lowest bounded LOAEL for reproduction, growth or survival.

Analyte	Media	Receptor	Endpoint	Toxicity Value Type	Toxicity Value	Units	Details/Notes
Zinc	Sediment	Aquatic community organism	Not Specified	NOAEL/NOEC	121	mg/kg	--
Zinc	Oral Dose	Mammals	Effects on reproduction and growth	NOAEL/NOEC	75.4	mg/kg/d	The interim final Eco-SSL TRV of 75.4 mg/kg/d for zinc in mammals is equal to the geometric mean of the NOAEL values for reproduction (offspring development, progeny weight, organ weight changes, pregnant females in population, progeny counts/numbers, testes weight, reproductive organ histology, general reproduction, resorbed embryos) and growth (body weight changes, general growth changes). This value is lower than the lowest bounded LOAEL for reproduction, growth or survival.
Zinc	Soil	Plants	Not specified	NOAEL/NOEC	160	mg/kg	The interim final Eco-SSL TRV of 160 mg/kg dw for zinc in terrestrial plants is equal to the geometric mean of the MATC values for three species under different test conditions (pH and OM%).
Zinc	Soil	Earthworms	Not specified	NOAEL/NOEC	1,200	mg/kg	--

Key: % = percent; µg/L = microgram per liter; dw = dry weight; EC10 = 10% effect concentration; EC20 = 20% effect concentration; Eco-SSL = Ecological Soil Screening Level; GMM = geometric mean; LOAEL = lowest observed adverse effect level; MATC = Maximum Acceptable Toxic Concentration; mg/kg = milligrams per kilogram; mg/kg/d = milligrams per kilogram per day; mg/kgBW/d = milligrams per kilogram of body weight per day; NOAEL = no observed adverse effect level; NOEC = no observed effect concentration; OM = organic material; ppm = parts per million; TEC = Threshold Effect Concentration; TRV = toxicity reference value; USEPA = U.S. Environmental Protection Agency

Source: Sample et al. 1996; Stantec 2010; LANL 2017

5.3. BIOACCUMULATION POTENTIAL OF MUNITIONS CONSTITUENTS

In addition to acute environmental exposure to munitions constituents that may result in detrimental effects to receptors, there is potential for receptors to experience detrimental effects from accumulation of these compounds from constant or repeated exposure to low levels of chemicals. Plants and animals can potentially bioaccumulate certain constituents above levels present in abiotic media in the environment if they are incorporated into the tissue of prey species or are accumulated by plants from the soil and/or water. Consequently, bioaccumulation can expose wildlife and plant species to high concentrations of munition constituents, even if those constituents are only present at low levels in the environment.

To measure the ability of plants and animals to bioaccumulate various constituents, bioconcentration factors (BCFs), bioaccumulation factors, transfer factors (TFs), or similar metrics have been developed to assess the potential for plants and animals to bioaccumulate various chemicals. These metrics are typically expressed as the concentration of a chemical in a test organism relative to the concentration of the chemical in the environment. LANL (2017) has identified TFs for a wide variety of munition constituents, and Kuperman (2003) have developed BCFs for plants and earthworms exposed to various munitions in soil. For constituents not covered in these two references, individual literature reviews were conducted to determine the potential for bioaccumulation of each munition constituent.

Bioaccumulation plays an important role in understanding the fate of a substance in the environment. Substances having a high bioaccumulation potential can be efficiently taken up by organisms, leading to elevated internal concentrations that can reach critical levels that elicit toxic effects even when the concentration in the environment is low. Bioaccumulative chemicals typically remain in the organism well after the external concentration has declined. A chemical is considered ‘‘bioaccumulative’’ primarily based on its potential to bioconcentrate (i.e., when the bioaccumulation factor in aquatic species is greater than 5000 ml g-1 wet weight or when the log KOW is greater than 5) (Gobas et al. 2009, cited in Lotufo et al. 2013). Lotufo et al. 2013 reports that explosive MC compounds are not considered bioaccumulative compounds as their BCF values are < 14 ml g-1, which is over two orders of magnitude lower than 5000 ml g-1.

However, there is some emerging research indicating that some toxic explosive compounds (e.g., TNT and degradation products) from underwater munitions disposal sites are accumulated by flatfish and other aquatic organisms in the Baltic Sea (Koske et al. 2020; Beck et al. 2018, 2021; Barbosa et al. 2023). Thus, there remains some uncertainty as to how well toxicological experiments represent natural communities and whether munitions contaminants can bioaccumulate in organisms greater than previously thought (Beck et al. 2018).

Table 12 presents the bioaccumulation information and associated sources identified during this review for explosives and propellants, while Table 13 identifies the same information for select metals. Site-specific conditions (e.g., soil type, organic carbon levels, pH) can influence the bioavailability and bioaccumulation of constituents so ranges of uptake factors are provided for some constituents.

Table 12 Bioaccumulation Summaries for Explosives and Propellants

Analyte	Exposure Media	Receptor	Uptake Factor Type	Uptake Factor Value	Details/Notes	Abbreviated Citation
2,4-DNAN	Soil	Soil invertebrate	BAF	2 to 12	BAFs varied over test duration (measured at 2 hours to 14 days); BAF values increased from 6 to 13 during 2 hour to 1 day exposure, and then decreased to BAF of 2, at 14 day exposure. During this study period, the soil DNAN concentration decreased from 24 to 4 mg/kg.	Hawari 2014
2,4-DNAN	--	Fish	--	--	Although DNAN is more soluble than TNT, its lower hydrophobicity and its tendency to form aminoderivatives that sorb irreversibly to soil make it less toxic than the traditional explosive TNT.	Hawari et al. 2015
2,4-DNT	Soil (aged)	Plant	BCF	BDL to 0.44	BCF (mg/kg dry mass plant divided by mg/kg dry soil) ranges differed for fresh versus aged soil, and between species (alfalfa, Japanese millet, and ryegrass). Exposure was varied (5-100 mg/kg) for 16–19 days.	Kuperman 2003
2,4-DNT	Soil (fresh)	Plant	BCF	BDL	BCF (mg/kg dry mass plant divided by mg/kg dry soil) ranges differed for fresh versus aged soil, and between species (alfalfa, Japanese millet, and ryegrass). Exposure was varied (5-100 mg/kg) for 16–19 days.	Kuperman 2003
2,4-DNT	Soil (aged)	Plant	BCF	BDL to 1.7	BCF (mg/kg dry mass plant divided by mg/kg dry soil) ranges differed for fresh versus aged soil, and between species (alfalfa, Japanese millet, and ryegrass). Exposure was varied (5-100 mg/kg) for 16–19 days.	Kuperman 2003
2,4-DNT	Sediment	Invertebrate	TF	0.893	mg-COPC/kg-dry invertebrate per mg-COPC/kg-dry sediment.	LANL 2017
2,4-DNT	Soil	Soil invertebrate	TF	0.893	mg-COPC/kg-dry invertebrate per mg-COPC/kg-dry soil.	LANL 2017
2,4-DNT	Soil	Plant	TF	0.376	mg-COPC/kg-dry plant matter per mg-COPC/kg-dry soil.	LANL 2017
2,4-DNT	--	Fish	--	--	Not expected to bioaccumulate significantly in animal tissue.	ATSDR 2016 in USEPA 2017c
2,6-DNT	Soil (fresh)	Plant	BCF	BDL to 1.8	BCF (mg/kg dry mass plant divided by mg/kg dry soil) ranges differed for fresh versus aged soil, and between species	Kuperman 2003

Analyte	Exposure Media	Receptor	Uptake Factor Type	Uptake Factor Value	Details/Notes	Abbreviated Citation
					(alfalfa, Japanese millet, and ryegrass). Exposure was varied (5-100 mg/kg) for 16–19 days.	
2,6-DNT	Soil	Plant	TF	3.14	mg-COPC/kg-dry plant matter per mg-COPC/kg-dry soil.	LANL 2017
2,6-DNT	Soil	Soil invertebrate	TF	1.14	mg-COPC/kg-dry invertebrate per mg-COPC/kg-dry soil.	LANL 2017
2,6-DNT	Sediment	Invertebrate	TF	1.14	mg-COPC/kg-dry invertebrate per mg-COPC/kg-dry sediment.	LANL 2017
Ammonium perchlorate	Soil	Soil invertebrate	TF	1	Perchlorate default value; mg-COPC/kg-dry invertebrate per mg-COPC/kg-dry soil.	LANL 2017
Ammonium perchlorate	Soil	Plant	TF	300	Perchlorate; mg-COPC/kg-dry plant matter per mg-COPC/kg-dry soil.	LANL 2017
Ammonium perchlorate	--	Fish	--	--	Bioconcentration of perchlorate appears to be low for aquatic and terrestrial species	ATSDR 2008
HC	--	Fish	--	--	Slight tendency to build up in fish, but they tend to break it down quickly.	ATSDR 1997
HMX	Soil (fresh)	Worm	BCF	1 to 0.32	Worms were exposed to 9 and 83 mg/kg of HMX for 14 days. BCFs were 1.0 and 0.32 for each concentration, respectively.	Kuperman 2003
HMX	Soil (aged)	Plant	BCF	0.018 to 0.037	BCF (mg/kg dry mass plant divided by mg/kg dry soil) ranges differed for fresh versus aged soil, and between species (alfalfa, Japanese millet, and ryegrass); exposure was 10,000 mg/kg for 16–19 days.	Kuperman 2003
HMX	Soil (fresh)	Plant	BCF	0.013 to 0.028	BCF (mg/kg dry mass plant divided by mg/kg dry soil) ranges differed for fresh versus aged soil, and between species (alfalfa, Japanese millet, and ryegrass); exposure was 10,000 mg/kg for 16–19 days.	Kuperman 2003
HMX	Sediment	Invertebrate	TF	0.313	mg-COPC/kg-dry invertebrate per mg-COPC/kg-dry sediment.	LANL 2017
HMX	Soil	Soil invertebrate	TF	0.313	mg-COPC/kg-dry invertebrate per mg-COPC/kg-dry soil.	LANL 2017

Analyte	Exposure Media	Receptor	Uptake Factor Type	Uptake Factor Value	Details/Notes	Abbreviated Citation
HMX	Soil	Plant	TF	2.15	mg-COPC/kg-dry plant matter per mg-COPC/kg-dry soil.	LANL 2017
HMX	--	Fish	--		Tissue residues found to be lower than environmental concentrations. Elimination half-lives for marine species relatively low, indicating that release from exposure would result in fast depuration and likely recovery from toxic effects.	Lotufo et al. 2013
Hydrocal	--	Fish	--	--	Toxic to fish due to its high alkalinity (pH > 12). Discharge of large quantities directly into waterways could kill fish. Bioaccumulation not expected.	USG 2017
NG	Soil	Plant	TF	13.3	mg-COPC/kg-dry plant matter per mg-COPC/kg-dry soil.	LANL 2017
NG	Soil	Soil invertebrate	TF	0.347	mg-COPC/kg-dry invertebrate per mg-COPC/kg-dry soil.	LANL 2017
NG	Sediment	Invertebrate	TF	0.347	mg-COPC/kg-dry invertebrate per mg-COPC/kg-dry sediment.	LANL 2017
NG	--	Fish	--	--	Although no data for the bioaccumulation of NG in marine or fish and invertebrates were found, based on the low log Kow the potential for bioconcentration in aquatic organisms is considered low.	Lotufo et al. 2013
NQ	Soil	Soil invertebrate	BAF	0.4	Preliminary BAF estimated using the concentration ratio of *Eisenia* tissue to soil after 14-day exposure in amended soil at sub-lethal conditions.	Hawari 2014
NQ	--	Fish	--	--	No data for bioaccumulation of NQ in marine fish and invertebrates were found; however, based on the low log Kow, the potential for bioconcentration in aquatic organisms is considered low.	Lotufo et al. 2013
NTO	Soil	Soil invertebrate	BAF	0.2	Preliminary BAF estimated using the concentration ratio of *Eisenia* tissue to soil after 14-day exposure in amended soil at sub-lethal conditions.	Hawari 2014
NTO	Water	Aquatic community member	BCF	3	An estimated BCF of 3 was calculated in fish for nitrotriazolone, using a log Kow of -1.699 and a regression-derived equation [EPI Suite]. According to a classification scheme, this BCF suggests the potential for bioconcentration in	NCBI 2020

Analyte	Exposure Media	Receptor	Uptake Factor Type	Uptake Factor Value	Details/Notes	Abbreviated Citation
					aquatic organisms is low. A BCF of 0.25 was measured in *Rana pipiens* tadpoles.	
RDX	Soil (aged)	Plant	BCF	0.39 to 0.66	BCF (mg/kg dry mass plant divided by mg/kg dry soil) ranges differed for fresh versus aged soil, and between species (alfalfa, Japanese millet, and ryegrass); exposure was 10,000 mg/kg for 16–19 days.	Kuperman 2003
RDX	Soil (fresh)	Plant	BCF	0.14 to 0.27	BCF (mg/kg dry mass plant divided by mg/kg dry soil) ranges differed for fresh versus aged soil, and between species (alfalfa, Japanese millet, and ryegrass); exposure was 10,000 mg/kg for 16–19 days.	Kuperman 2003
RDX	Soil (fresh)	Worm	BCF	13 to 2.9	Worms were exposed to 10 and 99 mg/kg of RDX for 14 days. BCFs were 13 and 2.9 for each concentration, respectively.	Kuperman 2003
RDX	Sediment	Invertebrate	TF	2.63	mg-COPC/kg-dry invertebrate per mg-COPC/kg-dry sediment.	LANL 2017
RDX	Soil	Soil invertebrate	TF	2.63	mg-COPC/kg-dry invertebrate per mg-COPC/kg-dry soil.	LANL 2017
RDX	Soil	Plant	TF	2.78	mg-COPC/kg-dry plant matter per mg-COPC/kg-dry soil.	LANL 2017
RDX	--	Fish	--		RDX has a low bioconcentration potential in aquatic organisms.	USEPA 2017a
TNT (breakdown product; TNB)	Soil (aged)	Plant	BCF	BDL	BCF (mg/kg dry mass plant divided by mg/kg dry soil) ranges differed for fresh versus aged soil, and between species (alfalfa, Japanese millet, and ryegrass). Exposure was varied (5-100 mg/kg) for 16–19 days.	Kuperman 2003
TNT (breakdown product; TNB)	Soil (fresh)	Plant	BCF	BDL to 0.3	BCF (mg/kg dry mass plant divided by mg/kg dry soil) ranges differed for fresh versus aged soil, and between species (alfalfa, Japanese millet, and ryegrass). Exposure was varied (5-100 mg/kg) for 16–19 days.	Kuperman 2003
TNT (breakdown product; TNB)	Soil	Plant	TF	1.02	1,3,5 TNB; mg-COPC/kg-dry plant matter per mg-COPC/kg-dry soil.	LANL 2017

Analyte	Exposure Media	Receptor	Uptake Factor Type	Uptake Factor Value	Details/Notes	Abbreviated Citation
TNT (breakdown product; TNB)	Soil	Soil invertebrate	TF	0.063	1,3,5 TNB; mg-COPC/kg-dry invertebrate per mg-COPC/kg-dry soil.	LANL 2017
TNT (breakdown product; TNB)	Sediment	Invertebrate	TF	0.063	mg-COPC/kg-dry invertebrate per mg-COPC/kg-dry sediment.	LANL 2017
TNT	Soil	Plant	TF	3.53	mg-COPC/kg-dry plant matter per mg-COPC/kg-dry soil.	LANL 2017
TNT	Soil	Soil invertebrate	TF	0.0581	mg-COPC/kg-dry invertebrate per mg-COPC/kg-dry soil.	LANL 2017
TNT	Sediment	Invertebrate	TF	0.0581	mg-COPC/kg-dry invertebrate per mg-COPC/kg-dry sediment.	LANL 2017
TNT	--	Fish	--	--	TNT is not expected to bioconcentrate to high levels in the tissues of exposed aquatic organisms or bioaccumulate in fish.	Houston and Lotufo 2005; USEPA 2017b
White Phosphorus	Water	Fish	BCF	9 to 2,000	BAF varied depending on species of fish and tissue type studied (highest uptake in liver; lower in muscle [maximum BCF of 68 in muscle]).	Davidson et al. 1987
White Phosphorus	Water	Invertebrate	BCF	10 to 1,267	BAF varied depending on species of invertebrate and tissue type studied (highest uptake in lobster hepatopancreas; maximum BCF in other invertebrates was 43)	Davidson et al. 1987
White Phosphorus	--	Fish	--	--	WP moderately bioconcentrates in aquatic organisms, but BCFs are much lower than those for other toxic organic chemicals. BCFs of elemental phosphorus in fish depend on water concentrations.	Reviewed in Sciences International 1997b

Key: BAF = bioaccumulation factor; BCF = bioconcentration factor; BDL = below detection limit; DNT = dinitrotoluene; DNAN = dinitroanisole; HC = hexachloroethane; HMX = High Melting Explosive; Kow = octanol-water partition coefficient; mg-COPC/kg = milligrams of contaminant of potential concern per kilogram; mg/kg = milligrams per kilogram; RDX = Research Department Explosive; NG = nitroglycerine; NQ = nitroguanidine; NTO = nitrotriazolone; TF = transfer factor; TNB = trinitrobenzene; TNT = trinitrotoluene; WP = white phosphorus

Table 13 Bioaccumulation Summaries for Select Metals

Analyte	Exposure Media	Receptor	Uptake factor Type	Uptake Factor Value	Details/Notes	Abbreviated Citation
Aluminum	Soil	Soil Invertebrate	TF	0.043	mg-COPC/kg-dry invertebrate per mg-COPC/kg-dry sediment	LANL 2017
Antimony	Soil	Soil Invertebrate	TF	0.0073	mg-COPC/kg-dry invertebrate per mg-COPC/kg-dry soil	LANL 2017
Antimony	Soil	Plant	TF	0.2	mg-COPC/kg-dry plant matter per mg-COPC/kg-dry soil	LANL 2017
Copper	Soil	Plant	TF	0.2	mg-COPC/kg-dry plant matter per mg-COPC/kg-dry soil	LANL 2017
Copper	Soil	Soil Invertebrate	TF	0.6364	mg-COPC/kg-dry invertebrate per mg-COPC/kg-dry soil	LANL 2017
Iron	Soil	Soil Invertebrate	TF	00.36	mg-COPC/kg-dry invertebrate per mg-COPC/kg-dry sediment	VERSAR 2020
Lead	Soil	Soil Invertebrate	TF	0.225	mg-COPC/kg-dry invertebrate per mg-COPC/kg-dry soil	LANL 2017
Lead	Soil	Plant	TF	0.117	mg-COPC/kg-dry plant matter per mg-COPC/kg-dry soil	LANL 2017
Zinc	Soil	Soil Invertebrate	TF	3.78	mg-COPC/kg-dry invertebrate per mg-COPC/kg-dry soil	LANL 2017
Zinc	Soil	Plant	TF	0.43	mg-COPC/kg-dry plant matter per mg-COPC/kg-dry soil	LANL 2017

Key: mg-COPC/kg = milligrams of contaminant of potential concern per kilogram

6. SUMMARY

The resumption of all-season live-fire training at ERF-IA will introduce munitions constituents into ERF-IA throughout the year (for the first time since 1990). The type of constituents in the munitions used during live-fire training will not appreciably change from existing conditions but the amount of munitions contaminant residue deposition into ERF-IA will increase. Also, IMs were not used when all-season live firing was last performed at ERF-IA.

The primary types of munitions constituents used at ERF-IA include explosives, illuminants, propellants, and metals. Both HE and non-HE training rounds are used at ERF-IA. HE rounds are primarily composed of explosives, iron (steel), aluminum, and copper. These rounds may include a variety of explosive residues and are the only rounds that generate metal shrapnel (non-HE rounds do not). Traditional HE munitions that have historically been used at ERF-IA (e.g., TNT, RDX, and HMX) are being phased out in favor of IMs (e.g., IMX-101 and IMX-104), which are less prone to unplanned detonations. However, these constituents result in higher deposition and have different breakdown and toxicity rates. WP and ammonium perchlorate are no longer used at ERF-IA, although capped ponds are still present at ERF-IA and could be damaged if struck by an errant round during training when protective ice is not present. However, with protective measures and mitigation in place, there would be a very low risk of such an occurrence. The locations of gravel caps have been mapped, and these areas would not be intentionally targeted during firing outside of winter ice conditions. Most gravel-capped areas are underwater during months when ERF is not frozen, and no targets would be placed on them. In the event of a misfire into a gravel-capped area, there would be a cease fire and a follow-up investigation. Additionally, mitigation to prohibit use of delay fuzes would minimize the potential for penetration of the gravel cap in the event of such a misfire.

LO detonations and UXOs (duds) are most likely to contribute to munitions residue deposition at ERF-IA. A conservative estimate is that LO detonations deposit 50 percent of their explosive mass into the environment, whereas dud rounds deposit 100 percent. However, the rate of contaminant deposition from UXO is variable as leaching rates will vary depending on site-specific factors. Thus, it is anticipated that contaminant exposure from duds at any given time would be low as full deposition of UXO residue may occur over a period of decades to centuries. LO detonation rates tend to be very low (0.1 to 0.3 percent), with UXO rates slightly higher (around 3.4 percent), although this is much greater than the dud rate observed by JBER personnel over the past 20 years.

It is estimated that a total of approximately 226.1 kilograms of munitions residue would be deposited annually at ERF-IA from training activities under Alternatives 1 and 2, assuming all training occurs at JBER under both alternatives. For Alternative 1, the estimated deposition would include 211.3 kilograms into existing ERF-IA and 14.8 kilograms into the proposed expansion area. Most of the residue would be contributed by UXOs (216 kilograms), with lesser amounts from LO detonations (10.4 kilograms) and HO detonations (0.021 kilogram). For Alternative 2, the entire amount of munitions residue could be deposited into the existing ERF-IA, as the impact area would not be expanded. Comparatively, the total estimated amount of residue deposition for the No Action Alternative would be 146 kilograms. The rate of degradation of munitions residue is dependent on a variety of environmental factors and conditions.

Attenuation processes cause the bioavailability of a given contaminant to decrease over time, reducing its potential to harm ecological receptors. Attenuation processes include physical, chemical, and biological processes that involve various pathways including biodegradation, photodegradation, dissolution, and sorption. Following the initial deposition of munitions contaminants into the environment, their fate and degradation in soil and groundwater are dependent on a variety of environmental factors and conditions, including the contaminant characteristics, subsurface geochemistry, and microbial community. Studies conducted in Alaska have found that explosive compounds biodegrade within days to months in anaerobic environments with sufficient organic matter content, such as those found over much of the existing ERF-IA. However, it should be noted that some LO and UXO residues are not available for degradation until dissolved, which may take days to years depending on particle size (Beal and Bigl 2022), explosive solubility, and exposure to water; breached UXO can continue to leak for decades or centuries (Taylor et al. 2011). Metals tend to sorb to sediments, which promotes sequestration and reduces their bioavailability as more toxic dissolved phases.

A review of available literature yielded benchmarks and toxicity values for aquatic and terrestrial community receptors. For birds, the most toxic chemicals identified were 2,4-DNT and WP. For mammals, WP was also one of the most toxic chemicals identified, although munitions with WP are no longer used at ERF-IA. WP risks would be associated with striking gravel caps when the ground is not frozen, and precautions will be taken to prevent penetrating capped areas. Plants and terrestrial invertebrates were better able to tolerate exposure to chemical constituents, where most toxicity values were above 1 mg/kg or greater concentrations of the constituent in the soil. Aquatic community organisms were generally the most sensitive to munitions constituents, where toxicity values are often less than 100 microgram per liter of munitions constituent concentration in water.

Firing during ice-free months is expected to result in more rapid removal of munitions constituents from the environment. When ice is not present, munitions residues have potential for more rapid transport out of the estuary than during conditions when residues are deposited on top of ice surfaces. This is particularly the case when residue deposition areas are hydrologically connected to Eagle River and Eagle Bay because constituent residence times would be reduced on the surface of the flats. Residue deposited on ice/snow during winter training does not all flush away to Knik Arm when spring arrives (as the thaw occurs slowly) and may adhere to sediments; therefore, it is likely to be retained in the estuary for longer periods than residue deposited during ice-free conditions.

Snow sampling conducted during HO testing at ERF-IA documented 10 to 100 percent of residues in dissolved phase immediately upon sample melt, depending on location, hydrological connectivity, and compound solubility (Beal et al. 2023). While these residues would be expected to mobilize quickly, those that partially adsorb to soil/sediment would not be immediately flushed out of the estuary. One study of LO particles from a 120-mm cartridge fired into ERF during winter documented relatively high quantities (300 grams; the equivalent of at least 22,000 HO rounds) still remaining in the sediment in May (Walsh et al. 2005). Based on these findings, it is expected that LO and dudded rounds resulting from live-fire training would be the primary concern for contaminating soil and water at ERF-IA. However, residue deposition for LO rounds would be limited due to their rare occurrences. UXO would likely remain in place for years, decades, or centuries, unless detonated by a BIP procedure but is only expected to result from 0–4 percent of all rounds fired. The extent and degree of munition contamination at ERF-IA resulting from the proposed action would depend on factors such as detonation location, breakdown pathways, tidal hydrology, and site-specific conditions. Munition residue is expected to be degraded or diluted to lower toxicity concentrations more quickly if it is deposited in areas that are hydrologically connected to wetlands and waterbodies rather than upland areas, although all UXO would be cleared from the proposed expansion area.

While this appendix provides an overview of information about the potential ecotoxicology and environmental fate of munitions constituents, there is still uncertainty about potential exposure of munitions contaminants to ecological receptors due to the complex environment and dynamic nature of ERF-IA. While much is known about fate/transport and breakdown pathways of traditional munitions, emerging research has shown that some IM constituents such as NTO and NQ are highly mobile and potentially toxic to ecological organisms. Based on the low bioaccumulation potential for most munitions residues and the highly reducing conditions present in ERF, the risk of impacts to ecological receptors from bioaccumulation appears to be low. However, without a comprehensive ecotoxicological assessment, site-specific sampling would be needed to further evaluate the potential for exposure to sensitive receptors to deposited munitions residues at ERF-IA.

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APPENDIX G–AIR QUALITY SUPPORTING INFORMATION

Appendix G:

AIR QUALITY SUPPORTING INFORMATION

PROPOSED MORTAR AND ARTILLERY TRAINING AT RICHARDSON TRAINING AREA, JOINT BASE ELMENDORF-RICHARDSON, ALASKA

INTRODUCTION

According to the Air Force Environmental Impact Analysis Process (EIAP; 32 CFR Part 989); the Air Force Air Conformity Applicability Model (ACAM) is the only quantitative estimating technique and tool approved and validated per AFMAN 32-7002 for performing air quality impact assessments under NEPA. Therefore, ACAM was used to quantify the net change in emissions for the proposed mortar and artillery training (PMART) Environmental Impact Statement (EIS). Of the project components, ACAM has the capability to quantify direct and indirect emissions associated with clearing, construction, and regular firebreak maintenance activities under Alternative 1. ACAM results provided in this appendix do not include other project components.

ACAM outputs are provided in the pages that follow. They include estimates of criteria pollutants and greenhouse gases (GHGs).

DETAIL AIR CONFORMITY APPLICABILITY MODEL REPORT

1. General Information

- Action Location
Base: ELMENDORF AFB
State: Alaska
County(s): Anchorage Municipality
Regulatory Area(s): NOT IN A REGULATORY AREA

- Action Title: Construction, Clearing, and Fire Break for Munitions Range

- Project Number/s (if applicable): Expansion of firing at base to avoid trips to other bases for training.

- Projected Action Start Date: 5 / 2024

- Action Purpose and Need:
Current range is too small for all operations. This requires extensive travel to other bases to complete training. With expansion, all training can occur on base. In out years, some clearing will occur for fire breaks.

- Action Description:
1.8 miles of 15 foot wide roads (gravel) would be built along with 50 x 50 feet service pads.
359 acres would be cleared for range extension.
Clearing of 5.8 acres every 2 to 3 years will occur for fire breaks. Assume 3 days to complete it out years.

- Point of Contact
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Report generated with ACAM version: 5.0.23a

- Activity List:

Activity Type		Activity Title
2.	Construction / Demolition	Construction and Clearing for Munitions Range
3.	Construction / Demolition	Roadway
4.	Construction / Demolition	Fire Break
5.	Construction / Demolition	Fire Break
6.	Construction / Demolition	Fire Break
7.	Construction / Demolition	Fire Break
8.	Construction / Demolition	Fire Break
9.	Construction / Demolition	Fire Break
10.	Construction / Demolition	Fire Break
11.	Construction / Demolition	Fire Break
12.	Construction / Demolition	Fire Break

Emission factors and air emission estimating methods come from the United States Air Force's Air Emissions Guide for Air Force Stationary Sources, Air Emissions Guide for Air Force Mobile Sources, and Air Emissions Guide for Air Force Transitory Sources.

2. Construction / Demolition

2.1 General Information & Timeline Assumptions

- Activity Location
County: Anchorage Municipality
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Construction and Clearing for Munitions Range

- Activity Description:
1.8 miles of 15 foot wide roads (gravel) would be built along with 50 x 50 feet service pads.
359 acres would be cleared.

- Activity Start Date
Start Month: 5
Start Month: 2024

- Activity End Date
Indefinite: False
End Month: 8
End Month: 2024

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.430199
SO_x	0.007255
NO_x	4.104601
CO	3.613953

Pollutant	Total Emissions (TONs)
PM 10	622.443398
PM 2.5	0.162588
Pb	0.000000
NH_3	0.001936

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.032608
N_2O	0.006771

Pollutant	Total Emissions (TONs)
CO_2	795.538190
CO_2e	798.371011

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.032608
N_2O	0.006771

Pollutant	Total Emissions (TONs)
CO_2	795.538190
CO_2e	798.371011

2.1 Site Grading Phase

2.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 5
Start Quarter: 1
Start Year: 2024

- Phase Duration
Number of Month: 4
Number of Days: 0

2.1.2 Site Grading Phase Assumptions

- General Site Grading Information

Area of Site to be Graded (ft^2): 15638040
Amount of Material to be Hauled On-Site (yd^3): 1111
Amount of Material to be Hauled Off-Site (yd^3): 0

- Site Grading Default Settings

Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Graders Composite	2	8
Other Construction Equipment Composite	2	8
Rollers Composite	1	8
Rubber Tired Dozers Composite	3	8
Scrapers Composite	6	8
Tractors/Loaders/Backhoes Composite	2	8

- Vehicle Exhaust

Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips

Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

2.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.36076	0.00489	3.17634	3.40450	0.17539	0.16136
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.34346	0.00488	3.24084	3.56285	0.20853	0.19184
Rollers Composite [HP: 36] [LF: 0.38]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.61835	0.00541	3.81402	4.19473	0.19185	0.17650
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.40864	0.00491	4.01022	3.25251	0.17852	0.16424
Scrapers Composite [HP: 423] [LF: 0.48]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.22855	0.00488	2.29173	1.71084	0.08854	0.08146
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.21500	0.00489	2.19159	3.49485	0.09716	0.08939

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02151	0.00430	530.17041	531.98982
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02144	0.00429	528.45375	530.26726
Rollers Composite [HP: 36] [LF: 0.38]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02380	0.00476	586.79790	588.81164
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02159	0.00432	532.20301	534.02939
Scrapers Composite [HP: 423] [LF: 0.48]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02146	0.00429	528.96796	530.78324
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02150	0.00430	529.93313	531.75173

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.31726	0.00124	0.17736	5.79132	0.00591	0.00523	0.05247
LDGT	0.27757	0.00154	0.22987	5.23096	0.00667	0.00590	0.04464
HDGV	0.82721	0.00339	0.72129	15.12556	0.02252	0.01992	0.09315
LDDV	0.14662	0.00123	0.14749	4.45024	0.00324	0.00298	0.01607
LDDT	0.24129	0.00142	0.48681	4.52780	0.00587	0.00540	0.01743
HDDV	0.16574	0.00437	2.76453	1.52915	0.05765	0.05304	0.06544
MC	1.97067	0.00149	0.73446	13.31300	0.01717	0.01519	0.05349

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.02430	0.00541	324.49560	326.70917
LDGT	0.02319	0.00742	401.51289	404.29879
HDGV	0.06349	0.02653	885.98938	895.46941
LDDV	0.07540	0.00066	364.73274	366.81386
LDDT	0.06080	0.00095	417.93561	419.73781
HDDV	0.04371	0.16148	1300.36269	1349.57603
MC	0.08824	0.00292	390.56216	393.63776

2.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD} = (20 * ACRE * WD) / 2000$

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
$VMT_{VE} = (HA_{OnSite} + HA_{OffSite}) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

3. Construction / Demolition

3.1 General Information & Timeline Assumptions

- Activity Location
County: Anchorage Municipality
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Roadway

- Activity Description:
1.8 miles of roadway clearing

- Activity Start Date
Start Month: 5
Start Month: 2024

- Activity End Date
Indefinite: False
End Month: 5
End Month: 2024

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.021272
SO_x	0.000288
NO_x	0.198073
CO	0.209178

Pollutant	Total Emissions (TONs)
PM 10	1.427709
PM 2.5	0.008764
Pb	0.000000
NH_3	0.000240

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.001354
N_2O	0.000498

Pollutant	Total Emissions (TONs)
CO_2	33.040398
CO_2e	33.222654

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.001354
N_2O	0.000498

Pollutant	Total Emissions (TONs)
CO_2	33.040398
CO_2e	33.222654

3.1 Site Grading Phase

3.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 5
Start Quarter: 1
Start Year: 2024

- Phase Duration
Number of Month: 1
Number of Days: 0

3.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 142560
Amount of Material to be Hauled On-Site (yd^3): 1320
Amount of Material to be Hauled Off-Site (yd^3): 0

- Site Grading Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Graders Composite	1	8
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	8
Tractors/Loaders/Backhoes Composite	2	7

- Vehicle Exhaust

Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips

Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

3.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.36076	0.00489	3.17634	3.40450	0.17539	0.16136
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.34346	0.00488	3.24084	3.56285	0.20853	0.19184
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.40864	0.00491	4.01022	3.25251	0.17852	0.16424
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.21500	0.00489	2.19159	3.49485	0.09716	0.08939

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02151	0.00430	530.17041	531.98982
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02144	0.00429	528.45375	530.26726
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02159	0.00432	532.20301	534.02939
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02150	0.00430	529.93313	531.75173

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.31726	0.00124	0.17736	5.79132	0.00591	0.00523	0.05247
LDGT	0.27757	0.00154	0.22987	5.23096	0.00667	0.00590	0.04464
HDGV	0.82721	0.00339	0.72129	15.12556	0.02252	0.01992	0.09315
LDDV	0.14662	0.00123	0.14749	4.45024	0.00324	0.00298	0.01607
LDDT	0.24129	0.00142	0.48681	4.52780	0.00587	0.00540	0.01743
HDDV	0.16574	0.00437	2.76453	1.52915	0.05765	0.05304	0.06544
MC	1.97067	0.00149	0.73446	13.31300	0.01717	0.01519	0.05349

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.02430	0.00541	324.49560	326.70917
LDGT	0.02319	0.00742	401.51289	404.29879
HDGV	0.06349	0.02653	885.98938	895.46941
LDDV	0.07540	0.00066	364.73274	366.81386
LDDT	0.06080	0.00095	417.93561	419.73781
HDDV	0.04371	0.16148	1300.36269	1349.57603
MC	0.08824	0.00292	390.56216	393.63776

3.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD}$ = (20 * ACRE * WD) / 2000

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

VMT_{VE} = (HA_{OnSite} + $HA_{OffSite}$) * (1 / HC) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

4. Construction / Demolition

4.1 General Information & Timeline Assumptions

- Activity Location
County: Anchorage Municipality
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Fire Break

- Activity Description:
In out years clearing of 5.8 acres every 2 to 3 years. Assume 3 days to complete.

- Activity Start Date
Start Month: 6
Start Month: 2026

- Activity End Date
Indefinite: False
End Month: 6
End Month: 2026

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.002667
SO_x	0.000041
NO_x	0.023090
CO	0.028223

Pollutant	Total Emissions (TONs)
PM 10	0.349051
PM 2.5	0.000967
Pb	0.000000
NH_3	0.000022

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.000188
N_2O	0.000038

Pollutant	Total Emissions (TONs)
CO_2	4.550149
CO_2e	4.566275

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.000188
N_2O	0.000038

Pollutant	Total Emissions (TONs)
CO_2	4.550149
CO_2e	4.566275

4.1 Site Grading Phase

4.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 6
Start Quarter: 1
Start Year: 2026

- Phase Duration
Number of Month: 0
Number of Days: 3

4.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 252648
Amount of Material to be Hauled On-Site (yd^3): 0
Amount of Material to be Hauled Off-Site (yd^3): 0

- Site Grading Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Excavators Composite	1	8
Graders Composite	1	8
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	8
Tractors/Loaders/Backhoes Composite	2	7

- Vehicle Exhaust
Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

4.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Excavators Composite [HP: 36] [LF: 0.38]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.39317	0.00542	3.40690	4.22083	0.09860	0.09071
Graders Composite [HP: 148] [LF: 0.41]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.31292	0.00490	2.52757	3.39734	0.14041	0.12918
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.28160	0.00487	2.73375	3.50416	0.15811	0.14546
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.35280	0.00491	3.22260	2.72624	0.14205	0.13069
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.18406	0.00489	1.88476	3.48102	0.06347	0.05839

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Excavators Composite [HP: 36] [LF: 0.38]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02381	0.00476	587.02896	589.04350
Graders Composite [HP: 148] [LF: 0.41]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02153	0.00431	530.81500	532.63663
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02140	0.00428	527.54121	529.35159
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02160	0.00432	532.54993	534.37751
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02149	0.00430	529.70686	531.52468

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.28372	0.00120	0.14039	5.32464	0.00555	0.00491	0.04907
LDGT	0.24148	0.00148	0.16906	4.54379	0.00619	0.00548	0.04137
HDGV	0.74636	0.00341	0.59144	13.29232	0.02088	0.01847	0.09066
LDDV	0.14733	0.00121	0.15247	4.83980	0.00365	0.00335	0.01632
LDDT	0.19934	0.00138	0.42749	4.20803	0.00566	0.00521	0.01683
HDDV	0.14016	0.00423	2.44894	1.43553	0.04231	0.03893	0.06692
MC	1.97481	0.00150	0.73042	12.91109	0.01712	0.01515	0.05430

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.02122	0.00494	313.85789	315.85438
LDGT	0.01924	0.00667	386.44065	388.90634
HDGV	0.05695	0.02564	891.64533	900.69716
LDDV	0.07669	0.00066	360.42228	362.53536

	CH_4	N_2O	CO_2	CO_2e
LDDT	0.05931	0.00095	406.18416	407.95008
HDDV	0.04390	0.16477	1259.96046	1310.15916
MC	0.08509	0.00290	390.79952	393.79192

4.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase
$PM10_{FD}$ = (20 * ACRE * WD) / 2000

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase
CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL}* 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
VMT_{VE} = (HA_{OnSite} + $HA_{OffSite}$) * (1 / HC) * HT

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

5. Construction / Demolition

5.1 General Information & Timeline Assumptions

- Activity Location
County: Anchorage Municipality
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Fire Break

- Activity Description:
In out years clearing of 5.8 acres every 2 to 3 years. Assume 3 days to complete.

- Activity Start Date
Start Month: 6
Start Month: 2025

- Activity End Date
Indefinite: False
End Month: 6
End Month: 2025

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.002657
SO_x	0.000039
NO_x	0.023811
CO	0.027144

Pollutant	Total Emissions (TONs)
PM 10	0.349124
PM 2.5	0.001034
Pb	0.000000
NH_3	0.000019

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.000178
N_2O	0.000036

Pollutant	Total Emissions (TONs)
CO_2	4.310723
CO_2e	4.325985

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.000178
N_2O	0.000036

Pollutant	Total Emissions (TONs)
CO_2	4.310723
CO_2e	4.325985

5.1 Site Grading Phase

5.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date

Start Month: 6
Start Quarter: 1
Start Year: 2025

- Phase Duration
Number of Month: 0
Number of Days: 3

5.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 252648
Amount of Material to be Hauled On-Site (yd^3): 0
Amount of Material to be Hauled Off-Site (yd^3): 0

- Site Grading Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Graders Composite	1	8
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	8
Tractors/Loaders/Backhoes Composite	2	7

- Vehicle Exhaust
Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

5.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.33951	0.00490	2.85858	3.41896	0.15910	0.14637
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.29762	0.00487	2.89075	3.51214	0.17229	0.15851
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.37086	0.00491	3.50629	2.90209	0.15396	0.14165

Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.19600	0.00489	2.00960	3.48168	0.07738	0.07119

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02155	0.00431	531.19419	533.01712
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02141	0.00428	527.74261	529.55369
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02159	0.00432	532.17175	533.99803
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02149	0.00430	529.86270	531.68105

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.30825	0.00122	0.15795	5.56638	0.00567	0.00502	0.05094
LDGT	0.26484	0.00151	0.20494	4.93596	0.00638	0.00565	0.04271
HDGV	0.80912	0.00340	0.66421	14.36576	0.02246	0.01987	0.09167
LDDV	0.14993	0.00122	0.15425	4.74052	0.00351	0.00323	0.01621
LDDT	0.24554	0.00139	0.49236	4.60151	0.00567	0.00522	0.01719
HDDV	0.15187	0.00430	2.59438	1.48047	0.04915	0.04522	0.06627
MC	1.97264	0.00150	0.73237	13.10298	0.01714	0.01517	0.05391

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.02302	0.00512	318.57790	320.67521
LDGT	0.02174	0.00697	393.65755	396.27273
HDGV	0.06120	0.02545	888.19798	897.30051
LDDV	0.07666	0.00066	362.65716	364.76980
LDDT	0.06043	0.00095	411.50918	413.30199
HDDV	0.04385	0.16332	1278.61579	1328.38112
MC	0.08660	0.00292	390.69172	393.72608

5.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD}$ = (20 * ACRE * WD) / 2000

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)

H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
$VMT_{VE} = (HA_{OnSite} + HA_{OffSite}) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

6. Construction / Demolition

6.1 General Information & Timeline Assumptions

- Activity Location
County: Anchorage Municipality
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Fire Break

- Activity Description:
In out years clearing of 5.8 acres every 2 to 3 years. Assume 3 days to complete.

- Activity Start Date
Start Month: 6
Start Month: 2027

- Activity End Date
Indefinite: False
End Month: 6
End Month: 2027

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.002396
SO_x	0.000039
NO_x	0.020612
CO	0.025940

Pollutant	Total Emissions (TONs)
PM 10	0.348932
PM 2.5	0.000857
Pb	0.000000
NH_3	0.000018

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.000177
N_2O	0.000036

Pollutant	Total Emissions (TONs)
CO_2	4.306735
CO_2e	4.321918

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.000177
N_2O	0.000036

Pollutant	Total Emissions (TONs)
CO_2	4.306735
CO_2e	4.321918

6.1 Site Grading Phase

6.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 6
Start Quarter: 1
Start Year: 2027

- Phase Duration
Number of Month: 0
Number of Days: 3

6.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 252648
Amount of Material to be Hauled On-Site (yd^3): 0
Amount of Material to be Hauled Off-Site (yd^3): 0

- Site Grading Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Graders Composite	1	8
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	8
Tractors/Loaders/Backhoes Composite	2	7

- Vehicle Exhaust

Average Hauling Truck Capacity (yd^3): 20 (default)

Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips

Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

6.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.29535	0.00490	2.28401	3.40565	0.12705	0.11688
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.25231	0.00487	2.49971	3.48392	0.13245	0.12186
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.34288	0.00492	3.09108	2.65644	0.13550	0.12466
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.17717	0.00489	1.80740	3.48712	0.05440	0.05005

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02155	0.00431	531.25291	533.07604
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02140	0.00428	527.44206	529.25211
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02160	0.00432	532.55942	534.38703
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02148	0.00430	529.61807	531.43559

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.27784	0.00118	0.13144	5.13988	0.00533	0.00472	0.04801

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGT	0.23138	0.00145	0.15262	4.34373	0.00606	0.00536	0.03951
HDGV	0.70527	0.00342	0.53463	12.40765	0.01988	0.01758	0.08854
LDDV	0.14371	0.00121	0.14661	4.94442	0.00371	0.00341	0.01645
LDDT	0.17587	0.00136	0.40936	4.14620	0.00595	0.00547	0.01669
HDDV	0.12936	0.00416	2.24004	1.39159	0.03612	0.03323	0.06744
MC	1.96978	0.00150	0.72867	12.74189	0.01710	0.01513	0.05464

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.02032	0.00483	308.56061	310.50284
LDGT	0.01798	0.00645	379.67239	382.03944
HDGV	0.05375	0.02467	893.75392	902.43904
LDDV	0.07660	0.00066	358.02935	360.13957
LDDT	0.05854	0.00095	402.92867	404.67508
HDDV	0.04396	0.16590	1238.62327	1289.15989
MC	0.08376	0.00290	390.88681	393.84491

6.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD} = (20 * ACRE * WD) / 2000$

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

$VMT_{VE} = (HA_{OnSite} + HA_{OffSite}) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

7. Construction / Demolition

7.1 General Information & Timeline Assumptions

- Activity Location
County: Anchorage Municipality
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Fire Break

- Activity Description:
In out years clearing of 5.8 acres every 2 to 3 years. Assume 3 days to complete.

- Activity Start Date
Start Month: 6
Start Month: 2028

- Activity End Date
Indefinite: False
End Month: 6
End Month: 2028

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.002354
SO_x	0.000039
NO_x	0.019948
CO	0.025919

Pollutant	Total Emissions (TONs)
PM 10	0.348889
PM 2.5	0.000818
Pb	0.000000
NH_3	0.000017

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.000177
N_2O	0.000036

Pollutant	Total Emissions (TONs)
CO_2	4.305454
CO_2e	4.320606

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.000177
N_2O	0.000036

Pollutant	Total Emissions (TONs)
CO_2	4.305454
CO_2e	4.320606

7.1 Site Grading Phase

7.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 6
Start Quarter: 1
Start Year: 2028

- Phase Duration
Number of Month: 0
Number of Days: 3

7.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 252648
Amount of Material to be Hauled On-Site (yd^3): 0
Amount of Material to be Hauled Off-Site (yd^3): 0

- Site Grading Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Graders Composite	1	8
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	8
Tractors/Loaders/Backhoes Composite	2	7

- Vehicle Exhaust
Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

7.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.28126	0.00491	2.08618	3.41790	0.11550	0.10626
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.24470	0.00487	2.43300	3.48645	0.12364	0.11375
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.34206	0.00492	3.04082	2.66346	0.13374	0.12304
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.17299	0.00489	1.74942	3.49553	0.04787	0.04404

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02155	0.00431	531.33158	533.15497
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02137	0.00427	526.92217	528.73043
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02162	0.00432	532.85820	534.68684
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02148	0.00430	529.56544	531.38277

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.26861	0.00116	0.11604	4.94482	0.00531	0.00470	0.04586
LDGT	0.22477	0.00143	0.13813	4.13949	0.00589	0.00521	0.03835
HDGV	0.64984	0.00342	0.47981	11.00038	0.01940	0.01716	0.08735
LDDV	0.14543	0.00120	0.15452	5.18410	0.00410	0.00377	0.01638
LDDT	0.10462	0.00126	0.09900	2.84453	0.00371	0.00341	0.01788
HDDV	0.11947	0.00409	2.04201	1.35107	0.02836	0.02609	0.06794
MC	1.95339	0.00150	0.72708	12.58690	0.01708	0.01511	0.05497

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01933	0.00470	304.03941	305.91963
LDGT	0.01724	0.00618	374.42910	376.69708
HDGV	0.04840	0.02396	893.93329	902.27289
LDDV	0.07544	0.00065	356.70456	358.78547
LDDT	0.06395	0.00095	375.83973	377.72056
HDDV	0.04408	0.16700	1219.74169	1270.60955
MC	0.08253	0.00290	390.96567	393.89245

7.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD}$ = (20 * ACRE * WD) / 2000

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

$VMT_{VE} = (HA_{OnSite} + HA_{OffSite}) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase

$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

8. Construction / Demolition

8.1 General Information & Timeline Assumptions

- Activity Location
County: Anchorage Municipality
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Fire Break

- Activity Description:
In out years clearing of 5.8 acres every 2 to 3 years. Assume 3 days to complete.

- Activity Start Date
Start Month: 6
Start Month: 2029

- Activity End Date
Indefinite: False
End Month: 6
End Month: 2029

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.002287
SO_x	0.000039
NO_x	0.018785
CO	0.025707

Pollutant	Total Emissions (TONs)
PM 10	0.348832
PM 2.5	0.000765
Pb	0.000000
NH_3	0.000017

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.000176
N_2O	0.000036

Pollutant	Total Emissions (TONs)
CO_2	4.301489
CO_2e	4.316596

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.000176
N_2O	0.000036

Pollutant	Total Emissions (TONs)
CO_2	4.301489
CO_2e	4.316596

8.1 Site Grading Phase

8.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 6
Start Quarter: 1
Start Year: 2029

- Phase Duration
Number of Month: 0
Number of Days: 3

8.1.2 Site Grading Phase Assumptions

- General Site Grading Information

Area of Site to be Graded (ft²): 252648
Amount of Material to be Hauled On-Site (yd³): 0
Amount of Material to be Hauled Off-Site (yd³): 0

- Site Grading Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Graders Composite	1	8
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	8
Tractors/Loaders/Backhoes Composite	2	7

- Vehicle Exhaust
Average Hauling Truck Capacity (yd³): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

8.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.26603	0.00490	1.89100	3.42562	0.10323	0.09497
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.23936	0.00487	2.35910	3.49263	0.11535	0.10612
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.33414	0.00491	2.85677	2.62663	0.12779	0.11756
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.17058	0.00489	1.70745	3.50145	0.04350	0.04002

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02154	0.00431	531.04687	532.86928
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02137	0.00427	526.88032	528.68844

Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02160	0.00432	532.42500	534.25214
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02147	0.00429	529.26401	531.08031

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.26061	0.00115	0.10629	4.70830	0.00523	0.00462	0.04505
LDGT	0.21628	0.00142	0.11275	3.91203	0.00570	0.00504	0.03671
HDGV	0.63023	0.00342	0.45754	10.66968	0.01954	0.01729	0.08526
LDDV	0.14168	0.00119	0.14827	5.35180	0.00435	0.00400	0.01645
LDDT	0.10232	0.00125	0.09173	2.80079	0.00373	0.00343	0.01766
HDDV	0.11370	0.00403	1.85765	1.32485	0.02480	0.02282	0.06823
MC	1.93930	0.00150	0.72554	12.43189	0.01706	0.01509	0.05528

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01851	0.00456	300.71014	302.52874
LDGT	0.01640	0.00588	371.20964	373.36852
HDGV	0.04782	0.02314	893.17844	901.25944
LDDV	0.07503	0.00065	354.92421	356.99429
LDDT	0.06300	0.00095	373.02835	374.88505
HDDV	0.04417	0.16761	1201.05765	1252.10824
MC	0.08132	0.00290	391.07198	393.96779

8.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD} = (20 * ACRE * WD) / 2000$

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

$VMT_{VE} = (HA_{OnSite} + HA_{OffSite}) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)

HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

9. Construction / Demolition

9.1 General Information & Timeline Assumptions

- Activity Location
County: Anchorage Municipality
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Fire Break

- Activity Description:
In out years clearing of 5.8 acres every 2 to 3 years. Assume 3 days to complete.

- Activity Start Date
Start Month: 6
Start Month: 2030

- Activity End Date
Indefinite: False
End Month: 6
End Month: 2030

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.002235
SO_x	0.000039
NO_x	0.018159
CO	0.025795

Pollutant	Total Emissions (TONs)
PM 10	0.348807
PM 2.5	0.000743
Pb	0.000000
NH_3	0.000017

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.000176
N_2O	0.000036

Pollutant	Total Emissions (TONs)
CO_2	4.300359
CO_2e	4.315446

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.000176
N_2O	0.000036

Pollutant	Total Emissions (TONs)
CO_2	4.300359
CO_2e	4.315446

9.1 Site Grading Phase

9.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date

Start Month: 6
Start Quarter: 1
Start Year: 2030

- Phase Duration

Number of Month: 0
Number of Days: 3

9.1.2 Site Grading Phase Assumptions

- General Site Grading Information

Area of Site to be Graded (ft^2): 252648
Amount of Material to be Hauled On-Site (yd^3): 0
Amount of Material to be Hauled Off-Site (yd^3): 0

- Site Grading Default Settings

Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Graders Composite	1	8
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	8
Tractors/Loaders/Backhoes Composite	2	7

- Vehicle Exhaust

Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips

Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

9.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.25506	0.00490	1.76292	3.41919	0.09783	0.09000
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.23337	0.00487	2.31265	3.48896	0.11095	0.10207
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.32880	0.00491	2.77253	2.67264	0.12596	0.11588
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.16638	0.00489	1.67562	3.49929	0.04010	0.03689

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02154	0.00431	531.04687	532.86928
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02137	0.00427	526.88566	528.69380
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02160	0.00432	532.38223	534.20923
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02147	0.00429	529.26401	531.08031

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.25455	0.00114	0.09316	4.49685	0.00516	0.00456	0.04396
LDGT	0.21160	0.00141	0.10127	3.76598	0.00566	0.00500	0.03670
HDGV	0.59164	0.00342	0.41683	10.16129	0.01867	0.01652	0.08659
LDDV	0.14273	0.00119	0.15151	5.58741	0.00478	0.00440	0.01630
LDDT	0.10046	0.00124	0.08635	2.78039	0.00381	0.00350	0.01745
HDDV	0.10657	0.00397	1.70770	1.29651	0.02105	0.01937	0.06863
MC	1.91729	0.00150	0.72408	12.27837	0.01704	0.01507	0.05567

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01773	0.00443	297.98505	299.74277
LDGT	0.01581	0.00581	369.24987	371.37211
HDGV	0.04616	0.02152	894.07785	901.63252

	CH_4	N_2O	CO_2	CO_2e
LDDV	0.07354	0.00065	354.27451	356.30712
LDDT	0.06219	0.00095	371.11035	372.94682
HDDV	0.04437	0.16847	1185.92681	1237.23950
MC	0.08012	0.00289	391.06589	393.93142

9.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase
$PM10_{FD} = (20 * ACRE * WD) / 2000$

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase
$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
$VMT_{VE} = (HA_{OnSite} + HA_{OffSite}) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works

NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

10. Construction / Demolition

10.1 General Information & Timeline Assumptions

- Activity Location
County: Anchorage Municipality
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Fire Break

- Activity Description:
In out years clearing of 5.8 acres every 2 to 3 years. Assume 3 days to complete.

- Activity Start Date
Start Month: 6
Start Month: 2031

- Activity End Date
Indefinite: False
End Month: 6
End Month: 2031

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.002180
SO_x	0.000039
NO_x	0.017403
CO	0.025378

Pollutant	Total Emissions (TONs)
PM 10	0.348779
PM 2.5	0.000716
Pb	0.000000
NH_3	0.000017

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.000175
N_2O	0.000036

Pollutant	Total Emissions (TONs)
CO_2	4.299586
CO_2e	4.314608

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.000175
N_2O	0.000036

Pollutant	Total Emissions (TONs)
CO_2	4.299586
CO_2e	4.314608

10.1 Site Grading Phase

10.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 6
Start Quarter: 1
Start Year: 2031

- Phase Duration
Number of Month: 0
Number of Days: 3

10.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 252648
Amount of Material to be Hauled On-Site (yd^3): 0
Amount of Material to be Hauled Off-Site (yd^3): 0

- Site Grading Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Graders Composite	1	8
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	8
Tractors/Loaders/Backhoes Composite	2	7

- Vehicle Exhaust
Average Hauling Truck Capacity (yd^3): 20 (default)
Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

10.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.24983	0.00490	1.68099	3.41141	0.09568	0.08803
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.21522	0.00487	2.15545	3.47633	0.09705	0.08928
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.32342	0.00491	2.66538	2.60458	0.12405	0.11412

Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.16247	0.00489	1.63682	3.49664	0.03656	0.03363

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02154	0.00431	531.04687	532.86928
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02137	0.00427	526.88032	528.68844
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02160	0.00432	532.38223	534.20923
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02147	0.00429	529.26401	531.08031

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.24320	0.00113	0.07210	4.11146	0.00478	0.00423	0.04412
LDGT	0.20279	0.00141	0.07760	3.54739	0.00533	0.00472	0.03603
HDGV	0.54696	0.00343	0.33642	9.46515	0.01710	0.01512	0.08626
LDDV	0.13820	0.00119	0.13814	5.56268	0.00488	0.00449	0.01624
LDDT	0.09890	0.00124	0.08136	2.75295	0.00388	0.00357	0.01723
HDDV	0.10156	0.00392	1.56515	1.26902	0.01807	0.01663	0.06886
MC	1.88961	0.00150	0.72302	11.96568	0.01694	0.01499	0.05594

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01578	0.00414	295.72719	297.35254
LDGT	0.01453	0.00532	367.79116	369.73527
HDGV	0.04159	0.01966	895.89413	902.78278
LDDV	0.07237	0.00065	353.24521	355.24815
LDDT	0.06141	0.00095	369.59355	371.41054
HDDV	0.04437	0.16892	1172.05029	1223.49785
MC	0.07789	0.00289	391.06041	393.86997

10.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD}$ = (20 * ACRE * WD) / 2000

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL}* 0.002205) / 2000

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)

H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase
$VMT_{VE} = (HA_{OnSite} + HA_{OffSite}) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

11. Construction / Demolition

11.1 General Information & Timeline Assumptions

- Activity Location
County: Anchorage Municipality
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Fire Break

- Activity Description:
In out years clearing of 5.8 acres every 2 to 3 years. Assume 3 days to complete.

- Activity Start Date
Start Month: 6
Start Month: 2032

- Activity End Date
Indefinite: False
End Month: 6
End Month: 2032

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.002072
SO_x	0.000039
NO_x	0.016183
CO	0.024232

Pollutant	Total Emissions (TONs)
PM 10	0.348704
PM 2.5	0.000647
Pb	0.000000
NH_3	0.000016

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.000175
N_2O	0.000036

Pollutant	Total Emissions (TONs)
CO_2	4.298933
CO_2e	4.313950

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.000175
N_2O	0.000036

Pollutant	Total Emissions (TONs)
CO_2	4.298933
CO_2e	4.313950

11.1 Site Grading Phase

11.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
Start Month: 6
Start Quarter: 1
Start Year: 2032

- Phase Duration
Number of Month: 0
Number of Days: 3

11.1.2 Site Grading Phase Assumptions

- General Site Grading Information
Area of Site to be Graded (ft^2): 252648
Amount of Material to be Hauled On-Site (yd^3): 0
Amount of Material to be Hauled Off-Site (yd^3): 0

- Site Grading Default Settings
Default Settings Used: Yes
Average Day(s) worked per week: 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Graders Composite	1	8
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	8
Tractors/Loaders/Backhoes Composite	2	7

- Vehicle Exhaust

Average Hauling Truck Capacity (yd^3): 20 (default)

Average Hauling Truck Round Trip Commute (mile): 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips

Average Worker Round Trip Commute (mile): 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

11.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.24185	0.00490	1.59765	3.40773	0.09096	0.08368
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.20403	0.00487	2.07785	3.46703	0.08887	0.08176
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.30289	0.00492	2.41416	2.32831	0.10945	0.10070
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	SO_x	NO_x	CO	PM 10	PM 2.5
Emission Factors	0.15988	0.00489	1.61021	3.49533	0.03433	0.03158

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02154	0.00431	531.04687	532.86928
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02137	0.00427	526.88032	528.68844
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02160	0.00432	532.42500	534.25214
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	N_2O	CO_2	CO_2e
Emission Factors	0.02147	0.00429	529.26401	531.08031

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGV	0.24051	0.00112	0.06894	3.93470	0.00473	0.00419	0.04224

	VOC	SO_x	NO_x	CO	PM 10	PM 2.5	NH_3
LDGT	0.19957	0.00140	0.07402	3.45132	0.00534	0.00472	0.03522
HDGV	0.52206	0.00344	0.30585	8.98064	0.01661	0.01469	0.08552
LDDV	0.13885	0.00119	0.14398	5.62255	0.00508	0.00467	0.01598
LDDT	0.09753	0.00123	0.07686	2.68023	0.00387	0.00356	0.01701
HDDV	0.09583	0.00388	1.43339	1.24101	0.01547	0.01423	0.06914
MC	1.87214	0.00150	0.72154	11.86266	0.01694	0.01498	0.05620

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	N_2O	CO_2	CO_2e
LDGV	0.01534	0.00411	293.42697	295.03264
LDGT	0.01432	0.00530	366.12939	368.06288
HDGV	0.04017	0.01934	898.20281	904.96104
LDDV	0.07021	0.00065	353.32093	355.26930
LDDT	0.06071	0.00095	367.91021	369.70972
HDDV	0.04435	0.16951	1159.63660	1211.25993
MC	0.07704	0.00289	391.05612	393.84417

11.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD} = (20 * ACRE * WD) / 2000$

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

$VMT_{VE} = (HA_{OnSite} + HA_{OffSite}) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase
VMT_{WT} = WD * WT * 1.25 * NE

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

12. Construction / Demolition

12.1 General Information & Timeline Assumptions

- Activity Location
County: Anchorage Municipality
Regulatory Area(s): NOT IN A REGULATORY AREA

- Activity Title: Fire Break

- Activity Description:
In out years clearing of 5.8 acres every 2 to 3 years. Assume 3 days to complete.

- Activity Start Date
Start Month: 6
Start Month: 2033

- Activity End Date
Indefinite: False
End Month: 6
End Month: 2033

- Activity Emissions:

Pollutant	Total Emissions (TONs)
VOC	0.002009
SO_x	0.000039
NO_x	0.015433
CO	0.023465

Pollutant	Total Emissions (TONs)
PM 10	0.348651
PM 2.5	0.000599
Pb	0.000000
NH_3	0.000015

- Activity Emissions of GHG:

Pollutant	Total Emissions (TONs)
CH_4	0.000175
N_2O	0.000036

Pollutant	Total Emissions (TONs)
CO_2	4.297314
CO_2e	4.312323

- Global Scale Activity Emissions for SCGHG:

Pollutant	Total Emissions (TONs)
CH_4	0.000175
N_2O	0.000036

Pollutant	Total Emissions (TONs)
CO_2	4.297314
CO_2e	4.312323

12.1 Site Grading Phase

12.1.1 Site Grading Phase Timeline Assumptions

- Phase Start Date
- **Start Month:** 6
- **Start Quarter:** 1
- **Start Year:** 2033

- Phase Duration
- **Number of Month:** 0
- **Number of Days:** 3

12.1.2 Site Grading Phase Assumptions

- General Site Grading Information
- **Area of Site to be Graded (ft^2):** 252648
- **Amount of Material to be Hauled On-Site (yd^3):** 0
- **Amount of Material to be Hauled Off-Site (yd^3):** 0

- Site Grading Default Settings
- **Default Settings Used:** Yes
- **Average Day(s) worked per week:** 5 (default)

- Construction Exhaust (default)

Equipment Name	Number Of Equipment	Hours Per Day
Graders Composite	1	8
Other Construction Equipment Composite	1	8
Rubber Tired Dozers Composite	1	8
Tractors/Loaders/Backhoes Composite	2	7

- Vehicle Exhaust
- **Average Hauling Truck Capacity (yd^3):** 20 (default)
- **Average Hauling Truck Round Trip Commute (mile):** 20 (default)

- Vehicle Exhaust Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	0	0	0	0	0	100.00	0

- Worker Trips
- **Average Worker Round Trip Commute (mile):** 20 (default)

- Worker Trips Vehicle Mixture (%)

	LDGV	LDGT	HDGV	LDDV	LDDT	HDDV	MC
POVs	50.00	50.00	0	0	0	0	0

12.1.3 Site Grading Phase Emission Factor(s)

- Construction Exhaust Criteria Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.23504	0.00490	1.52847	3.40111	0.08495	0.07815
Other Construction Equipment Composite [HP: 82] [LF: 0.42]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.19175	0.00487	1.99831	3.46028	0.07792	0.07169
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.29380	0.00492	2.27826	2.15269	0.10220	0.09402
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]						
	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**
Emission Factors	0.15737	0.00489	1.58463	3.49407	0.03124	0.02874

- Construction Exhaust Greenhouse Gasses Pollutant Emission Factors (g/hp-hour) (default)

Graders Composite [HP: 148] [LF: 0.41]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02154	0.00431	531.04687	532.86928
Other Construction Equipment Composite [HP: 82] [LF: 0.42]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02137	0.00427	526.88032	528.68844
Rubber Tired Dozers Composite [HP: 367] [LF: 0.4]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02160	0.00432	532.42500	534.25214
Tractors/Loaders/Backhoes Composite [HP: 84] [LF: 0.37]				
	CH_4	**N_2O**	**CO_2**	**CO_2e**
Emission Factors	0.02147	0.00429	529.26401	531.08031

- Vehicle Exhaust & Worker Trips Criteria Pollutant Emission Factors (grams/mile)

	VOC	**SO_x**	**NO_x**	**CO**	**PM 10**	**PM 2.5**	**NH_3**
LDGV	0.23626	0.00111	0.06452	3.74059	0.00476	0.00421	0.04053
LDGT	0.19645	0.00139	0.06851	3.32579	0.00529	0.00468	0.03443
HDGV	0.50325	0.00343	0.29031	8.61393	0.01656	0.01464	0.08518
LDDV	0.13528	0.00119	0.13695	5.66889	0.00551	0.00507	0.01596
LDDT	0.09697	0.00122	0.07404	2.61945	0.00389	0.00358	0.01674
HDDV	0.08843	0.00384	1.32140	1.21056	0.01305	0.01200	0.06930
MC	1.85100	0.00150	0.71999	11.75687	0.01694	0.01498	0.05646

- Vehicle Exhaust & Worker Trips Greenhouse Gasses Emission Factors (grams/mile)

	CH_4	**N_2O**	**CO_2**	**CO_2e**
LDGV	0.01486	0.00408	289.63918	291.22294
LDGT	0.01401	0.00527	362.08698	364.00528
HDGV	0.03933	0.01916	897.12170	903.80458
LDDV	0.06935	0.00065	351.72376	353.65040
LDDT	0.05967	0.00095	365.64576	367.41913
HDDV	0.04436	0.16981	1147.62038	1199.33188
MC	0.07617	0.00289	391.04557	393.81120

12.1.4 Site Grading Phase Formula(s)

- Fugitive Dust Emissions per Phase

$PM10_{FD}$ = (20 * ACRE * WD) / 2000

$PM10_{FD}$: Fugitive Dust PM 10 Emissions (TONs)
20: Conversion Factor Acre Day to pounds (20 lb / 1 Acre Day)
ACRE: Total acres (acres)
WD: Number of Total Work Days (days)
2000: Conversion Factor pounds to tons

- Construction Exhaust Emissions per Phase

$CEE_{POL} = (NE * WD * H * HP * LF * EF_{POL} * 0.002205) / 2000$

CEE_{POL}: Construction Exhaust Emissions (TONs)
NE: Number of Equipment
WD: Number of Total Work Days (days)
H: Hours Worked per Day (hours)
HP: Equipment Horsepower
LF: Equipment Load Factor
EF_{POL}: Emission Factor for Pollutant (g/hp-hour)
0.002205: Conversion Factor grams to pounds
2000: Conversion Factor pounds to tons

- Vehicle Exhaust Emissions per Phase

$VMT_{VE} = (HA_{OnSite} + HA_{OffSite}) * (1 / HC) * HT$

VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
HA_{OnSite}: Amount of Material to be Hauled On-Site (yd^3)
$HA_{OffSite}$: Amount of Material to be Hauled Off-Site (yd^3)
HC: Average Hauling Truck Capacity (yd^3)
(1 / HC): Conversion Factor cubic yards to trips (1 trip / HC yd^3)
HT: Average Hauling Truck Round Trip Commute (mile/trip)

$V_{POL} = (VMT_{VE} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{VE}: Vehicle Exhaust Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Vehicle Exhaust On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

- Worker Trips Emissions per Phase

$VMT_{WT} = WD * WT * 1.25 * NE$

VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
WD: Number of Total Work Days (days)
WT: Average Worker Round Trip Commute (mile)
1.25: Conversion Factor Number of Construction Equipment to Number of Works
NE: Number of Construction Equipment

$V_{POL} = (VMT_{WT} * 0.002205 * EF_{POL} * VM) / 2000$

V_{POL}: Vehicle Emissions (TONs)
VMT_{WT}: Worker Trips Vehicle Miles Travel (miles)
0.002205: Conversion Factor grams to pounds
EF_{POL}: Emission Factor for Pollutant (grams/mile)
VM: Worker Trips On Road Vehicle Mixture (%)
2000: Conversion Factor pounds to tons

AIR CONFORMITY APPLICABILITY MODEL REPORT
RECORD OF AIR ANALYSIS (ROAA)

1. General Information: The Air Force's Air Conformity Applicability Model (ACAM) was used to perform a net change in emissions analysis to assess the potential air quality impact/s associated with the action. The analysis was performed in accordance with the Air Force Manual 32-7002, *Environmental Compliance and Pollution Prevention*; the *Environmental Impact Analysis Process* (EIAP, 32 CFR 989); the *General Conformity Rule* (GCR, 40 CFR 93 Subpart B); and the *USAF Air Quality Environmental Impact Analysis Process (EIAP) Guide*. This report provides a summary of the ACAM analysis.

Report generated with ACAM version: 5.0.23a

a. Action Location:
Base: ELMENDORF AFB
State: Alaska
County(s): Anchorage Municipality
Regulatory Area(s): NOT IN A REGULATORY AREA

b. Action Title: Additional Clearing due to fire break

c. Project Number/s (if applicable):

d. Projected Action Start Date: 5 / 2026

e. Action Description:

clearing of 5.8 acres every 2 to 3 years. Assume 3 days to complete.

f. Point of Contact:
Name: Roger L. Wayson
Title: Senior Environmental Engineer
Organization: AECOM
Email: roger.wayson@aecom.com
Phone Number: 830 265 7687

2. Air Impact Analysis: Based on the attainment status at the action location, the requirements of the GCR are:

____ applicable
__X__ not applicable

Total reasonably foreseeable net direct and indirect emissions associated with the action were estimated through ACAM on a calendar-year basis for the start of the action through achieving "steady state" (hsba.e., no net gain/loss in emission stabilized and the action is fully implemented) emissions. The ACAM analysis uses the latest and most accurate emission estimation techniques available; all algorithms, emission factors, and methodologies used are described in detail in the *USAF Air Emissions Guide for Air Force Stationary Sources*, the *USAF Air Emissions Guide for Air Force Mobile Sources*, and the *USAF Air Emissions Guide for Air Force Transitory Sources*.

"Insignificance Indicators" were used in the analysis to provide an indication of the significance of the proposed Action's potential impacts to local air quality. The insignificance indicators are trivial (de minimis) rate thresholds that have been demonstrated to have little to no impact to air quality. These insignificance indicators are the 250 ton/yr Prevention of Significant Deterioration (PSD) major source threshold and 25 ton/yr for lead for actions occurring in areas that are "Attainment" (hsba.e., not exceeding any National Ambient Air Quality Standard (NAAQS)). These indicators do not define a significant impact; however, they do provide a threshold to identify actions that are insignificant. Any action with net emissions below the insignificance indicators for all criteria pollutants is considered so insignificant that the action will not cause or contribute to an exceedance on one or more

NAAQS. For further detail on insignificance indicators, refer to *Level II, Air Quality Quantitative Assessment, Insignificance Indicators*.

The action's net emissions for every year through achieving steady state were compared against the Insignificance Indicators and are summarized below.

Analysis Summary:

2026

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	NaN	250	No
NOx	NaN	250	No
CO	NaN	250	No
SOx	NaN	250	No
PM 10	NaN	250	No
PM 2.5	NaN	250	No
Pb	0.000	25	No
NH3	NaN	250	No

2027 - (Steady State)

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	0.000	250	No
NOx	0.000	250	No
CO	0.000	250	No
SOx	0.000	250	No
PM 10	0.000	250	No
PM 2.5	0.000	250	No
Pb	0.000	25	No
NH3	0.000	250	No

None of the estimated annual net emissions associated with this action are above the insignificance indicators; therefore, the action will not cause or contribute to an exceedance of one or more NAAQSs and will have an insignificant impact on air quality. No further air assessment is needed.

Roger L. Wayson, Senior Environmental Engineer — Jul 25 2024

Name, Title — **Date**

AIR CONFORMITY APPLICABILITY MODEL REPORT
RECORD OF AIR ANALYSIS (ROAA)

1. General Information: The Air Force's Air Conformity Applicability Model (ACAM) was used to perform a net change in emissions analysis to assess the potential air quality impact/s associated with the action. The analysis was performed in accordance with the Air Force Manual 32-7002, *Environmental Compliance and Pollution Prevention*; the *Environmental Impact Analysis Process* (EIAP, 32 CFR 989); the *General Conformity Rule* (GCR, 40 CFR 93 Subpart B); and the *USAF Air Quality Environmental Impact Analysis Process (EIAP) Guide*. This report provides a summary of the ACAM analysis.

Report generated with ACAM version: 5.0.23a

a. Action Location:
Base: ELMENDORF AFB
State: Alaska
County(s): Anchorage Municipality
Regulatory Area(s): NOT IN A REGULATORY AREA

b. Action Title: Construction, Clearing, and Fire Break for Munitions Range

c. Project Number/s (if applicable): Expansion of firing at base to avoid trips to other bases for training.

d. Projected Action Start Date: 5 / 2024

e. Action Description:

1.8 miles of 15 foot wide roads (gravel) would be built along with 50 x 50 feet service pads.
359 acres would be cleared for range extension.
Clearing of 5.8 acres every 2 to 3 years will occur for fire breaks. Assume 3 days to complete it out years.

f. Point of Contact:

Name: Roger L. Wayson
Title: Consultant
Organization: AECOM
Email: roger.wayson@aecom.com
Phone Number: 830 265-7687

2. Air Impact Analysis: Based on the attainment status at the action location, the requirements of the GCR are:

____ applicable
_X_ not applicable

Total reasonably foreseeable net direct and indirect emissions associated with the action were estimated through ACAM on a calendar-year basis for the start of the action through achieving "steady state" (hsba.e., no net gain/loss in emission stabilized and the action is fully implemented) emissions. The ACAM analysis uses the latest and most accurate emission estimation techniques available; all algorithms, emission factors, and methodologies used are described in detail in the *USAF Air Emissions Guide for Air Force Stationary Sources*, the *USAF Air Emissions Guide for Air Force Mobile Sources*, and the *USAF Air Emissions Guide for Air Force Transitory Sources*.

"Insignificance Indicators" were used in the analysis to provide an indication of the significance of the proposed Action's potential impacts to local air quality. The insignificance indicators are trivial (de minimis) rate thresholds that have been demonstrated to have little to no impact to air quality. These insignificance indicators are the 250 ton/yr Prevention of Significant Deterioration (PSD) major source threshold and 25 ton/yr for lead for actions occurring in areas that are "Attainment" (hsba.e., not exceeding any National Ambient Air Quality Standard (NAAQS)). These indicators do not define a significant impact; however, they do provide a threshold to identify actions that are insignificant. Any action with net emissions below the insignificance indicators for all criteria pollutants is considered so insignificant that the action will not cause or contribute to an exceedance on one or more NAAQS. For further detail on insignificance indicators, refer to *Level II, Air Quality Quantitative Assessment, Insignificance Indicators*.

The action's net emissions for every year through achieving steady state were compared against the Insignificance Indicators and are summarized below.

Analysis Summary:

2024

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	0.451	250	No
NOx	4.303	250	No
CO	3.823	250	No
SOx	0.008	250	No
PM 10	623.871	250	Yes
PM 2.5	0.171	250	No
Pb	0.000	25	No
NH3	0.002	250	No

2025

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	0.003	250	No
NOx	0.024	250	No
CO	0.027	250	No
SOx	0.000	250	No
PM 10	0.349	250	No
PM 2.5	0.001	250	No
Pb	0.000	25	No
NH3	0.000	250	No

2026

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	0.003	250	No
NOx	0.023	250	No
CO	0.028	250	No
SOx	0.000	250	No
PM 10	0.349	250	No
PM 2.5	0.001	250	No
Pb	0.000	25	No
NH3	0.000	250	No

AIR CONFORMITY APPLICABILITY MODEL REPORT
RECORD OF AIR ANALYSIS (ROAA)

2027

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	0.002	250	No
NOx	0.021	250	No
CO	0.026	250	No
SOx	0.000	250	No
PM 10	0.349	250	No
PM 2.5	0.001	250	No
Pb	0.000	25	No
NH3	0.000	250	No

2028

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	0.002	250	No
NOx	0.020	250	No
CO	0.026	250	No
SOx	0.000	250	No
PM 10	0.349	250	No
PM 2.5	0.001	250	No
Pb	0.000	25	No
NH3	0.000	250	No

2029

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	0.002	250	No
NOx	0.019	250	No
CO	0.026	250	No
SOx	0.000	250	No
PM 10	0.349	250	No
PM 2.5	0.001	250	No
Pb	0.000	25	No
NH3	0.000	250	No

2030

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	0.002	250	No
NOx	0.018	250	No
CO	0.026	250	No
SOx	0.000	250	No
PM 10	0.349	250	No
PM 2.5	0.001	250	No
Pb	0.000	25	No
NH3	0.000	250	No

AIR CONFORMITY APPLICABILITY MODEL REPORT
RECORD OF AIR ANALYSIS (ROAA)

2031

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	0.002	250	No
NOx	0.017	250	No
CO	0.025	250	No
SOx	0.000	250	No
PM 10	0.349	250	No
PM 2.5	0.001	250	No
Pb	0.000	25	No
NH3	0.000	250	No

2032

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	0.002	250	No
NOx	0.016	250	No
CO	0.024	250	No
SOx	0.000	250	No
PM 10	0.349	250	No
PM 2.5	0.001	250	No
Pb	0.000	25	No
NH3	0.000	250	No

2033

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	0.002	250	No
NOx	0.015	250	No
CO	0.023	250	No
SOx	0.000	250	No
PM 10	0.349	250	No
PM 2.5	0.001	250	No
Pb	0.000	25	No
NH3	0.000	250	No

2034 - (Steady State)

Pollutant	Action Emissions (ton/yr)	INSIGNIFICANCE INDICATOR	
		Indicator (ton/yr)	Exceedance (Yes or No)
NOT IN A REGULATORY AREA			
VOC	0.000	250	No
NOx	0.000	250	No
CO	0.000	250	No
SOx	0.000	250	No
PM 10	0.000	250	No
PM 2.5	0.000	250	No
Pb	0.000	25	No
NH3	0.000	250	No

AIR CONFORMITY APPLICABILITY MODEL REPORT
RECORD OF AIR ANALYSIS (ROAA)

The estimated annual net emissions associated with this action temporarily exceeds the insignificance indicators. However, the steady state estimated annual net emissions are below the insignificance indicators showing no significant long-term impact to air quality. Therefore, the action will not cause or contribute to an exceedance on one or more NAAQSs and will have an insignificant impact on air quality. No further air quality impact assessment is needed.

Roger L. Wayson, Consultant	Jul 25 2024
Name, Title	**Date**

APPENDIX H–WETLAND FUNCTIONAL ASSESSMENT MEMORANDUM

Date: 5 August 2020
To: Matt Beattie (673rd CES), Lucas Oligschlaeger (673rd CES)
From: Tara Bellion (AECOM), Kim Anderson (AECOM)
Re: JBER PMART EIS - Wetland Functional Assessment

Introduction

Wetland assessments are used to evaluate the functions and values that wetlands have within a landscape and can be used to monitor or predict change in those metrics over time and in response to planned actions. This memorandum presents the methodology and results of wetland functional assessments for the Eagle River Flats (ERF) estuarine and the Clunie Creek riparian wetland complexes on Joint-Base Elmendorf Richardson, (JBER), Alaska. These are the dominant wetland complexes in the project area for the Proposed Mortar and Artillery Training (PMART) Environmental Impact Statement (EIS) (Figure 1).

As presented in the EIS, Alternative 1 would allow all-season firing and expand the existing impact area into the proposed CALFEX expansion area. Potential direct impacts on wetlands associated with this alternative include the grubbing, clearing, and thinning of vegetation, and the detonation of HE munitions. Alternative 2 would allow all-season firing without expansion of the impact area, thus the direct impacts to wetlands under Alternative 2 are chiefly related to the detonation of HE munitions. Under either of the action alternatives, associated indirect impacts to wetlands could include disturbance of wetland soils, altered wetland hydrology, erosion, sedimentation, windthrow, invasive species, and phytotoxicity. The baseline use of ERF Impact Area (i.e., the No Action Alternative) currently restricts live-fire exercises to winter firing only, based on a requisite ice and/or frozen sediment thickness, which has been shown to protect the underlying wetlands from physical disturbance.

Methodology

Separate evaluations were completed for each wetland complex, as well as for both baseline and post-project functions and values to predict change as a result of the action alternatives. These assessments follow the wetland functional assessment methodology developed for use on JBER (Johnson and Schoofs 2020), which is a modification of—and largely compatible with—the Municipality of Anchorage (MOA) methodology (MOA 2012). The methodology evaluates wetlands on hydrologic, habitat, species, and social function components (listed in Tables 1 and 2) over multiple spatial scales. Listed in decreasing areal extent, wetlands are evaluated at the following scales:

1. Watershed: Hydrologic Unit Code (HUC) 12 (Watershed Boundary Database; USGS 2020)
2. Sub-basin (approximates the HUC 14/16 level; MOA 2020)
3. Wetland Complex (defined as those wetlands functioning hydrologically together; Johnson and Schoofs 2020)
4. Subject Wetland (the dominant Cowardin Subsystem) (FGDC 2013, Johnson and Schoofs 2020)

Baseline wetland functions were largely informed by the assessments completed for the ERF and Clunie Creek wetland complexes by Charlene Johnson, Biological Scientist for JBER (Johnson

2020a, b). The pre- and post-project assessments presented here use the following wetland data sources, listed in decreasing order of accuracy:

1. Wetland boundaries refined for the CALFEX expansion area, developed by AECOM (2020)
2. JBER wetland inventory (i.e., 'Wetland_A' from the JBER GEODATA geodatabase, which represents the default wetland inventory for the installation)
3. National Wetland Inventory (NWI) (USFWS 2020)

Every wetland inventoried on JBER has a unique identifier number corresponding to the "wetland ID" designated in the SDSFEATURE attribute of GEODATA.Wetland_A, referenced in item 2 above. These labels were applied for the recent desktop delineation completed for the CALFEX expansion area completed by AECOM (2020). One of the wetland polygons delineated by AECOM and labeled as Wetland No. 1680 for the purposes of functional assessment was extended so that its boundary reflected the extent of that wetland type outside of the project area boundary, and in this way better captured the extent of the wetland complex. The shapefile including this adjustment is named 'Wetland_AECOM_FnAsmnt.shp' and is included as an attachment to this memorandum.

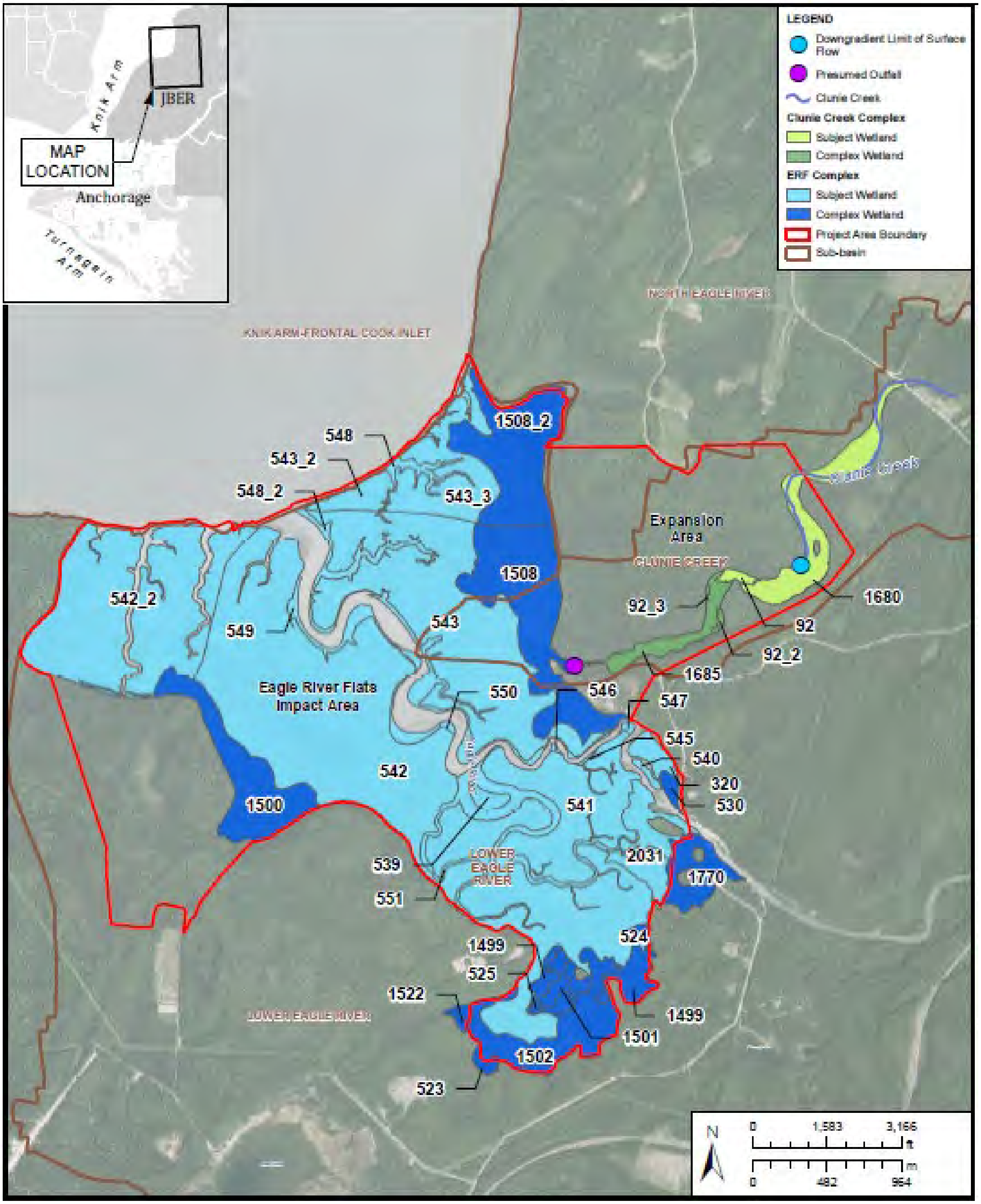
Areas of Uncertainty

In accordance with the EIS scope of work, no field work was conducted to support the wetland functional assessments presented here. While the JBER wetland inventory boundaries for the ERF estuary have an acceptable level of accuracy, the wetland boundaries for the proposed CALFEX expansion area (Figure 1) were refined using ArcGIS and have not been confirmed by on-site field investigation (AECOM 2020). As such, the boundaries presented for the Clunie Creek riparian complex may over- or underrepresent the true extent of wetland habitat.

While the majority of functional assessment metrics required by the JBER methodology can be determined remotely from geospatial and ancillary data, a field visit is required to verify several metrics. Specifically, the cover of robust emergent and/or Sphagnum moss (Functional Score Component 1.9), the number of plant community types present (2.1), soil type (2.8), presence of rare plant species (3.2), and extent of aesthetic disturbance (4.6) within the wetland complex are recommended to be confirmed in the field. Because these metrics have not been verified in the field, the level of uncertainty regarding the wetlands' capacity for pollutant uptake and filtration (1.9), diversity of plant communities and life forms (2.1), presence of hydric soils (2.8), support of rare plant species (3.2), and aesthetic value (4.6) is higher than levels associated with field-verified data.

The lack of bird survey and water quality data for the Clunie Creek wetlands adds additional uncertainty. Due to this lack of data, the nutrient quality of water (2.10), presence of bird species of special concern (3.6), or obligate wetland birds (3.10) cannot be scored, which results in a reduction of the habitat and species occurrence component function scores for Clunie Creek wetlands in their baseline condition.

The ERF estuary is fully contained in an active impact area. For this reason, field verification cannot be completed for parameters related to the ERF estuarine complex. However, the Clunie Creek riparian wetland complex is in a training area that is currently open to recreational access. It is recommended that prior to any project actions, a formal wetland delineation be performed for the riparian wetlands, water samples be collected from Clunie Creek to determine total dissolved solids, and bird surveys be completed.



Source: Desktop Wetland Delineation in the proposed CALFEX Expansion Area (AECOM 2020); JBER Wetland Inventory GEODATA.Wetland_A

Figure 1: Subject and Complex Wetlands in ERF Impact Area and the Proposed CALFEX Expansion Area.

Results

Eagle River Flats Estuarine Wetlands

The ERF estuary is a large (2,087-acre) distributary delta through which Eagle River drains to the navigable marine waters of Cook Inlet. Distributary channels are fringed by estuarine and palustrine emergent wetlands, transitioning to coastal uplands with gain in elevation. ERF comprises the majority of estuarine wetlands and nearly a quarter of all wetlands on JBER (JBER 2019). Variable conditions of inundation and salinity across the estuary creates a mosaic of aquatic and terrestrial habitats, which are important to fish and wildlife. Eagle River is an anadromous water that—among other trophic functions—supports prey species for the endangered Cook Inlet beluga whale. The estuary is a staging and nesting area for multiple species and large numbers of waterfowl, including several obligate wetland bird species and bird species of special concern.

The ERF estuary has a baseline summary score of 74 percent, derived from high individual scores for habitat (97 percent), species (83 percent), and hydrologic (74 percent) function. Due to its current use as an active firing range, to which access is prohibited, the estuary has a low social function score (18 percent). In accordance with the MOA Wetland Management Plan (2014), wetlands with the highest resource value (i.e., class 'A' wetlands) perform at least two, but typically more, significant wetland functions. Based on metrics presented in the Wetland Management Plan (MOA 2014), estuarine wetlands in ERF exceed the cut off scores for hydrology (95 points), habitat (90 points), and species occurrence (40 points) values, thereby satisfying the criteria for the highest-resource value, or class 'A' wetland in its baseline condition. The intent of the 'A' designation is that wetlands not be altered or otherwise disturbed in any manner (MOA 2014).

Revisions to Baseline Functional Scores

Different from both the original functional assessment for ERF (Johnson 2020a; 17,379 acres of wetlands in ERF at the HUC 14 watershed scale) and the wetland areas provided in the JBER methodology (Table 7 Johnson and Schoofs 2020; 6,655 acres of wetlands in the Lower Eagle River sub-basin), a value of 3,123 acres of wetlands in the Lower Eagle River sub-basin was used for the assessment presented here. This value was calculated from the intersection of the sub-basin (MOA 2020) with the coincident NWI coverage (USFWS 2020). Use of the 3,123 acre value did not change the baseline score for relevant metrics (i.e., 1.5 Flow Augmentation, 1.6 Extent of Wetlands in Catchment).

Other revisions to baseline functional scores include:

- 1.8 Sensitivity to Water Quality Degradation: score revised from 4 to 6 on the basis that Eagle River is anadromous, and the estuary supports waterbird nesting and recreational fishing.
- 1.13 Erosion Buffering: score revised from 10 to 8 on the basis that points be awarded for principal vegetation forms only.
- 3.1 Scarcity Value: score increased from 7.7 to 10 based on the subject wetlands representing the entirety of Estuarine Wetlands in the Lower Eagle River sub-basin (noting that this percentage is artificially increased by comparing wetland extent mapped by JBER to the lesser wetland extent mapped by NWI).

- 3.5 Fish Rearing: score increased from 20 to 25 based on a total of 10 resident fish and the presence of all five Pacific salmon species in Eagle River.
- 4.5 Types of Disturbances: revised from -3 to -4 based on presence of trails, unexploded ordnance (UXO) munitions, and drainage and fill from remediation activities.

Change in Function As a Result of the Proposed Action

Implementation of either action alternative, which would allow all-season firing in the ERF estuary is expected to reduce the functional summary score from 74 percent to 73 percent. Resumption of all-season firing would increase the potential for the loss and degradation of vegetation as well as the introduction of contaminants to water when sediments and water are not frozen and/or armored by ice (Social Function Component 4.5) and has the potential to adversely impact waterbird nesting (Hydrologic Component 1.8). Similarly, all-season firing would increase visual impacts to wetlands in the targetable areas of the ERF Impact Area (Social Function Component 4.6). Table 1 summarizes the components and scoring in support of the baseline and post-project function and value scores; descriptions of components, metrics, and score categories can be found in Johnson and Schoofs (2020).

Both Alternative 1 and Alternative 2 would adversely impact wetlands in the ERF estuary through the direct physical impact of high explosive detonations and potentially through the introduction of phytotoxins. Because Alternative 2 would not expand ERF Impact Area, firing in the ERF estuary would be more concentrated under implementation of this alternative; however, the magnitude of change from the baseline condition or between the two action alternatives is not great enough to generate different functional scores.

Table 1: Summary of Function and Value Assessment for the Eagle River Flats Estuary

Area of Lower Eagle River sub-basin:	17,379 acres
Area of wetlands in Lower Eagle River sub-basin:	3,123 acres
Complex Wetland No. 320, 523-525, 530, 539-543, 545-552, 1499-1502, 1508, 1522, 1770, 2031 (includes 542_2, 543_2, 543_3, 548_2, 1508_2):	2,087 acres
Subject Wetland No. 320, 524, 539-543, 545-552, 2031 (includes 542_2, 543_2, 543_3, 548_2):	1,618 acres
Subject NWI Class:	Estuarine Intertidal (E2)
Subject HGM Type:	Estuarine

Number	Description of Metric	Description of Score	Baseline	Post-Project
		Hydrologic Component		
1.1	Type of stormwater wetlands detain	Natural (ambient) stormwater flow	2	2
1.2	Position of wetlands in watershed	In lower third of watershed	2	2
1.3	Down-gradient land use	Lands below outflow enter a waterbody or wetland	5	5
1.4	Wetland complex size	Wetland size >200 acres	25	25
1.5	Flow augmentation	Catchment is >6,500 acres; complex wetlands are 2,087 acres representing 12.0% of the 17,379 acre catchment	25	25
1.6	Extent of wetlands in catchment	Wetlands in complex are 2,087 acres, representing 67% of the 3,123 acres of wetlands in the Lower Eagle River sub-basin	15	15
1.7	Wetland location	Riverine (at river mouth) or Estuarine	10	10
1.8	Sensitivity to water quality degradation	Fish spawning and rearing habitat, waterbird nesting habitat, sport fishing	6	4
1.9	Pollutant uptake and filtration	40-60% coverage of robust emergent vegetation	10	10
1.10	Pollutant sources in catchment	Impermeable grounds with impermeable structures and infrastructure - the town of Eagle River occupies portions of the larger Lower Eagle River HUC 12 watershed	15	15
1.11	Long-term nutrient retention	Wetland with organic soils on <50% of area, mineral soils or very shallow peat	5	5
1.12	Water quality maintenance	Inflow is from stream flows or from storm event overflow and detention time is moderate. Area has moderate storage capacity and moderate nutrient uptake.	12	12
1.13	Erosion buffering	Subject wetlands are Estuarine Emergents	8	8
		Total for Hydrologic Component	**140**	**138**
		Percent of total possible score (190)	**74%**	**73%**

Number	Description of Metric	Description of Score	Baseline	Post-Project
Habitat Component				
2.1	Vegetation community structure	9 communities, 37 vegetation forms	25	25
2.2	Plant community diversity	>7 communities in the wetland complex	5	5
2.3	Plant community interspersion	Type 3	3	3
2.4	Diversity of surrounding habitat	Open fields, mixed forest, undeveloped terrain, open water bodies, creeks	12	12
2.5	Proximity to other aquatic habitats	Hydrologically connected by surface flow to other wetlands (different HGM type) within .25 mile (Eagle River and Otter Creek Riparian wetlands)	10	10
2.6	Open water types	Type 5	12	12
2.7	Hardiness zone	Zone 4b	3	3
2.8	Soil types	530 acres organic, 972 acres mineral, 0 acres clay	3.66	3.66
2.9	Aquatic habitat type	All subject wetlands are estuarine - see supporting worksheet	2	2
2.10	Nutrient status of surface water	Sampling in Otter Creek returned 477; 276 average TDS (mg/l). Score between 3 and 6, Using average	4.5	4.5
2.11	Surface water persistence	Present-Permanent or nearly so. Water regime = F,G,H,J,K,M,N,L,P	10	10
2.12	Water body size	>4 acres	15	15
2.13	Contiguity with stream or waterbody	Stream/lake/perennial pond lies within or is directly contiguous to wetland	5	5
2.14	Size evaluation	Habitat score is 122.2, Complex wetland acres is >400	80	80
		Total for Habitat Component	**190.16**	**190.16**
		Percent of total possible score (197)	**97%**	**97%**
Species Occurrence Component				
3.1	Scarcity value	subject wetland type is Estuarine and Marine Wetlands (i.e., E2*), 1,618 acres, representing 100% of Estuarine and Marine Wetlands in the Lower Eagle River sub-basin (1,590.0 acres); 100%*10=10	10	10
3.2	Plant species of statewide significance	No occurrences, congeners of 2 species and habitat for 6 species of conservation concern	0	0
3.3	Habitat for federally listed Cook Inlet beluga whale and other marine mammals	Wetland in Eagle River or Cook Inlet estuarine system	25	25

Number	Description of Metric	Description of Score	Baseline	Post-Project
3.4	Fish spawning	5+ species of anadromous coho, Chinook, sockeye, pink, or chum salmon, eulachon, longfin smelt.	25	25
3.5	Fish rearing	5+ species known or likely to rear	25	25
3.6	Habitat for bird species of special concern	>3 known species	15	15
3.7	Waterfowl staging	High importance: high numbers of several species (> 8 waterfowl species and> 150 individuals) seen regularly at one time during migration.	15	15
3.8	Waterbird production	High importance: produces several broods of >6 species.	15	15
3.9	Colonial Waterbirds	Known to have nested in the past 5 years; Confirmed nesters only documented at study plots within 0.5 miles	9	9
3.10	Obligate wetland breeding bird diversity	High value (>8 obligate or >15 total)	25	25
		Total for Species Occurrence Component	**164**	**164**
		Percent of total possible score (198)	**83%**	**83%**
Social Function Component				
4.1	Type of wetland-associated use	None known for waterfowl hunting, passive aquatic recreation, fishing, boating, or other water related activities	0	0
4.2	Educational use	No known or potential use	0	0
4.3	Existing facilities and programs	No specific education or outreach program exists for this wetland	0	0
4.4	Watershed views	Distinct: Wetland type represents greater than 50% of the total wetland area for that type within its watershed	15	15
4.5	Types of disturbances	Roads/trails, drainage, filling, UXO munition debris, vegetation clearing, water pollution	-4	-5
4.6	Extent of aesthetic disturbance	Moderate	10	6
4.7	Ownership and accessibility	Use level = permanently closed/off limits, Access = difficult	0	0
		Total for Social Function Component	**21**	**16**
		Percent of total possible score (115)	**18%**	**14%**
		Total summary score	**508.86**	**501.86**
		Percent of total possible score (700)	**73%**	**72%**

Clunie Creek Riparian Wetlands

The Clunie Creek riparian wetlands comprise a relatively small complex (92.2 acres) represented by a mix of forested and shrub wetlands with varying contribution of needleleaf and broadleaf species (AECOM 2020). These lowland vegetation types are relatively common in the sub-basin and the greater ecoregion. Clunie Creek is an influent stream that originates outside of the project area at Clunie Lake and loses its surface water expression approximately 0.5 km into the CALFEX expansion area. Downgradient of this point, the creek is presumed to maintain subterranean flow along the inactive stream channel until its outfall in the tidal reach of ERF (Brandt et al. 2020). Indicators of wetland vegetation and hydrology are evident in the inactive stream channel immediately downgradient of Clunie Creek's point of inflow but weaken in the direction of the creek's presumed outfall at ERF (Figure 1). Clunie Creek supports resident, but not anadromous fish species. Biological surveys for bird and wildlife species have not been conducted for Clunie Creek and surrounding habitat. Although the wetlands provide different habitat than those comprising the adjacent ERF estuary, the lack of species surveys serves to lower the species occurrence score (Table 2).

The Clunie Creek riparian wetlands have a baseline summary score of 32 percent, with habitat (52 percent) and hydrology (46 percent) components serving to compensate for low social function (26 percent) and species occurrence (4 percent) scores. As discussed above, the lack of species occurrence data serves to lower the score for this functional component. In accordance with the MOA Wetland Management Plan (2014), wetlands with the moderate resource value (i.e., 'B' wetlands) are typically characterized by a mixture of higher and lower values and functions, with a portion of the wetlands having a fairly high degree of biological or hydrological functions. Based on metrics presented in the Wetland Management Plan (MOA 2014), riparian wetlands associated with Clunie Creek exceed the class 'A' cut off score for habitat (90 points) but not for hydrology (95 points), and fall below the class 'B' cut off score for species occurrence (30 points) and social function (40 points). Based on this mix of function and value level, the Clunie Creek wetland complex in its baseline condition satisfies the criteria for a moderate-resource value, or class 'B' wetland. The intent of the 'B' designation is to conserve and maintain key functions and values by limiting and minimizing fills and development to less critical zones while preserving higher value areas (MOA 2014).

Revisions to Baseline Functional Scores

Different from both the original functional assessment for Clunie Creek (Johnson 2020b; 1,301 acres of wetlands in Clunie Creek at the HUC 14 watershed scale) and the wetland areas provided in the JBER methodology (Table 7 Johnson and Schoofs 2020; 1,406 acres of wetlands in the Clunie Creek sub-basin), a value of 919 acres of wetlands in the Clunie Creek sub-basin was used for the assessment presented here. This value was calculated from the intersection of the sub-basin (MOA 2020) with the coincident NWI coverage (USFWS 2020). Use of the 919 acre value produced a higher baseline score for the flow augmentation hydrologic component (1.5; original score of 18, increased to 22).

Other revisions to baseline functional scores include:

- 1.4 Wetland Complex Size: use of the revised wetland boundaries (AECOM 2020) returns a wetland complex size of 92 acres, and a subsequent increase in score from 14 to 16.

- 2.1 Vegetation Community Structure: score reduced from 14 to 13 on the basis that narrow-leaf emergent vegetation is unlikely to occur as a component of a dry to mesic quaking aspen/birch spruce forest.
- 3.1 Scarcity Value: score decreased from 6.5 to 2.7 based on the calculation of 230 acres of palustrine forested wetlands (PFO4B) occurring in the Clunie Creek sub-basin. The 6.5 acre value used in the original assessment was determined from the subjective selection of forested wetlands associated with Clunie Creek.
- 3.4 Fish Spawning: score increased from 0 to 5 based on the presence of one species of resident fish (slimy sculpin) in Clunie Creek.
- 3.7 Waterfowl Staging: score changed from 'Not Available' to 0 on the basis of limited presence of open water.
- 3.8 Waterbird Production: score changed from 'Not Available' to 0 on the basis of limited presence of open water.
- 3.9 Colonial Waterbirds: score changed from 'Not Available' to 0 on the basis of limited presence of open water.

Change in Function As a Result of the Proposed Action

The resumption of all-season firing is proposed under both alternatives. Alternative 1 would expand the impact area into the proposed CALFEX expansion area, where the Clunie Creek wetlands are located. Alternative 2 would not expand the current ERF Impact Area and therefore would not result in any direct impacts to the Clunie Creek wetlands.

All-season firing has the potential to adversely impact waterbird nesting (Hydrologic Component 1.8) and while the direct loss of wetlands is not expected under Alternative 1, grubbing, clearing, and firing in adjacent uplands is likely to reduce the cover of moss (which is more sensitive to the deposition of dust and sedimentation than vascular plant species), and subsequently the capacity for pollutant uptake and filtration within the wetland (Hydrologic Component 1.9). Although targets would not be placed in the wetland complex, there is the potential for ordnance to detonate off target, as well as the translocation of energetic residues via erosion of contaminated soils or runoff of contaminated surface water. Accidental firing and/or inadvertent introduction of pollutants to the Clunie Creek wetlands would increase the types and intensity of post-project disturbances (Social Function Component 4.5).

The greatest reduction in Clunie Creek function and values would result from the visual impact and restricted access under implementation of Alternative 1. Following initial clearing, openings would be maintained by prescribed burning and line of sight would be maintained in the non-cleared area (including Clunie Creek wetlands) by selective thinning of trees, which would result in intense and widespread aesthetic disturbance to the wetland complex and surrounding uplands (Social Function Component 4.6). Under Alternative 1, the Clunie Creek wetland complex, which is currently open to recreation, would become part of an active firing range and thus closed to access, there by eliminating its use for recreation and berry picking (Social Function Component 4.1).

Adverse impacts to the Clunie Creek wetlands that would occur under Alternative 2 include thinning of trees within the wetland complex and the indirect impacts of erosion, sedimentation, wind throw and increased susceptibility to invasive plant species and pathogens. Collectively, these impacts could reduce the diversity of plant species, communities, and representative life forms, and subsequently the value of habitat and the type and abundance of species that this habitat supports. However, the methodology employed lacks the sensitivity to produce a change in functional score for either habitat or species occurrence.

Table 2: Summary of Function and Value Assessment for the Clunie Creek Riparian Wetlands

Area of Clunie Creek sub-basin: 4,131.8 acres
Area of wetlands in Clunie Creek sub-basin: 919.6 acres
Complex Wetland No. 92, 92_2, 92_3, 1680, 1685**:** 92.2 acres
Subject Wetland No. 92, 1680: 66.4 acres
Subject NWI Class: Palustrine Freshwater Forest (PFO4/1B)
Subject HGM Type: Riverine

Number	Description of Metric	Description of Score	Baseline	Post-Project
Hydrologic Component				
1.1	Type of stormwater wetlands detain	Natural (ambient) stormwater flow	2	2
1.2	Position of wetlands in watershed	In lower third of watershed	2	2
1.3	Down-gradient land use	Lands below outflow enter a waterbody or wetland	5	5
1.4	Wetland complex size	Wetland size 78-92 acres	16	16
1.5	Flow augmentation	Catchment is between 2,101 and 6,500 acres; complex wetlands are 92.2 acres, representing 2.2% of the 4,132 acre catchment	22	22
1.6	Extent of wetlands in catchment	Wetlands in complex are 92.2 acres, representing 10% of the 919.6 acres of wetlands in the Clunie Creek sub-basin	2	2
1.7	Wetland location	Riverine (channel)	7	7
1.8	Sensitivity to water quality degradation	Waterbird nesting habitat	2	0
1.9	Pollutant uptake and filtration	<5% coverage of robust emergent vegetation/submerged aquatics/Sphagnum moss	3	2
1.10	Pollutant sources in catchment	Mixture of Unimproved and Semi-Improved Grounds	3	3
1.11	Long-term nutrient retention	Wetland with organic soils on <50% of area, mineral soils or very shallow peat	5	5

Number	Description of Metric	Description of Score	Baseline	Post-Project
1.12	Water quality maintenance	Inflow is from stream flows or storm events but is from relatively undisturbed or undeveloped areas and detention time and storage capacity are moderate.	8	8
1.13	Erosion buffering	Subject wetlands are riverine trees and shrubs	10	10
		Total for Hydrologic Component	**87**	**84**
		Percent of total possible score (190)	**46%**	**44%**
Habitat Component				
2.1	Vegetation community structure	2 communities, 13 vegetation forms	13	13
2.2	Plant community diversity	2-4 communities in the wetland complex	3	3
2.3	Plant community interspersion	Type 1	1	1
2.4	Diversity of surrounding habitat	Open fields, mixed forest, undeveloped terrain, creeks	8	8
2.5	Proximity to other aquatic habitats	Hydrologically connected by surface flow to other wetlands (different HGM type) within .25 mile (Flats wetlands on N side of Artillery Rd)	10	10
2.6	Open water types	Type 1	4	4
2.7	Hardiness zone	Zone 4b	3	3
2.8	Soil types	62.2 acres mineral, 0 acres organic, 0 acres clay	5	5
2.9	Aquatic habitat type	Wetlands in complex are riverine channel and organic flat see supporting worksheet	3.9	3.9
2.10	Nutrient status of surface water	No data available	NA	NA
2.11	Surface water persistence	Present- ephemeral or shallow (non-permanent). Water Regime = A, C, or E	6	6
2.12	Water body size	400 sq. ft. to 0.5 acre	5	5
2.13	Contiguity with stream or waterbody	Stream (Clunie Creek)/lake (Clunie Lake)/perennial pond lies within or is directly contiguous to wetland	5	5

Number	Description of Metric	Description of Score	Baseline	Post-Project
2.14	Size evaluation	Habitat score is 66.9, Subject wetland acres is 61-75 acres	36	36
		Total for Habitat Component	**102.9**	**102.9**
		Percent of total possible score (197)	**52%**	**52%**
Species Occurrence Component				
3.1	Scarcity value	Subject wetland type is Palustrine Freshwater Forest (PFO1/4B), 62.6 acres, representing 27% of Palustrine Forested Wetlands (PFO4B) in the Clunie Creek sub-basin (230.1 acres); 0.27 *10=2.7	2.7	2.7
3.2	Plant species of statewide significance	no occurrences	0	0
3.3	Habitat for federally listed Cook Inlet beluga whale and other marine mammals	Does not apply	0	0
3.4	Fish spawning	1 species (resident, not stocked)	5	5
3.5	Fish rearing	No species known or likely to rear	0	0
3.6	Habitat for bird species of special concern	No species known	NA	NA
3.7	Waterfowl staging	Not used for staging (no open water)	0	0
3.8	Waterbird production	No known habitat for waterbird production	0	0
3.9	Colonial Waterbirds	None known	0	0
3.10	Obligate wetland breeding bird diversity	No species known to nest in or around wetland	NA	NA
		Total for Species Occurrence Component	**7.7**	**7.7**
		Percent of total possible score (198)	**4%**	**4%**
Social Function Component				
4.1	Type of wetland-associated use	Moderate use for passive recreation and other (5 points each)	10	0
4.2	Educational use	No known or potential use	0	0
4.3	Existing facilities and programs	No specific education or outreach program exists for this wetland	0	0

Number	Description of Metric	Description of Score	Baseline	Post-Project
4.4	Watershed views	Indistinct: Wetland type represents 25% or less of the total wetland area for that wetland type within its watershed	0	0
4.5	Types of disturbances	Types of baseline disturbance include: roads/trails, training debris; types of post project disturbance would also include: water pollution, vegetation clearing, UXO/munition debris (-1 point each)	-2	-5
4.6	Extent of aesthetic disturbance	Baseline aesthetic disturbance evaluated as 'minor/localized/scattered' based on visibility trails; post-project aesthetic disturbance expected to be ‘moderate’	10	6
4.7	Ownership and accessibility	Baseline use level is 'open' and access is 'easy at certain times'; post-project use level would be 'permanently closed/off-limits' where access is 'difficult'	8	0
		Total for Social Function Component	**26**	**-1**
		Percent of total possible score (115)	**23%**	**0%**
		Total summary score	**223.6**	**195.6**
		Percent of total possible score (700)	**32%**	**28%**

Conclusion

The ERF estuarine and Clunie Creek riparian wetland complexes are considered high (class 'A') and moderate (class 'B') resource value wetlands, respectively, based on the assessment of their baseline functions and values following the JBER methodology (Johnson and Schoofs 2020). It is predicted that implementation of the proposed project action would reduce the functions and values of wetlands in the project area, with the greatest reductions expected for social value of the Clunie Creek wetlands under Alternative 1, and social value of the ERF estuary under both alternatives. Predicted reductions in specific functions and/or values are not great enough to produce a change in resource value designation (i.e., A or B class) for either wetland complex, regardless of alternative.

The low sensitivity of the methodology employed here does not appear to fully capture the reduction in wetland functions expected for the proposed project action alternatives. The marginally lower functional value returned for wetlands affected by the proposed project action will be used to inform the effects determination but will not be used as the sole justification of a determination of non-significance or significance of impacts.

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APPENDIX I–NHPA EXTERNAL COORDINATION AND MEMORANDUM OF AGREEMENT

**PROGRAMMATIC AGREEMENT
AMONG
673d AIR BASE WING,
11th AIRBORNE DIVISION, AND
THE ALASKA STATE HISTORIC PRESERVATION OFFICER
REGARDING
PROPOSAL FOR MORTAR AND ARTILLERY TRAINING AT RICHARDSON TRAINING AREA, JOINT BASE ELMENDORF-RICHARDSON, ALASKA**

WHEREAS, the 11th Airborne Division (11th ABN DIV), acting through the 673 Air Base Wing (673 ABW), on Joint Base Elmendorf-Richardson (JBER), Alaska, is currently hosting winter firing within JBER's Eagle River Flats Impact Area but proposes to reestablish all-season training and expand the impact area (hereafter referred to as "the Undertaking"); and

WHEREAS, 11th ABN DIV is the project proponent and retains operational responsibility, and 673 ABW is the lead federal agency for this Agreement; and

WHEREAS, the 11th ABN DIV is completing a draft National Environmental Policy Act (NEPA) Environmental Impact Statement (EIS) in which two action alternatives include all-season training in Eagle River Flats, with an expanded impact area of approximately 585 acres included in one of these alternatives; and

WHEREAS, all-season training is necessary to ensure that Soldiers achieve and maintain critical combat skills, and the conditions under which indirect live-fire weapons training can be conducted at JBER must be modified to meet Army doctrinal standards; and

WHEREAS, 673 ABW has defined the Undertaking's area of potential effects (APE) as the 905 acres within the Eagle River Flats Impact Area, which may contain unidentified historic properties, and the Expanded Impact Area adjacent to Eagle River Flats identified in **Exhibit 1** hereto; and

WHEREAS, increased firing frequency represented by the proposed all-season training at Eagle River Flats Impact Area increases potential risks of adverse effects to unreported historic properties that may exist within the Eagle River Flats Impact Area, particularly during summer months when protective snow and ice are absent; and

WHEREAS, parties agree that 673 ABW shall not conduct an archaeological survey of the 905 acres within the Eagle River Flats Impact Area because of the risks to human health and safety from unexploded ordnances; and

WHEREAS, 673 ABW has conducted archaeological surveys in the Expanded Impact Area in 2002 2003, and 2020, and six archaeological sites identified in **Exhibit 2** and **Appendix A** (ANC-04563, ANC-04564, ANC-04565, ANC-02606, ANC-02603, and ANC-02602) were identified in 2020; and

WHEREAS, parties agree that archaeological site ANC-04564 is eligible for the National Register of Historic Places and the archaeological district ANC-04610 (consisting of ANC-02606, ANC-04565, and ANC-02603) is eligible for the National Register of Historic Places; and

WHEREAS, the Undertaking will result in adverse effects to historic properties ANC-04564, ANC-04610 (including ANC-02606, ANC-04565, and ANC-02603), and potential unidentified historic properties in Eagle River Flats Impact Area; and

WHEREAS, 673 ABW has consulted with the Alaska State Historic Preservation Officer (SHPO) pursuant to 36 Code of Federal Regulations (CFR) Part 800 regulations implementing Section 106 of the National Historic Preservation Act (NHPA) (54 USC 306108) and the SHPO has concurred with a finding of Historic Properties Adversely Affected for both alternatives; and

WHEREAS, in accordance with 36 CFR § 800.6(a)(1), 673 ABW notified the Advisory Council on Historic Preservation (ACHP) of its adverse effect determination with specified documentation on February 10, 2021, and the ACHP has chosen *not to* participate in the consultation pursuant to 36 CFR § 800.6(a)(1)(iii); and

WHEREAS, 673 ABW consulted with the Upper Cook Inlet Tribes, including the Native Village of Eklutna (NVE), Chickaloon Village Traditional Council (CVTC), and Knik Tribal Council (Knik), pursuant to 36 CFR Part 800.6, through the NEPA process and continued consultation during Tribal meetings and a site visit; and

WHEREAS, 673 ABW invited the Municipality of Anchorage Historic Preservation Commission, the Certified Local Government, to participate; and

WHEREAS, Eagle River Flats and adjacent areas are part of the land traditionally used by Upper Cook Inlet Dene peoples. NVE, a Federally Recognized Tribe, has established a relationship with 673 ABW through the government-to-government Memorandum of Agreement (MOA). The Federally Recognized Tribes of Knik Tribal Council (Knik) and Chickaloon Village Traditional Council (CVTC) have also been consulted about this Undertaking. NVE, CVTC, and Knik support further investigation of Upper Cook Inlet Dene prehistoric and historic sites and, in such, have requested to be signatories to this Programmatic Agreement (PA); and

NOW, THEREFORE, 673 ABW, the 11th ABN DIV, and the SHPO agree that should the 11th ABN DIV and 673 ABW decide to initiate all-season training within Eagle River Flats Impact Area and Expand Impact Area, 673 ABW shall ensure that the following stipulations are implemented in order to take into account the effects of the Undertaking on historic properties and to satisfy 673 ABW's NHPA Section 106 responsibilities:

STIPULATIONS

673 ABW and the 11th ABN DIV shall ensure that the following measures are carried out:

I. PHASE 1 IDENTIFICATION PHASE SURVEY

A. If the Expanded Impact Area alternative is selected and before any construction takes place, 673 ABW and the 11th ABN DIV will conduct an identification/evaluation phase survey of the Expanded Impact Area, in accordance with Stipulation V of this PA and II.B.3 of the *Programmatic Agreement among 673d Air Base Wing, the Alaska State Historic Preservation Officer, and the Advisory Council on Historic Preservation Regarding the Operation, Maintenance, and Development Activities at Joint Base Elmendorf-Richardson and Associated Training Lands, Alaska* (OMD PA). This states that when identifying historic properties in the APE, if previous surveys are more than 10 years old, a new survey shall be completed to evaluate NRHP eligibility of cultural resources present. The survey and reporting will be completed before the area is developed.

B. The survey will incorporate standardized methods appended to the JBER Integrated Cultural Resource Management Plan (ICRMP) and agreed to through consultation, including strategies for systematic pedestrian survey, field documentation, subsurface testing, recordation of culturally modified trees, and metal detecting. Treatment and investigation of newly reported historic properties may vary based on location, association with project features, type of site, NRHP eligibility criterion, and type of adverse effect. Newly reported historic properties will be treated as described in Stipulation II.A and II.B. If data recovery is required, it will comply with II.C.

C. If the Expanded Impact Area alternative is not selected, Stipulation I will not be implemented.

D. SUBMITTALS

1. 673 ABW will provide a research and survey design to Signatories and Consulting Parties no less than 45 days before any field work to fulfill Stipulation I.A. The Signatories and Consulting Parties shall provide review comments within 30 days. Historic properties identified as a result of this survey will be recorded within the guidelines established by the ICRMP and reported to the SHPO for addition into the Alaska Heritage Resource Survey (AHRS). The criteria of adverse effect will be applied to any new historic properties in compliance with 36 CFR Part 800.5. Resolution of adverse effects, if any, will be resolved per 36 CFR Part 800.6, which may require amendment to this PA (refer to Stipulation VIII below).

2. 673 ABW will submit a final report to the Signatories and Consulting Parties no later than two (2) years following the end of all identification fieldwork. The report will meet the *Secretary of the Interior's Standards and Guidelines for Archaeological Documentation (48 FR 44734-37).* AHRS forms for all sites shall be attached to the report as an appendix. The report shall include determinations of eligibility and assessments of effects. Upon receipt of the documentation, the Signatories and Consulting Parties shall provide review comments within 45 days. Final submittals, taking into consideration the comments, shall be no later than 60 days after receipt of review comments. No site-sensitive information will be released to the public.

II. INDIRECT ADVERSE EFFECTS TO IDENTIFIED ARCHAEOLOGICAL SITES

A. Vegetation buffer. The 11th ABN DIV will ensure a natural vegetation buffer will be retained throughout use of Eagle River Flats Impact Area and Expanded Impact Area of at least 200 feet around affected historic properties ANC-04564, ANC-02606, ANC-04565, and ANC-02603 and any newly identified historic properties in the Expanded Impact Area.

B. Site protection measures.

1. The 11th ABN DIV will place barriers made from felled trees and vegetation along the outside edge of the vegetation buffer in the vicinity of historic properties at the time that the expanded impact area is developed. Throughout the military's use of the Expanded Impact Area, training activity (troops maneuvering and live-firing) and maintenance (such as tree/brush trimming) will be prohibited within 200 feet of eligible historic properties.
2. The 11th ABN DIV and 673 ABW will ensure that a Secretary of Interior-qualified professional (Stipulation V) will monitor site conditions annually, which will consist of a visual inspection of the historic properties and the 200-foot buffer (hereinafter, Site Inspection). Site inspections may be suspended after five (5) years if no indirect effects are observed, in consultation with the Signatories and Consulting Parties. Site Inspections must be coordinated with Range Control and Explosives Ordinance Disposal teams for safety. Site Inspections may use unmanned aerial vehicles (drones) if physical inspection is not possible. "Rounds Out of Safe"[1] incidents will require Site Inspections prior to resumption of training

[1] "Round Out of Safe" has impacted inside the surface danger zone but outside the Target Box.

in that area. Training may continue in other areas. The annual inspection report will include personnel, methods, descriptions of any disturbance, maps, photographs, assessment of effects, and recommendations for repairs, maintenance, and mitigation. There are no additional annual reporting requirements for this PA. Any site inspections under this agreement will terminate when the range is no longer in use as an impact area for military training.

C. Data recovery. Data recovery will only be required if the Expanded Impact Area alternative is selected. Data recovery will begin prior to construction of the Expanded Impact Area and must be complete before the area is used for live-fire training.
   1. The professional qualifications of at least one individual (Field Director) will, at a minimum, meet Secretary of Interior qualifications for an archaeologist (Stipulation V). In addition to these minimum qualifications, it is preferred that the Field Director have at least 1 year of full-time professional experience at a supervisory level in the field of archaeology in Alaska. The Field Director will have direct and on-site oversight of day-to-day work by the field crew, including completing field forms, reviewing field notes, and reporting directly to the 673 ABW Cultural Resource Manager (CRM). The Field Technicians will be experienced in archaeological field techniques and be able to recognize various resource types that may be encountered.
   2. Systematic subsurface testing will be used to identify stratified features and activity areas at ANC-04564, ANC-02606, ANC-04565, and ANC-02603, as well as any newly identified historic properties. Approximately 10% of each site will be excavated to sterile soil. The selected areas will represent architectural features, activity areas, and multiple feature types comprising the site. The data recovery plan will include details of the archaeological methods employed. The plan will be reviewed by Signatories and Consulting Parties as described in II.D.2.

D. SUBMITTALS
   1. 673 ABW will report the results of Site Inspections in a report submitted no later than March 31 of every year throughout the duration of this agreement. It will also be included as an appendix in the annual report required in the JBER OMD PA.
   2. Data recovery plan and research design.
   3. 673 ABW will ensure that the data recovery plan and research design will be provided to Signatories and Consulting Parties at least 90 days before data recovery field efforts that includes a literature review, field and laboratory methods, plan for encountering human remains, management of collections and data, and a timeline for field, analysis, and reporting.

      a. 673 ABW will provide the draft data recovery plan and research design to Signatories and Consulting Parties, who will have 30 days following receipt to review and respond.
      b. 673 ABW will provide the final data recovery plan and research design to Signatories and Consulting Parties within 45 days of receiving comments.
   4. Data recovery report.
      a. 673 ABW shall submit a draft data recovery report to Signatories and Consulting Parties within nine (9) months of the completion of all field work and analysis. 673 ABW shall ensure that the report is responsive to professional standards and to the *Secretary of the Interior's Format Standards for Final Reports of Data Recovery Programs* (42 FR 5377-79). Upon receipt, Signatories and Consulting Parties shall have 30 days to review the draft and submit comments to 673 ABW.
      b. 673 ABW shall take into consideration Signatories and Consulting Parties' comments. 673 ABW shall submit a printed and an electronic copy of the final data recovery report to Signatories and electronic copies to Consulting Parties no later than 90 days after receipt of comments. 673 ABW shall retain one printed copy and make an electronic copy available upon request.

d. 673 ABW shall submit updated AHRS forms to SHPO within nine months after the completion of all fieldwork and analysis with the draft data recovery report.

III. UNANTICIPATED EFFECTS AND INADVERTENT DISCOVERIES

A. If cultural remains are inadvertently discovered from any action or there are inadvertent adverse effects as a result of training or other activities associated with this Undertaking,

1. The 11th ABN DIV and 673 ABW will ensure that work in the area is stopped, the area is secure and protected, establish a 100-foot buffer, and contact the 673 ABW Cultural Resource Manager (CRM) or Conservation Law Enforcement.
2. The 673 ABW CRM shall notify Signatories and Consulting Parties within 48 hours of the inadvertent discovery in accordance with 36 CFR 800.13.
3. The 673 ABW CRM shall provide documentation to Signatories and Consulting Parties including assessment for eligibility for the NRHP, proposed actions to resolve any adverse effects, reports and analysis as appropriate, and a plan for curation (pursuant to Stipulation IV).
4. Signatories and Consulting Parties must comment within 48 hours of receipt of the notification.
5. Ground disturbing activity may continue outside of the buffer area. After on-site measures are implemented, ground disturbance within the buffer may continue.

B. If any activities in the ERF-IA or Expanded Impact Area result in adverse effects to historic properties, the following procedures will be followed:

1. 11th ABN DIV shall stop training activity and begin an investigation in accordance with United States Army Alaska Regulation 350-2 *Range Safety*.
   a. For rounds out of safe, the units will immediately notify Range Operations Firing Desk and the unit command. The incident is to be investigated by the unit's command, assisted by Range Operations, with a final report submitted from the unit command to the 11th ABN DIV.
   b. For a round out of impact[2], the unit will immediately notify Range Operations Firing Desk and the unit's command. The incident is to be investigated by the 11th ABN DIV Firing Incident Investigation Team, assisted by the firing units, with a final report submitted from the unit command to the 11th ABN DIV.
   c. For a lost round whose point of impact is unknown (unobserved round), it is assumed to have impacted outside of range limits until proven otherwise. Lost rounds will be immediately reported to Range Operations Firing Desk and firing will not resume until unit cleared to do so by Range Operations.
2. If a round out of safe or a round out of impact is known to have impacted in the vicinity of a historic property, Range Operations will contact the 673 ABW CRM. A notice will be provided to Signatories and Consulting parties within 72 hours.
3. If an unobserved round is thought to have impacted in the vicinity of a historic property, Range Operations will contact the 673 ABW CRM. A notice will be provided to Signatories and Consulting parties within 72 hours.
4. As soon possible and if safe to do so, the 673 ABW CRM will examine potentially affected historic properties. The 673 ABW CRM shall provide documentation to Signatories and Consulting Parties including results of the 11th ABN DIV investigation, proposed actions to resolve any adverse effects, reports and analysis as appropriate, and a

[2] A "round out of impact" is one that detonates or whose fuse functions outside of the target box and Areas A, B or C of the surface danger zones

plan for curation (pursuant to Stipulation IV). There is no expected timeline for the duration of these investigations. 673 ABW and 11th ABN DIV will provide schedules and updates.

C. If any sacred objects, funerary objects, or objects of cultural patrimony are inadvertently encountered, the area will be avoided. Activities will cease in the immediate area, measures will be taken to protect objects, and the CRM will be notified immediately so that appropriate action can be taken in order to follow regulations set forth in 43 CFR Part 10 Native American Graves Protection and Repatriation Act (NAGPRA) and 673 ABW Policy on Human Remains Discovery (JBER Policy 27).

D. If human remains are encountered, then the following actions will be taken:

1. Activities within the area immediately stop and 673 ABW, the SHPO, relevant Alaska Native Tribes including NVE, CVTC, and Knik, and the Alaska State Troopers (AST) shall be contacted immediately (Alaska Statutes 12.65.5).
2. If the remains appear recent in the judgment of the anthropologist, 673 ABW shall defer to the opinion of the AST and Alaska State Medical Examiner (SME) for a determination of whether the remains are of a forensic nature and/or subject to criminal investigation.
3. If the ethnic/cultural identity of any human remains is in question, a qualified anthropologist experienced in human remains analysis shall examine the remains. This examination may take place in a laboratory and will occur within 30 days of discovery. Tribal representatives will be consulted and offered the opportunity to be present throughout the examination.
4. If the human remains are determined to be Native American, 673 ABW will follow NAGPRA regulations set forth in 43 CFR Part 10.
5. If the remains are not Native American and a determination is made by the AST and Alaska SME that a death investigation is not warranted, then 673 ABW, in consultation with the Alaska SME, will inform the known descendants of the deceased. If no descendants are found, then the remains shall be re-interred in a designated area.
6. If the standards of 43 CFR Part 10 are revised, Parties agree to consult and amend this agreement.

IV. CURATION OF MATERIALS

Collection of artifacts under Stipulation I, Identification Phase Survey, shall follow the guidelines set forth in the ICRMP. All artifacts deemed worthy of curation collected during data recovery or through inadvertent discovery resulting from use of Eagle River Flats Impact Area or Expanded Impact Area, will be curated at the University of Alaska Fairbanks Museum of the North (UAMN). This determination will be made by an archaeologist that meets the Secretary of Interior's professional qualification standards, and in consultation with the designated representative of the Signatories and Consulting Parties and University of Alaska Fairbanks Museum. Data processing of artifacts will follow curation guidelines set by Department of Defense and the UAMN.

Artifacts collected under Stipulation II.C, Data Recovery, shall be curated at the UAMN and comply with stipulations set forth in the *Memorandum of Agreement between Joint Base Elmendorf-Richardson, Alaska, and the University of Alaska Museum, Fairbanks, Alaska for Curatorial Services* (updated August 2019).

V. PROFESSIONAL STANDARDS

673 ABW and 11th ABN DIV shall ensure that all work pursuant to this PA will be developed by or under the supervision of a person or persons meeting the minimum professional qualifications of an archaeologist as included in Secretary of the Interior's Historic Preservation Professional Qualification Standards (Federal Register Vol. 62, No.119, pp. 33719). Traditional Dene knowledge is deemed an integral part of all the work associated with this PA, and as such, a Dene cultural subject matter expert shall be provided the opportunity to participate in execution of Stipulations I and II.C and the development of archaeological methods, research questions and design, and analysis.

VI. DISPUTE RESOLUTION

A. Should any signatory or invited signatory to this PA object to the manner in which the terms of this PA are implemented, 673 ABW shall consult with the objecting party to resolve the objection. If 673 ABW cannot resolve the objection, the following shall apply:
    1. If the parties cannot resolve the dispute, then 673 ABW shall forward all documentation relevant to the dispute, including 673 ABW's proposed resolution, to the ACHP. The ACHP shall provide 673 ABW with its advice on the resolution of the objection within forty-five (45) days of receiving adequate documentation.
    2. If the ACHP does not provide its advice regarding the dispute within the forty- five (45) day period, 673 ABW may make a final decision on the dispute and proceed accordingly.
    3. Prior to reaching a final decision on the dispute, 673 ABW shall prepare a written response that takes into account any timely advice or comments regarding the dispute from the SHPO, ACHP, signatories and concurring parties, and provide them with a copy of this written response.
    4. 673 ABW and the 11th ABN DIV’s responsibilities to carry out all other actions subject to the terms of this PA that are not the subject of the dispute remain unchanged.

B. At any time during implementation of any stipulation in this PA, should an objection pertaining to this PA be raised by a member of the public, 673 ABW shall notify the Signatories and Consulting Parties to this PA and take the objection into account.

VII. NOTICES

All notices, submissions, consents, demands, requests, or other communications which may or are required to be given hereunder to any Signatory shall be sent by (a) hand delivery (which shall be deemed to have been received upon delivery), (b) reputable overnight courier (which shall be deemed to have been received one business day after the date sent), (c) United States mail, registered or certified, return receipt requested, postage prepaid (which shall be deemed to have been received upon receipt by the sender of the return receipt), (d) facsimile, with a copy sent by reputable overnight courier (which shall be deemed to have been received when the sender receives a confirmation of successful transmission of the facsimile) or (e) electronic mail (which shall be deemed to have been received when the sender receives a confirmation of successful transmission). Such documents shall be sent to contact in **Appendix B**.

VIII. AMENDMENT

673 ABW, the 11th ABN DIV, SHPO, or Invited Signatories may request that this PA be amended whereupon they will consult in accordance with 36 CFR Part 800 to consider such amendment. In particular, they will consider the information developed in 673 ABW's reports under Stipulations I and II to determine if 673 ABW can effectively or efficiently carry out activities to support its mission through revisions to this PA. This PA may be amended when such an amendment is agreed to in writing by all signatories. The amendment will be effective on the date a copy signed by all the signatories is filed with the ACHP.

IX. NULLIFICATION

Parties to this PA recognize that the 11th ABN DIV is currently reviewing its options with respect to establishing year-round artillery firing in Eagle River Flats Impact Area. One of the action alternatives currently being considered is to resume all-season training and construct the Expanded Impact Area. A second action alternative would resume all-season firing with no expansion. Parties to this PA understand: that no decision has been made on which option best serves the 11th ABN DIV's mission: that in entering into this PA, 673 ABW does not represent that the 11th ABN DIV has decided on establishing all-season training in the Eagle River Impact Area in lieu of the other options currently being considered; that this PA in no way commits the 11th ABN DIV to selecting all-season training in the Eagle River Impact Area and construction of the Expanded Impact Area as its course of action; that this PA will only come into effect should the 11th ABN DIV decide that all-season training at Eagle River Flats Impact Area and/or construction of the Expanded Impact Area best serves the 11th ABN DIV’s interests: and should the 11th ABN DIV decide to not lift existing restrictions or change current use of the Eagle River Flats Impact Area, parties to this PA assert that this PA is null and void.

X. TERMINATION

673 ABW, the 11th ABN DIV, SHPO, or Invited Signatories may propose to terminate this PA by providing 30 calendar days written notice to all signatories explaining the reasons for the proposed termination. The SHPO, 673 ABW, the 11th ABN DIV, and Invited Signatories will consult during this period to seek agreement on amendments or other actions that will avoid termination. If within thirty (30) days an amendment cannot be reached, any signatory may terminate the PA upon written notification to the other signatories. Once the PA is terminated, and prior to work continuing on the undertaking, 673 ABW must either (a) execute an PA pursuant to 36 CFR § 800.6 or (b) request, take into account, and respond to the comments of the ACHP under 36 CFR § 800.7. 673 ABW shall notify the Signatories and Consulting Parties as to the course of action it will pursue.

XI. ANTI-DEFICIENCY ACT

A. All requirements set forth in this PA requiring the expenditure of 673 ABW funds are expressly subject to the availability of appropriations and the requirements of the Anti-Deficiency Act (31 USC Section 1341). No obligation undertaken by 673 ABW under the terms of this PA will require or be interpreted to require a commitment to expend funds not obligated for that particular purpose.

B. If 673 ABW cannot perform any obligations set forth in the PA due to the unavailability of funds, 673 ABW, the SHPO, and ACHP intend the remainder of the PA to be executed. In the event that any obligation under the PA cannot be performed due to the unavailability of funds, 673 ABW agrees to utilize its best efforts to renegotiate the provision and may require that the parties initiate consultation to develop an amendment to this PA when appropriate.

XII. DURATION

This signed PA shall not be executed until signature of a Record of Decision for the *Environmental Impact Statement for the Proposal for Mortar and Artillery Training at Richardson Training Area, JBER*, and shall remain in effect until terminated in accordance with Stipulation X or ten (10) years after the signing of the Record of Decision for the EIS, whichever is longer.

XIV. EXECUTION IN COUNTERPARTS

This PA may be executed in counterparts, each of which shall constitute an original, and all of which shall constitute one and the same agreement.

XV. EXECUTION AND IMPLEMENTATION of this Memorandum of Agreement by 673 ABW, the 11th ABN DIV, and SHPO provides evidence that parties have taken into account the effects of this undertaking on historic properties and afforded the ACHP an opportunity to comment.

PROGRAMMATIC AGREEMENT
AMONG
673d AIR BASE WING,
11th AIRBORNE DIVISION, AND
THE ALASKA STATE HISTORIC PRESERVATION OFFICER
REGARDING
PROPOSAL FOR MORTAR AND ARTILLERY TRAINING AT RICHARDSON TRAINING AREA, JOINT BASE ELMENDORF-RICHARDSON, ALASKA

SIGNATORIES

MABBUTT.LISA.M.1162029645 Digitally signed by MABBUTT.LISA.M.1162029645 Date: 2024.10.08 13:58:10 -08'00'

LISA M. MABBUTT, Colonel, USAF Date
Commander, 673d Air Base Wing

PROGRAMMATIC AGREEMENT
AMONG
673d AIR BASE WING,
11th AIRBORNE DIVISION, AND
THE ALASKA STATE HISTORIC PRESERVATION OFFICER
REGARDING
PROPOSAL FOR MORTAR AND ARTILLERY TRAINING AT RICHARDSON TRAINING AREA, JOINT BASE ELMENDORF-RICHARDSON, ALASKA

SIGNATORIES

Joseph E. Hilbert Jr. AUG 2 9 2024

JOSEPH E. HILBERT JR. Date
MG, USA
Commanding, 11th Airborne Division

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PROPOSAL FOR MORTAR AND ARTILLERY TRAINING AT RICHARDSON TRAINING AREA, JOINT BASE ELMENDORF-RICHARDSON, ALASKA

SIGNATORIES

Judith Bittner 10/28/2024

Judith Bittner Date
Alaska State Historic Preservation Officer
State of Alaska, Division of Natural Resources
Office of History and Archaeology

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REGARDING
PROPOSAL FOR MORTAR AND ARTILLERY TRAINING AT RICHARDSON TRAINING AREA, JOINT BASE ELMENDORF-RICHARDSON, ALASKA**

CONCURRING PARTIES

____
Aaron Leggett Date
President, Native Village of Eklutna

PROGRAMMATIC AGREEMENT
AMONG
673d AIR BASE WING,
11th AIRBORNE DIVISION, AND
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PROPOSAL FOR MORTAR AND ARTILLERY TRAINING AT RICHARDSON TRAINING AREA, JOINT BASE ELMENDORF-RICHARDSON, ALASKA

CONCURRING PARTIES

____
Alfred Tellman Date
President, Knik Tribe Traditional Council

PROGRAMMATIC AGREEMENT
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CONCURRING PARTIES

Chief Gary Harrison
Chief Gary Harrison (Jul 20, 2024 22:27 AKDT)

Gary Harrison Date
Chief, Chickaloon Village Traditional Council

PROGRAMMATIC AGREEMENT
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11th AIRBORNE DIVISION, AND
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REGARDING
PROPOSAL FOR MORTAR AND ARTILLERY TRAINING AT RICHARDSON TRAINING AREA, JOINT BASE ELMENDORF-RICHARDSON, ALASKA

CONCURRING PARTIES

____
Bryce Klug Date
Chair, Municipality of Anchorage Historic Preservation Commission

EXHIBIT 1: **Area of Potential Effect**

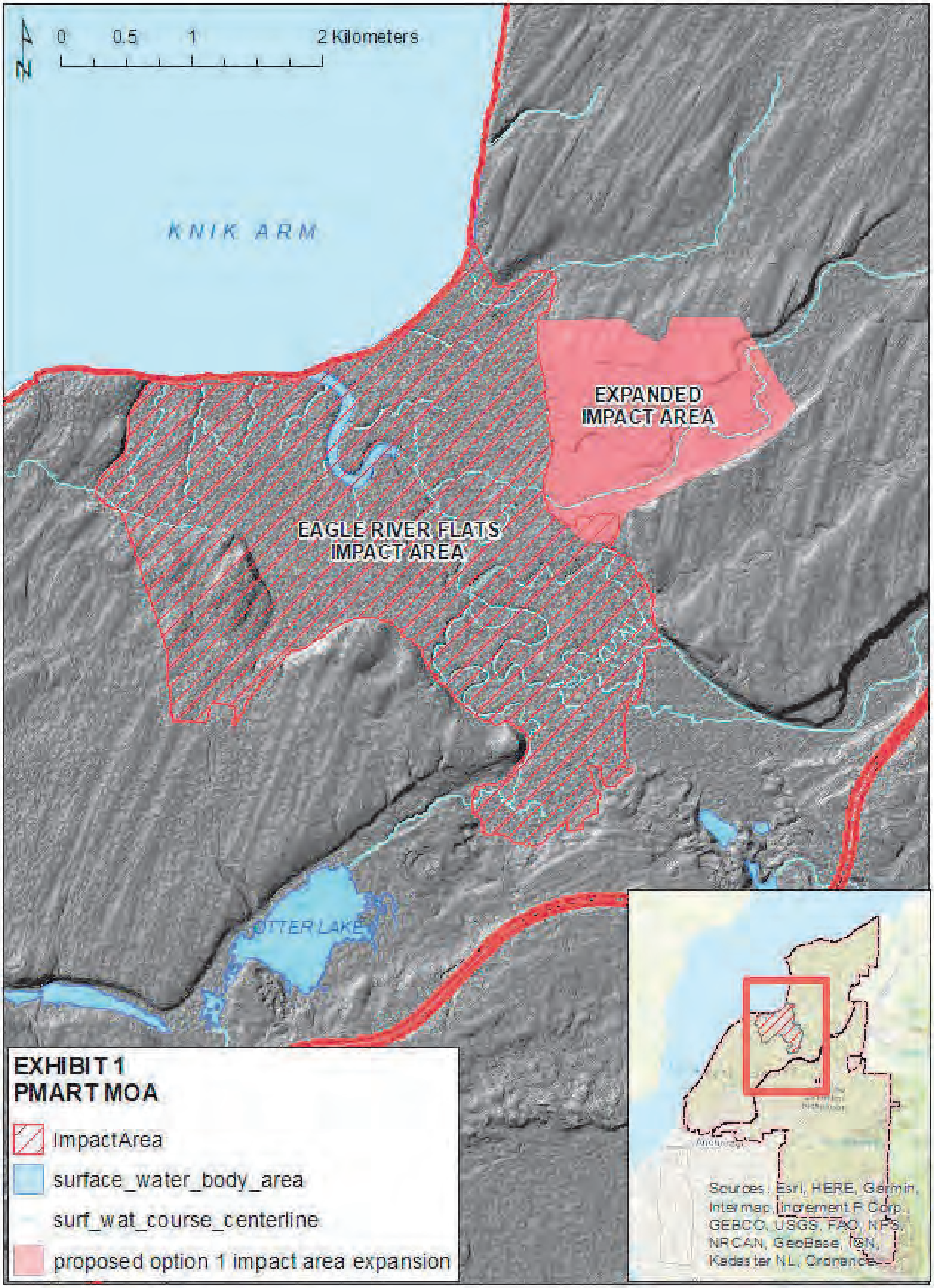


EXHIBIT 2: Historic properties

[redacted]

Historic properties (ANC-04564, ANC-04565, ANC-02606, ANC-02603), TA406 Archaeological District boundaries (ANC-04610), and archaeological sites (ANC-04563 and ANC-02602)

APPENDIX A: AHRS forms for sites in Exhibit 2

***This appendix contains restricted information and is redacted**

APPENDIX B: Points of Contact

If to JBER:
673 ABW/CC
10471 20th Street, Suite 139
JBER, AK 99506

Copy:
Cultural Resources Manager
673 CES/CEIEC
6326 Arctic Warrior Drive
JBER, AK 99506
margan.grover@us.af.mil and elizabeth.ortiz.10@us.af.mil

If to the SHPO:
State Historic Preservation Officer
Office of History and Archaeology
550 West 7th Avenue, Suite 1310
Anchorage, AK 99501
Oha.revcomp@alaska.gov

If to NVE:
Native Village of Eklutna
26339 Eklutna Village Road
Chugiak, AK 99567
nve@eklutna.org

If to Knik Tribe:
Knik Tribe
PO Box 871565
Wasilla, AK 99687
rmartin@kniktribe.org

If to CVTC:
Chickaloon Village Traditional Council
PO Box 1105
Chickaloon, AK 99674
thpo@chickaloon-nsn.gov

APPENDIX C: Data Recovery Plan – 673 ABW recommended methods

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS, JOINT BASE ELMENDORF-RICHARDSON
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

MEMORANDUM FOR DISTRIBUTION

FROM: JBER Installation Commander

SUBJECT: Policy on Human Remains Discovery (JBER-27)

1. Construction anywhere on the installation has the potential to encounter human remains. This memorandum outlines procedures to follow in case human remains are discovered.

2. When remains are discovered during excavation, the project officer or job foreman will immediately stop work in the area and contact the JBER Cultural Resource Manager (CRM) at 384-3467 or 384-2444, or JBER Conservation Law Enforcement at 552-8609. The CRM will then notify Security Forces at 552-5251 or 911.

3. JBER Security Forces will establish security for the remains such as limiting access to the site and cordoning off the area. The base CRM (and a forensic anthropologist or bioarchaeologist, if necessary) will determine if the remains are human. Should the remains prove to be human, Security Forces will notify AFOSI and, if the area involves concurrent jurisdiction, the Anchorage Police Department. AFOSI is the sole lead investigative agency for all deaths until any DoD affiliation is determined IAW AFI-71-101, Criminal Investigations. When appropriate, AFOSI will notify the Alaska State Medical Examiner's Office at 334-2200.

4. If the remains are determined to be modern, law enforcement officials determine when the project activities may resume. If the remains are not modern and not Alaska Native, the CRM will determine if the discovery site is eligible for the National Register of Historic Places (NRHP). Should the discovery site be eligible for the NRHP, any further work in the area will continue to be restricted and the JBER CRM will work with appropriate DoD, state, and federal agencies.

5. If the human remains are Alaska Native and not modern, the discovery site will continue to have restricted access and the JBER CRM will work with appropriate DoD, state, federal, and tribal agencies. At that time, the Native American Graves Protection and Repatriation Act discovery process applies. Typically, project ground disturbing activities may proceed 30 days after a written Plan of Action has been executed among JBER and tribal agencies regarding the removal, treatment, and disposition of the remains.

6. I fully endorse preserving our nation's rich cultural history and treating Alaska Native peoples with the utmost respect. If you have any questions, please contact the JBER CRM at 384-3467 or 384-2444.

WILSON.DAVID.JAMES.1243168658 Digitally signed by WILSON.DAVID.JAMES.1243168658 Date: 2023.02.24 13:39:57 -09'00'

DAVID J. WILSON, Colonel, USAF
Commander

Chickaloon Village Traditional Council
Human Remains Policy

A. Purpose

The purpose of this policy is to act as a guide in event of previously unknown cultural or human remains are encountered in the traditional lands of Chickaloon Village Traditional Council (CVTC). All inadvertent discoveries of previously unrecorded archaeological material, or items defined under Native American Graves Protection and Repatriation Act (NAGPRA) and in respectful consultation with CVTC such as: Native American human remains, funerary objects, sacred objects and objects of cultural patrimony shall fall under this policy.

Any ground disturbing acts the project archaeologist and/or staff must have a tribal council appointed representative on site at all times. Unless otherwise agreed upon prior to ground disturbance.

B. Discovery

In the event of an inadvertent discovery of cultural material, Ancestral remains, disturbance to burial site, or suspected cultural/Ancestral remains, all work within 50 meters must immediately cease. The following protocol must be followed.

C. Notification

1. The representative on site notifies the THPO of the discovery immediately.
2. The THPO or appointed representative and Archaeological representative gathers all pertinent information: Location, project description, project manager information, and ensures all operations within 50 m of the discovery are stopped.
3. The THPO contacts the following representatives within 12 hours.
    a. CVTC Traditional Chief
    b. CVTC Executive Director
    c. CVTC Tribal Chief of Police
4. The Archaeological Monitor will fulfill the State Requirements for Notification per http://dnr.alaska.gov/parks/oha/ahrs/remains.htm

D. Concurrent Notification

a. THPO will be in charge of notifying other tribal entities as needed.

E. Protection

a. Strict confidentiality will be always adhered to, no photos or notifications of discovery will be released without explicit consent by CVTC.
b. No observing by unauthorized personnel associated or not with the project.
c. Remains must be stabilized if needed and covered in a respectful manner.

F. Procedure

a. The Project archaeologist and CVTC will work together to identify, analyze, and report on the remains per the procedures outlined by the Programmatic Agreement or contract and/or CVTC Inadvertent Discovery Procedures.

G. Authorship

a. This policy was written with the guidance of Tribal Elders and our Traditional Chief.

Culturally Modified Trees

Guidance

Culturally Modified Trees (CMTs) are trees that have been altered by humans in the past. They have been marked or shaped to provide waypoints and directions, shelter, tools, medicines, food, and other purposes. The Dene created and value the CMTs on JBER, and these trees provide information about cultural and subsistence traditions, land stewardship, and ways the landscape was occupied and provided resources for the people. Documenting these important resources is one part of building and preserving our knowledge of the past.

GUIDANCE FOR CMT DATA RECORD FORM

Date: Date of observations

Project: Associated project for recording area

Initials: all members of your team's initals here

CMT#: Follow the CMT naming convention provided for your project. Example: "RW 3-10" = Runway project, team/area 3, CMT# 10. Enter this number as the description on your GPS unit when you mark the point below.

GPS Point #: Write the number that is displayed on your GPS unit when you mark the tree point. (different than the CMT#)

N°: write down latitude displayed on the GPS unit (JBER starts with 61.***** or 61° **',**")

W°: write the longitude (-149.***** or 149° **', **")

Landform: briefly describe terrain. Examples include: flat, trail, ridge, wetland, slope (write direction of slope "Slope NS")

Tree species: birch, spruce, cottonwood, alder (see below for photo examples)

Condition: alive, dying, dead, fallen/falling

Modification type(s): Many CMTs have more than one modification. These include: alcove, alcove shelter, bark strip-triangle, bark strip-rectangle, blazed, burned, carved, elbow, goal-post, hacked, knotted, painted, plank removal, oval scar, stump, and twisted. Modifications can include modern activities like nails, sap bores, and modifications for vehicle passage. See below for photo examples and descriptions.

Description: Include characteristics of the tree and the modifications, and other notes and observations. Blazes mark trails; do you see any other trees with blazes nearby? Elbows can point to features such as water sources, trails, food storage areas (caches, cache pits); are there any features nearby? Can you see a linear pattern? Include any observations about the surrounding areas and nearby CMTs, be as detailed as possible and use additional paper if necessary.

Core: Was a tree core sample taken? Yes or no.

Core #: Write the core sample number on both the wrappings of the sample and on this sheet.

dbh (diameter at breast height): This is a common measurement for tree sciences. At chest height, or approximately 4' from the surface, measure the width of the tree in centimeters.

Circumference: measure the circumference (in centimeters) of the tree at chest height also.

Mod(ification) width: The distance measured (in cm) from the left to right of the modification at the widest point. This can be estimated if the scar is out of reach. Elbows, knots, and twists are difficult to measure, so the width, length, and depth are not practical for some types of modifications, so this field may be left blank. You can add information about approximate size in the description section above.

Mod length: The distance measured (in cm) from the base of the modification to the top. Can be estimated or left blank if it can't be measured.

Mod depth: The distance measured (in cm) of the deepest part of a cut mark or modification. Can be estimated or left blank.

Height above ground: The distance measured (in m/cm) from the ground surface at the base of the tree to the base or bottom of the modification. This can be estimated or left blank for modifications that are not practical to measure in this way. Include information in the description field above.

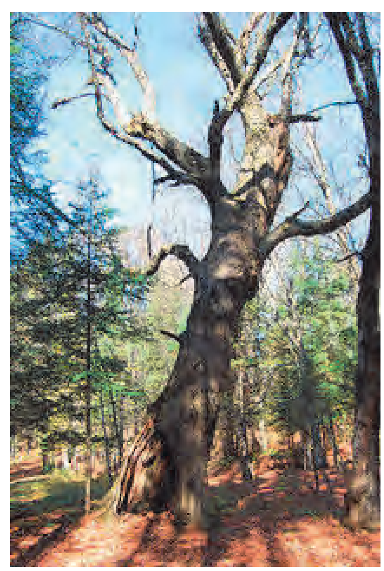
Photo 1, 2 #: write the file number from the camera or the photo log. You may take and document more photos, but take at least 2

Looking: when you take the photo, mark what direction you are taking the photo. Example "Photo #1 view looking northeast".

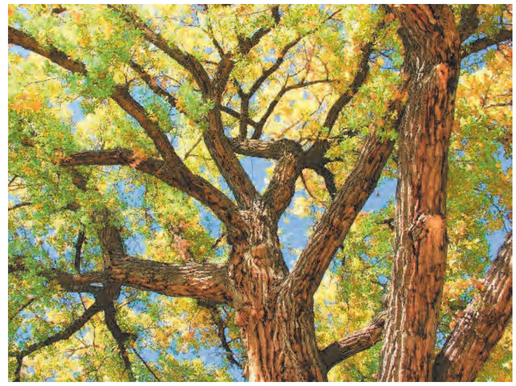
TREE SPECIES

The most common CMT on JBER is older birch trees. Spruce and Cottonwood may also be modified.

BIRCH

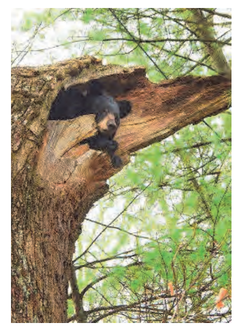


SPRUCE **COTTONWOOD**



Cottonwood and old-growth Birch look similar, but note the deeply grooved bark of the cottonwood.

ALDER **BE AWARE! COTTONWOOD AND OTHER LARGE TREES CAN BE BEAR DENS!**

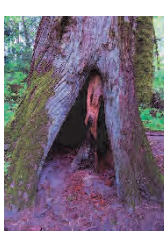


MODIFICATION DESCRIPTIONS (Adapted from Autrey and Stanford 2002)

Alcoves:

Alcoves are wedge-shaped holes hacked into the heart or center of a tree. These were used to test the center of trees for suitability for canoe construction and more modern loggers to estimate the commercial value of the tree. Common in the Tongass National Forest. Not yet seen on JBER.

Alcove Shelter:



Alcove made by hollowing out a large enough space within the tree trunk to make an area that could be used as a shelter. This could have been created by hacking and burning out a natural hollow. Common in many areas of the Pacific Northwest. These may exist on JBER, but are not well documented.

Bark Strip Triangle:

Found on Spruce trees and can be difficult to determine from natural scars. This CMT is created by the removal of a long thin triangular-shaped strip of bark. Chop marks were made near the base of the tree (at the surface, but be aware that the surface may be above the snow pack- it could be 3+ feet above the ground). These chops would be deep enough to get fingers under the bark and then the bark was pulled up and out to remove a long narrow tapering strip of fiber. Common in Tongass and Prince William Sound. Not yet identified on JBER.

Bark Strip Rectangle:

The removal of a rectangular slab of bark. Cut marks may be seen at the top and bottom of the scar. Rectangle scars are found on spruce and birch trees, and have been identified on JBER.

Blaze:

Blaze marks are the small removal of bark strips from any species of tree. They may have a top and bottom cut or may be from a singular hack. Blazed trees may have been used to mark trails, trap lines, mine claims, property boundaries, and many other reasons. They may be ancestral or modern in origin and are common on JBER.

Burn:

Culturally burned trees are difficult to tell from natural fires or lightning strikes. On CMTs burnt wood is usually restricted to a strip around the tree or in a hollow or blaze cut into the tree. Burn modifications are not found as an isolated modification, and have not yet been identified on JBER.

Carved:

Southeast Alaska has spectacular carved trees and poles with animal and human motifs. Smaller carvings may mark spiritual places, property boundaries, and logging values. These can be ancestral, historic, or modern.

Elbow:

Trails and resources were marked by modifying trees. Branches were tied in tight knots or bends that signaled information to others. These trees have branches with prominent angle bends or "U" shapes that can be indicating the location of resources. These branches can be growing upwards, downwards, knotted in a circle, twisted around other branches, on opposite sides of a tree like a goalpost, and some trees have many altered branches. Some mark a trail, and some point at water sources or other culturally important resource. When recording elbows, write down what direction the branches are indicating by using a compass. Also describe if the elbow is 90°, rounded U, or an acute (tight) angle. These are common on JBER.

Goal Post:

Elbow trees that have branches at the same height on opposite sides of the tree. The bends in the two branches create a goal post-like structure. These have been seen on JBER. Document the direction of the branches as well as any visual resources between the goal posts (both directions) or that either arm is pointing to.

Hacked:

Axe or Adze chop marks on a tree this can be at the top or base of a scar, or independent of other markings. Some examples could be testing wood, creating kindling, starting to fell a tree, or setting a trap line. Describe in the notes section of the form when observed.

Knotted:

Bent branch or elbow trees that were once tied in a circle or twisted into a knot. May still have a circle shape, or have grown more into a spiral over time. These have been observed on JBER.

Painted:

Paint can be used for modern tree and trail marking, but there are places in Alaska that have animals or faces painted on the bark. The most common paint markings on JBER are for long-term ecological studies, trails, logging areas, marking trees that are diseased, or boundaries between recreational and training areas.

Plank removal:

Plank removals are long, rectangular scars similar to the bark strips but cut deeper into the woody portion of the tree. A plank of wood was removed from a standing live tree by making large cuts at the top or bottom and then pounding wedges from the cuts and/or along the sides to pry the slab away from the trunk. Adze or Axe marks are usually visible. This is common in Southeast Alaska cedar trees and has not yet been observed on JBER.

Oval Scar:

Similar to a blaze or rectangle bark strip but has rounded edges and is long and narrow. Can be found on any type of tree and could be obscured by the tree's growing lobes over the scar. It is difficult to tell if this modification is cultural or naturally occurring. Look for any cutmarks around the margins. These were sometimes cut in a way to pool sap at the bottom for use as pitch or glue. Seen on both spruce and birch trees on JBER, but not yet documented.

Twisted:

Twisted trees are seen on JBER, and are the result of repeated hide processing or similar activity. When the hides are stretched around the tree, pressure is put on the trunk and bark. This causes the tree to swirl on its axis and sometimes swirl and lean. These trees may have other modifications on them also.

Other/Modern:

Please document other modifications that you observe that aren't listed here. There are signs nailed to trees, science project markers, trail markers, machine interactions (chain saw, snow plow bites), and animal activity markings present.

Culturally Modified Trees

Data Record Form

Date ______________________ **Project** ______________________

Initials ______________________ **CMT#** ______________

GPS Point # ______________________

N: ______________________ **elevation** ______________________ (ft/m)

W: ______________________ **landform** ______________________

Tree species ______________________

Condition ______________________

Modification type(s) ______________________

Description ______________________

Core __________ (Y/N) Core # ______________________

dbh circumference ______________________ cm

mod width ______________________ cm

mod length ______________________ cm

mod depth ______________________ cm

height above ground ______________________ cm

______________________ cm

Photo 1 # ______________________ **looking** ______________________

Photo 2# ______________________ **looking** ______________________

Fighting Positions Guidance

Historic Context Relevant to the Military History of JBER
American troops arrived in Anchorage in 1940, beginning a decade of rapid growth and military expansion. The population of Anchorage doubled as a result of military construction. Elmendorf Field at Fort Richardson was established after Executive Orders 8102 and 8343 withdrew lands for the base. This included acquisition of homestead lands (Daugherty and Saleeby 1998; Hollinger 2001).

As the threat of war with Japan loomed, Alaska's strategic location was more widely recognized. The Anchorage area was chosen for Alaska's first air base because of its railroad and port facilities when Fort Richardson was established by a Presidential Executive Order in 1939. Early on, construction materials had to be shipped in because there were no land connections to the Lower 48 states and air routes had not yet been established (Bacon et al. 1986; Cook et al. 1999). American troops arrived in Anchorage in 1940, beginning a decade of rapid growth and military expansion. The population of Anchorage soon doubled as a result of military construction.

With the outbreak of World War II and the Japanese attack on the Aleutians, Anchorage became a center of the American defense of Alaska and later a staging point for attacks on the Kurile Islands. Seven historic districts were developed during this time. At the outset of the Cold War in 1946, Alaska found itself to be strategically located to defend against Soviet bombers. The population of Anchorage was 3,000 in 1940 and increased significantly to 47,000 by 1951. The Alaska Road Commission completed a road between Seward and Anchorage along Turnagain Arm in the early 1950s. The Alaska Statehood Act in 1959, the state's primary industry shifted to oil and gas development (Tower 1996; Waddell 2003).

Throughout the Cold War, there was a continuing buildup of a military infrastructure on JBER, particularly small- and large-scale training facilities and housing. Fort Richardson was primarily a training and administrative center of Army forces in Alaska. A training area is an arbitrary land designation for administrative and management purposes. A variety of activities may take place in a training area, mostly related to practicing movements and tactics for ground and combat forces. The foxholes, trenches, bunkers, and other earthworks in most training areas on Fort Richardson result from light and heavy maneuver tactical training. Light maneuvers are limited to a small unit(s) using only wheeled vehicles. Heavy maneuvers have no unit size limit and can include all types of vehicles and equipment (such as tracked vehicles). The features found in light and heavy maneuver training areas depend on the training task (Smith et al. 2010). These features include: tactical assembly areas, forward operating bases, and bivouac sites; landing, pickup, and drop zones; artillery firing points; mortar firing points; observation posts; land navigation courses; tactical use, movement, and maneuver trails; and other features such as earthworks and foxholes (U.S. Army 2016).

During the Cold War, training at Fort Richardson was focused on typical small and large arms training, and light and heavy maneuver training. The Alaska Railroad was used to move troops, supplies, and equipment, and thus played an important role in these exercises (Waddell 2003). The majority of training throughout the Cold War involved infantry units stationed at JBER, although the areas were also available to the US Army Reserve and Alaska National Guard. Large exercises included logistics and coordination from around the Pacific region. Small scale training continued on a regular basis using established training protocols.

In 1950, Fort Richardson moved to the current location of JBER-Richardson, and Elmendorf field was taken over by the USAF to become Elmendorf Air Force Base (EAFB) (Denfeld 1994; 673 ABW 2017). Elmendorf was a support facility for Forward Operating Bases (FOBs) and was where aircraft maintenance, supply distribution, and command was centered. Important construction during the duration of the Cold War include the Anti-Aircraft Artillery (AAA) gun batteries at Fort Richardson (1952-1959, no longer extant), establishment of the Nike batteries (1959-1979), construction of the White Alice Communications System (1956) and its consolidation under the 5070th Air Defense Wing at Elmendorf (1960), the First Military Airlift Command (1965), and the AN/FLR 9 circularly disposed antenna array ("Elephant Cage," 1966) (673 ABW 2017:13-15). In September 1971, President Richard Nixon flew to Elmendorf to meet Japanese Emperor Hirohito, the first visit by a reigning Japanese emperor to the United States, and the first ever visit between a Japanese emperor and a sitting U.S. president. In 1975, Alaska Command (ALCOM) was inactivated, but later re-established under the Pacific Command (PACOM) in 1989. As the Cold War ended, JBER began regularly hosting foreign units, joint exercises, and dignitaries (673 ABW 2017). Fort Richardson and EAFB were consolidated as Joint Base Elmendorf-Richardson (JBER) in 2010.

Military Training Processes

What is a "foxhole"? A foxhole is commonly understood to be a hole used by troops to shelter against enemy fire and as a firing point. The military categorizes a foxhole as a type of "fighting position". The *Soldier's Manual for Common Tasks* (SMCT) training publication is used to "plan, conduct, sustain, and evaluate individual training" of critical common tasks and drills. This includes constructing fighting positions. The manual applies to active Army, Army National Guard, and US Army Reserve. A recruit must show competence in these skills before they can be released from basic training and occasionally go through "Common Tasks Testing" as part of their regular training schedule. "A fighting position provides cover from fire and concealment from observation while allowing you to engage the enemy with your weapon." The following information is summarized from the SMCT (U.S. Army 2015).

An "Individual Fighting Positions" is the first skill test in constructing fighting positions. Leadership decisions, time available, level of protection, and weapon type dictate the exact placement and size of the hole. For example, the proportions are determined by weapon type. An M4 is 7 inches (18 cm) longer than an M16; an M16 is 39.5 inches or 1 m long. Overhead cover can be built on top of the parapets (usually sandbags and/or mounded fill from the hole) and are up to 18 inches (46cm) high. The overhead cover was designed to allow for more covered space in the fighting position. It can also be at or below ground level and is no more than 12 inches (30 cm) above ground. This design is less detectable but provides less space to move around. To account for this restricted space the width of the fighting position should be extended to three M16 lengths (118.5 inches or 3 m) (U.S. Army 2015).

There are two types of fighting positions – hasty and deliberate. A hasty fighting position is built when there is little time to build more substantial cover. It should provide front cover from direct fire and allow firing to the front and at oblique angles. A hasty fighting position uses whatever cover is available and can be developed into a deliberate fighting position later. The steps are:

1. Lay prone on your side and scraping the soil underneath and next to you with an entrenching tool
2. Pile the soil into a low parapet between yourself and the enemy
3. This can be converted into a prone fighting position by increasing the depth to 18 inches (46cm)
4. The soil from the hole is used to create cover around the edge of the position (U.S. Army 2015).

A deliberate fighting position can be large enough for an individual or for two people. It begins by digging a hole with an entrenching tool that is large enough for two people and their equipment (see figures below). The size is not defined because the amount and type of equipment varies from troop to troop. The two-person fighting position is preferred and is built in four phases:

1. Use sector stakes to prevent your weapon from being pointed outside your sector, a sandbag or support stake is placed at the edge of the hole to rest the rifle stock on. Another is placed forward of the first stake/sandbag and holds the rifle barrel.
2. Add overhead cover supports at least 12 inches (30 cm) from the edge of the hole (about one helmet length). Logs can be use instead of sandbags for parapet walls, which should be at least 10 inches (25cm) high. The excavated soil is used to fill the sandbags, while grass and foliage is set aside for camouflage.
3. Dig the position with vertical walls to a maximum depth of armpit deep. If the soil is unstable, you can slope the walls or use retaining walls (like plywood). Dig two grenade sumps in the floor on each end (one entrenching tool blade wide, one e-tool deep, and as wide as the floor). Slope floor towards the sumps. Dig a storage compartment in the bottom of the back wall. Place stringers.
4. Install overhead cover. Put on a dust proof cover (boxes, plastic panel, and plywood). Nail the cover to the stringers. Put at least 18 inches (46cm) of sandbags for overhead burst protection. Fill the center cavity with fill from the hole. Camouflage the position (U.S. Army 2015).

The next common task is to construct a machine gun fighting position (see figure below). This follows similar steps as a deliberate fighting position, but it includes two distinct firing platforms, which are 6-8 inches (15-20 cm) deep and one M16 square (U.S. Army 2015).

Finally, a troop must build a launched missile fighting position. This position is similar to the two-person deliberate fighting position but is used with a shoulder firing launched missile. The missile is fired from a modified standing position by leaning against the rear wall. Thus, the rear wall does not have a parapet and that the camouflage must not combustible (U.S. Army 2015).

Theoretically, it should be possible to distinguish between these various fighting positions. A hasty position will be shallow (no more than 18 inches or 46 cm), poorly defined, and with low earthen berms on two sides. A deliberate fighting position will be approximately 8-10 feet (2.5-3 m) long with varying widths. It will be at least "armpit" deep and have berms on four sides. Overhead cover may or may not be preserved. There may be sandbags visible along the berms. There will be grenade sumps and possible storage nooks along the rear wall. A one-person deliberate fighting position will narrower while a two-person position will be about 118.5 inches (3 m) wide. It is unclear if fighting positions for machine gun positions are made from earth, sandbags, or lumber. If there are clear platforms on two corners, the position was likely of this type. If there is no berm along one long side of the position, it may be a launched missile position. There are several challenges to fighting position identification; the position was reused or modified during later training, elements were removed after training, soil slumped or eroded back into the hole over time, or parapets (berms) were pushed back into the hole or distributed after training.

A training area is an arbitrary land designation for administration and management purposes. A variety of activities may take place in a training area, mostly relayed to practicing movements and tactics for ground and combat forces. The fighting positions (foxholes), trenches, bunkers, and other earthworks in most training areas on JBER-Richardson result from light and heavy maneuver tactical training. Light maneuvers are limited to a small unit(s) using only wheeled vehicles. Heavy maneuvers have no unit size limit and can include all types of vehicles and equipment (such as tracked vehicles). The features found in light and heavy maneuver training areas depend on the training task (Smith et al. 2010). These features include: tactical assembly areas, forward operating bases, and bivouac sites; landing, pickup, and drop zones; artillery firing points; mortar firing points; observation posts; land navigation courses; tactical use, movement, and maneuver trails; and other features such as earthworks and fighting positions (U.S. Army 2016).

Maneuver training exercises allow the military to practice tactics to detect, approach, and overcome an enemy force. This may include use of vehicles, walking in formations, navigating overland individually or as a unit, seeking cover, establishing defensive perimeters and ambush sites, creating hasty fighting positions, and parachute drops (Gaines 2017; U.S. Army Garrison Alaska 2004). The type of field exercises

in the large scale operations areas vary depending on the size of the unit and their training needs. The area where a training exercise is held may be limited to a single firing point or training village, for example, or can span multiple training areas and ranges. JBER has 13 small arms ranges, three large arms gunnery ranges, 37 indirect fire large arms ranges, six collective (large and small) live fire ranges, six special live fire ranges, 53 non-live fire ranges, 13 light maneuver training areas (28,446 acres), 19 heavy maneuver training areas (24,123 acres), four drop zones, and 37 helicopter landing zones (Gaines 2017).

Training exercises are short in duration, have occurred in the JBER-Richardson area since at least 1954, and information on specific activities is not documented. In other words, a foxhole may result from any number of training exercises and activities. The dimensions and placement of features such as fighting positions are entirely dependent on individual leadership decisions during training and are not designed with a broader plan in mind. It is not possible to connect the foxholes as a group to specific periods of significance or training exercises. A hasty fighting position may be needed for offensive or defensive training. It may be created as part of a light or heavy maneuver training exercise. Finally, there is no connection between the design and layout of foxholes, as a group, to any specific unit.

During the Cold War, training at Fort Richardson was focused on typical small and large arms training, and light and heavy maneuver training. A notable training was winter and mountain operation skills. Alaska's first combat parachute company was assigned to Fort Richardson in 1962. They were trained in cross-country skiing and snowshoeing. These exercises took place primarily in training areas above the tree line, such as Ship Creek, Snowhawk Valley, and Eklutna Glacier. Several of the infantry units on Fort Richardson participated year-round. "Adventure training" or "dynamic arctic training" took place in 1970 and 1971. The maneuvers lasted one or two weeks and included Army, Air Force, and Alaska National Guard. They included movement in and out of remote areas, as well as training in radio communications, demolitions, reconnaissance, and weaponry. These exercises did not [physically] take place on JBER but the base coordinated logistics. Similar regional exercises continued into the 1980s. The Alaska Railroad was used to move troops, supplies, and equipment, and thus played an important role in these exercises. Another important change in training was a new emphasis on technology (Waddell 2003). The majority of training throughout the Cold War involved infantry units stationed at JBER, although the training areas were also available to the U.S. Army Reserve and Alaska National Guard. Large exercises included logistics and coordination from around the Pacific region. Small scale training continued on a regular basis using established training protocols.

Evidence of Training Features from Archaeological Surveys

As discussed previously, a training area is an arbitrary land designation. Training exercises often occur across several training areas. There have been many large-scale archaeological surveys of JBER-Richardson. However, not all of them recorded fighting positions (i.e. foxholes and trenches) and they each employed various levels of recordation for these features. Some reports simply state there are "many foxholes" in an area (Hedman et al. 2003; Raymond-Yakoubian and Robertson 2005; Robertson et al. 2004). Others took detailed measurements and location information for each feature (Corbin et al. 2018). That makes it difficult to develop a picture of the distribution of these features across the installation or identify any patterns of types. For example, 117 acres of the eastern portion of Training Area 410 was surveyed in 2009 (Cassell 2010). The report stated that the most common military-related feature was an "entrenchment", meaning foxholes, bunkers, and/or gun emplacements. The report did not include a tally of each type of entrenchment and the survey results map included polygons enclosing large areas of unspecified “entrenchments, paths, etc.”. These features were determined not eligible for the NRHP individually and as a group (Cassell 2010).

A 2003 archaeological survey of the firing fan for the Multi-Purpose Training Range and Infantry Platoon Battle Course covered multiple training areas west of Training Area 410. They were reported as follows:

> *As found during previous surveys on Fort Richardson, evidence of previous military activity was prolific throughout the proposed training areas. Heavy disturbance from trench building, foxholes, and UXO (unexploded ammunitions) were observed frequently during the survey. Although there is a possibility that some of these features may date to trainings undertaken during World War II and the immediate post-war period, none of these features can be clearly assigned to a specific date* (Robertson et al. 2004:7).

The report goes on to state that these features have no clear pattern or relationship, that the continuous use of the area has affected their integrity, and that they are not eligible for the NRHP. The report includes a map of these features, termed “military survival tactic sites”, but no coordinates for these individual features was provided. However, it is clear from the map that fighting positions were encountered throughout the survey area (Robertson et al. 2004).

Based on archaeological survey results from 2003, 2009, and 2018, fighting positions (foxholes, trenches, earthworks, bunkers, and gun emplacements) are likely to be found throughout the training areas on JBER-Richardson. The 2018 survey (Corbin et al. 2018) was a large enough sample to categorize the features. It reported 268 “foxholes” or “groupings of foxholes”. The majority were rectangular and averaged between 5 and 7 feet in length and 2 and 3 feet in width and depth. However, there were also U-shaped, L-shaped, T-shaped, I-shaped, and triangular or ovular. They all had vertical side walls. Occasionally, there was modern MRE (meal ready to eat) packaging or other items associated with the features. Sixteen fighting positions appeared to be mechanically excavated. These features were linear, but varied in size from 40 to 120 feet in length, and 10 to 20 feet in width. Surprisingly, the archaeologists did not observe any type of additional construction such as sandbags or timber.

Training Features and Fighting Position as Individual Sites

There are generally five approaches to reporting fighting position features on JBER:

- Fighting position features were not recorded and not designated as sites (Hedman et al. 2003)
- Individual fighting positions were recorded and designated as AHRS sites (Callina 2015a; Corbin et al. 2018)
- Small groupings of fighting positions were recorded as individual AHRS sites (Shaw 2000)
- Relatively expansive areas that include fighting positions, roads, and “tank emplacements” were grouped as large AHRS polygons (Cassell 2010; Smith et al. 2019)
- Large groups of fighting position features were described and evaluated for NRHP eligibility, but not designated as AHRS sites (Blanchard 2013; Guilfoyle and Stern 2012)

As other cultural resources investigations have noted (Shaw 2000), the training features are indeterminate in age. JBER has yet to identify clear patterns or associations with a significant historic theme. Training features are also unlikely to contribute significantly to the understanding of Cold War or other military training at JBER. For these reasons, training features have been recorded as isolates and not AHRS sites. Individually, fighting positions have been consistently described as lacking sufficient information about military training history to be eligible for the NRHP. These decisions appear to be consistent with DoD guidance (Archibald et al. 2010c) regarding the significance of individual features within military training ranges:

> *No individual building/structure/element [within a training range] will ever be significant. … Military training ranges need to be researched and evaluated as a whole landscape, including all*

> *the buildings/structures, firing lines, target mechanisms, etc. and not evaluated as individual elements that sit on the range. Military training ranges were originally designed and intended to be utilized as a whole complex* (Archibald et al. 2010:210c).

This does not preclude the importance of recording basic information about these features. That effort will provide additional information about the distribution and characteristics. It would also allow the JBER Cultural Resource Manager to track ground disturbance that results from training.

Training Features and Fighting Positions as Historic Districts

There does not appear to be a precedent for recording these types of features collectively as a historic district. Blanchard considered the creation of a historic district composed of base ground defense features, but ultimately determined that such a district would require a detailed study of such features at the level of the entire base (Blanchard 2013). In 2018, the Alaska State Historic Preservation Office requested that JBER evaluate a group of training features and fighting positions (foxholes and earthworks) as a historic district for NRHP eligibility (Teeter and Miller 2019). National Register Bulletin 15: *How to Apply the National Register Criteria for Evaluation* (National Park Service 1995) states, "A [historic] district possesses a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development." The guidance further clarifies that a district is a "unified entity" and that its identity depends on the "interrelationship of its resources". This may be a visual sense of the historic period, or properties that have a historical or functional relationship. As previously established, because the foxholes are not datable, the association may only be functional. According to National Register Bulletin 15, the boundaries of a district are "seldom defined… by the limits of current parcels of ownership, management, or planning boundaries. The boundaries [of the district] must be based upon a shared relationship among the properties constituting the district."

There is little dating evidence remaining at a vast majority of these features. Typically, the only material remains are cartridges, C-ration cans, ammunition clips, and wire cut nails. Cartridges are most commonly .30 shells and M200 training rounds. The .30 round was used during both World War II and the Cold War, although if the headstamp is visible, it is possible to date to a specific year. M200 training rounds are used in all military rifles since the beginning of the Cold War. C-ration cans changed little from late in World War II until the end of the Cold War. These broad manufacturing dates make it difficult to a specific military era. According to National Register Bulletin 15 (National Park Service 1995), one unifying characteristic of contributing features in a historic district is a historical relationship. This is rarely possible with fighting positions on JBER.

Several JBER archaeological reports have assumed that features such as fighting positions, foxholes, trenches, bunkers, and earthworks may have been associated with defense from ground-based attacks during World War II (Blanchard 2013; Guilfoyle and Stern 2012; Shaw 2000). However, there is no documentary or archaeological evidence to support that conclusion in most cases. Fighting position features, in particular, are most likely related to training exercises. Department of Defense guidance on training features and past JBER archaeological reports agree that that an in-depth investigation of training fighting positions would add little to our understanding of World War II or the Cold War and that they are not individually eligible. To be eligible as a group, they are to be approached as a landscape, not a district (Archibald et al. 2010c).

Recommendations for NRHP Evaluation

The following section provides recommendations for evaluating fighting positions within the context of training exercises. Because it has been well established that they are not individually eligible, this section focuses on NRHP evaluation as a landscape or district.

Criterion A (event): To be eligible under Criterion A, a property must be associated with one or more of the events in the defined historic context. In addition, National Register Bulletin 15 (National Park

Service 1995) states, “The property… must be documented… to have existed at the time of the event or pattern of events and to have been associated with those events. A property is not eligible if its associations are speculative.” Significant local events include the 1964 Good Friday Earthquake, effects of the oil industry on the economy after 1968, the organization of the Municipality of Anchorage in 1976, and the growth of tourism and its effects on the economy. Significant local events related specifically to JBER include winter and mountain operations skills beginning in World War II and continuing into the present. This training primarily occurred in alpine and glacier environments. Alaska’s first combat parachute company was based at JBER beginning in 1962. This type of training requires drop zones. It is possible that some of the foxholes and earthworks in the training areas were constructed by this unit but their significance must be related to the training landscape along with other structures and features. Because the dates of construction for the foxholes cannot be determined, it is not possible to tie these features as a district to these events or historic trends. In addition, the training area environments represent various indeterminate training activities – offensive or defensive training, and light or heavy maneuver training. Some of the military units on JBER played a significant role in earthquake response and recovery in 1964, but no link can be made between that event, any specific military unit, and these training features.

A training landscape or district that is eligible for the NRHP under Criterion A should retain a cohesive connection among critical features (such as drop zones, observation points, firing points, fighting positions, and natural features). The landscape or district should also be linked to a historically significant event, such as innovative training exercises or unique training events of national, state, or local significance.

Criterion B (persons): To be eligible under Criterion B, a property must be associated with individuals whose activities are demonstrated in the defined historic context. Since 1954, there have been several locally significant people who worked or were stationed at JBER. However, no association between locally significant individuals and a particular landscape of training features can be made. The inability to date these as a district or landscape to a specific period makes it impossible to connect the period when individuals achieved significance and the features.

A training landscape or district that is eligible for the NRHP under Criterion B must be connected to how a person achieved significance. That person may have developed a new tactic or approach to training. Or they may have used training gained at JBER in the field during an event in which they played a significant role.

Criterion C (construction): To be eligible under Criterion C, a property must embody distinctive characteristics of a type, period, or method of construction, represent the work of a master, or possess high artistic value. According to National Register Bulletin 15 (National Park Service 1995), distinctive characteristics “are the physical features or traits that commonly recur in individual types, periods, or methods of construction. To be eligible a property must clearly contain enough of those characteristics to be considered a true representative of a particular type, period, or method of construction.” Specifically, both districts and landscapes should demonstrate the evolution of historic character of a particular span of time.

To define the distinctive characteristics of a fighting position, we considered what aspects distinguish it from other earthworks. This includes an excavation with steep or straight walls, distinct berms or parapets, and the relatively small size (compared to other earthworks like bunkers). Some fighting positions also do not include any structural elements because they are expedient constructions. These are characteristics common to all fighting positions found throughout the JBER-Richardson training areas. A training landscape or historic district that expresses more unique or distinctive characteristics may be eligible for the NRHP under Criterion C, such as the Tanaina Lake Stone Feature Complex (ANC-04420) and the Snowhawk Ridge Stone Feature Complex (ANC-04503) (Smith and Bishop 2020; Smith et al. 2019). As described in DoD guidance (Archibald et al. 2010c), an eligible landscape or district must include all the elements of the training features and have integrity of association.

Criterion D (information potential): A property that is eligible under Criterion D has the potential to yield or has yielded information important to the human past. The characteristics of fighting positions can be compared to identify any patterns that distinguish one grouping from another. This may include size, shape, orientation, depth, and relation to topography. There may be patterns in associations among these characteristics, as well. Recorded information should also note any diagnostic artifacts or characteristics associated with the fighting positions that can be used to establish evolution of style or character over time. A training landscape or historic district that is eligible for the NRHP should retain enough characteristics or patterns to address any research questions about military training exercises. For example, how leadership may adapt training guidance to weather, environment, or topography.

Integrity: There are seven aspects of integrity: location, design, workmanship, setting, materials, feeling, and association. A property should retain those aspects of integrity that convey its significance. Integrity is only addresed after the significance of a property is established. Critical aspects of integrity for training landscapes or historic districts would be design, workmanship, feeling, and association.

Conclusions and Recommendations

A complicating factor in assessing the historic use of fighting positions, training landscapes, or historic districts on JBER is the destruction of training records in a fire in 1978 (Gaines 2017). Without these records and lacking any diagnostic characteristics or artifacts, the period of significance cannot be determined. In addition, the use of the area for training continuously introduces new features and it is possible that the existing features are reused.

Past archaeological reports establish the fact that earthworks like fighting positions, trenches, and bunkers are found throughout the training areas on JBER-Richardson. While fighting positions are distinct from other features, they lack characteristics that can be used to establish association with certain training activities or association with specific units and eras. It is not possible to establish boundaries for any landscape or historic district of training features when they are not spatially limited and are not distinguished in construction styles or patterns. With no ability to designate these features temporally and spatially, or to relate them to types of training activities, it is extremely difficult to establish boundaries for any historic districts using these features.

It is the position of JBER that fighting positions are not individually eligible for the NRHP. Groupings of fighting positions with no other associated training features are also not likely to be eligible, nor do they meet the guidance for defining a historic district provided in National Register Bulletin 15 (National Park Service 1995). However, archaeologists working on JBER should record the characteristics of all military features they encounter. This will include:

- Location – GPS coordinates and Training Area
- Measurements – length, width, depth
- Shape – rectangular, ovoid, C-shaped, V-shaped, L-shaped, etc.
- Description of walls - vertical, well-defined, amorphous, slanted, etc.
- Presence or absence of berms and placement of berms
- Any constructions – plywood or lumber, plastic, sandbags, firing platforms, etc.
- Orientation in azimuth along the long axis
- Relation to topographic features
- Any associated cultural material – nails, cans, ammunition, food packaging, paracord, etc.

This is a time-consuming effort but is necessary to fill in the picture about the characteristics and distribution of training features on the installation.

Methods for Metal Detector Surveys

Using a metal detector to determine site boundaries is a reliable remote sensing technique. These systematic methods have been adopted and endorsed by the Register of Professional Archaeologists as part of the Advanced Metal Detecting for the Archaeologist program. They allow the archaeologist to maximize the data gathered using the detector. JBER Cultural Resources has proposed the following procedures.

Metal detector settings

- Do not use discrimination or block ranges of conductivity
- Make sure you ground test the unit
- Focus on strong, unbroken target signals

There are several survey methods that are preferred but not required: systematic transects along base lines, survey area systematic transects, topographic transects, or sampling blocks. Select the method that works best for the type of site, soils, vegetation, topography, and occupations. These techniques are more accurate and time-efficient than systematic subsurface testing.

Systematic transects along four base lines

The map you produce will show where artifact concentrations are found along each base line and may be used to draw site boundaries. It does not cover the entire survey area and works well when there is limited time and/or few metal detectors on site.

1. Establish a datum near the center of the site.
2. Establish a base line in the four cardinal directions from the datum.
    a. The distance varies by site, but will likely be between 20 and 40 meters.
    b. The purpose is to determine where the artifact distribution ends and where there are concentrations.
3. Walk away from the datum along one side of the base line, sweeping the detector is a normal arc.
4. Do the same walking toward the datum on the other side of the base line.
    a. This will give you coverage of a 4 to 5 meter wide transect.
5. Mark all targets with a fiberglass flag.
    a. You may choose to use different colored flags for objects with different conductivity.
    b. You can also mark conductivity on the flag. Particularly interesting or strong signals can be marked with multiple flags (i.e. high conductivity targets such as coins or buttons).
6. Excavate each target or excavate a sample of targets (ferrous and non-ferrous).
7. Collect points for all targets on your GPS or field computer.
8. Record data about the location and characteristics of each target.
    a. With accurate data collection, you may find that some artifact types at the site have a consistent conductivity and depth. This will allow you to excavate fewer targets or to detect outside the base line transects without excavation.
9. Repeat for all base lines.

Survey area systematic transects

This method will also show artifact concentrations and site boundaries. This method works well when you have multiple metal detectors available.

1. Position archaeologists with detectors in transects about 4 meters apart along a baseline.
2. Walk along transects, sweeping the detectors in a normal arc.
3. Mark all targets with a fiberglass flag.
    a. You may choose to use different colored flags for objects with different conductivity.
    b. You can also mark conductivity on the flag. Particularly interesting or strong signals can be marked with multiple flags (i.e. high conductivity targets such as coins or buttons).
4. Excavate each target or excavate a sample of targets (ferrous and non-ferrous).
5. Collect points for all targets on your GPS or field computer.
6. Record data about the location and characteristics of each target.
    a. With accurate data collection, you may find that some artifact types at the site have a consistent conductivity and depth. This will allow you to excavate fewer targets or to detect outside the base line transects without excavation.
7. Repeat transects until the survey area is complete.
8. You may choose to walk a second set of transects perpendicular to the first ones. This will give you a more thorough coverage.

Topographic transects

This method will show site location. This method works well when you have multiple metal detectors available. It is less thorough than systematic transects. It is preferred when you need to locate a deposit in a large area

1. Position archaeologists with detectors in transects about 4 meters apart along a baseline.
2. Walk transects following the topography, sweeping the detectors in a normal arc and maintaining an equal distance.
    a. Topography includes breaks in slope or bluff edges, benches, river banks, and lake edges.
    b. The transects will <u>not</u> remain evenly spaced. Each individual will follow the anchor (the person following the topographic feature).
3. Mark all targets with a fiberglass flag.
    a. You may choose to use different colored flags for objects with different conductivity.
    b. You can also mark conductivity on the flag. Particularly interesting or strong signals can be marked with multiple flags (i.e. high conductivity targets such as coins or buttons).
4. Excavate each target or excavate a sample of targets (ferrous and non-ferrous).
5. Collect points for all targets on your GPS or field computer.
6. Record data about the location and characteristics of each target.

Sampling blocks

This method will allow you to gather sufficient data to characterize the occupation of a site. It is not good for establishing site boundaries or artifact concentrations. This method does not cover the entire survey area and works well when there is limited time and/or few metal detectors on site.

1. Divide the site into survey units (i.e. 5x5 meters or 20x20 meters).
2. Select only a portion of the blocks for survey.
    a. The percentage is subjective, It depends on how many detectors you have and how much time is available.
3. Each archaeologist detects 100% of their assigned block.
4. Mark all targets with a fiberglass flag.
    a. You may choose to use different colored flags for objects with different conductivity.
    b. You can also mark conductivity on the flag. Particularly interesting or strong signals can be marked with multiple flags (i.e. high conductivity targets such as coins or buttons).
5. Excavate each target or excavate a sample of targets (ferrous and non-ferrous).
6. Collect points for all targets on your GPS or field computer.
7. Record data about the location and characteristics of each target.

With accurate data collection, you may find that some artifact types at the site have a consistent conductivity and depth. This will allow you to excavate fewer targets or to detect outside the base line transects without excavation.

Methods for Subsurface Testing of Archaeological Sites

All fieldwork conducted at JBER will be sufficient to identify the presence or absence of archaeological sites and subsurface cultural deposits, including details concerning the nature and extent of deposits and descriptions of structural remains. Fieldwork will focus on detailed site description and documentation, photo documentation, GPS/GIS mapping, and collection and analysis of data. In general, this will include examination of cultural features (including their location and physical proximity to other features) and allow for determination of site affinity, contemporaneity, potential site significance, and eligibility to the NRHP. The sites will be mapped using a survey instrument or tape-and-compass, clear symbology, and include heights and depths on plan maps. If transects, features, and datums are marked with flagging, they will be removed before the end of field work. Efforts will made to minimize impacts to the environment. Vegetation clearing for proposed site documentation is expected but should be minimized.
All cultural resources shall be documented with the following records:

- Site forms or field notes meeting a professional quality and standard;
- GPS coordinates collected sufficient to establish a site polygon accurate to the shape of the sites and may include establishing a site datum marked with a survey flagging;
- Cadastral site plan map drawn to scale with representative feature descriptions or numbers, and;
- Sufficient photographs to characterize the site and its component features.

A Phase II condition assessment must include previously identified cultural features, new features, a description of their condition, site boundaries, and any natural or human threats, vandalism, or disturbance. If additional undocumented features are identified, the site description and map will be updated and amended, the GIS data will be updated, and this information will be included in the survey results. The assessment will enhance the existing site documentation and bring existing site information up to the standard to be applied to newly discovered sites.

Fieldwork will typically include subsurface testing to achieve these results. Subsurface tests may be completed using soil probes, augers, trowels, or shovels. The placement of the tests may be judgmental or systematic. The methods selected depend a great deal on landscape and site classification.
JBER Cultural Resources has proposed the following procedures.

Site Identification and Classification
Archaeological sites on JBER span several thousand years. Precolonial sites are Alaska Native sites predating European contact. Historic sites are sites created by European and/or Alaska Native peoples after European contact. It is possible for a single site to be multicomponent – yielding precolonial and historic components. Classification of a site as precolonial, historic, or multi component will determine the methods used to document it.

Subsurface testing may be required during Phase I pedestrian survey. Systematic testing is rarely required along transects on JBER. When surface features or artifacts are encountered, or if examining a previously reported site, conduct linear transects to relocate the features described in previous surveys and identify any new features or surface artifacts.

The decision to initiate subsurface testing is based on the best judgment of the JBER Cultural Resource Manager or Principal Investigator. Not only should it be done when there are visible surface features or artifacts, but it should also be done when encountering topographic features, such as knobs, drumlins, well-drained lake margins, and overlooks. Proximity to lakes and rivers can be a consideration but should not be the sole factor in determining of a formation is suitable for subsurface testing.

Site Documentation

Precolonial sites. The most common visible characteristic of precolonial sites in the Cook Inlet region are surface depressions, including house pits and storage pits. Sites with a precolonial context may also contain lithic materials, organic tools (bone, antler, ivory, or wood), or faunal remains in isolation or in association with visible depressions. Square or rectangular depressions associated with semi subterranean houses vary in size from 3 meters (m) x 3 m to 9 m x 12 m (30 ft x 39 ft) and up to 1.5 m (5 ft) deep. They are enclosed by earthen berms and may have one or more attached depressions and collapsed entrance tunnels. Dena'ina winter houses had central hearths, with multiple hearths in longer, multi-family houses.

Sites containing house and storage pit features will be documented using the following procedures. Detailed information on probes, shovel tests, and test units follow.

- The archaeologists will measure the dimensions and depth of the depression(s) and record any potentially associated features, such as a hearth in the center, possible cache features attached to or near the depression, or berms surrounding the house pits. This should include any culturally modified trees. The archaeologists will map and photograph the depression(s) using a scale. The map will include the dimensions and if relevant orientation of the door.
- Because rectangular, bermed depressions were also created by the military, a metal detector will be used on all square or rectangular depressions. The presence of military artifacts (such as cartridges, links, or Meals-Ready-to Eat packaging) should not lead to an automatic classification of the depression as solely a military site since soldiers commonly use existing depressions for defensive purposes, if needed.
- Probes will be used to determine if a depression contains cultural materials, charcoal, or ash layers. A probe will be used inside and outside the feature, as well as the berm. The probes must include no less than 5-cm of glacial till to confirm it reached sterile soils. The results of the probes will help determine where to place test excavations.
- When documenting a possible house feature, the archaeologists will excavate 50-cm x 50-cm test units inside one edge and in the center of each house pit. The excavation will continue at least 10-cm into glacial till to confirm it has reached sterile soils.
- When documenting a possible cache pit, a probe will be used to determine if the feature contains characteristics consistent with a cache pit (see Table below). No 50-cm x 50-cm test unit will be used inside the feature.
- If possible, a probe or 50-cm x 50-cm test unit will be placed outside the site boundaries to document natural soil formation.
- If all probe results are negative, or if all the test pits excavated outside the depression are negative, a 50-cm x 50-cm test unit will be excavated in the middle of the depression. If the central test of a depression is negative and the cultural context of the depression remains unclear, a test unit will be implemented in the wall of the depression, where the stratigraphy can be compared with the natural stratigraphy of the surrounding test units. If the test unit stratigraphy is inconsistent with the stratigraphy of surrounding profiles, then the feature will be recorded as cultural. If the feature does not appear to be culturally modified, it is likely to be of natural origin, including being created from a tree throw, frost boil, or other natural taphonomy and should not be recorded as a site.

Table: Attributes of Dena'ina and Ahtna cache pits

Attribute	Description
Stain/Fiber	Remnants of decayed wood and bark due to heavy deterioration
Spruce/Birch bark	Potential bark found in the walls or lining the base of a cache pit
Wood	Potential wood found in walls of the cache pit
Charcoal/ash	Result of cleansing, reusing, keeping away insects through fire

Cache pit depth	Cache pit is normally within 10 cm of culturally sterile gravel sediments
Disturbed soils	These soils should be evident near the edge of the depression
Cultural resources	Lithics, metal, fauna, or flora associated with human activity
Source: Arndt 1977 (Table IV-3, IV-4)	

APPENDIX J–NHPA INTERAGENCY COORDINATION

DEPARTMENT OF THE AIR FORCE HEADQUARTERS,
JOINT BASE ELMENDORF-RICHARDSON
JOINT BASE ELMENDORF-RICHARDSON, ALASKA

MEMORANDUM FOR ADVISORY COUNCIL ON HISTORIC PRESERVATION
FEDERAL PROPERTY MANAGEMENT OFFICE
ATTENTION: CHRISTOPHER WILSON
401 F STREET NW, SUITE 308
WASHINGTON DC 20001-2637

FROM: 673 CES/CEIEC
6326 Arctic Warrior Drive
JBER AK 99506-3240

SUBJECT: Notice of Transition from *Memorandum of Agreement Among 673d Air Base Wing, 11th Airborne Division, and the Alaska State Historic Preservation Officer Regarding Proposal for Mortar and Artillery Training at Richardson Training Area, Joint Base Elmendorf-Richardson* to a Programmatic Agreement

1. Purpose: Joint Base Elmendorf-Richardson (JBER) Environmental Conservation Section (673d CES/ CEIEC) notified your office of our intent to amend the *Memorandum of Agreement Between Joint Base Elmendorf-Richardson, U.S. Army Alaska, Native Village of Eklutna, and the Alaska State Historic Preservation Officer Regarding Resumption of Year-Round Firing at Eagle River Flats Impact Area at JBER-Richardson* (2012 MOA) in a letter on January 21, 2021. The Advisory Council on Historic Preservation (ACHP) replied on February 10, 2021, declining to participate in consultation.

Through consultation, the Parties agreed to allow the 2012 MOA to expire and begin a new MOA. Since 2021, the *Memorandum of Agreement Among 673d Air Base Wing, 11th Airborne Division, and the Alaska State Historic Preservation Officer Regarding Proposal for Mortar and Artillery Training at Richardson Training Area, Joint Base Elmendorf-Richardson* (MOA) has developed alongside an Environmental Impact Statement (EIS). In February 2023, the Signatories agreed to transition to a Programmatic Agreement (PA) in accordance with 36 CFR Subpart C 800.14(b). The purpose of this letter is to provide you with information on progress in these consultations and invite you to participate.

2. Background: The 11th Airborne Division (11 ABN DIV; formerly U.S. Army Alaska) has used the Eagle River Flats Impact Area for live-fire training since the 1940s. Restrictions put in place in 1991 allow use of the impact area for winter firing only (November 1 through March 31), provided required ice thickness conditions are also met. With these seasonal restrictions in place, units stationed at JBER have not been able to conduct the full range of required indirect live-fire training exercises at JBER and must deploy to other installations during portions of the year to conduct their required training.

In 2010, a Draft Environmental Impact Statement (EIS) to resume all-season indirect live-fire training at the former Fort Richardson was developed. The Air Force also completed Section 106 and Government-to-Government consultation for that proposal, which resulted in the signing of an MOA on February 28, 2012. Since the release of the Draft EIS, organizational changes resulted in the joint basing of former

Elmendorf Air Force Base and Fort Richardson into a single installation. As the managing agency of JBER, the Air Force 673d Air Base Wing is the lead agency for the preparation of a new EIS and consultation under all applicable cultural resource laws and regulations. The Army retains operational responsibility for training areas and ranges and is a cooperating agency.

JBER notified the ACHP, Alaska State Historic Preservation Officer (AKSHPO), and Consulting Parties of this undertaking and the need to amend the 2012 MOA in a letter on January 21, 2021. On February 10, 2021, the ACHP declined to participate in consultation. The AKSHPO, Native Village of Eklutna (NVE), Chickaloon Village Traditional Council (CVTC), and Knik Tribe agreed to consult. Several meetings have been held to discuss alternatives, mitigation and avoidance measures, and adverse effects. JBER has also conducted site visits to locations of concern to Tribes. As the alternatives and EIS have evolved, Signatories agreed that a PA was more appropriate for resolving adverse effects. In addition, we agreed to allow the 2012 MOA to expire in accordance with Stipulation XIII. A PA is more appropriate for resolving adverse effects of this undertaking primarily because the preferred alternative has not been selected and several actions must be included. In addition, the alternatives are different in several key aspects from the 2012 MOA, the effects are different, and Tribal concerns have changed. Finally, Knik Tribe, CVTC, and the Anchorage Historic Preservation Commission were not consulted in 2012.

3. Alternatives for the Undertaking and Areas of Potential Effect: Although the preferred alternative has not been selected, the action alternatives hold several commonalities. The action alternatives focus on live-fire mortar and artillery training that requires a permanent explosive munitions impact area. Both action alternatives would change indirect-fire weapons systems currently in use at JBER. Specifically, this would include the use of 155-mm Howitzers, which is not currently allowed on JBER. This may include various fuse types (such as impact, near-surface, proximity, and delay fuzes) and various materials (such as high-explosive, illumination, smoke, or inert). White phosphorous will not be fired under any alternative. Both action alternatives would reinstate all-season training at JBER that is currently limited. They both would also result in a redistribution of targets. All action alternatives include the existing Eagle River Flats Impact Area (ERF-IA) in the area of potential effect.

Under Alternative 1, the existing ERF-IA would increase in size to roughly 3,086 acres by adding approximately 585 acres of adjacent upland. The expanded impact area would connect the ERF-IA to the Infantry Platoon Battle Course (Figure 1). This requires clearing 359 acres of vegetation, creating approximately 1.8 miles of gravel service roads and five vehicle gravel service pads inside the cleared area, and creating a 3-mile firebreak along the boundary of the cleared area. An approximately 226-acre vegetated buffer would remain, which encompasses historic properties and wetlands. Establishing an expanded upland impact area would optimize training opportunities and provide additional habitat protections to marine mammals, migratory birds, and Pacific salmon by reducing the quantity of mortar and artillery rounds fired into ERF-IA.

Under Alternative 2, ERF-IA would not be expanded, and all mortar and artillery rounds would be fired within the existing impact area boundary. While resumption of all-season firing and incorporation of 155-mm howitzers would allow for a training environment that marginally fulfills specific training requirements, Soldiers would not experience the impacts of mortar and artillery rounds in close proximity and would not receive the full benefit of those training requirements. This alternative would not include construction of service roads, service pads, or a fire break.

[redacted]

Figure 1. *Proposed undertaking.*

4. Cultural Resources in the Area of Potential Effect: The 673d ABW and 11 ABN DIV have determined that vegetation removal, surface preparation, project facilities, training needs, maintenance, and operations are activities that have the potential to effect historic properties. The 673d ABW and 11 ABN DIV have added avoidance measures and protective barriers to avoid direct effects. The following historic properties are within the area of potential effect:

a. ANC-04610 (TA406 Archaeological District) includes three pre-colonial bermed structures (ANC-02606, ANC-04564, and ANC-04565). Two of these structures have been radiometrically dated to the eighteenth century. These sites and the district have the potential to yield information about the emergence of intensive salmon fishing and storage, the development of social stratification, the emergence of *Qeshqas*, and the emergence of sedentism. These are long-standing research questions in southcentral Alaska, as few intact houses from this period have been identified. The site's significance is further enhanced by the fact that only one other confirmed Dene pre-colonial house is known in the Anchorage area. The TA406 Archaeological District is eligible for the National Register of Historic

Places (NRHP) under Criteria A and D. Figure 2 illustrates the association of the district, contributing sites, and features of the action alternatives.

- ANC-02606 is a pre-colonial, multi-room bermed structure and at least two associated caches. No cultural material was recovered in subsurface tests at this site. ANC-02606 is eligible for the NRHP under Criteria A and D and is a contributing property to the TA406 Archaeological District (ANC-04610). ANC-02606 will also have a vegetated site buffer supplemented with an earth and log berm meant to protect the site from munitions fragmentation. If the expanded impact area is constructed, this site will be within the impact area and no longer accessible for research. Indirect effects may also occur from rounds out of safe[1] or rounds out of target.[2] Data recovery at this site is included in the draft final PA to mitigate indirect effects if the expanded impact area alternative is selected.
- ANC-04564 is a pre-colonial, multi-room structure with bermed walls and at least one circular depression. Subsurface test excavations recovered ash and charcoal, burned (calcine) bone, unburned bone, fire-cracked rock, and a single glass bead. Radiocarbon samples returned a result of 190±30 BP [1726-1813 cal. AD (224-137 cal. BP); Beta Number 579035]. ANC-04564 is eligible for the NRHP under Criteria A and D and is a contributing property to the TA406 Archaeological District (ANC-04610). ANC-04564 will be within a buffered site boundary with an earth and log berm meant to protect the site from munitions fragmentation. Indirect effects include its location within the impact area, accessibility for future research, and effects from rounds out of safe or rounds out of target. The draft final PA proposes to complete data recovery from a sample of the site to mitigate these indirect effects if the expanded impact area alternative is selected.
- ANC-04565 is the third pre-colonial, rectangular, bermed structure. Subsurface testing of the feature recovered ash, fire-cracked rock, and burned (calcine) bone. Radiocarbon samples returned a result of 200±30 BP [1726-1811 cal. AD (224-139 cal. BP); Beta Number 596866]. ANC-04565 is eligible for the NRHP under Criteria A and D and is a contributing property to the TA406 Archaeological District (ANC-04610). This site is within the proposed expanded impact area vegetation buffer and approximately 75 meters from the existing ERF-IA. Indirect effects to this site are the same as other contributing sites to the archaeological district. Data recovery from a portion of ANC-04565 is included in the draft final PA to mitigate indirect effects if the expanded impact area alternative is selected.

b. ANC-02603 is a collapsed log pole cabin and associated scatter of historical debris. Preliminary analysis indicates the site dates to the homestead period, although there is no homestead claim filed for this area. ANC-02603 is eligible for the NRHP under Criterion D and has the potential to provide information on pre-WWII non-homestead occupation on JBER lands. This site is in the vegetation buffer of the proposed expanded impact area. Indirect effects may occur to this site from rounds out of safe or rounds out of target, although its location is several hundred meters from the closest target area. The draft final PA includes regular inspections to be completed annually to monitor its condition.

The draft final PA also requires a renewed archaeological survey of the expanded impact area if that alternative is selected. Because two pre-colonial sites (ANC-04564 and ANC-04565) were not identified during surveys in 2006 and 2018, the methods were determined to be inadequate. In accordance with Stipulation II.B.3 of the *Programmatic Agreement among 673d Air Base Wing, the Alaska State Historic Preservation Officer, and the Advisory Council on Historic Preservation Regarding the Operation,*

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[1] "Round Out of Safe" has impacted inside the surface danger zone but outside the Target Box.
[2] A "round out of impact" is one that detonates or whose fuse functions outside of the Target Box and Areas A, B or C of the surface danger zones.

Maintenance, and Development Activities at Joint Base Elmendorf-Richardson and Associated Training Lands, Alaska, the survey must be revisited before the area is developed.

[redacted]

Figure 2. *Cultural resources and features of proposed undertaking. Note that the map includes archaeological sites that have been determined not eligible for the NRHP.*

5. Conclusion: The 673 CES/CEIEC invites the ACHP to participate in consultation on this PA. Copies of this letter will be sent to AKSHPO, Federally Recognized Tribes (Native Village of Eklutna Traditional Council, Native Village of Tyonek, Knik Tribal Council, and the Chickaloon Village Traditional Council), and the Anchorage Historic Preservation Commission. If you have any questions, please contact Margan Grover at margan.grover@us.af.mil and 384-3467 or Liz Ortiz at elizabeth.ortiz.10@us.af.mil.

DYE-PORTO.JEANNE.L.1246003641

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Date: 2024.05.13 06:32:05 -08'00'

JEANNE L. DYE-PORTO, GS-14, DAF
Chief, Installation Management Flight

May 23, 2024

Margan A. Grover
Cultural Resource Manager
Joint Base Elmendorf Richardson
Department of the Air Force
724 Quartermaster Road
Joint Base Elmendorf Richardson, AK 99505

Ref: *Proposed Munitions and Artillery Training on Richardson Training Area*
Joint Base Elmendorf-Richardson, Alaska
ACHP Project Number: 020951

Dear Mr. Grover:

On May 13, 2024, the Advisory Council on Historic Preservation (ACHP) received your notification and supporting documentation regarding the potential adverse effects of the referenced undertaking on a property or properties listed or eligible for listing in the National Register of Historic Places. Based upon the information you provided, we have concluded that Appendix A, *Criteria for Council Involvement in Reviewing Individual Section 106 Cases*, of our regulations, "Protection of Historic Properties" (36 CFR Part 800) implementing Section 106 of the National Historic Preservation Act, does not apply to this undertaking. Accordingly, we do not believe our participation in the consultation to resolve adverse effects is needed.

However, if we receive a request for participation from the State Historic Preservation Officer (SHPO), Tribal Historic Preservation Officer, affected Indian tribe, a consulting party, or other party, we may reconsider this decision. Should the undertaking's circumstances change, consulting parties cannot come to consensus, or you need further advisory assistance to conclude the consultation process, please contact us.

Pursuant to Section 800.6(b)(1)(iv), you will need to file the final Section 106 agreement document (Agreement), developed in consultation with the Alaska SHPO and any other consulting parties, and related documentation with the ACHP at the conclusion of the consultation process. The filing of the Agreement and supporting documentation with the ACHP is required in order to complete the requirements of Section 106 of the National Historic Preservation Act.

Thank you for providing us with your notification of adverse effect. If you have any questions or require our further assistance, please contact Chris Wilson at (202) 517-0229 or by e-mail at Chris

Wilson@achp.gov and reference the ACHP Project Number above.

Sincerely,

Dana Daniels
Historic Preservation Technician
Office of Federal Agency Programs

From:	GROVER, MARGAN A CIV USAF PACAF 673 CES/CEIEC
To:	Meitl, Sarah J (DNR)
Cc:	ORTIZ, ELIZABETH M CIV USAF PACAF 673 CES/CEIEC
Subject:	RE: JBER PMART (final?) Programmatic Agreement
Date:	Wednesday, June 26, 2024 12:46:00 PM
Attachments:	[redacted]

Here is the final PA with all the signature pages and (most) of the appendices. When I was inserting the appendices, I saw that the cards for ANC-04563 and ANC-04564 had not been updated yet, including no DOE. I think it would be confusing to attach AHRS forms that say the sites are unevaluated. So I only included the district (ANC-04610), ANC-02602, and ANC-02603 (the last two are not included in the district). I'll put in a request with Jeff and add the DOE's to ANC-02606, ANC-04563, ANC-04564, and ANC-04565.

From: GROVER, MARGAN A CIV USAF PACAF 673 CES/CEIEC
Sent: Tuesday, June 25, 2024 12:13 PM
To: Meitl, Sarah J (DNR) <sarah.meitl@alaska.gov>
Cc: ORTIZ, ELIZABETH M CIV USAF PACAF 673 CES/CEIEC <elizabeth.ortiz.10@us.af.mil>
Subject: RE: JBER PMART (final?) Programmatic Agreement

Hey Sarah
Sorry, I forgot to delete that! Yes. The May 2024 version of the PA is our final.
Please let us know whether you have additional comments. Otherwise, we'll start moving it for signature at the Army, Air Force, and Tribes.
Thank you!
Margan

From: Meitl, Sarah J (DNR) <sarah.meitl@alaska.gov>
Sent: Monday, June 24, 2024 1:47 PM
To: GROVER, MARGAN A CIV USAF PACAF 673 CES/CEIEC <margan.grover@us.af.mil>
Cc: ORTIZ, ELIZABETH M CIV USAF PACAF 673 CES/CEIEC <elizabeth.ortiz.10@us.af.mil>
Subject: [Non-DoD Source] RE: JBER PMART (final?) Programmatic Agreement

Hi Margan,
If I delete draft from page one would that make the May 2024 version the same as a final?
Sarah

From: GROVER, MARGAN A CIV USAF PACAF 673 CES/CEIEC <margan.grover@us.af.mil>
Sent: Tuesday, June 18, 2024 11:24 AM
To: Meitl, Sarah J (DNR) <sarah.meitl@alaska.gov>
Cc: ORTIZ, ELIZABETH M CIV USAF PACAF 673 CES/CEIEC <elizabeth.ortiz.10@us.af.mil>
Subject: RE: JBER PMART (final?) Programmatic Agreement

Good afternoon Sarah
I know you guys are swamped, but do you have an ETA on this?

Thanks!
Margan

From: GROVER, MARGAN A CIV USAF PACAF 673 CES/CEIEC
Sent: Wednesday, May 15, 2024 4:15 PM
To: Meitl, Sarah J (DNR) <sarah.meitl@alaska.gov>
Cc: ORTIZ, ELIZABETH M CIV USAF PACAF 673 CES/CEIEC <elizabeth.ortiz.10@us.af.mil>
Subject: RE: JBER PMART (final?) Programmatic Agreement

Hey Sarah
Maj Gen Eifler (11 ABN DIV) is leaving June 27. Col Wilson (673 ABW) is leaving 16 July 16.
It's a pretty tight schedule, I know. New leadership tend to be hesitant to sign documents until they're comfortable with their new position, so it can be months and months.
Thanks
Margan

From: Meitl, Sarah J (DNR) <sarah.meitl@alaska.gov>
Sent: Wednesday, May 15, 2024 1:21 PM
To: GROVER, MARGAN A CIV USAF PACAF 673 CES/CEIEC <margan.grover@us.af.mil>
Cc: ORTIZ, ELIZABETH M CIV USAF PACAF 673 CES/CEIEC <elizabeth.ortiz.10@us.af.mil>
Subject: [Non-DoD Source] RE: JBER PMART (final?) Programmatic Agreement

Good afternoon,

AK SHPO received the draft PA. Thank you for taking our comments into consideration. I'll get the agreement routed for a draft final review. When in June will the commands change?

Best,
Sarah

Sarah Meitl
Review and Compliance Coordinator
Alaska State Historic Preservation Office
Office of History and Archaeology
907-269-8720

From: GROVER, MARGAN A CIV USAF PACAF 673 CES/CEIEC <margan.grover@us.af.mil>
Sent: Monday, May 13, 2024 2:43 PM
To: 'Richard Martin' <rmartin@kniktribe.org>; 'Angie Wade' <alwade@chickaloon-nsn.gov>; Meitl, Sarah J (DNR) <sarah.meitl@alaska.gov>; 'Norma Johnson' <nmjohnson@chickaloon-nsn.gov>; 'THP Officer' <THPO@chickaloon-nsn.gov>; 'cbrophil@eklutna.org' <cbrophil@eklutna.org>; 'aleggett@anchoragemuseum.org' <aleggett@anchoragemuseum.org>; 'Marc Lamoreaux' <marcl@eklutna.org>; 'NVE Maria Coleman' <maria.nve@eklutna.us>; tom.davis@anchorageak.gov

Cc: ORTIZ, ELIZABETH M CIV USAF PACAF 673 CES/CEIEC <elizabeth.ortiz.10@us.af.mil>; BOSTON, JOY E CIV USAF PACAF 673 ABW/CDP <joy.boston.2@us.af.mil>; Tucker, Steven L (Steve) CIV USARMY 11 ABN DIV (USA) <steven.l.tucker2.civ@army.mil>
Subject: JBER PMART (final?) Programmatic Agreement

Good afternoon
I'm sending a "clean" version of the agreement document for the Proposed Munitions and Artillery Training (PMART) at Eagle River Flats on JBER, as well as the marked up version.

You might have noticed that this is no longer a Memorandum of Agreement. The AKSHPO suggested in our last round of edits that because the action alternative has not been selected, a Programmatic Agreement is more appropriate. We are hoping this will be the final version, as both the Army and Air Force are having a change of command in June. Both Maj General Eifler and Col Wilson are ready to execute this agreement before they leave and it would be great to take advantage of their enthusiasm.

Please note that the marked up version may not reflect comments received in email or letter form. I recommend you look at both the clean and marked up versions. If I missed a comment or edit, please let me know. Also, you will see that we sent this latest version to the Advisory Council on Historic Preservation. When we shifted from an MOA to a PA, we are required to extend another invitation. They have 15 days to respond.

Please make sure you respond to this email to let us know if you feel that this version is ready for signature by your organization within 30 days.

You've all been extremely patient, helpful, and supportive. Liz and I appreciate all your input.

Warm regards,

Margan Grover
Cultural Resource Manager
673 CES/CEIEC Environmental Conservation
Joint Base Elmendorf-Richardson, Alaska
Office: 907-384-3467 (DSN: 317-384-3467)
Mobile: 907-244-9188
I live and work on Dena'ina land.

From:	GROVER, MARGAN A CIV USAF PACAF 673 CES/CEIEC
To:	Marc Lamoreaux; Kyle Robillard; THPO@chickaloon-nsn.gov; alwade@chickaloon-nsn.gov; Richard Martin; tom.davis@anchorageak.gov
Cc:	ORTIZ, ELIZABETH M CIV USAF PACAF 673 CES/CEIEC; BOSTON, JOY E CIV USAF PACAF 673 ABW/CDP
Subject:	JBER PMART Final Programmatic Agreement
Date:	Thursday, June 27, 2024 11:21:00 AM
Attachments:	[redacted]

All -

Here is the final PA for the Proposed Mortar and Artillery Training at Richardson Training Area on JBER. There was an issue with the official AHRS cards from the Office of History and Archaeology did not have the correct determinations of eligibility. I submitted the corrected cards and will ensure they are included in the final PA pdf. Note that I included the archaeological district (ANC-04610), ANC-02602, and ANC-02603 (the last two are not included in the district). The card for ANC-04610 describes the lists the contributing sites.

The PA has been sent to Army and Air Force signatories concurrently with this email. We would appreciate it if you could **return the signature page to us by August 9, 2024**.

We appreciate everything that you have done to support finding the most appropriate mitigation measures for indirect effects to these very important sites. As always, Liz, Joy, and I are happy to talk and listen.

Margan Grover
Cultural Resource Manager
673 CES/CEIEC Environmental Conservation
Joint Base Elmendorf-Richardson, Alaska
Office: 907-384-3467 (DSN: 317-384-3467)
Mobile: 907-244-9188
I live and work on Dena'ina land.

THE STATE of ALASKA
GOVERNOR MIKE DUNLEAVY

Department of Natural Resources

DIVISION OF PARKS AND OUTDOOR RECREATION
Office of History & Archaeology

550 West 7th Avenue, Suite 1310
Anchorage, AK 99501-3561
907-269-8700
http://dnr.alaska.gov/parks/oha

October 28, 2024

File No.: 3480 AF PMART / 2020-00432

Margan Grover
Cultural Resource Manager
673 CES/CEIEC Environmental Conservation
Joint Base Elmendorf-Richardson, Alaska
Margan.grover@us.af.mil

Subject: PMART Programmatic Agreement (dated August 2024)

Dear Ms. Grover:

The Alaska State Historic Preservation Office (AK SHPO) received the request to sign the *Programmatic Agreement Among 673d Air Base Wing, 11 Airborne Division, and the Alaska State Historic Preservation Officer regarding Proposal for Mortar and Artillery Training at Richardson Training Area, Joint Base Elmendorf-Richardson, Alaska* (PA) on October 15, 2024. We commend your efforts to continue consultation on the PA with consulting parties while new leadership staff at JBER reviewed the PA and requested revisions to the June 2024 version.

AK SHPO has reviewed the subject PA, and we find it to be satisfactory. As such, a copy of our signature page is included with this email. We look forward to receiving a copy of the fully executed PA for our records.

Our office appreciates the consultation that went into the agreement. Please contact Sarah Meitl at 907-269-8720 or sarah.meitl@alaska.gov if you have any questions or if we can be of further assistance.

Sincerely,

Judith E. Bittner
State Historic Preservation Officer

JEB:sjm

December 12, 2024

Margan A. Grover
Cultural Resource Manager
Department of the Air Force
724 Quartermaster Road
Joint Base Elmendorf Richardson, AK 99505

Ref: *Proposed Munitions and Artillery Training on Richardson Training Area*
Joint Base Elemendorf-Richardson, Alaska
ACHP Project Number: 020951

Dear Mr. Grover:

On November 15, 2024, the Advisory Council on Historic Preservation (ACHP) received a copy of the executed Section 106 agreement document (Agreement) for the referenced undertaking. In accordance with 36 CFR § 800.6(b)(1)(iv), the ACHP acknowledges receipt of the Agreement. The filing of the Agreement and implementation of its terms fulfills the requirements of Section 106 of the National Historic Preservation Act and its implementing regulations, "Protection of Historic Properties" (36 CFR Part 800).

We appreciate receiving a copy of this Agreement for our records. Please ensure that all consulting parties are provided a copy of the executed Agreement in accordance with 36 CFR § 800.6(c)(9). If you have any questions or require additional assistance, please contact Katharine Cline at (202) 517-0225 or by e-mail at kcline@achp.gov and reference the ACHP Project Number above.

Sincerely,

Dana Daniels

Dana Daniels
Historic Preservation Technician
Office of Federal Agency Programs