REQUEST FOR INCIDENTAL HARASSMENT AUTHORIZATION

UNDER THE MARINE MAMMAL PROTECTION ACT

FOR EXPLORATION ACTIVITIES

IN WEST HARRISON BAY, ALASKA

November 2024

Revised April 2025

Narwhal, LLC
406 W Fireweed Lane
Suite 100
Anchorage, AK 99503

Submitted To:

National Marine Fisheries Service
Office of Protected Resources
1315 East-West Highway, F/PR1 Room 13805
Silver Spring, MD 20910

Prepared by:

ECO49

ECO49 Consulting LLC
907-903-9714
www.ECO49.com

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ACRONYMS AND ABBREVIATIONS

°	Degrees
%	Percent
3D	3-dimensional
AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
AEWC	Alaska Eskimo Whaling Commission
AIR	aerial infrared
APDES	Alaska Pollutant Discharge Elimination System
agl	above ground level
AOGCC	Alaska Oil and Gas Conservation Commission
ASAMM	Aerial Surveys of Arctic Marine Mammals
ATV	All-terrain vehicle
BLM	Bureau of Land Management
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management Regulation and Enforcement
BSEE	U.S. Bureau of Safety and Environmental Enforcement
CAA	Conflict Avoidance Agreement
CFR	Code of Federal Regulations
CI	Confidence Interval
CL	Confidence Limit
cm	centimeter
cu. in.	cubic inch
CV	coefficient of variation
dB	decibels
DPS	Distinct Population Segment
ESA	Endangered Species Act
esw	effective strip width
EZ	Exclusion Zone
FAA	Federal Aviation Administration
FR	Federal Register
ft	feet
GPS	Global Positioning System
HF	high-frequency
hp	horsepower
Hz	hertz
IHA	Incidental Harassment Authorization
IWC	International Whaling Commission
kg	kilograms
kHz	kilohertz
km	kilometer
km^2	square kilometers
LF	low-frequency
LIDAR	light detection and ranging
m	meter

m^2	square meters
MF	mid-frequency
mph	miles per hour
MMPA	Marine Mammal Protection Act
m/s	meters per second
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NSB	North Slope Borough
OA	Otariids and other non-phocid marine carnivores in air
OPR	Office of Protected Resources (NOAA)
OSRP	Oil Spill Response Plan
OW	Otariids and other non-phocid marine carnivores underwater
P&A	Plugged and abandoned
PA	Phocid pinnipeds in air
PBF	biological habitat feature
PBR	potential biological removal
POC	Plan of Cooperation
PSO	Protected Species Observer
PTS	permanent threshold shift
PW	Phocids underwater
re 1 µPa at 1m	referenced to 1 microPascal at 1 meter
rms	root mean square
seals/km^2	seals per square kilometer
SEL	sound exposure level
SHS	shallow hazard survey
SPCC	Spill Prevention Countermeasure Control
SPL	sound pressure level
TS	threshold shift
TTS	temporary threshold shift
µPa	microPascal
U.S.	United States
USFWS	U.S. Fish and Wildlife Service
WHB	West Harrison Bay

1 INTRODUCTION AND ACTIVITY DESCRIPTION

1.1 INTRODUCTION

Narwhal LLC (Narwhal) is requesting an Incidental Harassment Authorization (IHA) from the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) Office of Protected Resources (OPR) for the incidental take of small numbers of ringed and bearded seals, and bowhead whales in West Harrison Bay (WHB) in the Beaufort Sea, Alaska for a 1-year period from August 1, 2025, to July 31, 2026. Narwhal is committed to ensuring that compliance requirements under the Marine Mammal Protection Act (MMPA) and the Endangered Species Act (ESA) regarding the prohibition of take of marine mammals under the jurisdiction of the NMFS are met.

1.2 PURPOSE OF THE ACTION

Narwhal is an Alaska-based oil and gas exploration company and is the owner of State of Alaska oil and gas leases located in WHB. To explore WHB area leases, Narwhal proposes to conduct routine summer field studies, shallow hazard surveys (SHS) and exploratory drilling operations in WHB. The action area is shown in Figure 1-1. During the period of January 2026 through April 2026, Narwhal plans to drill and evaluate up to five exploration wells on WHB area leases. Narwhal is considering both a one-rig or two-rig drilling program; a single rig program is expected to allow a maximum of three wells to be drilled, whereas a two-rig program will enable drilling of up to five wells total.

Prior to drilling operations, preliminary field activities will be conducted in summer 2025; these activities are necessary to support project permitting, planning, and engineering for the proposed winter drilling program in 2026. Summer activities planned during August and September 2025 include marine SHS, freshwater source lake surveys, an archaeological survey, and gathering technical data to support project planning and engineering. Equipment may also be advance staged in the action area during August and September 2025 to support future winter operations. Progress of the summer program will be subject to weather conditions and may extend into October if necessary and open water conditions persist.

As part of the permitting program for this project, Narwhal intends to obtain an IHA for the nonlethal, incidental taking of small numbers of ringed and bearded seals and bowhead whales for the planned field activities in summer 2025 and winter 2025/2026. Narwhal also plans to sign a Conflict Avoidance Agreement (CAA) to avoid and minimize potential effects on the bowhead whale subsistence hunt. To the extent practicable, Narwhal plans to begin seismic surveys in the areas furthest offshore with the intention of completing seismic activities that are on the seaward boundary of WHB first. WHB and the seismic surveys areas are not within the bowhead whale migration corridor (waters >15 meters [m] deep further offshore).

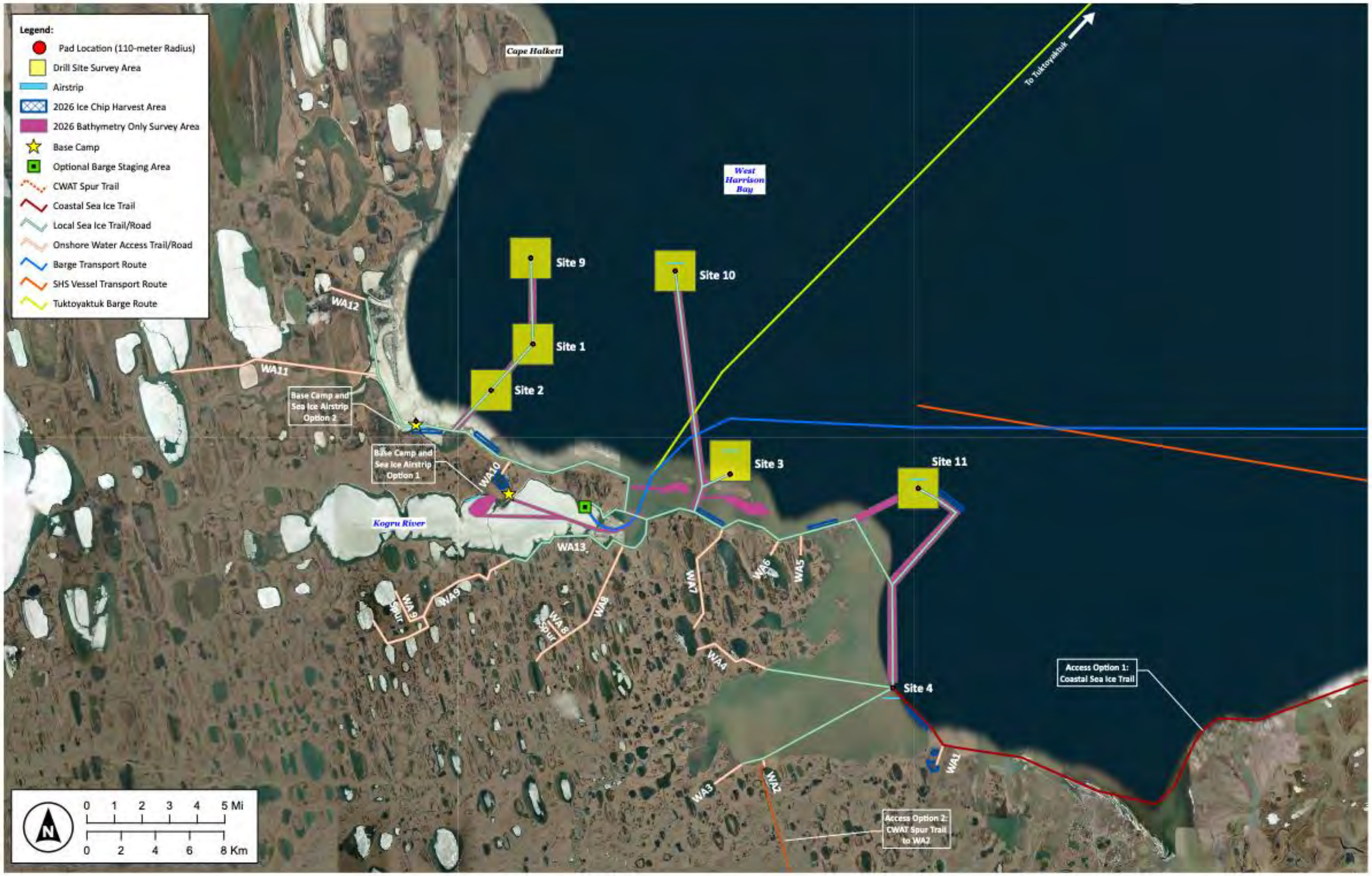
Figure 1-1 shows the action area in WHB for both the Summer 2025 survey work and the winter drilling activities expected during the period of January through April 2026. For the drilling program, a coastal sea ice trail (Option 1) or a spur to the CWAT trail (Option 2) is expected to enable access to the action area. Figure 1-2 shows the WHB operations area in more detail including the local infrastructure (temporary base camp, temporary airstrips, ice trails/roads, sea ice trail and preliminary drill site location areas). Specific locations for this infrastructure will be determined after summer surveys are completed in 2025. Table 1-1 shows the estimated timing, duration, equipment, and number of personnel for the project activities, and Figure 1-3 shows the Gantt chart for these activities. While Table 1-1 presents Narwhal's best estimate regarding the timing and duration of activities. Local conditions, logistics and other factors related to operations could result in changes to the proposed dates during project execution. The mobilization route (either Option 1 or 2) will be selected during the winter season based on actual weather, snow and ice conditions that year. During mobilization, all-terrain vehicles (ATVs) such as rolligons or steigers will transport equipment and materials to and from WHB.

Post-mobilization, ongoing logistics to support the exploration program will commence either via Option 1 or Option 2 as described above. While the coastal sea ice trail (Option 1) is preferred, should actual metocean conditions, safety concerns, or other operational concerns make the coastal sea ice trail impracticable, the CWAT spur (Option 2) will be used. The coastal sea ice trail will be constructed primarily on grounded sea ice. Logistics during the exploration program will be conducted by ATVs such as rolligons or steigers for transport to and from WHB. In the immediate vicinity of WHB, up to 172 km of local ice trails or roads will be constructed on sea ice and onshore tundra for access to the drilling locations and onshore freshwater sources.

FIGURE 1-1. NARWHAL ACTION AREA IN WEST HARRISON BAY, VESSEL ROUTE AND PROPOSED MOBILIZATION[1] OPTION 1 (COASTAL SEA ICE TRAIL) AND OPTION 2 (CWAT TO WA2)

[1] Narwhal will construct either Option 1 or Option 2 for mobilization.

FIGURE 1-2. WEST HARRISON BAY ACTION AREA



[1] Narwhal will construct only one Base Camp; two options are shown in this map as possible locations, one of which will be chosen prior to mobilization.

TABLE 1-1. ESTIMATED TIMING, DURATION, EQUIPMENT AND NUMBER OF PERSONNEL FOR PROJECT ACTIVITIES

Item	Activity	Estimated Timing	Estimated Duration (Days)	Estimated Equipment
1	Offshore SHS including high-resolution 3-dimensional (3D) seismic	1 Aug – 30 Sep 2025	45	Fathometer, side scan sonar, sub-bottom profiler, sparker, airgun and seafloor geophone array, vibracoring (if needed), up to 4 survey vessels
2	Offshore archaeological clearance	1 Aug – 15 Aug 2025	Concurrent with SHS above	Side scan sonar and sub-bottom profiler data from the SHS will be reviewed as part of the overall archaeological clearance process
3	Onshore archaeological clearance	1 Aug – 15 Aug 2025	Concurrent with lake surveys below	Helicopter
4	Onshore freshwater lake surveys, installation of thermistors in tundra along freshwater lake access routes	1 Aug – 15 Aug 2025, concurrent with onshore archaeological clearance above	10	Helicopter, drone, small boat, nets, fathometer
5a[1]	Optional advance staging of equipment and materials in WHB area on the existing Kogru airstrip (preferred option, subject to access)	15 Aug – 30 Sep 2025[2]	30	One tug and barge, excavator for setting tundra protection mats onshore, two trucks and two front-end loaders for offloading equipment
5b[1]	Optional advance staging of equipment and materials in WHB area on barges	15 Aug – 30 Sep 2025	30	Up to six empty barges, one camp barge vessel, one fuel barge, two tugs for transport of barges from Canada, one tug and barge for transport of equipment from West Dock Prudhoe Bay or Oliktok Point, two trucks and two front-end loaders for offloading equipment.
5c	Two personnel to monitor staged equipment with weekly helicopter support, subject to 5a or 5b	15 Sep – 30 Nov 2025	75	Self-contained small camp skid/trailer, generator, skiff, snowmachines, helicopter
6	Aerial infrared (AIR) surveys for polar bear dens	1 Dec – 15 Dec and 15 Dec 2025 – 10 Jan, 2026	2	Fixed-wing aircraft[3] equipped with infrared camera; pilots, observer, and camera operator

Item	Activity	Estimated Timing	Estimated Duration (Days)	Estimated Equipment
7a	Option 1: Coastal sea ice trail construction Oliktok Point to WHB, installation of safety shack at west side of Colville River Delta	1 Dec – 31 Dec 2025	30	15-person camp at Oliktok Point, rolligons, steigers, tuckers, sea ice pumpers
7b	Option 2: Spur to WA2 from existing Community Winter Access Trail (referred to as CWAT to WA2)	15 Dec 2025 – 15 Jan 2026	10	15-person camp at 2P pad along existing CWAT, rolligons, steigers, tuckers
8	Mobilization to WHB of additional camp facilities, ice construction equipment, consumables, and drilling rigs	1 Jan – 10 Feb 2026	41	Rolligons, steigers, estimate 12 units transporting freight
9	Local ice trail/road, airstrip and ice pad construction in WHB	5 Dec 2025 – 25 Mar 2026 if equipment is advance staged, otherwise 7 Jan – 30 Mar 2026	110	Ice construction equipment, front end loaders, motor grader, sea water pumpers, ice trimmer/chipper, tractor/trailers, fixed-wing aircraft[2]
10	Exploratory drilling	20 Jan – 15 Apr 2026	85	Logistical support equipment including camp, tractor/trailers, pickup trucks, rolligons, steigers, fixed-wing aircraft[3], drilling rig
11	Demobilization of remaining equipment (in success drilling case, some equipment may be stored at existing Kogru airstrip on gravel or anchored barges)	16 Apr – 5 May 2026	15	Rolligons and steigers to transport all equipment and materials back to Oliktok Point via the coastal sea ice trail or CWAT to WA2
12	Summer cleanup (stickpicking)	1 Jul – 15 Jul 2026	6[4]	Helicopter

Note: This schedule presents Narwhal's best estimate regarding the timing and duration of activities. Local conditions, logistics and other factors related to operations could result in changes to the proposed dates during project execution.

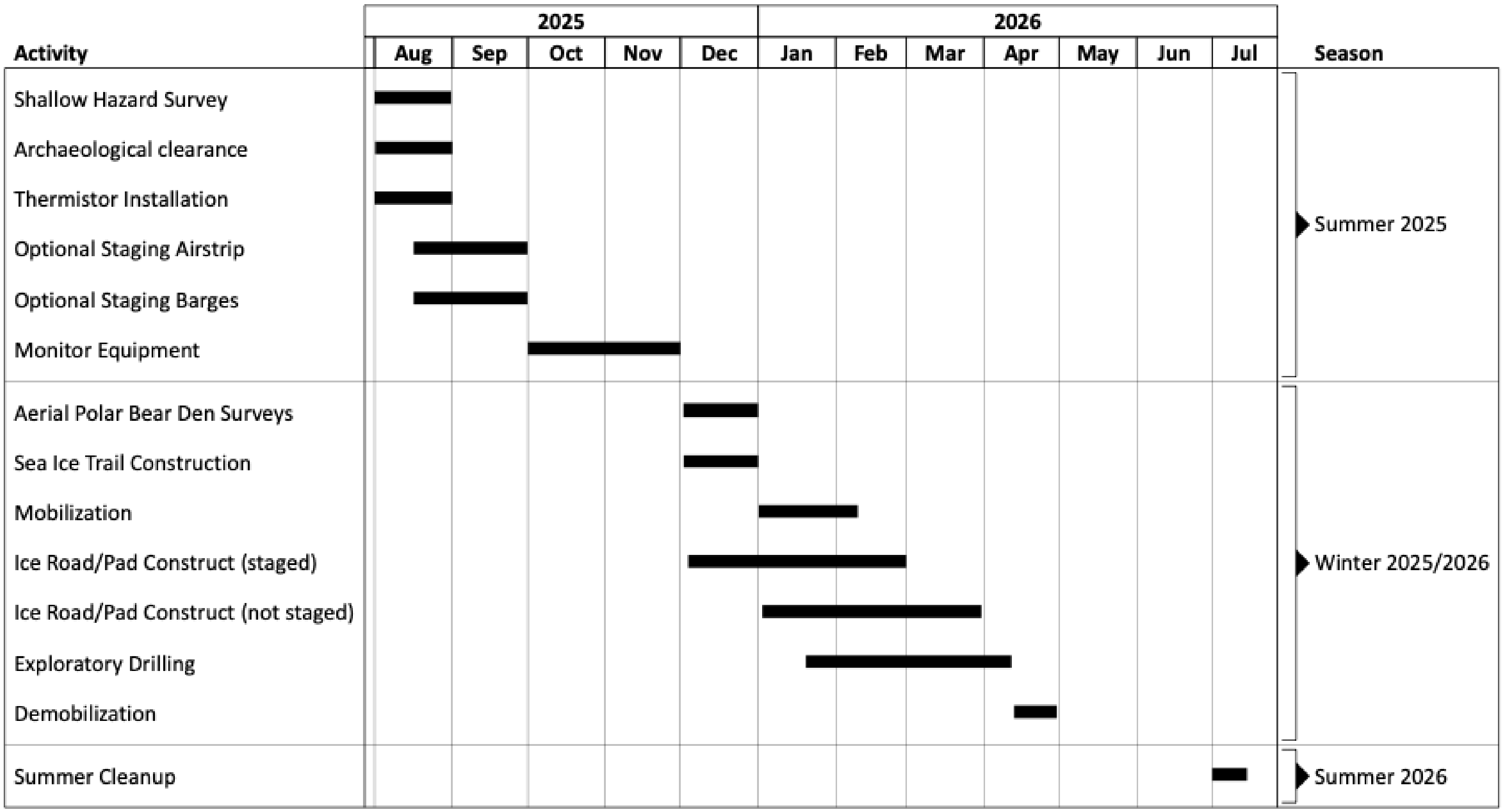
[1] Options 5a and 5b – if advance staging occurs, only one of these options (not both) will occur. See Section 1.3.1.5 for additional detail.

[2] Narwhal will coordinate closely with whaling communities to minimize disturbance during the whaling season through a CAA and by implementing a Plan of Cooperation (see Section 8).

[3] Fixed-wing aircraft used during winter operations may include Single Engine Otter on skis, Cessna 206/207, Cessna Grand Caravan, Piper Navajo, Helio Courier, DHC-6 Twin Otter, Beech King Air 200, Beech 1900, or similar.

[4] For summer stickpicking, 3-6 days are estimated if Option 2 CWAT to WA2 is constructed. If Option 1 is used for mobilization, only 3-5 days are required for stickpicking.

FIGURE 1-3. GANTT CHART SHOWING PROJECT ACTIVITIES



1.3 PROJECT DESCRIPTION AND EQUIPMENT

1.3.1 ACTIVITIES DURING SUMMER 2025 OPEN-WATER SEASON

1.3.1.1 Archaeological, Historical, and Cultural Resources Clearance

Federal, state, and local laws require protection of cultural and historical resources and consultation with Native communities prior to and during exploration and development activities. Cultural resources include both historic and prehistoric archaeological sites, historic structures, archaeological or historic districts, and traditional land use sites. In the case of remote, relatively unexplored areas like the North Slope, a reconnaissance-level archaeological survey prior to exploration or development to identify and protect existing and previously unknown cultural resources is typically required. “Clearance” is achieved through desktop studies and an in-person site visit(s) to identify potential historical or cultural resources to avoid during project activities. Both onshore and offshore areas in the vicinity of WHB will be surveyed for cultural and historical resources.

Onshore field archaeological surveys will be conducted in the area immediately south and west of WHB, where onshore ice trails/roads will be constructed to access freshwater source lakes. Aerial surveys will be flown by helicopter (i.e., a Bell 206L or similar type of helicopter) at an altitude of 457 m when safe to do so using a transect width of approximately 1.3 km. If necessary, landings are made to investigate landforms or settings that have characteristics that may contain cultural or historical resources. If such landforms are deemed likely to contain cultural resources, or if surface artifacts are found, shovel testing may be conducted to determine the presence of subsurface artifacts. Typically, one to three landings are made per day to investigate landforms or settings that have characteristics that may contain cultural or historical resources or to confirm the non-existence of such resources. Based on the size of the onshore area to be evaluated to the south of WHB and potential weather delays, approximately 3 days of aerial surveys are anticipated, with approximately one flight per day (approximately 3 hours per day). This activity must occur in the snow-free season, thus is planned for the first half of August 2025.

Offshore archaeological and historical surveys will assess routes planned for the coastal sea ice trail, trails/roads, and pads. Coastal areas of the project with shallow water less than 1.8 m in depth that is generally inaccessible by geophysical survey vessels will be surveyed during helicopter flights in conjunction with the onshore archaeological surveys discussed above. The helicopter will fly at an altitude of approximately 457 m above sea level to conduct these limited surveys in conjunction with onshore survey work over a period of approximately 10 days (see Table 1-1). Using side scan sonar during the SHS program described in Section 1.3.1, underwater areas will be surveyed as part of the archeological clearance process. Potential archaeological sites identified by these techniques may be further investigated by shallow draft vessel, as needed.

1.3.1.2 Onshore Freshwater Lake Surveys

Narwhal will investigate onshore lakes south of WHB for available freshwater to support ice trail or road and pad construction as well as use in camp and exploratory drilling. Larger lakes shown in Figure 1-4 are the most likely freshwater sources to be surveyed. These lakes have been preliminarily identified to have sufficient depth and volume to supply water for ice trail/road and pad construction.

Helicopters will be used to access water sources for collection of data on each selected lake. A zodiac type portable vessel or a water borne drone may be used to collect bathymetry data. Small nets will be placed in the water to assess fish presence and the crew will collect water quality data from each lake. Water volume calculations will be made from the bathymetric data, and water quality analysis will include total chlorides, pH, dissolved oxygen, turbidity, and other parameters to be determined.

FIGURE 1-4. ONSHORE ACCESS ROADS TO POTENTIAL FRESHWATER SOURCES

Lake surveys will be conducted during the first half of August 2025, with an estimated 10 days of survey time and one helicopter flight each day to the work area from Deadhorse. While in enroute to the lake survey area, the helicopter will fly at an altitude of 457 m above ground level (agl) or higher when safe to do so. As these surveys will be over land, no harassment of marine mammals under NMFS' jurisdiction is expected. For this reason, onshore freshwater surveys are not considered in the take estimate and not discussed further. Bathymetry data may also be collected by LIDAR techniques via a small battery powered multi rotor flying drone launched from land in the general vicinity of the lakes to be surveyed. LIDAR is a laser imaging system that can be used for bathymetric and topographical data collection. The drone may also be deployed from a nearshore WHB area vessel, depending upon the distance of the lakes from the WHB shoreline. Helicopters will still be necessary to access lakes for LIDAR surveys in the vicinity of WHB. Each option will include implementing specific measures to minimize potential harassment of polar bears (see Section 9).

1.3.1.3 Thermistor Installation

Thermistors may be installed along the tundra access routes from the sea ice to selected source water lakes to monitor soil temperatures during freeze up in October, November, and December of 2025. Thermistors may also be installed on the optional CWAT spur trail to the WA2 location to confirm freeze back of the tundra active layer and that conditions are acceptable for ATV tundra travel. A thermistor is a temperature sensor which exhibits a change in resistance that is proportional to a change in temperature. If needed, thermistors will be installed in the tundra to depths of 30 centimeters (cm) and thermistor locations will be recorded using a Global Positioning System (GPS). Data from the thermistors will be reviewed in December 2025 to confirm that soil temperatures are acceptable to support tundra travel using ATVs, such as rolligons or steigers, to access freshwater sources. The 12 onshore freshwater lake access routes are estimated to be approximately 57 km in total length, if all routes are used. However, the actual distance is likely much less given that the status of each lake as a water source is unknown at this time and more than 25 lakes have been identified as potential water sources. Narwhal will only construct access routes to the fewest number of lakes needed to supply freshwater for the project (see Figure 1-4). Onshore ice routes and thermistor installation will be on land and therefore, have no potential to affect marine mammals under NMFS jurisdiction and are not discussed further.

1.3.1.4 Shallow Hazard Surveys (SHS)

Alaska Oil and Gas Conservation Commission (AOGCC) regulations require that for an offshore exploration well, the subsea strata need to be evaluated by side scan sonar and seismic techniques from the seafloor surface to a depth of 610 m[1] below the seafloor. Narwhal's proposed SHS will use various geophysical methods and equipment to acquire graphic records of seafloor and sub-seafloor geologic conditions to satisfy this requirement. Beginning in August 2025, Narwhal proposes to conduct SHS during summer open water at up to six offshore locations. These investigations will enable the selection of any of these six sites for exploratory drilling in winter 2026 based on the most suitable seafloor and subsurface characteristics. Two additional sites (Sites 4 and 13) are located in 0.6 m of water depth or less and will be evaluated using alternative techniques approved by AOGCC (i.e., reprocessing existing data) rather than techniques used for deeper water. Of the eight potential drilling locations, Narwhal anticipates drilling no more than five wells during January to April 2026 with the other three sites serving as alternate drilling locations.

Data acquired using the techniques outlined in the following subsections will involve bathymetry, side scan sonar, sub-bottom profiling, high-resolution 3D seismic, and possibly vibracore sediment sampling. Data collected through these surveys will help define geologic, geotechnical and archeological conditions at each site and support the permitting, planning and engineering for the project.

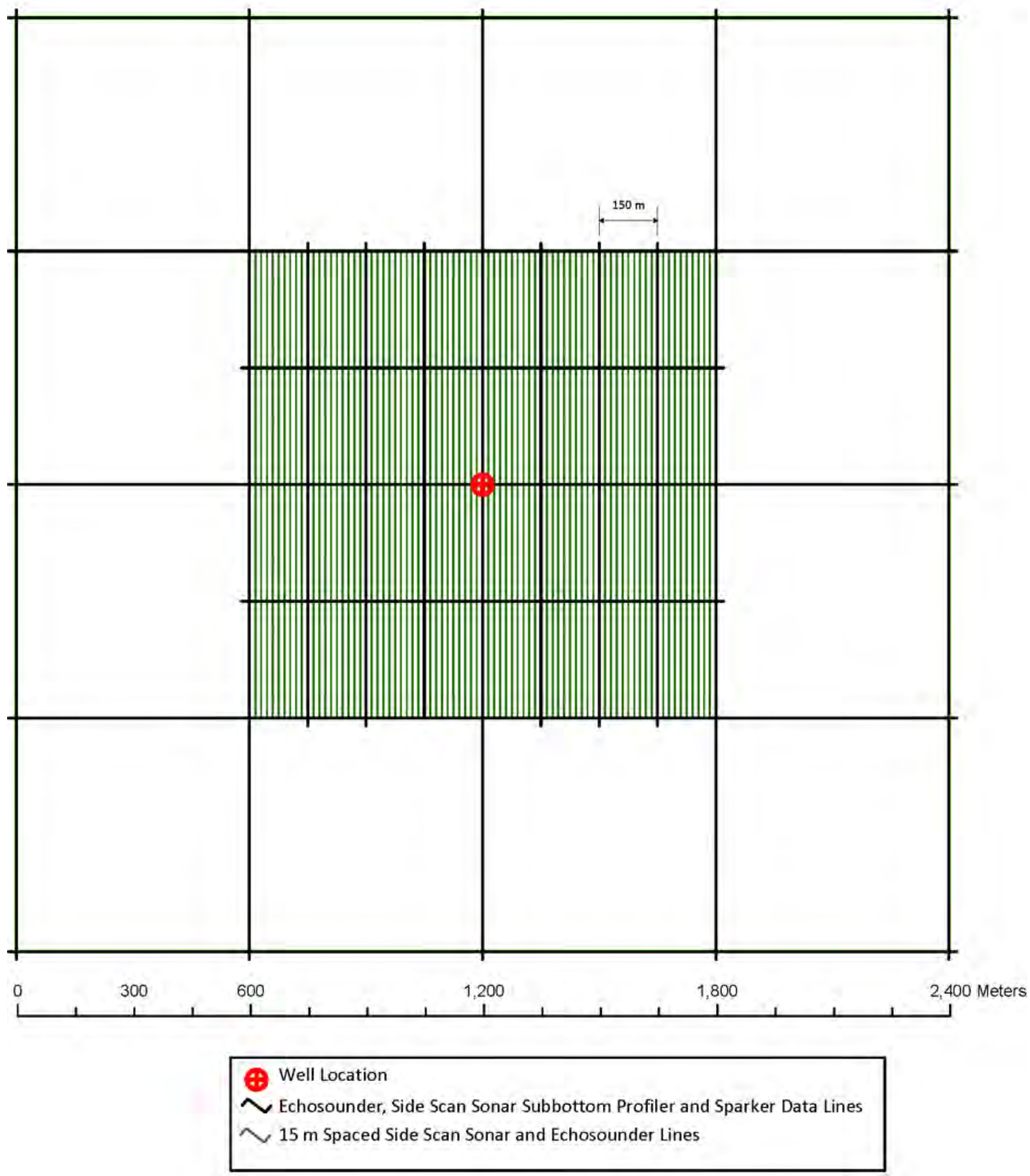
The SHS program will be mobilized by vessel(s) out of West Dock in Prudhoe Bay or from Oliktok Point. Periodic resupply, logistics support, and personnel transfers for SHS is planned to be from Oliktok Point. Figure 1-1 shows the anticipated mobilization and resupply routes for the SHS vessel(s). Narwhal estimates daily trips between Oliktok Point and the WHB work area will be required over a period of 45 days during SHS. The 3D seismic survey will require one vessel equipped with a single airgun, and one vessel responsible for deploying and retrieving geophones on the seafloor. The non-3D seismic SHS work

[1] AOGCC regulations specify a depth of 2,000 ft, which equals 610 m.

(bathymetry, sub-bottom profiler, side scan sonar, sparker) will be conducted from a single vessel. It is expected one to two additional vessels will support all on-water work, offering crew berthing, expediting, and resupply operations as needed. These support vessels may transit to Oliktok Point during the day if necessary to pick up supplies or transport personnel.

SHS of the six sites will occur in grids, as shown in Figure 1-5. Bathymetry and side scan sonar will be conducted within 2,400 m by 2,400 m grids with survey track lines spaced as close as 15 m apart. This grid pattern achieves 100 percent (%) overlap of side scan sonar coverage of the seafloor around the proposed well location. Through close coordination with AOGCC, the number or orientation of track lines required may be reduced to accommodate water depth limitations. Thus, this estimate represents the maximum number of track lines that are anticipated to be conducted per location.

FIGURE 1-5. SHS GRID



1.3.1.5 Geophysical Equipment for SHS

The types of geophysical equipment planned for use in the WHB SHS are listed in Table 1-2. The echosounder, side scan sonar, and sub-bottom profiler are included in the table; however, the use of these instruments will not result in harassment of marine mammals, as described below.

TABLE 1-2. MANUFACTURER INFORMATION FOR GEOPHYSICAL EQUIPMENT SIMILAR TO THAT PROPOSED FOR SHS

Equipment[1]	Example System	Depth of Imaging	Frequency Range[1]
Echosounder/Fathometer	Teledyne Single-beam Echotrac E-20	Seafloor surface	$\geq$200 kilohertz (kHz)
Side Scan Sonar	EdgeTech 4200 Side Scan	Seafloor surface	$\geq$200 kHz
Sub-bottom Profiler	EdgeTech 3400-OTS Sub-bottom Profiler (CHIRP)	4.5 to 76 square meters (m^2)	2 kHz to 16 kHz
Sparker	Applied Acoustics UHD Dura-Spark Sound Source	198 m	300 hertz (Hz) to 1,500 Hz
Sparker Receiver	Geometrics MicroEel Multichannel Hydrophone	198 m	N/A
3D Single Seismic Airgun	Sercel 105 cubic inch (cu. in.) Airgun	> 610 m	20 to 1,000 Hz
3D Seismic Receivers	Geospace GS-One Low-frequency Seafloor Embedded Geophones	> 610 m	N/A

[1] The equipment listed in this table are provided as examples and while specific models or brands may not be available, the type of equipment to be used will be similar in terms of the potential effects in the marine environment (i.e., sound produced). Please see Appendix A for types of equipment and frequency ranges. Frequency and depth ranges presented in this table are approximate and may not represent project-specific plans. Please refer to the project description for specific application of these or similar equipment.

[2] This represents the depth range for which this type of tool may be used. The depth at Narwhal's project site is an average of about 1-3 m.

[3] 610 m, as required by AOGCC.

1.3.1.6 Echosounder, Side Scan Sonar, and Sub-bottom Profiler

Echosounders, side scan sonars, and sub-bottom profilers are generally hull-mounted or towed behind a single vessel traveling at ~1.5 to 2.3 meters per second (m/s). As described in Ruppel *et al.* (2022), certain high-resolution geophysical are considered "Tier 4" sound sources, which are unlikely to result in take of marine mammals under the MMPA for the following reasons. Tier 4 sound sources may include equipment such as non-impulsive (non-seismic) high-resolution instruments and the lowest powered operations for certain impulsive sources such as sparkers or three-plate boomers. Tier 4 sources may operate using: 1) a narrow beam width such that the portion of the water column ensonified is quite small; 2) frequencies higher than 180 kHz (i.e., above marine mammal hearing ranges); 3) source levels less than 160 decibels (dB) referenced to 1 microPascal at 1 meter (re 1 µPa @ 1 m); or 4) in the case of some acoustic telemetry equipment, at source levels less than ~210 dB re 1 µPa @ 1 m (Ruppel *et al.* 2022). Based on these characteristics (i.e., narrow beam width, high-frequency above marine mammal hearing, and degree of exposure due to ping rate and duration of use), these types of sonar equipment are considered *de minimis* for potential acoustic harassment of marine mammals because no adverse effects on marine mammals are expected to occur.

Narwhal anticipates collecting bathymetric data using a single-beam echosounder due to the shallow water at each survey location. Bathymetric data will be used to create seafloor contour maps along offshore trail/road routes and pads, nearshore access locations, and areas that may be used for advance staging of equipment and materials, as shown in Figure 1-2. Side scan sonar and echosounder data will be collected along all track lines shown in Figure 1-5. The echosounder and side scan sonar will be operated at or above 200 kHz, which is outside the hearing range (>180 kHz) of marine mammals (Southall *et al.* 2019). The sub-bottom profiler proposed by Narwhal will be pointed vertically from the water surface into the water column along track lines spaced 600 m, 300 m, and 150 m apart (see Figure 1-5). As described in Crocker and Fratantonio (2016), sub-bottom profiling systems transmit an acoustic impulse at relatively low frequency. The sub-bottom profiler planned for use is considered a mobile, intermittent source. It utilizes a precisely controlled ‘‘chirp’’ system that emits high-energy sounds to profile the shallow sediments of the seafloor. While specific underwater sound source data are not available for the model of sub-bottom profiler included in Appendix A and Table 1-2, the source level for this instrument is estimated at 202 dB re 1 µPa at 1 m and has a beam width of 20 degrees (°).

Sparkers were categorized as “Tier 3” high-resolution geophysical sources in Ruppel *et al.* (2022), which stated that certain sparkers are also considered *de minimis*[2] in terms of the potential to affect marine mammals. On September 17, 2021, underwater sound pressure levels (SPLs) from two types of sub-bottom profilers (a sparker and a chirp system) were measured by Autonomous Multi-Channel Acoustic Recorders during a SHS program in Lower Cook Inlet (52°35.621’ N and 152°31.002’ W) (Lawrence *et al.* 2022). A Dura-Spark, similar to that proposed by Narwhal, was towed 30 m behind the vessel while an EdgeTech chirper was towed at a distance of 68.6 m behind the vessel; vessel speed was ~2 m/s. The sparker fired every 2 seconds, while the chirper fired 4 times per second. The estimated Level B 160 dB re 1 µPa threshold for the Dura-Spark was 85 m (best fit) (distance extrapolated from the closest measured range of 348 m). Distances to the Level A thresholds for the Dura-Spark were less than 10 m for all marine mammal hearing ranges, except for [very] high-frequency cetaceans,[3] which was estimated to be 25 m (best fit) (Lawrence *et al.* 2021).

Using the NMFS user tool[4] and the estimated source level of 226 dB re 1 µPa at 1 m (based on the manufacturer sound source level estimate shown in Appendix A) for the sub-bottom profiler (assuming a water depth of 3 m, frequency of 2 kHz and a beam width of 20°), underwater sound may extend ~0.5 m horizontally from the source to the Level B threshold of 160 dB (Guan 2020). At this distance, the effects of underwater sound from the sub-bottom profiler are considered negligible. Considering the information summarized in Ruppel *et al.* (2022) and given the estimated distance for the sub-bottom profiler proposed will be below the Level B threshold, incidental takes for marine mammals are not anticipated or requested for this equipment.

---

[2] Based on water depth, operational scenarios, and marine mammal mitigation measures implemented.

[3] High-frequency cetaceans (now referred to by NMFS as Very High Frequency [VHF]) are not expected to occur in the action area.

[4] https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance; Accessed August 25, 2022.

Vibracoring may be conducted to obtain shallow cores of the seafloor sediment from the surface. Sediment cores will be analyzed for load-bearing capacity, shear strength, grain size, and other parameters to be determined. The proposed mini vibracore sampler is a high-frequency, hand-held device of a with a three-position switch that allows immediate on/off controls (see example in Appendix A).

This smaller version of a vibracore sampler is designed for use in shallow water. To collect samples, an electric motor oscillates the core barrel into the sediment to extract a sediment core. Generally, the sound source (driving mechanism) operates for 1 to 2 minutes with the entire process requiring less than 1 hour. Chorney *et al*. (2011 in Reiser *et al.* (2010)) reported sound measurements during vibracoring in the Chukchi Sea, Alaska with a SPL of 187.4 dB re 1 µPa at 1 m and a frequency range of 10 Hz to 20 kHz.

If vibracoring is needed, it would be conducted at short intervals within the footprint of the exploratory drilling location. Following the rationale described in an IHA issued by NMFS for Cook Inlet oil and gas activities involving vibracoring (NMFS 2015), the very brief duration of this continuous, non-impulsive sound, combined with the small number of samples that may be needed by Narwhal for work in WHB, incidental takes of marine mammals due to the use of this tool are not expected because they are considered discountable; therefore, are not requested in this application.

1.3.1.7 High-Resolution 3D Seismic

Narwhal proposes to conduct a high-resolution 3D seismic survey at six[5] potential exploratory drilling locations utilizing a single 105-cu. in. towed airgun and geophone sound receivers. Approximately 480 geophones will be set by a support vessel according to the grid in Figure 1-6 (indicated by blue dots) and will be spaced at 50 m intervals along receiver lines. This pattern will be the same in each of the exploratory drilling locations where seismic is planned.[5] Geophones will be embedded in the seafloor by hand with a wood or aluminum planting pole to a maximum depth of 2 m. The insertion depth below the seafloor is generally anticipated to be less than 1 m and will be determined by the consistency of the sediments, which are expected to be primarily sand, silt and clay. The technique of placing the geophones in the seafloor sediments to a maximum depth of 2 m will minimize excessive feedback noise that typically occurs at these shallow depths if a traditional towed streamer is used. Figure 1-7 shows the geophone assembly including a geophone in the seafloor (2 m depth), anchor, cable, and surface recorder buoy.

The single 105 cu. in. airgun will be towed by the source vessel perpendicular to the receiver lines while a support vessel will deploy and retrieve the geophones from the seafloor. The airgun will be suspended in the water under a floating buoy as it is towed behind the source vessel and will be supplied with compressed air from a compressor located on the vessel deck. Figure 1-8 shows an example airgun with supply and control lines attached. The airgun will fire every 12.5 m along the red track lines identified in Figure 1-6. This will result in the airgun firing about once every 6 or 7 seconds while traveling at a speed of approximately 2 m/s. There will be approximately 125 m between track lines and a total of

[5] Given the shallow water depth at Sites 4 and 13, alternative techniques that do not produce underwater sound will used to evaluate the subsurface.

approximately 48 linear km surveyed using the airgun per site. The airgun will only be used while surveying the six exploratory drilling locations that have sufficient depth for the airgun.

The 3D seismic surveys will occur in a sequence. First, a support vessel will place all geophones along the receiver lines within a survey grid, which will take approximately 2 days. Once all geophones within a grid are placed, the source vessel, such as the R/V *Ukpik*, will tow the airgun along the red lines shown in Figure 1-6 over a period of one or two days for up to 12 hours per day. While the airgun vessel is surveying the initial grid, the geophone support vessel will be setting the next grid (i.e., exploratory drilling location). When the second grid is set, the source vessel will then begin surveying the second grid while the geophone support vessel returns to the first site to retrieve all geophones. Additional vessels in field may also retrieve geophones to expedite the overall process. This process will be repeated until the program is complete, which is anticipated to be a total of 30 days.

FIGURE 1-6. 3D SEISMIC SURVEY GRID

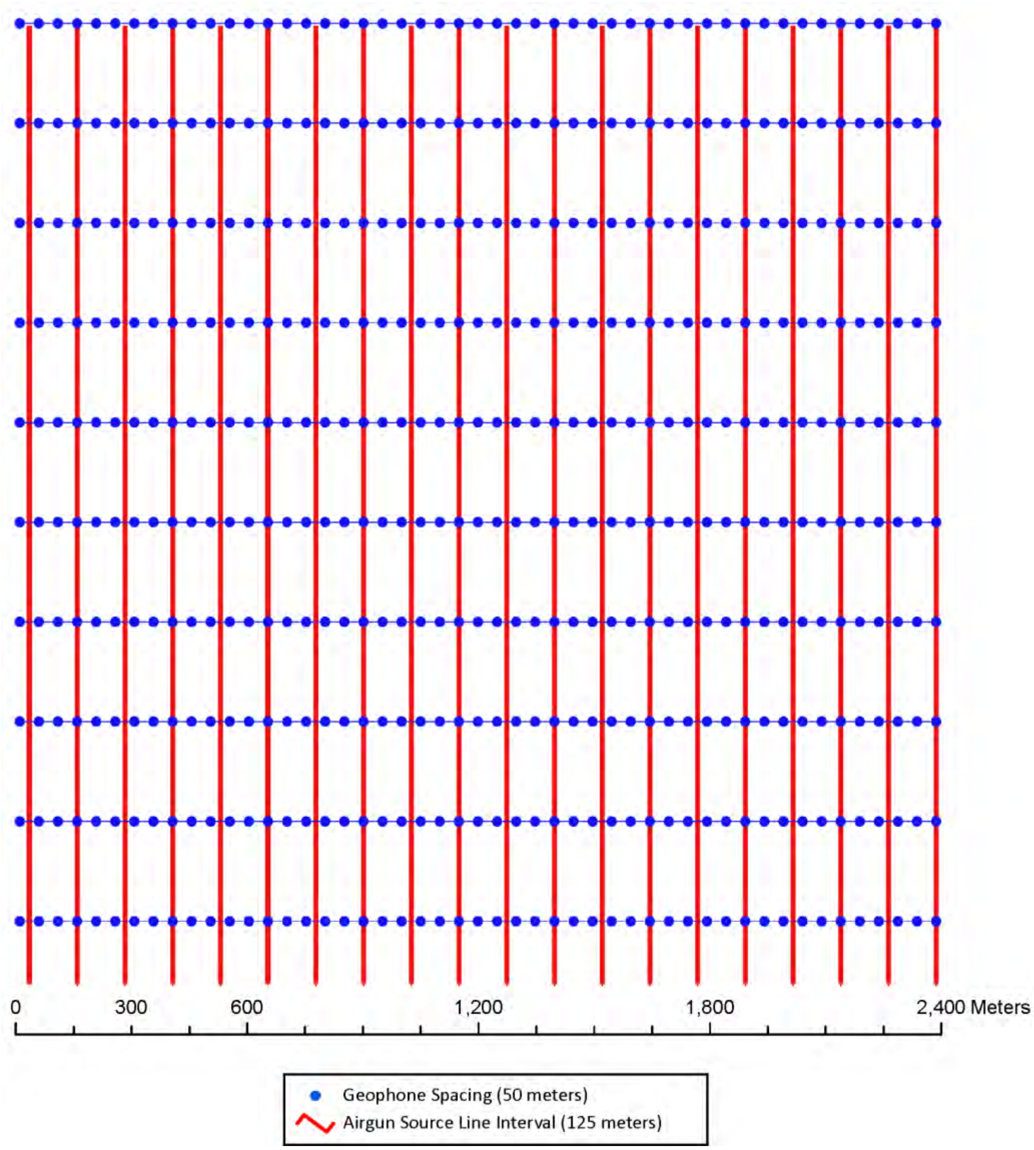


FIGURE 1-7. EXAMPLE SEISMIC GEOPHONE WITH SEAFLOOR ANCHOR AND BUOY ASSEMBLY

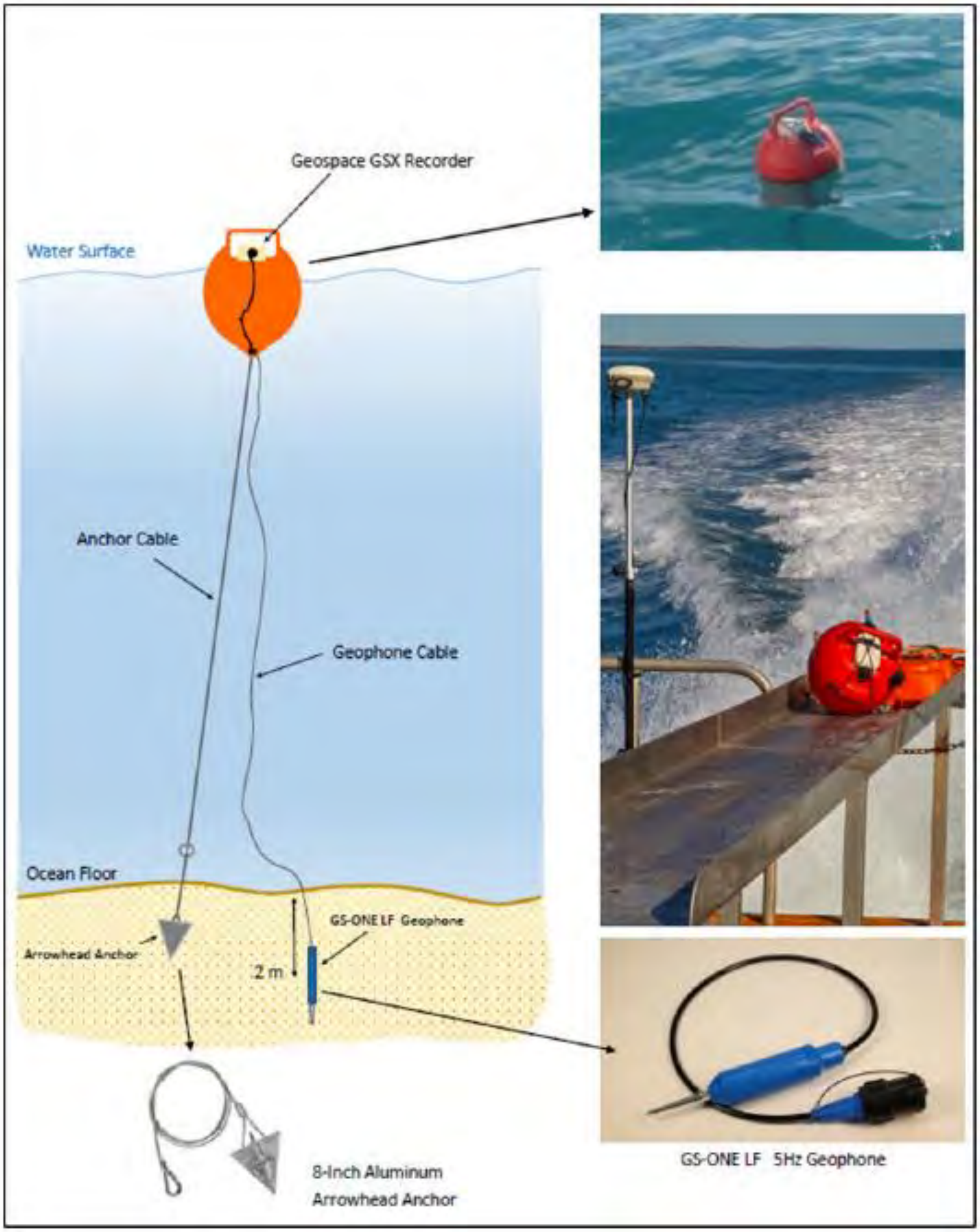


FIGURE 1-8. EXAMPLE SEISMIC AIRGUN WITH AIR SUPPLY AND CONTROL LINES

1.3.1.8 Survey Vessels

Narwhal intends to use existing North Slope-based vessels to support survey operations, whenever possible. As described in previous sections, up to four vessels may be used during the execution of the 3D seismic survey and non-3D SHS work. Such vessels may include the M/V *Wildcat*, R/V *Ukpik*, and the R/V *Annika Marie,* as shown in Appendix A. These are shallow draft vessels that are well suited to the action area in WHB and have capacity to berth the geophysical crews on site, which will minimize transit back and forth between Oliktok Point and WHB. Any vessels that are brought in to supplement the existing North Slope (Deadhorse/Prudhoe Bay) available fleet would be trucked to Deadhorse from other Alaska ports. Table 1-3 provides summary specifications for the three example vessels.

TABLE 1-3. SPECIFICATIONS FOR THE TYPES[1] OF VESSELS TO BE USED

Specification	M/V *Wildcat*	R/V *Ukpik*	R/V *Annika Marie*
Length (feet [ft])	39.0	50	43.0
Beam (ft)	14.6	16	15.0
Draft (ft)	1.5	4	3.5
Main Engines	Twin Cat C-9 diesel, 510 horsepower (hp) each	Twin Cummins 8.3L diesel, 450 hp each	Twin Cummins 5.9L diesel, 305 hp each
Fuel (gallons)	400.0	1,000	570
Freshwater	35.0	300	300
Berths	Variable	8	5
Certification	United States (U.S.) Coast Guard	U.S. Coast Guard	U.S. Coast Guard

[1] If these specific vessels are not available, vessels used will be similar in terms of size and power.

1.3.1.9 Optional Advance Equipment Staging

Narwhal may stage equipment in advance of winter activities to reduce the total number of ATV trips and time required for mobilizing project equipment to WHB via either the coastal sea ice trail (Option 1) or the CWAT to WA2 (Option 2). Advance staging allows expedited commencement of operations once sea ice conditions permit (potential commencement of exploratory drilling up to 4 weeks earlier) and offer lower safety and environmental exposure by significantly reducing the loads to be mobilized via sea ice trail or CWAT (removing 120 to 240 trips during mobilization). To stage equipment in advance of winter work, bathymetric data are required to assess potential locations for staging. Advance equipment staging would occur during mid-August and possibly through the end of the 2025 open water season to enable an early start of ice construction activities in early December 2025. Assuming an advance staging scenario, the first drilling location and associated local ice trails/roads and pads may be substantially complete by the time the sea ice trail from Oliktok Point is operational.

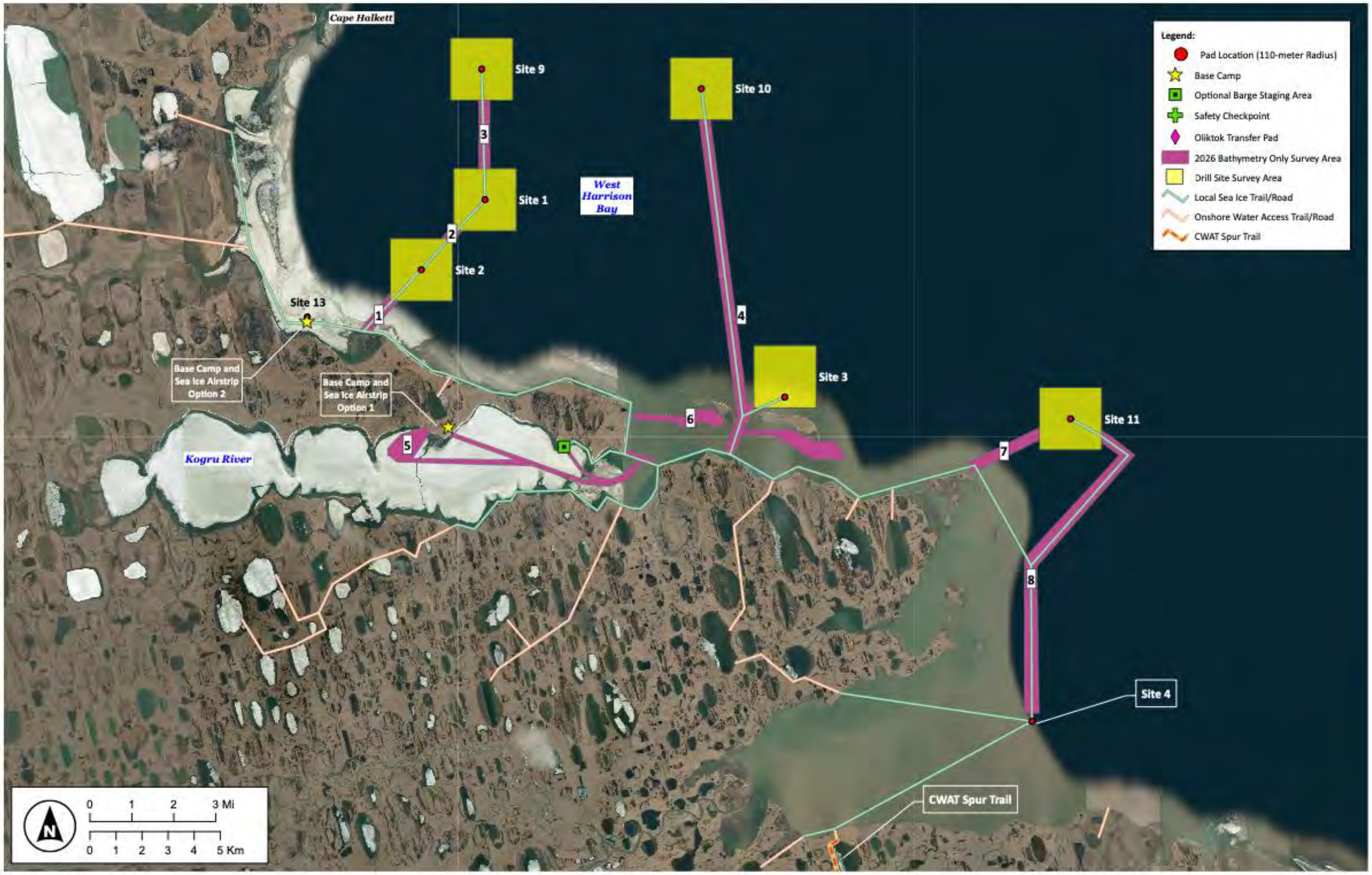
There are two options for advance staging sites. The first option involves utilizing the existing gravel Kogru airstrip (gravel option) indicated in Figure 1-9. If the Kogru airstrip is used, a series of interlocking tundra mats would be installed on the tundra in August or September 2025 between the shoreline and the airstrip to avoid the potential of damaging tundra (see Appendix A for an image of tundra mats frequently used on the North Slope for this purpose). Tundra mats then provide support for offloading materials from barges along shore up to the existing Kogru airstrip. Figure 1-9 shows the concept for staging of equipment and materials at the Kogru airstrip. This scenario is dependent on identifying sufficient water depth in the nearshore vicinity of the Kogru airstrip per the planned bathymetric surveys.

FIGURE 1-9. ADVANCE STAGING GRAVEL OPTION AT EXISTING KOGRU AIRSTRIP

The second option is to place up to eight to eight anchored barges (barge option) in a protected location within WHB. See Figure 1-10 for the potential transit route for barges originating in Tuktoyaktuk. Protected locations for the barge option have been identified in the Kogru River and on the south side of the Eskimo Islands, as shown in Figure 1-11, generally in shallow waters less than 1 m in depth. Collecting bathymetric data at these shallow locations will likely require a zodiac type inflatable vessel or skiff. Bathymetric data collection will not result in Level B harassment (see Section 1.3.1.5).

FIGURE 1-10. POTENTIAL BARGE ROUTE FROM TUKTOYAKTUK, CANADA

FIGURE 1-11. BATHYMETRIC SURVEY AREAS FOR POTENTIAL ADVANCE STAGING LOCATIONS AND ACCESS ROUTES



Up to eight empty barges (76 m x 15 m) and possibly a camp barge and fuel barge will be towed to the location from Canada. Barges will be anchored in a protected location in WHB and frozen in place during the fall of 2025. The barges will be maneuvered into a suitable beach by a tug and a temporary ramp would be set on the beach to enable offloading of a front-end loader onto the beach. The loader will set four to six anchors on the beach that will be connected to the barges by anchor lines to hold the barges fast to the shoreline. The barges will be tied to each other in a rectangle arrangement to provide a continuous staging surface for the placement of equipment and materials. An estimate of two to four anchors may also be placed in the water at the open-water end of the barges. These anchors will be set by lowering them into the water (estimate 1 m depth) and then connected to the moored barges to complete the mooring arrangement.

Due to the shallow water at potential staging locations (~1 m) and the method of slowly lowering anchors into the water from the barge, underwater sound during this activity is expected to be very low and will not expose marine mammals to sounds above regulatory thresholds (see Table 6-5). Final locations for placement of anchors on the beach and in open water will be subject to a mooring analysis that will ensure the barges are not moved off location by wind and ice movement during breakup.

The area selected for advanced staging will be chosen intentionally for relatively calm ocean conditions and shallow water; for this reason, when anchors are set in shallow water, the need for a tug to hold the barge against a tide or current is not expected. Considering that tugs would not be required to hold against significant tides or current, only two to four anchors are anticipated be placed in the water, and in light of the shallow depths at the potential locations that could be chosen for advance staging, setting an anchor would involve simply lowering each anchor to the seafloor. Data regarding underwater sounds from simply lowering an anchor are lacking but it is suspected it could be similar to setting a DASAR (sound recorder) on the seafloor. In addition, the potential advance staging sites would be against a shoreline, which would absorb much of any underwater sounds that could be emitted during the act of lowering an anchor. Lowering anchors in shallow water is not likely to result in underwater sound levels above NMFS thresholds for either Level A or Level B harassment.

It is unlikely that any significant damage will occur to the frozen in barges in WHB. Barges are annually frozen in at West Dock in Prudhoe Bay and the Mackenzie River in Canada, which is where the staging barges would originate. The advance staging barges that would be frozen in place in WHB would be demobilized to the Mackenzie River/Tuktoyaktuk in the latter half of July or early August, when ice conditions permit barge transport. Figure 1-12 shows the concept for advance staging of equipment and materials on anchored barges.

Approximately 100,000 gallons of fuel will be staged during this process and stored in a secure and self-contained facility. For the gravel option, this facility would consist of a lined containment area installed on the gravel airstrip with 6 or 7 400 bbl certified fuel tanks located inside the containment area. The barge option will have the containment area and tanks installed on the deck of a staging barge. Alternatively, fuel may be stored in a designated fuel barge that has interior double-wall tankage. The exact coastal location of the potential barge staging area will be determined during the summer bathymetry survey work. For both the gravel and barge equipment and fuel staging options, the facility would be monitored by on-site personnel during installation, loading, freeze up period, and active use.

FIGURE 1-12. ADVANCE STAGING OPTION ON ANCHORED BARGES

For either the gravel option or the barge option, equipment and materials will be transported to the chosen staging location by U.S. flagged tug and barge equipment from West Dock in Prudhoe Bay or Oliktok Point. It is estimated a total of 5 to 10 barge trips would be required to advance stage equipment. A two-person caretaker crew will remain on site during and after the staging period from September 15 through November 30, 2025 to monitor the equipment and fuel, patrol the area, and collect basic metocean data. The small skid camp will be equipped with a generator, kitchen, bunks, shower, waterless toilet, and heat. It will be located at the advance staging location so that the two monitoring personnel can easily access the equipment and tankage that they are required to look after. Greywater will be held in a holding tank for future disposal or discharged to the surface under the Alaska Pollutant Discharge Elimination System (APDES) General Permit. Food waste and trash will be kept indoors or in secure containers and removed by helicopter on a weekly basis. A skiff, snow machines, polar bear deterrence equipment, satellite phone or Starlink, and other emergency response equipment will be kept on site. One helicopter flight per week will provide support to the caretaker crew.

The advanced staging site will be monitored after December 1 by the startup crew that will conduct early development tasks for the project and prepare the equipment and materials for deployment to the first construction location. As the exploration drilling program commences, the advance staging location will be monitored as part of the active action area.

Neither of the advance staging options would result in disturbance of marine mammals either because it would occur on land or would consist of securing empty barges near shore by simply setting anchors in the shallow water less than ~1 m deep. The total estimated area used by the barges would be approximately 0.014 square kilometers (km^2). Given the small area to be occupied by the staged barges and shallow water depth, the effects of the barges is considered negligible to seals or their habitat, and is therefore, not considered in the take estimate.

1.3.2 ACTIVITIES DURING WINTER 2025 AND 2026

1.3.2.1 Coastal Sea Ice Trail Construction

The project leases are located within a remote area in WHB along the Beaufort Sea where there are no existing roads. Project equipment must be mobilized from the closest established gravel road infrastructure located at Oliktok Point.

There are two options for mobilization routes to access WHB. Option 1 is a coastal sea ice trail from Oliktok Point westward along the coastline. Option 2 involves constructing a 47-km snow trail on land between the existing Community Winter Access Trail (CWAT), to the coastline of WHB near Site 4 (referred from here forward as Option 2 CWAT to WA2). In 2019, the U.S. Bureau of Land Management (BLM) Arctic District Office, in cooperation with the State of Alaska and the North Slope Borough, authorized a right-of-way through National Petroleum Reserve-Alaska (NPR-A) for the CWAT; the permit was recently renewed for another five years[6].

Option 1 (coastal sea ice trail) is Narwhal's preferred option and is dependent upon weather and sea ice conditions, particularly across the Colville River Delta, and for this reason, the determination to use this option will be made by Narwhal during the early winter season prior to mobilization. Option 2 (CWAT to Site 4) is also subject to weather conditions and provides Narwhal with an alternate access route if conditions along the coast and the Colville River Delta are not suitable for ice travel during that time of year (i.e., early December). Narwhal aims to allow sufficient schedule time to conduct the exploration drilling operations while maintaining a safe operation.

A sea ice trail is:

> *An unimproved access corridor used by tracked vehicles designed to move on snow (i.e., Tuckers or PistenBullys® snow machines (i.e., ATVs), and similar tracked equipment or trucks. To construct the trail, snow machines and light-weight tracked vehicles are used to initially mark the corridor as soon as it is determined to be safe for access. Generally, snow removal or large surface modifications are not required for ice trails.* (NMFS 2020)

Under Option 1, construction of a coastal sea ice trail will begin as soon as there is stable grounded sea ice along the shoreline at Oliktok Point. The coastal trail will be approximately 10 m wide on average. Once sea ice conditions are suitable, Narwhal expects to install a small, 15- to 20-person camp on a 0.008-km^2 ice pad adjacent to Oliktok Point on grounded sea ice. This location will serve to receive freight from the existing gravel road infrastructure for subsequent transfer to WHB by ATV.

Once the Oliktok Point camp is installed, the crew will pioneer the first section of the sea ice trail southwesterly along the coast on grounded ice to the Colville River Delta (see Figure 1-1). The distance between Oliktok Point and the western extent of the Delta is 56.89 km. Initially, the coastal sea ice trail

[6] https://www.akbizmag.com/industry/transportation/cwat/; Accessed March 18, 2025.

may be smoothed during initial ATV passes with a trail conditioning device during setting of the trail and periodically thereafter. Three or four channels in the Delta will require ice thickening[7] to support heavy equipment transport. Initially, very lightweight equipment may be deployed by snowmachine to thicken the channels of the Colville River. This equipment would include centrifugal or auger pumps that can be installed manually in a hole in the ice to pump water to the ice surface. Pumps would be periodically repositioned along the route across the channel and once the ice is thick enough to support heavier pumping/auger equipment, which will be self-driven from Oliktok Point along the grounded sea ice trail, to complete thickening of the channel(s) sea ice to the prescribed thickness. Thickening of the Delta channels is anticipated to take up to 25 days.

To thicken the ice, seawater will be pumped to the surface and allowed to freeze in lifts until at least 0.9 m of ice thickness has been achieved to allow for medium weight equipment to be moved down the trail. Figure 1-13 shows a typical seawater pumping unit for ice thickening. An estimate of six pumping units will be mobilized to the Delta in six trips. Six trips per day are estimated between Oliktok Point and the western extent of the Delta, which will be necessary for fuel resupply, crew change, and technical support. At the completion of Delta channel flooding, this equipment will be mobilized to WHB once the trail route is finalized. Cracks on the coastal sea ice trail will be avoided by adjusting the trail route slightly, if possible. Otherwise, cracks will be bridged with rig mats and the mats will be frozen in place with freshwater.

After the Colville River Delta channels are thickened, the second section of the coastal sea ice trail (23.76 km) will be constructed over a period of 5 days. Construction of this second section of the sea ice trail will not require significant ice construction work and will consist of a two-person crew and two ATVs to scout the remaining trail and set the GPS points along the trail. The two-person crew will return to Oliktok Point after completing the trail to support mobilization of additional equipment to the WHB area. Total construction of the coastal sea ice trail is anticipated to occur over a period of 30 days.

[7] While ice thickening is typically an activity associated with more established sea ice roads, specific places along the Colville River Delta will require thickening as described herein.

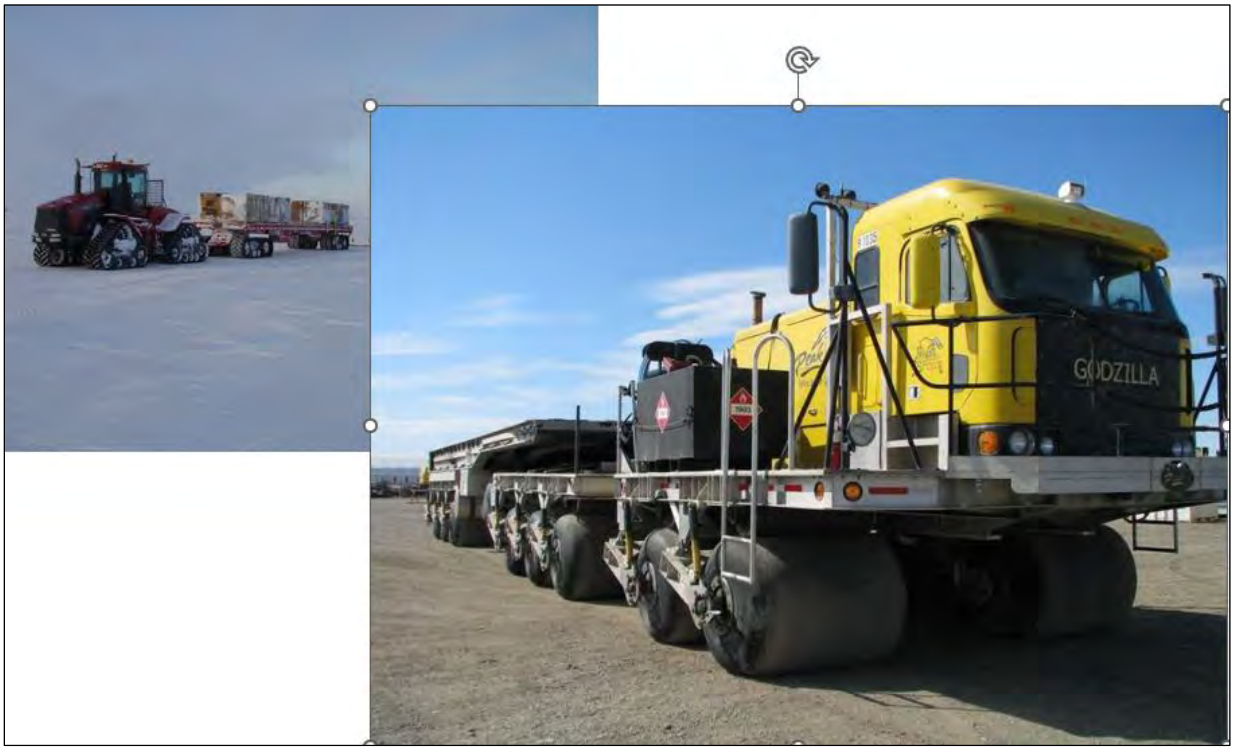
FIGURE 1-13. TYPICAL SEAWATER FLOODING UNIT FOR ICE THICKENING

Under Option 2 (CWAT to WA2), Narwhal will begin construction of the spur snow trail on land as shown in Figure 1-1. The CWAT from 2P pad to Narwhal's spur trail junction will be constructed by others. CWAT construction typically starts in December with pre-packing the trail using all-terrain vehicles. Narwhal would also be prepacking the trail from the CWAT northward to the coast during this time. Transit along the CWAT ranges from December or early January through April, as dictated by weather conditions that affect the condition of the route for travel. As soon as the CWAT is ready for travel, construction of Narwhal's CWAT to WA2 snow trail will continue (i.e., similar to CWAT construction) during late December or early January with ATVs preparing the route for transport of heavy equipment loads. The CWAT spur to WA2 trail will be constructed in segments and will be approximately 10-12 m wide. Construction of the CWAT to WA2 will require approximately 10 days. Once the route is complete the mobilization phase to WHB will commence.

1.3.2.2 Equipment Mobilization

All necessary equipment will be mobilized to the WHB area via the coastal sea ice trail (Option 1) or the CWAT to WA2 (Option 2) utilizing ATVs such as rolligons or steiger tractors. Other ATV equipment, such as Piston Bullys and Tucker Sno-Cats, may also be used. Figure 1-14 shows examples of rolligon and steiger ATV equipment on the North Slope. The order of priority will be to initially transport camp and ice construction equipment followed by equipment and materials needed for exploratory drilling once the initial ice pad(s) are complete. The ATVs will travel in groups of two or more for safety purposes and this practice will typically result in two to four groups of ATVs traveling the trail on a daily basis. Approximately 410 ATV trips are anticipated for mobilization in January and early February 2026 for a two-rig program. If advance staging of equipment and materials is conducted, as discussed in Section 1.3.1.9, total ATV trips on the coastal sea ice trail during mobilization will be reduced by approximately 120 or more trips. Advance equipment staging may also lead to an earlier start of activities on the westernmost sites. At the completion of mobilization (using either Option 1 or 2), it is anticipated that on average 10 ATV round trips will occur per day on the coastal sea ice trail during regular drilling operations for a two-rig program, as described in Section 1.3.2.5.

FIGURE 1-14. TYPICAL STEIGER AND ROLLIGON FOR HAULING EQUIPMENT AND SUPPLIES



1.3.2.3 Temporary Airstrips and Camp Facilities

Narwhal plans to construct a temporary airstrip on grounded sea ice to support personnel and priority cargo movement. Up to five sea ice airstrips may be constructed adjacent to the base camp and sites 4, 11, 3, and 10. The specific location for the sea ice airstrip associated with these sites will depend on summer 2025 bathymetry survey results. Figure 1-15 shows a typical layout for temporary sea ice airstrip adjacent to a base of operations center for both base camp options. Only one base camp sea ice airstrip will be constructed and used during operations.

Construction of the temporary airstrip will entail plowing snow off the sea ice to provide a smooth surface for aircraft and to install perimeter lighting for visual flight operations. For maintenance, the airstrip may be plowed, as necessary, with a motor grader to remove snow. A snow blower may also be used if large drifts occur; however, the airstrip will be sited to avoid drifted snow to the extent possible. Freshwater may also be periodically spread on the runway surface, as needed, to maintain a hard, smooth and safe surface for aircraft. Initially, aircraft equipped with skis (such as a single engine Otter) will likely be utilized until a freshwater cap can be placed on the airstrip to allow for landings by wheeled aircraft such as a Cessna 206/207, Cessna Grand Caravan, Piper Navajo, Helio Courier, DHC-6 Twin Otter, Beech King Air 200, Beech 1900 or similar aircraft. The airstrip is expected to be 23 m wide and 915 m long, and may be extended to 1,525 m in length if deemed necessary.

Aircraft will use the temporary airstrip(s) as early as December 6, 2025, through demobilization by mid-May 5, 2026. Helicopters are not anticipated to be used once the sea ice airstrip(s) is established. During ice construction and drilling, fixed-wing aircraft may be used over the period of approximately December 2025 through mid-April 2026. An estimated 170 flights may occur during this period. The sea ice airstrip may be in use until the mid-May (for demobilization). As the airstrips will be located on grounded sea ice or water depths less than 3 m, (ringed seals prefer sea ice where water depths are ~3 m or greater (NMFS 2022)), they are not expected to have an effect on ringed seals or their habitat, and therefore, are not considered further for potential takes.

The 2003 annual report (Annex 4.1) for Northstar discussed underwater sounds from a helicopter propagation of helicopter sounds underwater. Sounds from helicopters (i.e., Bell 212 helicopters) have been reported in several annual reports for Northstar. Aerts *et al.* (2008) reported that in deeper water (i.e., away from shore) sounds from helicopters are limited to the helicopter route, with tones from the Bell 212 helicopter ranging between 11 and 55 Hz. The 2011 Northstar comprehensive report for 2005–2010 reported that sounds from helicopters ranged between ~82–106 dB re 1 µPa (Richardson 2011). These underwater sound measurements from aircraft are below the Level B threshold of 160 dB for behavioral harassment. Narwhal proposes to use a Bell 206L helicopter (or similar model), which is smaller than the Bell 212 and therefore, produces less sound. Therefore, in-air sounds from the helicopter are not considered in the take estimate.

Regarding in-air noise from aircraft, Richardson *et al.* (1995) reported that fixed-wing propellered aircraft sounds were 75 to 90 dB and airborne sounds from helicopters were 60 to 70 dB. Robinson (2017) reported sounds from a Robinson R66 helicopter during an overflight at 150 m agl, 109 knots (202 km per hour) and maximum gross weight of 1,225 kg. Sound measured on the ground at this distance and speed was 84.5 dB re 20 µPa (A-weighted). Robinson (2017) also reported results from Federal Aviation Administration (FAA) testing of a typical helicopter takeoff and approach as 87.8 dB re 20 µPa (A-weighted). These sound levels are below the NMFS behavioral threshold for airborne pinniped disturbance (90 dB for harbor seals and 100 dB for all other pinnipeds) (NMFS 2023). Disturbance of seals due to airborne sounds from aircraft are expected to be below levels that could result in disturbance (i.e., less than 100 dB in air) and therefore, are not considered for takes in this application.

The initial winter startup operation in WHB will be to ready equipment to the first construction site followed by the assembly and start-up of the camp where modules approximately 3.7 m wide by 18 m long will be set side by side with a front-end loader. Internal and external utilities will be hooked up and the heating system started. The exact size for camps required at each location have not been determined but an estimated footprint is 100 m by 50 m. Depending on camp availability, supplemental sleeper units may be added to accommodate the required number of personnel within this footprint. Additional sea ice or pad area around camp will be utilized for staging equipment and materials, fuel storage and loading and receipt of freight. Sufficient space will be allotted to this area to maintain clear site lines for early detection of polar bears in the vicinity.

FIGURE 1-15. EXAMPLE OF TEMPORARY AIRSTRIP AND BASE CAMP ON SEA ICE

Note: Site 13 drill site is located adjacent to the base camp. Due to shallow water depths at this location, no seismic surveys will be conducted at this site.

1.3.2.4 Sea Ice Trail/Road and Pad Construction

Narwhal may elect to construct conventional sea ice roads in the project area to enable rolling stock to travel between locations. Sea ice roads are created by clearing and grading snow, then pumping seawater through drilled holes in the ice to achieve the desired ice thickness. Freshwater is often used to strengthen the top layer of ice on the road. As described in NMFS (2020), "ice roads are typically constructed with pumps and augers and may be maintained using equipment such as graders, snow blowers, or plows".

Alternatively, sea ice trails may be created and used by tracked vehicles, which do not require capping with fresh water. The final decision to construct sea ice trails versus sea ice roads will be determined by a number of factors including freshwater availability, the availability of ATV compatible equipment (e.g., skid mounted vac unit versus vac truck on wheels), project schedule (i.e., conventional ice roads require more time to construct), and other logistical considerations. Once equipment and supplies arrive via coastal sea ice trail or CWAT to WA2, local sea ice trails/roads and pads will be constructed to support exploratory drilling operations. Sea ice pads (one at each drill site) will be constructed using the same techniques as for sea ice roads, as described in more detail in the following pages (see Figure 1-19). An ice pad will be located within a maximum of five of the eight sites identified in Figure 1-2. Onshore ice trails/roads will be constructed on land to access freshwater lakes.

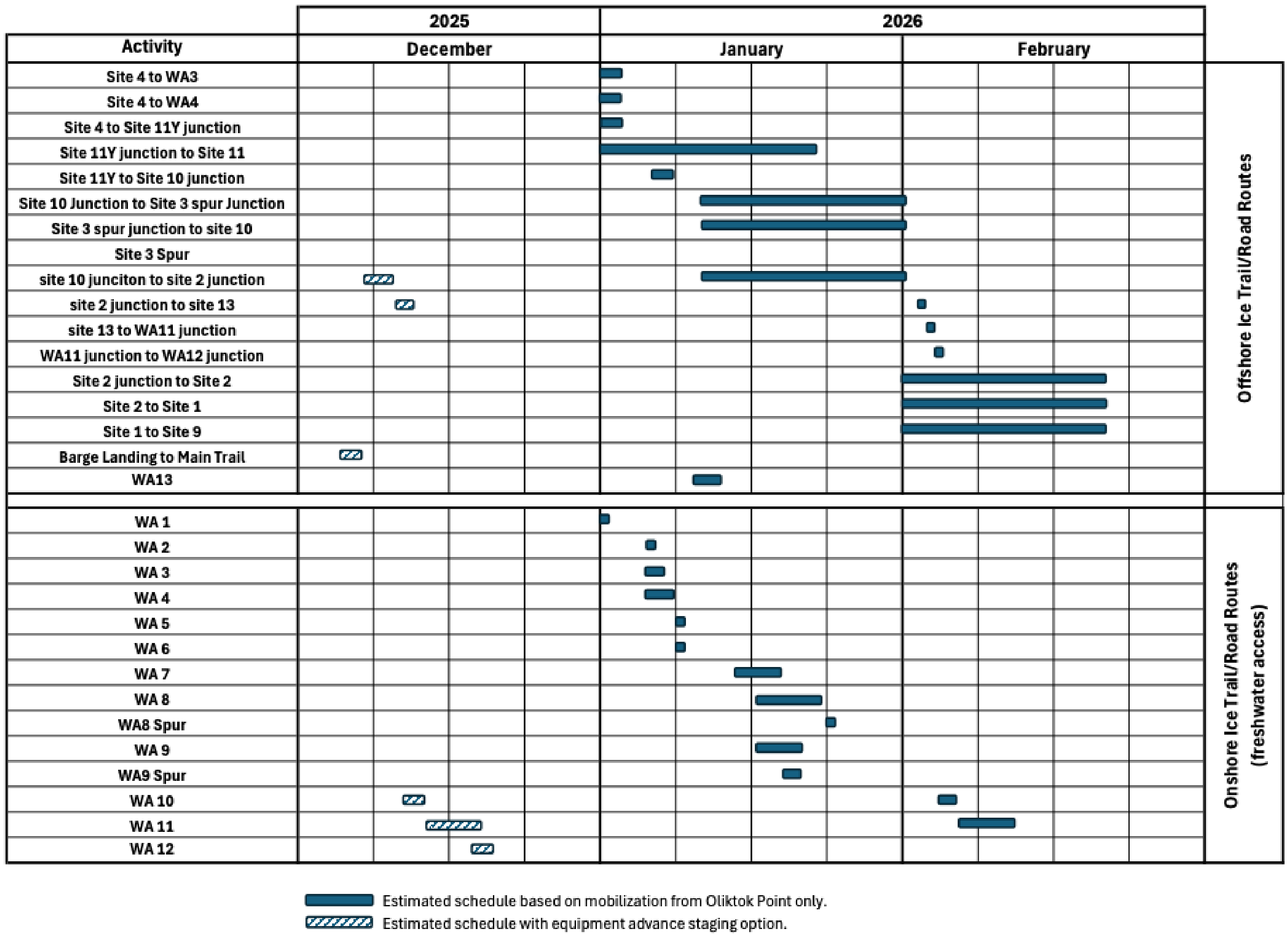
Table 1-4 summarizes the estimated lengths of each ice trail/road and timeframes for construction. Timing and actual dates of field operations are subject to weather and other factors. Whenever possible, sea ice trails/roads will be constructed on grounded ice to minimize the need for sea ice thickening and the potential to encounter ringed seal habitat defined in NMFS (2022). The six locations that will be surveyed using 3D seismic are within close proximity to shore (see Figures 1-1 and 1-2) where average water depths are less than 3 m. Therefore, the majority of sea ice trails/roads in WHB will be on grounded ice. All sea ice trail/road and pad construction will be initiated by March 1, 2026. Initial disturbance activities prior to March 1st will include staking and packing snow, flooding, grading and other construction activities permitted, as per the 2020 NMFS sea ice trail, road and pad final rule (NMFS 2020). Figure 1-16 shows the Gantt chart for these activities.

TABLE 1-4. OFFSHORE AND ONSHORE ICE TRAIL/ROAD TIMING AND DURATION

Offshore Sea Ice Trails/Roads	km	Construction Start	Construction End	Days
Site 4 to WA3	9.84	1-Jan-26	4-Jan-26	3
Site 4 to WA4	7.43	1-Jan-26	4-Jan-26	3
Site 4 to Site 11Y Junction	5.88	1-Jan-26	4-Jan-26	3
Site 11Y Junction to Site 11	8.26	1-Jan-26	22-Jan-26	21
Site 11Y to Site 10 Junction	26.45	5-Jan-26	8-Jan-26	3
Site 10 Junction to Site 3 Spur Junction	1.54	11-Jan-26	1-Feb-26	21
Site 3 Spur Junction to Site 10	12.67	11-Jan-26	1-Feb-26	21
Site 3 Spur	1.78	11-Jan-26	11-Jan-26	
Site 10 Junction to Site 2 Junction	14.73	11-Jan-26	1-Feb-26	21
Site 2 junction to Site 13	2.15	2-Feb-26	3-Feb-26	1
Site 13 to WA11 Junction	3.23	4-Feb-26	5-Feb-26	1
WA11 junction to WA12 Junction	4.48	6-Feb-26	7-Feb-26	1
Site 2 junction to Site 2	3.48	1-Feb-26	22-Feb-26	21
Site 2 to Site 1	3.64	1-Feb-26	22-Feb-26	21
Site 1 to Site 9	5.01	1-Feb-26	22-Feb-26	21
Barge Landing to Main Trail	3.06	5-Dec-25	7-Dec-25	2
WA13	10.51	12-Jan-26	15-Jan-26	3
Total Local Sea Ice Trails/Roads	**124.14**			**167**
Onshore Ice Trails/Roads	**km**	**Construction Start**	**Construction End**	**Days**
WA 1	1.13	1-Jan-26	2-Jan-26	1
WA 2	0.46	5-Jan-26	6-Jan-26	1
WA 3	2.01	5-Jan-26	7-Jan-26	2
WA 4	4.61	5-Jan-26	8-Jan-26	3
WA 5	1.19	9-Jan-26	10-Jan-26	1
WA 6	0.98	11-Jan-26	12-Jan-26	1
WA 7	6.58	13-Jan-26	18-Jan-26	5
WA 8	8.68	16-Jan-26	23-Jan-26	7
WA8 Spur	1.31	23-Jan-26	24-Jan-26	1
WA 9	11.57	16-Jan-26	21-Jan-26	5
WA9 Spur	2.78	19-Jan-26	21-Jan-26	2
WA 10	0.92	3-Feb-26	5-Feb-26	2
WA 11	12.22	6-Feb-26	12-Feb-26	6
WA 12	2.16	8-Feb-26	10-Feb-26	2
OPTION 2: CWAT to WA2[d]	47	15-Dec-25	15-Jan-26	10
Total onshore ice roads	**56.60**			**39**

Note: Timing and actual dates of field operations are subject to weather and other factors.
[a] WA – Water Access Ice Trail/Road; [b] WA 1 is located on sea ice along the southern shoreline of the Kogru River. [c] If advance staging does not occur, work may continue through March 25; however, the area will be disturbed prior to March 1st. [d]CWAT to WA2 is optional to the coastal sea ice trail; therefore, not included in the total.

FIGURE 1-16. SEA ICE TRAIL/ROAD AND ONSHORE ICE TRAIL/ROAD ACTIVITY GANTT CHART



Figures 1-17 and 1-18 show examples of ice trail/road and pad construction equipment and activities. Final WHB ice trail/road routes to exploratory drilling locations and onshore freshwater source lakes will be determined by through ongoing geological and geophysical analysis, the results of the SHS program, and the pre-clearance archaeological and freshwater lake surveys. Floating sections of sea ice will be thickened by flooding techniques shown in Figure 1-18 until the ice is grounded or at least 1.5 m to 1.8 m thick to enable transport of the heaviest loads anticipated during mobilization. For the seal ice trail/road layouts in WHB, the majority are expected to be grounded ice, however, there could be very few sections (if any) of sea ice routes that will be floating ice as water depth approaches a maximum 3 m. Otherwise, the majority of sea ice trails/roads in WHB are likely to be grounded ice. Ice chips or snow may also be added to the road surface and frozen in place with freshwater to expedite the thickening process. Any snow or ice chips will be collected from grounded sea ice areas or from freshwater lakes. After the ice trail/road is sufficiently grounded or thickened to the prescribed depth, a freshwater cap may be placed on the surface to provide a harder and more durable surface for rolling stock to travel on. In a typical year, natural sea ice growth in WHB generally reaches a maximum of approximately 1.8 m early to mid-April, which is anticipated to be the maximum ice trail or road thickness. The maintained ice trail/road width, including taper areas and shoulders where blown snow may be placed, is about 49 m.

Smoothing of sea ice road routes in WHB may be done by similar ATV techniques used on the coastal sea ice trail (Option 1) or using a motor grader on grounded ice trail/road sections that do not require flooding. Any ungrounded sea ice road sections that require flooding to thicken the road will generally be smoothed out by the flooding process and, in the case of ice road construction, a motor grader may be used when the road is near completion when it can support heavier equipment. A bulldozer, such as a D6 Cat, would only be used to breach any ice ridges present on the sea ice route. Ice ridges are not anticipated to be a significant issue in WHB, as the ice sheet is generally very smooth over most of the area with ice ridging occurring along the subsea feature of Pacific Shoal. Cracks on sea ice routes will be bridged with rig mats and the mats will be frozen in place. Re-routing of sea ice routes will be minimized, when possible.

Site 13 is adjacent to a favorable location for the base camp, which will only require very short distance travel between the base camp staging area and the Site 13 pad. For the remaining westernmost well locations at Sites 2, 1 and 9, vehicle trips on local ice trails/roads in WHB will be concentrated between the base camp and the active exploration well location(s) and it is estimated that 25 round trips will occur on a daily basis between the rig and base camp. Vehicles traveling on WHB ice roads may include rolling stock such as pickup trucks, a crew bus, heavy equipment (i.e., front end loader, motor grader, etc.) and tractor trailers. If sea ice trails are used instead of ice roads, vehicles may include low ground pressure vehicles such as steigers, rolligons, Piston Bullys, and Tuckers. Tracked vehicles may also be used on ice roads. If a well is being tested (i.e., as separate from drilling), there will be an additional estimated 20 round trips per day to the testing well. Well testing operations on a given well are anticipated to last approximately 15 days.

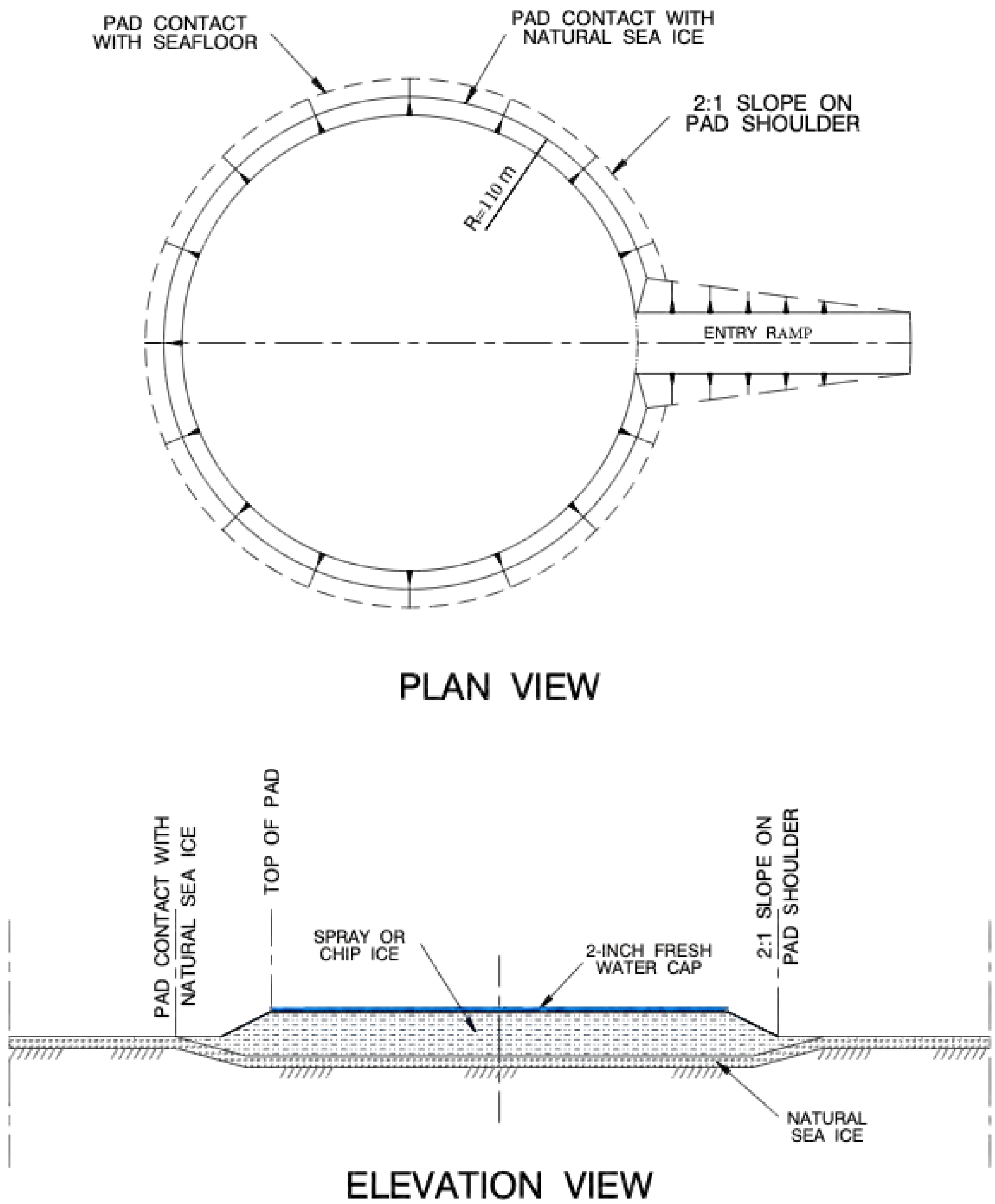
A total of five ice pads may be constructed using several techniques depending on the water depth at the pad location. Sea ice pads in shallow water (1 m or less) will be built by the flooding technique if the ice is not already grounded. Snow or ice chips may also be added with water to freeze the material in place. All ice pads will be grounded with additional freeboard above sea level to protect against ice movement during a storm event that may cause sea level rise and potential lateral movement from moving ice. Pads in deeper waters (up to 2.5 m water depth) may be constructed with the addition of spray ice techniques (see Figure 1-17) to rapidly build up the base level with sufficient freeboard to ensure the ice pad will not be moved during a storm event. Figure 1-18 shows an ice chipper for harvesting ice chips from areas of grounded ice.

FIGURE 1-17. SPRAY ICE CONSTRUCTION OF AN ICE PAD IN PROGRESS

FIGURE 1-18. SURFACE ICE CHIPPER FOR ICE CONSTRUCTION

When the desired pad elevation has been achieved, the surface will be smoothed with a bulldozer and motor grader, and a freshwater cap will be added to provide a durable work surface as is done for ice roads. The finished diameter of an ice pad is approximately 220 m. Ice pad construction will be concurrent trail/road construction and will take approximately 2-3 weeks depending on water depth and ambient temperatures. Figure 1-19 shows a typical ice pad layout.

FIGURE 1-19. EXAMPLE LAYOUT OF ICE PAD



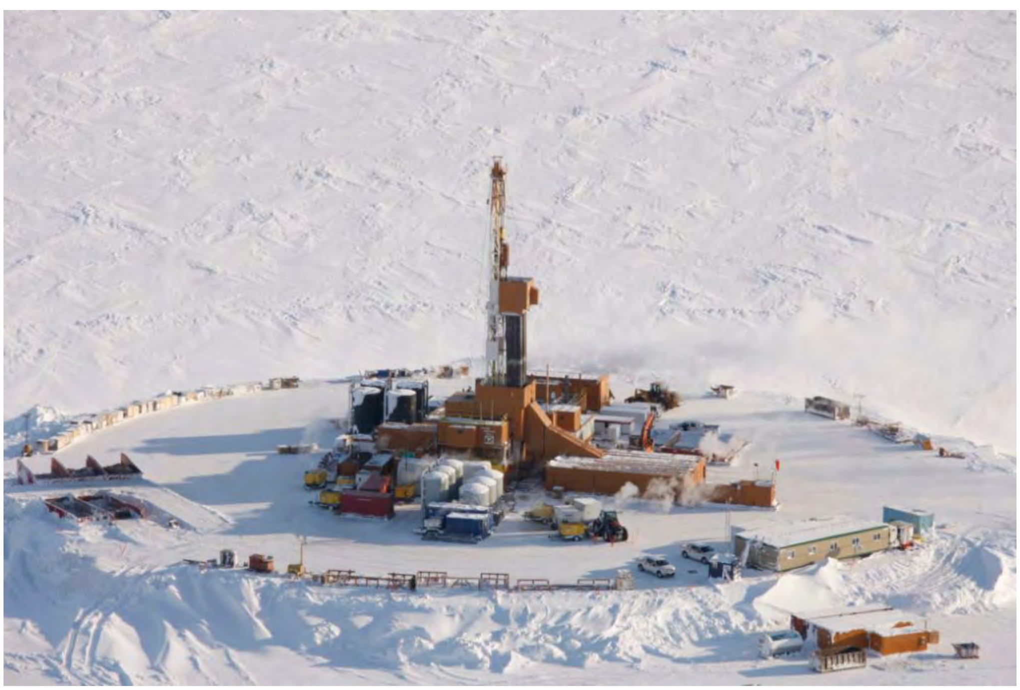
1.3.2.5 Winter 2026 Exploratory Drilling Operations

Upon completion of the sea ice trails/roads and pads for a specific location, the exploratory drilling rig(s) will be assembled on site over about 7 to 10 days. The preferred exploratory drilling rig for this type of activity is compact and highly transportable Arctic rated rig, similar to the Doyon Drilling Arctic Fox (see Figure 1-20). These rigs can be transported by ATV along the coastal sea ice route and have proven to be reliable for more than 15 years of exploration activity on the North Slope. Rigs of similar characteristics to the Arctic Fox exist from Nabors and Nordic, as well as others.

When all systems and crew are ready, exploratory drilling will commence and wells will be drilled to the program depth. Exploratory drilling is estimated to take 21 to 30 days per well including moving between sites via sea ice trail/road. Flow testing may be conducted on a well well if the analysis of well results indicate this information is beneficial.

Well testing is traditionally executed on a completed well with a test tree installed on the wellhead. The downhole well completion (for example perforated casing) and the test tree allow reservoir fluids to enter the wellbore and be flowed to surface in a fully controlled manner. As the fluids pass through the test tree, they will be directed via high-pressure piping through a choke manifold, line heater, and into a separator which will allow the surface separation of gas, liquids, and solids. Separated gas will be measured and flared with oil and water directed to storage tanks for measurement. Produced liquids will either be reinjected back into the well after testing is complete or backhauled to the Prudhoe Bay infrastructure for disposal. Testing operations including rig up and rig down of the test spread is anticipated to take 15 days. At the completion of testing operations, the well will be plugged and abandoned (P&A) in accordance with AOGCC regulations. All well operations, including P&A will be conducted within AOGCC regulations noted in Alaska Admin Code section 20 AAC 25.

FIGURE 1-20. DOYON ARCTIC FOX EXPLORATORY DRILLING RIG ON AN ICE PAD

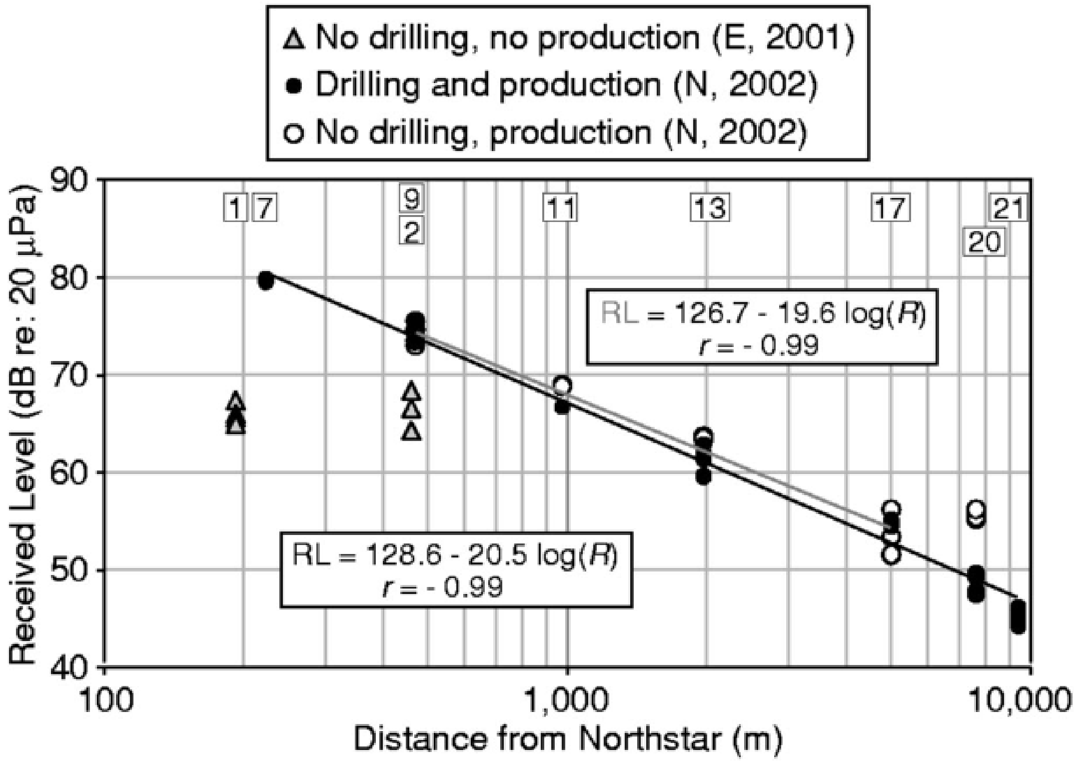


Operations will be conducted on a 24-hour basis with personnel working 12-hour shifts. Rig moves between wells are expected to take 5 days or less and will be done with conventional heavy haul trucks and trailers or ATVs. Each rig move is anticipated to require 60 trips from one drilling location to the next. Up to 86 drilling operation days, including time to move the rig, are estimated (see Section 2 and Appendix A). All drilled exploration wells will be P&A during the 2026 winter season. Regular resupply of consumables such as fuel, food, and spare parts, and backhaul of waste materials will be continuous during exploratory drilling operations between January 20 and April 16, 2026. During this 86-day period, an estimated average of 10 ATV trips per day will transit from Oliktok Point to the WHB area for daily resupply if supporting a two-rig program. For a one-rig program, approximately five ATV trips per day are anticipated for daily support. The ATVs will travel in groups of two or more for safety purposes resulting in an average of two to four groups of ATVs transiting the sea ice trail daily during this period. Each trip will likely take approximately 6 hours (i.e., 12 hours roundtrip within a 24-hour period).

Drilling sounds are expected to transmit poorly from the drill rig machinery through ice or soft substrate into the water (Richardson *et al.* 1995). Recordings of underwater sounds during drilling operations were recorded in late February and early March of 2001 and 2002 from Northstar Island, an artificial gravel island located approximately 125 km east of WHB in water 11.9 m deep. Underwater sound during drilling alone (i.e., without other production noises from the island) were reported in Blackwell *et al.* (2004a) as 114 dB re 1μPa at 250 m from the source during ice-covered conditions. The lowest level of underwater sound recorded during drilling alone was reported as 104 dB re 1μPa at 1 km, while background sound levels of 95 dB re 1μPa were reached 2 to 4 km from the source (Blackwell *et al.* 2004a). Considering none of these underwater sounds exceeded the NMFS Level B regulatory threshold for continuous sounds (120 dB) (see Section 6) at the reported distances close to the island, similar low-level underwater sounds are expected during short-term (i.e., 25 non-continuous days) exploratory drilling in WHB. For this reason, Level B harassment is not anticipated during exploratory drilling during winter in WHB and is not considered in the exposure estimate described in Section 6.

Airborne drilling sounds are also not expected to exceed the NMFS regulatory threshold of 100 dB re 20 1 μPa for pinnipeds that may occur in the action area during the ice-covered season. In the early winter-spring of 2001 and 2002, the levels, frequency characteristics, and range dependence of sounds and vibrations during industrial (i.e., mainly drilling and production) at Northstar were recorded (Blackwell *et al.* 2004a). The "drilling" category included only periods of time during which the drill bit was boring through subsurface formations. Airborne sounds (received broadband 10–10 000 Hz, unweighted) are shown in the Figure 1-2. Only recordings when wind speed was <5m/s were used to minimize contamination in the data. The highest (80 dB re 20 mPa) and lowest (44 dB re 20 mPa) broadband levels were recorded in 2002 at 220 m and 9.4 km, respectively (Figure 1-21). These sound levels are below the NMFS threshold for in air sounds (100 dB re 20 μPa), and are therefore, not considered in the take estimate.

FIGURE 1-21. AIRBORNE DRILLING SOUNDS RECORDED AT NORTHSTAR IN 2001 AND 2002



Source: (Blackwell *et al.* 2004a)

1.3.2.6 Project Demobilization

At the completion of drilling operations, all project equipment, materials, and personnel will be demobilized from the WHB operations area. Up to 400 ATV trips are anticipated to transport equipment and materials from WHB to Oliktok Point via the coastal sea ice trail if a two-rig program is completed. In some cases, equipment may be stored at the advance staging area over the summer period, rather than transported back to Oliktok Point. All demobilization activities will be complete by the end of April or early May 2026.

1.3.3 FUEL SUPPLY, HANDLING, AND STORAGE

As part of the overall project permitting process, Narwhal will develop a site-specific Spill Prevention Countermeasure Control (SPCC) plan for fueling and fuel storage operations associated with the project. The SPCC Plan will be submitted to the U.S. Environmental Protection Agency. In addition to the SPCC plan, Narwhal will hold an approved Oil Discharge Prevention and Control Plan (ODPCP) from the Alaska Department of Environmental Conservation (ADEC). Spill notification protocol and response tactics will be described and documented in the SPCC Plan and the ADEC approved ODPCP.

All fuel will be ultra-low sulfur for vehicles and equipment. During winter operations, long-haul sleigh tanks and fuel tanks mounted on ATV decks will be used for transporting fuel from Oliktok Point to WHB. Fuel will be delivered to a 100,000± gallon fuel depot near the base camp area, which will be set up in accordance with Alaska Department of Natural Resources and U.S. Bureau of Land Management (BLM) mitigation measures and regulatory requirements. In the event the supply is disrupted by weather or other unforeseen events, fuel may also be delivered by aircraft to the temporary airstrip if needed to continue or maintain critical infrastructure operations. Off-loading fuel from aircraft will also be done in accordance with established fuel transfer procedures that will be specifically developed for the project as part of the ADEC (18 Alaska Administrative Code [AAC] 75.425) and BSEE (30 CFR 254.50) approved oil spill contingency plans.

If advance staging of equipment is done in August and September of 2025, 100,000± gallons of fuel may be staged for the ice construction crew that will commence ice trail/road and pad construction activities directly in WHB as the coastal sea ice trail from Oliktok Point is constructed. This fuel will be stored in an engineered containment facility that will meet state and federal regulatory requirements for temporary fuel storage facilities.

Spill prevention procedures will include standard practices such as placing drip pans under parked vehicles and all hose or pipe connections to diesel fuel tanks. North Slope fuel tanks are double wall construction and dye is added to all fuel to enhance spill detection. All spills, no matter what the size, will be recorded and cleaned up, as required per 18 AAC 75.434.

Robertson *et al.* (2020) reviewed a dataset of 1,761 spills compiled from a range of sources of available records for the period 1971 - 2019. Only spills larger than 1 barrel and identified as associated with Alaska North Slope oil and gas exploration, development, or production infrastructure or activities were included in the review. Over the ~50-year period, only 17 spills were associated with exploration facilities for a total volume of 101 barrels, which is 0.3% of the total volume of reported spills over this time. Thus, the potential for significant spills from WHB exploration operations is very low and Narwhal's OSRP will address spill response for all operations, including the potential for loss of well control.

SHS operations may require refueling of vessels at West Dock or in WHB. Dockside fueling of vessels is supported by Alaska Clean Seas, as described in their tactics manual.[8] Refueling activities will follow established procedures, including deployment of a boom around the vessel and completion of a pre-fueling job checklist. Fuel will be transferred to the survey vessels from a standard North Slope fuel truck with trained personnel and designated spill prevention equipment and materials on site during vessel fueling operations.

For any ship-to-ship transfers, fuel will only be transferred from one vessel to another in protected calm waters with both vessels anchored and tied abreast to minimize the potential for any spillage. The vessels will also deploy a containment boom prior to fueling and maintain sufficient quantities of sorbent materials to recover any diesel fuel that could potentially be discharged to the water during fuel transfer operations.

---

[8] http://www.alaskacleanseas.org/wp-content/uploads/2016/03/Volume_1_Tactics_Descriptions.pdf; Accessed September 9, 2022.

1.3.4 WASTE MANAGEMENT

Narwhal will develop a comprehensive waste management program for the entire WHB exploration project that will cover food wastes, exploratory drilling waste, solid waste, and the disposal of any spilled hydrocarbon laden snow.

Management of on-site food and garbage will minimize wildlife attractants. Food waste generated by the field operations will be stored in vehicles or indoors until the end of the shift. Waste will then be consolidated at the camp in a central secure area in wildlife resistant containers for disposal by backhaul or incineration in a regulatory compliant incinerator.

Storage and handling of exploratory drilling waste for transport and disposal off site will be done in accordance with ADEC regulations (18 AAC 60.430). Narwhal will obtain a permit for temporary storage of exploratory drilling waste that will detail how these wastes are handled. Narwhal's preliminary plan is to have a dedicated ice pad where drilling wastes will be stored and frozen. The frozen waste will then be chipped and loaded into suitable bins or trucks for backhaul to Oliktok Point for disposal according to the requirements of the temporary storage permit. Narwhal also plans to recycle metals used throughout the project. These metals will be segregated on site for backhaul and recycling.

If any hydrocarbons are spilled on the sea ice or tundra, local operations will cease until the source of the spill has been isolated, an assessment of the spill has been made, and cleanup operations initiated. Recovered diesel-laden snow and other materials will be segregated and backhauled in secure containers to Oliktok Point for disposal in Deadhorse or Prudhoe Bay in compliance with ADEC regulations (8 AAC 75.325-390). All spills, regardless of size, will be reported to the appropriate agencies and tracked internally by Narwhal, as required under 18 AAC 300. Camp wastewater will be treated in a sanitary disposal unit that will discharge to the sea ice surface or land in accordance with the APDES General Permit AKG332000 regulatory requirements.

1.3.5 SUMMER CLEANUP

After the tundra is no longer covered by snow in early to mid-July 2026, Narwhal will use a helicopter to conduct cleanup (stickpicking) of the coastal sea ice route, CWAT to WA2 (if used) and freshwater access routes in the WHB vicinity to search for any visible project debris that may have been left behind. Any project debris that can be safely retrieved will be collected for disposal in Deadhorse. One helicopter will complete this work over a period of approximately 3 to 6 days, including possible weather delays. Stickpicking activities typically require about 6 hours per day of flight time with up to 20 total takeoffs and landings per day.

2 DATES, DURATION, AND SPECIFIC GEOGRAPHIC REGION

2.1 PROJECT DATES AND DURATION OF ACTIVITIES

The project schedule for Narwhal's SHS and exploratory drilling program is shown in Figure 2-1. The overall duration of project field activities will be approximately 12 months. Durations and the schedule for specific field activities are discussed in more detail below.

Field activities for freshwater lake and archaeological surveys will commence around August 1, 2025, after the snow cover and ice have melted on the tundra and lakes are clear of ice. These onshore activities have no potential to affect marine mammals under NMFS jurisdiction.

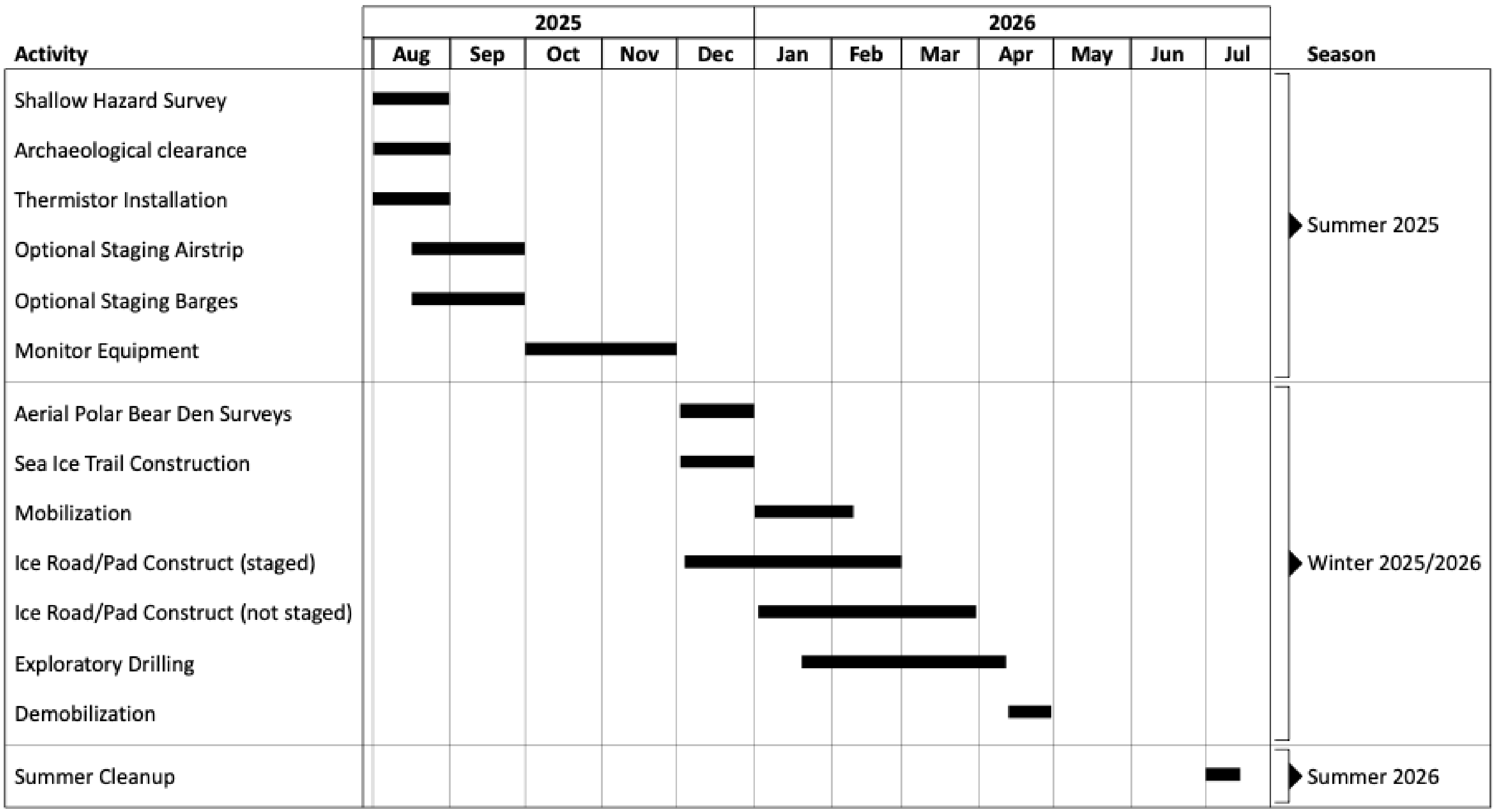
The SHS will commence around August 1, 2025 when open-water conditions are present in WHB and the vessel travel route between Oliktok Point and WHB is navigable (i.e., generally when sea ice is less than 4 tenths coverage). These conditions are typically anticipated by mid-July. SHS field work is estimated to require up to 45 days from approximately August 1 to September 15, 2025. Bathymetry, side scan sonar, sub-bottom profiling and sparker activities will require approximately 12-15 days and the 3D seismic survey will require approximately 30 days, pending weather conditions. Offshore archeological clearance will be concurrent with the side scan sonar activity.

The optional advance equipment staging activity, pending ice conditions, is planned to occur in late August through early October 2025. Narwhal will implement conflict avoidance mitigation measures for subsistence hunting in coordination with the Alaska Eskimo Whaling Commission (AEWC) and local Nuiqsut subsistence hunters.

Narwhal will conduct an initial AIR survey with a fixed-wing aircraft (e.g., de Havilland DHC-6 Twin Otter or similar aircraft) between December 1 and 15, 2025 to identify putative maternal polar bear dens along the coastal sea ice route and in the WHB action areas. The optional route if the CWAT spur may also be surveyed at this time. The routes for AIR survey are identified in Figure 1-1. A second AIR survey will be conducted between December 15, 2025 and January 10, 2026.

Access to the grounded sea ice at Oliktok Point is expected to be available on or about December 1, 2025, which will enable construction of the coastal sea ice trail under Option 1. Sea ice trail construction is anticipated to take up to 30 days in December 2025. If Option 2 (CWAT to WA2) is chosen for mobilization from Oliktok Point to WHB, construction of the spur will begin as soon as travel along the CWAT route is authorized (likely December). Once the mobilization route is complete (approximately December 2025 or early January 2026), all necessary equipment for ice trail/road, pad construction, and exploratory drilling operations will be mobilized to WHB and operations will commence.

FIGURE 2-1. NARWHAL PROJECT SCHEDULE



Approximately 410 trips will be made by ATV to transport equipment to WHB during the mobilization period of about 40 days for a two-rig exploration program, with half as many for a one-rig program. If advance staging of equipment is conducted as discussed above, the number of trips for mobilization activities will be reduced by approximately 120 trips.

Beginning as early as the first week in December 2025 or early January 2026, installation of the first temporary airstrip on grounded sea ice will enable routine and emergency fixed-wing air support. Crews will simultaneously begin constructing ice trails/roads on grounded sea ice, flooding the sea ice as needed to access the first drilling location and freshwater sources. This activity is anticipated to take 6 weeks or less, depending on weather conditions and the depth of water at the initial pad location. Sea ice construction activities are expected to occur as early as December 5, 2025 and continue through March 20, 2026.

Drilling operations will commence after equipment is mobilized and the first ice pad is complete (i.e., mid- to late January 2026). Exploratory drilling is expected to continue into mid-April 2026.

Demobilization of all equipment and personnel will commence after completion of exploratory drilling operations in mid-April and is anticipated to be complete by April 30 or early May 2026.

Summer cleanup (i.e., stickpicking) via helicopter will occur following the exploration program when the area is no longer covered by snow and ice, which is usually in early to mid-July. A helicopter will be used for summer cleanup, which is expected take up to 6 days, typically with 6 hours per day flight time and up to 20 total takeoffs and landings per day.

2.2 SPECIFIC GEOGRAPHIC REGION OF ACTIVITIES

Narwhal's proposed activities are located in WHB in the Beaufort Sea, Alaska (see Figure 1-1). A seasonal ice trail (i.e., coastal sea ice route) will extend approximately 80 km from Oliktok Point, west towards WHB. The coastal sea ice route will be located just offshore on grounded ice.

3 SPECIES AND NUMBERS OF MARINE MAMMALS IN THE ACTION AREA

Marine mammal species under NMFS' jurisdiction that may occur in or near WHB are shown in Table 3-1. Due to shallow water depths in Harrison Bay, cetacean species would not be expected to range into the bay and thus, are not expected to be encountered during project activities described in Section 1. However, bowhead whales found offshore outside of WHB could experience physical disturbance or be at risk (although the probability is very low) to vessel strikes during project vessel transit activity between Oliktok Point and the action area in WHB.

TABLE 3-1. MARINE MAMMAL SPECIES POTENTIALLY AFFECTED BY PROJECT ACTIVITIES

Species and Stock or DPS	Stock Abundance Estimate[1]	ESA Status[2]	MMPA Status[3]	Habitat	Occurs In or Offshore of WHB?
Bowhead Whale *Balaena mysticetus* Bering-Chukchi-Beaufort Stock[4]	15,227	E	D, S	Pack ice, open water coastal and offshore	Yes
Ringed Seal *Phoca hispida* Arctic Stock	342,836[5]	T	D, S	Landfast (but not bottom fast) and pack ice, open water	Yes
Spotted Seal *Phoca largha* Bering Stock	461,625	NL	NS	Pack ice, open water, coastal haulouts	Yes
Bearded Seal *Erignathus barbatus nauticus* Beringia Distinct Population Segment (DPS)	301,836[6]	T	D, S	Pack ice, open water	Yes

[1] Sources: Young *et al.* (2023), Young *et al.* (2024).
[2] E – Endangered, T – Threatened, NL – Not listed.
[3] D – Depleted, S – Strategic, NS – Not strategic
[4] Also known as the Western Arctic Stock (Young *et al.* 2023).
[5] Conn *et al.* (2014) calculated an abundance estimate of 171,418 using a subset of aerial survey data collected in 2012 by Moreland *et al.* (2013) that covered the entire ice-covered portions of the Bering Sea. This estimate for Bering Sea ringed seals is considered to be low by a factor of two or more because availability bias due to seals in the water at the time of the surveys was not accounted for and the estimate did not include ringed seals in the shorefast ice zone (Young et al. 2023). Therefore, abundance has been multiplied by a factor of two (i.e., 342,836 animals).
[6] U.S. portion of the Bering Sea only.

3.1 CETACEANS

Bowhead whales may be encountered by project vessels offshore outside WHB; this species is carried forward for analysis and is described in detail in Section 4. While beluga whales are occasionally encountered in the Beaufort Sea, they are distributed generally at or beyond the continental shelf break and outside of typical areas of vessel activity (Ireland *et al.* 2016); the main migratory corridor for both beluga whales and bowhead whales is far offshore of the proposed survey locations. Therefore, project vessels are not expected to encounter beluga whales and they are not discussed further.

Gray whales and harbor porpoise are found in the eastern Chukchi Sea but rarely range east of Point Barrow. While gray whales are frequently present near Point Barrow, historically only a few gray whales have been sighted farther to the east (Ireland *et al.* 2016, Moore 2000, Rugh and Fraker 1981). Point Barrow is approximately 200 km west of WHB where project activities will occur. In addition, Point Barrow is likely the northeastern extent of the regular range of the Bering Sea stock of harbor porpoises (Suydam and George 1992 as cited in (Ireland *et al.* 2016)). Only two sightings of harbor porpoises were recorded during industry-sponsored aerial surveys in both 2007 and 2008 (Ireland *et al.* 2016). These sightings were observed between Harrison Bay east to Camden Bay in mid- to late September.

Due to the paucity of sightings of these species east of Point Barrow, gray whales and harbor porpoise are not expected to interact with project vessels operating in WHB and to the east of Harrison Bay. Therefore, gray whales and harbor porpoise are not discussed further. NMFS-managed species that are found in the Chukchi Sea but are considered to be extralimital to the Beaufort Sea offshore of WHB include fin whales, humpback whales, minke whales, and killer whales. These species have no potential to be affected by project activities and are not discussed further.

3.2 PINNIPEDS

Ringed, spotted, and bearded seals are present in the Beaufort Sea year-round. As shown in Table 3-1, these species may be encountered within Harrison Bay, and are carried forward for analysis. Detailed descriptions are provided in Section 4.

Ribbon seals are found in the southern Bering Sea during late winter and early spring and may move into the southern Chukchi Sea during summer and fall, but sightings in this area are infrequent (Ireland *et al.* 2016). Ribbon seals are not expected to be encountered in the vicinity of Harrison Bay and are not discussed further.

4 AFFECTED SPECIES STATUS AND DISTRIBUTION

4.1 RINGED SEALS

Abundance and Status

The Arctic ringed seal subspecies was listed as threatened under the ESA in 2012 (77 Federal Register [FR] 76706). Of primary concern for this population is the anticipated continued loss of sea ice and snow cover due to climate change effects. This habitat loss poses a sizeable threat to the persistence of the stock (Young *et al.* 2023). Because of its threatened status under the ESA, this stock is designated as depleted under the MMPA and is also classified as a strategic stock. Survey methods have been developed and applied to substantial portions of the range of ringed seals in U.S. waters but efforts to date have not produced a reliable population estimate for the entire Arctic stock (Young *et al.* 2023).

Reliable abundance estimates are not yet available for the Chukchi and Beaufort seas. However, Conn *et al.* (2014) calculated an abundance estimate of 171,418 using a subset of aerial survey data collected in 2012 by (Moreland *et al.* 2013) that covered the entire ice-covered portions of the Bering Sea. This estimate for Bering Sea ringed seals is considered to be low by a factor of two or more because availability bias due to seals in the water at the time of the surveys was not accounted for and the estimate did not include ringed seals in the shorefast ice zone (Young *et al.* 2023). For this reason, abundance of has been multiplied by a factor of two for this analysis (i.e., 342,836 animals). Reliable data on trends in population abundance for the U.S. Arctic stock of ringed seals are not available. Potential biological removal (PBR) for the U.S. portion of the Arctic stock of ringed seals is estimated to be 4,755 (Young *et al.* 2023).

Distribution

Ringed seals are distributed in all seasonally ice-covered seas of the Northern Hemisphere (Lang *et al.* 2021, Muto *et al.* 2020). Five subspecies of ringed seals are currently recognized, with only the Arctic stock (*Phoca hispida hispida)* occurring in U.S. waters of the Arctic Ocean and Bering Sea (Rice and Society for Marine Mammalogy 1998). They are year-round residents of the Chukchi and Beaufort seas and are generally the most encountered seal in the U.S. Arctic. While other ice seals, such as spotted and bearded seals, may be present in the Beaufort Sea during the open-water season, only ringed seals are expected to be in the nearshore environment during the ice-covered months.

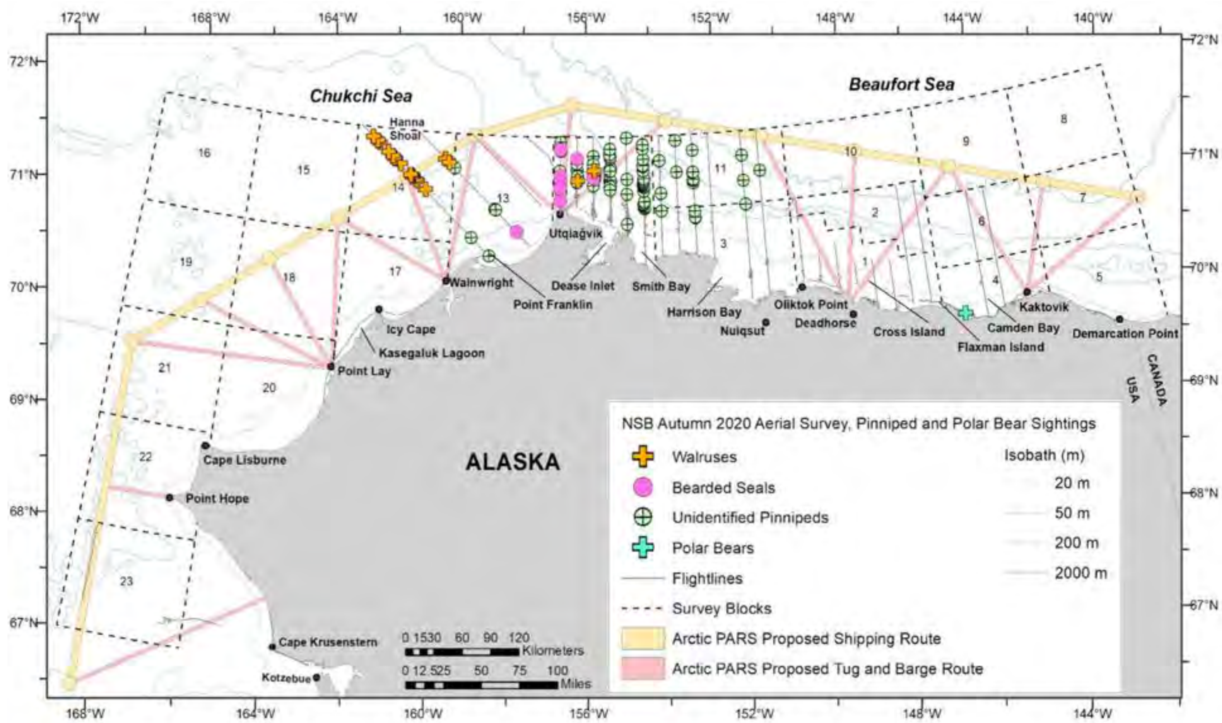
Ringed seals are abundant in the winter and spring on shorefast and pack ice in the northern Bering Sea, Norton Sound, Kotzebue Sound, Chukchi Sea, and Beaufort Sea, where they utilize sea ice for pupping and nursing, as well as resting. Landfast ice has been shown to be the best habitat for ring seal pupping (Kelly 1988). Moulton *et al.* (2002) found the highest concentrations of ringed seals on stable, shorefast ice over water depths of about 10–20 m in late May and early June; waters less than 5 m deep are not preferred wintering areas for ringed seals (Frost *et al.* 2004, Moulton *et al.* 2002). In the summer months, they use sea ice as a platform for molting and resting, although ringed seals can remain pelagic in productive foraging areas for long periods of time. In the fall, ringed seals utilize sea ice as a platform for resting, and rarely haulout in terrestrial habitats.

Ringed seals have been observed in Harrison Bay and in waters adjacent to Oliktok Point at low densities (Brandon *et al.* 2011; Green and Negri 2005, 2006; Green *et al.* 2007; all as cited in (BLM 2020), and

Hauser *et al.* (2008). In 2021, the NMFS Alaska Fisheries Science Center conducted aerial surveys for seals and polar bears in the Beaufort Sea.[9] Results from the 2021 aerial surveys are not yet available on the NMFS website.

Ringed seals were the most common pinniped observed during marine mammal monitoring for installation of an offshore fiber optic cable in the Beaufort and Chukchi seas; 57 groups (77 individuals) were recorded (Green *et al.* 2018). All but three of the seals were recorded during operations offshore of Oliktok Point. Four of the ringed seals were identified as juveniles. Figure 4-1 depicts pinnipeds sightings during autumn aerial surveys in 2020. As shown in the figure, pinnipeds are more frequently observed farther offshore, several kilometers from the action area.

FIGURE 4-1. PINNIPEDS OBSERVED DURING 2020 ASAMM AERIAL SURVEYS



Source: Brower *et al.* (2022). On this map, Harrison Bay is indicated between Smith Bay and Nuiqsut.

Appearance, Diet, and Life History[10]

Ringed seals have a dark coat with light-colored rings on their back and sides, and a light-colored belly. Their bodies are plump with a small head and snout. Pups are born with a white natal coat called lanugo, which is shed when they reach about 4 to 6 weeks of age. Ringed seals have thick, strong claws on their small fore flippers that they use to maintain breathing holes through 2 m or more of ice. Their length at

[9] https://www.fisheries.noaa.gov/resource/outreach-materials/research-brief-2021-aerial-survey-seals-and-polar-bears-beaufort-sea; Accessed October 10, 2022.

[10] https://www.fisheries.noaa.gov/species/ringed-seal; Accessed October 5, 2022.

maturity averages 1.2 to 1.4 m and they weigh between 50 and 70 kilograms (kg). The average weight of a ringed seal pup at birth is about 4.5 kg.

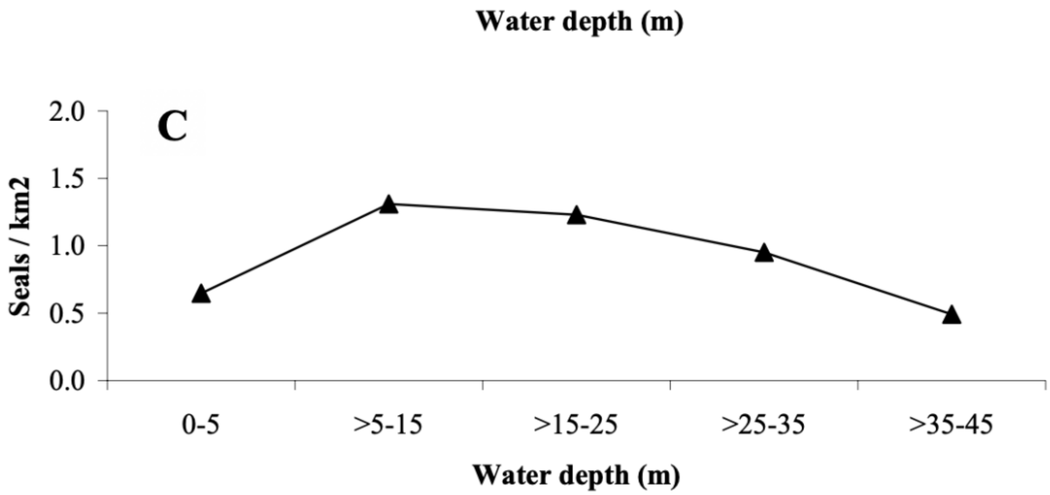
The ringed seal diet is composed predominantly of pelagic fish such as cod (Crain *et al.* 2021), but also includes shrimp and planktonic crustaceans; the relative importance of each type of prey depends on local availability and season (Lowry et al. 1998, as cited in (Ireland *et al.* 2016)). They have been shown to dive to depths of up to 46 m or more while foraging.

Ringed seals are hunted by killer whales and polar bears. Spatial distributions and population fluctuations of ringed seals and polar bears appear to be tightly correlated in some areas (Stirling and Øritsland 1995 as cited in (Ireland *et al.* 2016)).

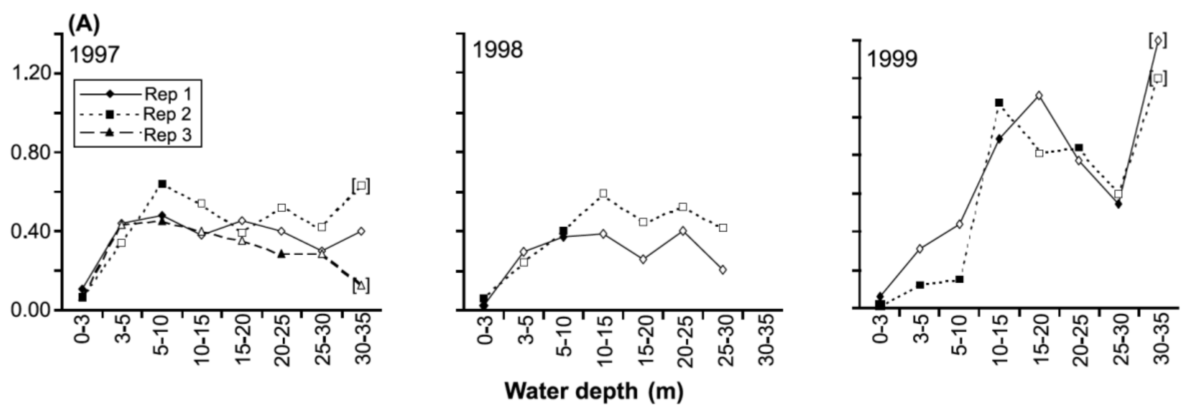
During winter, ringed seals excavate and maintain breathing holes in the ice and occupy lairs in accumulated snow (Smith and Stirling 1975). Breathing holes allow seals to access air while hunting for prey species, and also provide them routes to escape from polar bears and other predators. Ringed seals give birth in lairs from mid-March through April, nurse their pups in the lairs for 5 to 8 weeks, and mate in late April and May (Smith 1973; Hammill et al. 1991; Lydersen and Hammill 1993; as cited in (Ireland *et al.* 2016)). Subnivean lairs are especially important for protecting pups, providing protection from predators and thermal protection from cold temperatures and wind. Seal mothers continue to forage throughout lactation and move young pups between a network of four to six lairs (Ireland *et al.* 2016).

Arctic ringed seals generally prefer landfast ice along the shoreline for pupping. Univariate analysis reported in Frost *et al.* (2002) indicated that water depth had a significant effect on observed ringed seal densities in each survey year (1980s and 1990s), and for all years combined ($P<0.001$). Observed densities in the 1980s were lowest in water <5 m deep (0.30-0.93 seals/km^2) and >35 m deep (0.42-0.48 seals/km^2) and highest in >5-25 m water depths (1.13-2.79 seals/km^2). The surveys summarized in Moulton *et al.* (2002) began at the shoreline whereas Frost *et al.* (2004) surveys began at the 3m contour. Moulton *et al.* (2002) described that the 3-year average density in areas <3m deep was 0.06 seals/km^2. If data from shallow areas (<3m) are included, Moulton et al. (2002) (which are the same data as (Richardson and Williams 2002)) reported seal densities of 0.39, 0.35 and 0.56 seals/km^2 (1997-1999, respectively). WHB ice routes are primarily grounded ice or areas with water depths < 3m (see Figure 4-2).

FIGURE 4-2. OBSERVED DENSITIES OF RINGED SEALS BY WATER DEPTH IN THE CENTRAL BEAUFORT SEA 1985-1987 AND 1996-1999



Source: Frost *et al.* (2002)



Source: Moulton *et al.* (2002)

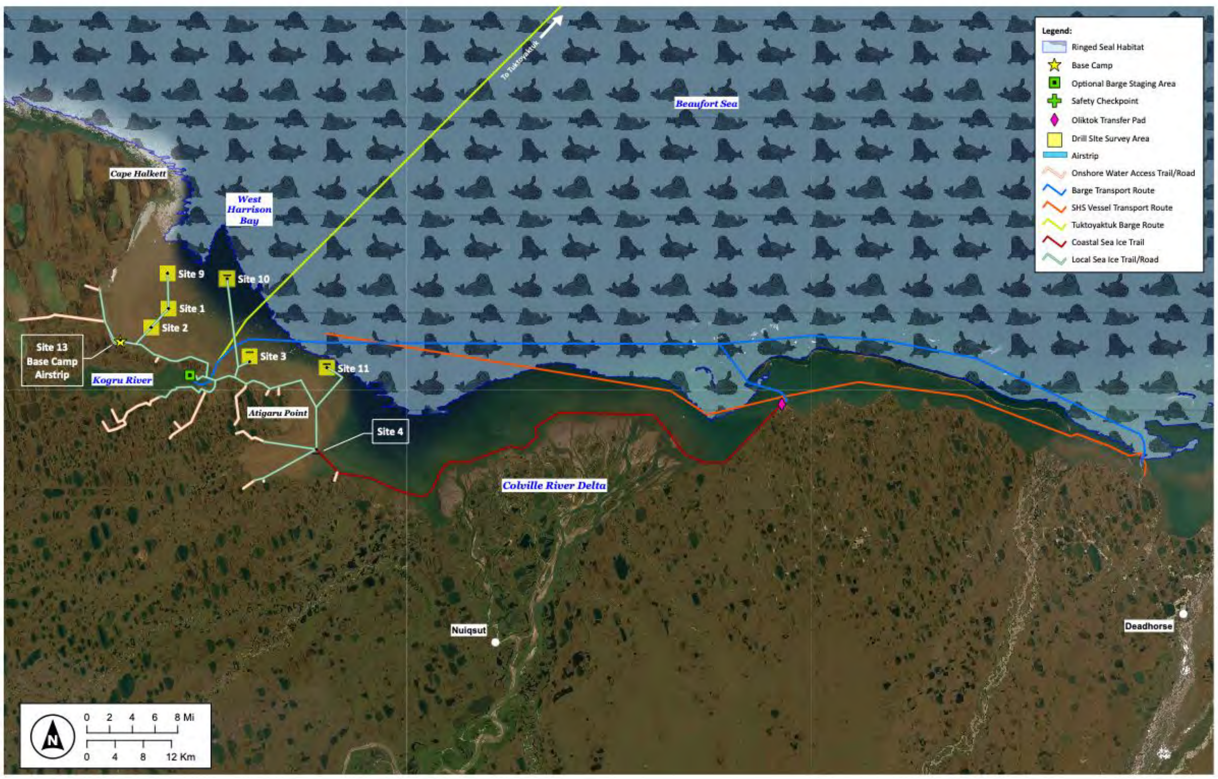
Optimal overwintering areas for ringed seals in the Beaufort Sea occur in waters between 10 and 35 m deep, preferably in the landfast ice along the shoreline close to lead systems. In May 2022, two trained wildlife-detection dogs to survey an area in Prudhoe Bay, near Northstar Island that was previously studied in 1983. A total of 61 ringed seal structures (47 breathing holes and 14 lairs) were identified in an 88.2-km^2 area resulting in a density of 0.68 structures/km^2. Lair density was higher in water deeper than 5 m; however, seal structures were found in all water depths (Quakenbush *et al.* 2022). Ringed seal movements during winter and spring are typically quite limited, especially where ice cover is extensive (Kelly *et al.* 2010a).

During spring (i.e., May and June in the Arctic), ringed seals spend time basking on the ice. Based on a tagging study in the mid-2000s between Point Barrow and Peard Bay along the Chukchi Sea coast, tagged seals (n=43) spent an average of 3% (95% confidence limit [CL]: 1–4%) of their time in lairs and an average of 37% (95% CL: 32–41%) of their time basking after the first emergence from the subnivean lair. Basking duration (median) on the ice increased to 9 hours before ice melt during the course of the study (Kelly *et al.* 2010a).

Critical Habitat

On April 1, 2022, NMFS designated critical habitat for the Arctic subspecies of ringed seals (87 FR 19232). The critical habitat designation covers areas of marine habitat in the Bering, Chukchi, and Beaufort seas (Figure 4-3).

FIGURE 4-3. RINGED SEAL ARCTIC SUBSPECIES CRITICAL HABITAT



Source: https://media.fisheries.noaa.gov/2022-03/arctic-ringed-seal-critical-habitat.pdf Accessed August 10, 2023

To identify specific areas that may qualify as critical habitat for ringed seals, NMFS considered five factors: (1) geographical area occupied by the species at the time of listing; (2) physical or biological habitat features essential to the conservation of the species; (3) specific areas occupied by the species that contain one or more of the essential primary biological features (PBFs); (4) which of the essential features may require special management considerations or protection; and (5) whether a critical habitat designation limited to geographical areas occupied by the species at the time of listing would be inadequate to ensure the conservation of the species (87 FR 19180).

PBFs considered in the determination included:

- Snow covered sea ice suitable for subnivean birth lair formation and maintenance—defined as waters 3 m or more in-depth containing area of shorefast ice or dense stable pack ice that contain snow drifts at least 54 cm deep to maintain lairs;

- Sea ice suitable for basking and molting—defined as waters 3 m or more in depth with 15% or higher concentrations of sea ice; and
- Primary prey resources to support ringed seals—defined as small, schooling fish and small crustaceans.

These essential sea ice features of ringed seal critical habitat are dynamic with variable locations on both spatial and temporal scales. Ringed seal movements and habitat use are strongly influenced by the seasonality of sea ice; the seals range widely, choosing the most suitable habitat conditions. The identified essential features can be found in any given year in the designated critical habitat (87 FR 19180). Regarding potential effects of activities on ringed seal critical habitat, areas along the coast with water depths of >3 m are considered part of ringed seal critical habitat based on PBFs described above.

Ringed seal critical habitat may be modified by the warming climate and projections that suggest continued or accelerated warming in the future (Kelly *et al.* 2010b). Climate models project ice and snow cover losses throughout the 21st Century, with some variations, and increasing atmospheric concentrations of greenhouse gases that drive climate warming and increase ocean acidification (BOEM 2018a), thereby affecting ringed seal habitat. The greatest impacts to ringed seals from climate change would manifest in less snow cover (BOEM 2018a). Also, the duration of ice cover could be reduced leading to lower snow accumulation on ice (BOEM 2018a, b), particularly over ringed seal subnivean lairs. Such changes could also threaten prey communities on which ringed seals depend.

Subsistence Use

Natchiq (ringed seals) are an important resource for the Inupiat of Alaska (Ireland *et al.* 2016). Meat, blubber, and oil are eaten, and bones and hides are used as materials in artworks and handicrafts. The number of ringed seals taken varies from year-to-year, depending on ice conditions and the availability of other marine mammal species, such as bowhead or beluga whales, to subsistence hunters (Ireland *et al.* 2016).

Nelson *et al.* (2019) considered ice seal harvest survey data collected from 1992 to 2014 from 41 communities that regularly hunt ice seals to estimate the average regional and statewide subsistence harvest. The authors identified stable or decreasing trends in the annual numbers of ice seals harvested, and determined the best statewide estimate of the average number of ringed seals harvested in 2015, including struck and lost animals, to be 6,454 ringed seals (Nelson *et al.* 2019). The Ice Seal Committee (2024a) reported that in 2014 (the year in which the most data were reported), a total of 58 ringed seals were taken by Nuiqsut residents (population 415), including animals that may have been struck and lost. In Utqiaġvik in 2014 (population 2,461), a total of 428 ringed seals were taken, including animals that may have been struck and lost.

4.2 BEARDED SEALS

Abundance and Status

The Beringia DPS of bearded seals was listed as threatened under the ESA in 2012 (77 FR 76740). Like ringed seals, the anticipated continued loss of sea ice and snow cover due to climate change effects, is of primary concern for this stock and poses a sizeable threat to its persistence (Young *et al.* 2023).

As described for ringed seals, aerial abundance and distribution surveys of ice seals were conducted by U.S. and Russian researchers in the spring of 2012 and 2013; the surveys were conducted over the entire ice-covered portions of the Bering Sea (Moreland *et al.* 2013). Using a subset of the data collected from U.S. waters during the 2012 survey, Conn *et al.* (2014) calculated an abundance estimate of 301,836 bearded seals (95% confidence interval [CI]: 238,195-371,147). Spring surveys conducted in 1999 and 2000 along the Alaska coast indicate that bearded seals are typically more abundant 37-185 km from shore than within 37 km from shore (Young *et al.* 2023). Reliable data on trends in population abundance for the bearded seals are not available. PBR for the U.S. portion of the Beringia stock of bearded seals is estimated to be 8,210 (Young *et al.* 2023).

Distribution

Bearded seals are associated with sea ice and exhibit an Arctic circumpolar distribution (Young *et al.* 2023). One of two subspecies of bearded seals, *Erignathus barbatus nauticus,* is divided into two DPSs, one of which is the Beringia DPS, which inhabits U.S. waters (Ireland *et al.* 2016). The distribution of bearded seals in Alaskan waters is very similar to that of ringed seals, but they do not range as far offshore in the Arctic as ringed seals.

During winter, most bearded seals in Alaskan waters are found in the Bering Sea as their movements are related to the advance and retreat of sea ice (Kelly 1988). In the Chukchi and Beaufort seas, favorable conditions for bearded seals are more limited, and they are less abundant. From mid-April to June as the ice recedes, some of the bearded seals that overwintered in the Bering Sea migrate northward through the Bering Strait to the Chukchi and Beaufort seas. During the summer, bearded seals are found near the fragmented margin of multi-year ice that covers the continental shelf of the Chukchi Sea and in nearshore areas of the central and western Beaufort Sea (Ireland *et al.* 2016). During the summer period, bearded seals occur mainly in relatively shallow areas because they predominantly feed on benthic bivalves (Burns and Eley 1978). Figure 4-4 shows locations of bearded seal observations (as well as for other unidentified pinnipeds which could include ringed or spotted seals) during 2020 Aerial Surveys of Arctic Marine Mammals (ASAMM) surveys (Brower *et al.* 2022). As shown in Figure 4-1 in the ringed seal description, bearded seal observations (pink dots in the figure) are concentrated west of Harrison Bay, near Point Barrow and farther offshore than the action area.

Appearance, Diet, and Life History[11]

Bearded seals, which range in length from 2 to 2.5 m and weigh from 260 to 360 kg, are the largest species of Arctic ice seal. Their coats are generally gray to brown with no distinct pattern; they have large bodies and small square fore flippers. Long, white whiskers give this species its "beard."

Bearded seals primarily feed on benthic invertebrates such shrimps, crabs, clams, and whelks and fish such as cod and sculpin. They forage near the bottom and typically dive to depths of less than 100 m. Like spotted seals, they do not like deep water and prefer to forage in waters less than 200 m deep, where they can reach the ocean floor.

Bearded seals tend to prefer sea ice with natural openings but they have been reported to maintain breathing holes in sea ice and broken areas within the pack ice, particularly where water depth is <200

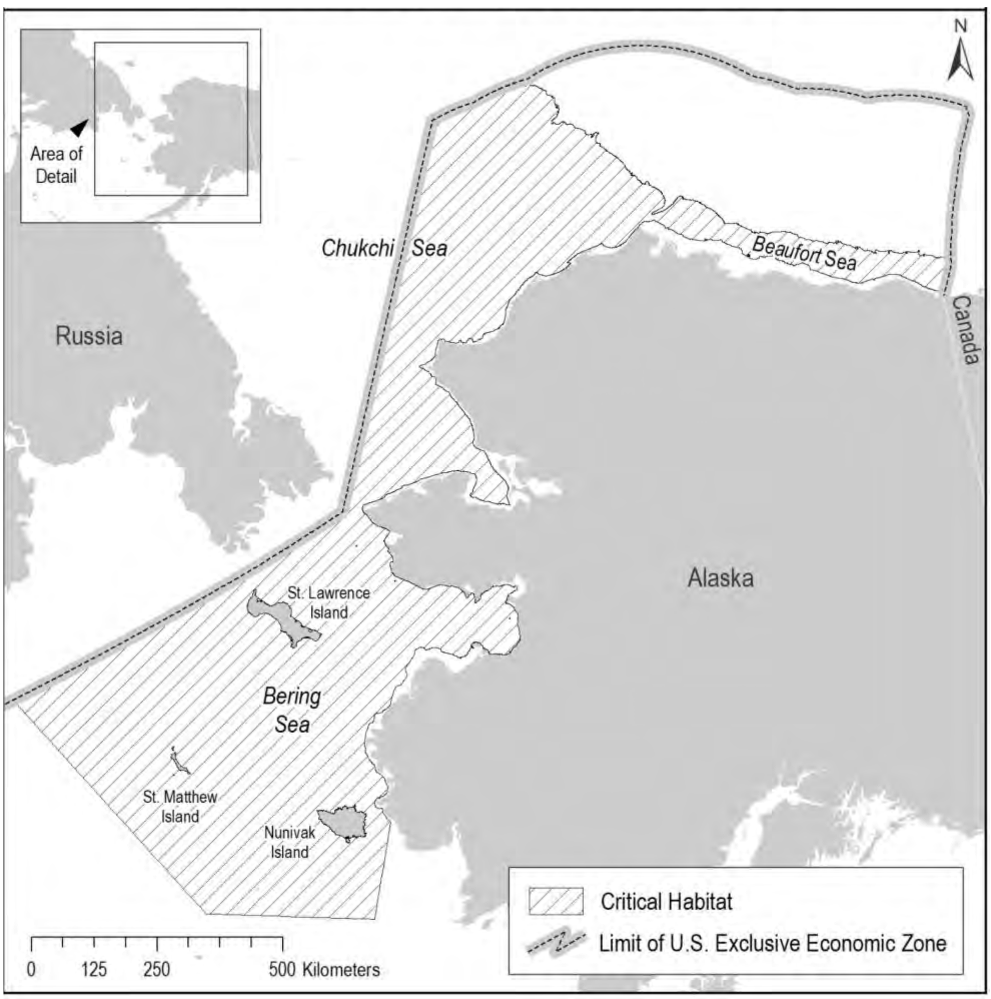
[11] https://www.fisheries.noaa.gov/species/bearded-seal; Accessed October 6, 2022.

m (Harwood *et al.* 2005). Like spotted seals, bearded seals reach sexual maturity at about 6-7 years of age and give birth on the sea ice, which they use as a platform for molting and resting also. Pups are nursed on the ice for about 24 days. By the time they are a few days old, they spend about half their time in the water. Within a week of birth, pups are capable of diving to a depth of about 60 m.

Critical Habitat: On April 1, 2022, NMFS designated critical habitat for the Beringia DPS of bearded seals (87 FR 19180). The critical habitat designation covers areas of marine habitat in the Bering, Chukchi, and Beaufort seas (Figure 4-4), and overlaps with the Alaska Fisheries Science Center research areas.

To identify specific areas that may qualify as critical habitat for bearded seals of the Beringia DPS, NMFS considered five factors: (1) geographical area occupied by the species at the time of listing; (2) physical or biological habitat features essential to the conservation of the species; (3) specific areas occupied by the species that contain one or more of the essential physical and biological features; (4) which of the essential features may require special management considerations or protection; and (5) whether a critical habitat designation limited to geographical areas occupied by the species at the time of listing would be inadequate to ensure the conservation of the species (87 FR 19180).

FIGURE 4-4. BEARDED SEAL BERINGIA DPS CRITICAL HABITAT



Source: https://media.fisheries.noaa.gov/2022-03/beringia-dps-bearded-seal-critical-habitat.pdf Accessed August 10, 2023

Subsistence Use

Oogruk (bearded seals) are hunted for their meat and skins; skins are used to make *umiaq*—the boats used by Alaska Natives during the spring bowhead hunt (Ireland *et al.* 2016). Nelson *et al.* (2019) considered ice seal harvest survey data collected from 1992 to 2014 from 41 communities that regularly hunt ice seals to estimate the average regional and statewide subsistence harvest. Bearded seals are the preferred species for food and umiak coverings (Ice Seal Committee 2017). Spotted and ribbon seals are also harvested (Muto *et al.* 2020), but not as frequently. In 2014, the Ice Seal Committee (2017) reported a total of 1,070 bearded seals taken by hunters in Utqiaġvik and 26 bearded seals by hunters in Nuiqsut. No bearded seal subsistence harvest data were reported for Kaktovik for 2014 by the Ice Seal Committee (2017). For 2014, the Ice Seal Committee (2024a) reported that a total of 26 bearded seals were taken by Nuiqsut residents (population 415) and a total of 1,070 bearded seals were taken by Utqiaġvik residents (population 2,461), including animals that may have been struck and lost.

4.3 SPOTTED SEALS

Abundance and Status

As described for ringed seals, aerial abundance and distribution surveys of ice seals were conducted by U.S. and Russian researchers in the spring of 2012 and 2013; the surveys were conducted over the entire ice-covered portions of the Bering Sea (Moreland *et al.* 2013). Using a subset of the data collected from U.S. waters during the 2012 survey, Conn *et al.* (2014) calculated an abundance estimate of 461,625 spotted seals (95% CI: 388,732 – 560,348). This is considered to be the best estimate for the entire portion of the Bering stock of spotted seals in U.S. waters (Muto *et al.* 2022).

Reliable data on trends in population abundance for the Bering stock of spotted seals are not available. PBR for the U.S. portion of the Bering stock of spotted seals is estimated to be 25,394 (Muto *et al.* 2022).

The Bering stock of spotted seals is not listed as threatened or endangered under the ESA, nor is it designated as depleted under the MMPA. In 2009, NMFS completed a comprehensive status review of the species and concluded that listing the stock as threatened or endangered under the ESA was not warranted at that time in 2009 (Boveng *et al.* 2009).

Distribution

In U.S. waters, spotted seals from the Bering stock are distributed along the continental shelf of the Bering, Chukchi, and Beaufort seas (Muto *et al.* 2022). They are present in the Beaufort Sea from July through late August (Ireland *et al.* 2016); they sometimes haul out on land but also spend extended periods at sea and are rarely seen on the pack ice. During the spring when pupping, breeding, and molting, spotted seals are found along the southern edge of the sea ice in the Okhotsk and Bering seas (Rugh *et al.* 1997). As the ice cover thickens at the onset of winter, spotted seals leave the northern portions of their range and move into the Bering Sea (Lowry *et al.* 1998; Von Duyke *et al.* 2016; as cited in Ireland *et al.* (2016)).

Historically, the Colville and Sagavanirktok rivers deltas supported up 600 spotted seals; however, by the late 1900s, fewer than 20 seals were been seen at either location (Johnson *et al*. 1999; as cited in (Ireland *et al.* 2016)). Johnson *et al.* (1999) stated that while specific surveys for spotted seals were not conducted in 1998, known haulouts were checked opportunistically during aerial surveys for other species. An estimated 16 seals were hauled out on a small island in the East Channel off the mouth of the Kachemach River, on August 25, 1998. Four seals were observed hauled out at a consistently used site at the southwest end of Anachlik Island on September 14, 1998. In 1997, during eight aerial surveys, small groups of spotted seals were seen on four occasions, hauled out on sand spits or in adjacent shoals in these same two locations. Seals were not seen elsewhere on the delta, nor were any seen on or around the Jones Islands or Pingok Island in 1997 (Johnson *et al.* 1999).

In 2014, visual and passive acoustic monitoring was undertaken from August 25 – September 30 in an approximately 30-km^2 survey area between the Spy Islands and Oliktok Point near Simpson Lagoon (i.e., near the Colville River Delta) (Lomac-MacNair *et al.* 2018). An Inupiat hunter also conducted vessel-based visual surveys for spotted seal haulout sites in the area. A total of 90 marine mammals were observed during visual surveys including 40 spotted seals, five ringed seals, 28 seals identified as either spotted or ringed, two bearded seals, three polar bears and two beluga whales (Lomac-MacNair *et al.* 2018). Lomac-MacNair *et al.* (2018) acknowledges the general lack of information on marine mammal presence in this area.

During oil exploration projects from 1996 to 2001, 12 spotted seals were positively identified near a seismic source vessel during open-water in the central Alaskan Beaufort Sea (Moulton and Lawson 2002; as cited in (Moulton *et al.* 2005). Bisson *et al.* (2013) recorded 38 sightings of spotted seals during 2012 operations in the Beaufort Sea, and 46 spotted seal sightings were reported during barge operations between West Dock and Cape Simpson (Green *et al*. 2007; as cited in Ireland *et al.* (2016)). Most sightings occurred from WHB to Cape Simpson, with only one sighting occurring offshore of the Colville River Delta.

Spotted seals have been observed in low densities in Harrison Bay and in waters adjacent to Oliktok Point (Hauser *et al.* 2008, Reiser *et al.* 2011). Clarke *et al.* (2020) reported small groups (1-25) of seals (not identified to species) hauled out near the mouth of Fish Creek from early September to early October 2019. Clarke *et al.* (2018) also reported a group of 15 unidentified pinnipeds on the beach in Harrison Bay in September. In addition, regarding spotted seals specifically, Quakenbush *et al.* (2019) reported that five spotted seals (and one bearded seal) were tagged in the Colville/Fish Creek area.

Appearance, Diet, and Life History[12]

True to their name, spotted seals have a light-colored coat with dark spots. Their heads are round with a narrow snout and small body; their flippers are narrow and short. Pups are born with a white coat that sheds when weaned. Spotted seals grow to an average length of 1.5 m and weigh from about 64 to 113 kg when full grown. Males and females are similar in appearance. Spotted seal pups range from about 7 to 12 kg at birth.

A review of literature on the diet of spotted seals shows that they consume a flexible, varied diet consisting of several species of fish, shrimp, crab, squid, octopus, and a variety of pelagic and hyperbenthic crustaceans (Boveng *et al.* 2009). It has been noted that younger animals mostly consume crustaceans, while older seals mainly eat fish. Spotted seals do not dive very deeply for prey; they feed

[12] https://www.fisheries.noaa.gov/species/spotted-seal; Accessed October 6, 2022.

almost exclusively over the continental shelf in waters less than 200 m deep. Their main predators are killer whales and polar bears.

Spotted seals reach sexual maturity at 5 years of age. Pups are born between January and April. Unlike ringed seals, spotted seals give birth on top of stable ice floes rather than in subnivean lairs. The pup, mother, and her mate remain in close proximity until the pup is weaned around 4 to 6 weeks after birth. Pups born on the sea ice rarely enter the water until they have been weaned and undergone a molt. During the first few weeks after weaning, pups remain at least partially dependent on ice while they become proficient at diving and foraging for themselves. The maximum lifespan of a spotted seal is about 30 to 35 years.

Subsistence Use

Qasigiaq (spotted seals) are harvested for subsistence in Alaska and Chukotka. Within Alaska, they are of significant importance to hunters in the Yukon–Kuskokwim and Bering Strait regions (Coffing *et al*. 1998,1999; Georgette *et al.* 1998; as cited in (Ireland *et al.* 2016)). The annual harvest of spotted seals varies year-to-year within communities and is dependent on the availability of animals, which for the most part is influenced primarily by ice conditions (Ireland *et al.* 2016).

The 2014 total number of spotted seals taken, including struck and animals, by Nuiqsut and Utqiaġvik residents was 7 and 98, respectively (Ice Seal Committee 2024a). Nelson *et al.* (2019) considered ice seal harvest survey data collected from 1992 to 2014 from 41 communities that regularly hunt ice seals to estimate the average regional and statewide subsistence harvest. As described for ringed seals, the authors identified stable or decreasing trends in the annual ice seal harvest. They determined the best statewide estimate of the average number of spotted seals harvested in 2015, including struck and lost animals, to be 5,253 spotted seals (Nelson *et al.* 2019).

4.4 BOWHEAD WHALES

Abundance and Status

The western Arctic stock of bowhead whales is listed as endangered under the ESA. All stocks of bowhead whales were intensely commercially hunted beginning in the early 16th Century near Labrador, Canada; hunting efforts spread to the Bering Sea in the mid-19th Century (Ross 1993, Braham 1984, Bockstoce and Burns 1993, Bockstoce *et al*. 2007; as cited in (Young *et al.* 2023). Woodby and Botkin (1993 as cited in Young *et al.* (2023) reported a minimum worldwide population estimate of 50,000 bowhead whales prior to commercial whaling, with 10,400 to 23,000 in the Western Arctic stock (dropping to less than 3,000 at the end of commercial whaling). Brandon and Wade (2006), as cited in (Young *et al.* 2023), used Bayesian model averaging to estimate that the Western Arctic stock consisted of 10,960 bowhead whales in 1848 at the start of commercial whaling.

In spring of 2019, an ice-based visual survey and a summer aerial line-transect survey were conducted to provide independent estimates of bowhead whale abundance. For the 2019 ice-based survey (Givens *et al.* 2021a), estimated an initial abundance of 12,505 whales (coefficient of variation [CV] = 0.228). Givens *et al.* (2021b) developed a correction factor to account for the potential disturbance to bowheads from powered skiffs. Based on ice-based counts and aerial line-transect surveys in 2019, the updated best estimate of abundance, derived from an inverse-variance weighted average of abundance estimates, is 15,227 bowhead whales. The previous lower estimate of 14,025 was derived from the 2019 ice-based estimate alone (Young *et al.* 2024). PBR for the western Arctic stock is calculated to be 116 bowhead whales (Young *et al.* 2023).

Using data from an ice-based visual survey of the Bering-Chukchi-Beaufort Seas stock of bowhead whales conducted in spring 2019 near Utqiaġvik, Givens *et al.* (2021a) estimated Bering-Chukchi-Beaufort Seas stock population abundance of 12,505 with 95% CI of (7,994, 19,560) and a CV of 0.228. Analytical methods mirrored those used for the 2011 survey as much as possible; however, unlike 2011, simultaneous acoustic monitoring was not conducted in 2019. The estimated abundance from 2019 data is lower than the 2011 estimate of 16,820, but the 2019 CI encompasses the 2011 estimate, and the authors did not interpret this as evidence of a population decline for the stock (Givens *et al.* 2021a). The International Whaling Commission (IWC) Scientific Committee continues to consider the estimate of 16,820 bowhead whales as the most appropriate for management and use (Muto *et al.* 2022). PBR for the Bering-Chukchi-Beaufort Seas stock is calculated to be 161 whales. Because the stock is listed as endangered under the ESA, it is considered depleted and strategic under the MMPA.

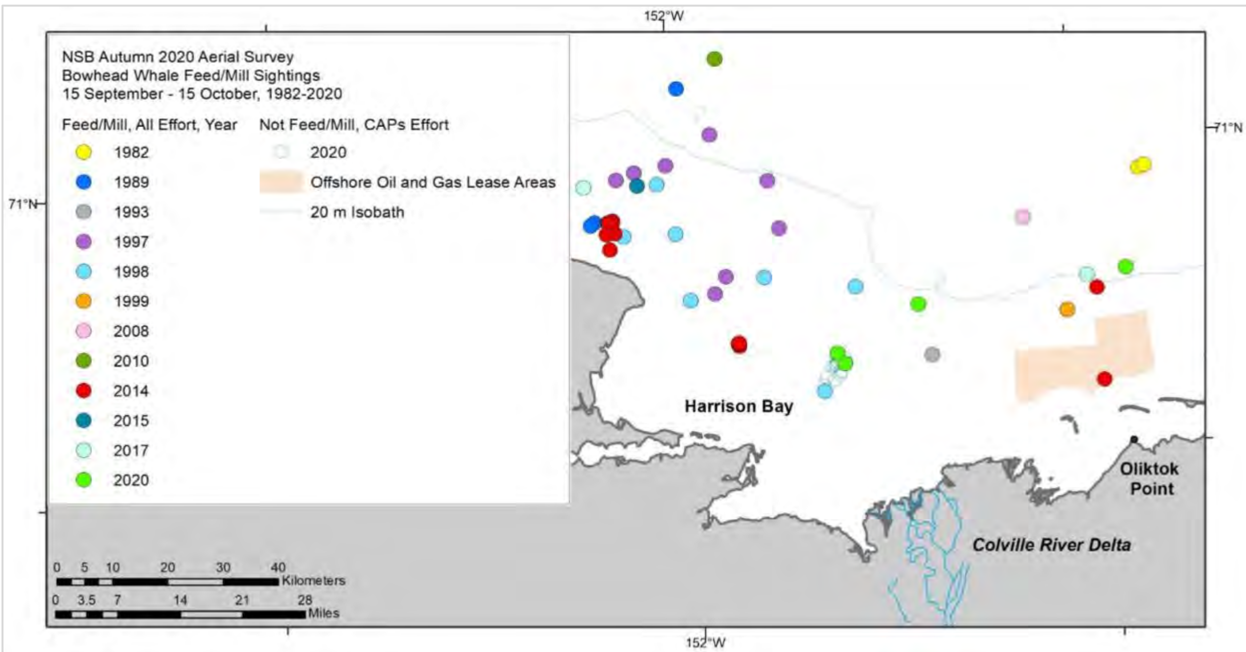
Distribution

Most of the stock winters in the Bering Sea and migrates through the Bering Strait, Chukchi Sea, and Alaskan Beaufort Sea to summer feeding areas in the Canadian Beaufort Sea. The spring migration pattern is influenced by environmental conditions; for example, it can be delayed by heavy ice coverage in the Bering Strait (Szesciorka and Stafford 2023). After feeding in the Canadian Beaufort Sea during summer, the Bering-Chukchi-Beaufort stock of bowhead whales migrates west through the Alaskan Beaufort Sea in the fall, returning to wintering areas in the Bering Sea. The westward migration of bowhead whales into and through the Alaskan Beaufort begins in late August and is generally complete by early to mid-October (Ireland *et al.* 2016). Data from a satellite-tagging study conducted between 2006 and 2018 indicated that, although most tagged whales began to leave the Canadian Beaufort Sea in September, the timing of their westward migration across the Beaufort Sea was highly variable (Young *et al.* 2023).

While migrating through the Alaskan Beaufort Sea, bowhead whales are more strongly associated with inner continental shelf habitat than with other habitat types (Moore *et al.* 2000). Szesciorka and Stafford (2023) reported that northward migration during the spring was earlier in seasons with less sea ice area in the Chukchi Sea in January through March, while greater sea ice area delayed migration during these months. Heavy nearshore ice cover in the fall was also reported to result in moving the westward migration corridor farther from the coast, and over deeper water (Moore *et al.* 2000, Treacy 2002, Treacy *et al.* 2009). In September 2020, Brower *et al.* (2022) reported an unusual sighting of an aggregation of bowhead whales just east of Harrison Bay (see Figure 4-9). Bowhead whales had not typically been observed in this area since 1982, when similar aerial surveys (now referred to as ASAMM) began (Brower *et al.* 2022). The sighting data represented in Figure 4-5 are approximately 5 to 10 km west-northwest of Narwhal's proposed activities that would occur during the open-water season (see Figure 1-1). As described in Brower *et al.* (2022), the aggregation of bowheads near Harrison Bay was attributed to a large oceanographic front due to high freshwater discharge from the Colville River (three and a half times the historical mean), which can aggregate prey.

Hauser *et al.* (2008) reported results for bowhead whale surveys near the Colville River Delta in August and September 2008, reporting that most bowheads were observed between 25 and 30 km north of the barrier islands offshore. In 2017, Quintillion Subsea Operations, LLC monitored for marine mammals during installation of a fiber optics cable more than 50 km offshore of Oliktok Point moving west to Point Barrow and beyond (Green *et al.* 2018). In the fall of 2017, the project recorded 17 groups of bowhead whales (25 individuals) during operations offshore of Oliktok Point. Bowhead whale group size ranged from 1 to 5 with a mean of 1.47 (Green *et al.* 2018).

FIGURE 4-5. BOWHEAD WHALE OBSERVATIONS SEPTEMBER 15 – OCTOBER 15, 1982 - 2020



Source: Brower et al. (2022)

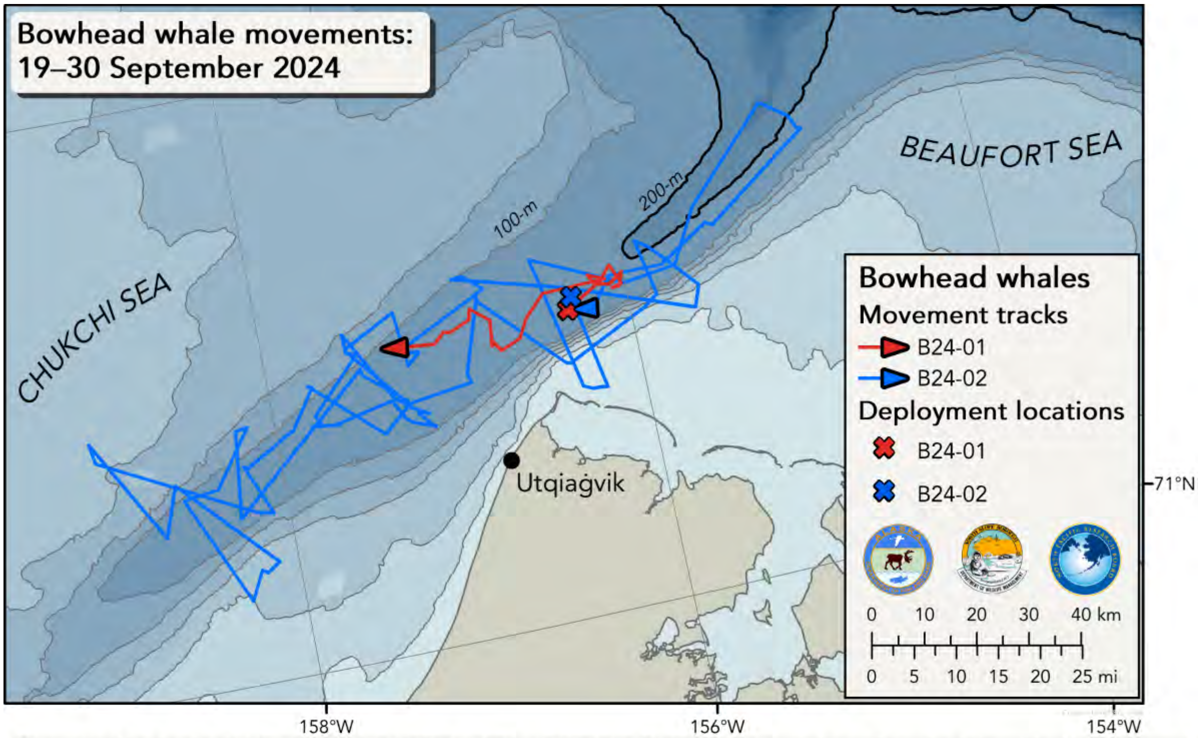
In July-August 2014, Smultea *et al.* (2014) conducted marine mammal monitoring during a shallow geohazard seismic and seabed mapping survey within Foggy Island Bay, extending from the shoreline up to 10.5 km offshore. Foggy Island Bay is situated about 19 km northeast of Prudhoe Bay and about 15 km east of the Endicott Satellite Drilling Island. No bowhead whales were observed during the study.

A multi-year study, conducted by the Alaska Department of Fish and Game (ADF&G), to determine how bowhead whales' migration behavior and distribution have changed since 2006 in response to changing conditions in sea ice, wind, water temperature, and human activities used location data from satellite-linked tags to track whales. In September 2024, two whales were tagged and their movements recorded over a period of 11 days (September 19 – 30) as shown in Figure 4-6.[13] The project began in 2006 and is a collaboration among the ADF&G, the AEWC, Whaling Captain's Associations of Barrow, Kaktovik, Gambell, and Savoonga, the Aklavik and Tuktoyaktuk Hunters and Trappers Committees, the North Slope Borough (NSB), the Barrow Arctic Science Consortium, the Department of Fisheries and Oceans

[13] http://www.adfg.alaska.gov/index.cfm?adfg=marinemammalprogram.bowhead; Accessed October 15, 2024.

Canada, and the Greenland Institute of Natural Resources. Figure 4-6 shows the movements of two tagged bowhead whales over the period September 19-30, 2024.

FIGURE 4-6. MOVEMENTS OF SATELLITE TRACKED BOWHEAD WHALES IN 2024



Movements of two bowhead whales tagged on 19 September 2024 near Utqiaġvik, Alaska, USA. This project is a collaboration between the Alaska Department of Fish and Game (ADF&G), the Alaska Eskimo Whaling Commission, the Barrow Whaling Captain's Association, and the North Slope Borough Department of Wildlife. Whales were tagged with transdermal SPOT tags manufactured by Wildlife Computers, WA, USA. This project is supported by North Pacific Research Board (Project No. 2113). Tagging activities are conducted under NMFS permit #24334 issued to ADF&G and under an approved ADFG Animal Care and Use Committee Protocol #0027-2023-25.
For more information, visit: http://www.adfg.alaska.gov/index.cfm?adfg=marinemammalprogram

Source: https://www.adfg.alaska.gov/index.cfm?adfg=marinemammalprogram.bowheadmaps; Accessed October 15, 2024

Appearance, Diet, and Life History[14]

Bowhead whales have a dark body with a distinctive white chin and no dorsal fin. Their bow-shaped large, thick skull can be more than 4.8 m long and allows them to break through 20-cm-thick sea ice. The bowhead whale also has a 43- to 48-cm thick blubber layer, which is thicker than the blubber of any other whale.To feed, bowheads filter large volumes of seawater water though baleen plates. They have the longest baleen of all whales, and feed almost exclusively on small- to mid-sized marine invertebrates (i.e., krill copepods) and small fish. Stomach content analyses and habitat associations suggest that Bering-Chukchi-Beaufort bowhead whales feed on concentrations of zooplankton such as krill throughout their range (Muto *et al.* 2022). In areas of the western Beaufort Sea, bowhead whales feed in September and October in ephemeral prey patches on the continental shelf out to approximately the 50 m isobath (Muto *et al.* 2022).

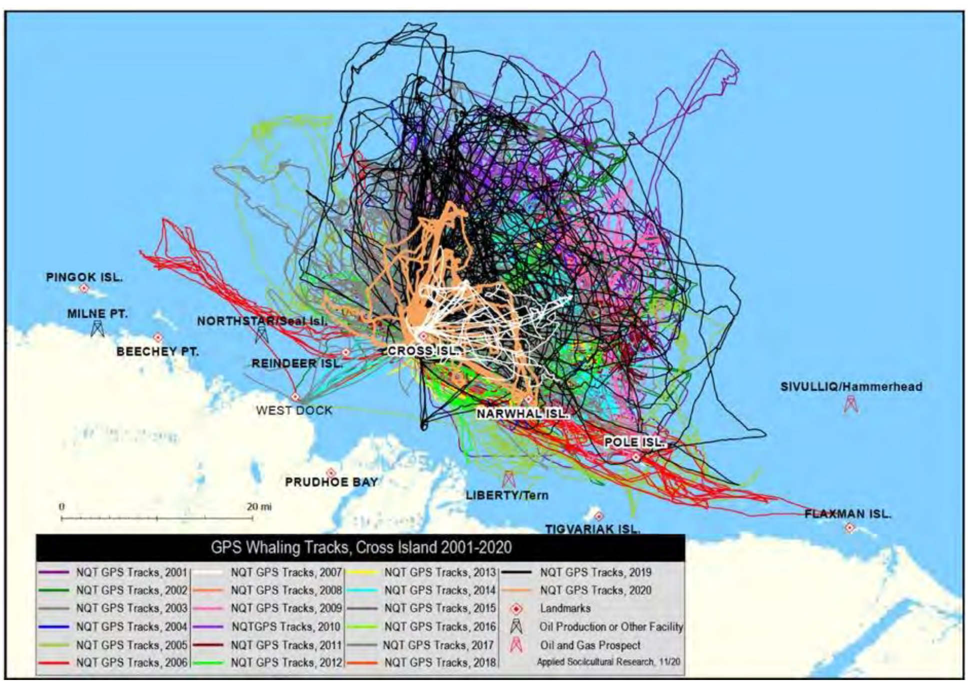
[14] https://www.fisheries.noaa.gov/species/bowhead-whale; Accessed October 4, 2022.

Bowhead whales rely on their sensitive hearing for navigating, avoiding predators, foraging, and communicating in the marine environment. They are highly vocal and produce a large variety of calls. Although direct measurements of hearing ability in baleen whales are lacking, scientists predict that bowheads hear low-frequency (LF) sounds, which are capable of propagating great distances and may allow for communication over long ranges. Bowhead whales can live for more than 100 years, and reach sexual maturity at approximately 25 years, when their total body length is about 10 to 14 m. Mating behavior occurs year-round, but conception occurs during late winter or spring. Most calves are born between April and early June. Females typically bear one calf every 3 to 4 years; at birth calves are about 4 m long, weigh about 1 metric ton, and can swim.

Subsistence Use

Commercial whale hunting ended in the 1920s, and no bowhead whales were hunted for more than 50 years until Inupiaq subsistence harvesting of bowhead whales resumed in the early 1970s (Suydam *et al.* 2020). The subsistence hunt for bowhead whales is regulated by the IWC, NMFS, and the AEWC. Subsistence hunts occur during spring and fall corresponding to annual migration patterns. Three communities along the Beaufort Sea (Barrow, Nuiqsut, and Kaktovik) participate in traditional indigenous bowhead hunting activities. Hunts typically occur during the fall as ice leads close to shore typically remain unnavigable until after the whales have passed through on their spring migration to summer feeding grounds in the Canadian Beaufort Sea. As shown in Figure 4-7, subsistence hunting of bowhead whales is focused on the area near Cross Island, which is located about 136 km to the east of the action area in WHB. In 2024, the harvest quota set by the IWC included 33 strikes available that were carried forward from the previous year for a combined strike quota of 100 (67 + 33 strikes carries forward) (59 FR 20945; March 26, 2024).

FIGURE 4-7. CROSS ISLAND SUBSISTENCE WHALING GPS TRACKS 2001-2020



Source: Galginaitis (2021)

5 TYPE OF INCIDENTAL TAKING AUTHORIZATION REQUESTED

Narwhal requests an IHA under Section 101(a)(5)(D) of the MMPA for the non-lethal unintentional taking of small numbers of ringed and bearded seals and bowhead whales due to Level B harassment during certain project activities in WHB, Alaska. Narwhal requests an IHA for 1 year with an effective date of August 1, 2025, with an option to renew for 1 year (i.e., through August 2027) if the specified activities have not been completed. A detailed description of project activities is included in Section 1, including certain activities for which takes are not requested (e.g., bathymetry surveys).

The type of incidental taking requested in this application includes Level B harassment that may result from behavioral disturbance or temporary [hearing] threshold shift (TTS). Level B harassment is defined as:

> *…any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Id. § 1362(18)(A)(ii)).*

Table 5-1 lists which of Narwhal's activities may result in Level B incidental take to ringed and bearded seals and bowhead whales. As indicated in Table 5-1, only the following activities are considered in the exposure estimate for Level B takes: 3D seismic; physical presence of vessels or vehicles; or construction/operation of sea ice trails, roads, or pads.

Level A take is not expected for this project and this application does not seek authorization for incidental Level A take or for mortality. Level A harassment can include auditory injury (permanent threshold shift [PTS]) or non-auditory injury that is not expected to result in serious injury or mortality. A serious injury is an injury that will likely (>50% probability) result in mortality (50 CFR 216.3).

There are no records of lethal take of ringed or bearded seals or bowhead whales in WHB due to industry activities. In 1998, one ringed seal mortality was reported during monitoring activities for on-ice vibroseis outside the barrier islands east of Bullen Point (MacLean 1998a). In 1999, during a NMFS workshop concerning on-ice monitoring and research, a researcher reported that one dead ringed seal pup was discovered in a seal structure approximately 1.5 km from the Northstar ice road in 1999. No data were available regarding the age of the pup or date of death; the cause of death could not be determined (Richardson and Williams 2000b). With mitigation measures in place (see Section 11), Narwhal does not anticipate Level A harassment for any marine mammals, and is therefore, not requesting Level A take. No mortality of any marine mammals is expected due to Narwhal's activities.

Section 6 describes how Level B take estimates were calculated, including all assumptions. Take estimates account for the planned mitigation and monitoring measures described in detail in Sections 11 and 13 to minimize potential for harassment to the maximum extent practicable.

TABLE 5-1. ACTIVITY, EQUIPMENT, AND POTENTIAL FOR LEVEL B TAKE

Activity	Description	Required Equipment	Level B Incidental Take? (Y/N)
SUMMER 2025			
Aircraft Support Flights[1]	Crew transport, resupply, and archeological pre-clearance	Helicopter, fixed-wing aircraft[1]	N
Aerial Freshwater Lake Surveys and Installation of Thermistors[2]	Aerial freshwater lake surveys to confirm sources; installation of thermistors up to 30 cm deep in tundra along onshore trail/road routes	Helicopter, small boat, nets, fathometer	N
Bathymetry, Imagery, Sediment Data and Seafloor Mapping	Seafloor bathymetry, morphology, imagery, and seafloor mapping; archeological pre-clearance	Echosounder, side scan sonar, sub-bottom profiler, sparker	N
3D High-Resolution Seismic Surveys	Subsea geophysical data collection	105 cu. in. single airgun, multi-channel hydrophones, one seismic vessel, one support vessel, up to two crew boats	Y
Barge Transit	Transport of equipment and supplies	Tug and barge	N
Temporary Advance Staging Area	Option 1: Using the existing Kogru airstrip; or Option 2: Using anchored barges adjacent to shore	Tundra mats (see Appendix A example), excavator on shore, two trucks, two front-end loaders Tundra mats and helicopter (Option 1) six empty barges and tugs (Option 2)	N
Summer Clean Up (on land)	Stickpicking	Helicopter	N
WINTER 2025			
AIR Surveys (2)	Pre-activity surveys (two) to detect putative or confirmed polar bear dens	Fixed-wing aircraft[1]	N
Aircraft Support Flights[1]	Crew transport and resupply between temporary sea ice airstrip and Deadhorse airport (on land)	Fixed-wing aircraft[1]	N
Mobilization Option 1: Coastal Sea Ice Trail Construction and Operation[3]	Construction of sea ice trail from Oliktok Point to Colville River Delta; temporary safety shack located mid-route to WHB	Rolligon, tractor, snowplow, pump trucks, ATV, grader, loader	Y

Activity	Description	Required Equipment	Level B Incidental Take? (Y/N)
Mobilization Option 2: CWAT to WA2	Construction and operation of 47 km snow trail on land from the existing CWAT	Rolligon, tractor, snowplow, ATV, grader, loader	N
WHB Offshore Sea Ice Trail/Road and Pad Construction	Construction and operation of sea ice trails/roads and pads	Rolligon, tractor, snowplow, pump trucks, ATV, grader, loader	Y
Operation of WHB Sea Ice Trails/Roads	Transport equipment	Rolligon, tractor, equipment, ATV	Y
Onshore Ice Trail/Road Construction and Operation	Construction and operation of sea ice trails/roads and pads	Rolligon, tractor, snowplow, pump trucks, ATV, grader, loader	N
Exploratory Drilling	Temporary drilling activities through sea ice	Exploration drill rig, camp, associated support equipment	N
Temporary Airstrip on Grounded Ice	Construction of temporary airstrip	Tractor, snowplow, pump trucks, grader, loader	N
Oliktok Point Transfer Pad on Grounded Ice	Construction and operation of temporary freight transfer pad		N
Temporary Base Camp	Construction and operation of temporary base camp in WHB	Rolligon, tractor, snowplow, pump trucks, ATV, grader, loader	N

[1] Helicopter aircraft during summer surveying activities may include an Airbus AS350 (A-Star), Bell 206 L3, Bell 206 L4 and Robinson R44. Fixed-wing aircraft used during winter operations may include a Single Engine Otter on skis, Cessna 206/207, Cessna Grand Caravan, Piper Navajo, Helio Courier, DHC-6 Twin Otter, Beech King Air 200, Beech 1900 or similar.

[2] Thermistor installation itself will not cause disturbance; rather, only helicopter disturbance is considered for Level B take.

[3] The coastal sea ice trail will be constructed on grounded ice except for small portions such as along the Colville River Delta; therefore, only the Colville River Delta section is included in the exposure estimate.

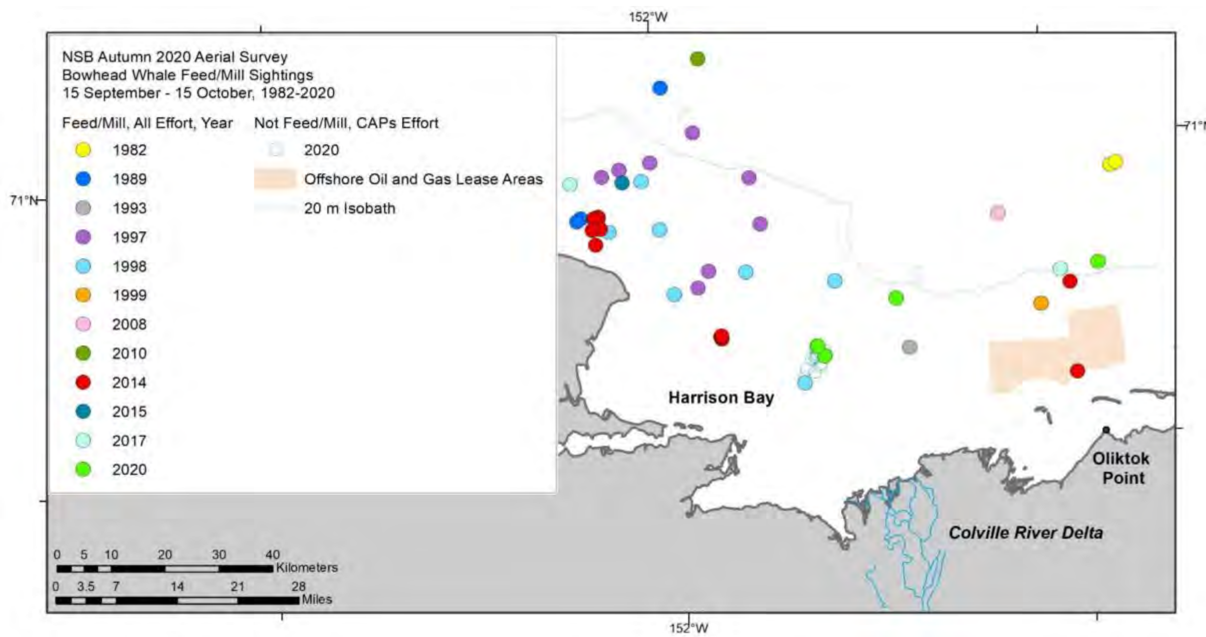
6 TAKE ESTIMATES FOR MARINE MAMMALS

6.1 MARINE MAMMAL DENSITIES AND OBSERVATIONS IN THE ACTION AREA

6.1.1 BOWHEAD WHALE DENSITIES AND OBSERVATIONS IN THE REGION

A few bowhead whales may occur in the Central Beaufort Sea during summer months generally beginning in mid-July. During the ice-covered season (winter and spring), there will be few to no bowhead whales near WHB. The bowhead population migrates west to the Bering Sea during the fall and does not migrate eastwards through the Beaufort Sea again until spring. During this eastward migration, most of the whales are distributed offshore. During the open-water season, bowhead whales have not typically been sighted in Harrison Bay during aerial surveys 1982 – 2020, as indicated by the low number of sightings shown in Figure 6-1 (Brower *et al.* 2022).

FIGURE 6-1. BOWHEAD WHALE SIGHTINGS IN HARRISON BAY BY YEAR 15 SEPTEMBER – 15 OCTOBER 1982-2020



Source: Brower *et al.* (2022)

Bowhead whale sighting data from ASAMM survey Block 3 (which includes Harrison Bay) for the period 2012 – 2020 were used to estimate bowhead density near the action area. For reference, Harrison Bay is approximately 250 km^2 relative to the larger total area of ASAMM survey Block 3. Therefore, the density estimates presented here are higher than would be expected in Harrison Bay. Densities were calculated using a two-step approach; first, a sighting rate is calculated based on whales per km, then transect length (km) is multiplied by the effective strip width (esw) of the transect using the modeled esw for bowhead whales observed during aerial surveys conducted from an Aero Commander airplane (1.15 km (CV = 0.08)) (Ferguson and Clarke 2013). Therefore, whales per km^2 = whales per km/(2*1.15km). For survey Block 3, the average density estimate in summer is 0.009 bowhead whales per km^2 and the average fall density is 0.008 bowhead whales per km^2 (Table 6-1).

TABLE 6-1. ESTIMATED BOWHEAD WHALE DENSITY IN BLOCK 3 BASED ON AERIAL SURVEYS*

Year	Time Period	On Transect Effort (km)	On Transect Sightings	Whales/km	Whales/km^2
2012 Summer Fall	Jul-Aug Sep-Oct	1742 1388	1 26	0.001 0.019	0.004 0.083
2013 Summer Fall	Jul-Aug Sep-Oct	950 1217	8 7	0.009 0.006	0.0039 0.0026
2014 Summer Fall	Jul-Aug Sep-Oct	1290 1927	0 1	0.000 0.001	0.000 0.0004
2015 Summer Fall	Jul-Aug Sep-Oct	1570 1949	0 66	0.000 0.034	0.000 0.0148
2016 Summer Fall	Jul-Aug Sep-Oct	1845 1959	259 61	0.141 0.032	0.0613 0.0139
2017 Summer Fall	Jul-Aug Sep-Oct	2188 2269	6 35	0.003 0.016	0.0013 0.0070
2018 Summer Fall	Jul-Aug Sep-Oct	2049 2390	7 32	0.004 0.014	0.0017 0.0061
2019 Summer Fall	Jul-Aug Sep-Oct	2822 3853	7 8	0.003 0.003	0.0013 0.0013
2020 Fall	Sep-Oct	654	32	0.049	0.0213
			Summer Average Summer Range		**0.009** 0.000-0.0613
			Fall Average Fall Range		**0.008** 0.0004-0.0213

Source: Brower *et al.* (2022), Clarke *et al.* (2014), Clarke *et al.* (2018), Clarke *et al.* (2015), Clarke *et al.* (2012), Clarke *et al.* (2017a, 2017b), Clarke *et al.* (2013)
Note: Only fall surveys were conducted in 2020.

6.1.2 RINGED SEAL DENSITIES

Ringed seals are present in the nearshore Beaufort Sea waters and sea ice year-round. During winter months, ringed seals maintain breathing holes and excavate subnivean lairs in the landfast ice (Frost *et al.* 2002, Kelly *et al.* 2005). Frost and Lowry (1987) described shorefast (landfast) ice as "...anchored to the beach, solid cover with or without occasional cracks, pressure ridges, and shear lines". Ringed seal densities vary depending on the time of year. Project activities are planned for both the open-water and ice-covered seasons and for this reason, densities for summer/fall and winter/spring are described below. In this application, summer and fall include the months July through October (i.e., open water), while winter/spring is defined as November through June, when sea ice may be present.

6.1.2.1 Winter and Spring Ringed Seal Densities

Site-specific surveys for ringed seals along the Beaufort Sea coast were conducted in association with industry activities in the late 1980s and continued into the 2000s. These studies assessed the winter abundance, density, and ecology of ringed seals (Frost and Lowry 1987, Frost and Burns 1989, Kelly *et al.* 1986, Richardson and Williams 2001, Richardson and Williams 2002, Richardson and Williams 2004). Moulton *et al.* (2002) specifically estimated density based on seals observed in fast ice habitat (excluding pack ice data) whereas Frost *et al.* (2004) reported densities for all ice types (fast ice and pack ice) which generally results in higher estimates. Fast ice habitat is representative of Narwhal's action area. Ground-based studies estimated approximate seal densities by considering the detection of seal structures such as breathing holes, haulout lairs or pupping lairs using trained dogs, while aerial surveys relied on seal counts from observations from the air. During the period May – June 1986, aerial surveys in Sector B2 surveyed 11% of landfast ice between Lonely DEW Line and Oliktok Point (Frost and Lowry 1987) using a fixed-wing aircraft flying at 300 ft altitude between Barrow and Barter Island. As reported in Frost *et al.* (2002), habitat-related variables including water depth, location relative to the fast ice edge, and ice deformation has shown to result in substantial and consistent effects on the distribution and abundance of seals.

(Frost *et al.* 2004), Moulton *et al.* (2002) emphasized that distance from shore and water depth is correlated with ringed seal density. We re-iterate that water depths in the action area of WHB range between 0 – 6 m (see Figure 4-2).

Table 6-2 presents data from 1986 ringed seal aerial surveys across different distances from shore. Distances ranging 0-3.7 km from shore most closely resembles water depths in the action area as indicated in bold text.

TABLE 6-2. ESTIMATED RINGED SEAL DENSITY AND DISTANCE FROM SHORE ALONG THE BEAUFORT SEA COAST BASED ON AERIAL SURVEYS OF SHOREFAST ICE MAY – JUNE 1986

Distance from Shore (km)	Sector B2 Seal Density (seals/km^2)
0-3.7	**0.74**
3.7-7.4	1.14
7.4-11.1	1.02
11.1-14.9	1.14
14.9-18.5	1.13

Source: Frost and Lowry (1987).
Note: Sector B2 is located between Lonely DEW Line and Oliktok Point

Moulton *et al.* (2005), Moulton *et al.* (2003) reported that environmental factors, such as date, water depth, degree of ice deformation, presence of meltwater, and percent cloud cover, had more conspicuous and statistically-significant effects on seal sighting rates than did any human-related factors. Based on the best available data and considering the majority of the action area includes water depths less than 3m, a mean density was calculated using the data summarized in Table 6-3. To estimate exposures, the mean density of 0.49 seals/km² shown in Table 6-3 is used for winter/spring seal density in this request.

TABLE 6-3. REPORTED RINGED SEAL WINTER/SPRING DENSITY ALONG THE BEAUFORT SEA COAST BASED ON SURVEYS 1983 – 2023

Year	Ringed Seal Density Based on No. of Structures[a]			Ringed Seal Density from Aerial Surveys[b]	
	Structures/km²	**Seals/km²**	**Source**	**Seal/km²**	**Source**
1983	0.81	0.28	Kelly *et al.* (1986)	-	-
1983	3.60	1.26	Frost and Burns (1989)	-	-
1986	-	-	-	0.74[c]	Frost and Lowry (1987)
1997	-	-	-	0.39	Moulton *et al.* (2002)[d]
1998	-	-	-	0.35	Moulton *et al.* (2002)[d] Richardson and Williams (2002)
1999	0.7 (Dec)	0.25	Richardson and Williams (2001)	0.56	Moulton *et al.* (2002)[d] Richardson and Williams (2002)
2000	1.20 (May) 0.46 (Nov-Dec)	0.42 0.16	Richardson and Williams (2001) Richardson and Williams (2002)	0.47	Richardson and Williams (2002)
2001	0.76 (March) 0.93 (May	0.27 0.32	Richardson and Williams (2002)	0.54	Richardson and Williams (2002)
2002	0.93	0.32	Richardson and Williams (2002)	0.83	Richardson and Williams (2004)
2022	0.68	0.24	Quakenbush *et al.* (2022)	-	-
2023	0.83	0.29	Quakenbush *et al.* (2023)	-	-
Mean Density[d]	**0.49 seals/km²**				

[a] Assuming 2.85 seals use a single structure (Kelly *et al.* 1986), ringed seal density based on number of structures was calculated by dividing the number of structures by 2.85. This is likely to a conservative estimate of ringed seal density (Kelly *et al.* 1986).
[b] If a range of densities were reported, the highest value is shown here.
[c] Data from Sector B2 at 0-3.7 km from is shown here; Sector B2 is located between Lonely DEW Line and Oliktok Point.
[d] Moulton et al (2002) data include areas <3m water depth which are representative of the ice route action area.

6.1.2.2 Summer and Fall Ringed Seal Densities

Following spring pupping, ringed seals tend to range considerable distances from their natal sites, thereby reducing summer densities in the action area. Summer aerial surveys of ringed seals in the central Alaskan Beaufort Sea by ADF&G began in the early 1970s (Burns and Harbo 1972). The number of seals expected to be in the action area during the open-water season (i.e., July – October) is likely to be much lower than the ice-covered months.

Hauser *et al.* (2008) summarized sighting data from a 2008 seismic survey (inside and outside the barrier islands) near Thetis Island north and east of the action area. Hauser *et al.* (2008) states: “Most seal sightings were made in the “deep” waters seaward of the barrier islands (~76% of 38 sightings) vs. the “shallow” waters shoreward of the barrier islands...”. Narwhal’s action area is most similar to what Hauser *et al.* (2008) defined as “shallow” waters. Table 5.10 from Hauser *et al.* (2008) reported a seal density for all species combined of 0.11 seals/km^2 for shallow waters during open-water conditions. While this average seal density based on actual observations do not reflect seals that may not have been visible to observers, several publications acknowledge that during open-water months, ringed seals are more abundant farther offshore (Harwood and Stirling 1992, Kelly *et al.* 2010b, McLaren 1958, Von Duyke *et al.* 2020). For example, 1999 aerial surveys conducted over 8 days near Prudhoe Bay reported that the density of seals visible near shore decreased compared to the density offshore (Richardson and Williams 2000b). This application uses a summer density for ringed seals of 0.24 seals/km^2 (i.e., 50% of the estimated winter/spring density of 0.49 seals/km^2) (Table 6-3).

6.1.3 BEARDED SEAL DENSITIES

At present, there is no official population estimate for bearded seals occupying the Beaufort Sea (Muto *et al.* 2022). Bearded seals prefer the continental shelves of the Bering, Chukchi, and Beaufort seas where they feed on benthic prey (Burns and Eley 1978, Burns and Harbo 1972) and during the open-water months, the most favorable bearded seal habitat is found in the central or northern Chukchi Sea along the margin of the pack ice (Bengtson *et al.* 2005). The Beaufort Sea continental shelf is narrower, and the pack ice edge frequently occurs seaward of the shelf and over water too deep for seals to forage (Kelly *et al.* 2010b, Muto *et al.* 2022). Therefore, few bearded seals are expected to occur in the Beaufort Sea as compared to the Chukchi or Bering seas.

Across all seasons, bearded seals are more commonly encountered during the open-water season in the Beaufort Sea than during fall and winter months. Bearded seals favor pack ice with natural openings such as cracks for breathing as well as areas of open water for foraging (Burns and Frost 1979); they also tend to avoid continuous areas of landfast ice and unbroken drifting ice (NMFS 2020). During the ice-covered season, some bearded seals may remain in the Beaufort Sea, though the majority of the population migrates west into the Bering and the Chukchi Seas during winter months (NMFS 2020). The few bearded seals that remain in the Beaufort are generally encountered farther offshore (32-161 km) in the pack ice (NMFS 2012). Therefore, bearded seals are not expected to occur in WHB where landfast or grounded ice is present during winter. For the period 2000 to 2009, only one bearded seal was observed during the open-water season in an area approximately 40 km east of Oliktok Point and 120 km east of WHB. For this reason, bearded seals would not be exposed to Narwhal’s winter activities and Level B takes of bearded seals are not considered for such activities.

Hauser *et al.* (2008) documented that marine mammal surveys in the Beaufort Sea during seismic surveys in August and September 2008, reported 52% of the seal sightings as unidentified seals, about 18% as bearded or spotted seals and 11% as ringed seals. Funk *et al.* (2010) reported seal sightings from vessel-based monitoring during seismic operations in the Beaufort Sea 2006 – 2008. While the area surveyed was farther offshore (and not in WHB), Funk *et al.* (2010) stated ringed seal were the most frequently identified seal species (33% of total sightings) followed by bearded and spotted seals over the 4-year period (see Table 6-4). Therefore, to estimate the number of bearded seals in the action area, the estimates are calculated as a proportion of ringed seals observed as report by Funk *et al.* (2010). Based on the number of ringed seals observed in water, approximately 20% were bearded seals, 35% were spotted seals. Based on these ratios, bearded seal summer/fall density is estimated as 0.05 seals/km^2 or 20% of the summer ringed seal density (see Section 6.1.2.2).

TABLE 6-4. NUMBER OF SEAL SIGHTINGS RECORDED FROM VESSELS OPERATING IN THE BEAUFORT SEA 2006 – 2008

Species	2006	2007	2008	*Total*
Seals in Water				
Bearded Seal	13 (14)	31 (41)	91 (95)	***135 (150)***
Ribbon Seal	0	0	3 (3)	***3 (3)***
Ringed Seal	56 (64)	84 (91)	523 (612)	***663 (767)***
Spotted Seal	50 (59)	57 (86)	89 (125)	***196 (270)***
Unidentified Seal	187 (197)	121 (140)	657 (813)	***965 (1150)***
Unidentified Pinniped	0	2 (2)	15 (15)	***17 (17)***

Source: Funk *et al.* (2010)

6.1.4 SPOTTED SEAL DENSITIES

Spotted seals occur in low numbers during open-water conditions (generally mid-July through mid-November) in the Beaufort Sea. Spotted seals may occur in low numbers along the Alaskan Beaufort Sea coast (Boveng *et al.* 2009), though a reliable population estimate is not available (Muto *et al.* 2022). At the onset of freeze up in the fall, spotted seals return to the Chukchi Sea and continue south to the Bering Sea where they spend the winter and spring (Boveng *et al.* 2009, Von Duyke *et al.* 2020). Thus, spotted seals are not present during the ice-covered winter season.

As described for bearded seals in Section 6.1.3, spotted seal density during the open-water season was calculated as a proportion of the ringed seal summer density based on the percentage of pinniped sightings during monitoring surveys in 2008 near Thetis Island (Funk *et al.* 2010, Hauser *et al.* 2008). Therefore, spotted seal density is estimated as 0.09 seals/km^2 or 35% of the summer ringed seal density (see Section 6.1.2.2).

6.2 MARINE MAMMAL EXPOSURES DURING SUMMER ACTIVITIES

6.2.1 MORTALITY OR PHYSICAL DISTURBANCE DUE TO PRESENCE OF EQUIPMENT AND VESSELS

Disturbance of marine mammals due to the presence of vessels and underwater equipment is possible during 3D seismic operations and vessel transit. For the period 1975 through 2002, 292 ship strike reports of large whales were reviewed by (Jensen and Silber 2003). According to the ship strike database, Jensen and Silber (2003) show that 48 ship strikes (16.4%) resulted in injury and 198 (68%) were fatal. The average vessel speed in 58 of the reported strike cases was 18.6 knots, with speed ranges falling into one of three categories: 13 to 15 knots, 16 to 18 knots and 22 to 24 knots (Jensen and Silber 2003). Possibly due to their smaller size and more agile nature, ship strikes of pinnipeds and smaller cetaceans are not common. Low vessel speed and route selection can reduce vessel-marine mammal interactions.

As described in the 2012 Biological Opinion for Northstar (NMFS 2012), "…between 1976 and 1992, only three ship strike injuries were documented out of a total of 236 bowhead whales (0.01%) examined from the Alaskan subsistence harvest (George *et al.* 1994)". Bowhead whales have been documented to allow slow moving vessels that do not change direction or speed suddenly to approach within several hundred meters, indicating some level of tolerance of vessel presence (Heide-Jørgensen *et al.* 2021, Richardson *et al.* 1995, Wartzok *et al.* 2003).

Proposed mitigation measures described in Section 11.1 include but are not limited to reducing vessel speed and avoiding multiple changes in direction. Barges and other larger vessels associated with the Narwhal project follow established shipping lanes and/or be in close proximity to shore or inside barrier islands. There have been no incidents of ship strike with bearded or ringed seals documented in Alaska (BOEMRE 2011). Bearded, ringed and spotted seals are not expected to be at risk for vessel strike also due to their agile nature and reduced vessel speeds within WHB. Also, bearded seals are more likely to be farther out from shore than where vessels may be transiting, further reducing the risk of interaction.

Vessel strike of bowhead whales is not expected due to the mitigation measures such as low vessel speeds and the evidence described in this section from (Heide-Jørgensen *et al.* 2021, Richardson *et al.* 1995, Wartzok *et al.* 2003). Seals are not expected to be struck by vessels due to their agile nature and low vessel speeds. For these reasons, injury or mortality due to marine mammal-vessel interactions is not included in the take estimate. Potential behavioral disturbance due to the presence of vessels and in-water equipment are accounted for in the exposure estimate by considering the area of disturbance (see Section 6.2.3).

6.2.2 ACOUSTIC THRESHOLD CRITERIA FOR MARINE MAMMALS

A noise-induced threshold shift (TS) is ascribed to animals that have been exposed to sufficiently intense sounds and experience an increased hearing threshold (i.e., poorer sensitivity) for some period following exposure. If the TS eventually returns to zero (i.e., the threshold returns to the pre-exposure value), it is called a TTS. If after a relatively long interval (on the order of weeks), the TS does not return to zero, the residual TS is called a noise-induced PTS.

The 2024 NMFS guidance identifies the received levels and auditory weighting functions at which marine mammals are likely to experience changes in their hearing sensitivity (either temporary or permanent) for acute (<24 hours), incidental exposure to underwater or in-air anthropogenic sound sources (NMFS 2024). These groups and their generalized hearing ranges are shown in Table 6-5. Only LF cetaceans and phocid pinnipeds may occur in the action area. Ringed, bearded and spotted seals are phocids, while bowhead whales are LF cetaceans.

TABLE 6-5. GENERALIZED HEARING RANGES FOR MARINE MAMMAL HEARING GROUPS

Hearing Group	Species	Hearing Range
Underwater		
Low-frequency (LF) cetaceans	Bowhead, Humpback, Fin, Gray, Minke Whales	7 Hz to 36 kHz
High-frequency (HF) cetaceans	Beluga and Killer Whales	150 Hz to 160 kHz
Very high-frequency (VHF) cetaceans	Harbor and Dall's Porpoises	200 Hz to 165 kHz
Phocid pinnipeds (PW)	Ice Seals, Harbor Seals	40 Hz to 90 kHz
Otariids and other non-phocid marine carnivores (OW)	Steller Sea Lions	60 Hz to 68 kHz
In Air		
Phocid pinnipeds (PA)	Ice Seals, Harbor Seals	42 Hz to 52 kHz
Otariids and other non-phocid marine carnivores (OA)	Steller Sea Lions	90 Hz to 40 kHz

Source: NMFS (2024)
Gray shading indicates species not likely to occur in the action area.

Acoustic thresholds for generating auditory injury defined as PTS (Level A harassment) in marine mammals are described in (NMFS 2024). A dual metric approach considering both cumulative sound exposure and peak sound levels was used to determine the PTS for impulsive sounds such as those generated by airguns. Auditory threshold criteria for impulsive sounds are shown in Table 6-6. As defined in the Technical Acoustic Guidance (NMFS 2024), different thresholds and auditory weighting functions are provided for different marine mammal hearing groups. NMFS assumes that marine mammals exposed to impulsive underwater sounds with received levels ≥160 dB re 1 µPa (root mean square [rms]) have the potential to be disturbed behaviorally (i.e., Level B incidental harassment).

TABLE 6-6. ACOUSTIC THRESHOLD CRITERIA FOR MARINE MAMMALS

Hearing Group	Impulsive Sources (Seismic)		
	Level A Dual Criteria		Level B (dB rms)
	(dB Peak SPL)	(dB SEL_{24hr})	
Underwater			
LF cetaceans (*bowhead whales*)	222	183	160
HF cetaceans[b]	230	193	
VHF cetaceans[b]	202	159	
Phocid pinnipeds (PW) (*ice seal species*)	223	183	
Otariid pinnipeds and other non-phocid carnivores (OW)	230	185	
In Air			
Phocid pinnipeds (PA)	162	140	100[c]
Otariid pinnipeds (OA)	177	163	

Sources: NMFS (2023, 2024)

[a] All dB levels are referenced to 1 µPa for underwater sources and 20 µPa for sources in air. Only LF cetaceans and phocid pinnipeds (PW) may occur in the action area.

[b] Gray shading indicates species not likely to occur in the action area.

[c] Pinnipeds other than harbor seals (NMFS 2023, Southall *et al.* 2007).

6.2.3 DISTURBANCE DUE TO UNDERWATER SOUND DURING OPEN WATER (SUMMER 2025)

Three-dimensional seismic activities in WHB may result in incidental harassment of bowhead whales or ringed, bearded or spotted seals in the action area due to underwater sound. The following subsections describe how potential exposure of marine mammals to seismic sounds during Narwhal's activities have been accounted for in the exposure estimate based on the criteria presented in Section 6.2.2.

6.2.3.1 Underwater Acoustic Modeling Results for the Single Seismic Airgun

To assess the potential for exposure to underwater sounds that might exceed NMFS regulatory thresholds during seismic surveys, in October 2024, Narwhal conducted noise modeling of the single 105 cu. in. airgun using sound source levels shown in Table 6-7 based on Gundalf Designer software (Gundalf Cloud vC8.3n 2024). Please also refer to Appendix B for acoustic modeling results and supplemental information. The estimated distances discussed in this section are used for evaluating potential effects on NMFS-managed species. In addition, for comparison, the 2024 NMFS user spreadsheet as "a means to estimate distances (isopleths) associated with the Technical Guidance's PTS onset thresholds" (NMFS 2024). The results using the NMFS user spreadsheet tool, when adjusted to apply a number of 192 airgun pulses in a 24-hour period and a propagation loss coefficient of 10 to account for the very shallow water in the action area (i.e., due to numerous reflections from the seafloor and water surface), the results are comparable to the modeling described in this section.

TABLE 6-7. SOURCE LEVELS FOR THE SINGLE SEISMIC AIRGUN

Source Levels	3D Source
Peak sound pressure level (Pk SPL) (dB re 1 µPa @ 1 m)	231
Root-mean-square sound pressure level (rms SPL) (dB re 1 µPa @ 1 m with a 90%-energy pulse duration of 12.5 milliseconds)	204
Sound exposure level (SEL) (dB re µPa2·s @ 1 m)	193

Source: SLR (2024)

The noise source was assumed to be omnidirectional and modeled as a point source. With the known noise source levels, either frequency-weighted or unweighted, the received noise levels are calculated following the procedure outlined below based on SLR (2023).

- One-third octave source spectral levels are obtained, either via spectral integration of linear source spectra for the seismic sources, or via empirical formula;
- Transmission loss is calculated using the Parabolic Equation numerical algorithm at one-third octave band central frequencies from 8 Hz to 800 Hz, based on an average 10 m source depth corresponding to the most relevant source scenarios (see Shallow water limitations below). The acoustic energy of higher frequency range (> 1 kHz) is significantly lower, and therefore, is not included in the modeling;
- Propagation paths for the transmission loss calculation have a maximum range of up to 200 km and bearing angles with a 10-degree azimuth increment from 0° to 350° around the source locations. The bathymetry variation of the vertical plane along each modeling path is obtained via interpolation of the bathymetry dataset;
- The one-third octave source levels and transmission loss are combined to obtain the received levels as a function of range, depth, and frequency;
- The overall received levels are calculated by summing all frequency band spectral levels.
- Cumulative SEL has been assessed for 192 airgun shots (one transect line); and
- Peak SPL has been assessed for single airgun shot.

Previous empirical studies demonstrate that at relatively close distances from the airgun sources (within 1.0 km), the difference between SELs and rms SPLs could be between 10 dB to 15 dB (Austin *et al.* 2013; McCauley *et al.* 2000). The differences could drop to under 5 dB when the distances are close to 10 km (Austin *et al.* 2013). The differences are expected to drop further with increasing distances beyond 10 km (Simon *et al.* 2018).

For this project, the RMS SPLs were estimated using the following conversion factors to be applied to the modeled SELs within different distance ranges. These conversion factors are conservatively estimated based on the single airgun modeling results and above previous measurement results:

- 0-100 m, a conversion factor of 11 dB. This is the difference between RMS SPL and SEL of the far-field signature of the 105 cu. in. G-Gun array as modeled in the far-field section;
- 100-1,000 m, conversion factors 11 to 10 dB, following a logarithmic trend with distance;
- 1,000-10,000 m, conversion factors 10 dB to 5,0 dB, following a logarithmic trend with distance;

- 10,000-100,000 m, conversion factors 5.0 dB to 0.0 dB, following a logarithmic trend with distance; and
- 100,000 m, a conversion factor of 0.0 dB.

Shallow water challenges and limitations

The shallow environments of the northern coast of Alaska present challenges and limitations which are detailed below:

- The region examined in this study presents unique challenges in terms of modeling how sound travels underwater due to the extreme shallowness & flatness (slope) of the region (e.g. depths of 4-5 m persist 10 to 20 km offshore) as most types of underwater acoustic models run on standard "depth" grid size of 10 m.
- A hydrographic survey or acquisition of a bathymetric dataset (with greater than 4-arc second resolution) is strongly recommended before conducting additional modeling or estimating impact zones. The interaction of sound over long ranges and shallow depths is best described as a combination of nearly cylindrical spreading (e.g., a transmission loss coefficient of 10) combined with losses from multiple reflections between the water surface and seafloor (which occur increasingly in shallow waters).
- Specialized and "hybrid" models (employing separate methodologies for low and high frequencies) are available. When high-resolution bathymetry of the area is available, they can account for acoustic energy above 1 kHz. The acoustic energy of the 105 CUI source is clearly concentrated in lower frequency bands; however, this does not mean that marine mammals belonging to higher frequency hearing groups (e.g., VHF) do not perceive some of the higher frequency components of the source spectrum.

6.2.3.2 Estimated Distances to Level A Thresholds During Seismic Operations

Level A distances were modeled for the single 105-cu. in. airgun, which is considered an impulsive, mobile source. Estimated distances to Level A thresholds for weighted SEL_{24hr} are presented in Table 6-8 (also see Appendix B). Seismic surveys will be conducted one site at a time. As described in Section 1.3.1.4, each survey block is approximately 2,400 m by 2,400 m in area. The airgun will fire every 12.5 m along a track line (i.e., every 6 or 7 seconds traveling at a speed of 2 m/s). Therefore, there will be an estimated 192 airgun shots per track line. The area of ensonification for the seismic survey was calculated by multiplying the estimated distances (in km) to the NMFS thresholds by the distance of the seismic track line (in km) to be surveyed each day. A single track line is approximately 2 km in length, which will take approximately 20 minutes to shoot assuming a vessel speed of 2 m/s. In a 24-hour period, assuming no delays, the survey team will be able to collect data for approximately 10 km within a site over a period of 12 hours. The following equation is used to estimate the ensonified area:

Mobile Ensonification Area (km^2) Equation = Distance*(2*Threshold Value/1000)+(Pi*(Threshold Value/1000)^2)

For comparison, using the 2024 NMFS use spreadsheet tool to estimate potential distances of the single 105 cu. in. airgun at a source level of 201.4 dB (SEL), none of thresholds were reached for the cumulative (SEL cum) thresholds for phocid pinnipeds, otariid pinnipeds, or LF cetaceans.

The estimated Level A distance for LF cetaceans is 1,076 m and the estimated distance for phocids is 322 m from the seismic source vessel while the airgun is operating. Underwater sounds are expected to be truncated by land given the location of most sites in WHB. Nonetheless, a 1,100-m shutdown will be implemented if a bowhead whale is observed at that distance. The NMFS recommended Exclusion Zone (EZ) for Tier 2[15] seismic sources is 100 m. Thus, a 350-m shutdown zone will be implemented for pinnipeds. The exposure analysis excel workbook submitted with this application includes a detailed description of these inputs used to calculate exposures during seismic activity.

TABLE 6-8. ESTIMATED DISTANCES TO CUMULATIVE LEVEL A THRESHOLDS FOR THE SINGLE AIRGUN DURING SEISMIC SURVEY OF A TRACKLINE (192 AIRGUN PULSES)

Hearing Group	Maximum Horizontal Perpendicular Distances (m) from Assessed Survey Lines to Cumulative Level A PTS (weighted SEL_{24hr}) Thresholds	
Low-frequency cetaceans (LF) (*bowhead whales*)	183	1,076
Phocid pinnipeds in water (PW) (*ice seal species*)	183	322
Otariid pinnipeds and other non-phocid carnivores (OW)	185	--

Note: All dB levels are referenced to 1 µPa. Cumulative levels are weighted for the hearing group for assessment to the threshold. A dash indicates threshold not reached.

6.2.3.3 Estimated Distances to the Level B Thresholds During Seismic Operations

The estimated distance to the 160 dB re 1 µPa Level B threshold for the single 105-cu.in. airgun (considered an impulsive source) based on noise modeling for Site 10 was 3,188 m.

By using the following equation, the total ensonified area per day is estimated to be 337.98 km^2.

Mobile Ensonification Area (km^2) Equation = Distance*(2*Threshold Value/1000)+(Pi*(Threshold Value/1000)^2)

Sites 10 and 11 are located farther from shore than the other sites and have similar water depths (<10 m). The remaining sites are located close to shore, where water depths are <3 m on average. For these reasons, noise modeling for Site 10 represents the greatest area to which underwater sound is likely to extend during open-water seismic. In addition, given the close proximity to shore, some sound is likely to be truncated by land to a certain extent. Therefore, the area to be ensonified during seismic is likely to be less than 337.98 km^2. Nonetheless, this application uses the area of 337.98 km^2 to estimate exposure to underwater sounds that could result in Level B harassment.

6.2.4 SUMMER EXPOSURE ESTIMATE

Marine mammal exposures were estimated based on the total ensonified area for Level B harassment, as shown in Table 6-9. Level A (weighted SEL_{24hr}) harassment thresholds were not reached for any species with the exception of LF cetaceans (bowhead whales), which was 1,076 m. Bowhead whales are not expected to be present at shallow water depths in WHB and Narwhal plans to implement a 1,100-m

[15] Tier 2 includes single airguns or smaller arrays.

shutdown zone for any bowhead whale sited at that distance during seismic surveys. For this reason, Level A takes are not requested. Table 6-9 summarizes total Level B estimated exposures during 3D seismic activities in summer 2025. For detailed calculations, see Appendix C. Please see Sections 11 and 13 for additional detail on mitigation and monitoring measures.

TABLE 6-9. ESTIMATED LEVEL B EXPOSURES OF MARINE MAMMALS DURING OPEN WATER 2025 SEISMIC WITHOUT MITIGATION

	Area Ensonified (km^2)	Bowhead Whale Summer/Fall Exposures	Bearded Seal Summer/Fall Exposures	Spotted Seal Summer/Fall Exposures	Ringed Seal Summer/Fall Exposures
		Densities			
		0.009	***0.05***	***0.09***	***0.24***
Level B (rms SPL)	337.98	17.74	98.83	172.96	494.16

6.3 MARINE MAMMAL EXPOSURES DURING WINTER ACTIVITIES

6.3.1 MORTALITY OR SERIOUS INJURY DURING SEA ICE TRAIL, ROAD OR PAD CONSTRUCTION OR OPERATIONS

In the late 1990s, one ringed seal mortality associated with a vibroseis program outside the barrier islands east of Bullen Point in the eastern Beaufort Sea was reported (MacLean 1998b). During a 1999 NMFS workshop to review on-ice monitoring and research, Dr. Brendan Kelly (then of the University of Alaska), also indicated that a dead ringed seal pup was found during research using trained dogs to locate seal structures in the ice. The dead ringed seal pup was located approximately 1.5 km from the Northstar ice road. No data on the age of the pup, date of death, necropsy results, or cause of death are available. Therefore, whether ice road construction or other industry-related activities contributed to the death of this pup could not be determined (Richardson and Williams 2000a). These are the only reported ringed seal mortalities during industry activities in winter months along the Beaufort Sea coast over a period of more than 20 years.

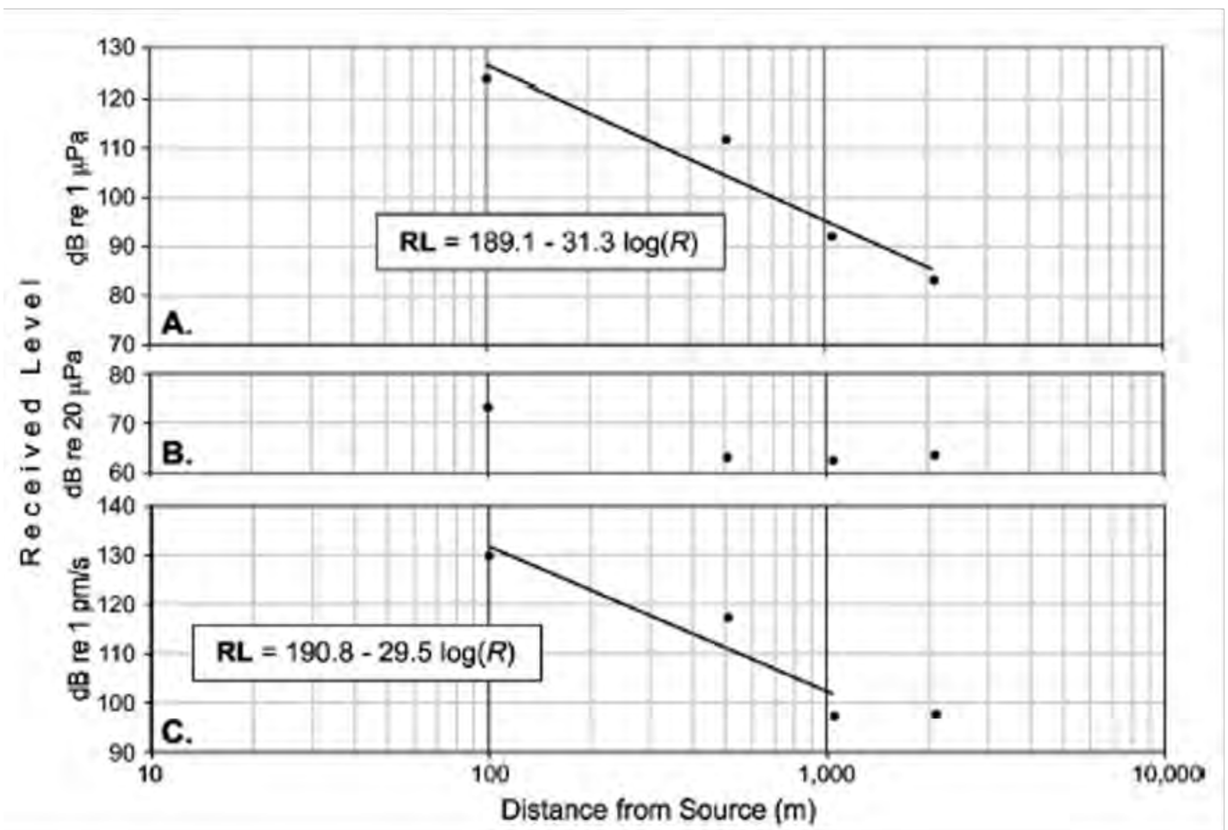
Narwhal's sea ice trail from Oliktok Point to WHB and the sea ice trails/roads within WHB are primarily on grounded sea ice, which is not considered preferred ringed seal habitat. Therefore, mortality or serious injury during construction of small portions of the coastal sea ice trail along the Colville River Delta or sea ice trails/roads that extend offshore in WHB are not expected. In addition, specific mitigation measures including but not limited to initiating ice trail/road construction for offshore portions prior to March 1st will minimize the potential to overlap with ringed seal lairs. For this reason, Narwhal is not requesting takes for mortality or serious injury due to sea ice trail/road construction.

6.3.2 BEHAVIORAL DISTURBANCE DURING SEA ICE TRAIL CONSTRUCTION

Activities on sea ice during the winter (i.e., November through April) may disturb ringed seals. As described previously, no other species is expected to be in the action area during winter months.

Specific measurements during ice road construction at Northstar provide insight about the potential propagation of noise underwater (in ice conditions) during such activities. Greene *et al.* (2007) reported underwater and airborne sounds that were recorded in sea ice during construction of Northstar February through May 2000. Construction sounds and vibration that were recorded included ice augering, pumping sea water to flood the ice and build an ice road, a bulldozer plowing snow, a Ditchwitch cutting ice and trucks hauling gravel over the ice road. Recordings were made over a range of distances (approximately 40 to 5,300 m) along transects that extended out across landfast ice from the sound source. Each recording station was about twice as far from the sound source as the previous location, but pressure ridges often prevented transects being straight lines. During ice road construction, field recordings were collected between 100 to 2,100 m on February 1st and again February 2nd between 97 to 1,200 m. Based on these measurements, Greene *et al.* (2008) reported received levels of 120 dB re 1 μPa (Level B threshold for continuous sound) for overall ice road construction at approximately 170 m, as shown in Figure 6-2. Figure 6-3 shows broadband levels of sounds at 100 m underwater during ice trail/road construction (left three [hydrophone measurements] and right three [geophone measurements] columns). The ice road regression (see Figure 3 in Greene *et al.* (2008)) was used for the bulldozer, auguring and pumping sounds except for airborne data, for which spherical spreading (20 log(R)) was assumed.

FIGURE 6-2. BROADBAND RECEIVED SOUND LEVELS VS. DISTANCE FOR GENERAL ICE ROAD CONSTRUCTION ACTIVITIES AT NORTHSTAR IN 2000



Source: Greene *et al.* (2008).

Background noise recorded during the Northstar study ranged from 77 to 116 dB re 1 µPa underwater (Greene *et al.* 2007). During ice road construction, the highest recorded sound underwater for all ice road activities was 189 dB re 1 µPa (using 31.3 logR), which was associated with a bulldozer. Distance from sound sources was 100 m. The results for bulldozers from three devices (hydrophone, microphone and geophone) were quite variable and reported as 114.2 dB, 64.7 dB and 129.8 dB, respectively. Ice road construction activity was difficult to separate into individual components given that one or more machines may be working at the same time. Other activities including the use of ice augers and pumping were below 115 dB (Greene *et al.* 2007). Importantly, the water depth at Northstar is approximately 11 m, whereas in WHB, proposed exploration sites are in waters where the average depth is less than 3 m. WHB sea ice roads are likely to be on grounded ice. Likewise, the majority of the coastal sea ice trail (except portions within the Colville River Delta) will also be on grounded ice. Therefore, sounds during ice trail, road and pad activities will expected be much less during Narwhal's activities than the levels reported for Northstar in 2000.

Distances to median background levels for the strongest one-third octave bands for bulldozers, auguring, and pumping during ice road construction at the Northstar facility in 2000 was <1 km for in-air sounds (Greene *et al.* 2008). Greene *et al.* (2008) describes that ice road construction activities were difficult to separate into individual components because equipment was often working concurrently. Therefore, broadband sound levels as a function of distance were reported for the ice road construction activity as a whole (Greene *et al.* 2008). For airborne sounds, see Figure 6-3, middle three columns (Greene *et al.* 2008).

FIGURE 6-3. SUMMARY OF LEVELS OF SOUND AND VIBRATIONS DURING ICE ROAD CONSTRUCTION ACTIVITIES AT NORTHSTAR IN 2000

	Hydrophone (10–10,000 Hz)			Microphone (10–10,000 Hz)			Geophone (10–500 Hz)		
Sound Source	Broadband @ 100 m (dB re 1 µPa)	Center of strongest 1/3 OB (Hz)	Distance to 0 dB S/N in 1/3 OB (m)	Broadband @ 100 m (dB re 20 µPa)	Center of strongest 1/3 OB (Hz)	Distance to 0 dB S/N in 1/3 OB (m)	Broadband @ 100 m (dB re 1 pm/s)	Center of strongest 1/3 OB (Hz)	Distance to 0 dB S/N in 1/3 OB (m)
Bulldozer	114.2	63	1163	64.7	10	73	129.8	10	3613
Augering	103.3	250	1702	67.9	20	389	104.3	10	338
Pumping	108.1	800	1832	72.0	12.5	168	111.1	12.5	582
					50	631			
Ditchwitch	122.0	20	7292	76.3	12.5	612	121.9	16	9963
Trucks	123.2	160	3256	74.8	80	828	126.2	10	3310
Backhoe	124.8	10	3275	NA	NA	NA	145.7	12.5	2500
Vibr.sheet	142.9	25	2930	81.0	50	2,822	146.1	25	1207

Source: Greene *et al.* (2008).

Richardson and Williams (2001) reported that during construction in 2000, the most easily distinguishable sounds (to the human ear) were the back-up alarms of heavy equipment, which produced an intermittent tone at 1,571 Hz. Aerts *et al.* (2008) stated that wind speed is one of the most important factors affecting in-air sound measurements; sounds will attenuate rapidly with increasing distance if in-air sounds are measured "upwind".

There is compelling evidence that factors other than received sound level, including the activity state of animals exposed to different sounds, the nature and novelty of a sound, and spatial relations between the sound source and receiving animals (i.e., the exposure context), strongly affect the probability of a behavioral response (Ellison *et al.* 2012). Williams *et al.* (2006) reported that ringed seals exposed to disturbance due to vehicle or human presence maintained breathing holes and lairs for up to 163 days despite the presence of low-frequency industrial noise and vehicular use of ice roads. Ringed seal structures were established within a few meters of the Northstar Development in the landfast ice before and during construction activities.

The Northstar studies seem to indicate that disturbance and displacement effects on seals that may occur are likely subtle and localized (Blackwell *et al.* 2004b, Moulton *et al.* 2002, Moulton *et al.* 2003, Moulton *et al.* 2008, Richardson and Williams 2000b, 2001, 2003). There is no evidence these temporary effects have resulted in biologically significant consequences for individual seals or the seal population. However, Narwhal is requesting authorization for takes due to the potential for ringed seals to be exposed to sound that may cause disturbance during ice trail, road, and pad construction along the Colville River Delta or within WHB, as described in Section 6.3.3.

6.3.3 WINTER EXPOSURE ESTIMATE

Ringed seals are the only marine mammal species under NMFS' jurisdiction that may occur in the project area during winter activities. To estimate exposures of ringed seals to disturbance that may result in a take, the total area of potential disturbance (i.e., exposure area) associated with construction and maintenance of specific portions of the coastal sea ice trail are included in the exposure estimate. The coastal sea ice trail will be on grounded ice; however, the Colville River Delta is included in the take estimate to account for the possibility that ringed seals may occur in that section of the route given the potential for open leads or cracks in the sea ice, which could provide habitat for ringed seals. For the offshore sea ice trails/roads in WHB, water depths at planned pad locations are less than 3 m (average); therefore, ice trails/roads in WHB will be on grounded ice or limited portions of floating ice in water depths between 1.6 m and 3 m.

While there are two options for mobilization, only Option 1 could result in potential Level B incidental take by harassment of ringed seals because Option 2 would involve a snow trail on land. This application uses the estimated exposure assuming Option 1 is chosen to represent potential interactions with ringed seals. As shown in Table 6-10, the exposure area for the linear coastal sea ice trail across the Colville River Delta is defined as 170 m on either side of the ice trail centerline; a total width of 340 m. The total width (340 m or 0.34 km) is then multiplied by a portion of the total length of trail/roads, as described above. The linear distance of the coastal sea ice trail across the Colville River Delta is 57.8 km. To calculate the potential exposure area, linear distance is multiplied by the total width (i.e., 57.8 km * 0.34 km = 19.65 km^2). Total area of exposure (19.65 km^2) is multiplied by the winter/spring ringed seal density (0.49 seals/km^2) to calculate the total estimated ringed seals exposed (see Table 6-1).

TABLE 6-10. ESTIMATED TOTAL LEVEL B HARASSMENT EXPOSURES OF MARINE MAMMALS DURING COLVILLE RIVER DELTA COASTAL SEA ICE TRAIL ACTIVITIES

Activities	Area of Disturbance (km^2)[b]	Ringed Seal Winter/Spring Exposures (0.49 seals/km^2)
Construction of Colville River Delta Portion of Coastal Sea Ice Route[a]	19.65	9.6
Operation of Colville River Delta Portion of Coastal Sea Ice Route	19.65	9.6
Demobilization of Colville River Delta Portion of Coastal Sea Ice Route	19.65	9.6
	TOTAL	**28.7**

[a] The Coastal Sea Ice Route will be on grounded ice; however, the Colville River Delta is included in the take estimate to account for the possibility that ringed seals may occur in that section of the route. WHB sea ice trails/roads will be on grounded ice or floating in areas where water depths are 1.6 to 3 m. Therefore, WHB sea ice trails/roads are not included in the exposure estimate. If Option 2 is chosen for mobilization, the estimated takes would be lower than estimated here because Option 2 would involve an snow trail on land.

[b] Buffers are included as follows: 145 m buffer on either side of ice route; total width = 340 m (0.34 km).

6.4 TOTAL LEVEL B INCIDENTAL HARASSMENT TAKES REQUESTED

Over the 12-month project period beginning August 1, 2025, the total number of estimated Level B incidental harassment takes of bowhead whales, and ringed, bearded, and spotted seals is presented in Table 6-11. Requested Level B takes are based on the exposure estimates rounded to the nearest whole number to account for the possibility that these species may occur in the action area during project activities. Total Level B for ringed seals includes exposures during the open-water season and the ice-covered season. No other species will be in the action area during ice-covered conditions. Level B takes for bowhead whales are not likely to occur, as these large whales are not likely to come within 3,188 m of seismic operations given the shallow depths in WHB; large whales have historically been sighted further offshore (see Section 4).

TABLE 6-11. TOTAL REQUESTED INCIDENTAL LEVEL B HARASSMENT TAKES OF MARINE MAMMALS

Species	Requested Level B Takes[a]
Bowhead Whales	18
Ringed Seals	552
Bearded Seals	99
Spotted Seals	173

[a] Requested Level B takes were rounded to the nearest whole number.

[b] Total Level B for ringed seals includes both open-water season and ice-covered season exposures. No other species will be in the action area during ice-covered conditions.

7 ANTICIPATED IMPACT OF THE ACTIVITY ON SPECIES AND STOCKS

7.1 MORTALITY AND SERIOUS INJURY

Marine mammal mortality is not likely to occur as a result of Narwhal's activities in WHB, as mitigation measures (i.e., reduced speeds, avoidance measures, etc.) to be employed during vessel transit or vessel operations during seismic activities would avoid this impact. Additionally, with the implementation of mitigation measures such as pre-survey clearance and a shutdown zone for bowhead whales (i.e., 1,100 m), serious injury will not occur as a result of project activities in WHB (see Sections 5 and 6). Therefore, no takes for mortality or serious injury are requested in this application.

7.2 HEARING IMPAIRMENT AND NON-AUDITORY INJURY

Level A harassment due to hearing impairment or injury is not anticipated due to the mitigation measures that would avoid exposure to underwater sounds from Narwhal's activities in WHB, as described in Sections 6.1 and 6.2.

The distances to Level A thresholds for cumulative SEL_{24hr} were 1,076 m for LF cetaceans (bowheads) and 322 m for phocid pinnipeds (ringed seals). Level A thresholds were not reached for any other species group. Bowhead whales are not likely to be in WHB given the shallow water, nor are they likely to approach the vessel at this close range. In addition, a 1,100-m shutdown zone will be implemented if a bowhead whale is observed within this distance when the seismic airgun is firing, and a 350-m shutdown zone will be implemented for ringed seals. Level A takes due to sound exposure from seismic surveys are not requested.

Injury due to vessel transit or sea ice trail, road and pad construction and operation are not expected due to mitigation measures such as low vessel speeds less than 7 knots during SHS and seismic surveys in WHB (less than 5 knots if a marine mammal is sighted), initiating all sea ice trail/road construction in waters that may be greater than 3 m prior to March 1st following the NMFS 2020 final rule for sea ice trails/roads (NMFS 2020) and the use of observers to monitor for the presence of marine mammals during project activities (see Sections 11 and 13).

Artificial and natural sounds can disrupt behavior by masking. The masking of communication signals by anthropogenic noise may be considered as a reduction in the communication space of animals (Clark *et al.* 2009). Erbe *et al.* (2016) reviewed the current state of understanding of masking in marine mammals, including anti-masking strategies for both receivers and senders. When a signal and noise are received from different directions, a receiver with directional hearing can reduce the masking impact. This is known as spatial release from masking, and this ability has been found in dolphins, killer whales and harbor seals. Further, animals may attempt to counteract masking by increasing the source level of their vocalizations in the presence of noise. Given the hearing abilities of marine mammals, it is likely that most, if not all, species have this ability to some extent (Erbe and JASCO Applied Sciences Inc. 2011).

7.3 DISTURBANCE REACTIONS AND LEVEL B HARASSMENT

Exposure to underwater sounds can result in behavioral changes ranging from indifference, partial or total avoidance of the sound source, changes in animal movement (migratory route), swimming speed, respiratory, surfacing and diving behavior (Breitzke *et al.* 2008), or calling rates or behavior (Blackwell *et* *al.* 2015, Thode *et al.* 2020). Behavioral responses are highly variable and as such, cannot be unequivocally related to received sound levels (Wartzok *et al.* 2003). In 2017, a 207.5-cu. in. airgun was measured using drifting recorders over a period of about 4 hours. Received pulse SELs for the 207.5-cu. in. airgun were reported to decrease below 130 dB re 1 µPa^2 s by 2.5 km and background levels were reached at approximately 3 km (Heide-Jørgensen *et al.* 2021).

Data collected during an aerial survey from 2006 to 2008 in the Alaskan Beaufort Sea indicated that feeding bowheads did not exhibit large-scale distribution changes in relation to late summer, early autumn seismic operations (Funk *et al.* 2010). Koski *et al.* (2008) reported that aerial surveys conducted in the central Beaufort Sea during late summer and early autumn of 2007 detected large numbers of feeding bowhead whales in an area where feeding has been seen in the past but is not common. While seismic surveys were conducted 10-50 km to the east, whales remained in the same general area and bowheads were seen as close as 1.4 km from the source vessel. Some small-scale avoidance of the seismic operation was reported; however, one group of three whales tolerated received levels of seismic sounds approximately 180 dB re 1 µPa, three groups (five individuals) tolerated levels >170 dB re 1 µPa, and at least 12 groups (19 individuals) tolerated levels 150 to 170 dB re 1 µPa.

Harris *et al.* (2001) documented results of marine mammal monitoring during 3-D seismic surveys between 24 July and 18 Sept 1996 in the Beaufort Sea. A total of 112 shutdowns took place because of seals sighted within the “shutdown radius”. Of the 362 sightings, 19% were beyond 250 m from the source vessel. Seal sightings consisted mostly of ringed seals (92%), bearded seals (7%), and spotted seals (1%). Seals were seen at nearly identical rates during periods with no guns firing, one gun firing, and the full-array firing. However, sighting rates stratified by distance did vary significantly during seismic operations and no seismic operations. The results indicate that seals avoided the zone within 150 m of the vessel during full-array firing operations. However, it appears that few seals moved beyond 250 m from the vessel, as sighting rates beyond 250 m from the vessel did not change significantly with or without seismic operations. Seal behavior (categorized as one of five states) did not very with seismic state.

As described in Wisniewska *et al.* (2014), one method for reducing the potential to cause TTS in marine mammals is to reduce the airgun source level. Decreasing the source level by 6 dB could decrease the ensonified area by nearly half according to Wisniewska *et al.* (2014). Narwhal proposes to use a single airgun similar to the Sercel GI 210 (see Section 1.3), which reduces the potential area ensonified thereby reducing the number of animals that may be exposed to sound levels above Level B thresholds. Sills *et al.* (2020) reported hearing TSs at 400 Hz in seals exposed to four to ten consecutive pulses (cumulative SEL 191–195 dB re 1 lPa2 s; 167–171 dB re 1 lPa2 s with frequency weighting for phocid carnivores in water). Bowhead whales are expected to be outside of the 1,076-m radius from seismic sites given the shallow depths.

While underwater sound during 3D seismic activities has the potential to exceed Level B thresholds out to approximately 3,188 m on average based on noise modeling of previous sites, which were farther from shore (see Section 6.2), disturbance to swimming seals is expected to be minor and temporary. A relatively small number of seals is expected to be in the action area and the estimated takes would only amount to approximately 0.26% of the ringed seal population,[16] 0.04% of the bearded seal population[13] and effectively 0.0% of the spotted seal population.[13] Therefore, Level B exposure numbers (see Table 6-13) will not cause population-level effects. Seismic surveys are expected to last up to 30 days and would only occur up to 7 hours intermittently each day, thereby further reducing the potential for marine mammal exposure to underwater sounds above the 160 dB acoustic threshold for behavioral disturbance. As described in Section 13.3, a 1,100-m monitoring zone will be implemented to document marine mammals out to that distance for required reporting. To account for pinnipeds that may be more difficult to see at that distance (1,100-m), Narwhal will estimate the number of animals potentially exposed to the Level B threshold by multiplying the densities for each species by the area calculated between 1,100 m and 3,188 m.

A seal survey was conducted in 2019 in the project vicinity as part of oil and gas activities. The vessel operator reported that during three vessel transits along the 2-3 m depth contour between Oliktok Point and Harrison Bay, only two seals were sighted (Pers. Comm. M. Fleming; May 17, 2023). Based on monitoring reports by Ireland *et al.* (2016), Patterson *et al.* (2007), there is evidence that seals may avoid seismic operations. Open-water seismic activities involving larger airguns and multiple arrays in the Chukchi Sea in the mid-2000s reported that bearded, spotted and unidentified seal sighting rates were higher during non-seismic periods than periods when airguns were operating. Post-seismic sighting rates were also greater than those during seismic periods. No ringed seals were sighted during non-seismic periods for comparisons. For all species combined, the seal sighting rate for non-seismic periods (67.1 seals/1000 h of “daylight effort”) was significantly greater than the seismic rate (~31.1 seals/1000 h of “daylight effort” $\chi 2 = 13.22$, df = 1, $p < 0.005$ (Patterson *et al.* 2007). Importantly, the seismic operations during this monitoring program included multiple arrays of larger airguns (greater than 3,000 cu. in.) and therefore, would result in measurably greater underwater sound than the single Narwhal airgun.

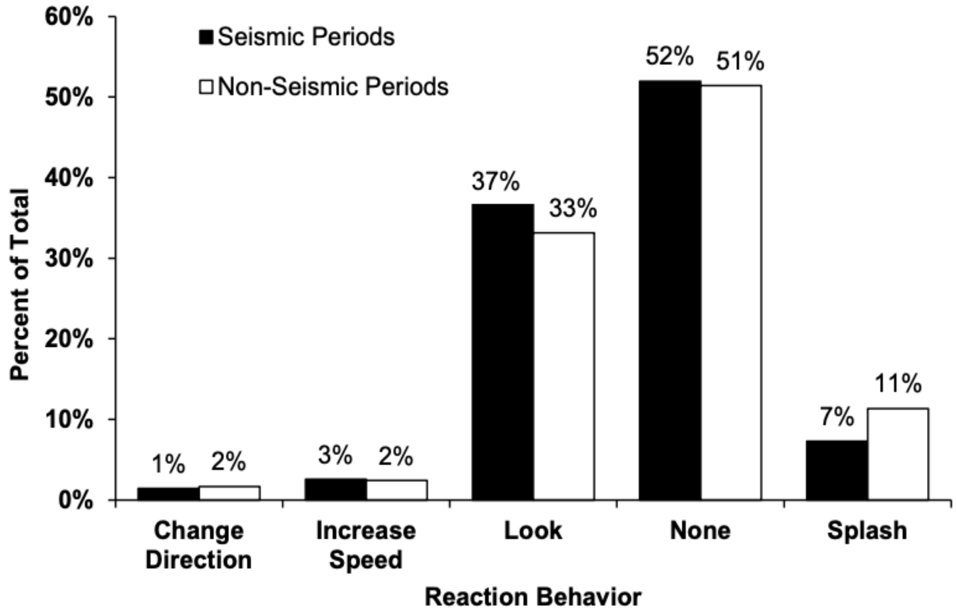
Figure 7-1 presents a comparison of seal reactions between seismic and non-seismic periods in the Beaufort and Chukchi seas between 2006 and 2013. Most seals (>50%) were reported as having no reaction to either period (seismic or non-seismic), while 37% and 33% of seals had a response of “look” to seismic and non-seismic periods, respectively (Ireland *et al.* 2016). Movement patterns reported by Ireland *et al.* (2016) during open-water seismic and non-seismic periods between 2006 and 2013 activities in the Chukchi and Beaufort seas, as shown in Figure 7-2. These data seem to indicate that based on observations, there appeared to be little difference in behaviors during non-seismic and seismic periods. Based on available information, pinnipeds and small odontocetes seem to be more tolerant of exposure to airgun pulses than are baleen whales (NMFS 2008). Nonetheless, a small number of Level B takes is included for potential disturbance due to underwater sounds during 3D seismic operations (see Table 6-11).

Potential Level B incidental takes would be 0.21% of the total population of bowhead whales and will have a negligible effect on the species. Overall, while specific abundance estimates are lacking for the ice seal species (bearded, spotted and ringed seals) the number of Level B incidental takes are low (less

[16] Estimated based on the best available information; see Section 6.

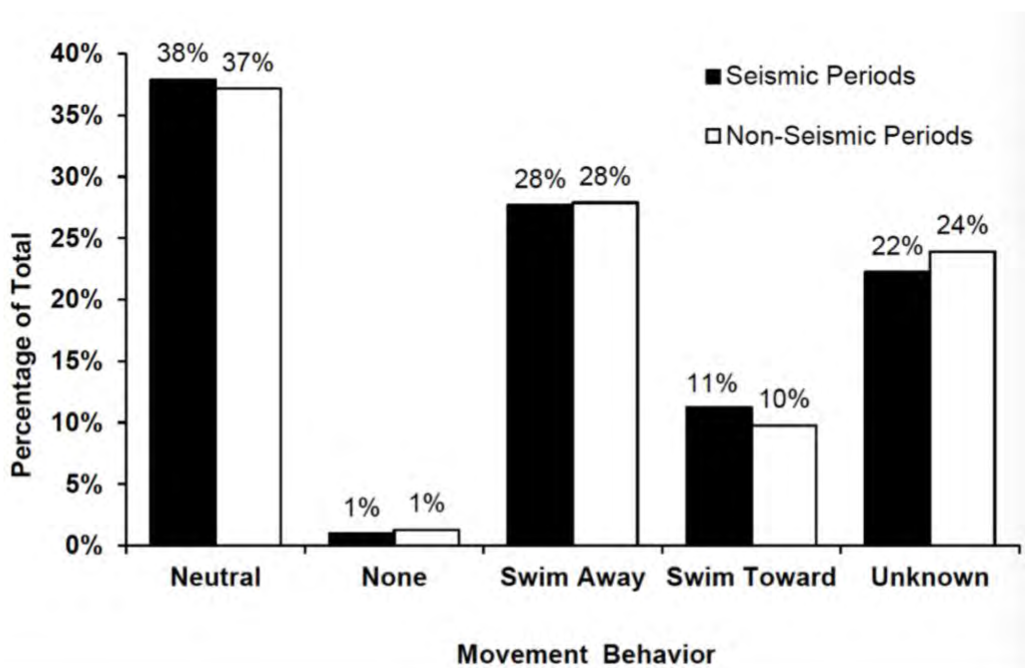
than 1% of any population estimate) relative to the thousands of animals in each population (Muto *et al.* 2022) and is also considered negligible for these populations.

FIGURE 7-1. COMPARISON OF SEAL BEHAVIORS DURING OPEN-WATER SEISMIC AND NON-SEISMIC PERIODS IN THE CHUKCHI AND BEAUFORT SEAS 2006 - 2013



Source: Ireland *et al.* (2016)

FIGURE 7-2. SEAL MOVEMENT BEHAVIORS DURING OPEN-WATER SEISMIC AND NON-SEISMIC PERIODS IN THE CHUKCHI AND BEAUFORT SEAS 2006 - 2013



Source: Ireland *et al.* (2016)

8 ANTICIPATED IMPACTS ON SUBSISTENCE USES OF MARINE MAMMALS

8.1 SUBSISTENCE USE OF BOWHEAD WHALES

Subsistence integrates nutritional and spiritual relationships to the land through the pursuit, collection, and sharing of natural resources. Subsistence connects hunters, families, and communities together for simple sharing and complex cultural celebrations including religious and social occasions; the most important ceremony, Nalukataq, celebrates the bowhead whale harvest (Bacon *et al.* 2011, Thewissen and George 2021, Unger 2014). Other values included an emphasis on the community, its needs, and its support of other individuals. As such, subsistence connects community members and relatives through food sharing and cooperative hunting and harvesting efforts within the community (Unger 2014). Sharing, trading, and bartering of subsistence foods also structures relationships among communities, while the practice of giving of such foods maintain ties with family members elsewhere in Alaska (Courtnage and Braund 1984).

Since 1981, the AEWC and NSB Department of Wildlife Management have collected information on the bowhead whale subsistence harvest including the number of whales landed, whales struck and lost, and basic morphometric data of the whales (Thewissen and George 2021). The IWC initiated efforts in the 1970s to create a new regime for managing bowhead whale subsistence hunting to protect not only bowhead whales, but also the availability of the whales to communities to meet cultural and nutritional needs (Suydam *et al.* 2021). The number of whales allowed for harvest (included struck and lost whales) is determined under a quota system in compliance with the regulations. For the past 20 years (~2000), Nuiqsut (Cross Island) has struck and landed between two and four whales per year, including a total of three whales in 2019; Utqiaġvik has landed between 16 and 29 whales per year, including 10 whales in 2019 (Suydam *et al.* 2020). In 2024, the harvest quota set by the IWC included 33 strikes available that were carried forward from the previous year for a combined strike quota of 100 (67 + 33 strikes carries forward) (59 FR 20945; March 26, 2024). WHB is likely too shallow for bowhead whales to enter; therefore, no subsistence hunting of bowheads occurs in WHB, where Narwhal's activities are planned.

Based on data from ADNR regarding subsistence whaling zones, the action area is approximately 70-80 km from the eastern side of the Western Subsistence Whaling Zone used by hunters from Utqiaġvik. The Central Subsistence Whaling Zone is approximately 40 km from the action area. Therefore, Utqiaġvik whaling crews may hunt whales offshore further west of WHB; however, Narwhal's activities will occur very close to shore and in shallow waters where hunting is not likely. In addition, seismic activities are not expected to result in Level B acoustic thresholds that extend beyond 3,188 m from the source in WHB. Transiting vessels will also be in close proximity to shore and are not expected to disrupt bowhead whale hunting during late August or early September 2025. Nuiqsut whaling is concentrated near Cross Island, which is approximately 136 km east of the action area. Narwhal activities are not expected to affect whaling at Cross Island given the great distance between the action area and the Nuiqsut hunting area. If empty barges are transported from the Tuktoyaktuk area to WHB, it is planned that the barges will be transported in August, pending ice conditions, and before whaling commences in late August or September. Narwhal will coordinate all barging activities to and from Tuktoyaktuk with the Kaktovik whaling captains. The majority of the barge route is a minimum of 50 km offshore at all times and transport will be conducted prior to Kaktovik whaling activities. Potential impacts to whaling activities from barge transport are not likely given these coordination efforts to avoid interactions during whaling season.

8.2 SUBSISTENCE USE OF BEARDED, SPOTTED AND RINGED SEALS

Sealing may occur in areas further west of WHB (i.e., hunters from Utqiaġvik) or around the Colville River Delta (i.e., hunters from Nuiqsut). Seal meat is eaten, although the dietary significance of seals in both communities primarily comes from seal oil, which is typically served with meals that include subsistence foods. Seal oil is also used as a preservative for meats, greens, and berries. Seal skins are used for clothing, and spotted seal skins are often preferred for making boots, slippers, mitts, and parka trim. In practice, however, ringed seal skins are used more often in the making of clothing because the harvest of this species is more abundant (Bacon *et al.* 2011).

The two communities closest to the action area that hunt seals are Utqiaġvik and Nuiqsut. An offshore area seaward of the Colville River Delta is an important seal hunting area for Nuiqsut hunters, extending as far west as Fish Creek and as far east as Pingok Island (149°40’W). Nuiqsut hunters harvest ice seals primarily during the open-water period of July through August, when boat crews hunt ringed, spotted and bearded seals (Ice Seal Committee 2024b). Bearded seals are the preferred species for food and umiak coverings. They are more commonly targeted than ringed seals, which are used for food and blubber that is rendered into seal oil. Bearded seals are harvested primarily in the spring during breakup of the sea ice when use of the coastal sea ice trail will be discontinued due to the sea ice melting.

A report published in 2024 by the Ice Seal Committee (2024b), acknowledged that while data collection (using household surveys) on ice seal harvest on the North Slope has been consistent since 1994, not all of these data have been compiled. For Nuiqsut and Utqiaġvik, 2014 is the most recent year for which data has been compiled; there is no complied data for 2001-2013 for Nuiqsut and for 2002 and 2004-2013 for Utqiaġvik (Ice Seal Committee 2024b).

According to the Ice Seal Committee report, based on limited household surveys, 25 and 58 ringed seals were harvested by Nuiqsut hunters in 2000 and 2014, respectively; Nuiqsut hunters took no bearded seals in 2000 but harvested 26 bearded seals in 2014 (Ice Seal Committee 2024b). Utqiaġvik hunters harvested 729 bearded seals and 586 ringed seals in 2000, 327 bearded seals and 387 ringed seals in 2001, 776 bearded seals and 413 ringed seals in 2003, and 1,070 bearded seals and 428 ringed seals in 2014 (Ice Seal Committee 2024b).

For 2015, Nelson *et al.* (2019) reported an average harvest of ringed seals (including struck and lost animals) of 465 for Utqiaġvik and 74 for Nuiqsut. Annually during the period 1994 through 2014, hunters in Utqiaġvik harvested an average of 465 ringed seals, 713 bearded seals, and 39 spotted seals (Nelson *et al.* 2019).

Utqiaġvik seal hunting is expected to occur closer to the community, which is approximately 165 km west of the action area and therefore, is not expected to be affected by project activities. While Nuiqsut hunters may use areas offshore of the Colville River Delta for seal hunting, Narwhal will work closely with Nuiqsut to ensure that impacts to subsistence harvest of ice seals are avoided.

8.3 NOTIFICATION TO AFFECTED COMMUNITIES AND PLAN OF COOPERATION

On July 8, 2022, Narwhal contacted the AEWC to request an opportunity to present an overview of the proposed project at the AEWC meeting in Fairbanks, Alaska on July 14 and 15, 2022. AEWC responded by explaining that the July 2022 agenda was full, but Narwhal may request time at the AEWC meeting in December 2022. Narwhal presented project information to the AEWC at the December 2022 and February and December 2023 meetings. Additional outreach will continue to communicate information about the proposed activities in WHB to groups including but not limited to the NSB Department of Wildlife Management and Native Villages of Nuiqsut and Kaktovik; co-management organizations such as AEWC, NSB, Ice Seal Committee; and the Kuukpik Corporation. Appendix D presents a summary of community engagement activities as of March 2025, which will continue to be updated by Narwhal throughout the project and can be provided to NMFS upon request as well as with the final monitoring report.

While the proposed activities may have temporary effects on bowhead whale or ice seal behavior, it will not alter the ability of Alaska Native residents to hunt these species over the long-term. Through implementation of the Plan of Cooperation (POC), and spatial temporal project planning (i.e., scheduling or routing transit vessels to avoid subsistence harvest timing or locations), impacts to subsistence hunting are not anticipated. Narwhal will continue to coordinate with Alaska Native villages and Tribal organizations to identify and avoid the potential short-term conflicts. The POC and coordination with these groups will help minimize effects the project might have on subsistence harvest (see Appendix D).

Narwhal plans to sign a CAA to minimize and avoid effects of project activities on the bowhead whale hunt. If required in the CAA, surveys will temporarily cease during the fall bowhead whale hunt to avoid acoustical interference with the Kaktovik-, Cross Island-, or Utqiaġvik-based hunts. To the extent practicable, Narwhal plans to begin seismic surveys in areas furthest offshore, with the intention of completing seismic activities that are on the seaward boundary of WHB first. WHB and the seismic surveys areas are not within the bowhead whale migration corridor (waters >15 m deep further offshore).

9 ANTICIPATED IMPACTS ON HABITAT

9.1 ACTIVITIES DURING SUMMER 2025 OPEN-WATER SEASON

Under normal operations, as described in Section 1.3.1, none of the activities proposed for open-water work would be expected to significantly alter marine substrates or affect marine water quality. While vibracoring will be used to obtain shallow cores of the seafloor sediment within the footprint of the winter exploratory drilling location, the few samples collected would be expected to have only a slight, temporary effect on benthic habitat. Therefore, impacts on habitat from proposed activities during open-water activities would be limited to potential impacts on prey species of bowhead whales and ice seals.

Noise studies with cod, crab, and schooling fish found little or no injury to adults, larvae, or eggs when exposed to impulsive noises exceeding 220 dB (Christian *et al.* 2004, Davis *et al.* 1998, Greenlaw *et al.* 1988).

Experimental studies have shown that sounds from non-explosive survey devices, such as airguns, are generally not lethal to fish (Sharp 2011). The characteristics of airgun sounds are such that the zone of potential injury to fish and invertebrates would be limited to a few meters from the source (Buchanan *et al.* 2004, Sharp 2011). Adult fish near seismic operations are likely to avoid the immediate vicinity of the sound source and thus avoid injury. Sound pulses at levels of 180 dB have been documented to cause noticeable changes in behavior (Pearson *et al.* 1992). While underwater sounds from seismic activities may reach 180 dB, the areas ensonified to 160 dB are not expected to exceed 3,188 m from the source and would be temporary (i.e., up to 12 hours per day for a total of 6 days intermittently within a period of 30 days). Underwater sound levels from seismic activities in WHB are not expected to result in measurable effects to prey fish species populations.

As described in Section 1.3.1.6, underwater sounds produced by echosounders, side scan sonar, and sub-bottom profilers are considered to be minimal; therefore, summer project activities would be expected to have negligible effects on bowhead whale and seal prey species.

9.2 ACTIVITIES DURING WINTER 2025 AND 2026

During winter, only ringed seals would be expected to be present in or near the action area. On April 1, 2022 (effective May 2, 2022), NMFS issued final rules designating critical habitat for the Arctic subspecies of ringed seals (87 FR 19232) and for the Beringia DPS of bearded seals (87 FR 19180). The critical habitat designations for both species cover areas of marine habitat in the Bering, Chukchi, and Beaufort seas. The proximity of project activities to ringed seal designated critical habitat is shown in Figure 4-3. Critical habitat for bearded seals is shown in Figure 4-6. No winter project activities will occur within designated ringed seal or bearded seal critical habitats. While the barge transit route shown in Figure 1-10 may go through portions of seal critical habitat, vessel transit is not likely to adversely modify these habitats; the barge route would follow established route for this type of transit.

The construction and maintenance of the coastal sea ice trail within the Colville River Delta is not expected to cause measurable impacts on ringed seal critical habitat PBFs. The ice roads and pads to be located in WHB will be on grounded ice or small portions of floating ice where water depths are 1-2 m.

Areas along the coast with water depths of >3 m are considered part of ringed seal critical habitat based on PBFs described above. Ringed seals prefer to pup in landfast ice (Kelly 1988).

Narwhal's coastal sea ice trail will be short-term, occurring over one winter season. Long-term disruption of the availability of natural ice habitat for ringed seals is not expected considering the large areas of ice habitat along the broader Beaufort Sea coastline. Mitigation and monitoring measures described in Sections 11 and 13 for the construction of the sea ice trail further reduce the potential for project impacts to ringed seal critical habitat. In addition, ringed seals feed on fish and a variety of benthic species including crabs and shrimp (NMFS 2022). Adverse effects from temporary underwater sound during seismic operations over a 30-day period or from sea ice construction activities on the distribution of fish or zooplankton are not expected. In addition, sea ice trails, roads and pads will melt in summer months and will not affect water circulation, substrate, fish presence or use of the area, or benthic populations.

10 ANTICIPATED IMPACTS OF HABITAT LOSS OR MODIFICATION OF PREY SPECIES

As described in Section 9, none of the project activities planned for the summer open-water season will damage or otherwise affect marine mammal habitat that will result in large areas of habitat loss or modification. During winter activities, the small area of ice seal habitat potentially impacted by project sea ice trails, roads or pads and the areas of seafloor impacted by exploratory drilling, are not expected to have noteworthy effects on overall marine mammal use of the region given the small footprint of these activities. Any modification of marine mammal habitat during both winter and summer project activities is expected to be modest in scope and temporary. Any impacts to prey resources are considered negligible and no long-term effects would occur.

While changes in prey availability as ocean temperatures rise may affect migration patterns of bowhead whales by creating ice-free areas along the shelf break, increased upwelling and potentially more feeding opportunities for foraging whales, the current increase in the bowhead population (see Section 4.1) seems to indicate that prey availability overall is not affecting bowhead population growth.

Long-term habitat loss and modification resulting from climate change is perhaps a more noteworthy concern regarding the conservation status of ice seals (Muto *et al.* 2022). Ringed seals are dependent on subnivean lairs for giving birth, nursing and protecting pups from predation and hypothermia; thus, ringed seals are likely to be highly sensitive to climate induced reductions in the availability of sea ice (Laidre *et al.* 2008). Laidre *et al.* (2008) also concluded that bearded seals are likely to be highly sensitive to climate change but that spotted seals are slightly less dependent on sea ice and snow cover and are likely to be moderately sensitive to climate change impacts. Designated critical habitat for bearded seals will not be affected by project activities. Ringed seal prey (one of the critical habitat PBFs) will not be adversely modified by project activities given the limited extent of underwater sounds and temporary nature of activities.

11 MITIGATION MEASURES

Mitigation measures are proposed by Narwhal to reduce exposure and potential harassment takes to the lowest level practicable and are described below. A copy of the IHA will be in the possession of the holder, vessel operator, other relevant personnel, lead observer and any other relevant designees operating under the authority of the authorization.

11.1 MITIGATION MEASURES FOR VESSELS

Vessel operators will comply with the below measures, except under extraordinary circumstances when the safety of the vessel or crew is in doubt or the safety of life at sea is in question. These requirements do not apply in any case where compliance would create an imminent and serious threat to a person or vessel or to the extent that a vessel is restricted in its ability to maneuver and, because of the restriction, cannot comply.

- Narwhal will inform NMFS of impending in-water activities a minimum of 1 week prior to the onset of those activities (email information to akr.prd.records@noaa.gov).
- Vessel operators and Protected Species Observers (PSOs[17]) (see Section 13) will conduct a joint onboard briefing prior to beginning work to ensure that responsibilities, communication procedures, monitoring and safety protocols and IHA requirements are understood. This briefing will be repeated for any new relevant personnel;
- Vessel operators will check waters immediately adjacent to the vessel(s) to ensure that no whales are injured when the vessel gets underway. While underway, operators will maintain watch for marine mammals at all times;
- Vessel speed within WHB will be restricted to 15 knots or less. Vessel speed will be reduced to 5 knots when a whale is sighted within 274 m of the vessel;
- Vessels will, to the maximum extent practicable, operate to maintain a minimum separation distance of 91 m from marine mammals, with an understanding that at times this may not be possible for animals that approach the vessel (i.e., seal species);
- If a whale is sighted within 274 m while a vessel is underway, the vessel will take action, as necessary, to maintain the separation distance (e.g., attempt to remain parallel to the animal's course, avoid excessive speed or abrupt changes in direction until the whale has left the area, reduce speed, not cross in front of a whale in a way), or to move further away from the whale unless doing so is necessary for maritime safety;
- If a whale's course and speed are such that it will likely cross in front of a vessel that is underway or approach within 91 m of the vessel, and if maritime conditions safely allow, the engine will be put in neutral to allow the whale to pass beyond the vessel. Vessels will take reasonable steps to alert other vessels in the vicinity of the whale; and

[17] The term PSO in this application includes dedicated observers who have been trained according to Narwhal's marine mammal monitoring protocol approved by NMFS. Limited capacity on project vessels, in camps and on aircraft necessitates that staff perform multiple roles, however observers will have no other assigned tasks during monitoring periods.

- Vessels will not allow lines to remain in the water unless both ends are under tension and affixed to vessels or gear. No materials capable of becoming entangled around marine mammals will be discarded into marine waters.

11.2 MITIGATION MEASURES DURING SHALLOW HAZARD SURVEYS

Narwhal will implement the following mitigation measures during SHS surveys in WHB following the tiers summarized in Table 11-1. Additional detail on monitoring measures is included in Section 13.

Acoustic sources will be deactivated when not acquiring data or preparing to acquire data, except as necessary, for testing. If the activated volume of the airgun exceeds the notified capacity, this will be communicated to PSOs and fully documented.

TABLE 11-1. SUMMARY OF TIERS AND ASSOCIATED PROTOCOL DURING SHS IN WHB

Sources	Tier[a] 2	Tier[a] 3
	Single Airgun	Sparker[b]
Visual PSOs	Minimum of two NMFS-approved PSOs on duty during daylight hours (30 minutes before sunrise through 30 minutes after sunset); Limit of 4 consecutive hours on watch followed by a break of at least 1 hour; Maximum of 12 hours on watch per 24-hour period	Minimum of one PSO on duty during daylight hours (30 minutes before sunrise through 30 minutes after sunset); PSOs must be either designated by the federal agency funding/conducting the survey or approved by NMFS
Exclusion Zones (EZ)	1,100 m (baleen whales) 350 m (pinnipeds)	10 m (all marine mammals)
Pre-start Clearance	15-minute clearance of the following zones: • 1,100 m (baleen whales) • 350 m (pinnipeds) If detected in the zone, animal must be observed exiting or additional 15 minutes is added; or the in-water activity will move to an alternate location that is clear of listed species in the shutdown zone.	15-minute clearance of the following zones: • 10 m all marine mammals If detected in the zone, animal must be observed exiting or additional 15 minutes is added; or the in-water activity will move to an alternate location that is clear of listed species in the shutdown zone.
Ramp-Up	Not required	Required when technically feasible; ramp up half power for 5 minutes and then to full power
Shutdown	Required for marine mammals detected in EZs. Re-start allowed following clearance period of 15 minutes	

[a] Source: NMFS OPR, February 22, 2023
[b] Based on results in Lawrence *et al.* (2021) that the estimated distance for all marine mammals except baleen whales was < 10 m; for baleen whales, the distance was 25 m. The estimated Level B 160 dB re 1 µPa threshold for the Dura-Spark was 85 m (best fit).

11.3 MITIGATION MEASURES FOR AIRCRAFT

Aircraft operators will comply with the below measures, except under extraordinary circumstances when the safety of the aircraft or crew is in question. These requirements do not apply in any case where compliance would create an imminent and serious threat to a person or aircraft or to the extent that an aircraft is restricted in its ability to maneuver and, because of the restriction, cannot comply.

- Except during take-off and landing, aircraft will not operate at altitudes lower than 457 m agl while maintaining FAA flight rules. When weather conditions do not allow a 457-m agl flying altitude, aircraft may be operated below this altitude for the minimum duration necessary to maintain aircraft safety and, as safety allows, alter course to maintain at least 457 m horizontal separation from all observed listed species and non-listed marine mammals (except during takeoff or landing if human safety is at risk);
- Helicopters will not hover or circle over marine mammals.

11.4 MITIGATION MEASURES FOR CONSTRUCTION AND OPERATION OF SEA ICE TRAILS, ROADS, AND PADS

Narwhal will perform ice trail, road, and pad construction following the best guidance available to avoid and minimize (to the greatest extent possible) impacts on the environment, species protected under the MMPA and ESA, and designated critical habitat for ringed seals. The coastal sea ice[18] trail construction occurs from approximately December 1st (or as soon as sea ice conditions allow safe access and permit such activity) and is expected to continue for approximately 30 days. Therefore, disturbance to the sea ice trail route will be initiated prior to March 1st. Small work around areas may be necessary after March 1st to maintain the sea ice for safe travel. Demobilization of the coastal sea ice trail is planned for April and early May 2026. To avoid ringed seal breathing holes and lairs, and to reduce the taking of ringed seals to the lowest level practicable, the specific mitigation measures described in this section will ensure the least practicable impact on ringed seals and their habitat. These measures are proposed for the construction and maintenance of the sea ice trail, specifically the portion across the Colville River Delta where water depth may be greater than 3 m (the minimum depth preferred by ringed seals for establishing lairs) or where there may be open leads in the sea ice. Ice trail activities are described in Section 1.3.2.

11.4.1 GENERAL CONDITIONS

Narwhal will implement the following list of general conditions:

- Narwhal will implement a POC, as provided in Appendix D.
- Prior to initiation of sea ice trail, road, and ice pad construction, project personnel will receive training on implementing mitigation and monitoring measures including:
    - Personnel will be advised that interacting with or approaching any marine mammal is prohibited;

[18] The majority of Narwhal's sea ice roads and coastal sea ice trail will be on grounded ice. Nonetheless, this application applies the mitigation measures to all sea ice roads and the coastal sea ice trail as outlined in Section 11 to minimize potential interactions with seals or disturbance to seal lairs.

  - Ice seal identification and brief life history;
  - Physical environment (habitat characteristics and how to identify potential habitat);
  - Ringed seal presence in the ice trail, road, and pad region (timing, location, habitat use, birthing lairs, breathing holes, basking, etc.);
  - Potential effects of disturbance; and
  - Importance of lairs, breathing holes, and basking to ringed seals.

11.4.2 GENERAL MITIGATION MEASURES IMPLEMENTED THROUGHOUT THE SEASON

- Sea ice trail speed limits along the Colville River Delta and offshore within WHB will be no greater than 45 miles per hour (mph); speed limits will be determined on a case-by-case basis based on environmental and route conditions (i.e., longevity considerations).
- Delineators will mark the sea ice routes within WHB in a minimum of 0.4 km (¼-mile) increments on both sides of the route to delineate the path of vehicle travel.[19] Delineators will be color-coded to indicate the direction of travel and location of the ice route.
- The coastal sea ice trail (if Option 1 is used for mobilization) will be established with GPS point coordinates and operators will be required to adhere to the route during transit. Any deviation from the established route will be for safety purposes only or to avoid a seal or polar bear on the trail.
- If needed during construction, corners of rig mats, steel plates, and other materials used to bridge sections of hazardous ice, will be clearly marked or mapped using GPS coordinates of the locations.
- Personnel will be instructed that approaching or interacting with marine mammals is prohibited.
- Personnel will be instructed to remain in the vehicle and safely continue if they encounter a ringed seal within 50 m or if a known seal lair is encountered within 50 m while driving on the coastal sea ice trail or sea ice roads and trails.
- If a ringed seal or seal structure is observed within 50 m of the centerline of the ice trail or the edge of an ice pad, the Narwhal Project Manager will be informed of the observation and the following will occur:
  - The seal will be avoided and the location of the seal will be verbally described on the monitoring form relative to the location of the ice road/trail and the observer’s location.
  - A seal structure will be physically marked within 15 m of the edge of the sea ice road noting the location of the seal/seal structure along the axis/edge of the road (maintaining a distance of at least 15 m from the seal/structure);
  - Construction or maintenance work will not occur within 50 m of the seal. These activities may continue if the seal is 50 m or greater away. If the seal is within 50 m of these activities, they may continue as soon as the seal, of its own accord, moves farther than 50 m distance

[19] It is not feasible to install delineators along the 130 km coastal sea ice trail. See the following measure for the trail.

away from activities or has not been observed within that area for 24 hours. Transport vehicles may continue within the designated route without stopping.
  - All other personnel using the area will be notified following the notification protocols described in the Wildlife Management Plan;
  - During the period in which a seal structure is periodically monitored, as described in the communication and monitoring procedures for seal and seal structure observations in Section 11.4.3, maintenance work will proceed in a manner that minimizes impacts or disturbance to the area.
- Personnel will stay in the vehicle and continue traveling at a constant speed if a seal is observed near the ice road/trail/pad. Do not slow down, stop, or exit the vehicle.
- Monitoring and reporting will be implemented, as described in the Section 13.

11.4.3 MITIGATION MEASURES TO FOLLOW AFTER MARCH 1ST

The following mitigation measures apply to the Colville River Delta portion of the sea ice trail (Option 1), where water depth may be greater than 3 m or where there may be open leads (cracks) in the ice. Ice trail activities in areas with 3 m or less water depth are not subject to these mitigation measures.

- Ice trail construction, maintenance and decommissioning must be performed within the boundaries of the trail and shoulders, with most work occurring within the driving lane. To the extent practicable and when safety of personnel is ensured, equipment must travel within the driving lane and shoulder areas.
- The coastal sea ice trail (if Option 1 is chosen for mobilization) will be surveyed with the route established and disturbed prior to March 1st.
- If safety concerns due to unstable ice road/trail conditions warrant the creation of workaround route, the route will be surveyed for seal structures using a trained observer in a tracked vehicle approximately 2 days prior to establishing the route, weather permitting. The following protocol will be used for these surveys:
  - During daylight hours with good visibility, a trained wildlife observer will survey the route 2 days prior to route construction to search for potential seal structures. The observer will be dedicated to monitoring for seal structures while the driver operates the tracked vehicle.
  - If a suspected seal structure is observed within 50 m of either edge of the proposed new or workaround route, a marker will be placed 15 m from the location and GPS coordinates will be recorded. The new route will avoid any suspected seal structures by a 50-m distance.
- Blading and snow blowing of ice roads must be limited to the previously disturbed ice trail/shoulder areas to the extent safe and practicable. Snow must be plowed or blown from the ice road surface.
- If snow is accumulating on a road within a 50-m of an identified downwind seal or seal lair, operational measures must be used to avoid seal impacts, such as pushing snow further down the road before blowing it off the roadway. Vehicles must not stop within 50 m of identified seals or within 50 m of known seal lairs.

- To the extent practicable and when safety of personnel is ensured, tracked vehicle operation must be limited to the previously disturbed ice trail areas. If safety requires a workaround route on the ice trail to be constructed after March 1st, construction activities such as survey layout and ice coring must be conducted only during daylight hours with good visibility. Flooding and ice buildup or maintenance activities may be conducted in these areas during non-daylight hours.
- Ringed seal structures must be avoided by a minimum of 50 m during ice thickness testing and new trail construction.
- Once the new ice trail is established, tracked vehicle operation must be limited to the disturbed area to the extent practicable and when safety of personnel is ensured.
- If a seal or suspected seal structure is observed on ice within 50 m of the centerline of the ice trail or within 50 m of the edge of a sea ice pad, the following mitigation measures must be implemented:
    - A marker will be placed within 15 m of the edge of the ice trail noting the location of the seal/seal structure (e.g., its position along the axis of the ice trail).
    - Construction, maintenance or decommissioning activities associated with ice roads and trails must not occur within 50 m of the observed ringed seal, but may proceed as soon as the ringed seal, of its own accord, moves farther than 50 m distance away from the activities or has not been observed within that area for at least 24 hours; and
    - Transport vehicles (i.e., vehicles not associated with construction, maintenance or decommissioning) may continue their route within the designated road/trail without stopping.

12 MITIGATION MEASURES TO PROTECT SUBSISTENCE USES

Narwhal will coordinate closely with the Alaska Native community of Nuiqsut as well as the NSB, AEWC, and the Ice Seal Committee to minimize potential effects on subsistence hunting of bowhead whales, and ringed and bearded seals. Narwhal plans to sign a CAA to avoid and minimize effects on subsistence hunting of bowhead whales.

As described in the POC (Appendix D), Narwhal will conduct all activities such that, to the greatest extent practicable, adverse effects on the availability of bowhead whales and ringed and bearded seals for subsistence uses are minimized:

- Narwhal will conduct community consultation to discuss the planned activities with subsistence stakeholders including the NSB, the Native Village of Nuiqsut, subsistence users and community members in Nuiqsut, the State of Alaska, the U.S. Fish and Wildlife Service (USFWS), and other applicable federal, state, or local stakeholders; and
- Based on these consultations, Narwhal, to the best of its ability, will identify and resolve as applicable the concerns of stakeholders regarding the project’s effects on subsistence hunting of bowhead whales or ringed or bearded seals. If any concerns remain unresolved, Narwhal will modify the POC in consultation with the NMFS and subsistence stakeholders to address remaining concerns. If possible, Narwhal will develop mitigation measures to address remaining concerns.

13 MONITORING AND REPORTING

13.1 MONITORING DURING OPEN-WATER SEASON (SUMMER 2025)

All marine mammal sightings during this project will be reported to NMFS (see Section 13.3). On-site project personnel will be trained in marine mammal identification, mitigation measures, and reporting requirements described herein. Due to limited space in project camps, vehicles, aircraft, vessels, and shift considerations, project personnel will be trained to serve multiple roles. Monitoring will include the measures described below.

13.1.1 PROTECTED SPECIES OBSERVERS

- Protected species training: Narwhal will conduct a formalized protected species training program (to be reviewed by NMFS) for crew members on vessels and in vehicles using ice trails/roads. Training will include topics such as species identification, monitoring and sighting protocols, decision-making factors to avoid take, and reporting requirements.
- PSOs[20]: Narwhal will provide trained, qualified personnel to carry out monitoring and mitigation activities during all geophysical surveys in WHB. A lead PSO will be approved by NMFS and have the necessary experience as a marine mammal observer. The lead PSO will coordinate duty schedules and serve as the primary point of contact for the vessel operator for marine mammal protocols. Resumes for the lead PSO, and candidates to serve as PSOs who will support the lead PSO, shall be provided to NMFS for review. Inupiat observers or other crew chosen as PSOs shall be experienced in the region and familiar with marine mammals in the area.
- PSOs will have the following minimum qualifications:
    - Ability to conduct field observations and collect data according to assigned protocols;
    - Experience or training in marine mammal identification and behaviors;
    - Training, orientation, or experience with the planned project operations for personal safety during project activities; and
    - Writing skills sufficient to prepare a report of observations (see additional details under reporting requirements below).
- PSOs will monitor for a maximum of 4 consecutive hours on a shift and no more than 12 hours in a 24-hour period.
- PSOs will have no other assigned tasks during monitoring periods and be equipped with, at minimum, binoculars and rangefinders.
- PSOs will coordinate to ensure 360° visual coverage around the vessel from the most appropriate posts and shall conduct observations using binoculars or the naked eye in a systematic manner while free from distractions.

[20] In this application, the term PSO includes staff trained as dedicated marine mammal observers based on a NMFS-approved protocol. Limited capacity on project vessels, in camps and on aircraft necessitates that staff perform multiple roles, however observers will have no other assigned tasks during monitoring periods.

13.1.2 VISUAL MONITORING DURING SEISMIC DATA ACQUISITION

PSOs will conduct the following activities during seismic operations in WHB:

- One PSO will conduct monitoring duties from the source vessel and one PSO will conduct monitoring from a support vessel during daylight hours while the single airgun is active or while vessel are in transit during seismic activities occur in WHB.
- During airgun seismic activities, PSOs will monitor a clearance zone of 1,100 m around the centerpoint of the source vessel for LF cetaceans (baleen whales) and out to 350 m for pinnipeds for 15 minutes prior to initiation of airgun operation, during, and for 15 minutes post airgun operation. If no large whales or pinnipeds are observed within their respective clearance zones, airgun use may commence. If a marine mammal(s) is observed within its respective clearance zone during the clearing, the PSOs will continue to watch until either: 1) the animal(s) is outside of and on a path away from the clearance zone; or 2) 15 minutes have elapsed.
- If LF cetaceans (baleen whales) are sighted within or about to enter an EZs (1,100 m), the airgun will be shut down immediately. If a pinniped is sighted within or about to enter an EZ of 100 m, the airgun will be shut down immediately.
- Following a shutdown, re-start of the airgun is only allowed if the marine mammal is not observed within the EZ for a period of 15 minutes.
- If a marine mammal is already within an EZ when first detected, the airgun will be shut down immediately.
- If the airgun has been operational before the onset of poor visibility conditions, it can remain operational through poor visibility.
- Observations of marine mammals by crew members aboard any vessel associated with the survey shall be relayed to the lead PSO.

13.1.3 VISUAL MONITORING DURING THE USE OF A SPARKER

A PSO will conduct the following activities during use of a sparker in WHB:

- One qualified observer will conduct monitoring duties from the source vessel during daylight hours while the sparker is in use in WHB. Trained shipboard personnel may be considered a qualified observer to fulfill this role.
- The observer will conduct visual monitoring no less than 15 minutes prior to (i.e., pre-clearance), during and 15 minutes after use of the sparker.
- The observer will ensure 360° visual coverage around the vessel from the most appropriate viewpoint and use binoculars or the naked eye to observe, free from distractions.
- The sound source (sparker) will be ramped up at half power for 5 minutes and then proceed to full power. The observer will be notified before ramp-up begins. Ramp-up will not commence before pre-clearance or if any protected species is observed within the EZs. Ramp-up will occur during times of poor visibility.
- The observer shall monitor the EZs defined in Table 11-1 and Section 13.1.2 and implement shutdown procedures defined in Section 13.1.2.

13.2 MONITORING DURING ICE-COVERED SEASON (WINTER 2026)

During project activities, monitoring to avoid ringed seals and ringed seal lairs will be conducted, as described below. The majority of the coastal sea ice trail will be on grounded ice, as described in Section 1.3.2.1, and a 58-km section of the coastal sea ice trail will extend across the Colville River Delta where ringed seals may occur (see Section 6.3). Therefore, observations for potential ringed seals will be undertaken along the 58-km section within the delta, as described below. Due to space limitations in vehicles used on the coastal sea ice trail, the driver will conduct monitoring duties, as described below.

- Colville River Delta Monitoring:
  - ATV (steiger tractors and rolligons) drivers operating along the coastal sea ice trail will be trained in ringed seal and ringed seal habitat identification following the training program described in Section 13.1. Each driver will be responsible for monitoring for ringed seals within the 58-km stretch of sea ice trail within the Colville River Delta to observe if any ringed seals are within 50 m of the coastal sea ice trail.
  - If a ringed seal is observed within 50 m of the center of the sea ice trail, one ATV driver in a traveling group will stop the vehicle and monitor the seal from the cab for 15 minutes to document the specific location using GPS as well as seal behavior and other parameters described in Section 13.3. If the seal remains in the area after the 15-minute observation period, one ATV will stop at the GPS location on a subsequent trip to monitor for the seal to report the presence or absence of the seal during daylight conditions. Once the seal is no longer observed by drivers/observers on subsequent trips, it will no longer be necessary to stop for 15 minutes to conduct monitoring and a return to regular monitoring protocols will be followed.
  - If weather conditions deteriorate to the point where the seal is no longer visible, the driver will resume traveling the trail, weather permitting.
  - If a ringed seal breathing hole or lair is observed within 50 m of the sea ice trail within the Colville River Delta, the location of the structure will be documented to the extent possible from the sea ice trail using GPS and reported to the Narwhal Permitting and Compliance Manager.
    - At least one ATV driver from a traveling group will monitor the breathing hole/lair from the trail for 15 minutes in daylight conditions on the day of the initial sighting to determine whether a ringed seal is present; and
    - Observations by an ATV driver for a seal near the breathing hole/lair will occur for 15 minutes each day while the trail is traveled unless it is determined the structure is not actively being used (i.e., a seal is not sighted at that location during monitoring).
    - During this monitoring period, maintenance work will proceed in a manner that minimizes impacts or disturbance to the area of the seal/seal lair observation.
- Narwhal will engage subsistence hunters for monitoring recommendations:
  - Narwhal will engage local hunters through the Ice Seal Committee point of contact to gather recommendations on methods for ringed seal detection within the exposure areas along the Colville River Delta; and

- Narwhal will incorporate recommendations, as appropriate, into training materials provided to personnel responsible for monitoring for ringed seals along the sea ice trail.

13.3 DATA COLLECTION

Observers and PSOs will record the following information during winter survey efforts and observation events:

- The date and start/stop time for each survey including effort in total number of minutes of observation. This will include a summary of environmental conditions, such as visibility, that can affect ringed seal or lair detection;
- Date and time of each observation event (e.g., initial observation of a seal or seal structure) and subsequent monitoring;
- Number of animals per observation event; and number of adults/juveniles/pups per observation event;
- Behaviors of seals during each observation event;
- Geographic coordinates to the extent possible from the road/trail/pad of the observed animals or structure (breathing hole or lair), with the position recorded by using the most precise coordinates practicable (coordinates will be recorded in decimal degrees, or similar standard and defined coordinate system); and
- Activities occurring during observation, including equipment being used and its purpose, and approximate distance to ringed seal(s).

For monitoring during open-water activities, the following information will be collected:

- Date and participants of PSO briefings;
- PSO names;
- PSO locations on vessels and height of monitoring location above water surface;
- Vessel name(s), size and type;
- Visual monitoring equipment used;
- On/off survey effort;
- Vessel location, heading and speed;
- Water depth and environmental conditions during monitoring including the Beaufort Sea state, and relevant weather conditions including cloud cover, fog, glare, and visibility;
- Survey activity and acoustic source power output while operating and tow depth of airgun;
- Upon visual observation of protected species, the following information will be collected:
    - Watch status (i.e., who reported sighting and under what conditions such as on/off effort, opportunistic, etc.);
    - Activity at time of sighting;
    - Time;
    - Detection methods;
    - Sighting cue;

  - Vessel location, direction of travel and speed;
  - Water depth;
  - Direction of animal's travel relative to vessel;
  - Genus/species to lowest possible taxonomic level, estimated number of animals and estimated number by cohort, if possible;
  - Description of any distinguishing features such as shape, color, scars, markings, etc.;
  - Animal's closest point of approach; and
  - Detailed behavior observations (e.g., number of blows/breaths, surfaces, diving, feeding, traveling, etc.).

For monitoring ice road or trail use:

- Date and time of each observation event (*e.g.*, initial observation of a seal or seal structure) and subsequent monitoring;
- Environmental conditions during each observation event;
- Number of animals per observation event; and number of adults/juveniles/pups per observation event;
- Behaviors of seals during each observation event; and
- Geographic coordinates of the observed animals or structure (breathing hole or lair), with the position recorded by using the most precise coordinates practicable (coordinates will be recorded in decimal degrees, or similar standard, and defined coordinate system).

For all observation events, mitigation measures implemented to minimize impacts will be recorded and reported.

13.4 MMPA REPORTING

At the end of the project, Narwhal will:

- Submit a final end-of-season reports, compiling all ice seal observations to NMFS OPR within 90 days of decommissioning the sea ice trail or 60 calendar days prior to the requested issuance of any subsequent IHA for this project, whichever comes first. A final report shall be prepared and submitted within 30 calendar days following receipt of any NMFS comments on the draft report. If no comments are received from NMFS within 30 calendar days of receipt of the draft report, the report shall be considered final.
- All draft and final monitoring reports must be submitted to: PR.ITP.MonitoringReports@noaa.gov and leah.davis@noaa.gov
- The report will include information described in the *Data Collection* section above, and associated data sheets.
- In the event Narwhal project personnel discover an injured or dead seal during ice trail activities, Narwhal must report the occurrence to the NMFS OPR (PR.ITP.MonitoringReports@noaa.gov and leah.davis@noaa.gov) and to the Alaska regional stranding network, as soon as feasible.
  - If the death or injury was clearly caused by a specified activity, Narwhal will immediately cease the specified activity until NMFS OPR is able to review the circumstances of the

incident and determine what, if any, additional measures are appropriate to ensure compliance with the terms of this IHA. The holder must not resume their activities until notified by NMFS.

- The report must include the following information:
    - Time and date of the discovery or incident;
    - Description of the discovery or incident;
    - Environmental conditions (e.g., cloud over, and visibility);
    - Description of all marine mammal observations in the 24 hours preceding the discovery or incident;
    - Species identification or description of the animal(s) involved;
    - Fate of the animal(s); and
    - Photographs or video footage of the animal(s).

13.5 ESA REPORTING

- If a specific mitigation measure is implemented during ice road/trail/pad activities in association with an observed seal/seal structure (e.g., a breathing hole is monitored for seal presence), a preliminary report of the activity will be submitted to AKR.section7@NOAA.gov within 14 days after the cessation of that activity.
- The applicant will submit an annual monitoring report after the end of the ice road/trail/pad season to summarize the activities during ice trail construction, maintenance, use, and de-commissioning that occurred that year. Records associated with ringed seal/seal structure observations and monitoring will be transmitted to NMFS by August 31 of the year of ice trail decommissioning.
- Annual and final reports will be submitted via electronic mail to AKR.section7@NOAA.gov.
- Reports and data will be submitted as digital, queryable documents (data submitted as a spreadsheet or database, reports submitted in standard word processing format).

14 RESEARCH COORDINATION

Narwhal's activities will be conducted following all federal, state, and local regulations and industry best practices, which will minimize the potential for impacts to the species, stocks, and subsistence use of polar bears and walruses. Cooperation with NMFS, USFWS, other federal agencies, the State of Alaska, NSB, and the potentially affected community Nuiqsut will be incorporated into Narwhal's project. To the extent practicable, Narwhal will coordinate with monitoring programs from other studies to combine research data as applicable, and to assess measures that can be taken to eliminate or minimize any impacts from these study activities. As such, Narwhal will cooperate with other industry or research partners to collaborate on ringed seal/seal lair detection surveys during winter or other surveys for marine mammals during the open-water season. Information gathered to identify marine mammal sighting data will be compiled over the course of the project and will be shared with agency and other stakeholders. By sharing information and resources and assisting with logistics where possible and practical, Narwhal will support academic or government research. Narwhal proposes to conduct sound source verification during 1 day of seismic operations during summer 2025. These data will be provided to interested parties to contribute to a better understanding of underwater sound propagation in WHB.

Narwhal will enact local engagement strategies in Nuiqsut and will incorporate Traditional Ecological Knowledge to the extent possible to inform future project planning and decision-making. Historical habitat, locally observed use patterns, and observed behavior patterns can aid in reducing human/marine mammal interactions and impacts to subsistence resources and users.

15 REFERENCES

Aerts, L. A. M., M. Blees, S. Blackwell, C. Greene, K. Kim, D. Hannay and M. Austin (2008). Marine Mammal Monitoring and Mitigation during Bp Liberty Obc Seismic Survey in Foggy Island Bay, Beaufort Sea, July-August 2008: 90-Day Report.**:** 199 pp.

Bacon, J., T. R. Hepa, J. Harry K. Brower, M. Pederson, T. P. Olemaun, J. C. George and B. G. Corrigan (2011). Estimates of Subsistence Harvest for Villages on the North Slope of Alaska, 1994-2003**:** 136 pp.

Bengtson, J. L., L. M. Hiruki-Raring, M. A. Simpkins and P. L. Boveng (2005). "Ringed and Bearded Seal Densities in the Eastern Chukchi Sea, 1999–2000." Polar Biology **28**(11): 833-845.

Bisson, L. N., H. J. Reider, H. M. Patterson, M. Austin, J. R. Brandon, T. Thomas and M. L. Bourdon (2013). Marine Mammal Monitoring and Mitigation during Exploratory Drilling by Shell in the Chukchi and Beaufort Seas, July-November 2012: Draft 90-Day Report, Shell Offshore Inc**:** 290 pp.

Blackwell, S. B., C. R. Greene Jr. and W. J. Richardson (2004a). "Drilling and Operational Sounds from an Oil Production Island in the Ice-Covered Beaufort Sea." Journal of the Acoustical Society of America **116**(5): 3199-3211 pp.

Blackwell, S. B., J. W. Lawson and M. T. Williams (2004b). "Tolerance by Ringed Seals (*Phoca Hispida*) to Impact Pipe-Driving and Construction Sounds at an Oil Production Island." Journal of the Acoustical Society of America **115**(5 Pt 1): 2346-2357.

Blackwell, S. B., C. S. Nations, T. L. McDonald, A. M. Thode, D. Mathias, K. H. Kim, C. R. Greene and A. M. Macrander (2015). "Effects of Airgun Sounds on Bowhead Whale Calling Rates: Evidence for Two Behavioral Thresholds." PLoS ONE **10**(6): e0125720.

BLM (2020). Willow Master Development Plan, Final Environmental Impact Statement. Anchorage, AK, U.S. Dept. of the Interior, Bureau of Land Management. **Vol. 1-7:** 393 pp + appendices.

BOEM (2018a). Liberty Development and Production Plan, Final Environmental Impact Statement. Anchorage, AK, U.S. Dept. of the Interior, Bureau of Ocean Energy Management. **Vol. 1-2:** 621 pp + appendices.

BOEM (2018b). Liberty Development Project Fiinal Environmental Impact Statement. Anchorage AK, US Departmenr of Interior Bureau of Ocean Energy Management. **VOL 1**.

BOEMRE (2011). Beaufort Sea Planning Area, Shell Offshore Inc. 2012 Revised Outer Continental Shelf Lease Exploration Plan Camden Bay, Beaufort Sea, Alaska, Flaxman Island Blocks 6559, 6610 & 6658, Beaufort Sea Lease Sales 195 & 202, Environmental Assessment. Anchorage, AK, U.S. Dept. of the Interior, Bureau of Ocean Energy Management Regulation and Enforcement**:** 238 pp.

Boveng, P., J. L. Bengtson, T. W. Buckley, M. F. Cameron, S. P. Dahle, B. P. Kelly, B. A. Megrey, J. E. Overland and N. J. Williamson (2009). Spotted Seal Status Review, National Marine Fisheries Service**:** 153 pp.

Breitzke, M., O. Boebel, S. El Naggar, W. Jokat and B. Werner (2008). "Broad-Band Calibration of Marine Seismic Sources Used by R/V Polarstern for Academic Research in Polar Regions." Geophysical Journal International **174**(2): 505-524.

Brower, A., A. Willoughby and M. Ferguson (2022). Distribution and Relative Abundance of Bowhead Whales and Other Marine Mammals in the Western Beaufort Sea, 2020**:** 155 pp.

Buchanan, R. A., J. R. Christian, V. D. Moulton, B. Mactavish and S. Dufault (2004). 2004 Laurentian 2-D Seismic Survey Environmental Assessment. Rep. From Lgl Ltd., St. John's, Nfld., and Canning & Pitt Associates, Inc., St. John's, Nfld., for Conocophillips Canada Resources Corp. Calgary, Alberta**:** 274 pp.

Burns, J. J. and T. Eley (1978). The Natural History and Ecology of the Bearded Seal (*Erignathus Barbatus*) and the Ringed Seal (*Phoca Hispida*), ADF&G**:** 62 pp.

Burns, J. J. and K. Frost (1979). The Bearded Seal, Alaska Department of Fish & Game**:** 9 pp.

Burns, J. J. and S. J. J. Harbo (1972). "An Aerial Census of Ringed Seals, Northern Coast of Alaska." Arctic **25**(4): 279-290.

Christian, J. R., A. Mathieu and R. A. Buchanan (2004). Chronic Effects of Seismic Energy on Snow Crab (Chionoecetes Opilio), Environmental Studies Research Funds.

Clark, C. W., R. Suydam and C. George (2009). Acoustic Monitoring of the Bowhead Spring Migration Off Pt. Barrow, Alaska: Results from 2009 and Status of 2010 Field Effort. Barrow Acoustics Report. Anchorage AK.

Clarke, J., A. Brower, C. L. Christman and M. Ferguson (2014). Distribution and Relative Abundance of Marine Mammals in the Northeastern Chukchi and Western Beaufort Seas, 2013 Annual Report, U.S. Dept. of the Interior, Bureau of Ocean Energy Management**:** 348 pp.

Clarke, J., A. Brower, M. Ferguson and A. Willoughby (2018). Distribution and Relative Abundance of Marine Mammals in the Eastern Chukchi and Western Beaufort Seas, 2017 Annual Report, U.S. Dept. of the Interior, Bureau of Ocean Energy Management**:** 486 pp.

Clarke, J., A. Brower, M. Ferguson, A. Willoughby and A. Rotrock (2020). Distribution and Relative Abundance of Marine Mammals in the Eastern Chukchi Sea, Eastern and Western Beaufort Sea, and Amundsen Gulf, 2019 Annual Report, U.S. Dept. of Interior, Bureau of Ocean Energy Management**:** 628 pp.

Clarke, J., A. A. Brower, M. C. Ferguson, A. S. Kennedy and A. L. Willoughby (2015). Distribution and Relative Abundance of Marine Mammals in the Eastern Chukchi and Western Beaufort Seas, 2014 Annual Report, U.S. Dept. of the Interior, Bureau of Ocean Energy Management**:** 433 pp.

Clarke, J., C. L. Christman, A. Brower and M. Ferguson (2012). Distribution and Relative Abundance of Marine Mammals in the Alaskan Chukchi and Beaufort Seas, 2011, U.S. Dept. of the Interior, Bureau of Ocean Energy Management**:** 358 pp.

Clarke, J. T., A. A. Brower, M. C. Ferguson and A. L. Willoughby (2017a). Distribution and Relative

Abundance of Marine Mammals in the Eastern Chukchi and Western Beaufort Seas, 2015 Annual Report**:** 446 pp.

Clarke, J. T., A. A. Brower, M. C. Ferguson and A. L. Willoughby (2017b). Distribution and Relative Abundance of Marine Mammals in the Eastern Chukchi and Western Beaufort Seas, 2016 Final Report**:** 484 pp.

Clarke, J. T., C. L. Christman, A. A. Brower and M. C. Ferguson (2013). Distribution and Relative Abundance of Marine Mammals in the Northeastern Chukchi and Western Beaufort Seas, 2012**:** 364 pp.

Conn, Paul B., Jay M. Ver Hoef, Brett T. McClintock, Erin E. Moreland, Josh M. London, Michael F. Cameron, Shawn P. Dahle, Peter L. Boveng and C. Francis (2014). "Estimating Multispecies Abundance Using Automated Detection Systems: Ice-Associated Seals in the Bering Sea." Methods in Ecology and Evolution **5**(12): 1280-1293.

Courtnage, C. S. and S. Braund (1984). Barrow Arch Socioeconomic and Sociocultural Description, US Department of the Interior Minerals Management Service**:** 150 pp.

Crain, D. D., S. A. Karpovich, L. Quakenbush and L. Polasek (2021). "Using Claws to Compare Reproduction, Stress and Diet of Female Bearded and Ringed Seals in the Bering and Chukchi Seas, Alaska, between 1953–1968 and 1998–2014." Conservation Physiology **9**(1).

Crocker, S. and F. D. Fratantonio (2016). Characteristics of Sounds Emitted during High-Resolution Marine Geophysical Surveys. Sensors and Sonar Systems DepartmentNaval Undersea Warfare Center Division, Newport, Rhode Island**:** 266 pp.

Davis, R. D., D. H. Thomson and C. I. Malme (1998). Environmental Assessment of Seismic Exploration on the Scotian Shelf, LGL Limited.

Ellison, W. T., B. L. Southall, C. W. Clark and A. S. Frankel (2012). "A New Context-Based Approach to Assess Marine Mammal Behavioral Responses to Anthropogenic Sounds." Conserv Biol **26**(1): 21-28.

Erbe, C. and JASCO Applied Sciences Inc. (2011). Underwater Acoustics: Noise and the Effects on Marine Mammals.

Erbe, C., C. Reichmuth, K. Cunningham, K. Lucke and R. Dooling (2016). "Communication Masking in Marine Mammals: A Review and Research Strategy." Marine Pollution Bulletin **103**: 15-38.

Ferguson, M. and J. Clarke (2013). Estimates of Detection Probability for Bwasp Bowhead Whale, Gray Whale, and Beluga Sightings Collected from Twin Otter and Aero Commander Aircraft, 1989 to 2007 and 2008 to 2011**:** 52 pp.

Frost, K. and L. Lowry (1987). Ringed Seal Monitoring: Relationships of Distribution and Abundance to Habitat Attributes and Industrial Activities**:** 59 pp.

Frost, K. J. and J. J. Burns (1989). Winter Ecology of Ringed Seals (*Phoca Hispida*) in Alaska. Minerals Management Service, Noaa Contract No. Na-81-Rac-00045, Final Report 1 January 1981-31

December 1984, Alaska Department of Fish and Game, Division of Game, Fairbanks. Fairbanks, AK, Minerals Management Service and National Oceanic and Atmospheric Administration**:** 116 pp.

Frost, K. J., L. F. Lowry, G. Pendleton and H. R. Nute (2002). Monitoring Distribution and Abundance of Ringed Seals in Northern Alaska. Anchorage AK, Alaska Department of Fish and Game**:** 66 pp.

Frost, K. J., L. F. Lowry, G. W. Pendleton and H. R. Nute (2004). "Factors Affecting the Observed Densities of Ringed Seals, Phoca Hispida, in the Alaskan Beaufort Sea, 1996-99." Arctic **57**(2): 115-128.

Funk, D. W., D. S. Ireland, R. Rodrigues and W. R. Koski (2010). Joint Monitoring Program in the Chukchi and Beaufort Seas, Open-Water Seasons, 2006–2008, Shell Offshore, Inc., ConocoPhillips Alaska, Inc., Eni U.S. Operating Co., Inc. and other Industry Contributors**:** 499 pp.

Galginaitis, M. (2021). Monitoring the Cross Island Subsistence Whale Hunt for Effects from Liberty Development and Production, Central Beaufort Sea, Alaska – 2020 Annual Report, U.S. Dept. of the Interior, Bureau of Ocean Energy Management**:** 136 pp.

Givens, G. H., C. George, R. Suydam and B. Tudor (2021a). "Bering Chukchi and Beaufort Seas Bowhead Whale (*Balaena Mysticetus*) Abundance Estimate from the 2019 Icebased Survey." J. Cetacean Res. Manage **22**: 63 pp.

Givens, G. H., J. C. George, R. Suydam, B. Tudor, A. VonDuyke, B. Person and K. Scheimreif (2021b). Correcting the 2019 Survey Abundance of Bering-Chukchi-Beaufort Seas Bowhead Whales for Disturbance from Powered Skiffs., Umpublished document submitted to the International Whaling Commission Scientific Committee**:** 17 pp.

Green, G. A., M. Blees, P. G. Cartier, L. R. Olson and J. B. Leavitt (2018). Quintillion 2017 Subsea Cable System Phase 1 Installation Program Marine Mammal Monitoring 90-Day Report. Anchorage, AK, Quintillion Subsea Operations LLC**:** 35 pp + appendices.

Greene, C. R., Jr., S. B. Blackwell and M. W. McLennan (2007). "Sounds and Vibrations in the Frozen Beaufort Sea during Gravel Island Construction." Journal of the Acoustical Society of America **123**(2): 687-695 pp.

Greene, C. R., Jr., S. B. Blackwell and M. W. McLennan (2008). "Sounds and Vibrations in the Frozen Beaufort Sea during Gravel Island Construction." Journal of the Acoustical Society of America **123**(2): 687-695 pp.

Greenlaw, C., D. Holliday, R. Pieper and M. Clark (1988). "Effects of Air Gun Energy Releases on the Northern Anchovy." The Journal of the Acoustical Society of America **84**(S1): S165-S165.

Guan, S. (2020). Interim Recommendation for Sound Source Level and Propagation Ananlysis for High Resolution Geophysical (Hrg) Sources**:** 4 pp.

Harris, R. E., G. W. Miller and W. J. Richardson (2001). "Seal Responses to Airgun Sounds during Summer Seismic Surveys in the Alaskan Beaufort Sea." Marine Mammal Science **17**(4): 795-812.

Harwood, L. A., F. McLaughlin, R. M. Allen, J. Illasiak and J. Alikamik (2005). "First-Ever Marine Mammal and Bird Observations in the Deep Canada Basin and Beaufort/Chukchi Seas: Expeditions during 2002." Polar Biology **28**(3): 250-253.

Harwood, L. A. and I. Stirling (1992). "Distribution of Ringed Seals in the Southeastern Beaufort Sea during Late Summer." Canadian Journal of Zoology **70**(5): 891-900.

Hauser, D. D. W., V. D. Moulton, K. Christie, C. Lyons, G. Warner, C. O'Neill, D. Hannay and S. Inglis (2008). Marine Mammal and Acoustic Monitoring of the Eni/Pgs Open-Water Seismic Program near Thetis, Spy and Leavitt Islands, Alaskan Beaufort Sea, 2008: 90-Day Report., Eni US Operating Co.; PGS Onshore, Inc.**:** 194 pp.

Heide-Jørgensen, M. P., S. B. Blackwell, O. M. Tervo, A. L. Samson, E. Garde, R. G. Hansen, M. C. ò. n. Ngô, A. S. Conrad, P. Trinhammer, H. C. Schmidt, M.-H. S. Sinding, T. M. Williams and S. Ditlevsen (2021). "Behavioral Response Study on Seismic Airgun and Vessel Exposures in Narwhals." Frontiers in Marine Science **8**.

Ice Seal Committee (2017). The Subsistence Harvest of Ice Seals in Alaska—a Compilation of Existing Information, 1960–2015. Anchorage AK, Ice Seal Committee**:** 1-78.

Ice Seal Committee (2024a). The Subsistence Harvest of Ice Seals in Alaska – a Compilation of Existing Information, 1960-2022**:** 87 pp.

Ice Seal Committee (2024b). The Subsistence Harvest of Ice Seals in Alaska – a Compilation of Existing Information, 1960-2022 Draft, Ice Seal Committee**:** 87 pp.

Ireland, D. S., L. Bisson, S. B. Blackwell, M. Austin, D. E. Hannay, K. Bröker and A. M. Macrander (2016). Comprehensive Report of Marine Mammal Monitoring and Mitigation in the Chukchi and Beaufort Seas, 2006–2015., National Marine Fisheries Service, U.S. Fish and Wildlife Service**:** 558 pp + appendices.

Jensen, A. S. and G. K. Silber (2003). Large Whale Ship Strike Database. NOAA Technical Memorandum, National Oceanic and Atmospheric Administration**:** 37 pp.

Johnson, C. B., B. E. Lawhead, J. R. Rose, M. D. Smith, A. A. Stickney and A. M. Wildman (1999). Wildlife Studies on the Colville River Delta, Alaska, 1998, Rep. from ABR, Inc., Fairbanks, AK, for ARCO Alaska, Inc.**:** 111 pp.

Kelly, B. P. (1988). Bearded Seal, *Erignathus Barbatus*. Selected Marine Mammals of Alaska/Species Accounts with Research and Management Recommendations. Lentifer, J. W. Washington DC, Marine Mammal Commission**:** 77-94.

Kelly, B. P., O. H. Badajos, M. Kunnasranta, J. R. Moran, M. Martinez-Bakker, D. Wartzok and P. Boveng (2010a). "Seasonal Home Ranges and Fidelity to Breeding Sites among Ringed Seals." Polar Biology **33**(8): 1095-1109.

Kelly, B. P., J. L. Bengtson, P. Boveng, M. F. Cameron, S. P. Dahle, J. K. Jansen, E. A. Logerwell, J. E. Overland, C. L. Sabine, G. T. Waring and J. M. Wilder (2010b). Status Review of the Ringed Seal (*Phoca Hispida*). NOAA Technical Memorandum. Anchorage AK, US Department of Commerce, National Marine Fisheries Service**:** 250 pp.

Kelly, B. P., O. P. Harding, M. Kunnasranta, L. Quakenbush and B. D. Taras (2005). Correction Factor for Ringed Seal Surveys in Northern Alaska: Final Report, MMS**:** 37 pp.

Kelly, B. P., L. T. Quakenbush and J. R. Rose (1986). Ringed Seal Winter Ecology and Effects of Noise Disturbance. Final Report of Principal Investigators. Anchorage AK, Outer Continental Shelf Environmental Assessment Program Reseach Unit**:** 86 pp.

Koski, W. R., D. Ireland, C. Lyons, A. M. Macrander and L. Voparil (2008). Feeding by Bowhead Whales near an Offshore Seismic Survey in Central Beaufort Sea**:** 14 pp.

Laidre, K. L., I. Stirling, L. F. Lowry, W. Oystein and M. P. Heide-Jørgensen (2008). "Quantifying the Sensitivity of Arctic Marine Mammals to Climate-Induced Habitat Change." Ecological Applications **18**(2): S97–S125.

Lang, A. R., P. Boveng, L. Quakenbush, K. Robertson, M. Lauf, K. D. Rode, H. Ziel and B. L. Taylor (2021). "Re-Examination of Population Structure in Arctic Ringed Seals Using Dartseq Genotyping." Endangered Species Research **44**: 11-31.

Lawrence, C., M. Reeve and M. Austin (2021). Sound Source Verification Field Report, Hilcorp Alaska 2021 Lower Cook Inlet Shallow Hazards Survey**:** 34 pp.

Lawrence, C., G. Warner and M. Austin (2022). Underwater Sound Measurements of Tugs Towing a Jack-up Rig**:** 31 pp.

Lomac-MacNair, K. S., M. A. Smultea, T. Yack, M. Lammers, T. Norris, G. Green, K. Dunleavey, D. Steckler and V. James (2018). "Marine Mammal Visual and Acoustic Surveys near the Alaskan Colville River Delta." Polar Biology **42**(2): 441-448.

MacLean, S. A. (1998a). Marine Mammal Monitoring of an on-Ice Seismic Program in the Eastern Alaskan Beaufort Sea, April 1998, Prepared for BP Exploration (Alaska) Inc.**:** 17 pp.

MacLean, S. A. (1998b). Marine Mammal Monitoring of an on-Ice Seismic Program in the Eastern Alaskan Beaufort Sea, April 1998. Anchorage AK, LGL Alaska Research Associates. **Final Report:** 17.

McLaren, I. (1958). "The Biology of the Ringed Seal (Phoca Hispida Schreber) in the Eastern Canadian Arctic." Bulletin of the Fisheries Research Board of Canada **118**: 1-97.

Moore, S. (2000). "Variability of Cetacean Distribution and Habitat Selection in the Alaskan Arctic, Autumn 1982-91." ARCTIC **53**.

Moore, S. E., D. P. DeMaster and P. K. Dayton (2000). "Cetacean Habitat Selection in the Alaskan Arctic in the Summer and Autumn." Arctic **53**(4): 432-447.

Moreland, E., M. Cameron and P. Boveng (2013). "Bering Okhotsk Seal Surveys (Boss), Joint Us-Russian Aerial Surveys for Ice-Associated Seals, 2012-13." Alaska Fisheries Science Center Quarterly Report (July-August-September 2013): 1-6.

Moulton, V. D., W. J. Richardson, R. Elliott, T. L. McDonald, C. Nations and M. T. Williams (2005). "Effects of an Offshore Oil Development on Local Abundance and Distribution of Ringed Seals (*Phoca Hispida*) of the Alaskan Beaufort Sea." Marine Mammal Science **21**(2): 217-242.

Moulton, V. D., W. J. Richardson, T. L. McDonald, R. E. Elliott and M. T. Williams (2002). "Factors Influencing Local Abundance and Haulout Behaviour of Ringed Seals (*Phoca Hispida*) on Landfast Ice of the Alaskan Beaufort Sea." Canadian Journal of Zoology **80**(11): 1900-1917.

Moulton, V. D., W. J. Richardson, M. T. Williams and S. B. Blackwell (2003). "Ringed Seal Densities and Noise near an Icebound Artificial Island with Construction and Drilling." Acoustics Research Letters Online **4**(4): 112-117.

Moulton, V. D., M. T. Williams, S. Blackwell and W. J. Richardson (2008). Zone of Displacement for Ringed Seals (*Pusa Hispida*) Wintering around Offshore Oil-Industry Operations in the Alaskan Beaufort Sea, BP Exploration (Alaska) Inc.**:** 49 pp.

Muto, M., V. Helker, B. J. Delean, C. N. Young, J. C. Freed, R. Angliss, N. A. Friday, P. Boveng, J. M. Breiwick, B. Brost, M. F. Cameron, P. J. Clapham, J. L. Crance, M. Dahle, M. E. Dahlheim, B. S. Fadely, M. Ferguson, L. Fritz, T. Goetz, R. C. Hobbs, Y. V. Ivashchenko, A. Kennedy, J. M. London, S. Mizroch, R. Ream, E. L. Richmond, K. Shelden, K. Sweeney, R. G. Towell, P. R. Wade, J. M. Waite and A. Zerbini (2022). Final Alaska Marine Mammal Stock Assessments, 2021. NOAA Technical Memorandum, National Marine Fisheries Service**:** 304 pp.

Muto, M. M., V. T. Helker, B. J. Delean, R. P. Angliss, P. L. Boveng, J. M. Breiwick, B. M. Brost, M. F. Cameron, P. J. Clapham, S. P. Dahle, M. E. Dahlheim, B. S. Fadely, M. C. Ferguson, L. W. Fritz, R. C. Hobbs, Y. V. Ivashchenko, A. S. Kennedy, J. M. London, S. A. Mizroch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, K. L. Sweeney, R. G. Towell, P. R. Wade, J. M. Waite and A. N. Zerbini (2020). Alaska Marine Mammal Stock Assessments, 2019. NOAA Technical Memorandum**:** 404 pp.

Nelson, M., L. T. Quakenbush, B. D. Taras and I. Committee (2019). "Subsistence Harvest of Ringed, Bearded, Spotted, and Ribbon Seals in Alaska Is Sustainable." Endangered Species Research **40**.

NMFS (2008). 73 Fr 49421 Iha Conocophillips Shallow Hazard and Site Clearance Surveys in the Chukchi Sea in 2008. Federal Register. **73:** 49421-49443.

NMFS (2012). Biological Opinion: Bpxa Northstar Development Marine Mammal Protection Act Authorization 2012-2016, Beaufort Sea, Alaska, National Marine Fisheries Service**:** 127 pp.

NMFS (2015). Cook Inlet Iha 80 Fr 37446 Exxon Geotechnical and Geophysical Surveys 2015**:** 29 pp.

NMFS (2020). "85 Fr 83451 Final Rule: Hilcorp-Eni Ice Road, Trail and Pad Construction, Operation, Maintenance, Alaska North Slope." Federal Register **85**: 83451-83473.

NMFS (2022). Final Rule 87 Fr 19232 Arctic Ringed Seal Critical Habitat**:** 56 pp.

NMFS (2023). National Marine Fisheries Service: Summary of Marine Mammal Protection Act Acoustic Thresholds**:** 7 pp.

NMFS (2024). 2024 Update To: Technical Guidance for Assessing the Effects of Anthropogenic Sound on

Marine Mammal Hearing (Version 3.0) Underwater and in-Air Criteria for Onset of Auditory Injury and Temporary Threshold Shifts**:** 192 pp.

Patterson, H., S. B. Blackwell, B. Haley, A. Hunter, M. Jankowski, R. Rodrigues, D. Ireland and D. W. Funk (2007). Marine Mammal Monitoring and Mitigation during Open Water Seismic Exploration by Shell Offshore Inc. In the Chukchi and Beaufort Seas, July–September 2006: 90-Day Report, Shell Offshore, Inc.**:** 150 pp.

Pearson, W. H., J. R. Skalski and C. I. Malme (1992). "Effects of Sounds from a Geophysical Survey Device on Behavior of Captive Rockfish (*Sebastes Spp.*)." Canadian Journal of Fisheries and Aquatic Sciences **49**: 1343 - 1356 pp.

Quakenbush, L., A. L. Bryan and J. Crawford (2022). Winter Ringed Seal Density within Beaufort Sea Oil and Gas Project Areas. Annual Report for 2022, BOEM**:** 36 pp.

Quakenbush, L., A. L. Bryan and J. Crawford (2023). Winter Ringed Seal Density in Beaufort Sea Oil and Gas Project Areas. Quarterly Report for April - June 2023**:** 18 pp.

Quakenbush, L., J. Crawford, M. A. Nelson and J. Olnes (2019). Ice Seal Movements and Foraging: Village-Based Satellite Tracking and Collection of Traditional Ecological Knowledge Regarding Ringed and Bearded Seals – Final Report, BOEM**:** 238 pp.

Reiser, C. M., D. W. Funk, R. Rodrigues and D. Hannay (2010). Marine Mammal Monitoring and Mitigation during Open Water Seismic Exploration by Shell Offshore, Inc. In the Alaskan Chukchi Sea, July–October 2009: 90-Day Report, Shell Offshore Inc.; National Marine Fisheries Service; U.S. Fish and WIldlife Service**:** 268 pp.

Reiser, C. M., D. W. Funk, R. Rodrigues and D. Hannay (2011). Marine Mammal Monitoring and Mitigation during Marine Geophysical Surveys by Shell Offshore, Inc. In the Alaskan Chukchi and Beaufort Seas, July–October 2010: 90-Day Report, LGL Alaska Research Associates Inc., Anchorage, AK, and JASCO Applied Sciences, Victoria, BC for Shell Offshore Inc, Houston, TX**:** 240 pp.

Rice, D. W. and Society for Marine Mammalogy (1998). Marine Mammals of the World : Systematics and Distribution. Lawrence, KS, Society for Marine Mammalogy.

Richardson, W. J. (2011). Monitoring of Industrial Sounds, Seals, and Bowhead Whales near Bp's Northstar Oil Development, Alaskan Beaufort Sea: Comprehensive Report for 2005-2010., LGL Alaska Research Assoc. Inc., Greeneridge Sciences Inc., WEST Inc. and Applied Sociocultural Research**:** 266 pp.

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

Richardson, W. J. and M. T. Williams (2000a). Monitoring of Ringed Seals during Construction of Ice Roads for Bp's Northstar Oil Development, Alaskan Beaufort Sea, 1999. Monitoring of Industrial Sounds, Seals, and Bowhead Whales near Bp's Northstar Oil Development, Alaskan Beaufort Sea, 1999–2004. Richardson, W. J. Anchorage Alaska, LGL, LTD.**:** 153.

Richardson, W. J. and M. T. Williams (2000b). Monitoring of Ringed Seals during Construction of Ice Roads for Bp's Northstar Oil Development, Alaskan Beaufort Sea, 1999., BP Exploration (Alaska) Inc.**:** 153 pp.

Richardson, W. J. and M. T. Williams (2001). Monitoring of Industrial Sounds, Seals, and Whale Calls during Construction of Bp's Northstar Oil Development, Alaskan Beaufort Sea, 2000. [Draft]. Monitoring of Industrial Sounds, Seals, and Bowhead Whales Near BP's Northstar Oil Development, Alaskan Beaufort Sea, 1999–2004 Draft. Anchorage, AK, LGL Ltd., Greeneridge Sciences Inc., WEST Inc., and Applied Sociocultural Research**:** 316 pp.

Richardson, W. J. and M. T. Williams (2002). Monitoring of Industrial Sounds, Seals, and Whale Calls during Construction of Bp's Northstar Oil Development, Alaskan Beaufort Sea, 2001., LGL Ltd., King City, Ont., and Greeneridge Sciences Inc.,**:** 337 pp.

Richardson, W. J. and M. T. Williams (2003). Monitoring of Industrial Sounds, Seals, and Bowhead Whales near Bp's Northstar Oil Development, Alaskan Beaufort Sea, 1999–2002., BP Exploration (Alaska) Inc.**:** 343 pp.

Richardson, W. J. and M. T. Williams (2004). Monitoring of Industrial Sounds, Seals, and Bowhead Whales near Bp's Northstar Oil Development, Alaskan Beaufort Sea, 1999–2003. [Annual and Comprehensive Report, December 2004.], BP Exploration (Alaska) Inc.**:** 297 pp.

Robertson, T., L. K. Campbell and S. Fletcher (2020). Oil Spill Occurrence Rates for Cook Inlet, Alaska Oil and Gas Exploration, Development, and Production. Plymouth, MA, U.S. Dept. of the Interior, Bureau of Ocean Energy Management**:** 78 pp.

Robinson (2017). R66 Pilot's Operating Handbook and Faa Approved Rotorcraft Flight Manual. Approved October 10, 2010. Revised August 29, 2017.

Rugh, D. and M. Fraker (1981). "Rugh, D. And M. Fraker. 1981. Gray Whale (Eschrichtius Robustus) Sightings in Eastern Beaufort Sea. Arctic 34(2):186-187." Arctic **34**: 186-187.

Rugh, D. J., K. E. W. Shelden and D. Withrow (1997). "Spotted Seals, *Phoca Largha*, in Alaska." Marine Fisheries Review **59**(1): 18 pp.

Ruppel, C. D., T. C. Weber, E. R. Staaterman, S. J. Labak and P. E. Hart (2022). "Categorizing Active Marine Acoustic Sources Based on Their Potential to Affect Marine Animals." Journal of Marine Science and Engineering **10**(9).

Sharp, L. (2011). A Review of Effects of Seismic Testing on Marine Fish and Fisheries as Applied to the Dcpp 3-D Seismic Project. San Luis Obispo, CA, Tenera Environmental**:** 34 pp.

Sills, J. M., B. Ruscher, R. Nichols, B. L. Southall and C. Reichmuth (2020). "Evaluating Temporary Threshold Shift Onset Levels for Impulsive Noise in Seals." J Acoust Soc Am **148**(5): 2973.

SLR (2023). Narwhal Llc Technical Letter -Slr Underwater Noise Modelling**:** 7 pp.

Smith, T. G. and I. Stirling (1975). "The Breeding Habitat of the Ringed Seal (Phoca Hispida). The Birth Lair and Associated Structures." Canadian Journal of Zoology **53**: 1297-1305 pp.

Smultea, M. A., K. S. Lomac-MacNair and C. Bacon (2014). Nmfs 90-Day Report for Marine Mammal Monitoring and Mitigation during Bpxa's Liberty Shallow Geohazard Seismic and Seabed Mapping Survey Beaufort Sea, Alaska, BP Exploration (Alaska) Inc.**:** 152 pp.

Southall, B. L., J. J. Finneran, C. Reichmuth, P. E. Nachtigall, D. R. Ketten, A. E. Bowles, W. T. Ellison, D. P. Nowacek and P. L. Tyack (2019). "Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects." Aquatic Mammals **45**(2): 125-232.

Suydam, R., C. George, B. Person, R. Stimmelmayr, T. Sformo, L. Pierce, A. Von Duyke, R. Acker and G. Sheffield (2020). Subsistence Harvest of Bowhead Whales (*Balaena Mysticetus*) by Alaskan Natives during 2019, International Whaling Commission and NSB Department of Wildlife Management**:** 8 pp.

Suydam, R., J. Lefevre, G. H. Givens, C. George, D. Litovka and H. K. Brower (2021). The Bowhead Whale Chapter 38 Conservation and Management**:** 14 pp.

Szesciorka, A. R. and K. M. Stafford (2023). "Sea Ice Directs Changes in Bowhead Whale Phenology through the Bering Strait." Movement Ecology **11**(1): 8.

Thewissen, J. G. M. and C. George (2021). The Bowhead Whale *Balaena Mysticetus*: Biology and Human Interactions. George, J. C. and Thewissen, J. G. M., Academic Press, Elsevier**:** 640 pp.

Thode, A. M., S. B. Blackwell, A. S. Conrad, K. H. Kim, T. Marques, L. Thomas, C. S. Oedekoven, D. Harris and K. Bröker (2020). "Roaring and Repetition: How Bowhead Whales Adjust Their Call Density and Source Level (Lombard Effect) in the Presence of Natural and Seismic Airgun Survey Noise." The Journal of the Acoustical Society of America **147**(3): 2061-2080.

Treacy, S. D. (2002). Aerial Surveys of Endangered Whales in the Beaufort Sea, Fall 2000, MMS**:** 106 pp.

Treacy, S. D., J. S. Gleason and C. J. Cowles (2009). "Offshore Distances of Bowhead Whales (*Balaena Mysticetus*) Observed during Fall in the Beaufort Sea, 1982–2000: An Alternative Interpretation." Arctic **59**(1).

Unger, S. (2014). Qaqamiiĝux: Traditional Foods and Recipes from the Aleutian and Pribilof Islands., Aleutian Pribilof Islands Association Inc.

Von Duyke, A. L., D. C. Douglas, J. K. Herreman and J. A. Crawford (2020). "Ringed Seal (Pusa Hispida) Seasonal Movements, Diving, and Haul-out Behavior in the Beaufort, Chukchi, and Bering Seas (2011–2017)." Ecology and Evolution **10**(12): 5595-5616.

Wartzok, D., A. N. Popper, J. Gordon and J. Merrill (2003). "Factors Affecting the Responses of Marine Mammals to Acoustic Disturbance." Marine Technology Society **37**(4): 10 pp.

Williams, M. T., C. S. Nations, T. G. Smith, V. D. Moulton and C. J. Perham (2006). "Ringed Seal (*Phoca Hispida*) Use of Subnivean Structures in the Alaskan Beaufort Sea during Development of an Oil Production Facility." Aquatic Mammals **32**(3): 311-324.

Wisniewska, D. M., L. A. Kyhn, J. Tougaard, M. Simon, Y.-T. Lin, A. Newhall, K. Beedholm, J. Lynch and P. T. Madsen (2014). Propagation of Airgun Pulses in Baffin Bay 2012. Aarhus University, Dce –

Danish Centre for Environment and Energy, 150 Pp. Scientific Report from Dce – Danish Centre for Environment and Energy No. 109 Http://Dce2.Au.Dk/Pub/Sr109.Pdf**:** 154 pp.

Young, N. C., A. Brower, M. Muto, J. C. Freed, R. Angliss, N. A. Friday, P. Boveng, B. Brost, M. F. Cameron, J. L. Crance, M. Dahle, B. S. Fadely, M. Ferguson, F. Goetz, J. M. London, E. Oleson, R. Ream, E. L. Richmond, K. Shelden, K. Sweeney, R. G. Towell, P. R. Wade, J. M. Waite and A. Zerbini (2023). Final Alaska Marine Mammal Stock Assessments, 2022. Seattle, WA, National Marine Fisheries Service**:** 316 pp.

Young, N. C., A. A. Brower, M. M. Muto, J. C. Freed, R. P. Angliss, N. A. Friday, B. D. Birkemeier, P. L. Boveng, B. M. Brost, M. F. Cameron, J. L. Crance, S. P. Dahle, B. S. Fadely, M. C. Ferguson, K. T. Goetz, J. M. London, E. M. Oleson, R. R. Ream, E. L. Richmond, K. E. W. Shelden, K. L. Sweeney, R. G. Towell, P. R. Wade, J. M. Waite and A. N. Zerbini (2024). Draft Alaska Marine Mammal Stock Assessments, 2023**:** 99 pp.

Appendix A

Types of Equipment and Vessels Similar To What May Be Used

ECHOTRAC E20

Hydrographic Echosounder for demanding 24/7 use

The new ECHOTRAC E20 is the result of more than 40 years of experience in precise echosounding and market leading sonar technology.

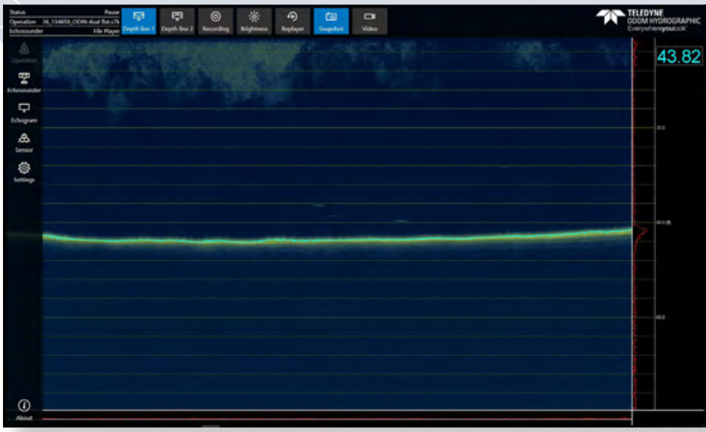
A portable, compact and robust echosounder designed for survey in all environments allowing you to maximize your utilization of the equipment and reducing your costs by having one unit for all applications.

Easy to use and fast to mobilize, the E20 allows you to begin your survey rapidly, delivering accurate results first time, every time. The E20 saves time and enables you to get results faster.

The ECHOTRAC E20 completes our portfolio of sonar solutions introducing yet another groundbreaking innovation into the day-to-day work life of our customers.

E20 product features

- 1 or 2 frequency agile channels from 10 to 250kHz
- 0.5 to 6,000m depth range
- Ruggedized and shock-proof, water resistant IP67



The new SBES UI operator software is being used to operate the ECHOTRAC E20 in shallow water at 200kHz

PRODUCT FEATURES

- Precise and reliable survey data for shorter data processing time, enabling you to complete your project faster.
- Dual channel survey echosounder from very shallow to deep sea, from 10 kHz to 250 kHz – giving you the flexibility for all your survey projects, maximizing utilization of your investment.
- The compact system with minimal interfacing effort, allows for fast mobilization, and extremely low space to go anywhere, enabling you to start work immediately.
- Intuitive user interface, easy to use, so you can focus on the job at hand.
- The ECHOTRAC E20 is compatible with a broad range of transducers with straightforward transducer interfacing.

TELEDYNE MARINE
ODOM HYDROGRAPHIC
Everywhereyoulook™

TELEDYNE MARINE

ECHOTRAC E20

TECHNICAL SPECIFICATIONS

	Single channel	Dual channel	Dual channel Extended Range
Operating frequency	HF channel 10 to 250Khz, optimized for 50-250kHz		
	LF channel 10 to 250khz, optimized for 10-50kHz		
Channels	Single[1]	Dual	Dual
Accuracy and Resolution			
200kHz	1cm resolution and 2cm +/- 0.1% of depth accuracy		
33kHz	5cm resolution and 10cm +/- 0.1% of depth accuracy		
12kHz	15cm resolution and 15cm +/- 0.1% of depth accuracy		
Depth Range[2]			
200kHz	0.5 to 250m		0.5 to 400m
33kHz	1.0 to 1,000m		1.0 to 3,000m
12kHz	3.0 to 1,000m		3.0 to 6,000m
Max ping rate	50Hz		
Pulse type	CW	CW	CW and FM (chirp)
Output power	Typically max output power varies between 1 and 3kW, depending on transducer		
Input power	10-30VDC, 100-230VAC[3] , max 50W		
Data output	Via LAN interface: For each channel the measured depth and full amplitude-time echogram, passed through auxiliary sensor data, s7k data protocol. Via serial port: For each channel the measured depth		
Transducer interfaces	Impedance: minimum 50 Ohm, Max power: 15W per channel RMS		
	• Single-connector TX1 for dual transducer		
	• Two separate connectors TX1 and TX2 for separate transducer cables		
Interfaces	3 serial connectors (RS-232):		
	• Input: GPS position and time, heave, motion, heading		
	• Output: depth		
	1 Ethernet LAN connector		
	1 sync connector		
Dimensions H x W x D	83.0mm x 300.0mm x 221.0mm		
Weight	5.7kg (excl. external cables and transducers)		
Environmental conditions and ingress protection	Temperature Operation (Storage): -20°C to +55°C (-30°C to +70°C)		
	IP67, Vibration, Drop: Complies with standard EN 60945 §8.7 and §8.6		

[1]The E20 SC single channel can utilize both channels, but not at the same time.
[2]The depth values are based on the performance of TC2122 for 200 and 33kHz, and HM210/12-8/20 for 12kHz. Stated depth ranges may be impacted by environmental conditions, vessel installation, and motion
[3]External AC power supply is included and intended for dry installation (not IP67 compliant).

TELEDYNE MARINE
ODOM HYDROGRAPHIC
Everywhereyoulook™

www.teledynemarine.com/odom-hydrographic
Tel. +45 4738 0022 (Europe) • Tel: +1 805 964 6260 (USA)
Email: odom@teledyne.com

Specifications subject to change without notice.
 PLD19162-4

4205

TRI-FREQUENCY / MOTION TOLERANT SIDE SCAN SONAR SYSTEM

FEATURES

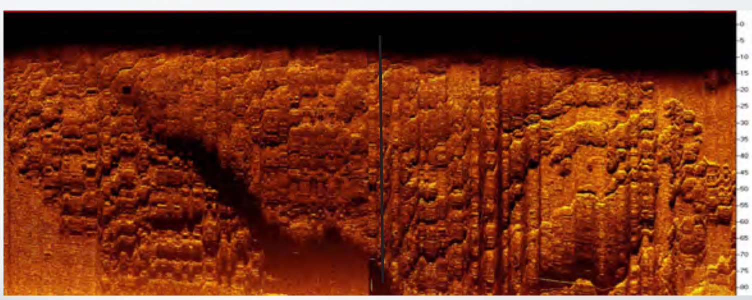
- Tri frequency side scan sonar
- Motion tolerant mode
- Improved target positioning
- Crisp, high resolution CHIRP imagery
- Increased towfish power to support wider range of 3rd party sensors
- Single pulse high resolution mode

APPLICATIONS

- Cable & pipeline surveys
- Geological/geophysical surveys
- Mine countermeasures (MCM)
- Geohazard surveys
- Channel clearance
- Search and recovery
- Archeological surveys

The next generation 4205 is a versatile side scan sonar system that can be configured for almost any survey application from shallow to deep water operations. The 4205 utilizes EdgeTech's Full Spectrum® CHIRP technology to provide crisp, high resolution imagery at ranges up to 50% greater than non-CHIRP systems; thus allowing customers to cover larger areas and save money spent on costly surveys. In addition to the high-resolution imagery that EdgeTech is known for, the 4205 comes with a number of new features which makes the system even more flexible and powerful in offshore operations. The 4205 is available in either a tri-frequency side scan sonar configuration or motion tolerant and multi-pulse configuration. The tri-frequency version allows surveyors the option to operate any two frequencies simultaneously from the tri-frequency system. Long range operations for example can be achieved with a selection of 230/540 kHz combination. Then, on-demand the system can be changed to a 540/850kHz system for an even higher resolution survey. The 4205 motion tolerant configuration with multi-pulse provides surveyors the ability to operate either at faster survey speeds or in more adverse weather conditions while still obtaining high quality underwater imagery. Additionally, this configuration can be operated in a single pulse high-resolution mode for those operations that require an even more finite view of the seafloor.

In both the tri-frequency and motion tolerant/ multi-pulse configurations, towfish and target positioning has been improved with the integration of a more accurate heading sensor. Additionally, all systems now come with increased towfish power to support a wider range of additional 3rd party sensors. All EdgeTech 4205 systems are comprised of a topside system and a reliable stainless steel towfish. Topside processors are rack mountable and come with easy-to-use GUI software that can be installed on the optional industrial workstation, laptop or customer provided PC.



Motion Tolerant Mode Sonar example: During turbulent conditions, the data on the left of side of this image was recorded using the EdgeTech 4205 Motion Tolerant mode. The right side of the image, depicting motion induced striping was captured without the Motion Tolerant mode for comparison.

4205

TRI-FREQUENCY / MOTION TOLERANT SIDE SCAN SONAR SYSTEM

KEY SPECIFICATIONS

SONAR SPECIFICATIONS	4205 TRI-FREQUENCY	4205 MULTI-PULSE/MOTION TOLERANT (MP/MT) AND HIGH DEFINITION MODE	
Frequency	Choice of either 120/410/850 kHz or 230/540/850 kHz	Choice of either 120/410 kHz, 230/540 kHz, 540/850 kHz or 230/850 kHz	
Operating Range (meters/side)	120 kHz: 600m, 230 kHz: 350m, 410 kHz: 200m, 540 kHz: 150m, 850 kHz: 90m		
		MP/MT	HDM
Horizontal Beam Width	120 kHz: 0.70° 230 kHz: 0.44° 410 kHz: 0.28° 540 kHz: 0.26° 850 kHz: 0.23°	120 kHz: 0.95° 230 kHz: 0.62° 410 kHz: 0.40° 540 kHz: 0.36° 850 kHz: 0.33°	0.70° 0.44° 0.28° 0.26° 0.23°
		MP/MT	HDM
Resolution Along Track	120 kHz: 2.4m @ 200m 230 kHz: 1.2m @ 150m 410 kHz: 0.5m @ 100m 540 kHz: 0.45m @ 100m 850 kHz: 0.20m @ 50m	120 kHz: 3.3m @ 200m 230 kHz: 1.7m @ 150m 410 kHz: 0.7m @ 100m 540 kHz: 0.6m @ 100m 850 kHz: 0.26m @ 50m	2.4m @ 200m 1.2m @ 150m 0.5m @ 100m 0.45m @ 100m 0.20m @ 50m
Resolution Across Track	120 kHz: 8cm; 230 kHz: 3cm; 410 kHz: 2 cm; 540 kHz: 1.5cm; 850 kHz: 1cm		
Vertical Beam Width	50°		
Depression Angle	Tilted down 25°		
TOWFISH	**STAINLESS STEEL**		
Diameter	12cm (4.75 inches)		
Length	140cm (55 inches)		
Weight in Air	52 kg (115 pounds)		
Depth Rating (Max)	2,000m		
Standard Sensors	Heading, pitch & roll		
Optional Sensor Port	(1) Serial – RS 232C, Bi-directional & 28 VDC +/- 4%		
Options	Pressure Sensor, Magnetometer interface, USBL Responder interface, Depressor, Power Loss Pinger and Custom Sensors		
TOPSIDE PROCESSOR	**4205 INTERFACE**		
Hardware	19" rack mount interface (150 watt or 400 watt)		
Display & Interface	Optional industrial workstation, laptop or customer provided PC		
Power Input	115/230 VAC		
File Format	Native JSF or XTF		
Sensor Interfaces	Ethernet, RS 232		
TOW CABLE			
	Coaxial Kevlar or double-armored up to 6,000m, winches available		

3400-OTS

POLE-MOUNT SUB-BOTTOM PROFILER

FEATURES

- Three over-the-side mount configurations:
  - Ultra-Lightweight Shallow Water
  - Lightweight Shallow Water
  - Low Frequency Deep Water
- Pipeline survey mode
- Digital receiver with ethernet telemetry and power
- Real-time pitch, roll, heave and depth sensors
- Surface echo attenuation
- Pulse library tailored for different survey applications
- Dual frequency transmission

APPLICATIONS

- Geological surveys
- Environmental site investigations
- Sediment classification
- Buried pipeline & cable surveys
- Archeological surveys
- Mining/dredging surveys
- Map, measure & classify sediment layers within the sea floor

Building on the long running success of the EdgeTech sub-bottom profiler product line, the new over-the-side pole mount 3400-OTS provides users many unique enhancements to current sub-bottom profiler systems. The 3400-OTS transmits wide band Frequency Modulated (FM) pulses utilizing EdgeTech's proprietary Full Spectrum CHIRP technology. The system uses flat multi-channel hydrophone array to generate high resolution images of the sub-bottom stratigraphy in oceans, lakes, and rivers and provides excellent penetration in various bottom types. The 3400-OTS receiver array is segmented for standard sub-bottom profiling operations or "pipeline" mode for optimal location and imaging of buried pipelines or cables. The system offers real-time reflection coefficient measurements. This unique ability of the EdgeTech sub-bottom profiler system allows users the ability to collect complex 'analytic' data using linear system architecture to measure sediment reflection and analyze sediment type determination. Additionally, the system has discrete transmit and receive channels allowing for continuous data collection resulting in a high ping rate particularly important for construction and pipeline surveys.

The lightweight 3400-OTS is ideal for shallow water surveys using small boats of opportunity. While the low frequency model with dual transmitters and large receive array is ideal for deep water and windfarm applications.

The EdgeTech 3400-OTS sub-bottom profiling system comes as a complete package including EdgeTech's DISCOVER sub-bottom acquisition & processing software. The 3400-OTS can also be interfaced to 3rd party software.

EdgeTech

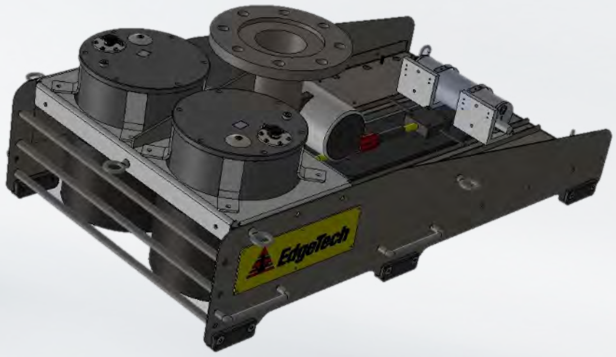
3400-OTS

POLE-MOUNT SUB-BOTTOM PROFILER

KEY SPECIFICATIONS

ACOUSTICS	3400-OTS ULTRA-LIGHT	3400-OTS LIGHT	3400-OTS LF
Frequency Range (kHz)	4-24	2-16	1-10
Number of Transmitters	1	1	2
Vertical Resolution (cm)	4-8	6-10	10-30
Penetration (typical) in sand (m) Penetration (typical) in clay (m)	2 40	6 80	20 200
Transmission Type	Full Spectrum® FM Signal (CHIRP)		
MECHANICS	**3400-OTS ULTRA-LIGHT**	**3400-OTS LIGHT**	**3400-OTS LF**
Length/Width/Height (cm)	77 x 33 x 34	77 x 33 x 34	117 x 75 x 51
Weight in Air	21.4 kg (47 lbs)	26.3 kg (58 lbs)	145 kg (320 lbs)
Deck Cable Length (m)	20 (50 max)		
TOPSIDE INTERFACE			
Hardware	Rugged, portable splash proof enclosure (or rackmounted)		
Power Amplifier (Watt)	200	200	4000
Recommended Operating System	Windows® 10		
Display (Optional)	Splash resistant semi-rugged laptop		
File Format	Native JSF, SEG-Y & XTF		
Input/Output	Ethernet		
Power Input	120/220 VAC Auto sensing		

3400-OTS ULTRA & LIGHTWEIGHT



3400-OTS LOW-FREQUENCY

For more information please visit EdgeTech.com

info@EdgeTech.com | USA 1.508.291.0057

APPLIED ACOUSTICS
Underwater Technology

Dura-Spark Geophysical Systems

www.appliedacoustics.com



The Dura-Spark System

a stable and repeatable sound source for sub-bottom geophysical surveys

The Applied Acoustics' Dura-Spark sub-bottom profiling package is a revolutionary sparker system that combines high quality data capture with improved resolution and hard-wearing sparker tips, to minimise operational downtime.

The system consists of a negative voltage seismic energy source, the CSP-N, a sparker sound source with up to 240 long-life tips, connected by a rugged high voltage cable. Designed for high and ultra high resolution geophysical surveys, and for use with single and multi-channel acquisition systems, the system is capable of providing high quality data with vertical resolution of up to 25cm, in water depths from 5 to 1000 metres.

Dura-Spark Sound Source

Key Features

- Long life, durable electrodes
- Pulse stability
- High resolution sub-bottom data
- Tip array selection from on board junction box

The Dura-Spark has been designed to provide a stable, repeatable sound source for sub-bottom geophysical surveys. The long life, durable electrodes produce a consistent pulse signature and keep operational maintenance to a minimum. This provides increased survey efficiency and equipment reliability as the sparker tips rarely, if ever, need replacement.

The Dura-Spark 240 is based on the CAT300 catamaran, providing a stable platform whilst under tow. The catamaran has robust solid floatation and is easily deployed from all survey vessels.

The Dura-Spark 240 consists of 3 arrays of 80 tips allowing the operator to tune the source from the vessel to its application. This flexibility, together with selectable source depth, allows the sound source to be used in both shallow and deep waters.

The typical operational bandwidth of the Dura-Spark 240 is 300Hz to 1.2kHz. When coupled with the CSP-N Seismic Power Supply the system offers 2000J/s peak discharge rate, as well as industry leading design and safety standards.

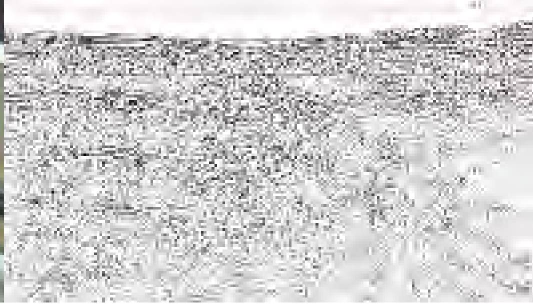
CSP-N Energy Source

Key features

- Unique negative output
- Fast discharge
- Additional safety/protection features
- All settings externally selectable
- Meets EC emissions regulations enabling interference-free field use

The CSP-N1200 seismic energy source is the driving force behind Applied Acoustics' Dura-Spark sound source that has extremely hard wearing electrode sparker tips. This durability is a consequence of the CSP's reverse polarity high voltage charger and unique proprietary thyristor switching.

Featuring all of the standard safety systems and operational functions found across the entire range of CSP energy sources, the CSP-N1200 is also suitable for use with the Applied Acoustics' S-Boom and single plate boomer systems.



Technical Specification

DURA-SPARK SYSTEM COMPONENTS

Dura-Spark on CAT 300 catamaran
CSP-N Seismic Energy Source
HVC 3500 High Voltage Cable, 75m standard

DURA-SPARK SEISMIC SOUND SOURCE

PHYSICAL

Dura-Spark 240 on CAT300 catamaran	
Dimensions	1700mm (L) 490mm (H) 660mm (W) frame/876mm (W) including floats
Weight	60kg
Connector	RMK 1/0 complete with locking collar

ELECTRICAL INPUT

Recommended energy	1000J/shot 5J per tip to minimise bubble collapse component
Maximum energy	1250J /shot
Operating voltage	3000-4000V
Maximum number of tips	240 (3 x 80)

SOUND OUTPUT

Source level	Typically 225dB re 1µPa at 1 metre with 1000J
Pulse Length	0.5 to 1.5ms. Dependent on tips and power applied

TYPICAL PULSE SIGNATURE AT 1000J

CSP-N1200 SEISMIC ENERGY SOURCE

PHYSICAL

Size	Transit Case (7U) with cover in place and handles flat: 50cm(H) x 58cm(W) x 74cm(D)
Weight	CSP-N, case and cover: 60kg

ELECTRICAL SPECIFICATION

Mains Input	240Vac 45-65Hz@4.0kVA single phase. 3 pin connector
	Variable Input Power Circuitry (AVIP) 'soft start' circuitry
Voltage Output	2500 to 3950Vdc, 4 pin interlocked connector
	Solid state semi-conductor discharge method
Output Energy	Easy switch selectable in increments, 50 to 1200 Joules
Charging Rate	2000J/second for continuous operation at 0-45°C
Capacitance	208µF, 10^8 shot life
Trigger	+ve key opto isolated or isolated closure
Repetition rate	6pps maximum
	Limited by charge rate, energy level and sound source rating

APPLIED ACOUSTICS
Underwater Technology

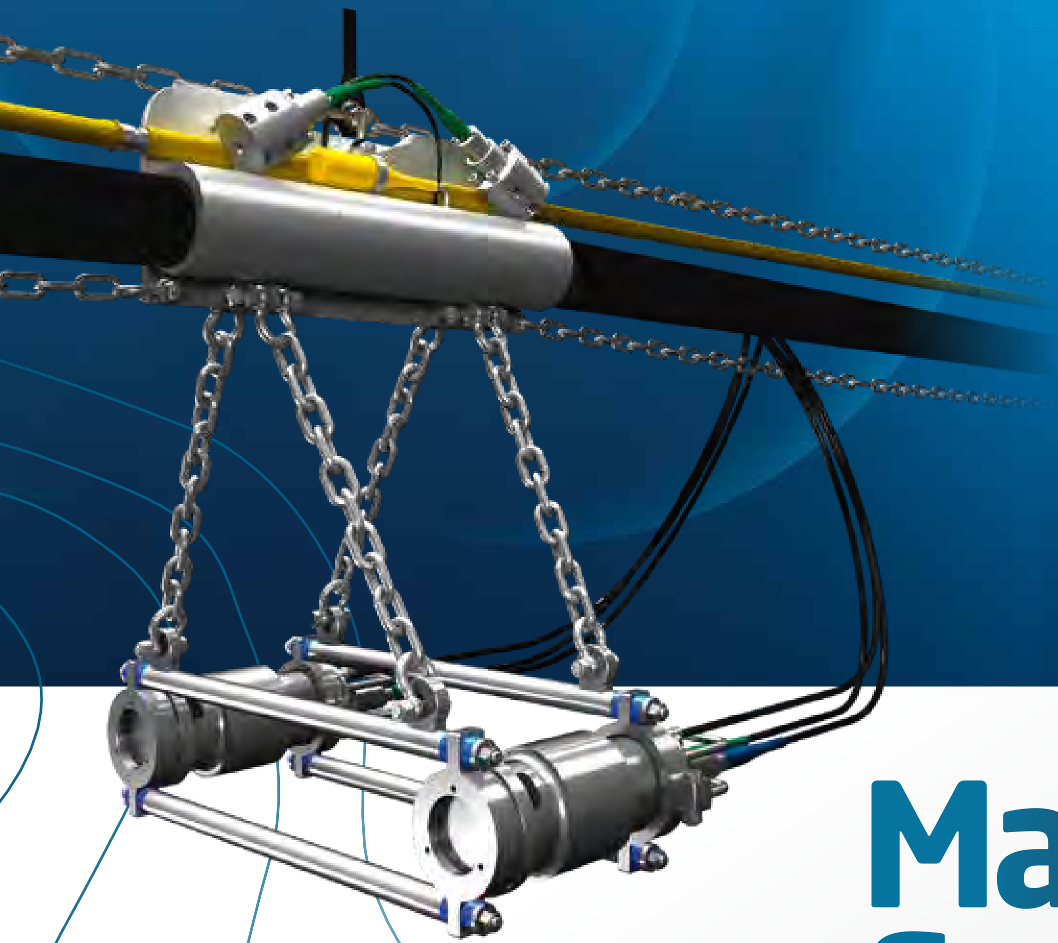
Applied Acoustic Engineering Ltd
Marine House, Marine Park
Gapton Hall Road
Great Yarmouth NR31 0NB
United Kingdom

T +44(0)1493 440355
F +44(0)1493 440720
E general@appliedacoustics.com
W www.appliedacoustics.com

With on-going research and development in cutting edge technology and acute awareness of current and future industry needs, our commitment to our customers is second to none. We are equally determined to aid and assist our customers worldwide with a network of partners, suppliers and overseas Support Centres. Together, we offer engineering excellence, trusted products and a first class professional service on a global scale.

www.appliedacoustics.com

LAND
DOWNHOLE
SEABED
MARINE



Marine Sources

High-performance impulsive sources

Sercel

Marine Sources

// HIGH-PERFORMANCE IMPULSIVE SOURCES

Sercel has 30 years of experience in the design and manufacture of marine sources. Throughout this time, Sercel has developed sources for all applications encountered within the seismic industry, including the most demanding environments.

This expertise has provided us with the foundations for designing a turnkey marine seismic source solution that can be adapted to every customer's need and operating environment as well as be built on for future source solutions and other in-sea equipment such as float systems.

The design philosophy driving all our marine source products is ease-of-use, safety and reliability. Sercel offers the most comprehensive air impulsive source portfolio in the industry that can be used for seismic & engineering applications such as towed streamer, shallow water/OBC/OBN and VSP surveys.

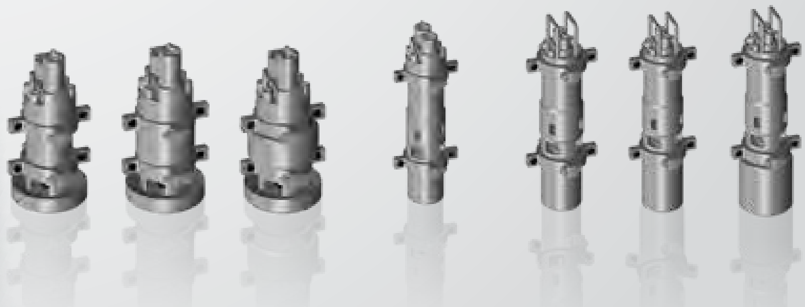
Complete Package

// G-SOURCE II

Streamer

Shallow Water

// Mini G-SOURCE & GI-SOURCE



Borehole

// G-SOURCE

Streamer

// G-SOURCE II

+5% 0-Peak Output compared to conventional impulsive sources

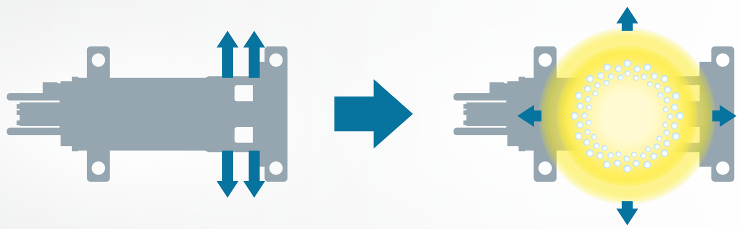
Designed to operate continuously at up to 3,000 psi (210 bars)

High degree of pulse repeatability

Recoiless

Possibility to deploy impulsive sources at sea without pressure

The G-SOURCE II is the safest, easiest-to-use and most reliable impulsive source in the industry. It offers a lightweight, compact solution for consistent performance and flexibility thanks to its advanced Volume Reducer technology.



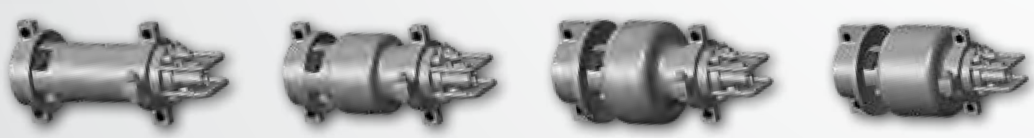
Phase 1

A special patented design allows the compressed air that is released to be deflected at the sides, resulting in recoilless shooting.

Phase 2

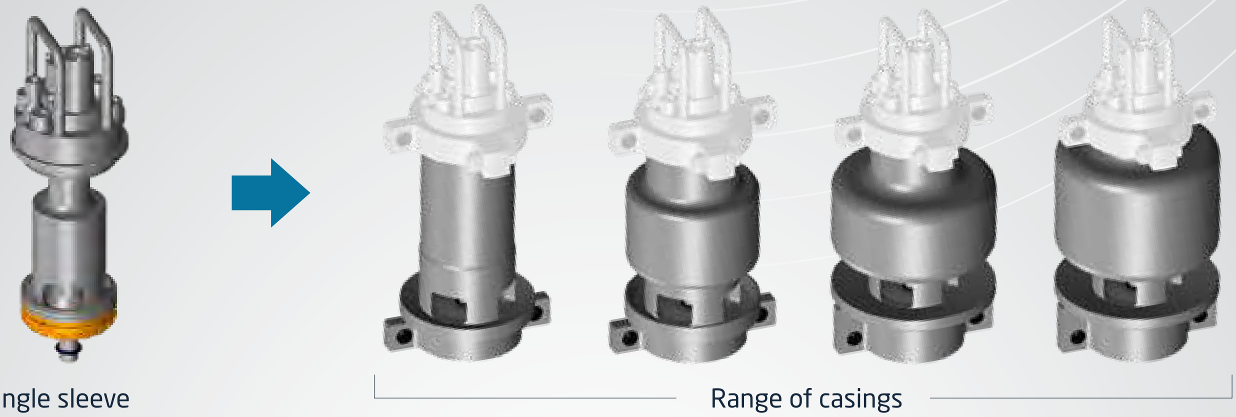
High-pressure air explosively released into the surrounding water generates the main acoustic pulse.

Specifications



	G-SOURCE II 150	G-SOURCE II 250	G-SOURCE II 380	G-SOURCE II 520
Available volume (cu.in)	45 • 50 • 60 • 70 • 80 • 90 • 100 • 110 • 120 • 130 • 140 • 150	180 • 200 • 210 • 220 • 250	320 • 340 • 350 • 360 • 380	520
Length	L = 597mm	L = 597mm	L = 640mm	L = 640mm
Width	W = 292mm	W = 292mm	W = 292mm	W = 292mm
Weight	55kg	65kg	85kg	90kg

Single impulsive source type



Single sleeve

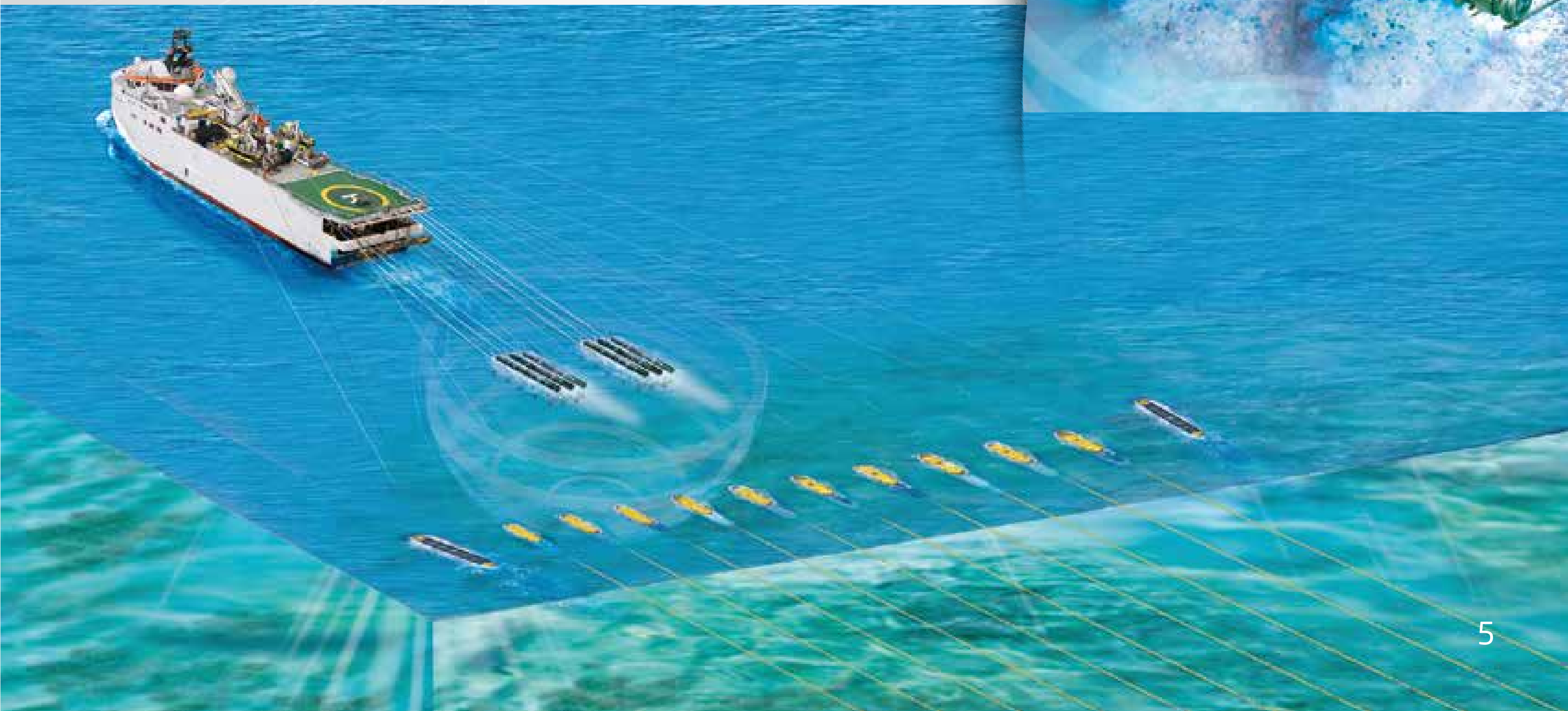
Range of casings

Each impulsive source volume can be easily changed by means of inexpensive "Volume Reducers" or by changing the external casing.

- Single set of spare parts for the entire G-SOURCE II range.
- Assemble/disassemble within minutes without special tooling.
- Firing/sensor/sleeve/shuttle system for all G-SOURCE II.

With its mechanical advantages and strong acoustic performance the G-SOURCE II is the impulsive source of choice for high-production seismic vessels.

For maximum energy output and high signature consistency shot after shot, G-SOURCE II impulsive sources can be configured in impulsive source clustered elements using our patented parallel cluster assembly design.



Shallow Water

// GI-SOURCE

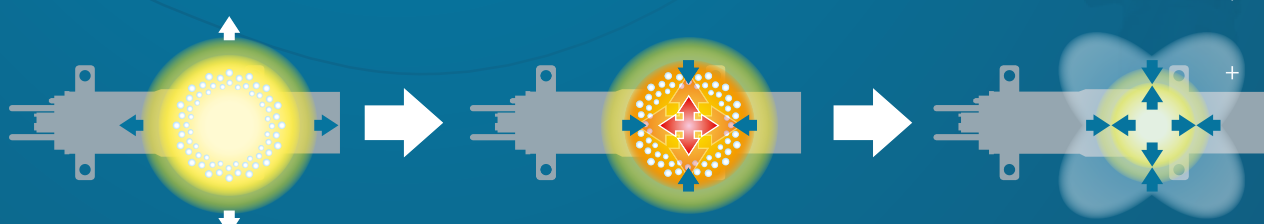
Clean acoustic signature

Light and compact

Flexible configuration

Sercel developed the GI-SOURCE to reduce and suppress the bubble oscillation from a single impulsive source to simplify processing. The GI-SOURCE impulsive source is based on the same technology as the G-SOURCE but is different in that it has two independent air chambers within the same casing.

- The Generator, generating the primary pulse and creating the main bubble.
- The Injector, injecting air inside the main bubble so that it collapses quickly.



Phase 1

The Generator is fired. The blast of compressed air produces the primary pulse and the bubble starts to expand.

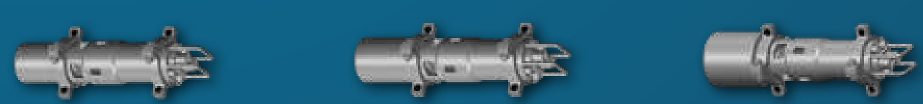
Phase 2

Just before the bubble reaches its maximum size, the injector is fired, injecting air directly inside the bubble.

Phase 3

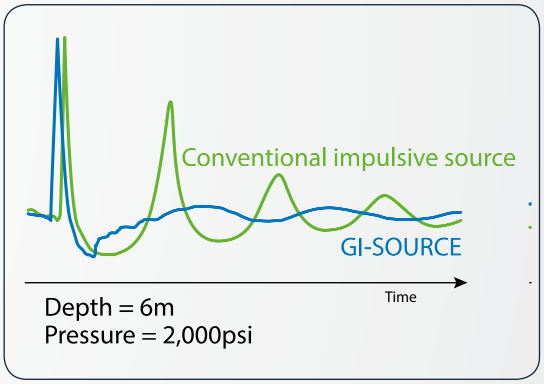
The volume of air released by the injector increases the internal pressure of the bubble and prevents its violent collapse. The oscillations of the bubble and the resulting secondary pressure pulses are reduced and reshaped.

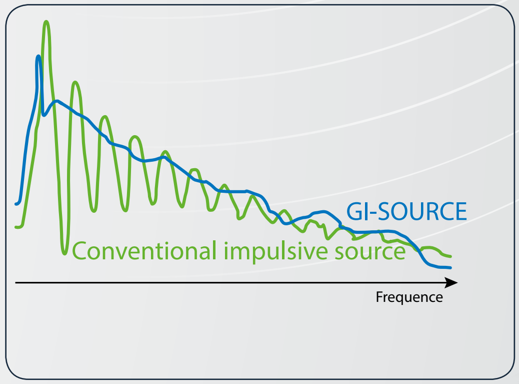
Specifications



	GI-SOURCE 210	GI-SOURCE 255	GI-SOURCE 355
Volume	210cu.in (G = 105cu.in I = 105cu.in)	255cu.in (G = 150cu.in I = 105cu.in)	355cu.in (G = 250cu.in I = 105cu.in)
Length	L = 790mm	L = 860mm	L = 860mm
Width	W = 312mm	W = 280mm	W = 280mm
Weight	74kg	87kg	97kg

Clean acoustic signature



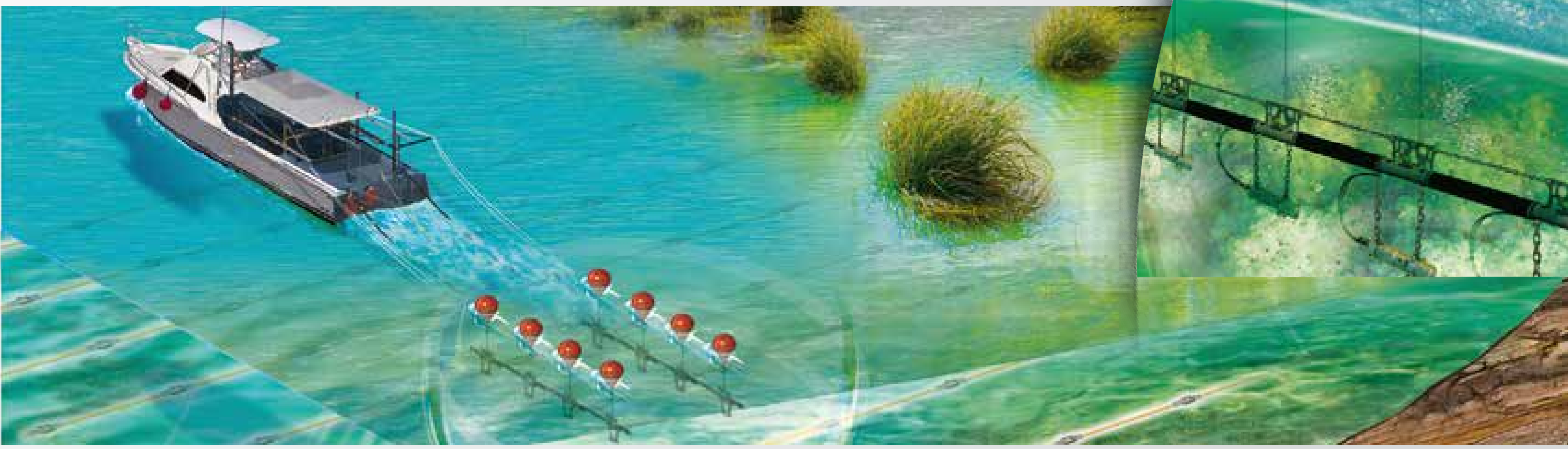


Near-field signatures

Compared to a conventional impulsive source, the peak-to-peak is reduced due to the volume of the Generator but the primary-to-bubble ratio is greatly increased resulting in a clean acoustic signature.

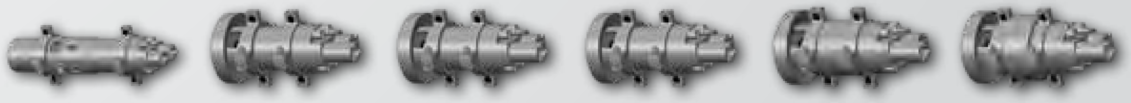
Near-field amplitude spectra

The "true GI mode" results in an almost total suppression of the bubble oscillation.



// Mini G-SOURCE / Mini GI-SOURCE

Scaled-down models from the already compact GI and G-SOURCE are available for high-resolution, shallow water and transition zone surveys. The Mini G. and Mini GI impulsive sources have the same advantages as their larger counterparts, but with even simpler technology.



	Mini GI	Mini G 12	Mini G 20	Mini G 24	Mini G 40	Mini G 60
Volume	60cu.in (G = 30cu.in I = 30cu.in)	12cu.in	20cu.in	24cu.in	40cu.in	60cu.in
Length	L = 560mm	L = 390mm	L = 390mm	L = 390mm	L = 390mm	L = 390mm
Width	W = 200mm	W = 200mm	W = 200mm	W = 200mm	W = 200mm	W = 200mm
Weight	28.1kg	25.4kg	24.2kg	23.7kg	24.3kg	25.8kg

Borehole

// G-SOURCE FOR DELTA CLUSTER

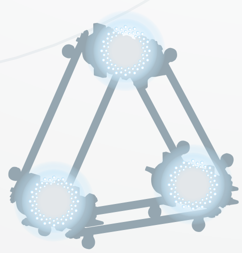
Delta cluster

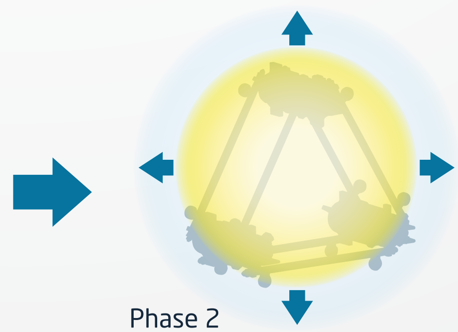
Designed to operate continuously at up to 3,000 psi (210 bars)

Recoiless

VSP market standard

Over the years the Sercel G-SOURCE range of products has become the system of choice for advanced VSP surveys, in both offshore and onshore environments. The G-SOURCE and delta cluster combines the advantages of a powerful source and a clean acoustic performance to maximize borehole data quality.





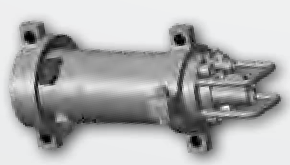
Phase 1

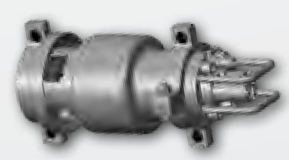
The Sercel delta cluster is an arrangement of three impulsive sources providing an improved signal characteristic.

Phase 2

The delta-cluster arrangement provides more output and a higher peak-to-bubble ratio compared to a single impulsive source of an equivalent volume.

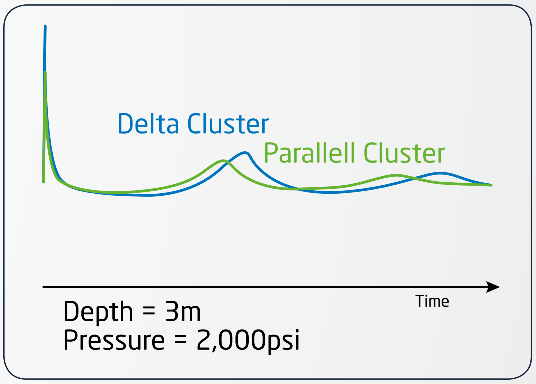
Specifications

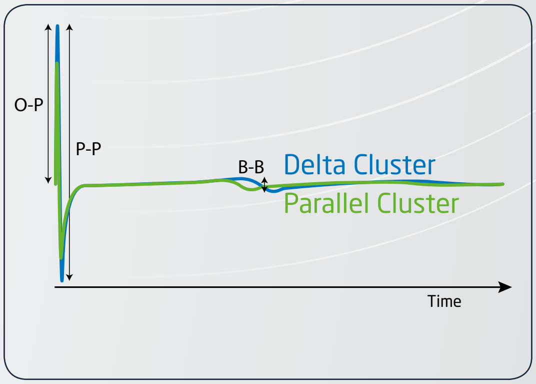




	G-SOURCE 150	G-SOURCE 250
Volume	45 • 50 • 60 • 70 • 80 • 90 • 100 • 110 • 120 • 130 • 140 • 150	180 • 200 • 210 220 • 250
Length	L = 597mm	L = 597mm
Width	W = 292mm	W = 292mm
Weight	55kg	65kg

High-energy cluster configuration





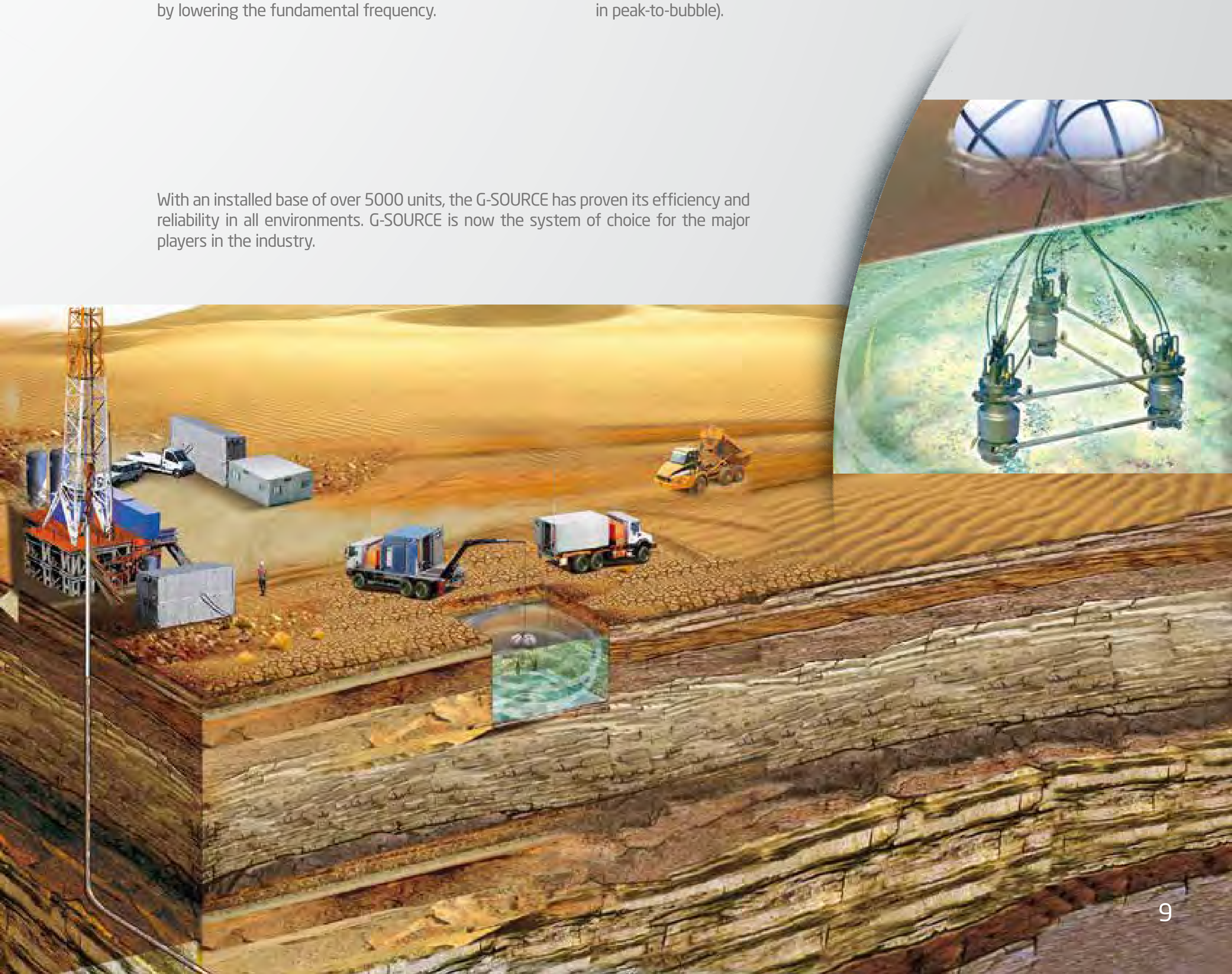
Near field signatures

The Delta Cluster & Parallel Cluster will produce a higher peak performance within a similar overall arrangement of a single impulsive source.
The Delta cluster getting the edge over the Parallel by lowering the fundamental frequency.

Far field amplitude spectra

Sercel developed the Delta Cluster by adding a third impulsive source to the Parallel cluster assembly. It generates great output performance with unrivalled acoustic signature (+33 % in Peak-Output, + 19% in peak-to-bubble).

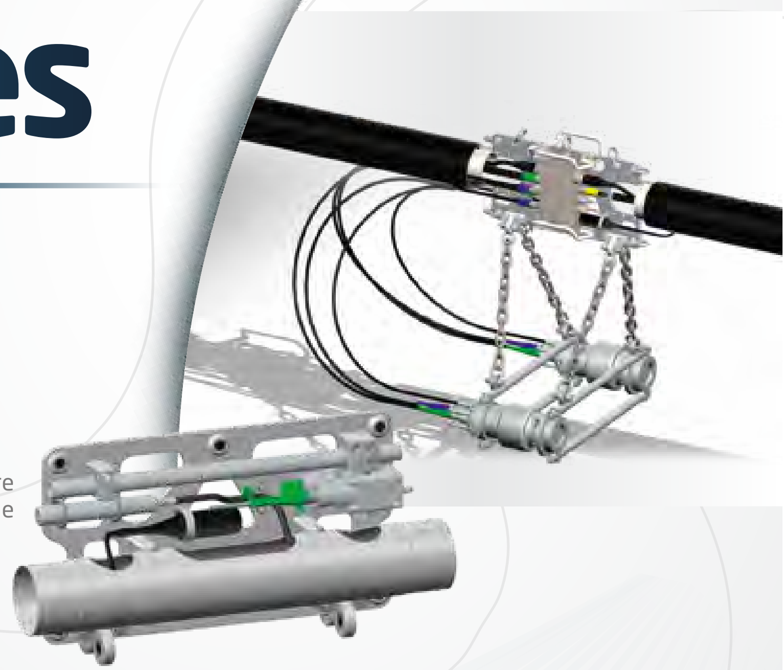
With an installed base of over 5000 units, the G-SOURCE has proven its efficiency and reliability in all environments. G-SOURCE is now the system of choice for the major players in the industry.



Accessories

//IMPULSIVE SOURCES PLATES

Sercel provides heavy duty impulsive source plates that are compatible with all impulsive source synchronizers available on the market.

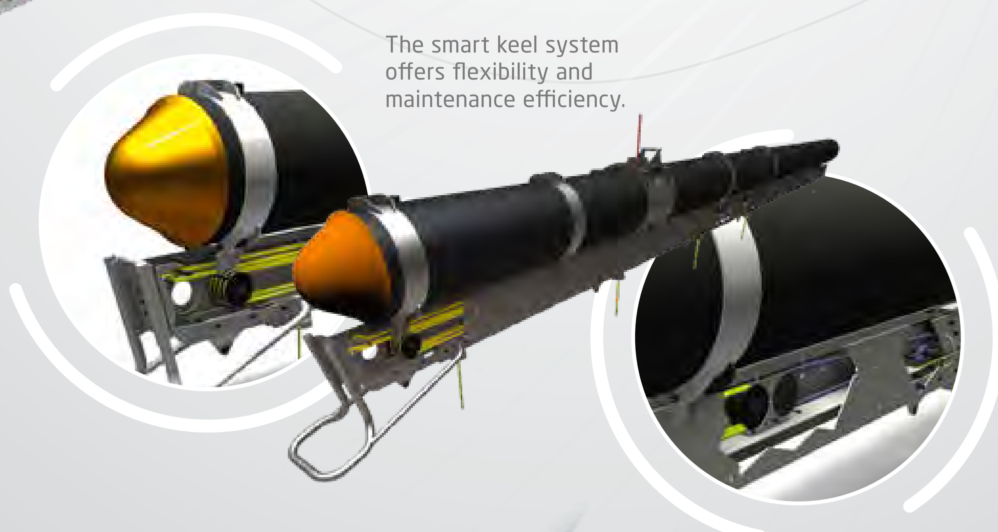


//FLOATS

Operated by major geophysical service providers, Sercel has developed float technology for rigid and flexible Handling systems:

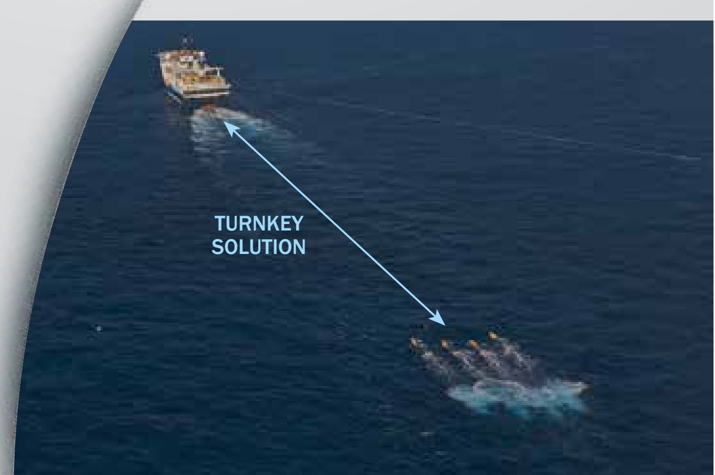
This flexible float is stable at sea due to its foam inserts & is safe as no inflation is required.

The smart keel system offers flexibility and maintenance efficiency.



//IMPULSIVE SOURCE EQUIPMENT

For customers looking for a turnkey solution, Sercel is able to provide associated marine source peripherals such as terminated armoured umbilicals, sliprings, air swivels, back-deck cables, interface panels and impulsive source synchronizers ensuring full compatibility between all our equipment.



Portable Solutions

Sercel is the exclusive distributor of the turn-key towing solutions designed by SeaScan Inc.

SeaScan Inc is the best partner for Sercel's turn-key solutions as the equipment is specifically designed for shallow water and transition zone areas.

The portable frames allow for quick mobilization and operations onboard multi-purpose vessels or barges.

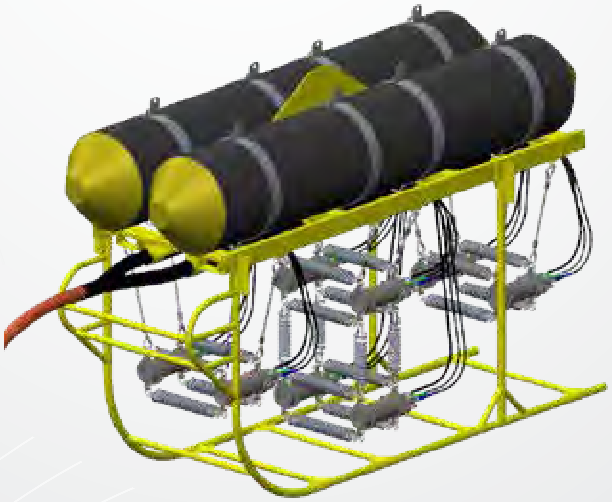
//TRI-CLUSTER®

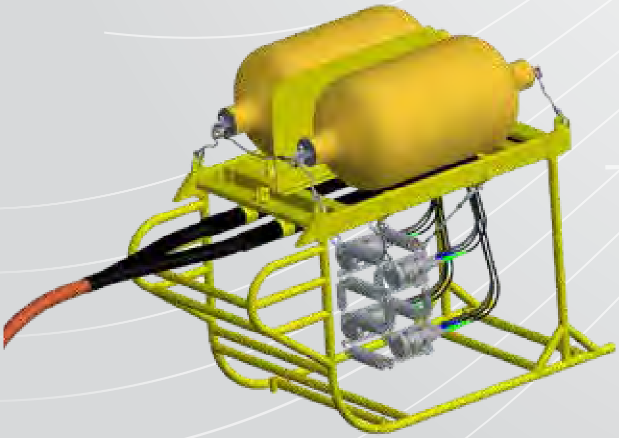
Medium size array

The Tri-Cluster offers high power output thanks to its unique point source design.

The array includes 8 sources, combining concentrated parallel and square clusters for maximized acoustic performances.

The Tri-Cluster can be fitted with an optional cage protecting the sources in hazardous water, such as rivers with heavy debris.





//MINI SLED

High resolution array

The MINI SLED is designed for operating 4 MINI G-SOURCE for high-resolution surveys.

Light and compact, it benefits from the square cluster powerful output.

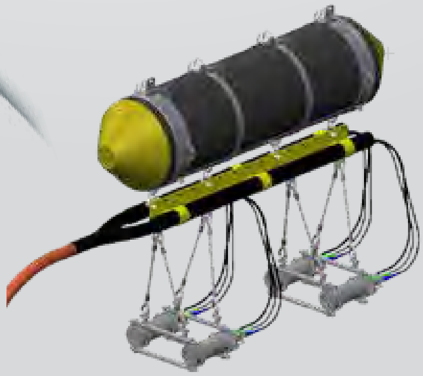
//SHALLOW WATER HARNESS

Shallow water array

The USW systems are designed for small arrays or ultra-shallow water operations.

Two versions are available:

- single sources (up to 2 sources)
- parallel cluster sources (up to 4 sources)



Marine Sources

High-performance impulsive sources

Sercel - France
16 rue de Bel Air
B.P. 30439 - 44474 CARQUEFOU Cedex
Téléphone : (33) 2 40 30 11 81
E-mail: sales.nantes@sercel.com
SAS au capital de 25 000 000 €
Siège Social : 16 rue de Bel Air - 44470 CARQUEFOU
378.040.497 R.C.S. Nantes Code APE 2651B

Sercel Inc. - U.S.A.
17200 Park Row
Houston, Texas 77084
Telephone : (1) 281 492 6688
E-mail : sales.houston@sercel.com

www.sercel.com

Produced according to the Sercel environmental printing standard

GS-ONE LF
GEOPHONE

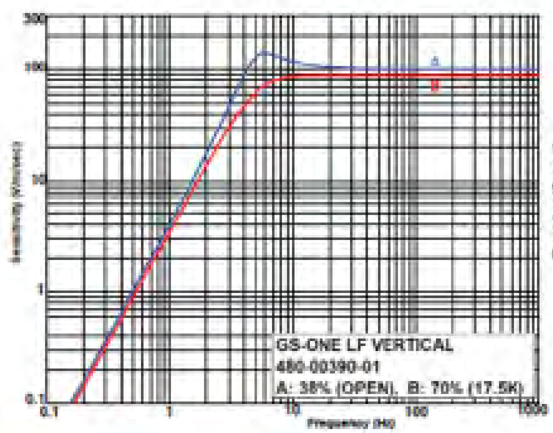
5 Hz Geophones
More Low-Frequency Response

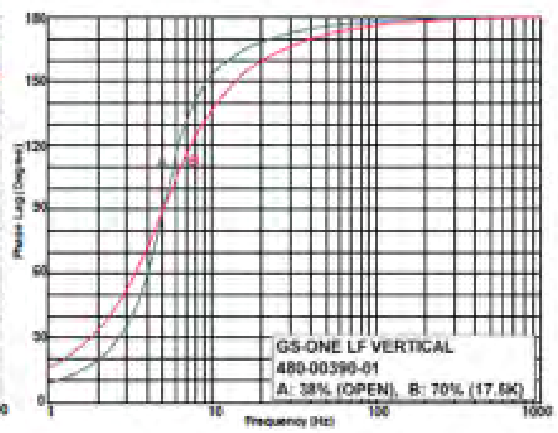
GS-ONE LF

VERTICAL

MECHANICAL SPECIFICATIONS		
Moving Mass	25.2 g	0.889 oz
Maximum coil excursion p-p	3 mm	0.120 in.
Diameter	30.5 mm	1.2 in.
Height	40.7 mm	1.6 in.
Weight	131 g	4.60 oz
Operating and Storage Temperature Range	–40°C to +80°C	–40°F to +176°F

ELECTRICAL SPECIFICATIONS	
All parameters are specified at 25°C in the vertical position unless otherwise stated.	
Open-circuit sensitivity	2.55 V/in/s (100.4 V/m/s) +5%, –5%
Frequency	5 Hz ±0.5 Hz
Spurious frequency	160 Hz Typical
Distortion at vertical	<0.15% measured at 12 Hz with 0.7 in/s p-p
Open-circuit damping	0.31 to 0.45
Coil resistance	2450 Ω ±5%
Sensitivity with 20 kΩ load	2.27 V/in/s (89.4 V/m/s) Typical
Damping with 20 kΩ load	0.67 Typical
Tilt angle when coil hit end stop	30° from vertical





GS-ONE LF
GEOPHONE

5 Hz Geophones
More Low-Frequency Response

GS-ONE LF

VERTICAL

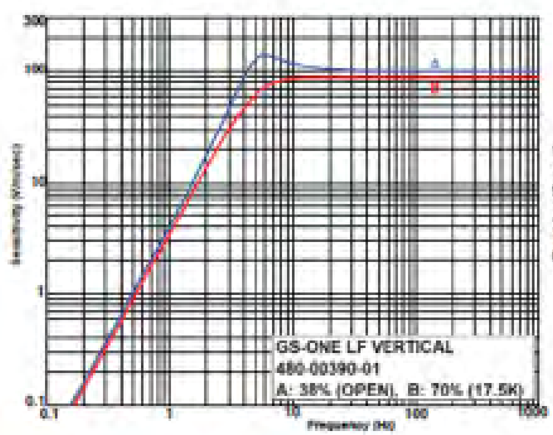
MECHANICAL SPECIFICATIONS

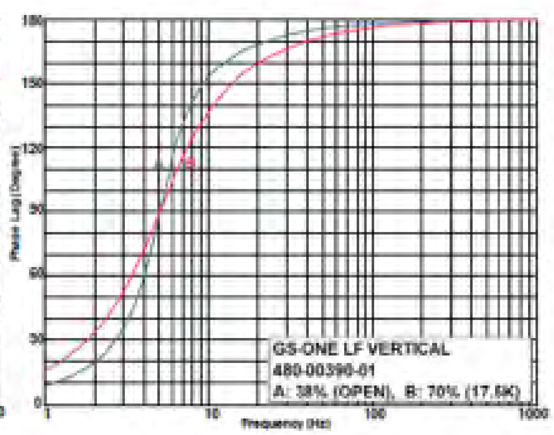
Moving Mass	25.2 g	0.889 oz
Maximum coil excursion p-p	3 mm	0.120 in.
Diameter	30.5 mm	1.2 in.
Height	40.7 mm	1.6 in.
Weight	131 g	4.60 oz
Operating and Storage Temperature Range	–40°C to +80°C	–40°F to +176°F

ELECTRICAL SPECIFICATIONS

All parameters are specified at 25°C in the vertical position unless otherwise stated.

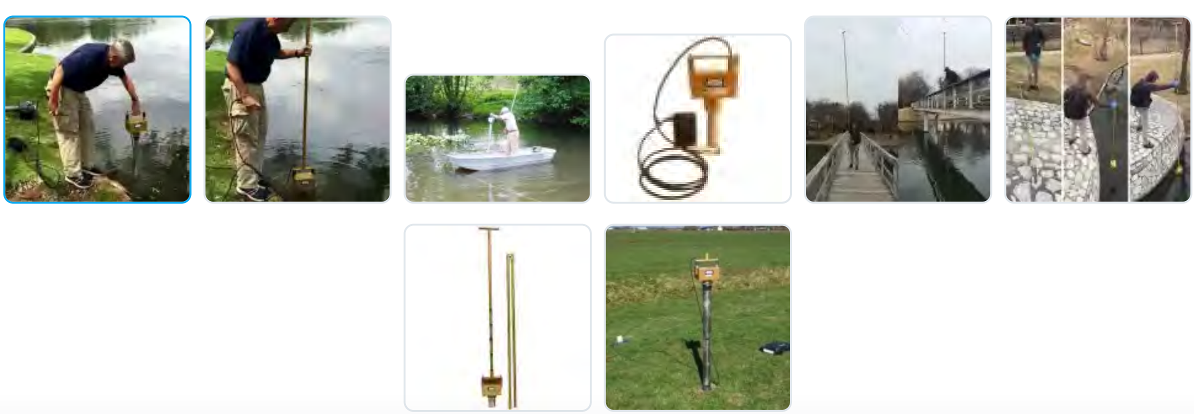
Open-circuit sensitivity	2.55 V/in/s (100.4 V/m/s) +5%, –5%
Frequency	5 Hz ±0.5 Hz
Spurious frequency	160 Hz Typical
Distortion at vertical	<0.15% measured at 12 Hz with 0.7 in/s p-p
Open-circuit damping	0.31 to 0.45
Coil resistance	2450 Ω ±5%
Sensitivity with 20 kΩ load	2.27 V/in/s (89.4 V/m/s) Typical
Damping with 20 kΩ load	0.67 Typical
Tilt angle when coil hit end stop	30° from vertical





Specifications subject to change at sole discretion of Geospace Technologies.

S D I



The SDI Vibecore Mini is a result of a development effort to improve hand held sediment sampling methods in areas with shallow water saturated sediments. The high frequency Vibecore-Mini is a light hand held sampler that can acquire a very undisturbed sample. The Vibecore-Mini has greatly reduced sample compaction typically present in push core sampling. The result is a sample with a better vertical representation of the sediments penetrated. The Vibecore-Mini also allows a hand held collection method that provides deeper penetration than can be achieved with push cores, Ponar grabs, box cores, ekman grabs, Shelby tubes or manual scooping.

Contact For Pricing

Categories: Sediment Sampling Accessories, Sediment Sampling Equipment

Tags: core compression, corer, coring equipment, ground truthing, lake management, pre-impoundment, preimpoundment, reservior management, sediment coring, sedimentation analysis, sedmient sampler, trace metals, Vibecore, Vibracore, vibrating core sampler

Share

DESCRIPTION SPECIFICATIONS DOWNLOADS

Specifications

Power	Twin internal 12V DC Batteries
Normal Active Time per core sample	20 sec. to 1 minute
Cores per Battery Charge	30+
Operating Frequency	5,000 to 6,000 cpm
Core Tube length	2 to 6 feet
Core Head Dimensions (in.)	11 ¼″Long x 5″ Wide x 10 ¼″ High
Core Tube Materials	Aluminum, PVC, Acrylic, Polycarbonate
Core Tube Diameter	2″, or 3″ nominal
Core tube wall	0.050″ (typical)
Air Weight with Batteries	12 lbs.
Shipping Weight	16 lbs.
Operating Temperature	2 to 45 C
Storage Temperature	-20 to 60 C

Specialty Devices Inc.
2905 Capital St.
Wylie Texas 75098

972-429-7240 office

EUROPEAN DISTRIBUTORS

Aquifer Advies bv
Ben ten Toom
Dr. Langeveldplein 6
3361 HE Sliedrecht
0184 – 413147
06 – 24745947

ABOUT SDI

For over 30 years, SDI has designed and manufactured bathymetric and sub-bottom survey systems, sediment coring devices, and other specialized survey systems. SDI also provides geospatial, geophysical, hydrographic, sub-bottom, and sediment sampling services.

DURA-BASE

BUILD TEMPORARY ROADS WITH PRO-TEC EQUIPMENT

With Pro-Tec Equipment's Dura-Base Composite Mat system, you can build a temporary road on a variety surfaces. From soft soils (muddy areas, swaps, fields) and sensitive areas (running tracks) to environmentally sensitive areas, the Dura-Base Composite Mat system allows you to build a temporary road without laying down tons of stone, wood planking or other stabilizing materials.

The Dura-Base Mat System provides a cost-effective, safe surface for year-round, all-weather performance.

FEATURES:

- Tread pattern to improve traction of load-bearing vehicles and equipment

- Twist-locks hold mats in place

- Mats conform to uneven terrain

- Overlap lip ensures a constant barrier between the ground and the surface, reducing slippage and movement

Specifications:

Size: 8' x 14' (providing a 7' x 13' pathway)

Thickness: 4.25"

Weight: 1,050 pounds

Color: Sand

Working temperature range: -20° to 200° F

Material: High-density polyethylene

Crushing pressure: 600 psi

CLICK HERE TO REQUEST MORE INFORMATION →

M/V WILDCAT

SHALLOW DRAFT MULTIPURPOSE VESSEL

SPECIFICATIONS

M/V WILDCAT

Vessel Particulars

Official Number:	1233898
Year Built:	2011
Hope Port:	Deadhorse, AK
Owner/Operator:	Northern Maritime Logistics, LLC 6250 South Airpark Place Anchorage, AK 99502
U.S.C.G. Classification:	Subchapter T/Annually inspected by the U.S.C.G.
Length:	39’
Breadth:	14’6”
Depth:	4’
Draft:	18”

Documents / Certificates Onboard

U.S.C.G. Certificate of Documentation

U.S.C.G. Certificate of Inspection

U.S.C.G. Stability Letter

FCC Radio Station License

FCC Radiotelephony Certificate

Propulsion

Main Engines: Twin Caterpillar C-9 Diesel Engines 510 hp each.

Drives: Twin Hamilton Jet HJ-372 Jet Drives

Auxiliary Generator: Lugger MG73LD3.3 5KW

Fuel Capacity: Twin 200 Gallon Diesel fuel tanks.

Fire-Fighting / Life Saving Equipment:

Fixed Engine Room Fire Fighting System: 2-50lb CO2 Fire suppression bottles located in each engine compartment.Automatic and manual activation system with Alarms.

2-5lb Kidde Dry Chemical Fire Extinguishers

4-10lb Kidde Dry Chemical Fire Extinguishers

Life Jackets: 32 Adult Type 1 PFD's with lights and whistles

Life Rafts: 2-16 passenger VIKING inflatable life rafts SOLAS A-Pack.

First Aid: 2-USCG Approved First Aid Kits. 1-Heart Start AED Defibrillator

EPIRB: E5 Smartfind 406mgz Emergency Position Indicating Radio Beacon

Life Rings: 2-USCG Approved 24" life rings with buoy line throw bag and strobe lights.

Flares: 6 Hand-held Red smoke flares

6 Hand Held Orange flares

2-Flare gun kits with multiple cartridges

Marine Electronics / Navigation Equipment

Radar:	FURUNO 1824C/NT 4kw, 24” radome, 10.4” display
GPS:	FURUNO BBWGPS with North Slope/Arctic Alaska Cartography (Cartography charts overlay radar system)
VHF Radio:	1- ICOM M504 Marine VHF radio 1-ICOM M604 Marine VHF radio 2-ICOM Hand held VHF RADIOS
Video Sounder:	FURUNO 235 NMEA0183 Color Video Sounder
Compass:	FURUNO NMEA8778 Electronic Compass 1-Richie Compass

Appendix B

Noise Modeling

SLR Consulting (Canada) Ltd.
200 - 887 Great Northern Way, Vancouver, BC V5T 4T5

October 31, 2024

Attention: Jesse Mohrbacher
Narwhal, LLC
406 W. Fireweed Lane Suite 100
Anchorage, Alaska 99503

SLR Project No.: 201.089416.00001

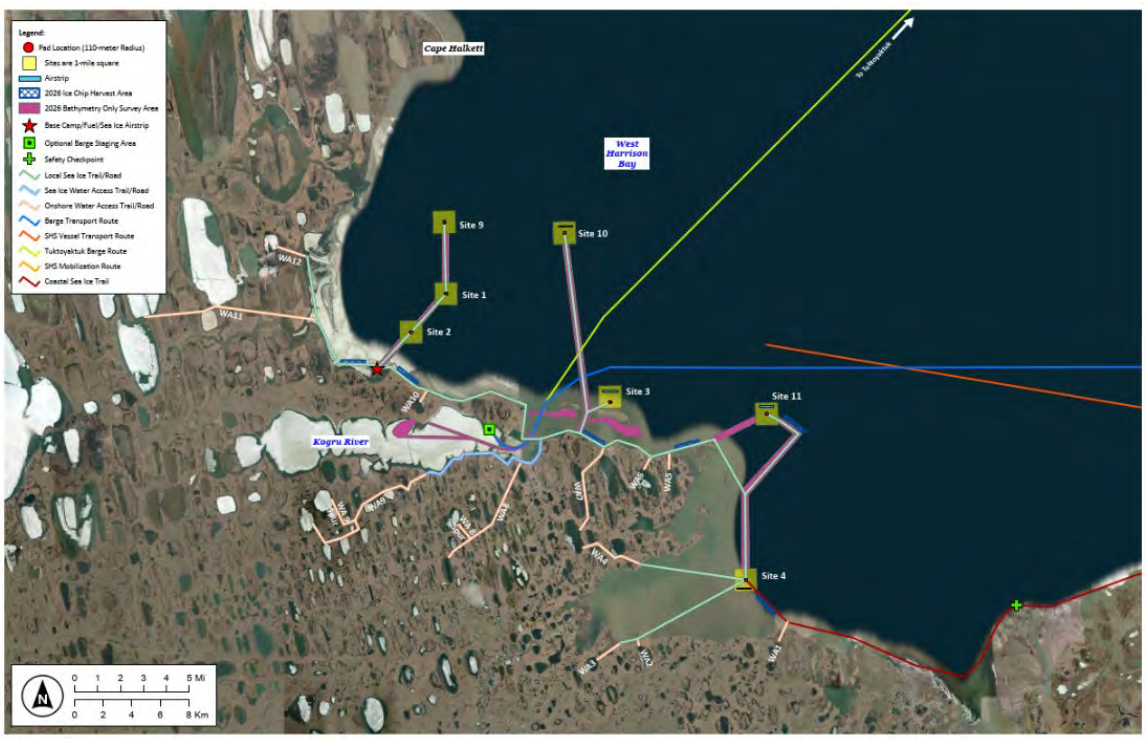
Client Reference No.: 002

Revision: 3.0

RE: Underwater Noise Source and Propagation Modelling for Level A &B

In October 2024, Narwhal LLC requested a revision of the Sound Transmission Loss Modelling (STLM) to assess the potential for exposure to underwater sounds that might exceed the 2024 NMFS regulatory thresholds during seismic surveys. Level A (PTS) and Level B (behavioural disturbances) were assessed for seismic air gun pulses at site 10 in shallow water in West Harrison Bay off the coast of Northern Alaska, as shown in Figure 1.

Figure 1:   Map of the project area with site locations in green



Methodology

A single G-GunII (105 cubic inch airgun) is proposed to be used for the seismic operations. The array consists of one active G-GunII airgun with an average towing depth of 1.0 and an operating pressure of 2,000 pounds per square inch (PSI). The noise emissions from the single airgun, including the source spectral levels and directivities, are modelled based on the Gundalf Designer software package (2018)[1].

Table 1: Gundalf Parameters

General Gundalf Inputs & Seismic Energy Parameters								
Gun	Pressure (psi)	Volume (cu.in)	X (m)	Y (m)	Z (m)	Total acoustic energy output (joules)	Total potential energy in array (joules)	Percentage (%) of potential energy appearing as acoustic energy
GunII	2000	105	0	0	1	408.4	23749.0	1.7

In the absence of clustering or combining multiple airguns in an array, the actual acoustic efficiency of a solitary airgun is typically less than 5% of the initial energy. Through clustering, efficiencies of 25% or greater are possible. Energy in the table above is expressed in joules (j).

Seabed Parameters

Seabed parameters, including sound speed, density, and attenuation (Jenson *et al*. 2011, Matthews & MacGillivray 2013) for each seabed layer used, are as follows:

Table 2: Seabed Parameters

Layer	Depth (m)	C (m/s)	Density (kg/m^3)	Attenuation (dB/wavelength)
Sand	0 – 15	1650	1900	0.8
Clay	15	2000	2000	1.1

Bathymetry

The bathymetry data used for the sound propagation modelling were obtained from the 15 arc seconds bathymetric dataset GEBCO_2019 Grid (GEBCO 2019). The GEBCO_2019 Grid is the latest global bathymetric product released by the General Bathymetric Chart of the Oceans (GEBCO). It was developed through the Nippon Foundation-GEBCO 'Seabed 2030 Project', a collaborative project between the Nippon Foundation of Japan and GEBCO[2].

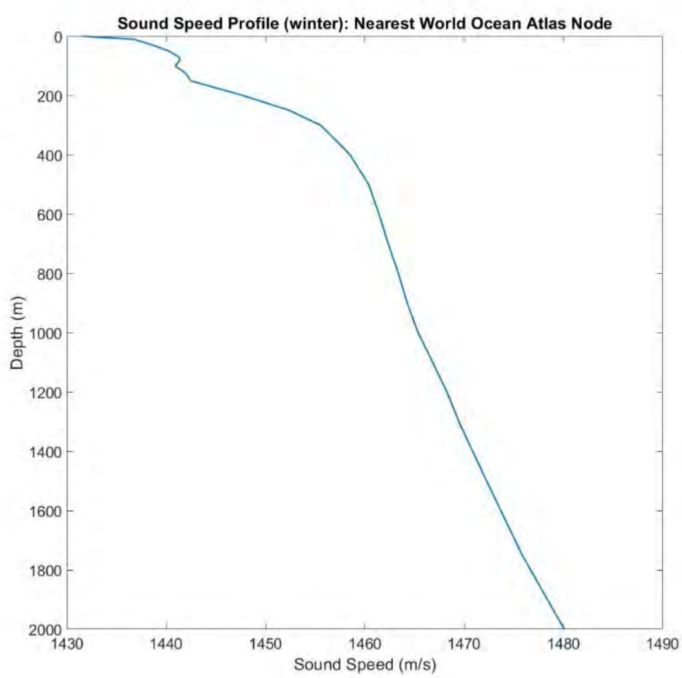
[1] Gundalf - Seismic Source Airgun Array Modelling Software & Courses
[2] GEBCO Gridded Bathymetry Data

Sound Speed profile

The summer season has the strongest downwardly refracting feature among the four seasons, and the winter season exhibits a deeper surface duct than the other three seasons. Due to the stronger surface duct within the profile, the winter season is expected to favor sound propagation from a near-surface acoustic source. The winter sound speed profile was selected as the modelling input based on conservative considerations. The winter profile can be used for this and any other effort during the year.

Based on the project latitude and longitude, the sound speed profile was obtained from the National Oceanographic Data Center (2013) at the nearest node as shown in Figure 2.

Figure 2: Sound Speed Profile (World Ocean Atlas)



Parabolic Equation (PE) modeling algorithm

Underwater noise propagation models predict the sound transmission loss between the noise source and the receiver. When the source level of the noise source based on is known, the predicted transmission loss is then used to predict the received level at the receiver location.

For noise modelling predictions concerning relatively low-frequency broadband noise emissions, such as a single airgun, the fluid parabolic equation (PE) modelling algorithm RAMGeo was used to calculate the transmission loss between the source and the receiver. RAMGeo is an efficient and reliable PE algorithm for solving range-dependent acoustic problems with fluid seabed geoacoustic properties. The noise source was assumed to be omnidirectional and modelled as a point source. With the known noise source levels, either frequency-weighted or unweighted, the received noise levels are calculated following the procedure outlined below.

- One-third octave source spectral levels are obtained via spectral integration of linear source spectra for the seismic sources;
- Transmission loss is calculated using RAMGeo at one-third octave band central frequencies from 12.5 Hz to 800 Hz, based on appropriate source depths corresponding to relevant source scenarios. The acoustic energy in the higher frequency range (> 1 kHz) is significantly lower and, therefore, is not included in the modeling;
- Propagation paths for the TL calculation have a maximum range of up to 200 km and bearing angles with a 10-degree azimuth increment from 0 to 350 degrees around the source locations. The bathymetry variation of the vertical plane along each modelling path is obtained via interpolation of the bathymetry dataset;
- The one-third octave source levels and transmission loss are combined to obtain the received levels as a function of range, depth, and frequency;
- The overall received levels are calculated by summing all frequency band spectral levels.
- Cumulative SEL has been assessed for 192 airgun shots (one transect line); and
- Peak SPL has been assessed for a single airgun shot.

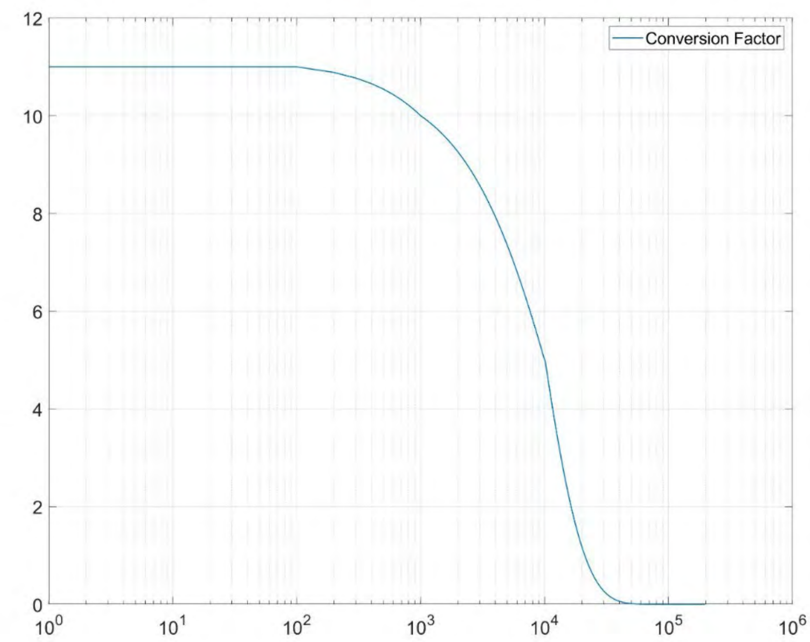
Conversion to RMS SPL over range

Previous empirical studies demonstrate that at relatively close distances from the airgun sources (within 1.0 km), the difference between SELs and RMS SPLs could be between 10 dB to 15 dB (Austin *et al*. 2013; McCauley *et al*. 2000). The differences could drop to under 5 dB when the distances are close to 10 km (Austin *et al*. 2013). The differences are expected to decrease further with increasing distances beyond 10 km (Simon *et al*. 2018).

For this project, the RMS SPLs were estimated using the following conversion factors to be applied to the modelled SELs within different distance ranges. These conversion factors are conservatively estimated based on the single airgun modelling results. The SEL to RMS SPL conversion factors as a function of horizontal ranges from the source array are shown in 3 below.

- 0 – 100 m, a conversion factor of 11 dB. This is the difference between RMS SPL and SEL of the far-field signature of the 105-inch (CUI) airgun.
- 100 – 1,000 m, conversion factors 11 dB to 10.0 dB, following a logarithmic trend with distance;
- 1,000 – 10,000 m, conversion factors 10.0 dB to 5.0 dB, following a logarithmic trend with distance;
- 10,000 – 100,000 m, conversion factors 5.0 dB to 0.0 dB, following a logarithmic trend with distance;
- > 100,000 m, a conversion factor of 0.0 dB.

Figure 3: RMS SPL conversion curve



Modelling results

Noise Signature, spectrum and beam pattern

The outputs of Gundalf software, as well as the set of inputs given to Gundalf, are described below in Table 3.

Table 3: Gundalf input parameters

General Gundalf Modelling Parameter	
Sample interval (s.)	0.0005
Modelling sample interval (s.)	0.0005
Number of samples	1000
Duration (s.)	0.5
Observation Point	Infinite far-field

The notational signature (or pressure waveform) of an individual source element (Figure 4) at a standard reference distance of 1 m is calculated by the Gundalf software. The procedure to combine the notional signature to generate the far-field source signature (one-third octave source level) is summarised as follows:

- The distance from each acoustic source to a nominal far-field receiving location is calculated.
- The time delays between the individual acoustic sources and the receiving locations are calculated.
- The signal at each receiver location from each acoustic source is calculated with the appropriate time delay. These received signals are summed to obtain the overall one-third octave signature and
- The overall array signature also accounts for the ocean surface reflection effects by including the “surface ghost.” A sea surface reflection coefficient of -1 adds an additional ghost source for each acoustic source element.

Beam patterns and angle-frequency forms (Figure 6 and Figure 7) are included in STLM studies for “visualization” purposes and completeness. The reader is not expected to extract or infer any additional information from the inclusion of said visualizations. For further “robustness,” a high-level description of beam pattern calculation follows:

- The airgun signature is calculated for all directions from the source using azimuthal and dip angle increments of 1 degree.
- The power spectral density (PSD) (dB re 1 μPa^{2}s/Hz @ 1m) for each pressure signature waveform is calculated using a Fourier transform technique (Figure 5).
- The PSD of the resulting signature waveform is combined to form the frequency-dependent beam pattern of the array.

The beam patterns illustrate the angle and frequency dependence of the energy radiation from the array. The unweighted sound exposure level (SEL) of the airgun is 193.0 dB re μPa2·s @ 1 m, and the peak sound pressure level (PK SPL) is 231.0 dB re 1 μPa @ 1 m (Table 4).

Table 4: Source levels of the array source

Source Levels	3D source array
Peak sound pressure level (Pk SPL) (dB re 1 μPa @ 1 m)	231.0
Root-mean-square sound pressure level (RMS SPL) (dB re 1 μPa @ 1 m with a 90%-energy pulse duration of 12.5 milliseconds)	204.0
Sound exposure level (SEL) (dB re μPa^2·s @ 1 m)	193.0

Figure 4: Notational signature (time) for the GI Gun - 105 CUI gun

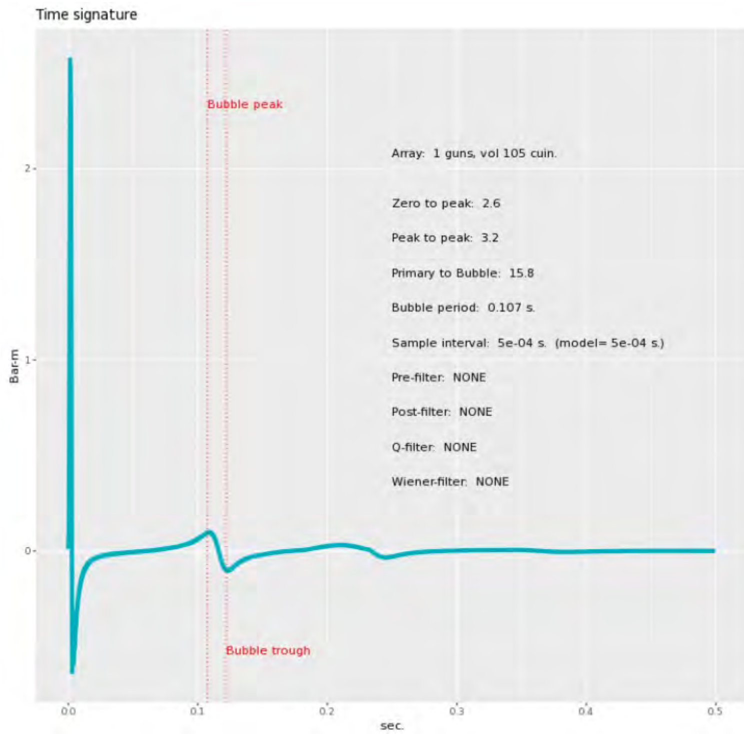


Figure 5: Airgun source spectra (PSD 105 CUI gun)

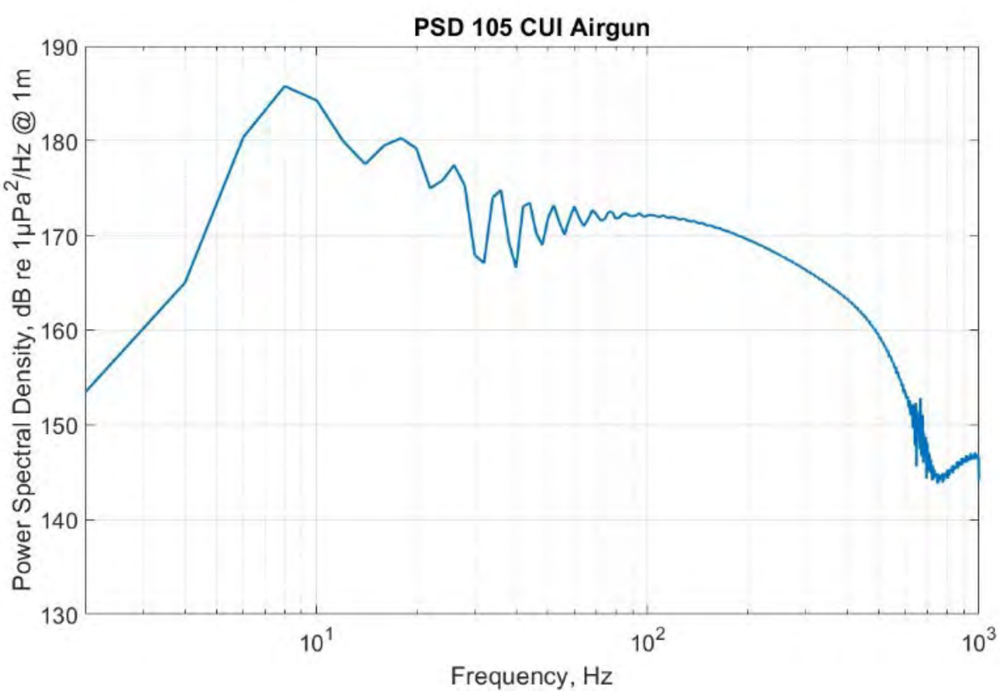


Figure 6: Array beam patterns for the GI Gun - 105 CUI gun, as a function of orientation and frequency (Dip/Azimuthal directivity 90 Hz)

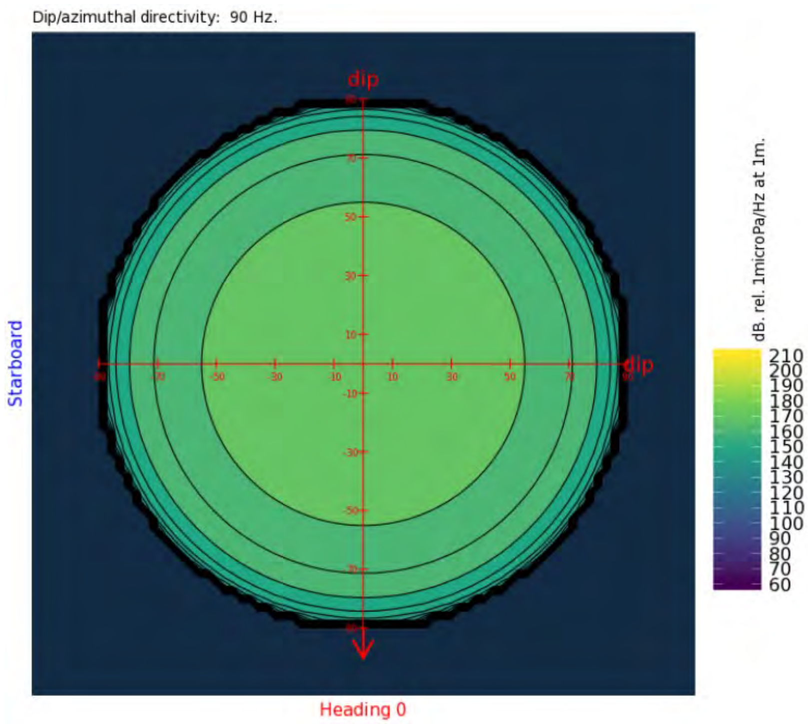
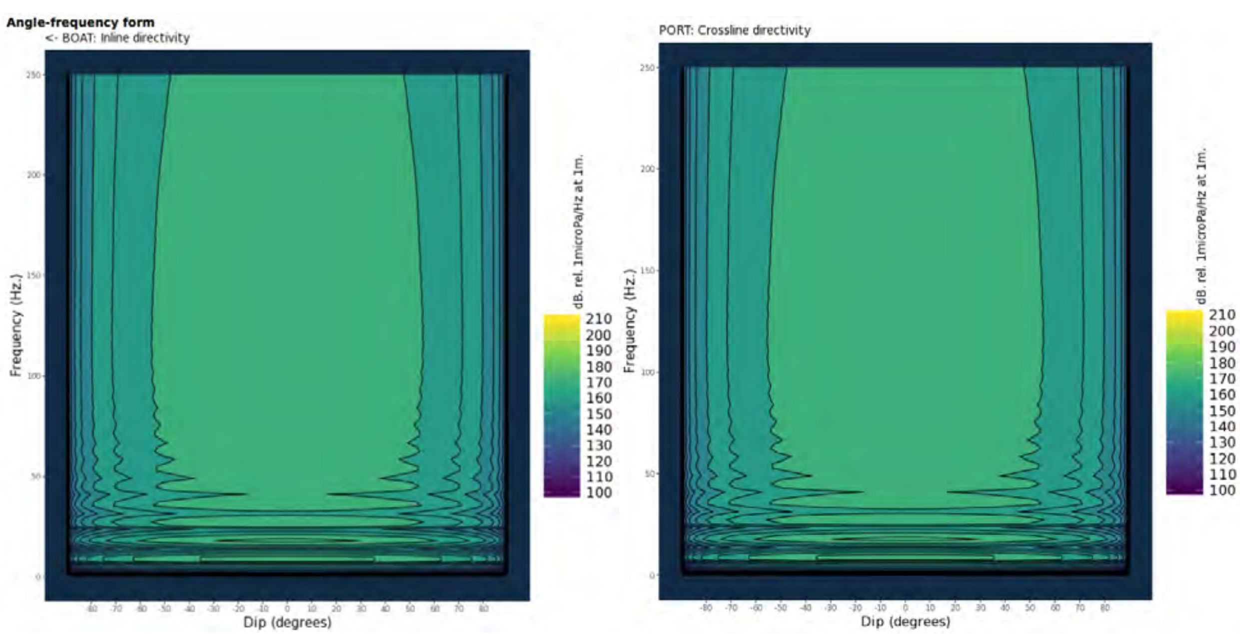


Figure 7: Angle-frequency form: Along-Track (left) and Cross-Track (right) Direction (GI Gun – 105 CUI gun)



Shallow water challenges and limitations

The shallow environments of the northern coast of Alaska present challenges and limitations, which are detailed below:

- The region examined in this study presents unique challenges in terms of modeling how sound travels underwater due to the extreme shallowness & flatness (slope) of the region (e.g., depths of 4-5 m persist 10 to 20 km offshore) as most types of underwater acoustic models run on standard “depth” grid size of 10 m.
- A hydrographic survey or acquisition of a bathymetric dataset (with greater than 4-arc second resolution) is strongly recommended before conducting additional modeling or estimating impact zones. The interaction of sound over long ranges and shallow depths is best described as a combination of nearly cylindrical spreading (e.g., a transmission loss coefficient of 10) combined with losses from multiple reflections between the water surface and seafloor (which occur increasingly in shallow waters).
- Specialized and “hybrid” models (employing separate methodologies for low and high frequencies) are available. When high-resolution bathymetry of the area is available, they can account for acoustic energy above 1 kHz. The acoustic energy of the 105 CUI source is concentrated in lower frequency bands; however, this does not mean that marine mammals belonging to higher frequency hearing groups (e.g., VHF) do not perceive some of the higher frequency components of the source spectrum.

Modeling Results & Findings for Level A and Level B

Level A – Immediate Impact

The immediate impacts from a single seismic airgun pulse for Level A are shown in Table 5 for marine mammals. Any blank entries indicate that the average or maximum distance to the threshold is less than 10 m or inside the vessel's footprint.

As expected, high-frequency (HF) cetaceans remain the group with the greatest risk (extending to 207 m) of immediate exposure to noise above the Level A threshold. All other marine mammal hearing groups have a maximum distance to a threshold of 10 m or less.

Level A – Cumulative Impact

The cumulative impact from 192 seismic airgun pulses for Level A are shown in Table 6 for marine mammals. Any blank entries indicate that the average or maximum distance to the threshold is less than 10 m or inside the vessel's footprint.

Low-frequency (LF) cetaceans remain the group with the greatest risk of cumulative exposure to noise above the Level A thresholds, with maximum ranges extending to 1,076 m.

Level A impacts to Phocids carnivores in water (PCW) are within 322 m from the source.

Level B

The average distance for behavioral distances to marine mammals across all sites (Table 7) is 3,188 m, and as an example, it has been centered on site 10, as shown in Figure 8.

Table 5: Distances of immediate impact from a single seismic airgun pulse for Level A – marine mammals

Marine mammal hearing group	Maximum horizontal distances from a single seismic airgun pulse to immediate impact threshold levels	
	Injury (PTS) onset	Maximum threshold distance, m
	Criteria - Pk SPL dB re 1µPa	Site 10 (10 m depth)
Low-frequency cetaceans (LF)	222	-
Mid-frequency cetaceans (F)	230	-
High-frequency cetaceans (VHF)	202	207
Phocids carnivores in water (PCW)	223	-
Other marine carnivores in water (OCW)	230	-
Note: A dash indicates the threshold is not reached.		

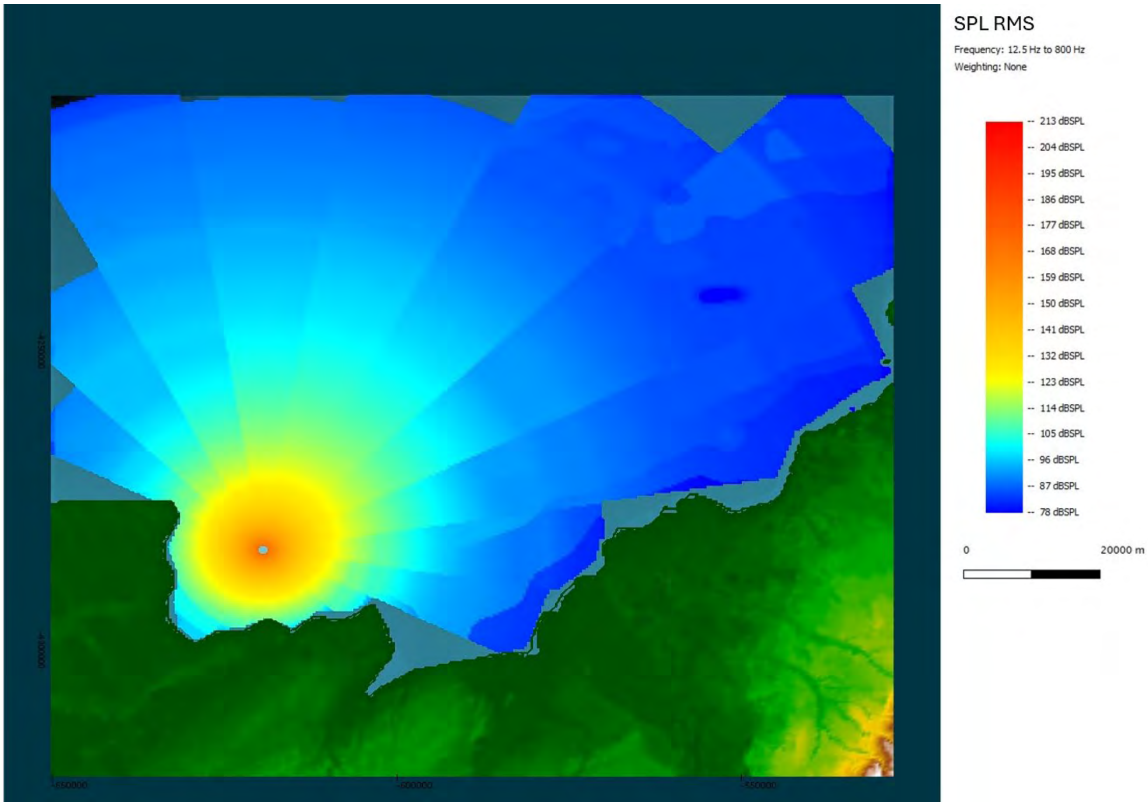
Table 6: Distances of cumulative impact from multiple airgun pulses (192) for Level A – marine mammals

Marine mammal hearing group	Maximum horizontal distances from multiple seismic airgun pulses to cumulative impact threshold levels	
	Injury (PTS) onset	Maximum threshold distance, m
	Criteria – Weighted SEL_{24hr} dB re 1 µPa^2·s	Site 10 (10 m depth)
Low-frequency cetaceans (LF)	183	1,076
Mid-frequency cetaceans (F)	193	-
High-frequency cetaceans (VHF)	159	-
Phocids carnivores in water (PCW)	183	322
Other marine carnivores in water (OCW)	185	-
Note: A dash indicates the threshold is not reached.		

Table 7: Distances of immediate impact from a single seismic airgun pulse for Level B (160 dB) – marine mammals

Site	Latitude	Longitude	Depth (m)	Maximum threshold distance, m
10	70.691062°	-151.985159°	~5 (10*)	3,188
*Modeled with an RMS SPL source level of 204.0 dB re µPa @ 1 m				

Figure 8: Maximum threshold distance to Level B (centered on site 10)



Statement of Limitations

This report has been prepared by SLR Consulting (Canada) Ltd. (SLR) for Narwhal LLC (Client) in accordance with the scope of work and all other terms and conditions of the agreement between such parties. SLR acknowledges and agrees that the Client may provide this report to government agencies, interest holders, and/or Indigenous communities as part of project planning or regulatory approval processes. Copying or distribution of this report, in whole or in part, for any other purpose other than as aforementioned is not permitted without the prior written consent of SLR.

Any findings, conclusions, recommendations, or designs provided in this report are based on conditions and criteria that existed at the time work was completed and the assumptions and qualifications set forth herein.

This report may contain data or information provided by third party sources on which SLR is entitled to rely without verification and SLR does not warrant the accuracy of any such data or information.

Nothing in this report constitutes a legal opinion nor does SLR make any representation as to compliance with any laws, rules, regulations, or policies established by federal, provincial territorial, or local government bodies, other than as specifically set forth in this report. Revisions to legislative or regulatory standards referred to in this report may be expected over time and, as a result, modifications to the findings, conclusions, or recommendations may be necessary.

Closure

Please do not hesitate to contact the undersigned for any clarification.

Regards,

SLR Consulting (Canada) Ltd.

Jonathan Vallarta, PhD
Principal Underwater Acoustics & Business Lead
jvallarta@slrconsulting.com

Justin Eickmeier, PhD
Underwater Acoustics Team Lead
jeickmeier@slrconsulting.com

Distribution: 1 electronic copy – Narwhal, LLC.
1 electronic copy – SLR Consulting (Canada) Ltd.

References

Austin, M., McCrodan, A., Wladichuk, J. 2013 Marine mammal monitoring and mitigation during Shell’s activities in the Chukchi Sea, July–September 2013: Draft 90-Day Report. (Chapter 3) *In* Reider, H. J., L. N. Bisson, M. Austin, A. McCrodan, J. Wladichuk, C. M. Reiser, K.B. Matthews, J.R. Brandon, K. Leonard, et al., (eds.). *Underwater Sound Measurements*. LGL Report P1272D–2. Report from LGL Alaska Research Associates Inc., Anchorage, AK, USA, and JASCO Applied Sciences, Victoria, BC, Canada, for Shell Gulf of Mexico, Houston, TX.

Jensen, F. B., Kuperman, W. A., Porter, M. B. and Schmidt, H. 2011. Computational Ocean Acoustics, Springer-Verlag New York.

Matthews, M.-N. & MacGillivray, A. “Comparing modeled and measured sound levels from a seismic survey in the Canadian Beaufort Sea.” Proceedings of Meetings on Acoustics, Vol.19, 070046 (2013).

McCauley R. D., Fewtrell J., Duncan A. J., Jenner, C., Jenner M. N., Penros J. D., Prince R. I. T., Adhitya A., Murdoch J. and McCabe K. 2000. Marine Seismic Surveys: Analysis and Propagation of Air Gun Signals, and Effects of Exposure on Humpback Whales, Sea Turtles, Fishes and Squid. Prepared for the APPEA. CMST, Curtin University.

National Oceanographic Data Center (2013). NODC Standard Product: World Ocean Atlas 2009 (NCEI Accession 0094866). NOAA National Centers for Environmental Information. Dataset. https://accession.nodc.noaa.gov/0094866.

National Marine Fisheries Service. 2018. 2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-59, 167 p.

Simon, C., Matthew, P. and David, P. 2018. Results of deployment of acoustic monitoring equipment for Taranaki Ltd for 2018 Māui 4D Seismic Survey, Report No. PM-18-Shell-Report 3 Results of acoustic equipment deployment 2018 Māui 4D MSS-v1.1.

Appendix A Sound Contour Maps

Underwater Noise Source and Propagation Modelling

Level A &B

Narwhal, LLC

SLR Project No.: 201.089416.00001

October 31, 2024

A.1 Sound Contour Maps

Figure A.1 Peak SPL for a single shot at Site 10

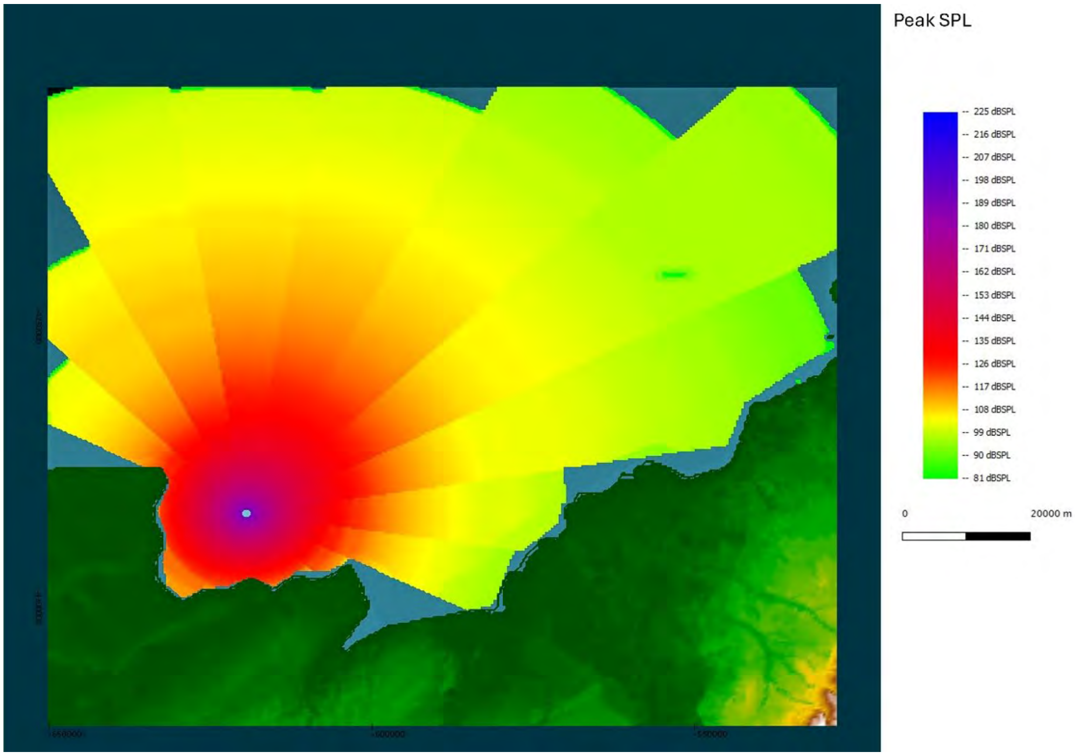


Figure A.2 SEL for LF Hearing Group (192 shot exposure) at Site 10

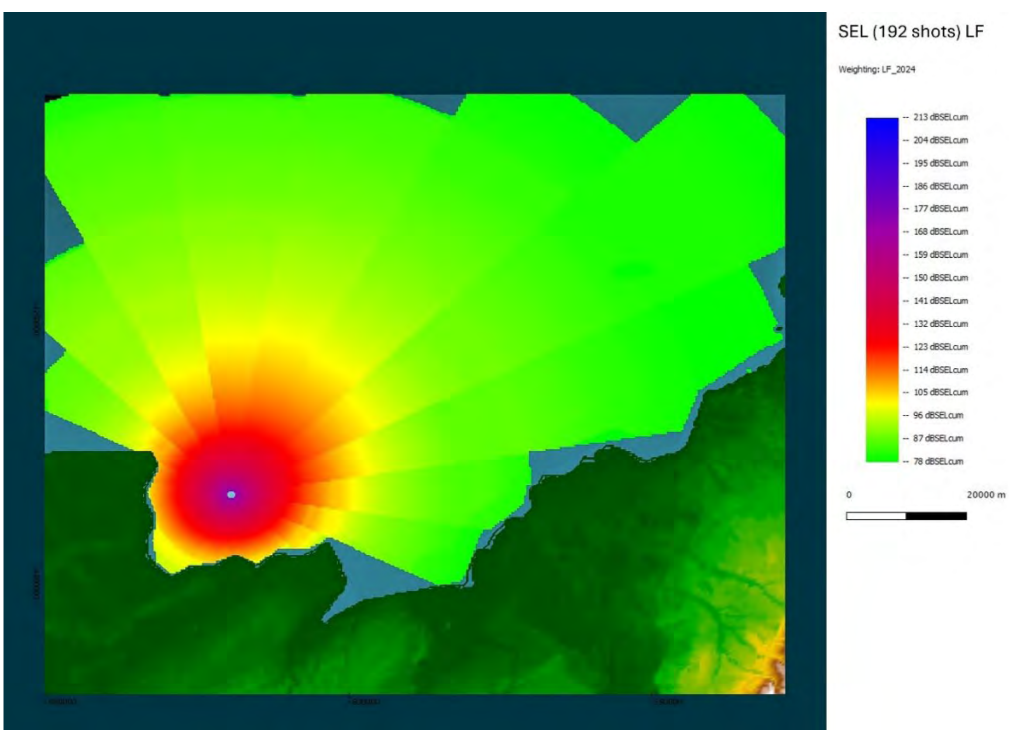


Figure A.3 SEL for HF Hearing Group (192 shot exposure) at Site 10

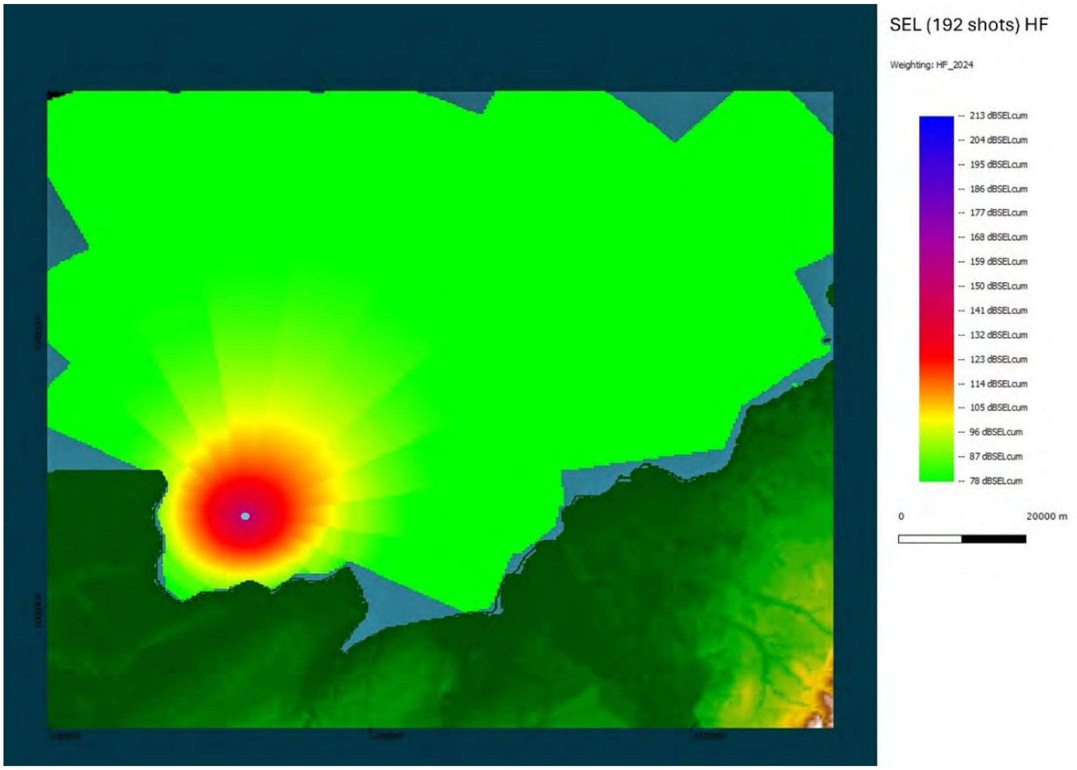


Figure A.4 SEL for VHF Hearing Group (192 shot exposure) at Site 10

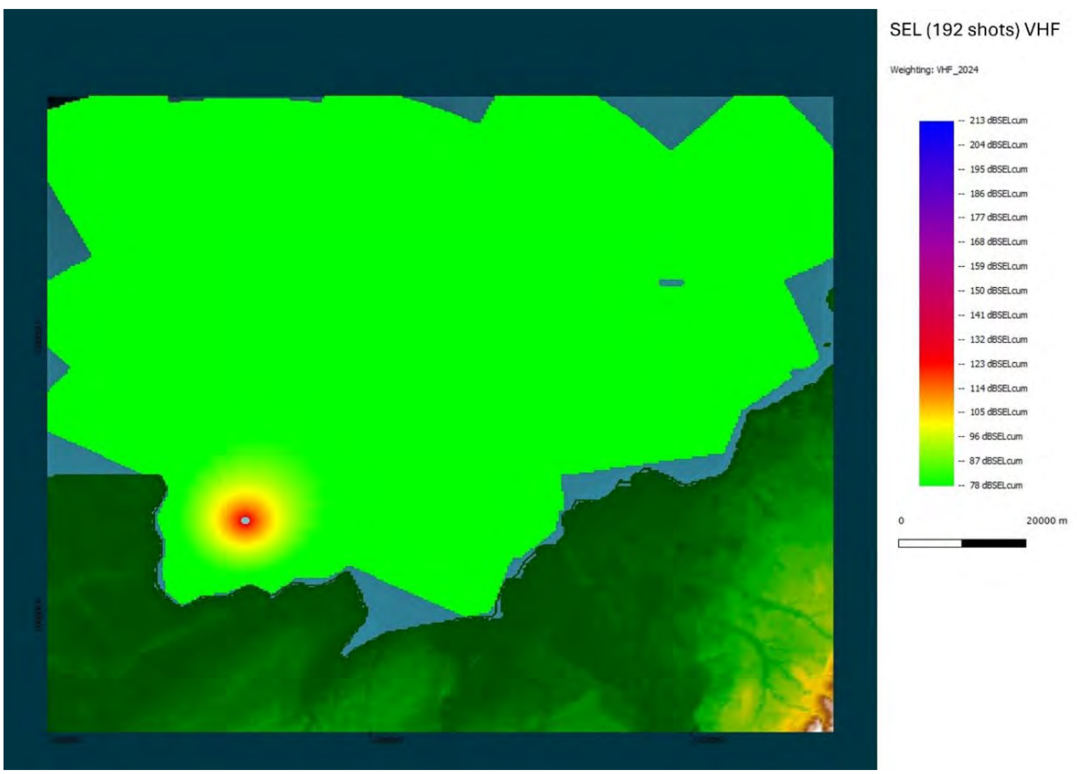


Figure A.5 SEL for PCW Hearing Group (192 shot exposure) at Site 10

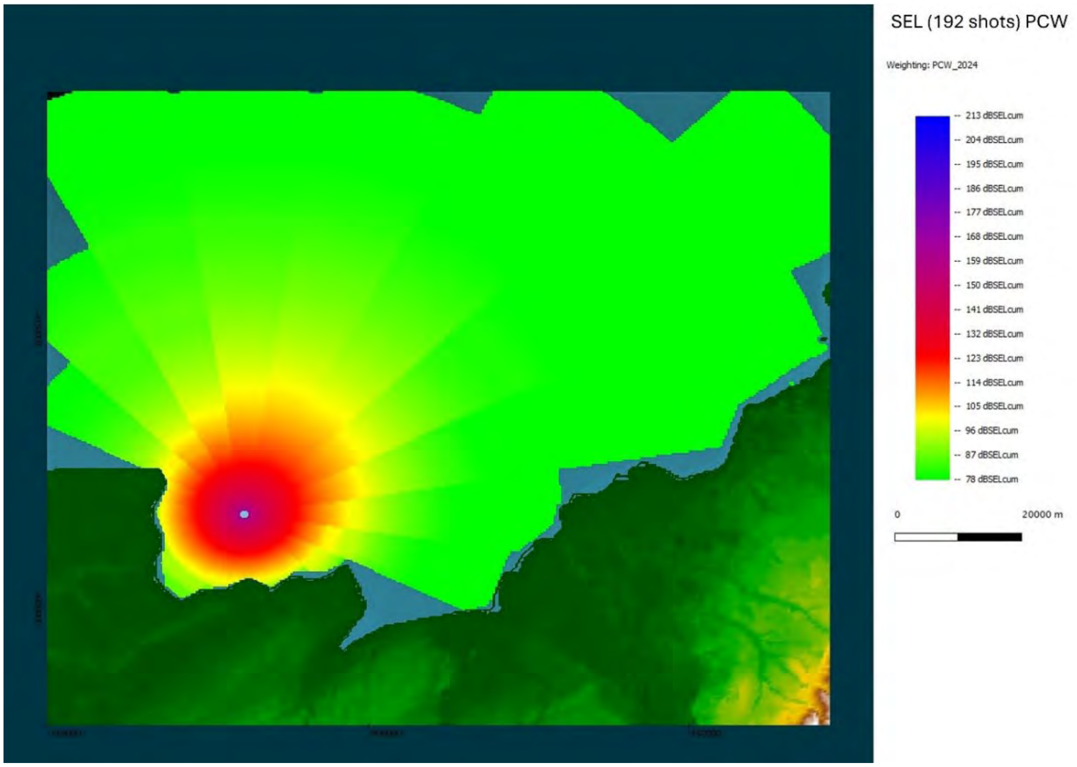
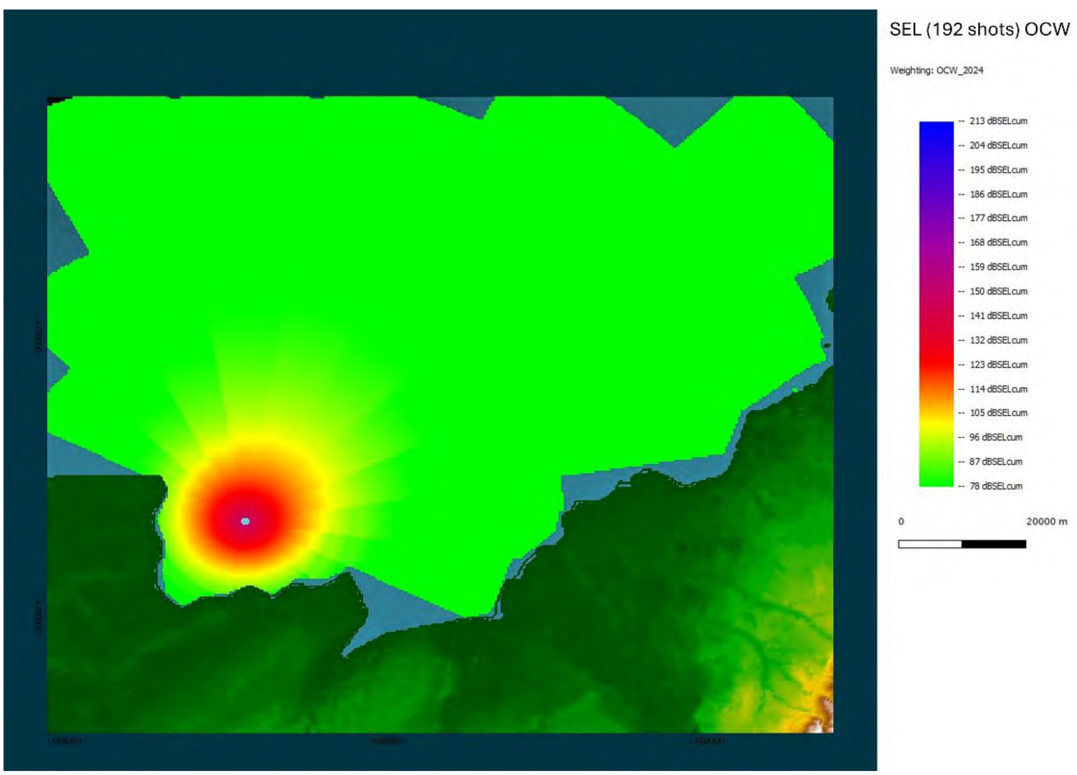


Figure A.6 SEL for OCW Hearing Group (192 shot exposure) at Site 10



Appendix C.
Marine Mammal Densities and Estimated Level A and B Exposures During Open Water Seismic
NOTE: Exposure estimates are based on Nov. 2024 noise modeling of Site 10 as representative of project activities.

Species	Summer/Fall Density (ind/km2)
Bowhead whales	0.009
Ringed Seals	0.24
Bearded Seals	0.05
Spotted Seals	0.09

Open Water Seismic Exposure Estimate									
West Harrison Bay									
Species	Area Ensonified (km2) Level A SEL	Area Ensonified (km2) Level B rms	Estimated Level A Exposures Per Day	Estimated Level B Exposures Per Day	Proportion of 24-hr Period of Active Survey	Total Days of Survey	Duration of Ensonification (Days)	Total Estimated Level A Summer Exposures	Total Estimated Level B Summer Exposures
Bowhead whales	106.93	337.98	0.94	2.96	0.5	12	6	5.61	17.74
Ringed seals	31.24		7.61	82.36				45.67	494.16
Bearded Seals	31.24		1.52	16.47				9.13	98.83
Spotted Seals	31.24		2.66	28.83				15.99	172.96

*Surveys would occur only 12 hours within a 24-hr period. Surveys would occur for 12 hours/day over 12 days (i.e., represented as 6 total days here).

Total Estimated Exposures During Seismic and Ice Road Activities

TOTAL EXPOSURES (Open Water Seismic and Winter Ice Route Activities)					
	Open Water Seismic Surveys		Winter Ice Routes	ALL SEASONS	
Species	Total Level A Exposures	Total Level B Exposures	Total Estimated Level B Winter Exposures	TOTAL Level A	TOTAL Level B
Bowhead whales	5.61	17.74	0.00	0.00	17.74
Ringed seals	45.67	494.16	28.73	0.00	522.89
Bearded seals	9.13	98.83	0.00	0.00	98.83
Spotted seals	15.99	172.96	0.00	0.00	172.96

Level A take will be avoided due to mitigation measures (shutdown zone) and lack of interaction.

Requested Level B Incidental Takes as a Percentage of the Population

	Bowhead Whales	Ringed Seals**	Bearded Seals	Spotted Seals
Requested Rounded to Nearest Whole Number	18	552	99	173
Population	16,820	342,836	301,836	461,625
Percent of Population	0.11%	0.16%	0.03%	0.00%

* Based on exposure estimate for Level B only. Level A take will be avoided due to mitigation measures and lack of interaction.
** Ringed Seal Population based on Conn et al (2014) abundance of 171,418 which used a subset of aerial survey data collected in 2012 by Moreland et al (2013). This estimate is considered to be low by a factor of 2 or more because availability bias due to seals in the water and the estimate did not include ringed seals in the shorefast ice zone (Young et al. 2023). Therefore, abundance is multiplied by a factor of 2 (i.e., 342,836 animals)

Plan of Cooperation

West Harrison Bay Exploration Program

Prepared by

Narwhal LLC

406 W Fireweed Lane
Suite 100
Anchorage, AK 99503

Prepared for

U.S. National Marine Fisheries Service

Permits and Conservation Division, Office of Protected Resources

1315 East-West Highway, F/PR1 Room 13805

Silver Spring, MD 20910

Table of Contents

1. Introduction and Project Description

Narwhal LLC (Narwhal) is proposing to drill up to five exploration wells in the shallow waters of west Harrison Bay (WHB) in the Beaufort Sea during January through April of 2026. The Project will involve both open water surveys in 2025 and winter drilling operations from ice pads in 2026. These activities will generally be conducted on grounded ice in water depths less than 3 m. This Plan of Cooperation (POC) has been prepared to guide and document Narwhal's community outreach and consultation with North Slope subsistence hunters to ensure that Narwhal's field activities do not impede access to whales, seals and other subsistence mammals. These community outreach and consultation activities are also anticipated to be required by the U.S. National Marine Fisheries Service (NMFS) for approval of an Incidental Harassment Authorization (IHA) for the potential non-lethal, incidental taking of bowhead whales and ringed, bearded and spotted seals that may occur in the action area.

Narwhal is an Alaska-based oil and gas exploration company and is the owner of State of Alaska oil and gas leases located in WHB. To explore WHB area leases, Narwhal proposes to conduct routine summer field studies, shallow hazard surveys (SHS) and exploratory drilling operations in WHB. The action area is shown in Figure 1-1. During the period of January 2026 through April 2026, Narwhal plans to drill up to five exploration wells on WHB area leases. Drilling of five exploration wells in one winter season will require two drilling rigs. Narwhal is considering both a one-rig or two-rig drilling program. If a single rig is utilized, a maximum of three wells will be drilled, whereas a two-rig program will enable completion of up to five wells total. Because mobilization of the second rig will lag the first rig by approximately three to four weeks, the second rig will most likely be unable to drill and evaluate more than two wells prior to the end of the winter season. Summer activities planned for August and September 2025 include marine SHS, freshwater source lake surveys, an archaeological survey, and gathering technical data to support project planning and engineering. Equipment may also be advance staged in the project area during August, September and October to support future winter operations. As part of the permitting program for this project, Narwhal is seeking an Incidental Harassment Authorization (IHA) for the nonlethal, incidental taking of small numbers of ice seals and bowhead whales, polar bears and Pacific walruses for the planned field activities in summer 2025 and winter 2025/2026.

Figure 1 shows the project vicinity where the proposed project activities will be conducted. Figure 2 shows the WHB operations area in more detail including approximate locations for local infrastructure (temporary base camp, temporary airstrip, ice roads, and preliminary drill site location areas). Table 1 shows the estimated timing, duration, equipment and number of personnel for the project activities and Figure 3 shows the Gantt chart for these activities. Narwhal's winter logistical program will be supported by a coastal sea ice trail approximately 80 km long extending from Oliktok Point to WHB (mobilization Option 1) or Option 2, a 47-km trail on land from the CWAT north to WHB (referred to as CWAT to WA2). Option 1 will be constructed primarily on grounded sea ice. All-terrain vehicles (ATV) such as rolligons or steigers will transport equipment and materials to and from WHB via the chosen route. In the immediate vicinity of WHB, up to 172 km of local ice roads will be constructed on sea ice and onshore tundra to enable conventional rolling stock to support the drilling operations. Narwhal plans to conduct preliminary activities in August through October 2025, followed by exploration drilling during the winter season from January through April 2026.

Figure 1. Project Area Overview

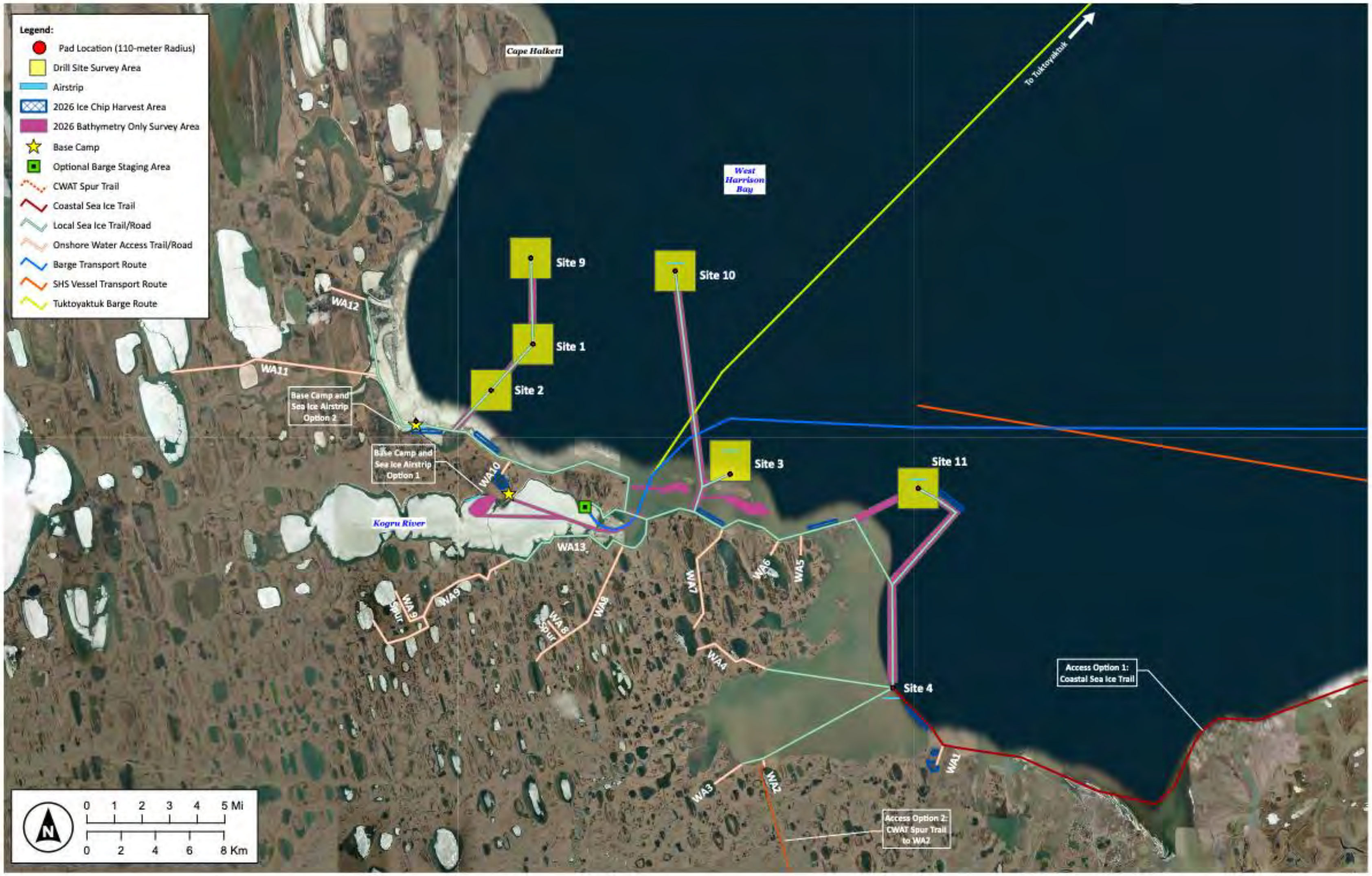


Figure 2. West Harrison Bay Action Area

Table 1. Estimated Timing, Duration, Equipment and Number of Personnel for Project Activities

Item	Activity	Estimated Timing	Estimated Duration (Days)	Estimated Equipment
1	Offshore SHS including high-resolution 3-dimensional (3D) seismic	1 Aug – 30 Sep 2025	45	Fathometer, side scan sonar, sub-bottom profiler, sparker, airgun and seafloor geophone array, vibracoring (if needed), up to 4 survey vessels
2	Offshore archaeological clearance	1 Aug – 15 Aug 2025	Concurrent with SHS above	Side scan sonar and sub-bottom profiler data from the SHS will be reviewed as part of the overall archaeological clearance process
3	Onshore archaeological clearance	1 Aug – 15 Aug 2025	Concurrent with lake surveys below	Helicopter
4	Onshore freshwater lake surveys, installation of thermistors in tundra along freshwater lake access routes	1 Aug – 15 Aug 2025, concurrent with onshore archaeological clearance above	10	Helicopter, drone, small boat, nets, fathometer
5a[1]	Optional advance staging of equipment and materials in WHB area on the existing Kogru airstrip (preferred option, subject to access)	15 Aug – 30 Sep 2025[2]	30	One tug and barge, excavator for setting tundra protection mats onshore, two trucks and two front-end loaders for offloading equipment
5b[1]	Optional advance staging of equipment and materials in WHB area on barges	15 Aug – 30 Sep 2025	30	Up to six empty barges, one camp barge vessel, one fuel barge, two tugs for transport of barges from Canada, one tug and barge for transport of equipment from West Dock Prudhoe Bay or Oliktok Point, two trucks and two front-end loaders for offloading equipment
5c	Two personnel to monitor staged equipment with weekly helicopter support, subject to 5a or 5b	15 Sep – 30 Nov 2025	75	Self-contained small camp skid/trailer, generator, skiff, snowmachines, helicopter
6	Aerial infrared (AIR) surveys for polar bear dens	1 Dec – 15 Dec and 15 Dec 2025 – 10 Jan, 2026	2	Fixed-wing aircraft[3] equipped with infrared camera; pilots, observer, and camera operator

Item	Activity	Estimated Timing	Estimated Duration (Days)	Estimated Equipment
7a	Option 1: Coastal sea ice trail construction Oliktok Point to WHB, installation of safety shack at west side of Colville River Delta	1 Dec – 31 Dec 2025	30	15-person camp at Oliktok Point, rolligons, steigers, tuckers, sea ice pumpers
7b	Option 2: Spur to Site 4 from existing Community Winter Access Trail (referred to as CWAT to WA2)	15 Dec 2025 – 15 Jan 2026	10	15-person camp at 2P pad along existing CWAT, rolligons, steigers, tuckers
8	Mobilization to WHB of additional camp facilities, ice construction equipment, consumables, and drilling rigs	1 Jan – 10 Feb 2026	41	Rolligons, steigers, estimate up to 12 units transporting freight daily
9	Local ice trail/road, airstrip and ice pad construction in WHB	5 Dec 2025 – 25 Mar 2026 if equipment is advance staged, otherwise 7 Jan – 30 Mar 2026	110	Ice construction equipment, front end loaders, motor grader, sea water pumpers, ice trimmer/chipper, tractor/trailers, fixed-wing aircraft[2]
10	Exploratory drilling	20 Jan – 15 Apr 2026	85	Logistical support equipment including camp, tractor/trailers, pickup trucks, rolligons, steigers, fixed-wing aircraft[3], drilling rig
11	Demobilization of remaining equipment (in success drilling case, some equipment may be stored at existing Kogru airstrip on gravel or anchored barges)	16 Apr – 5 May 2026	15	Rolligons and steigers to transport all equipment and materials back to Oliktok Point via the coastal sea ice trail
12	Summer cleanup (stickpicking)	1 Jul – 15 Jul 2026	6[4]	Helicopter

Note: This schedule presents Narwhal's best estimate regarding the timing and duration of activities. Local conditions, logistics and other factors related to operations could result in changes to the proposed dates during project execution[1] Options 5a and 5b – if advance staging occurs, only one of these options (not both) will occur.

[2] Narwhal will coordinate closely with whaling communities to minimize disturbance during the whaling season through a Conflict Avoidance Agreement and by implementing a Plan of Cooperation.

[3] Fixed-wing aircraft used during winter operations may include Single Engine Otter on skis, Cessna 206/207, Cessna Grand Caravan, Piper Navajo, Helio Courier, DHC-6 Twin Otter, Beech King Air 200, Beech 1900, or similar.

[4] For summer stickpicking, 3-6 days are estimated if Option 2 CWAT to WA2 is constructed. If Option 1 is used for mobilization, only 3-5 days are required for stickpicking.

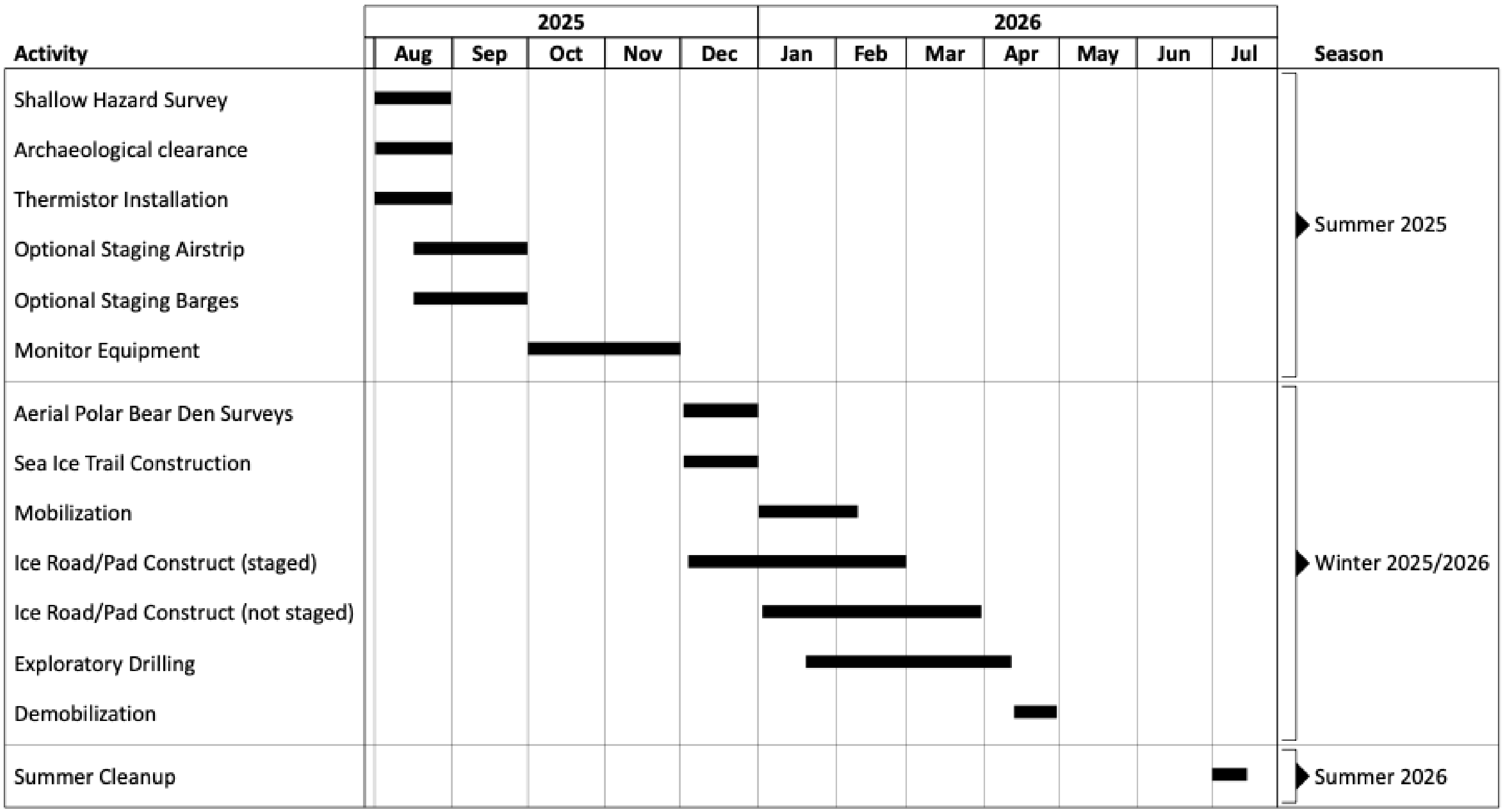


Figure 3. Project Activities Gantt Chart

2. Wildlife Safety, Awareness and Interaction Plan

Narwhal has prepared a Wildlife Safety, Awareness and Interaction Plan that describes how Narwhal will work to protect subsistence resources including whales and seals. As part of this plan, Narwhal's primary focus is avoidance of marine mammals and implementation of proven and effective mitigation techniques to ensure the safety of both animals and the field personnel working on Narwhal's project. In addition to avoidance techniques, mitigation measures to minimize impacts to whales and seals are contained in the plan.

3. Engagement and Cooperation

While Narwhal as an entity is a new operator on the North Slope, its Management Team has extensive oil and gas experience in Alaska and on the North Slope. This experience includes community outreach with North Slope Village personnel, the North Slope Borough (NSB) Planning and Wildlife Departments, and other stakeholders on the North Slope. As such, Narwhal understands the importance of stakeholder engagement and the importance of having decision makers involved in the engagement process.

Narwhal began engaging Alaska Native communities in December 2022 (see Section 5) and Narwhal plans to travel to the North Slope again to engage with stakeholders and initiate regular communication between Narwhal's Management Team and Alaska North Slope stakeholders. Narwhal endeavors that these meetings will enable the following:

- Introduce Narwhal and the WHB exploration program;
- Answer questions about the project;
- Listen to and address stakeholder concerns;
- Gather feedback for incorporation into project plans;
- Provide a mechanism for follow-up correspondence and project updates; and
- Build trust between Narwhal representatives and stakeholders.

Narwhal's intent for these engagement opportunities is to develop ongoing communication protocols with stakeholder entities that provide an open communication mechanism for Narwhal's Management Team to disseminate updates and project information to Alaska North Slope stakeholders.

Through the permitting process for the WHB exploration project, Narwhal will also engage with the NSB, state and federal agencies for the same purposes.

4. Mitigation Measures to Reduce Subsistence Impacts

Narwhal activities will be conducted in a manner that avoids conflicts with subsistence users. Prior to conducting activities, subsistence communities and organizations will be consulted to discuss potential conflicts or concerns for subsistence resources. Narwhal will incorporate feedback from these meetings into project planning to avoid potential impacts to subsistence resources.

The Wildlife Safety, Awareness and Interaction Plan referenced in Section 2 details mitigation measures that Narwhal will employ to minimize impacts to marine mammals. These mitigation measures may be adjusted based on feedback from the planned consultations with subsistence users and stakeholders.

5. Cooperation Consultations

Subsistence communities and stakeholders that Narwhal intends to engage with through 2026 for the WHB exploration program include the following entities:

- Alaska Eskimo Whaling Commission (Narwhal presented at the December 2022 AEWC meeting);
- Ice Seal Committee;
- North Slope Borough Planning Department;
- North Slope Borough Environmental Department;
- Nuiqsut Community;
- Nuiqsut Whaling Captains;
- Kuukpikmiut Subsistence Oversight Panel (KSOP);
- Kuukpik Corporation;
- Alaska Nannut Co-Management Council (ANCC)

Additional stakeholders may be added to this list during the planning and permitting process for the project.

Narwhal will utilize in person, video conferencing, telephonic, written, and email communication formats depending upon stakeholder representative locations, schedule availability, meeting location preferences and other factors. All stakeholder engagement activities and communications will be documented in the Narwhal Stakeholder Communication Log (see Attachment A).

On July 8, 2022, Narwhal contacted the AEWC to request an opportunity to present an overview of the proposed project at the AEWC meeting in Fairbanks, Alaska on July 14 and 15, 2022. AEWC responded by explaining that the July 2022 agenda was full, but Narwhal may request time at the AEWC meeting in December 2022. Narwhal presented project information to the AEWC at the December 2022, February 2023 and December 2023 meetings. Additional outreach will continue to communicate information about the proposed activities in WHB to groups including but not limited to the Native Villages of Nuiqsut and Kaktovik; co-management organizations such as AEWC, NSB, Ice Seal Committee; and the Kuukpik Corporation. Table 2 presents a summary of community engagement activities as of October 2024. Table 2 will continue to be updated by Narwhal throughout the project and can be provided to NMFS upon request as well as with the final monitoring report.

While the proposed activities may have temporary effects on bowhead whale or ice seal behavior, it will not alter the ability of Alaska Native residents to hunt these species over the long-term. Narwhal will continue to coordinate with Alaska Native villages and stakeholder organizations to identify and avoid the potential short-term conflicts. The POC and coordination with these groups will help minimize effects the project might have on subsistence harvest.

Table 2. Subsistence Community Outreach and Engagements

Date	Correspondence Type (meetings, etc.)	Associated Documents	Meeting Attendees	Topics	Summary of MMOA Subsistence-Related Concerns
July 8, 2022	Email	Appendix C	N/A	N/A	N/A
August 25, 2022	Introductory meeting		Andy Mack, President Kuukpik, Jesse Mohrbacher (Narwhal) and Duane Dudley (Narwhal)	Discussed Narwhal's project in West Harrison Bay and future coordination with Kuukpik entities.	
December 12, 2022	Meeting Presentation	Narwhal PowerPoint	AEWC, Whaling Captains, NSB, Other Stakeholders	Project schedule, CAA, distances to thresholds	CAA; Underwater Noise; Disturbance to Marine Mammals
February 3, 2023	Meeting Presentation	Narwhal PowerPoint	AEWC, Whaling Captains, NSB, Other Stakeholders	Project schedule, CAA, distances to thresholds	
February 16, 2023	Email from Jesse Mohrbacher to Isaac Nukapigak			Requested assistance in coordinating meetings in Nuiqsut with stakeholders.	
February 17, 2023	Phone call from Jesse Mohrbacher to Andy Mack, President of Kuukpik Corp.			Left message regarding planning a trip to Nuiqsut to meet with stakeholders including Whaling Captains.	
February 17, 2023	Email from Jesse Mohrbacher to Thomas Napageak, Jr.		Also copied on email: Isaac Nukapigak, Joe Nukapigak	Follow up to discussion in Utqiagvik with Carl Brower to request coordination of timing for meetings in Nuiqsut with stakeholders, including Whaling Captains.	Narwhal communication with Whaling Captains.
February 27, 2023	Text from Jesse Mohrbacher to Thomas Napageak Jr.			Requested call back to discuss planning a trip to Nuiqsut to meet with Whaling Captains.	Narwhal communication with Whaling Captains.

Date	Correspondence Type (meetings, etc.)	Associated Documents	Meeting Attendees	Topics	Summary of MMOA Subsistence-Related Concerns
March 8, 2023	Text from Jesse Mohrbacher to Thomas Napageak Jr.			Requested call to schedule meeting in Nuiqsut with Whaling Captains.	Narwhal communication with Whaling Captains.
March 11, 2023	Email from Jesse Mohrbacher to Andy Mack, President Kuukpik		Copied on email were Joe Nukapigak, Wendy/Carl Brower, P. Munson, N. Kaigelak, Jenny Evans, Stephane Labonte	Discussed Narwhal's project and desire to present at the Trilateral meetings in Nuiqsut.	Kuukpik is chair of the Nuiqsut Trilateral and will assist in coordination for Trilateral meetings
March 14, 2023	Text from Thomas Napageak, Jr. to Jesse Mohrbacher and return text			Thomas suggested to contact the City of Nuiqsut to schedule a city presentation and that he would coordinate Captains at the same time. Jesse stated that Narwhal was coordinating with Kuukpik to get on the Trilateral schedule in late March.	Ongoing Narwhal correspondence with Whaling Captains to schedule meeting in Nuiqsut.
March 14, 2023	Text from Jesse Mohrbacher to Thomas Napageak Jr.			Discussed that emails had also been send to Andy Mack and Joe Nukapigak regarding coordinating trip to Nuiqsut to meet with stakeholders.	Ongoing Narwhal correspondence to schedule meeting in Nuiqsut with stakeholders
March 17, 2023	Phone call from Andy Mack, President Kuukpik, to Jesse Mohrbacher			Discussed Narwhal presenting at the upcoming Trilateral meetings in Anchorage. Andy suggested that waiting until a later Trilateral may be prudent due to the busy schedule with CPAI and Oil Search	Ongoing Narwhal correspondence to schedule meeting in Nuiqsut with stakeholders.

Date	Correspondence Type (meetings, etc.)	Associated Documents	Meeting Attendees	Topics	Summary of MMOA Subsistence-Related Concerns
				presenting at the next Trilateral meeting.	
April 11, 2023	Email from Jesse Mohrbacher to Isabel Elavgak of AEWC		Email copied to all recipients on AEWC CAA email list	Notified Isabel that Narwhal had several requested changes to the proposed CAA.	
April 12, 2023	Call from Jesse Mohrbacher to Carl Brower			Left message requesting call back to coordinate meeting in Nuiqsut with Whaling Captains.	Narwhal communication with Whaling Captains.
April 12, 2023	Text from Jesse Mohrbacher to Carl Brower			Follow up communication from meeting in Barrow to discuss planning a trip to Nuiqsut. Requested call back from Carl.	Narwhal communication with Whaling Captains.
April 14, 2023	Email from Stéphane Labonte to Isabel Elavgak	Narwhal's proposed clarifications and changes to CAA.	Email cc'd Lesley Hopson, Jenny Evans, Jesse Mohrbacher and Anne Southam	Narwhal requested several changes and clarifications related to camp effluent discharge, sound source monitoring and other CAA content.	Narwhal communication with AEWC.
April 17, 2023	Text from Jesse Mohrbacher to Thomas Napageak Jr.			Discussed that Narwhal elected to not attend the Trilateral meeting in late March after conversation with Andy Mack, Kuukpik President, due to the already busy schedule with ConocoPhillips and Oil Search making presentations.	Narwhal communication with Whaling Captains.

Date	Correspondence Type (meetings, etc.)	Associated Documents	Meeting Attendees	Topics	Summary of MMOA Subsistence-Related Concerns
April 17, 2023	Call from Jesse Mohrbacher to Carl Brower			Carl said he was busy and out of town. Jesse followed up with email and text to coordinate meeting timing.	
April 17, 2023	Email from Jesse Mohrbacher to Carl Brower		Carl Brower, via Wendy Brower email	Discussed scheduling meeting in Nuiqsut to visit with Whaling Captains	Narwhal intends to communicate and coordinate with local subsistence users including Whalers.
April 17, 2023	Text from Jesse Mohrbacher to Carl Brower			Text communication to alert Carl that an email had been sent to him via his wife's (Wendy Brower) email address.	Narwhal communication with Whaling Captains.
April 17, 2023	Email from Jesse Mohrbacher to Thomas Napageak, Jr.			Copy of email sent to Carl Brower re scheduling meeting in Nuiqsut with Whaling Captains	Narwhal communication with Whaling Captains.
April 21, 2023	Phone call from Jesse Mohrbacher to Carl Brower.			Discussed coordinating visit to Nuiqsut to meet with Whaling Captains	Carl indicated he would consult with other Captains to set a date and that I should call him back the following Wednesday,.
April 26, 2023	Phone call from Jesse Mohrbacher to Carl Brower			Follow up to previous call. Discussed setting date to meet in Nuiqsut	Carl requested that Narwhal coordinate with Thomas Napageak Jr. (Kupa) regarding scheduling a trip to Nuiqsut to

Date	Correspondence Type (meetings, etc.)	Associated Documents	Meeting Attendees	Topics	Summary of MMOA Subsistence-Related Concerns
					meet with the Whaling Captains.
April 27, 2023	Text from Jesse Mohrbacher to Thomas Napageak Jr. and vice versa			Discussed that Carl Brower had asked Jesse to coordinate with Thomas (Kupa) for meetings in Nuiqsut in mid to latter May. Discussed possible dates of May 17-25 as possible dates.	Narwhal communication with Whaling Captains.
April 28, 2023	Text from Jesse Mohrbacher to Thomas Napageak Jr			Confirming dates of May 17-26 as suitable dates for meeting in Nuiqsut	Narwhal communication with Whaling Captains.
May 9, 2023	Text from Jesse Mohrbacher to Thomas Napageak Jr. and vice versa			Check in text to continue planning for Nuiqsut trip. Kupa in Washington DC, traveling. Jesse requested that Kupa let him know when ready to set a time for meeting in Nuiqsut.	Narwhal communication with Whaling Captains.
May 12, 2023	Text from Jesse Mohrbacher to Thomas Napageak Jr. and vice versa			Continue coordination of meeting in Nuiqsut, Kupa in Seattle traveling back to AK. Both Jesse and Kupa missed each other in Seattle airport. Kupa to be in Barrow for AEWC meetings next. Kupa to reach out to Captains to coordinate meeting.	Narwhal communication with Whaling Captains.

Date	Correspondence Type (meetings, etc.)	Associated Documents	Meeting Attendees	Topics	Summary of MMOA Subsistence-Related Concerns
July 25, 2024	Meeting with Jenny Evans (Nuiqsut Advocate)		Stéphane Labonté Jesse Mohrbacher Jenny Evans	Discussed planning for Nuiqsut visit to meeting with local subsistence hunters, whaling captains and residents.	Narwhal communication with local Nuiqsut stakeholders.
August 29, 2024	Outreach to Kuukpik Inupiat Corp. Representative(s)				Coordinate Narwhal project planning and scheduled activities with Kuukpik.
March 28, 2025	Emails with Jeremy Kasak, City of Nuiqsut Office Manager		Julie Lina	Planning for Community Meeting in Nuiqsut May 2025	

[a] Correspondence with communities as of March 31, 2025 The POC (Appendix C) will continue to be updated throughout the project.