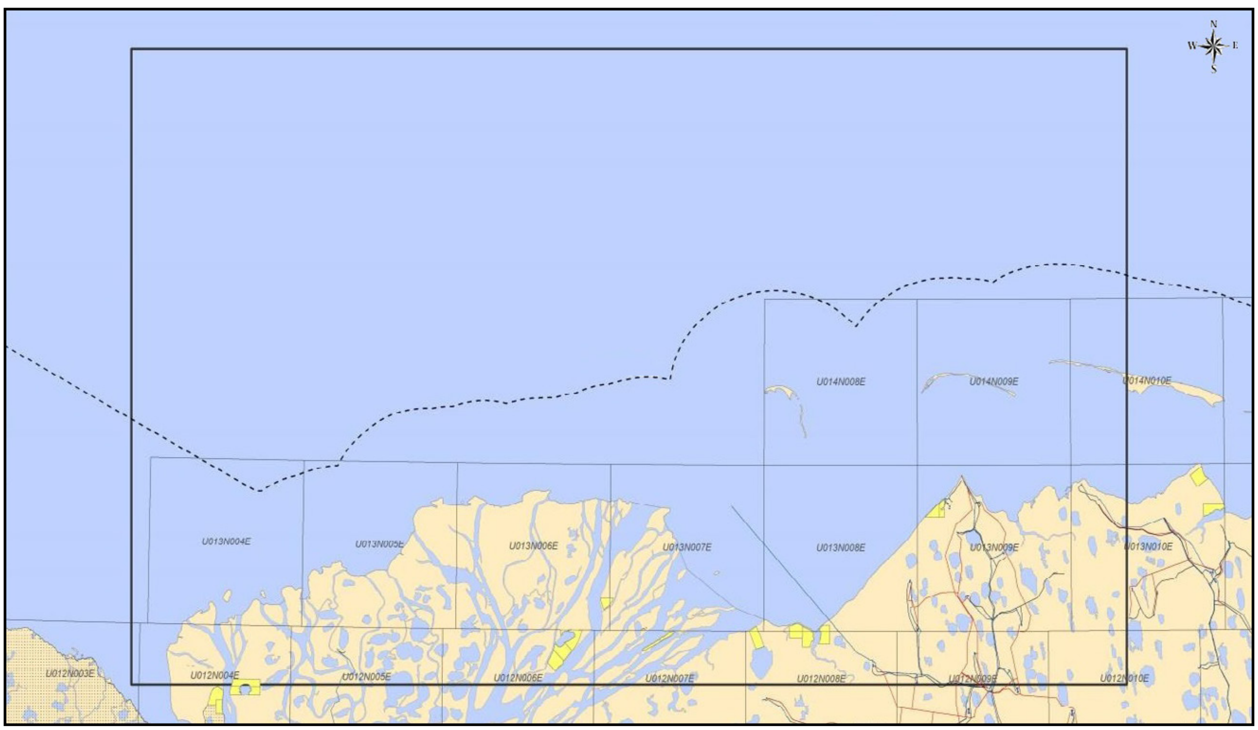
Alaska Outer Continental Shelf

OCS EIS/EA
BOEM 2014-605

SAExploration Inc.
Colville River Delta 2014
3D Geophysical Seismic Survey
Beaufort Sea, Alaska

ENVIRONMENTAL ASSESSMENT

Prepared By:
Office of Environment
Alaska OCS Region



U.S. Department of the Interior
Bureau of Ocean Energy Management
Alaska OCS Region

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Acronyms and Abbreviations

AAAQS ....Alaska Ambient Air Quality Standards
AAC ....Alaska Administrative Code
ACP ....Arctic Coastal Plain
ADEC ....Alaska Department of Environmental Conservation
ADF&G ....Alaska Department of Fish and Game
bar-m ....Bar-meter: One bar equals approximately one atmosphere of pressure
bbl..................................Barrel/Barrels
BOEM ....Bureau of Ocean Energy Management
BOEMRE ....Bureau of Ocean Energy Management, Regulation and Enforcement
CAH ....Central Arctic Caribou Herd
CEQ ....Council on Environmental Quality
CFR ....Code of Federal Regulations
CWA..............................Clean Water Act
dB re 1 μPa ....Decibels in Relation to a Reference Pressure of 1 Micropascal
EA..................................Environmental Assessment
EFH ....Essential Fish Habitat
EIS ....Environmental Impact Statement
EJ ....Environmental Justice
EP ....Exploration Plan
EPA ...............................U.S. Environmental Protection Agency
ESA ....Endangered Species Act
FR ....Federal Register
G&G ....Geological and Geophysical
Hz ....Hertz
IHA ....Incidental Harassment Authorization
ITA ....Incidental Take Authorization
LOA...............................Letter of Authorization
MMPA...........................Marine Mammal Protection Act
MMS..............................Minerals Management Service
M/V ....Marine Vessel
NAAQS ....National Ambient Air Quality Standards
NEPA ....National Environmental Policy Act
NMFS ....National Marine Fisheries Service
NMML ....National Marine Mammal Laboratory
NPR-A ....National Petroleum Reserve-Alaska
NOAA ....National Oceanic and Atmospheric Administration
NO_x................................Nitrogen Oxides
NPDES ....National Pollutant Discharge Elimination System
NRC...............................National Research Council
NSB ....North Slope Borough
OCSLA ....Outer Continental Shelf Lands Act
OCS ....Outer Continental Shelf
PEA ....Programmatic Environmental Assessment
psi ....Pounds Per Square Inch
PSO................................Protected Species Observer
SAE ....SAExploration, Inc.
SHPO ....State Historic Preservation Officer
TCH ....Teshekpuk Lake Caribou Herd
TSS ....Total suspended solids
USC. ....United States Code
USDOC .........................U.S. Department of Commerce
USDOI...........................U.S. Department of the Interior
USFWS..........................U.S. Fish and Wildlife Service
USGS.............................United States Geological Survey

VGP .... Vessel General Permit
WAH .... Western Arctic Caribou Herd

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1.0 PURPOSE AND NEED

SAExploration, Inc. (SAE) submitted a Geological and Geophysical (G&G) permit application to the Bureau of Ocean Energy Management (BOEM) on December 20, 2013 to conduct a three-dimensional (3D) ocean-bottom node (OBN) seismic survey in the U.S. Beaufort Sea. The survey would be conducted during the 2014 open water season, between July 1, 2014 and October 31, 2014.

The Proposed Action would occur in shallow waters of the Colville River Delta area in Harrison Bay of the U.S. Beaufort Sea in both Federal and State of Alaska jurisdictional waters. BOEM's jurisdiction to permit G&G surveys (30 CFR 551) applies to the portion of SAE's survey to occur seaward of the Federal-State Boundary.

BOEM assumes that the survey activities in the area under State jurisdiction are an interdependent part of the larger action, and depend on the larger action for their justification. Accordingly, the portion of the Proposed Action under State jurisdiction is treated as a connected action for purposes of NEPA analysis. However, any permits and associated restrictions issued by BOEM subsequent to this analysis apply only to activities in the U.S. waters seaward of the Federal-State Boundary (see Figure 1).

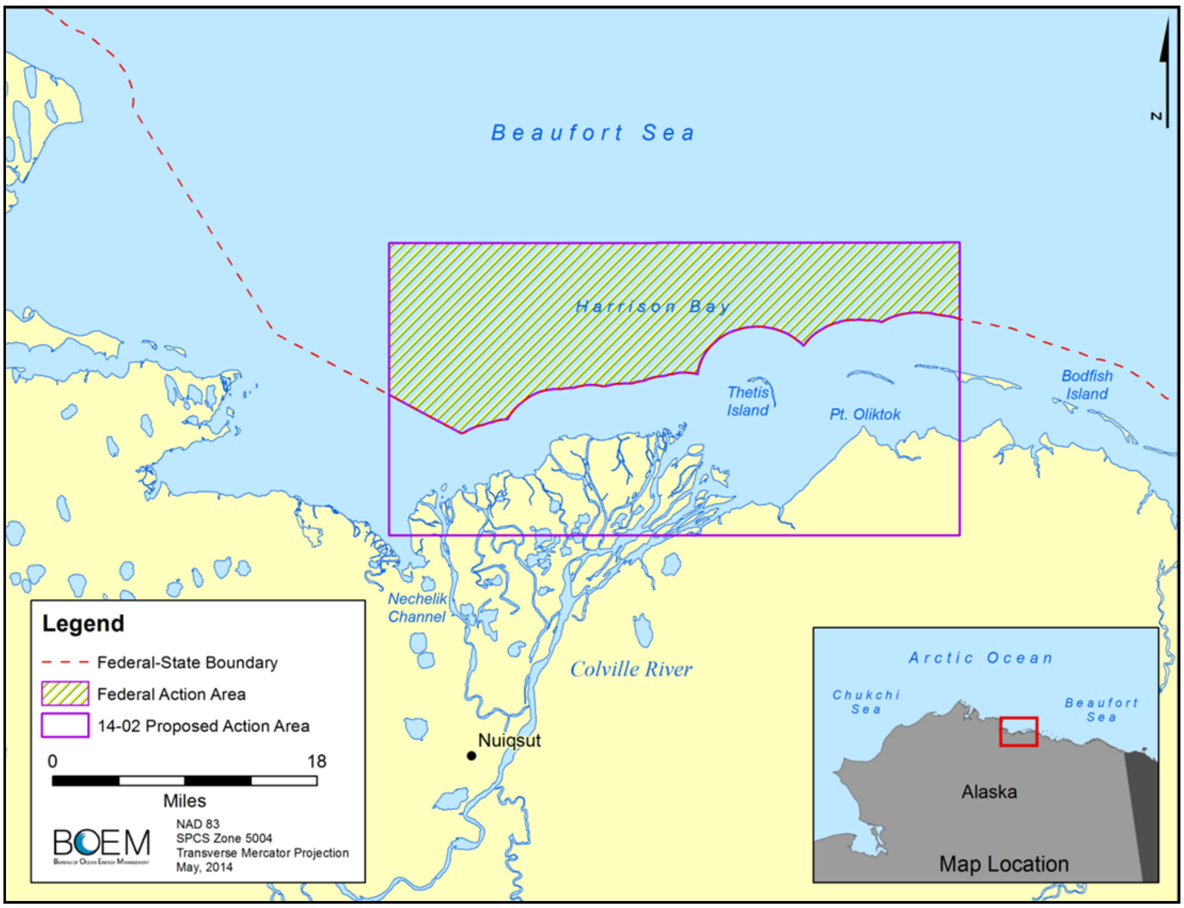

Figure 1. Proposed Action area. *The Proposed Action area (outlined in violet) includes areas of Federal as well as State of Alaska jurisdiction. The Federal action (permit) area is north of the Federal-State boundary and indicated by diagonal lines. BOEM has analyzed resources affected throughout the entire Proposed Action area. Any BOEM permits will apply solely to the Federal action area.*

BOEM has prepared an environmental assessment to analyze the potential environmental effects of the Proposed Action, to determine whether the Proposed Action would result in significant effects to the environment, and to determine whether to prepare an environmental impacts statement for BOEM's planning and decision-making in accordance with the following:

- National Environmental Policy Act (NEPA) (42 USC 4231 *et seq*).
- Council on Environmental Quality (CEQ) regulations at 40 CFR 1500 (particularly 1501.3(b) and 1508.27).
- Department of the Interior (DOI) regulations at 43 CFR Part 46.
- DOI policy in Section 516, Chapter 15 of the Department of the Interior Manual (DM) (516 DM 15).

Permit applications to conduct such seismic activities in areas under Federal jurisdiction are submitted pursuant to Federal regulations for Geological and Geophysical (G&G) Explorations of the OCS at 30 CFR 551.

1.1. Purpose of the Proposed Action

The Outer Continental Shelf Lands Act (OCSLA) (43 USC §1332) requires the Outer Continental Shelf (OCS) be made available for expeditious and orderly development, subject to environmental safeguards, in a manner which is consistent with the maintenance of competition and other national needs. The purpose of SAE's Proposed Action is to replace and/or augment existing data sets with better quality, higher resolution seismic data, and to provide new data to improve understanding of the geology and potential targets for oil and gas exploration (see 43 USC §1340(a)). This information will provide insight into the geologic evolution, basin architecture, and depositional and structural history of the petroleum system.

1.2. Previous Applicable Analyses

The level of NEPA review depends on the OCSLA stage (516 DM 15), the scope of the Proposed Action, and the agency's findings on the potential effects of the Proposed Action.

BOEM has completed previous NEPA reviews of U.S. Beaufort Sea OCS activities. These include the following:

- Environmental Assessment, BP Exploration (Alaska) Inc. North Prudhoe Bay 2014 OBS Geophysical Seismic Survey Beaufort Sea, Alaska, (OCS EIS/EA BOEM 2014-054) May 2014 (USDOI, BOEM, 2014).
- Environmental Assessment, Beaufort Sea and Chukchi Sea, Alaska, ION Geophysical, 2012 Seismic Survey, (OCS EIS/EA BOEMRE 2012-817), October 2012 (USDOI, BOEM, 2012) (hereafter "2012 ION Seismic Survey EA").
- Environmental Assessment - Shell Offshore, Inc., 2012 Revised Outer Continental Shelf Lease Exploration Plan, Camden Bay, Beaufort Sea, Alaska. (OCS EIS/EA BOEMRE 2011-039) (USDOI, BOEMRE, 2011a) (hereafter "2012 Shell Camden Bay EP EA").
- Environmental Assessment, Beaufort Sea and Chukchi Sea Planning Areas, ION Geophysical, Inc. Geological and Geophysical Seismic Surveys, (OCS EIS/EA BOEMRE 2010-027) September 2010 (USDOI, BOEMRE, 2010a) (hereafter "2010 ION Seismic Survey EA").
- Final Programmatic Environmental Assessment, Arctic Ocean Outer Continental Shelf, Seismic Surveys – 2006 (OCS EIS/EA MMS 2006-038) June 2006 (USDOI, MMS, 2006a) (hereafter "2006 Seismic PEA").
- Final Environmental Impact Statement, Beaufort Sea Planning Area Oil and Gas Lease Sales 186, 195 and 202—2003 (OCS EIS/EA MMS 2003-001) February 2003 (USDOI, MMS, 2003) (hereafter "Beaufort Sea Multiple-Sale EIS").

The EA and environmental impact statement (EIS) documents above, and others, are available on the BOEM Alaska Region website at: http://www.boem.gov/ak-eis-ea/. Relevant sections of some of these documents are summarized and incorporated by reference in this EA. This EA builds upon these previous analyses by analyzing site- and project-specific information from SAE’s permit application materials, and by incorporating new information from recent scientific studies.

No public comments were received on the Proposed Action during the open comment period of April 16, 2014 through midnight May 8, 2014.

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2.0 ALTERNATIVES

2.1. Description of the Alternatives

2.1.1. Alternative 1 – No Action

Alternative 1 - No Action. BOEM would not approve the 2014 SAE G&G Seismic Survey Application #14-02. SAE's proposed seismic survey would not occur in areas under jurisdiction of the United States.

2.1.2. Alternative 2 – Proposed Action

Alternative 2 - Proposed Action. BOEM would approve the 2014 SAE G&G Seismic Survey Application #14-02 for activities in the area under Federal jurisdiction, and SAE's proposed 3D seismic survey would occur in the U.S. Beaufort Sea beginning no sooner than July 1, 2014 and concluding no later than October 31, 2014.

2.1.2.1. Overview

SAE proposes to conduct a 3D seismic survey in the Colville River Delta, Harrison Bay area, of the U.S. Beaufort Sea during the 2014 open water season. The survey would use ocean-bottom recording nodes, a modification of the ocean bottom cable method that uses battery-powered cableless receivers. The 65 pound (29.5 kg) nodes, tethered together for ease of retrieval, would be placed on the ocean bottom. During 2014, all survey activities associated with the Proposed Action would occur within a 70 day period between July 1 and October 2014. Actual data acquisition is planned to occur between August 15 to October 15, 2014, with effective shooting of seismic anticipated to occur over approximately 70% of the 70 days (49 full days of shooting).

The survey would include:

- Two seismic sound-source vessels in operation 24 hrs/day. Airgun arrays would include 880 in^3 and 1760 in^3 in deeper water, and a 440 inc3 array in very shallow water (<1.5m deep).
- Other activities/vessels would include two node deployment vessels and associated support craft, and crew transport and mitigation vessels.

The Proposed Action area is approximately 727 square miles (1882 (square kilometers (km^2)), consisting of state waters, Federal waters, and onshore lands. The Proposed Action area includes waters on the OCS under Federal jurisdiction and waters inside State of Alaska jurisdiction. SAE is proposing a multi-year project (2014-2015) which would be permitted for one calendar year at a time per regulations.

Marine seismic operations would be based on a "recording patch" or similar approach. Recording patches are groups of six receiver lines and 32 source lines (Figure 2). Receiver lines have submersible marine sensor nodes tethered along the length of the line at approximately 50m (165 ft) intervals. Each node contains three velocity sensors and a hydrophone. Each receiver line is approximately 8 km (5 miles) in length and spaced approximately 402 m (1,320ft) apart, and each receiver patch is 19.4 km^2 (7.5 m^2) in area. Receiver lines would run parallel to the shoreline.

Source lines are 12 km (7.5 miles) long and spaced 502 m (1,650 ft) apart. Source lines run perpendicular to receiver lines, extending approximately 5 km (3 miles) beyond the outside receiver lines, and approximately 4 km (2.5 miles) beyond each end of the receiver lines. Outside dimensions of the maximum shot area during this type of "patch" shoot would be 12 km X 16 km (7.5 miles by 10 miles) or 192 km^2 (75 mi^2). Shot intervals along each source line would be 50m (165 ft) and it is expected that shooting each patch would take 3-5 days encompassing an area of 48 km^2 (18.75 mi^2).

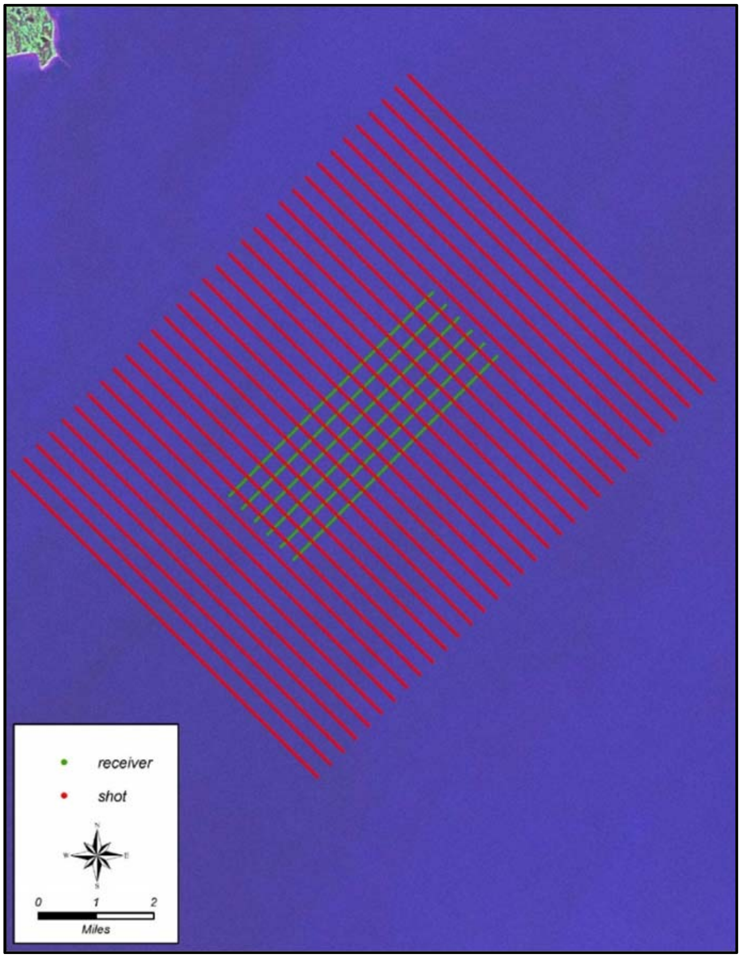

Figure 2. Typical Receiver/Shot Patch

The terrestrial component of this Proposed Action would have staging on privately owned property and existing private facilities in the Prudhoe Bay area. Land based activities, such as small vessel mobilization, vessel resupply, and demobilization are planned to occur at West Dock and Oliktok Point. Transportation to staging areas and docks would be conducted with light duty trucks and buses on existing roads. Helicopters are expected to be the primary transport for land crews and equipment when roads are not accessible and would be based at existing facilities located in Deadhorse, Kuparuk, or Alpine. Once on land, survey personnel would travel by foot, off the road system, crossing tidelands and small flowing drainages in the Colville River Delta. If it becomes necessary for survey personnel to cross major channels, helicopter or small watercraft support would be utilized.

The Proposed Action would include approximately 135 total personnel consisting of seismic crews, vessel management crews, marine mammal observers, support personnel, pilots, mechanics, and overall project management personnel. Marine based staff (100 personnel) would be housed on vessels with berths and food service. For protection from weather, vessels may anchor near barrier islands or other nearshore area locations. Personnel transfers may also occur at barrier islands or land locations during survey activities. Land based staff (35 personnel) would be housed in existing facilities at Deadhorse.

2.1.2.2. Seismic Survey and Support Vessels

Several offshore vessels would be required to support, seismic activities, recording data, and housing in the marine and near-shore environments. These vessels are listed and described below in Table 1.

Table 1. Summary of Number and Type of Vessels Involved.

Vessel	Operation	Size (feet)	Gross Tons	Berths	Main Activity/Frequency	Source Levels* (dB)
M/V *Peregrine Falcon* (or similar)	Source Vessel	120 x 25	100-250	10-20	Seismic data acquisition 24 hour operation/ 1200 hp	179.0
TBD	Source Vessel	80 x 25	100-250	10-20	Seismic data acquisition 24 hour operation	165.7
M/V *Miss Diane I* (or similar)	Node equipment deployment and retrieval	80 x 20	50	16	Deploying and retrieving nodes 24 hour operation/600 hp	165.3
M/V *Mark Stevens* (or similar)	Node equipment deployment and retrieval	80 x 20	50	16	Deploying and retrieving nodes 24 hour operation/750 hp	165.3
TBD	Mitigation / Housing Vessel	90 x 20	100	20-30	House crew 24 hour operation	200.1
TBD	Crew Transport Vessel	30 x 20	20-30	3	Transport crew intermittent 8 hours	191.8
Sleep Robber	Bow Picker	32 x 14	20-30	3	Deploying and retrieving nodes Intermittent operation/860 hp	171.8
Maxine	Bow Picker	30 x 20	20-30	3	Deploying and retrieving nodes Intermittent operation/900 hp	171.8

Note: *Sound source levels from Aerts et al. (2008) based on empirical measurements of vessels expected to be used during this survey.

Larger vessels (e.g., the first five vessels in Table 1) could arrive at the survey area after transiting from the west, as ice conditions allow. Smaller vessels (e.g., crew transport and bowpickers) would be transported overland to SAE operated staging areas in Prudhoe Bay and launched from West Dock, Prudhoe Bay or Oliktok Point when these areas are ice free.

Source Vessels - Source vessels would have the ability to deploy two arrays off the stern using large A-frames and winches and have a draft shallow enough to operate in ultra-shallow waters less than

1.5 m (5 ft) deep. On the source vessels, the airgun arrays should be on the stern without having to re-rig or move arrays. A large bow deck would allow sufficient space for source compressors and additional airgun equipment to be stored. The source vessels have sound source levels of 179.0 dB re 1 μPa and 165.7 dB re 1 μPa (Table 1).

Recording Deployment and Retrieval - Jet driven shallow draft vessels and bow pickers would be used for the deployment and retrieval of the offshore recording equipment. These vessels would be rigged with hydraulically driven deployment and retrieval squirters, allowing for automated deployment and retrieval from the bow or stern of the vessel. These vessels would also carry the recording equipment on the deck in fish totes. Recording and deployment vessels have a source level of approximately 165.3 dB re 1 μPa, while smaller bow pickers produce more cavitation, resulting in source levels of 171.8 dB re 1 μPa (Table 1).

Housing and Transfer Vessels – The housing vessel would be larger than the recording and deployment vessels with sufficient berthing to house marine crews and management. The housing vessel would have ample office and bridge space to facilitate the role as the “mother ship” and for central operations during the Proposed Action. The crew transfer vessel would be sufficiently large to safely transfer crew between vessels as needed. The crew transfer vessel also travels infrequently relative to other vessels and is usually operated at variable speeds. The housing vessel produces the loudest propeller noise of all vessels in the fleet (200.1 dB re 1 μPa), but this vessel is mostly anchored in place once it gets on the project site. The crew transfer vessel, during higher speed runs to shore, produces source noise levels of about 191.8 dB re 1 μPa, while during slower project site movements the source levels are only 166.4 dB re 1 μPa (Aerts et al., 2008).

Mitigation Vessel - To facilitate marine mammal monitoring of the Level B harassment zone, one dedicated vessel would be deployed to provide a survey platform for 2 or 3 Protected Species Observers (PSOs). These PSOs would work in concert with PSOs stationed aboard the source vessels, and would provide an early warning of the approach of any bowhead whale, beluga, or other marine mammal. It is assumed that the vessel would be of similar size and acoustical signature as a bowpicker.

Two source vessels would be used during the Proposed Action. The source vessels would travel along pre-determined lines at speeds of 1 to 5 knots depending on water depth. To limit the duration of the total survey, the source vessels would operate simultaneously alternating airgun shots (one vessel discharges airguns when the other vessel is recharging). Outside of the barrier islands, the two source vessels would be operating with expected shot intervals of eight to 10 seconds, resulting in a shot every four to five seconds due to the flip-flop mode of operation. Inside of the barrier islands, all three vessels, the two main source vessels and the shallow draft vessel (mitigation vessel), may be operating at the same time in this manner. Exact shot intervals would depend upon the compressor capacity, which determines the time needed for the airguns to be recharged. The mitigation vessel has a source level of 200.1 dB re 1 μPa (Aerts et al., 2008).

2.1.2.3. Schedule

The survey activities would occur over approximately 70 days between July 1 and October 31, 2014. Actual data acquisition is planned to occur between August 15 to October 15, 2014 with effective shooting of seismic anticipated to occur over approximately 70% of the 70 days (49 full days of shooting) unless delayed by weather/ice conditions or SAEs receipt of requisite permits and authorizations. Open water seismic operations can only begin when the Proposed Action area has a minimal sea ice coverage (<10% ice coverage), which could be mid-late July into August. SAE's survey activities begin prior to the fall bowhead whale migration and prior to most subsistence hunts which have, at times, started as early as August 25th . The majority of the Proposed Action is scheduled to occur during the fall whaling season, September and October, for the villages of Nuiqsut, Barrow and Kaktovik.

2.1.2.4. Sound Generation

The seismic sources to be used in the Proposed Action would include 880 and 1,760 cubic inch (in^3) sleeve airgun arrays for use in the deeper waters, and a 440 in^3 array in the very shallow (<1.5 m deep) water locations. Two airgun arrays would be in operation 24 hours/day for each of the working days. The first array is an 880 in^3 (14,420 cm^3) array that would utilize eight 2,000 pounds per square inch (psi) (13,789.5 kPa) sleeve. The array consists of four 70 in^3 airguns and four 150 in^3 airguns with a frequency of 0-150 Hz. The second array is a 1,760 in^3 (28,841 cm^3) array that utilizes sixteen 2,000 psi sleeve airguns. The array consists of eight 70 in^3 airguns and eight 150 in^3 airguns with a frequency of 0-150 Hz. The characteristics of each primary seismic source vessel airgun array are described below (Table 2). Each array would be towed at a distance of approximately 50 to 75 feet (15-22m) behind the source vessel stern at 9- 12 feet (3- 4 m) below the surface and towed along pre-determined source lines with a speed varying from approximately 1 to 5 knots, depending on water depth. In shallow waters the smaller arrays would be raised to depths up to 4.3 ft (1.3 m). To limit the duration of the total survey, the source vessels would be operating simultaneously, alternating airgun discharges; this means that one vessel would discharge airguns while the other vessel is recharging. The two main source vessels would be operating with expected discharge intervals of 8 to 10 seconds, resulting in an airgun discharge every 4 to 5 seconds.

The 440 in^3 array used in shallow water locations has a peak to peak estimated source level of 239.1 dB re 1 μPa @ 1 m (9.0 bar-m (Bar-meters: One bar is approximately equivalent to the pressure of one atmosphere. Unit is used throughout the survey industry), and root mean square (rms) at 221.1 dB re 1 μPa. The 880 in^3 array produces sound levels at source estimated at peak-peak 244.86 dB re 1 μPa @ 1 m (17.5 bar-m), and rms at 226.86 dB re 1 μPa. The 1,760 in^3 array has a peak-peak estimated sound source of 254.55 dB re 1 μPa @ 1 m (53.5 bar-m), with an rms sound source of 236.55 dB re 1 μPa. The 1,760 in^3 array has a sound source level approximately 10 dB higher than the 880 in^3 array.

Table 2. Airgun parameters.

Array Parameter	Vessel 1: 880 in^3 (14,420 cm^3) array	Vessel 2: 1760 in^3 (28,841 cm^3) array
Number of guns	Eight 2000 psi (13,789.5 kPa) sleeve airguns The array consists of four each 70 in^3 airguns and four each 150 in^3 airguns	Sixteen 2000 psi (13,789.5 kPa) sleeve airguns of 880 in^3 divided over 6 sub-arrays of 16 guns
Zero to peak Peak to peak	8.27 bar-m (238 dB//1uPa@1m) 17.5 bar-m (244 dB//1uPa@1m)	30.7 bar-m (250 dB//1uPa@1m) 53.4 bar-m (255 dB//1uPa @1m)
Frequency	0-150Hz	0-150Hz range
RMS	226 dB	237 dB
model	Tri-Cluster	Tri-Cluster
Manufacturer	SeaScan Inc.I/O sleeve guns	SeaScan Inc.

2.1.2.5. Monitoring and Mitigation

To ensure compliance with the Marine Mammal Protection Act (MMPA), SAE has applied to NMFS for an incidental harassment authorization (IHA) and to FWS for a letter of authorization (LOA). Mitigation and monitoring requirements in the IHA and LOA are intended to ensure that potential impacts to marine mammals would be negligible and that there would be no unmitigable impacts to the availability of subsistence resources. Therefore, BOEM will require that SAE receives the IHA and LOA before commencing BOEM-permitted seismic-survey activities. SAE has committed to a suite of typical monitoring and mitigation measures as part in their Plan of Operations, IHA application, and LOA application. These measures are described in the sections below, and are considered part of SAE's Proposed Action for the purpose of this environmental assessment.

Monitoring

Monitoring would include the following typically included measures:

Visual Vessel-Based Monitoring

The objectives of the vessel-based monitoring would be to:

- Ensure that disturbance to marine mammals is minimized and all permit stipulations are followed;
- Document the effects of the Proposed Action on marine mammals; and
- Collect data on the occurrence and distribution of marine mammals in the Proposed Action area.

Visual monitoring by Protected Species Observers (PSOs) during seismic survey operations, and periods when these surveys are not occurring, would provide information on the numbers of marine mammals potentially affected by Proposed Action activities and facilitate real-time mitigation to prevent impacts to marine mammals by industrial sounds or operations. Vessel-based PSOs onboard the survey vessels and mitigation vessel would record numbers and species of marine mammals observed in the area and any observable reaction of marine mammals to survey activities in the U.S. Beaufort Sea. The visual-based marine mammal monitoring would be implemented by a team of experienced PSOs, including both experienced field biologists and Inupiat personnel. PSOs would be stationed aboard the survey vessels and mitigation vessel through the duration of the project. Vessel-based monitoring for marine mammals would be done by trained PSOs throughout the period of survey activities. PSOs would monitor the occurrence of marine mammals near the survey vessel during all daylight periods while operations are occurring and during most daylight periods when operations are not occurring. PSO duties would include watching for and identifying marine mammals; recording their numbers, distances, and reactions to the survey operations; and documenting “take by harassment.”

The PSOs would watch for marine mammals from the best available vantage point on the survey vessels, typically the bridge. PSOs would scan the area around the vessel systematically with reticle binoculars (e.g., 7 × 50 and 16-40 × 80) and with the naked eye. Laser range finders would be available to assist with distance estimation. Night-vision equipment (Generation 3 binocular image intensifiers or equivalent units) would be available for use if and when needed. PSOs aboard the survey and mitigation vessels would give particular attention to the areas within the marine mammal exclusion zones around the source vessels. These zones are the maximum distances within which received levels may exceed 180 dB (rms) re 1 μPa (rms) for cetaceans, or 190 dB (rms) re 1 μPa for pinnipeds.

When a marine mammal is seen approaching or within the exclusion zone applicable to that species, PSOs would notify the seismic survey crew immediately so that mitigation measures called for in the applicable authorization(s) can be implemented.

Aerial Monitoring

Aerial monitoring is not part of this Proposed Action.

Monitoring zones

SAE predicted the acoustic propagation of the proposed 440-in^3, 880-in^3, and 1,760-in^3 airgun arrays using JASCO’s model provided in Aerts et al. (2008), corrected with the measured or manufacturer’s source levels. The results for the 190, 180, and 160 dB (rms) exclusion zones and zones of influence, in meters, are listed in Table 3. SAE would implement safety distances at the commencement of 2014 airgun operations to establish marine mammal exclusion zones used for mitigation. SAE would conduct sound source measurements of the airgun array at the beginning of survey operations in 2014 to verify the size of the various marine mammal exclusion zones. The acoustic data would be analyzed in the field as quickly as reasonably practicable and used to verify and adjust, as necessary, the marine mammal exclusion zone distances. The mitigation measures to be implemented at the 190 and 180 dB (rms) sound levels would include power downs and shut downs as described below.

Table 3. Safety zone radii for each airgun array.

Array (in^3)	Source level (dB)	190 dB radius (m)	180 dB radius (m)	160 dB radius (km)
440	221.10	126	325	1.33 km
880	226.86	167	494	1.5 km
1760	236.55	321	842	2.99 km

Pingers deployed from the node vessels would be used for positioning of nodes and a vessel-mounted transceiver calculates the position of the nodes by measuring the range and bearing from the transceiver to a small acoustic transponder fitted to every third node. The transceiver uses sonar to interrogate the transponders, which respond with short pulses that are used in measuring range and bearing. Because the transceiver and transponder communicate via sonar, they produce underwater sound levels. The commercial transceiver SAE intends to use has a transmission source level of 197 dB re 1 μPa @ 1 m and operates at frequencies between 35 and 55 kilohertz (kHz). SAE’s intended transponder produces short pulses of 184 to 187 dB re 1 μPa @ 1 m at frequencies also between 35 and 55 kHz. These sound levels (184 to 197 dB) exceed Level A criteria. Level A takes are not authorized by IHAs, and measures must be taken to avoid them. The NMFS criteria for Level A take are 180 dB for whales and 190 dB for seals. Operators would ensure that no marine mammals are in the safety zone or immediate vicinity prior to deployment of pingers and transponders.

PSOs would monitor the pre-established exclusion zones for the presence of marine mammals. When marine mammals are observed within, or about to enter, designated safety zones, PSOs have the authority to call for immediate power down (or shutdown) of airgun operations, as required by the situation.

Protected Species Observers

Vessel-based monitoring, as described above, would be done by trained PSOs throughout the period of seismic operations. PSOs would monitor the pre-established exclusion zones for the presence of marine mammals. When marine mammals are observed within, or about to enter, designated safety zones, PSOs have the authority to call for immediate power down (or shutdown) of airgun operations, as required by the situation.

A sufficient number of PSOs would be required onboard each survey vessel to meet the following criteria:

- 100% monitoring coverage during all periods of survey operations in daylight.
- Maximum of 4 consecutive hours on watch per pso.
- Maximum of 12 hours of watch time per day per pso.

The total number of PSOs may decrease later in the season as the duration of daylight decreases. Each vessel would have an experienced field crew leader to supervise the PSO team. Crew leaders and most PSOs would be individuals with experience as observers during recent seismic, site clearance, shallow hazards, and other monitoring projects in Alaska or other offshore areas in recent years. New or inexperienced PSOs would be paired with an experienced PSO or experienced field biologist so that the quality of marine mammal observations and data recording is kept consistent.

Two protected species observers (PSOs) would be stationed on each source vessel. An additional 2 or 3 PSOs would be stationed on the mitigation vessel, and would work in concert with PSOs stationed aboard the source vessels, to provide an early warning of the approach of any bowhead whale, beluga, or other marine mammal. The mitigation vessel plans to conduct zig-zag transects from 2 to 6 km (1-4 mi) ahead of the source vessel (based on water depth and weather conditions) to allow PSOs to effectively monitor the 160 dB zone of influence and to also monitor the edge of the 180 dB isopleth.

PSOs would watch for marine mammals at the seismic operation during all periods of source operations and for a minimum of 30 minutes prior to the planned start of airgun or pinger operations after an extended shut down. SAE vessel crews and operations personnel would also watch for marine mammals (insofar as practical) to assist and alert the PSOs for the airgun(s) to be shut down if marine mammals are observed in or about to enter the exclusion zone.

PSO Role and Responsibilities

When onboard the seismic or support vessels, PSOs have three general responsibilities:

- Observe and record sensitive wildlife species.
- Ensure mitigation procedures are followed accordingly.
- Follow monitoring and data collection procedures.

The main role of the PSOs in the monitoring program is to ensure compliance with requirements set in place by NMFS and USFWS to ensure that disturbance of marine mammals is minimized, potential effects on marine mammals are documented, and to implement the monitoring and mitigation measures specified in the NMFS IHA, USFWS LOA, and the Marine Mammal Monitoring and Mitigation Plan (4MP).

Duties of the PSOs on board the vessels are:

- Monitoring: Observe marine mammals and determine numbers of marine mammals exposed to sound pulses and their reactions (where applicable) and document those as required
- Mitigation: Implement mitigation clearing and ramp-up measures, observe and detect marine mammals within, or about to enter the applicable safety radii, implement necessary shut-down, power-down and speed/course alteration mitigation procedures when applicable, and advise marine crews of mitigation procedures.

The PSOs are stationed at the best available vantage point on the source and mitigation vessels from an elevated stable platform such as the bridge or flying bridge, with an unobstructed 360 degree view of the water. They scan systematically with the unaided eye and/or reticle binoculars, long-range binoculars, and night-vision equipment when needed. PSOs would record field observation data and information about marine mammal sightings that include:

- Species, group size, age/size/sex categories (if determinable).
- Physical description of features that were observed or determined not to be present in the case of unknown or unidentified animals.
- Behavior when first sighted and after initial sighting, heading (if consistent).
- Bearing and distance from observer, apparent reaction to activities (e.g., none, avoidance, approach, paralleling, etc.), closest point of approach, and behavioral pace.
- Time, location, speed, and activity of the source and mitigation vessels, sea state, ice cover, visibility, and sun glare.
- Positions of other vessel(s) in the vicinity.

When marine mammals are observed within, or about to enter, designated safety zones, PSOs have the authority to call for immediate power down (or shutdown) of airgun operations, as required by the situation.

Mitigation

Sound Source Verification

Prior to or at the beginning of the seismic survey, SAE would measure sound levels as a function of distance and direction from the proposed seismic source array (full array and reduced to a single mitigation airgun). Results of this acoustic characterization and SSV would be used to empirically refine the modeled distance estimates of the pre-season 190 dB, 180 dB, 170 dB, and 160 dB isopleths. Refined SSV exclusion zones would be used for the remainder of the seismic survey. Distance estimates for the 120 dB isopleth would also be modeled. The results of the SSV would be submitted to NMFS within five days after completing the measurements, followed by a report to be submitted within 14 days after completion of the measurements. A more detailed report would be provided to NMFS as part of the required 90-day report following completion of the acoustic program.

Shut-Down Procedure

A shut down is the immediate cessation of firing of all energy sources. If a marine mammal is sighted within or about to enter the applicable exclusion zone of the single mitigation airgun, the entire array would be shut down (i.e., no sources firing). Shut-downs can occur when a power-down would not avoid exposing a marine mammal to sound levels above those established for the subject mammal’s exclusion zone. PSOs have the authority to call for immediate power down (or shutdown) of airgun operations, as required by the situation and a shutdown procedure would be accomplished within several seconds (of a "one shot" period) of the determination that a marine mammal is either in or about to enter the applicable exclusion zone.

PSOs would watch for marine mammals for a minimum of 30 minutes prior to the planned start of airgun or pinger operations after an extended shut down. Operations would not proceed with air gun activity until the marine mammal has cleared the zone and the trained PSOs on duty are confident that no marine mammals remain within the appropriate exclusion zone. The animal would be considered to have cleared the exclusion zone if it:

- Is visually observed to have left the applicable exclusion zone.
- Has not been seen within the zone for 15 min in the case of small odontocetes and pinnipeds.
- Has not been seen within the zone for 30 min in the case of cetaceans.

Power-down Procedure

A power down is the immediate reduction in the number of operating energy sources from all airguns firing to some smaller number (e.g., a single mitigation airgun). The array would be immediately powered down whenever a marine mammal is sighted approaching close to or within the applicable exclusion zone of the full array, but is outside the applicable exclusion zone of the single mitigation airgun. Whenever marine mammals are observed within or about to enter the exclusion zone, PSOs have the authority to call for an immediate power-down of airgun operations. A power-down procedure involves reducing the number of air guns in use such that the radius of the 180 dB or190 dB zone is decreased to the extent that marine mammals are not in the exclusion zone. During a power down, a minimum of one mitigation air gun may be operated. If a marine mammal is detected outside the safety radius but is likely to enter that zone, air guns may be powered down before the animal is within the safety radius, as an alternative to a complete shutdown.

Similar to a shutdown, after a power-down procedure, air gun activity would not resume until the marine mammal has cleared the applicable exclusion zone. The animal would be considered to have cleared the applicable exclusion zone if it:

- Is visually observed to have left the applicable exclusion zone.
- Has not been seen within the zone for 15 min in the case of small odontocetes and pinnipeds.
- Has not been seen within the zone for 30 min in the case of cetaceans.

Ramp-up Procedure

A "ramp-up" procedure gradually increases air gun volume at a specified rate and involves a step increase in the number and total volume of airguns until the full volume is achieved. The purpose of the ramp-up or "soft start" is to warn marine mammals in the vicinity of airguns and provide sufficient time for them to leave the area avoiding potential injury. SAE proposes to ramp up the airgun arrays slowly. Full ramp ups (i.e., from a cold start after a shutdown, when no airguns have been firing) would begin by firing a single airgun in the array (i.e., the mitigation airgun). Full ramp up, after a shutdown, would occur after a minimum 30 minute observation of the safety zone by PSOs to assure that no marine mammals are present. The entire exclusion zone must be visible during the 30-minute lead-in to a full ramp up. If the entire exclusion zone is not visible, then ramp up from a cold start cannot begin. If a marine mammal is sighted within the safety zone during the 30-minute observation prior to ramp up, ramp up would be delayed until the marine mammal is sighted outside of the exclusion zone or the animal is not sighted for at least 15 minutes (15 minutes for pinnipeds, or 30 minutes for cetaceans).

SAE plans to conduct 24-hour operations. PSOs would not be on duty during ongoing seismic operations during darkness, given the very limited effectiveness of visual observation at night (there would be no periods of darkness in the survey area until mid-August). Night-vision equipment would be available for use if and when needed. SAE would use best available technology to improve detection capability during periods of fog and other types of inclement weather. Such technology might include night-vision goggles or binoculars as well as other instruments that incorporate infrared technology. The provisions associated with operations at night or in periods of poor visibility include the following:

- If during foggy conditions, heavy snow or rain, or darkness (which may be encountered starting in late August), the full 180 dB exclusion zone is not visible, the airguns cannot commence a ramp-up procedure from a full shut-down.
- If one or more airguns have been operational before nightfall or before the onset of poor visibility conditions, they can remain operational throughout the night or poor visibility conditions. In this case ramp-up procedures can be initiated, even though the exclusion zone may not be visible, on the assumption that marine mammals would be alerted by the sounds from the single airgun and have moved away.

Use of a Small-Volume Airgun during Turns and Transits

During the Proposed Action, SAE would employ the use of the smallest-volume airgun (i.e., “mitigation airgun”) to deter marine mammals from being within the immediate area of the seismic operations. The mitigation airgun would be operated at approximately one shot per minute and would not be operated for longer than three hours in duration (turns may last two to three hours for the Proposed Action).

During turns or brief transits (i.e., less than three hours) between seismic tracklines, one mitigation airgun would continue operating. The ramp up procedures described above would be followed when increasing the source levels from the one mitigation airgun to the full airgun array. However, keeping one airgun firing during turns and brief transits would allow SAE to resume seismic surveys using the full array without having to ramp up from a “cold start,” which requires a 30-minute observation period of the full exclusion zone and is prohibited during darkness or other periods of poor visibility. PSOs would be on duty whenever the airguns are firing during daylight and during the 30-minute periods prior to ramp-ups from a “cold start.”

Speed or Course Alteration

SAE can alter speed if a marine mammal gets too close to a vessel. PSOs would alert vessel captains as animals are detected to avoid coming into direct contact with marine mammals Whenever a marine mammal is detected outside the exclusion zone radius but is likely to enter the exclusion zone, PSOs have the authority to request an alternative ship track or alteration to the vessel's speed and course when practical and safe. This change in ship track or speed minimizes the effect of the seismic operations on marine mammals in the exclusion zone radius and can be used in coordination with a power-down procedure. Vessel speeds shall be less than 10 knots in the proximity of feeding whales or whale aggregations. and if any vessel approaches within 1.6 km (1 mi) of observed bowhead whales, except when providing emergency assistance to whalers or in other emergency situations, the vessel operator would take reasonable precautions to avoid potential interaction with the bowhead whales by taking one or more of the following actions, as appropriate:

- Reducing vessel speed to less than 5 knots within 300 yards (900 feet or 274 m) of the whale(s);
- Steering around the whale(s) if possible;

- Operating the vessel(s) in such a way as to avoid separating members of a group of whales from other members of the group;
- Operating the vessel(s) to avoid causing a whale to make multiple changes in direction; and
- Checking the waters immediately adjacent to the vessel(s) to ensure that no whales would be injured when the propellers are engaged.

Measures to Reduce Impacts to Subsistence Users

If the NMFS IHA is issued, the following mitigation measures are expected to be implemented by SAE to comply with the IHA. These mitigation measures are intended to effect the least practicable adverse impact on the availability of marine mammal species for subsistence uses, as follows:

- Establishment and operation of Communication and Call Centers (Com-Center) Program
  - For the purposes of reducing or eliminating conflicts between subsistence whaling activities and the Proposed Action, SAE would participate with other operators in the Com-Center Program. Com-Centers would be operated to facilitate communication of information between SAE and subsistence whalers. The Com-Centers would be operated 24 hours/day during the 2014 fall subsistence bowhead whale hunt.
  - All vessels would report to the appropriate Com-Center at least once every six hours, commencing each day with a call at approximately 06:00 hours.
  - The appropriate Com-Center would be notified if there is any noteworthy change in plans, such as an unannounced start-up of operations or substantial deviations from announced course, and that Com-Center would notify all whalers of such changes. The appropriate Com-Center also would be called regarding any unsafe or unanticipated ice conditions.
- SAE would monitor the positions of all of its vessels and exercise due care in avoiding any areas where subsistence activity is active.
- Vessels transiting in the Beaufort Sea east of Bullen Point to the Canadian border would remain at least 5 miles offshore during transit along the coast, provided ice and sea conditions allow. During transit in the Chukchi Sea, vessels would remain as far offshore as weather and ice conditions allow, and at all times at least 5 miles offshore.
- From August 31 to October 31, vessels in the Chukchi Sea or Beaufort Sea would remain at least 20 miles offshore of the coast of Alaska from Icy Cape in the Chukchi Sea to Pitt Point on the east side of Smith Bay in the Beaufort Sea, unless ice conditions or an emergency that threatens the safety of the vessel or crew prevents compliance with this requirement. This condition would not apply to vessels actively engaged in transit to or from a coastal community to conduct crew changes or logistical support operations.
- Vessels would be operated at speeds as necessary to ensure no physical contact with whales occurs, and to make any other potential conflicts with bowheads or whalers unlikely. Vessel speeds would be less than 10 knots in the proximity of feeding whales or whale aggregations.
- If any vessel inadvertently approaches within 1.6 kilometers (1 mile) of observed bowhead whales, except when providing emergency assistance to whalers or in other emergency situations, the vessel operator would take reasonable precautions to avoid potential interaction with the bowhead whales by taking one or more of the following actions, as appropriate:
  - reducing vessel speed to less than 5 knots within 900 feet of the whale(s) and steering around the whale(s) if possible;
  - steering around the whale(s) if possible;

  - operating the vessel(s) in such a way as to avoid separating members of a group of whales from other members of the group;
  - operating the vessel(s) to avoid causing a whale to make multiple changes in direction; and
  - checking the waters immediately adjacent to the vessel(s) to ensure that no whales would be injured when the propellers are engaged.
- Limitations on seismic surveys in the Beaufort Sea
  - Kaktovik: No seismic survey from the Canadian Border to the Canning River from August 25 to close of the fall bowhead whale hunt in Kaktovik and Nuiqsut. From August 10 to August 25, SAE would communicate and collaborate with the Alaska Eskimo Whaling Commission (AEWC) on any planned vessel movement in and around Kaktovik and Cross Island to avoid impacts to whale hunting.

    Nuiqsut: Pt. Storkerson to Thetis Island - No seismic survey prior to July 25 inside the Barrier Islands. No seismic survey from August 25 to close of fall bowhead whale hunting outside the Barrier Island in Nuiqsut. Canning River to Pt. Storkerson - No seismic survey from August 25 to the close of bowhead whale subsistence hunting in Nuiqsut.
  - Barrow: No seismic survey from Pitt Point on the east side of Smith Bay to a location about half way between Barrow and Peard Bay from September 15 to the close of the fall bowhead whale hunt in Barrow.
- SAE plans to conduct the Proposed Action in a joint partnership agreement with the Kuukpik Corporation. SAE states that it would be working closely with the communities on the North Slope to plan operations that would include measures that are environmentally suitable, do not impact local subsistence use, and would include measures to ensure its seismic activities do not adversely affect subsistence whaling. SAE would schedule and attend meetings in the villages of Nuiqsut, Barrow, Kaktovik, and any other affected communities.

2.1.3. Mitigation and Monitoring of Marine and Coastal Birds

SAE is required to implement the following special conditions related to the USFWS 2012 Biological Opinion (BO to avoid or minimize adverse effects to Endangered Species Act (ESA)-listed birds (spectacled eiders, Steller’s eiders, and yellow-billed loons):

1. SAE would minimize the use of high-intensity work lights on their vessels, especially within the 20-m bathymetric contour. Exterior lights would only be used as necessary to illuminate active, on-deck work areas during periods of darkness or inclement weather; otherwise they would be turned off. Interior and navigation lights should remain on as needed for safety.
2. All bird encounters on SAE vessels must be reported within 3 days to Bureau of Safety and Environmental Enforcement-Environmental Enforcement Division (BSEE-EED) and BOEM-Resource Evaluation (BOEM-RE). Each report shall include the following items to be considered complete:
   - Date and Time the bird was first observed.
   - Location of vessel in decimal degrees (format: latitude XX.XXXX longitude –XXX.XXXX).
   - Species, identified to lowest possible taxonomic level using standardized American Ornithologist Union (AOU) codes.
   - Weather (at time bird first observed): wind speed, fog, rain or snow.
   - General weather 24 hours prior to bird observation.

- Photographs of each bird (if practicable). For dead birds clear images of wing spread, top and bottom, and head views should be provided.
- Vessel operational status: at anchor/adrift or underway/in transit.
- Any indications that lighting may have factored into attracting birds to the vessel (e.g., was extra lighting on because it was dark or a specific activity was ongoing?).
- Any additional comments on bird behavior, physical description, injury or fate.

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3.0 AFFECTED ENVIRONMENT

3.1. Expected Operating Conditions

The CEQ, which oversees the implementation of the National Environmental Policy Act (NEPA), understands that the phenomenon of climate change may be relevant to proposed Federal actions. The Environmental Protection Agency (EPA) has determined that greenhouse gas (GHG) emissions influence climate change; there may be potential for health and environmental effects associated with GHGs. Therefore, the CEQ issued draft guidance in 2010 to advise Federal agencies to consider opportunities to reduce GHG caused by proposed Federal actions, and evaluate actions with respect to the effects of climate change (CEQ, 2010). In the guidance, Federal agencies are asked to consider, in the context of the NEPA process, how Federal actions could contribute to the emissions of GHG and how climate change could potentially influence the natural resources affected by Federal actions. The Proposed Action is located in the U.S. Beaufort Sea OCS Planning Area of the Arctic region, which is of particular importance to global climate and especially sensitive to climate change. The potential effects of climate change are discussed within the various natural resources sections, where climate change is considered relevant.

3.1.1. Meteorology

The Proposed Action would occur from early to mid-July through October 31, 2014 in the Colville River Delta area of the U.S. Beaufort Sea OCS. Assuming meteorological conditions observed in Nuiqsut and Deadhorse are reflective of weather in the Colville River Delta, temperatures will be cold in July and August and frigid by October. The average temperature in July will range from 40 degrees Fahrenheit (ºF) (4.5ºC) to 56ºF (13.4ºC). By October, rapidly falling temperatures will occur and average daily high temperatures are as low as 11ºF (-11.7ºC). Temperatures will average as low as 2ºF (-16.7ºC) and could fall as low as minus 15ºF (-26.1ºC) by the end of October. The U.S. Beaufort Sea is usually ice-free from early August through the middle of October.

When considering the average wind speeds and temperatures common to the North Slope, average daily wind chills will likely be 34ºF (1.1ºC) in the months of July and August decreasing to -4ºF (-20ºC) by late October. Occasional sudden storms can occur and the lack of natural wind barriers results in unrestricted wind flow over the North Slope. These storms bring cold temperatures and occur most frequently between September and November. The combined effect of cold temperatures and strong winds during storms makes the North Slope a wind-chill risk to persons exposed to outside conditions for even brief periods of time. In extreme cases the wind chill could drop as low as -53°F (-47.2ºC) in October.

A unique characteristic of the Alaska North Slope is the seasonal variation in sunlight, as the seismic survey will begin during a time of 24-hour sunlight during most of July. By the middle of August in Deadhorse there will be almost 19 hours of sunlight each day, with the Sun rising at 3:49 a.m. and setting at 10:03p.m. (all sunrise and sunset times are Alaska Standard Time). The Sun will rise at 7:07 a.m. by the end of September, and set at 6:19 p.m. By the end of October there will be only 6-7 hours of daylight, with the Sun rising at 9:23 a.m. and setting at 3:51 p.m. (USNO, 2014).

Cloudiness on the Coleville River Delta increases sharply from the middle of July through the middle of August. By the beginning of September, skies will likely be overcast the entire day. Most of the annual precipitation falls in the summer with an average of 0.91 inch (2.3 cm) falling in each month of July and August as light rain and 0.50 inch (1.27 cm) in each month of September and October, likely turning to light snow by the end of October (WRCC, 2012). The changing relative humidity fluctuates sharply in July and August, ranging from 60-70 percent to a high of 97 percent. Less moderate changes occur in September and October, ranging from 70-80 percent to 90-95 percent. Visibility is generally greater than 6 statute miles (9.7 km) during July and through October.

3.1.2. Ice Conditions

This sea-ice description builds upon discussion in sections III.A.4 of the Beaufort Sea Multiple-Sale EIS. Salient points from this document are summarized as follows. There are three general forms of sea ice in the Proposed Action area:

- Landfast ice, which is attached to the shore, is relatively immobile, and extends to variable distances offshore.
- Stamukhi ice, which is grounded and ridged ice.
- Pack ice, which includes first-year and multiyear ice and moves under the influence of winds and currents.

SAE's Proposed Action is planned for the Arctic summer "open-water" season from mid-July to late October 2014. The Proposed Action covers portions of the landfast ice zone which generally becomes ice free between around June 22 to July 12 (Mahoney et al., 2012). Stamukhi ice is not anticipated in the Proposed Action area during the Proposed Action. Pack ice could move into the Proposed Action area during the time of operations due to wind or currents.

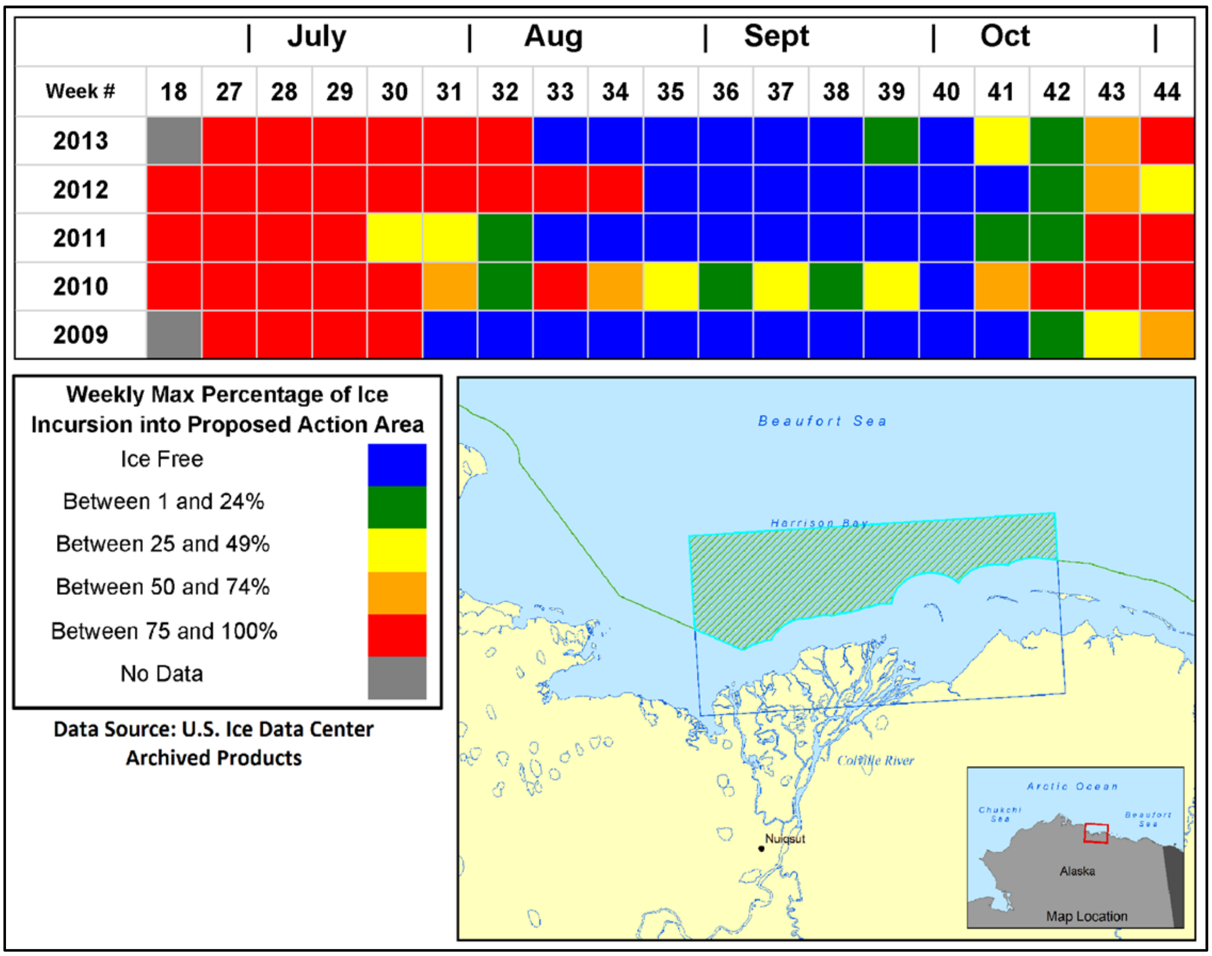

Figure 3. Weekly Maximum Percentage of Ice Incursion into the Federal portion of the Proposed Action area. *Based on archived National Ice Center Weekly Data.*

The concentration of Arctic sea ice reaches its northern minimum in mid- to late-September. The Arctic sea ice begins growing southward again with the onset of freezing temperatures. In the Beaufort Sea, the landfast ice begins forming in the third week of October in the lagoons and late

October to early November in the nearshore region (Mahoney et al., 2012, Leidersdof, Scott, and Vaudrey, 2012.). A weekly analysis of the National Ice Center sea ice data, from 2005 through 2012, shows great variability year to year in sea ice coverage from July to October (Figure 3). Sea ice coverage in the survey area generally increases from south to north.

The predominant ice stages within the survey area in October are thin first-year ice (30-70 cm (11.8-27.6 in)), young ice (10-30 cm (3.9-11.8 in)), new ice (<10cm (3.9 in)) in patches and small floes; however, multiyear ice floes can be blown by wind into the survey area at any time.

3.1.3. Sea State

The open water season in the shallow Beaufort Sea near the Colville River Delta is brief. During the open-water season, wave heights are limited by the shallow waters adjacent to the coast and the shelter provided by the barrier islands to the east. Westerly storms produce elevated water levels and easterly storms produce lower than normal water levels. Wave heights are generally 1 m (3.2 ft) or less and are up to approximately 3 m (9.8 ft) maximum (Weinzapfel et al., 2011).

3.2. Resources

3.2.1. Air Quality

Onshore air quality on the Alaska North Slope is considered a clean resource (40 CFR Part 81), and monitored data does not indicate a violation of any health-based National Ambient Air Quality Standard (NAAQS) (ADEC, 2011). Even with the increase in Arctic marine traffic (such as cargo barges, cruise ships, operation of research vessels), and the permanent emission sources at Kuparuk and Prudhoe Bay, the 2003 National Research Council (NRC) claims that air quality on the North Slope does not exceed either the Alaska Ambient Air Quality Standards (AAAQS) or the NAAQS. This is likely because the onshore area of the Alaska North Slope adjacent to the Beaufort Sea typically experiences steady winds averaging 12 miles per hour (mph) (5.36 meters per second (m/s)) during the period from July through October (see Appendix C, Figure C-3). This wind speed, combined with an east-northeast prevailing wind direction, is sufficient to mix, disperse, and transport air pollutants to vast open areas along the Brooks Range. By the time emissions are transported as far west as the National Petroleum Reserve – Alaska (NPR-A), the pollutants are well mixed and unable to cause a measurable air quality effect.

Thus, the wind conditions over the Proposed Action area, together with the pollutant sources both onshore or offshore, cause the quality of the air over the affected area to be consistently better than required by Federal standards (ADEC, 2011).

3.2.2. Water Quality

Water quality is a term used here to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose such as protection of fish, shellfish, and wildlife. Because the water column interacts continuously with seafloor surface sediments (e.g., deposition and suspension of particulate matter), these two aspects of overall water quality are tightly linked.

Water quality in the Beaufort Sea varies naturally throughout the year related to seasonal biological activity and naturally occurring processes, such as seasonal plankton blooms, hydrocarbon seeps, seasonal changes in turbidity due to terrestrial runoff, localized upwelling of cold water and formation of surface ice. Rivers and streams that flow into the Beaufort Sea contribute substantial freshwater to the marine system which affects salinity, temperature and other aspects of water quality, particularly within a band of water that runs along the seacoast.

The Colville River flows from the Brooks Range north and east into Harrison Bay. It is the largest river in the U.S. Arctic (north of the Brooks Range), in terms of average annual discharge. The river transports terrestrial organic matter (commonly measured as particulate and dissolved carbon and nitrogen) into the coastal waters. The flow and the concentration of constituents carried by the river vary seasonally, and are generally higher in the spring at the time of the initial melt (Townsend-Small et al., 2006).

Several scientific studies have contributed to the knowledge of water quality and seafloor surface sediment characteristics in the nearshore Beaufort Sea. Trefry and Trocine (2009) conducted vertical water column profiles at 8 stations in the Western Beaufort Sea at Camden Bay (approximately 80 miles (129 km)) east of the Proposed Action area) at depths from 22 m to 38 m (72 to 125 ft). Strong temperature stratification was observed at the four deeper sites. At the four shallower stations, stratification was less strong, particularly for salinity. Concentrations of dissolved oxygen were at 89% to 104% saturation, pH ranged from 7.8 to 8.4, and turbidity was low and relatively similar across all samplings. Total suspended solids (TSS) were less than 1 mg/L at all sites and depths. Surface waters contained a relatively higher concentration of particulate organic carbon than deeper waters

Anthropogenic (human-generated) pollution in the Beaufort Sea is primarily related to:

- Aerosol transport and deposition of pollutants (AMAP, 1997, 2004, 2011).
- Pollutant transport into the region by sea ice, biota, and currents (Chernyak et al.,1996).
- Discharges from international ship traffic.
- And effects from increasing carbon dioxide in the atmosphere (AMAP, 2013).

Wind, currents and drifting sea ice play an important role in the long-range transport and redistribution of constituents and contaminants in the Beaufort Sea. Pollutants such as polycyclic aromatic hydrocarbons are introduced by human activities around the globe and ultimately affect the Arctic (AMAP, 1997). Predictions indicate that the Arctic Ocean will continue to be affected by increasing carbon dioxide uptake by seawater which in turn, causes increased acidity (Steinacher et al., 2009).

The primary regulation for controlling pollutant discharges into waters of the U.S. is the Clean Water Act (CWA) of 1972, as amended. Section 402 of the CWA established the National Pollutant Discharge Elimination System (NPDES) permit program. Accordingly, EPA regulates discharges incidental to the normal operation of commercial vessels (greater than 79 feet in length) through the NPDES Vessel General Permit (VGP). The current VGP was issued by EPA in March 2013.

3.2.3. Lower Trophic Levels

The lower trophic organisms living within the Harrison Bay area and within the U.S. Beaufort Sea OCS consist of three diverse and abundant groups (Hopcroft et al., 2008). These are the pelagic, the epontic, and the benthic organisms.

The components of the pelagic communities are made primarily of two groups living at the surface and near-surface levels, the phytoplankton and zooplankton. Phytoplankton are the one-celled algae adapted to living in the photic zone (the upper areas where light adequate for phytoplankton penetrates the water) in the upper layers of the ocean surface (Steidinger and Garcces, 2006). Within Arctic waters, the combination of cold temperature, sea ice, and seasonal fluctuations in light regimes creates variation in the timing and extent of seasonal blooms. Phytoplankton blooms (including concurrent zooplankton organisms) tend to occur in two separate events of early and late summer, generally from July to August, with density and duration dependent upon weather conditions and nutrient fluxes (Kirchman et al., 2009). Zooplankton consist of permanent residents of the planktonic mass such as copepods, and animals exhibiting complex life cycles that include a developmental stage within the plankton blooms such as the larvae of fish, crustaceans, barnacles, polychaetes, and mollusks (Brusca and Brusca, 2002). The pelagic expanses between the surface and the benthic realms support diverse and abundant populations, including the larvaceans, pteropods, ctenophores, jellyfish, salps, squid, and other invertebrate organisms that contribute to the productivity of the region (Hopcroft et al., 2008).

The epontic organisms are ice-dwellers, organisms that live on or in the matrix of the ice (Gradinger, Bluhm, and Iken, 2010), and include the ice algae, amphipods, nematodes, polychaetes, and euphausiids (Hopcroft et al., 2008). Although essential to the primary productivity of the region (Lee, Whitledge, and Kang, 2008), these organisms are not present in abundance during the July through October activities of the Proposed Action.

The final group are the benthic organisms, consisting of both those groups living within the upper sedimentary matrix (infaunal organisms) and those living on or just above the benthic surface, or strongly associated with the benthic surface (epifaunal organisms). Offshore benthic communities can be quite diverse, but organisms commonly found in surveys include echinoderms, sipunculids, mollusks, polychaetes, copepods, and amphipods (Norcross, 2013; Dunton, Schonberg, and McTigue, 2009; Rand and Logerwell, 2011).

Most seafloor substrates on the U.S. Beaufort Sea OCS consist of aggregations of fine sands, muds, and silts, with percentages of substrate consisting of mud ranging from 17% to 84% (cANIMIDA, 2010; Trefry and Trocine, 2009). Limited extents of scattered cobblestone or pebbles may be found at shallower depths (Dunton, Schonberg, and McTigue, 2009). A focus on differences in communities based on physical factors is addressed in the BOEM-sponsored cANIMIDA studies on hydrocarbon chemistry and substrate composition (cANIMIDA, 2010), and the 2006 Seismic PEA. No known unique geological surface features, key reproductive sites, or unique biological communities exist in the area of the Proposed Action.

3.2.4. Fish

There are 36 known species of fish that occur in the Beaufort Sea. Fish species that are widespread in the Beaufort Sea include Arctic cod, saffron cod, sculpins, sand lance, capelin, flounders, poachers, eelpouts, snailfishes, pink salmon, chum salmon and herring. Small demersal fish are abundant in the Beaufort Sea and their distribution is characterized by sediment type, bottom salinity and bottom temperature. (Mecklenburg, Mecklenburg and Thorsteinsen, 2002, 2011; Logerwell et al., 2010).

In the summer of 2008, a field survey of fish and benthic invertebrates of the western Beaufort Sea was conducted by the National Oceanic and Atmospheric Administration (NOAA), the University of Washington and the University of Alaska (Logerwell et al., 2010; Rand and Logerwell, 2011). Following is a summary of results from these studies:

- Across all bottom trawls, 6% of all weight was comprised of vertebrate fish species and 94% by weight were invertebrate species.
- Thirty-six fish species were caught and identified.
- Arctic cod (*Boreogadus saida*) was the most abundant fish species caught during the summer 2008 survey, both by weight and numbers. Walleye pollock (*Theragra chalcogramma*) were present in small numbers and primarily as subadults.
- Fifteen species of smaller fish (eelpouts and sculpins) contributed a great number of fish to the total catch of the 2008 survey; however, they did not contribute much in terms of total weight.
- No specimens of adult or juvenile Pacific salmon species (*Oncorhynchus* sp.) were captured during sampling in the 2008 survey.
- Comparing the results of the NOAA survey data to opportunistic offshore bottom-trawl surveys conducted by Frost and Lowry (1983) in 1976 and 1977, the NOAA authors

indicate that there has been a shift in fish species composition and community structure in the western and central Beaufort Sea over the past three decades.

During summer months, some marine species (or age groups of a species) move shoreward and feed nearshore on the abundant epibenthic fauna (Craig, 1984). Nearshore fish known to commonly occur in Harrison Bay in the Proposed Action area and nearby bays include: capelin, fourhorn sculpin, saffron cod, Arctic flounder, and snailfish species (Jarvela and Thorsteinson, 1999; Craig et al., 1985; Schmidt, McMillan, and Gallaway, 1989).

Rivers and streams discharging into the U.S. Beaufort Sea provide estuarine and freshwater habitat for several anadromous and migratory species including salmon, Dolly Varden, whitefish, cisco species, and rainbow smelt (ADF&G, 2014a; Johnson and Daigneault, 2013).

Seven fish species that occur in the Proposed Action area are discussed in more detail below.

Arctic Cod. Arctic cod is widely distributed throughout the U.S. Arctic, including the pelagic, demersal, and nearshore environments of the Beaufort Sea. The absolute numbers of Arctic cod and their biomass is one of the highest of any finfish in the region (Logerwell et al., 2010; Frost and Lowry, 1983). Many species of vertebrates depend on Arctic cod as a major food source (Pirtle and Mueter, 2011).

Arctic cod move and feed in different groupings – as dispersed individuals, in schools, and in huge shoals. These distribution patterns appear to be dependent on several interacting factors including season, presence or absence of ice, salinity, water temperature, surface wind, currents, length of daylight, and the underside texture of ice. Inter-annual variation also plays a role in the pattern of distributions (Welch, Crawford, and Hop, 1993; Benoit et al., 2010).

Arctic cod migrate between offshore and onshore areas for seasonal spawning and spawn under the ice during winter (Craig et al., 1982; Craig, 1984; Bradstreet et al., 1986). Arctic cod eggs and larvae develop during late winter until early summer in the pelagic surface-water environment.

During open water, pelagic yearling and older Arctic cod were found to occur in high abundance at the continental shelf-break (100 m (328 ft)), and pelagic young-of-year were found most commonly inshore (Logerwell et al., 2010). Frost and Lowry (1983) found smaller Arctic cod more often in water less than 100 m (328 ft) deep. Craig et al. (1982) found adult and juvenile Arctic cod in shallow nearshore waters (1-12 m/3.3-39 ft) in the Beaufort Sea in summer and winter.

Arctic cod are associated with sea ice, using it at various life stages and seasons for shelter and as a forage habitat to feed on microorganisms on the underside of the ice. Amphipods on the underside of ice are an important food source for Arctic cod (Lonne and Gulliksen, 1989; Gradinger and Bluhm, 2004). Rough, irregular textures of the underside-ice may provide preferred habitat for Arctic cod to avoid predators (Cross, 1982). Gradinger and Bluhm (2004) and Lonne and Gulliksen (1989) observed and photographed Arctic cod in summer months using ice crevices and cracks on the underside of textured ice floes for escape and shelter.

Arctic cod also inhabit offshore and nearshore areas without ice during warmer times of year (Bradstreet and Cross, 1982; Bradstreet, 1982; Cross, 1982; Crawford and Jorgenson, 1993; Gradinger and Bluhm, 2004). Copepods and amphipods are common prey for Arctic cod in open water environments (Frost and Lowry, 1983; Benoit et al., 2010).

Saffron Cod. Saffron cod occur in the Beaufort Sea primarily in nearshore waters. Unlike Arctic cod, they do not specifically associate with ice. Saffron cod move seasonally from summertime feeding offshore to inshore for spawning where they enter coastal waters and tide-influenced riverine environments. Adults and juveniles forage on the epibenthos, opportunistically taking small crustaceans and fish (Froese and Pauly, 2013).

Pacific Salmon. Pacific salmon adults and juveniles occur in the Beaufort marine environment; however, their numbers are low when compared to the Bering Sea. Of the five Pacific salmon species, pink salmon (*Oncorhynchus gorbuscha*) and chum salmon (*O. keta*) have been the salmon species most commonly captured in the Beaufort Sea marine and nearshore environments (Craig, 1984; Craig and Haldorson, 1986; Fechhelm and Griffiths, 2001; Fechhelm et al., 2009). In the marine environment, adult pink and chum salmon in the U.S. Beaufort Sea are known to occur down to 200 m (660 ft) depth. As climate change occurs (ice reduction, warming waters) salmon are occurring further north in greater numbers (Moss et al., 2009; Kondzela et al., 2009).

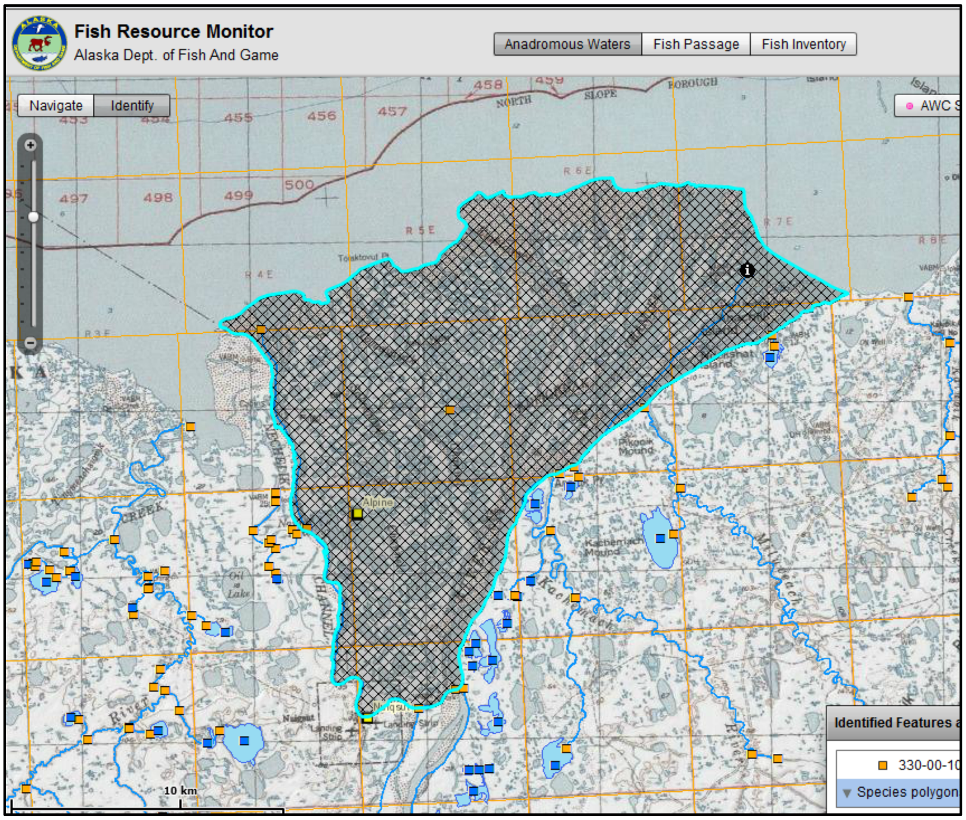

Figure 4. Colville River Delta: pink and chum salmon EFH. *The river delta is indicated with cross hatching*.

Source: Alaska Department of Fish and Game (ADF&G), 2014a.

Chum salmon and pink salmon have been documented as present in the Colville River and Colville River Delta area in the Alaska Department of Fish and Game (ADF&G) Anadromous Waters Catalog (Johnson and Daigneault, 2013) (Figure 4).

3.2.5. Marine and Coastal Birds

Most marine birds that occur in the Beaufort Sea are there during the open-water season. Arrival times usually coincide with the formation of leads during spring migration to coastal breeding areas. Spring migration for most species takes place between late March and late May.

Some birds that breed on the North Slope migrate to or through the Proposed Action area (Figure 1) twice each year. Some marine and coastal birds may breed outside the Proposed Action area, but spend time in the Beaufort Sea after breeding or during their non-breeding seasons. Departure times from the Beaufort Sea for the fall and winter vary between species and often by sex within the same species, but most marine and coastal birds will have moved out of the Beaufort Sea by late October before the formation of sea ice.

Full descriptions of the most important marine and coastal bird species in the Beaufort Sea were provided in the Beaufort Sea Multiple-Sale EIS (USDOI, MMS, 2003) and the Lease Sale 193 Final SEIS (USDOI, BOEMRE, 2011b), EAs for Lease Sales 195 and 202 (USDOI, MMS, 2004, 2006b), 2006 Seismic PEA (USDOI, MMS, 2006a), and the recent Biological Evaluation for the USFWS (USDOI, BOEMRE, 2011c). These descriptions are summarized and updated below. Existing information is sufficient to fully evaluate the potential effects of the two alternatives.

Descriptions of Species or Species Groups

Marine and coastal birds potentially affected by the Proposed Action can be grouped according to certain aspects of their life-history or status: ESA-listed birds or those abundant in the Proposed Action area (Table 4). The timing and specific location of the Proposed Action influences which birds could be affected. Birds listed as threatened or candidate (three species) or abundant in the Proposed Action area (five species) have the greatest potential for impacts and are described further.

Table 4. Marine and coastal birds most likely to be affected by the Proposed Action.

Species	Threatened or candidate species	Abundant in Proposed Action area	Carried forward under effects analysis
ESA-Listed Species			
Spectacled Eider	Yes	No	Yes
Steller's Eider	Yes	No	Yes
Yellow-billed Loon	Yes	No	Yes
Abundant Species			
Long-tailed Duck	No	Yes	Yes
Common Eider	No	Yes	Yes
King Eider	No	Yes	Yes
Northern Fulmar	No	Yes	Yes
Short-tailed Shearwater	No	Yes	Yes

Sources:USDOI, MMS (2003, 2004, 2006a & b) and USDOI, BOEMRE (2011a & b).

ESA-listed and Candidate Bird Species

The distribution, abundance, and legal status of birds designated as threatened or listed as candidate species under the ESA are most recently described in the ESA Section 7 Biological Opinion (USFWS, 2012) hereafter called the 2012 USFWS BO. These include the Steller's eider (*Polysticta stelleri*; threatened), the spectacled eider (*Somateria fisheri*; threatened), and the yellow-billed loon (*Gavia adamsii*; candidate species) and are often collectively referred to as ESA-listed birds.

Spectacled Eider. The North Slope spectacled eider population seems to be stable, at least since the initiation of aerial surveys of the Arctic Coastal Plain (ACP) in 1992 (Larned, Stehn, and Platte, 2009). Spectacled eiders breed in low densities across the Alaskan ACP east to about the Shaviovik River. Males leave the breeding grounds along the ACP for the ocean around mid - to late June at the onset of incubation by female eiders. Males are followed by females whose nests fail, and finally by successful breeding females and young birds in August and September. Female spectacled eiders migrate west along the Alaska coast as far as 40 km (25 mi) offshore. Some sub-adult spectacled eiders remain in nearshore coastal waters during the open-water season, ranging across the Beaufort Sea east to the Mackenzie River Delta, Canada (USGS, 2013). Most spectacled eiders will have migrated from the Beaufort Sea by mid-October, although small numbers of spectacled eiders could be encountered in nearshore locations of the Beaufort Sea.

Steller's Eider. A small number of Steller's eiders breed on the ACP of Alaska, most conspicuously near Barrow. Steller's eiders are rare east of Barrow to the Prudhoe Bay area. They are even rarer as the season progresses due to molt migration, failed breeding, etc. As with the more common spectacled eider, these birds move to nearshore coastal waters after their breeding season. Few if any Steller's eiders would likely be in the southern Beaufort Sea during the open-water season.

Yellow-billed Loon. The yellow-billed loon is relatively rare in the U.S. Arctic region (North, 1994). Dau and Bollinger (2009) reported an average of fewer than 50 yellow-billed loons during late-June surveys of the coast and barrier islands between Omalik Lagoon and the Canadian Border (2005-2009). Of the approximately 3,300 yellow-billed loons present on the breeding grounds on the North Slope, primarily between the Meade and Colville Rivers in the National Petroleum Reserve-Alaska (NPR-A), it is likely that there are fewer than 1,000 nesting pairs because some of the 3,300 are nonbreeders. Additionally, there are approximately 1,500 yellow-billed loons (presumably juvenile nonbreeders) that remain in nearshore marine waters or in large rivers during the breeding season. In total, there are fewer than 5,000 yellow-billed loons on the Arctic coast breeding grounds and near shore marine habitat (Earnst et al., 2005). There may be approximately 1,500 yellow-billed loons, presumably non-breeding adults and immatures, in nearshore marine waters or in large rivers during the breeding season. Yellow-billed loon numbers were thought to be declining (74 *FR* 12932, March 25, 2009), but the population is now considered stable (Stehn, Larned, and Platte, 2013).

Yellow-billed loons typically nest on low islands or narrow peninsulas on the edges of large, deep, tundra lakes. Breeding yellow-billed loons typically remain on their lakes until young are fledged.

Most yellow-billed loons from the ACP have moved into nearshore coastal waters by September. In addition, approximately 8,000 yellow-billed loons from the Canadian Arctic travel across the Chukchi Sea during spring and fall migration between Canada and wintering grounds in eastern Asia. Most loons stay very close to shore during fall migration until they reach the Lisburne Peninsula, where they head farther out to sea towards the Bering Strait (Rizzolo and Schmutz, 2010).

Low numbers, patchy distributions, and specific habitat requirements may make yellow-billed loons more susceptible to environmental perturbations such as disturbance, habitat alterations, and oil spills than other loon species that are more abundant, widely distributed, and able to exploit a greater diversity of habitats.

Other Birds

Loons and Waterfowl. The Pacific loon (*Gavia pacifica*), red-throated loon (*G. stellata*), Pacific brant (*Branta bernicla nigricans*), lesser snow goose (*Chen caerulescens caerulescens*), greater white-fronted goose (*Anser albifrons frontalis*), and tundra swan (*Cygnus columbianus*) occur in nearshore coastal waters of the Beaufort Sea and Chukchi Sea (USDOI, MMS, 2003, 2007; USDOI, BOEMRE, 2011a). Waterfowl species that are more abundant and occur in more offshore areas of the Beaufort Sea include the long-tailed duck (*Clangula hyemalis*), the common eider (*Somateria mollissima*), and the king eider (*Somateria spectabilis*) and are described below.

Long-Tailed Duck. The long-tailed duck population has decreased considerably since 1989, but it remains a common species in the Beaufort Sea during the open-water period (Mallek, Platte, and Stehn, 2007). Many long-tailed ducks molt in the lagoons along the Beaufort Sea coast. In late June and early July, most male and nonbreeding female long-tailed ducks migrate to coastal molting areas where they are flightless for a 3- to 4-week period. Breeding females molt on freshwater lakes during the last phases of duckling development before departing the North Slope in fall. While most long-tailed ducks migrate within 45 km (28 mi) of shore, infrequent observations of long-tailed ducks in pelagic waters occur in late September (Divoky, 1987).

The molt is an energetically costly time, and long-tailed ducks have abundant food resources in the shallow water lagoons (Flint et al., 2003). During the molt, long-tailed ducks tend to stay in or near the lagoons, especially near passes between lagoons and the open ocean (Johnson, Frost, and Lowry, 1992; Johnson, Wiggins, and Wainwright, 1992).

Molting long-tailed ducks tend to stay in or near the lagoons, feeding heavily in passes between barrier islands. Aerial surveys along coastal habitats of the entire ACP typically observe fewer than 7,500 long-tailed ducks, with about two-thirds of these associated with mainland habitats (Dau and Bollinger, 2009).

Common Eider. Common eiders nest on barrier islands or spits along the Beaufort Sea coast. Dau and Larned (2005) observed 1,819 common eiders along the Beaufort Sea coast with 652 on barrier islands and 1,167 on the mainland. Dau and Larned (2007) observed a total of 1,936 common eiders. Of these, 871 were along the Beaufort Sea coast with 423 along the barrier islands and 448 along the mainland. The highest concentrations were on survey segments on both sides of Kaktovik. In 2007, total birds and indicated breeding pairs were down 37.6% and 44.0%, respectively, from 2006 counts of 3,102 birds and 1,207 pairs. Total birds and indicated breeding pairs in 2007 were down 30.0 and 27.8%, respectively, from the 1999-2006 averages of 2,766+885 (1 standard deviation, range 1,353-4,449) birds and 937+264 (1 standard deviation, range 572-1,340) pairs (Dau and Larned, 2007).

After the molt is completed, some common eiders move offshore into pelagic waters, but most eiders remain close to shore (Divoky, 1987). When traveling along the northwest coast of Alaska, these eiders tend to stay along the 20-m isobath, approximately 48 km (29 mi) from shore. Most males are out of the Beaufort Sea by late August or early September, and most females were gone by late October or early November. Most breeding female common eiders and their young begin to migrate to molt locations in late August and September.

The common eider population in the Beaufort Sea declined by 53% between 1976 and 1996 (Suydam et al., 2000). Common eiders were surveyed in marine waters within 100 km (62 mi) of the Beaufort Sea shoreline between Barrow and Demarcation Point by Fischer and Larned (2004) during summers in 1999-2001. In general, common eiders were concentrated in waters <10 m (<33 ft), with the highest densities occurring in segments between Oliktok Point and Prudhoe Bay and between Tigvariak Island and Brownlow Point. Common eiders were most commonly associated with barrier islands in these segments, becoming less commonly observed up to 50 km (31 mi) seaward. Common eider densities were highest in areas of low ice cover.

Fischer and Larned (2004) concluded that because eider densities did not vary between summer months, the eiders they observed near barrier islands were local breeders rather than molt or fall migrants. This is consistent with Petersen and Flint (2002), who showed that satellite-tagged common eider hens remained in shallow waters close to their breeding sites through September.

Male common eiders begin moving out of the Beaufort Sea beginning in late June. Most males are out by late August or early September, and most females were gone by late October or early November. Most common eiders migrate within 48 km (29.8 mi) of the coast when traveling west along the Beaufort Sea.

King Eider. Most king eiders begin to arrive in the Beaufort Sea by the middle of May. Arrival times in the Beaufort Sea are dependent upon the location and timing of offshore leads along the Chukchi Sea (Barry, 1986). Most king eiders nesting on the North Slope between Icy Cape and the western boundary of the Arctic National Wildlife Refuge (ANWR) nested in three general areas: between the Colville River and Prudhoe Bay, southeast of Teshekpuk Lake and a large area near Atqasuk (Larned, Stehn, and Platte, 2009). Dau and Larned (2005, 2006, 2007, 2008) surveyed the Chukchi Sea and Beaufort Sea coastlines and found 810, 3,048, 1,621, and 2,227 king eiders in 2005, 2006, 2007, and 2008, respectively.

The king eider population in the Beaufort Sea appeared to remain stable between 1953 and 1976 but declined by 56% between 1976 and 1996 (Suydam et al., 2000). Fischer and Larned (2004) surveyed king eiders in marine waters within 100 km (62 mi) of the Beaufort Sea shoreline between Barrow and Demarcation Point during summers in 1999 and 2001. King eiders were the second most abundant species counted during the survey periods. King eider densities varied according to water depth, offshore distance, and percent of ice cover. Large flocks of king eiders concentrated in the mid-depth (10-20 m (33-66 ft)) zone offshore of Barrow and Oliktok Point. In 1999 and 2000, these flocks were in waters >10 m (>33 ft) deep but were found in the shallow (<10 m (<33 ft)) and mid-depth zone in July 2001. King eiders were unique among species surveyed by occurring in higher densities in low (31%) and moderate (31-60%) ice cover (Fischer and Larned, 2004).

Satellite telemetry was used to determine that most king eiders spent more than two weeks staging offshore in the Beaufort Sea prior to fall migration (Phillips, 2005; Powell et al., 2005). Female king eiders may need to remain in the Beaufort Sea longer than males to replenish fat stores depleted during egg laying and incubation (Powell et al., 2005). Prior to molt migration, king eiders in the Beaufort Sea usually were found about 13 km (8 mi) offshore; however, during migration to molting areas, king eiders occupied a wide area ranging from shoreline to >50 km (>31 mi) offshore (Phillips, 2005).

Seabirds

The common murre (*Uria aalge*), thick-billed murre (*U. lomvia*), tufted puffin (*Fratercula cirrhata*), horned puffin (*F. corniculata*), black-legged kittiwake (*Rissa tridactyla*), black guillemot (*Cepphus grylle*), Ross' gull (*Rhodostethia rosea*), ivory gull (*Pagophila eburnea*), Arctic tern (*Sterna paradisaea*), pomarine jaeger (*Stercorarius pomarinus*), parasitic jaeger (*S. parasiticus*), long-tailed jaeger (*S. longicaudus*), and glaucous gull (*Larus hyperboreus*) occur in the Chukchi Sea and Beaufort Sea (USDOI MMS (2003, 2007); USDOI, BOEMRE (2011a). Seabird species that are more abundant and occur in the Beaufort Sea include the northern fulmar (*Fulmarus glacialis*) and short-tailed shearwater (*Puffinus tenuirostris*) and are described below.

Northern Fulmar. Fulmars do not breed in the Arctic region, and those observed during the summer are nonbreeders or failed breeders from southern areas. Fulmars are most numerous from late August to mid-September. Flocks totaling in the low hundreds were observed during the late summer and early fall around the Klondike and Burger prospects during seabird surveys in 2008-2011 (Gall and Day, 2012). Similar distributions are anticipated to occur in the adjacent Beaufort Sea.

Short-Tailed Shearwater. Shearwaters do not breed in the Arctic region. These birds breed in the Southern Hemisphere. At northern latitudes, short-tailed shearwaters likely forage at highly productive patches of euphausiids and amphipods. Divoky (1987) reported short-tailed shearwaters north of Barrow and into Arctic Canada, depending on the presence of sea ice. In certain years, an estimated 100,000 short-tailed shearwaters passed Point Barrow in one day in mid-September (Divoky, 1987).

Gall and Day (2012) suggested that the shearwaters can rapidly respond to changes in oceanic conditions and exploit food resources when and where they are available. For example, Kuletz (2011) reported a single flock numbering over 15,000 short-tailed shearwaters in the western Beaufort Sea in late August–early September, 2011. Kuletz (2011) reported over 4,000 shearwaters during a seabird survey in the Chukchi Sea in late August – early September 2011 (the most abundant species reported), with many flocks numbering between 150-300 birds. These observations were consistent with those of Bankert (2012). Similarly, flocks totaling in the low hundreds were observed during the early fall around the Klondike, Burger, and Statoil prospects during seabird surveys in 2008-2011 (Gall and Day, 2012); however, during the early fall period in 2009, almost 12,000 short-tailed shearwaters were observed near the Klondike Prospect. Similar distributions are anticipated to occur in the adjacent Beaufort Sea.

3.2.6. Marine Mammals

Marine mammals most likely to occur in the Proposed Action area are beluga, bowhead, and gray whales; spotted, ringed, and bearded seals; polar bears in small numbers, and few, if any Pacific walruses. Species considered extralimital to this area include humpback and killer whales, harbor porpoises, narwhals, and ribbon seals. The numbers of individual marine mammals that would occur in the Proposed Action area should be low due to the shallow water depths in most of the Colville River Delta. Shallow waters cannot normally support the quantities and types of prey species marine mammals need for survival, because of ice freezing into the seafloor substrate, ice gouging, and a limited column.

ESA-protected cetaceans and seals are managed by NMFS, while Pacific walrus and polar bears are managed by the USFWS. Species protected by the ESA include bowhead and humpback whales, which are endangered; polar bears, ringed and bearded seals, which are threatened; and Pacific walruses, which are a candidate species for ESA-listing. Presently there are no established critical habitat areas for marine mammals in the Beaufort Sea. All marine mammals are protected by the Marine Mammal Protection Act.

ESA-Protected Marine Mammals

Bowhead Whales

Bowhead whales use waters deeper than what is found in most of the Proposed Action area, though they migrate westward along the Proposed Action area's northern edge in September and October. During the open water season, bowhead whales feed throughout the Beaufort Sea, but largely aggregate in the Canadian Beaufort Sea and Barrow Canyon, where upwellings concentrate prey species. Consequently, most bowhead whales do not feed in the survey area, although a small feeding area has been identified slightly north of Bodfish Island (Clarke et al. 2012, 2013).

Bearded and Ringed Seals

Bearded and ringed seals use dense to light areas of sea ice for resting and molting. While ringed seals feed on pelagic prey species in the water column, bearded seals generally feed on benthic prey on the seabed. Diving ability limitations for bearded seals restrict them to areas where they can access the seafloor to forage, and ringed seals have energetic limits restricting how far from sea ice or resting areas they can effectively forage. Bearded seals cannot feed on benthos on or near the continental shelf break because water depths prevent them from diving to the seafloor. The Proposed Action would occur after bearded and ringed seals have completed their reproductive cycles, and molted (Cameron et al., 2010; Kelly et al., 2010).

Pacific Walrus

Pacific walrus occur seasonally in very low numbers in the Beaufort Sea and most sightings occur west of Cape Halkett. However, a small number of Pacific walrus have been observed singly or in small groups as far east as Kaktovik (USDOI, MMS, 2003).

Polar Bear

Polar bears occur throughout the continental shelf of the Beaufort Sea. During the open water season, a portion of the Southern Beaufort Sea polar bear population remains onshore along the coastline and on the barrier islands. During the open water season, some bears may be observed swimming between offshore ice and the shoreline or barrier islands.

Other Marine Mammals

Beluga Whale

The main fall migration corridor of beluga whales is ~100+ km north of the coast. Satellite telemetry data show some belugas of this population migrate west considerably farther offshore, as far north as 76ºN to 78ºN latitude (Richard, Martin, and Orr, 1997; 2001), and spend most of their time feeding on fishes, over the continental shelf break. Occasionally a few appear in coastal areas and river deltas, however very few are expected to occur in the Proposed Action area.

Gray Whale

Gray whales are generalist feeders mostly foraging on benthic prey in shallow continental shelf waters (Carretta et al., 2013). The narrow continental shelf in the Beaufort Sea provides suboptimal feeding habitat for large numbers of gray whales, hence their presence in the Beaufort Sea is very low east of Barrow Canyon. The low number of gray whales in the Beaufort Sea, and the shallow water depths of Harrison Bay, make it very unlikely more than an occasional gray whale would occur in the Proposed Action area.

Spotted Seal

As with ringed and bearded seals, water depths in the project area permit winter sea ice to freeze into the sea floor, and heavily scour sea floor throughout much of the project area. Consequently, limited food resources exist throughout much of the survey area. The presence of spotted seals in the project area is likely associated with summer whitefish and/or salmon spawning runs that occur in the Colville River and some of its tributaries. Such food resources would be concentrated in the actual river channel and not in the marine environment, which suggests spotted seals would concentrate in the river system to feed on fish and not in the ocean. Considering the existing spotted seal haulout in the Colville River delta, other spotted seal haulout locations along the Beaufort Sea, and the lack of similar haulouts on barrier islands, general coastal areas, and river deltas lacking a whitefish/salmon component (Boveng et al., 2009; Rugh et al., 1993), such an assumption is probably valid. The Colville River haulout occurs on gravel/mud bars in the eastern edge of the Colville River Delta where spotted seals, numbering in the 10’s, regularly congregate. The Proposed Action would occur after spotted seals have completed their reproductive cycles, and molted.

3.2.7. Terrestrial Mammals

The species list of terrestrial mammals typically occurring in the Colville River Delta and surrounding islands includes caribou, muskox, artic foxes, and grizzly bears (ADF&G, 2014b; ADNR, 2009).

Grizzly Bear

Grizzly bears occur onshore, foraging in riparian areas, river deltas, coasts, and uplands according to food availability, or other habitat needs. Grizzlies in the Arctic require very large home ranges compared to bears farther south due to the brief growing season, and low productivity in the Arctic. No more than a few resident bears should occur near the Proposed Action area (ADF&G, 2014b; ADNR, 2009).

Caribou

Caribou herds using the Proposed Action area include elements of the Western Arctic Caribou Herd (WAH), the Central Arctic Caribou Herd (CAH), and the more sedentary Teshekpuk Lake Caribou Herd (TCH) (ADF&G, 2014b; ADNR, 2009). The WAH has declined by 4-6% annually since 2003, although the population estimate remains around 325,000 animals (Dau, 2011). Both the TCH and the CAH population estimates are much lower at 55,000 and 67,000 respectively (Parrett, 2011; Lenart, 2011). During summer and fall, caribou groups in the vicinity of the Proposed Action should consist of calves, yearlings, and adults seeking food. Up to several thousand caribou could be encountered in a single event in coastal areas, particularly if they are avoiding swarms of biting insects. Caribou are subject to mosquito harassment from mid- June into August, and oestrid fly harassment from mid-July to late-August. To escape biting insects, caribou usually move from inland feeding areas to windswept, vegetation-free coastal areas, where they rely on various wind prone coastal habitats such as sandbars, spits, river deltas, and some barrier islands for relief from insect pests (USDOI, MMS, 1987). Caribou that are encountered on barrier islands should occur in small groups numbering 20 animals or less.

Muskox

Muskoxen occur in riparian areas and along the Beaufort Sea coast grazing in meadows, and occasionally on gravel bars and islands in the Colville River drainage. Herd sizes should be small, likely consisting of a few calves mixed in with adults and yearlings. Muskox herds are mostly sedentary, usually remaining within a limited geographical area, although young males and sometimes females wander great distances. Though they typically avoid people, muskox can be very dangerous if approached too closely. Small numbers of muskoxen, likely numbering in the 10's should be encountered periodically during the Proposed Action (ADF&G, 2014b; ADNR, 2009).

Arctic Fox

Arctic foxes are ubiquitous and numerous throughout Arctic Alaska, and sometimes "island-hop" through the barrier islands of the Beaufort Sea scavenging, raiding bird nests, and caching food for later use. Arctic foxes should be encountered during onshore phases of the Proposed Action (ADF&G, 2014b; ADNR, 2009).

3.2.8. Subsistence, Environmental Justice, Public Health and Economy

3.2.8.1. Subsistence

Subsistence Activities

Subsistence activities are of high cultural and social value to Iñupiat of the North Slope and provide a sense of identity as well as being an economic pursuit. Subsistence is viewed by Alaska Natives not just as an activity that is embedded in the culture; it is viewed as the very culture itself (Wheeler and Thornton, 2005). Subsistence has such an important role in culture and society, that any reduction (or even a perceived reduction) in the availability of subsistence foods impacts food security and contributes to social pathologies such as crime, mental health issues, and increasing social disorganization (Wernham, 2007). Harvesting practice studies have indicated that North Slope Borough (NSB) communities have an annual harvest of between 153.2 to 665.3 pounds (69.6 to 301.8 kg) per person (Einarsson et al., 2004) with Bowhead whales being a subsistence resource paramount to the social and cultural organization of North Slope Communities. This cultural relevance of subsistence hunting and resources dominates subsistence discourse in North Slope Iñupiat Eskimo communities (USDOI, BOEMRE, 2011a). Subsistence harvests provide dietary variety and nutrition along with providing long-term, sustainable nutritional needs even when few or no bowhead whales are taken during the hunting season (USDOI, BOEMRE, 2011a). Two communities closed to the Proposed Action that utilize the area of the Proposed Action for subsistence harvests are Nuiqsut and Kaktovik.

Nuiqusut

Nuiqsut is a coastal community 17 miles inland from the Beaufort Sea coast along the western shore of the Colville River and is the village located closest to the Proposed Action. Thetis Island and Cross Island, from which Nuiqsut hunters base their seal, eider, and bowhead whaling activities, respectively, are located to the northeast. The Proposed Action area is located approximately 17 miles north of Nuiqsut and will occur July through October, 2014 with data acquisition occurring for 70 days between August 15 to October 15th. Nuiqsut's subsistence harvest areas are depicted in detail in MMS OCS Study 2009-003, Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow (SRB&A, 2010: Maps 131-136). Subsistence resources taken throughout the year are relied on to provide a substantial portion of the Nuiqsut subsistence diet (SRB&A, 2010).

Nuiqsut residents utilize marine and terrestrial environments for harvesting subsistence resources. Subsistence resources extend over a large area west between Barrow and Atqasuk, east to Kaktovik, and have occurred offshore over 50 miles (SRB&A, 2010). Summer subsistence hunts begin in July, with some hunts as early as May, increasing in June, and continuing through September (SRB&A, 2010).

Camps and cabins are located along the Colville River Delta. Use of these camps and cabins are important in allowing residents access to resource areas when conducting subsistence activities. There are many camps or cabins located on Cross Island and used in the harvesting of resources (SRB&A, 2010).

Kaktovik

Kaktovik is located on Barter Island just off the Beaufort Sea coast approximately 120 miles (193 km) east of Prudhoe Bay and 90 miles (145 km) west of the Canadian border just north of the Arctic National Wildlife Refuge (ANWR). Kaktovik residents utilize both marine and terrestrial subsistence resources throughout the year and these resources comprise a substantial portion of the Kaktovik subsistence diet (SRB&A, 2010). The Proposed Action area is more than 180 miles (290 km) west of Kaktovik. Kaktovik's subsistence harvest areas are depicted in detail in MMS OCS Study 2009-003, Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow (SRB&A, 2010: Maps 131-136).

SAE proposes to conduct the Proposed Action during the open-water season (July through October).The Proposed Action includes activities that have historically been halted beginning August 25 to avoid conflicts with the fall subsistence bowhead whale hunts of the villages of Kaktovik and Nuiqsut. SAE states in the plan of operation that surveys will temporarily cease during the fall bowhead whale hunt to avoid acoustical interference with Cross Island, Kaktovik, or Barrow based hunts.

Subsistence Resources

Bowhead Whale (*aġviq*)

Bowhead whaling in Nuiqsut occurs around late August through mid-October. In 2008, Cross Island bowhead whale hunting began earlier in the season with the first crew arriving on August 29 and since this time the season has continued to begin earlier. Monitoring of bowhead whales and related harvesting activities from 2001-2008 indicates the majority of bowhead whales harvested by Nuiqsut hunters have been in the northeast quadrant off Cross Island (Applied Sociocultural Research, 2012; USDOI, BOEMRE, 2011a; SRB&A, 2010: Maps 113 and 114).

Kaktovik bowhead whale hunters travel between Camden Bay to the west, Nuvagapak Lagoon to the east, and up to approximately 50 miles (80 km) from Kaktovik in search of bowhead whales July through October. Primary harvest is during September, when the ocean is ice-free (SRB&A, 2010). Bowhead whale hunting occurs up to approximately 25 miles (40 km) from shore, between Arey Island and Tapkaurak Lagoon. Hunters generally stay within 15 and 30 miles (24 – 38 km) from shore, traveling farther only when bowhead whales are not available closer to shore or when ice conditions or the presence of supply or drilling ships force hunters farther from shore (SRB&A, 2010).

Ringed Seal (*natchiq*) and Bearded Seal (*ugruk*)

Nuiqsut residents use bearded seal meat and oil for its nutritional value and hunters harvest ringed and bearded seal in the Beaufort Sea during summer months. Subsistence use areas for ringed seal are located west from Cape Halkett, east to Camden Bay, and up to approximately 20-25 miles (32-40 km) from shore with some hunters traveling up to 40 miles (64 km) offshore near Thetis Island (SRB&A, 2010: p. 284). Hunting of ringed seal occurs in open water as seals follow the ice pack between June and September. However, hunting has been reported in May and October with hunting peaks in July and August.

Kaktovik residents hunt for ringed seal while hunting for bearded seal. Hunts occur offshore between Prudhoe Bay to the west, Demarcation Bay to the east, and up to approximately 30 miles (48 km) from shore with periodic harvesting of ringed seal occurring inside lagoons close to Barter Island.

Nuiqsut bearded seal hunting occurs between Harrison Bay and Flaxman Island with a high number of hunts occurring between the mouth of Fish Creek and Thetis Island. Hunting occurs offshore up to 20 miles (32 km) extending as far west as Cape Halkett, as far east as Camden Bay, and offshore up to 40 miles (64 km).

In recent years, bearded seal hunting for Kaktovik residents is more common than ringed seal hunting. Bearded seal hunting occurs along the coast as far west as Prudhoe Bay and as far east as the United States/Canada border approximately 30 miles (48 km) from shore. Many hunters will generally hunt within five miles (8 km) of shore (SBR&A, 2010). Hunting activities for Kaktovik begin in March, peak in July and August, and conclude in September.

Fish: Arctic Cisco (*Qaaktaq*), Arctic Char/Dolly Varden (*paikłuk/iqalukpik*), Broad Whitefish (*Aanaagœiq*), and Burbot (*Tittaaliq*)

The Colville River plays an important role in the life cycle of the fish placing Nuiqsut in a unique location for harvesting this resource. Arctic cisco harvest occurs in October and November with some harvests as early as August and September (SRB&A, 2010). Generally, harvesting of Arctic char/Dolly Varden is conducted separately from Arctic cisco harvests in August and September and can occur in July through October along the Colville River. Harvest occurs between the delta and beyond the Chandler River, along the Anaktuvuk River, in Fish Creek south of Nuiqsut, and along the Colville River. Broad whitefish harvests occurs June through August with most fishing done in July along the Colville River between the mouth and the Sentinel Hill area, Fish Creek, Itkillik River, Chipp River, and in some area lakes. (SRB&A, 2010). Nuiqsut residents residing closest to the Proposed Action harvest fish primarily on inland waterways. The Proposed Action does not involve inland waterways during the temporal (July-October) and spatial (Harrison Bay area of the Beaufort Sea) location of the project. However, onshore survey personnel may cross small tidelands and small flowing drainages in the Colville River Delta by foot and major channels will be crossed with assistance from helicopters or small watercraft.

Kaktovik residents harvest Arctic Cisco during the summer, traveling as far west as Sagavanirktok River (east of the Proposed Action area). Residents fish off Barter Island, east of the Proposed Action area , and along barrier islands near Barter Island, Fishing areas may include distant locations such as Camden Bay and Demarcation Bay. Kaktovik fishes for Arctic char using coastal and inland locations between Mikkelsen Bay to the west and Shingle Point (in Canada) to the east. Fishinc also occurs inland along Sagavanirktok, Shaviovik, Canning, Hulahula, Kongakut, Mackenzie, and Big Fish Rivers. Kaktovik residents harvest Arctic char during July and August (SRB&A, 2010). Broad whitefish is a less common harvest in Kaktovik but does occur July through September. (SRB&A, 2010)

Geese, Swans, and Eider

Nuiqsut and Kaktovik residents harvest several species of geese: Greater white-fronted goose (*kigiyuk niålivailuk*), Canada goose (*iqsraġutilik*), Brant (*Niålinåaq*) and snow geese (*Kaÿuq*).

Nuiqsut goose hunting occurs around the Colville River near Ocean Point, the mouth of Itkillik River, and inland waterways during spring. May and June, hunters move closer to the coast to harvest waterfowl and between May and September, harvests for king eiders (*Qiÿalik*) and common eiders (*Qaugak*) are often combined with offshore seal hunts in the Colville River Delta(SRB&A, 2010).

Hunts occur in the Beaufort Sea between Atigaru Point and the mouth of the Kuparuk River, along the Colville River Delta, and eastward to Cross Island, where fall whaling occurs. Hunters may travel offshore over 30 miles to hunt waterfowl and have reported using Thetis Island as a base for hunting activities. The Proposed Action will occur primarily offshore ,in shallow water, and on land.

Kaktovik goose hunting occurs August to September as far west as Prudhoe Bay (SRB&A, 2010). Hunting also occurs inland along Hulahula, Okpilak, and Jago Rivers and across from Barter Island. Some residents harvest eiders as early as April and as late as October (SRB&A, 2010).

The Proposed Action will be limited in these areas during the temporal (July-October) and spatial (Harrison Bay area of the Beaufort Sea) location of the Proposed Action.

Caribou (*Tuttu*)

Caribou is an important subsistence food for the residents of Nuiqsut (SRB&A, 2010). Summer caribou are hunted by boat, along the coastline or shores of barrier islands where caribou congregate for relief from insects and heat. The coastal area used most frequently by hunters is the delta of the Colville River. Most residents hunt caribou June through September, and hunting peaks in July and August (SRB&A, 2010).

For Kaktovik residents, caribou hunting is a key terrestrial subsistence activity. Residents report traveling substantial distances from their community to hunt for caribou. Hunting areas are located as far west as Ikpikpuk River and eastward beyond the Mackenzie River Delta in Canada. (SRB&A, 2010). Hunting caribou occurs along the coast during the summer months, traveling inland during the winter months (usually starting in October) by snowmachine and along the coast by snowmachine hunting west or east of Barter Island along the coastline.

The Proposed Action is in the open water of Harrison Bay and includes onshore work during the temporal (July-October) and spatial (Harrison Bay area of the Beaufort Sea and Colville River Delta) location of the Proposed Action.

3.2.8.2. Environmental Justice

Executive Order 12898 (EO), "Federal Actions to Address Environmental Justice (EJ) in Minority Populations and Low-Income Populations," makes each Federal agency responsible for achieving environmental justice as part of its mission, and for identifying and addressing, as appropriate, "disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low income populations." The intent of EO 12898 is to promote the fair treatment of people of all races and income brackets, so no person or group of people bears a disproportionate share of the negative effects from Federal agency decisions.

According to the 2010 Census (NSB, 2012), demographics of the Nuiqsut and Kaktovik communities indicate they meet the 50% population threshold of an affected area, as follows:

- Nuiqsut - 88.2% of the population (402 residents) are Alaska Native (specifically Iñupiat) American Indian.
- Kaktovik - 88.7% of the population (239 residents) of Kaktovik are Alaska Native or American Indian.

For centuries, survival in the Arctic has centered on gathering of subsistence foods and materials and knowledge needed to harvest these resources. Iñupiat culture has depended upon passing on traditional knowledge and beliefs about subsistence resources, including observations of game behavior to successfully locate and harvest game, and hunter and family behaviors that ensure successful harvests in the future (Spencer, 1976). Although there have been substantial social, economic, and technological changes in the Iñupiat way of life, subsistence continues to be the central organizing value of Iñupiat sociocultural systems. Iñupiat continue to be socially, economically, and ideologically loyal to their subsistence heritage, with substantial amounts of subsistence food sharing within and between communities comprising important kin ties (Heinrich, 1963).

Disruption of subsistence harvest patterns could alter these cultural values, affect community social structure and result in disproportionately high adverse effects on this minority population.

3.2.8.3. Public Health

Good health is essential to cultural sustainability and socio-economic development and is a prerequisite to human productivity and development (Basavanthappa, 2008). Communities develop their own healthy or unhealthy patterns of interaction resulting from the interrelationships between many systems (social and organizational) within each community. Individual status, roles, and positions function together in an attempt to achieve goals of these systems. This is demonstrated by the relationships between subsistence hunting of bowhead whales and whaling crew structures in Iñupiat society. Subsistence food gathering is not only central to Iñupiat culture, but also to survival and good health (GAO, 2003).

Good health comes from socio-cultural identities incorporating their traditions, values, and norms that are accepted and reinforced, placing priorities on prevailing attitudes and values about health and illness, and about utilizing traditional medicines such as food to maintain a community's health.

Fuel and shipping costs to get food and supplies to villages varies across Alaska and is dictated by region. These high costs create higher food prices, directly impacting community health. Any real or perceived decrease in subsistence harvests coupled with higher food prices results in the availability of less nutritious foods and resulting "food deserts." Further, lack of accessibility to a variety of reasonably priced nutritious and fresh foods or subsistence harvest foods can be an obstacle to achieving the recommended daily diet (Block and Kouba, 2006). Research shows that people in low income communities pay proportionately more for food than people living in higher income communities. In the NSB this issue, along with others, plays a role in EJ, public health, and economic sustainability. Research shows there is an association between under-nutrition, malnutrition, high obesity rates, and decreased economic and social resources (Black and Macinko, 2008).

In terms of pounds, approximately one-third of the village of Nuiqsut's annual subsistence harvest is marine mammals (fish and caribou dominate the rest), of which bowhead whales contribute by far the most (Fuller and George, 1999).

Kaktovik residents primarily utilize marine mammals and in terms of pounds per person harvested Whales comprise 64% of the subsistence harvest, the highest percentage of diet. Land mammals and fish were also important harvests and many resources, such as birds, eggs, and vegetation, are utilized by the majority of the community, but had lower harvest levels in terms of pounds and percentage per person. Per capita, subsistence harvests for Kaktovik was 885.60 pounds (NSB, 2005)

3.2.8.4. Economy

The NSB is a mixed economy, characterized by a traditional cash economy and subsistence economy and has high unemployment and underemployment.

Outer Continental Shelf oil and gas activities generate economic benefits for the NSB in the form of direct and indirect employment, increasing personal income, and various types of revenues to the local government. NSB receives revenues primarily from property taxes from high value onshore oil and gas infrastructure. For a more detailed description of the structure and composition of the NSB economy, see the BOEM study on the "North Slope Economy, 1965 to 2005" (USDOI, MMS, 2006c).

3.2.9. Archaeological Resources

Archaeological resources/historic properties in the vicinity of the Colville River may be found both offshore and onshore. Within these locations, archaeological resources/historic properties are identified and discussed as either prehistoric or historic.

Offshore Archaeological Resources

Offshore cultural resources include historic and prehistoric cultural resources. Submerged historical resources include shipwrecks, aircraft, and objects or sites of historical importance. Submerged prehistoric cultural resources may include archaeological sites now buried below the seabed. Submerged prehistoric archaeological sites may be found in the Beaufort Sea in areas with water depths less than 200 ft. (60 m) (USDOI, MMS, 2007). The present day 200-ft (60-m) isobath is the location of the shoreline 15,000 years ago when the sea level was much lower. Current archaeological theories assert that human populations were moving into North America from Asia across the Bering Land Bridge (Goebel and Buvit, 2011; Holmes, 2011; Potter, 2011).

The Beringian Standstill Hypothesis received attention recently after Hoffecker et al., (2014) pointed out that ancestors of North America’s indigenous population had stayed in Beringia for almost 10,000 years. Genetic evidence shows that they migrated from Northeast Asia. DNA samples indicate that Native Americans lived isolated in Beringia for 10,000 years, around 25,000 years ago. With the melting of the Pleistocene ice sheets, the first migration to the Americas occurred nearly 15,000 years ago. Along this portion of the now submerged shelf, relic terrestrial landforms provide indicators of areas where there is a higher potential for archaeological sites to occur. The area under consideration is considered the most Easterly portion of Beringia.

Onshore Archaeological Resources

Information for some of the known archaeological sites onshore in the vicinity of the Colville River Delta in the Proposed Action area is in the Alaska Heritage Resources Survey (AHRS) File (ADNR, 2014). Archaeological information for sites west of Oliktok Point is known to BOEM. BOEM requested archaeological reports for sites in the 2014 Proposed Action area, extending about 1- ¼ miles east of Oliktok Point, and effects on sites in this narrow strip of land will be assessed on receipt. SAE reports that an archaeological survey by a qualified and experienced archaeologist is scheduled to begin in June 2014.

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4.0 ENVIRONMENTAL CONSEQUENCES

The following subsections analyze potential direct, indirect, and cumulative effects on environmental resources as a result of Alternative 1 - No Action, and Alternative 2 - Proposed Action.

Each alternative is analyzed for direct and indirect effects to the resources identified in Section 3.0. The analysis also identifies, where appropriate, mitigation that could be used to limit adverse effects. Potential cumulative effects are then discussed under each resource category. Each cumulative effects subsection discusses past, present, and reasonably foreseeable future actions that could affect each resource, and analyzes the potential for the Proposed Action to contribute incrementally to these impacts. The cumulative effects scenario (past, present, and reasonably foreseeable activities in the Proposed Action area) is presented in Appendix B. The cumulative effects analyses tier from the cumulative effects analyses in the previous, broader-scope NEPA documents cited in Section 1.3.

A level of effect determination (i.e., negligible, minor, moderate, or major) is provided by resource. Level of effect definitions are provided in Appendix A.

Fuel Spill Scenario. This EA considers the impacts of one accidental refueling spill. Refueling of the vessels will take place at West Dock or by delivery from an approved vessel (SAE, 2014, p. 12). All fueling will occur in accordance with applicable regulations and SAE spill prevention practices (SAE 2014, p. 12). For purposes of analysis, a seismic vessel transfer spill during refueling was estimated to have a volume range from <1-13 bbl (USDOI, BOEMRE, 2010a, b) for Alternative 2. The <1 bbl minimum volume represents a fuel spill where dry quick disconnect and positive pressure hoses function properly. The 13 bbl maximum spill volume represents a spill where spill prevention measures fail and fuel lines rupture. For Alternative 2 fuel spills could range from zero bbl if no fuel spills occur to <1 bbl-13 bbl if there is a spill during refueling, and spill prevention equipment functions properly (<1 bbl) or fails completely (13 bbl).

Previous NEPA analyses, such as those for Statoil, ION and TGS (USDOI, BOEMRE, 2010a, b; USDOI, BOEM, 2012; USDOI, BOEM, 2013) determined a <1-13 bbl spill would be localized and temporary. A <1 bbl fuel spill could persist for up to 30 hours in open water and up to 5 days in broken ice; a 13 bbl fuel spill could persist for up to 2 days in open water and up to 10 days in broken ice. Although SAE is not planning on operating in ice, ice blowing into the Proposed Action area or oil spreading into ice was considered for estimates of fuel oil persistence.

4.1. Alternative 1 – No Action

4.1.1. Direct and Indirect Effects

Under Alternative 1 –No Action, BOEM would not approve the 2014 SAE G&G Seismic Survey Application #14-02 and SAE’s proposed seismic survey would not occur in areas under jurisdiction of the United States. Not issuing the permit for the survey could result in delay in understanding of the geophysical makeup of the U.S. Beaufort Sea, a loss or delay of opportunities for discovery and extraction of natural resources, and any associated economic benefits. It might also delay the acquisition of information on the extent of OCS oil and gas resources, and the ability to evaluate the evolution of the petroleum system at the basin level, including identifying source rocks, migration pathways, and play types.

There would be no disturbance attributable to the Proposed Action of any resources described in Section 3.0. Thus, there would be no effects on air or water quality, fisheries, lower trophic populations, fish, marine and coastal birds, marine mammals, polar bears, access to subsistence harvest, or on archaeological resources.

4.1.2. Cumulative Effects

The Arctic Ocean ecosystem is rapidly changing, with melting sea ice and increasing sediment input from numerous regional river systems. Open-water seasons are longer than in years past, allowing for increased sunlight and a reduction in multi-year ice. Activities currently ongoing in the U.S. Arctic region or which may occur in the foreseeable future and affect OCS resources include: increased marine vessel and air traffic, fuel and petroleum spills, permitted and non-permitted discharges, long-distance aerosol-transported pollutants, climate warming, sea ice melting, ocean acidification, and risk of invasive species from ship hulls and deployed equipment. Specific activities known to be scheduled to occur during 2014 are summarized and included in Appendix B.

The 2006 Seismic PEA provides detailed descriptions of past activities, reasonably foreseeable future activities, and the environmental consequences of these activities in the Beaufort Sea. If the Proposed Action does not take place, no additional effects would be added to the effects associated with ongoing or reasonably foreseeable future activities in the U.S. Beaufort Sea.

4.2. Alternative 2 – Proposed Action

4.2.1. Air Quality

4.2.1.1. Direct and Indirect Effects

The operation of diesel marine propulsion and auxiliary engines on seismic survey vessels would cause direct and indirect emissions of potentially harmful air emissions. An evaluation of the Proposed Action's inventory of projected emissions, together with meteorological considerations such as local wind speed and direction, was conducted to predict the air quality level of effect onshore. A thorough description of the evaluation is included in Appendix C and includes the inventory of projected emissions.

The calculation of projected emissions shows the vessels cause emissions of nitrogen oxides (NO_x) to exceed the *de minimis* threshold of 100 tons. The remaining pollutants of projected emissions are below the 100-ton *de minimis* threshold. Pollutants with *de minimis* emissions are considered to not cause a measurable effect onshore.

Persistent oceanic winds that extend inland over the featureless expanse of the Colville River Delta will disperse and mix emissions of NO_x within the surrounding clean air. This would decrease the likelihood of measurable surface-based concentrations onshore. The itinerant and temporary conditions under which the survey and support ships operate further disperse the emissions.

As a result, the quality of onshore air will remain better than required by Federal standards and would have a negligible level of effect on coastal air quality.

4.2.1.2. Cumulative Effects

Small villages and towns upwind of the Colville River Delta operate permanent emission sources. Larger sources of emissions exist associated with the oil and gas activities of the more populated and industrial areas of Kuparuk and Prudhoe Bay. Onshore air quality impacts from these near-shore locations would be likely only when winds are from northerly directions. Marine traffic occurring during the same time and general area as the Proposed Action reflect temporary and transient emission sources. Onshore air quality impacts from these offshore locations would be likely only when winds are from a northerly direction. Prevailing winds during the Proposed Action are from the east-northeast (see Appendix C, Figure C-4). Even so, pollutant monitors positioned in the vicinity of Nuiqsut, Alaska, show pollutant concentrations of $NO_{x,}$ the most prevalent pollutant, to be 60% below the National Ambient Air Quality Standards (NAAQS) (ADEC, 2011).

Mixing, dispersion, and transport of emissions result not only due to the wind direction, but from increased wind speed. The offshore waters of the Beaufort Sea typically experience steady winds averaging 12 miles per hour (mph) (5.36 m/s) during the period from July through October (see Appendix C, Figure C-3).

As such, neither the permanent emission sources nor itinerant emissions from vessels had, or are having, an effect sufficient to increase pollutant concentrations to levels that threaten to equal or exceed the NAAQS. When combining the effects of the existing sources, together with the negligible effects of the Proposed Action, measurable cumulative effects are unlikely. Thus, the Proposed Actoin, when considered cumulatively with past, present, and future emission sources, would cause a negligible level of effect to onshore air quality.

4.2.2. Water Quality

4.2.2.1. Direct and Indirect Effects

The Proposed Action would occur in the Colville River Delta, in Eastern Harrison Bay nearshore and offshore marine environments, on coastal lands, and on two barrier islands during the period of July – October 2014. The level of effects of the Proposed Action on water quality during July to October, 2014 would be negligible. Depending on the specific activity, the effects would be localized (e.g., node placement and retrieval) or dispersed (e.g., source vessel discharges).

The potential direct and indirect effects from the Proposed Action on water quality include the following:

Insertion and Retrieval of Receiver Nodes. SAE proposes to insert nodes in seafloor, river delta, coastal land and barrier island environments. The insertion and retrieval of nodes would cause temporary degradation of water quality at these localized sites from increased suspended sediment and turbidity.

Vessel Discharges (100 personnel based at sea). Vessel discharges and deck runoff would cause degradation of water quality in localized surface and near-surface water due to particulate and contaminants in the wastewater. Concentrations would be highest near the vessel at the point of discharge from the vessel.

Non-point Runoff. Staging activities at coastal sites and repeated shallow-water craft landings could cause physical disturbance, sediment runoff and constituent runoff that would temporarily affect water quality at localized sites.

Potential for Introduction of Invasive Species. Potential vectors for introducing aquatic invasive species include fouled vessel hulls, ballast-water discharge and equipment placed overboard (e.g., anchors, seismic airguns, hydrophone arrays, ocean-bottom-nodes). Aquatic invasive species can cause effects on water quality through shifts in fauna that could affect nutrient uptake and distribution in the water, clarity of the water column, and introduction of pathogens into the water.

Accidental Fuel Spill. An accidental small fuel spill (<1 to 13 bbl) while refueling the source vessel would cause temporary water quality degradation in surface waters from introduction of diesel fuel hydrocarbons. This type of spill in open water could persist at the water surface for up to 2 days before volatizing and dissipating. If broken ice is present and prevents the fuel from spreading and dissipating, the fuel would persist on the water surface for up to 10 days.

4.2.2.2. Cumulative Effects

Past activities in the region include exploration drilling, seismic surveys, and shipping traffic. Activities that are known to likely occur in the reasonably foreseeable future include additional seismic surveys, geological surveys, and scientific research surveys. Two seismic operations (BP

Exploration (Alaska) Inc. (BPXA) - OBN Seismic Survey and BPXA - Shallow Hazard Survey) will be conducted in the Eastern U.S. Beaufort Sea during the 2014 open water season. These surveys, conducted in Prudhoe Bay and Foggy Island Bay areas of the U.S. Beaufort Sea, will not overlap with the Proposed Action in time. However, these surveys will occur in the same general area and in the same summer open water season as the Proposed Action.

Climate change in the Arctic is also currently affecting sea surface temperature, thickness and extent of sea ice, and sea water pH.

Mitigation: Prior to beginning work, the operator would receive permits required by EPA (under the Clean Water Act); the State of Alaska Department of Fish and Game (anadromous and resident fish); Department Natural Resources (land use, water withdrawals); and Department Environmental Conservation (wastewater, solid waste). Coast Guard regulations (33 CFR Part 151) that are in place are intended to reduce the transfer of invasive species from vessels brought into the State of Alaska or Federal waters. SAE and its contractors would be expected to follow the requirements of its Fluid Transfer Procedure. The requirements in these permits and the procedures would mitigate some of the potential effects of the Proposed Action on water quality.

Overall, the cumulative effects of the Proposed Action on water quality from past, current, and reasonably foreseeable future activities would be minor.

4.2.3. Lower Trophic Levels

4.2.3.1. Direct and Indirect Effects

Direct effects of the Proposed Action on lower trophic organisms may result from the energy emitted by air guns during the 3D survey and the potential of a small fuel spill. Indirect effects may also result from the disturbance of lower trophic populations due to vessel operations and the disturbance of benthic surfaces and epifaunal organisms during the deployment and retrieval of seismic nodes.

Air gun energy for this survey is expected to have an estimated source level of 255 dB re 1uPa @1m. Due to the energy levels involved, distances of exposure from the energy of the air guns, and populations of planktonic organisms expected to be found in the survey area that would potentially be affected by the operations of the vessels, these effects are expected to be negligible.

There is potential for a fuel spill during refueling operations. As described above (under Fuel Spill Scenario), a potential spill would be of low volume and persistence. Should a fuel spill occur, it would be localized and temporary and only effect upper pelagic and surface plankton organisms. These effects would be negligible to lower trophic populations.

Vessel operations would have only a localized and negligible effect to populations of lower trophic organisms. This is due to the low impact on typical populations of planktonic organisms that would potentially be affected by the operations of the vessels. The nodes deployed and retrieved for the purpose of recording and downloading data are expected to have a maximum weight of 65 lbs, with a water buoyancy effect of lowering that weight by approximately 25% upon deployment. The number of nodes and receiver placement will be adjusted for cultural sites, wildlife, and geographic features. Approximately 6 strokes, or receiver lines oriented in a North - South direction, will be needed to cover the survey area for both water and land. The potential of effects of deployment and retrieval of nodes on benthic surfaces would be minimized by the relatively low weight of the nodes and their low potential to cause more than a temporary (less than a week) disturbance to the benthic surface. These receiver lines will be deployed on the ocean bottom and on land with a minimum spacing of 660ft (201 m) and up to 880 ft (268.2 m) between lines. The source vessel will travel perpendicular over the offshore receivers along lines oriented in a East-West direction (parallel to the coastline) with a minimum spacing of 990 ft (301.8 m) and up to 1100 ft (335.8 m) between lines The areal coverage of the survey is expected to be 463.40 mi^2 (1,200 km^2) at maximum. Assuming a 1 ft^2 (0.093 m^2)

disturbance of benthic sediment, this translates to approximately 0.00532 mi^2 (0.014 km^2) coverage of the nodes from the 463.40 mi^2 (1,200 km^2) total area of the survey, which leads to a conclusion of a negligible effect when considering the entire Proposed Action area.

4.2.3.2. Cumulative Effects

Cumulative effects that may be currently influencing lower trophic populations in the Arctic region and the Proposed Action area include the presence and transit of cargo barges, cruise ships, research vessels and ongoing oil and gas industrial activities (refer to Appendix B, Cumulative Effects Scenario). Ocean acidification due to increased carbon dioxide in the atmosphere is also documented as ongoing and is currently one of the main effects on water quality which subsequently potentially effects lower trophic populations in the region.

Given the local and temporary potential impact to lower trophic populations from the Proposed Action, the incremental impact to lower trophic populations when added to these other cumulative factors would still be negligible.

4.2.4. Fish

4.2.4.1. Direct and Indirect Effects

The Proposed Action would occur in the Colville River Delta, in Eastern Harrison Bay nearshore and offshore marine environments, on coastal lands, and on two barrier islands during the period of July – October 2014.

Potential Effects on Fish:

Fish that occur in the lower Colville River, Colville River Delta, coastal areas, and nearshore areas would experience effects from the Proposed Action, including the following:

Insertion and Retrieval of Receiver Nodes. Nodes inserted into the seafloor, delta, coastal land, and barrier island environments would cause physical disturbance to fish occupying the benthic habitat (e.g., Arctic flounder sculpin species, saffron cod eggs). Fish would be affected by increased suspended sediment and decreased visibility in the water column which could interrupt feeding and reproductive activities and could alter migration routes into and out of the riverine system.

Water Withdrawals. Water withdrawn to operate hydraulic equipment (bury and retrieve receiver nodes) could entrain fish eggs, fish larvae, and small fish. Morbidity and mortality would result in a localized area of the water withdrawal.

Airguns and Vessel Noise. Vessel noise and airgun shots would ensonify the marine and estuarine environment. The noise could affect the natural sound levels and could cause scattering of fish, reduce feeding efficiency, disturb sensory orientation, disrupt reproductive activities, alter migratory pathways, and scatter the prey of fish species. (Fay, 2009; Radford et al., 2010; Simpson et al., 2010; Slabbekoorn et al., 2010; Purser and Radford, 2011).

Vessel Discharges (100 personnel based at sea). Fish near the vessel would be exposed to temporary water quality degradation in localized surface and near-surface water due to particulate and contaminants discharges from vessels and deck runoff. The type and degree of effect of these discharges would depend on the species, life stage, location of fish relative to the discharge, concentration in the discharge, and exposure time. Early life stages of fish - eggs, larvae and young of year – would be more vulnerable to vessel discharges than adult fish due to a relative lack of mobility and sensitive period of growth. Morbidity and mortality of young life stages could occur in localized areas.

Non-point Runoff. Fish close to the coastal staging areas and repeated shallow-water craft landings would be affected by disturbance of physical habitat, sediment runoff, and constituent runoff that would affect water quality at localized sites. Runoff could reduce visibility and expose vulnerable stages of fish to sediment and other constituents. The type and degree of effects would depend on the species, life stage, habitat occupied, and location relative to the staging activities. Morbidity and mortality of young life stages could occur in localized areas.

Potential for Introduction of Invasive Species. Potential vectors for introducing aquatic invasive species include fouled vessel hulls, ballast-water discharge and equipment placed overboard (e.g., anchors, seismic airguns, hydrophone arrays, ocean-bottom-equipment). Aquatic invasive species can cause effects through competing or overtaking habitat (e.g., encrusting surface areas), competing for food sources, competing for spawning grounds, preying aggressively on native species, or introducing pathogens.

Accidental Fuel Spill. An accidental small fuel spill while refueling vessels at sea or in coastal waters would expose fish to petroleum hydrocarbon toxicity in the surface water at the site of the spill. Young life stages of fish that are relatively immobile would be exposed to a high concentration of diesel fuel at the site of an accidental spill which would result in morbidity or mortality of those affected.

The level of effects of the Proposed Action on fish during July to October 2014 would be negligible. Depending on the specific activity, the effects would be localized (e.g., node placement and retrieval) or dispersed (e.g., airgun discharges from source vessel over the Proposed Action area).

Mitigation. The operator would apply for and hold permits required by EPA (under the Clean Water Act); the State of Alaska Department of Fish and Game (anadromous and resident fish); Department Natural Resources (land use, water withdrawals); and Department Environmental Conservation (wastewater, solid waste). Coast Guard regulations (33 CFR Part 151) that are in place are intended to reduce the transfer of invasive species from vessels brought into the State of Alaska or Federal waters. SAE and its contractors would be expected to follow the requirements of its Fluid Transfer Procedure. The requirements in these permits and the procedures would mitigate some of the potential effects of the Proposed Action on fish.

4.2.4.2. Cumulative Effects

Past activities in the region include exploration drilling, seismic surveys, and shipping traffic. Activities that are known to likely occur in the reasonably foreseeable future include additional seismic surveys, geological surveys, and scientific research surveys. Two other seismic operations (BPXA-Alaska Ocean Bottom Seismic Survey and BPXA-Alaska Shallow Hazards Survey) will be conducted prior to the Proposed Action in the U.S. Beaufort Sea. However, these actions will not overlap in time with the Proposed Action.

Climate change in the Arctic is also currently affecting sea surface temperature, thickness and extent of sea ice, and sea water pH, which in turn affects fish.

Overall, the cumulative effects of the Proposed Action on fish from past, current, and reasonably foreseeable future activities would be minor when considering the effects on the scale of the southern U.S. Beaufort Sea off the coast of Alaska.

4.2.5. Marine and Coastal Birds

4.2.5.1. Direct and Indirect Effects

Potential effects of the Proposed Action on coastal and marine birds are summarized in categories of:

- Disturbance from the physical presence of vessels and field crews.
- Disturbance from noise by vessels or seismic airguns.
- Birds encountering vessels.

Vessel activity could disturb birds. Flocks of migrating or flightless birds would generally move away from vessel activity. There is an energetic cost to repeatedly moving away from vessel disturbances as well as a cost in terms of lost foraging opportunities or displacement to an area of lower prey availability. Seismic survey activity is expected to have localized disturbance effects on certain marine bird species that are distributed across the Proposed Action area. The more abundant species (long-tailed ducks, common and king eiders) would be affected more than ESA-listed species that are less common in the Proposed Action area. Migrating birds would likely experience temporary impacts as they moved through the Action Area. Molting birds could be disturbed repeatedly if they were unable to relocate (i.e., flightless) to another area when seismic operations were occurring.

Field crews would conduct land-based operations during the nesting season. Individual nests may be disturbed repeatedly by field crew activity and helicopters. When disturbed, the female tends to flush from the nest. These nests may be abandoned and the eggs or young could die or be eaten by predators. This potential mortality would be considered a moderate level of effect.

During the course of normal feeding or escape behavior, some birds could conceivably be near enough to an airgun to be injured by a pulse. However, a bird would have to be very close to the airgun to receive a pulse strong enough to cause injury. Birds are most likely to move away from slow-moving seismic vessels well in advance of the towed seismic-airgun array. Flightless birds at sea remain capable of slowly moving away from disturbances as well. Therefore, with respect to injury to birds in offshore waters due to airguns, a negligible level of effect is expected.

Seabirds, attracted to lights and vessels in nearshore waters, could collide with a vessel and be injured or killed. Marine and coastal birds could be disoriented by storms or collide with vessels during inclement weather (e.g., fog, rain) or darkness. Additional scientific evidence indicates that many birds have poor frontal vision in flight and some species may be temporarily blind in the direction of flight (Martin, 2011). Vessels operating in marine environments often encounter passerines and shorebirds species when the birds are migrating.

In 2012, Shell Gulf of Mexico, Inc. and Shell Offshore, Inc. (collectively referred to as Shell) reported that at least 131 birds were observed on their drilling and support vessels (Schroeder, 2013). It appeared that birds sought refuge on a vessel in inclement weather, used it to rest, and continue migration. However, of the 131 birds observed, 83 (63%) were found dead. The causes of mortality are unclear. Klem (1990) noted that external injuries are not always obvious signs that a collision has occurred. It appeared that in some cases, exhausted birds alighted on a vessel, but did not survive. In other cases, some injuries and mortalities strongly indicated birds collided with vessel structures and died or later succumbed to injuries. Industry reported 18 bird/support vessel encounters during the 2013 open-water season, with a much reduced number of vessels in operation (Schroeder, 2014).

Based on the 2012 Shell bird encounter reports, SAE could experience an estimated 56 (8 vessels, 7 encounters per support vessel per season) bird encounters over their operational period; this is a conservative estimate and not all encounters would be expected to be fatal. On average, shearwaters, auklets and passerines would be the most frequent species groups anticipated to be reported, but as the SAE vessels would operate much closer to shore than the Shell fleet did, especially later in the open-water season, a larger proportion of seaducks and passerines would be expected. The number of bird/vessel encounters/strikes affecting a broad diversity of species over a season would not be expected to affect any particular bird population. The level of bird mortality from vessel collisions for most species would be considered a moderate level of effect.

While no listed eiders or yellow-billed loons were documented by Shell to interact with their vessels, king and common eiders and a grebe were reported. These reports suggest that it is possible listed spectacled or Steller’s eiders or a loon could be involved in future vessel encounters, but it is unlikely. SAE would work primarily in areas nearer to shore where ESA-listed bird densities are typically higher. An eider or yellow-billed loon killed striking an SAE vessel would not be considered a significant effect because these species populations appear stable and the loss of an eider or loon could be recovered in a generation.

This assessment is predicated on implementation of specific mitigation measures, including SAE reporting specific information to BOEM on all birds found on their project vessels within specified timeframes while operating in the Beaufort Sea. This reporting is intended to allow BOEM (and USFWS) to monitor the incidental take under the ESA and to review or modify ongoing SAE operations if large numbers of migratory birds or ESA-listed species are being harmed.

Overall, the Proposed Action is expected to have a moderate level of effect on marine and coastal birds.

4.2.5.2. Cumulative Effects

The level of effects for the Proposed Action with respect to marine and coastal birds is moderate. When considered in combination with other past, present, and reasonably foreseeable actions (Appendix B), effects on marine and coastal birds would remain moderate. Past projects include seismic surveys and exploration drilling, but the effects of these projects were temporary and no longer impact marine and coastal birds. Two BPXA seismic projects will be conducted prior to the Proposed Action in the U.S. Beaufort Sea. These activities would not combine to appreciably increase the level of effect on marine and coastal birds because the impact of the Proposed Action is relatively and incrementally small on any particular bird species.

4.2.6. Marine Mammals

4.2.6.1. Direct and Indirect Effects

The potential effects from geological and geophysical surveys on marine mammals in the Beaufort Sea were evaluated in the 2006 Seismic PEA (USDOI, MMS, 2006a), the NMFS Biological Opinion (NMFS, 2013), and the USFWS Biological Opinion (USFWS, 2012). Both the NMFS BO and the USFWS BO provide mitigation measures with which SAE must comply. An SAE permit from BOEM would also require that a copy of the NMFS IHA and USFWS LOA be received by BOEM prior to conducting seismic operations (NMFS, 2013). The analyses for marine mammals below are predicated on the implementation of the mitigation measures in these documents (typically included measures are described in Chapter 2 of this EA), which substantially reduces potential effects on marine mammals. Potential effects of the Proposed Action on marine mammals are summarized in categories, as follows:

- Disturbance from the physical presence of vessels and human activity.
- Disturbance from the positioning and retrieval of nodes and ropes.
- Disturbance from vessel and seismic airgun noise.
- Vessels striking marine mammals.
- Animal entanglement in lines or cables (collisions).
- Fuel spills during refueling. Refueling may occur at sea or onshore and will comply with applicable regulatory requirements.

Physical Presence of Vessels. Generally, walruses, polar bears, and ice seals enter the water if approached too closely by vessels. PSOs and vessel crew would be on constant look-out for marine mammals on ice or in the water and would avoid disturbing them with close approaches. Careful monitoring and avoidance procedures (as described in Chapter 2) will minimize impacts to marine mammals from vessel presence.

Vessel and Airgun Noise. Vessels have a transient presence in any location, normally having limited effects on marine mammals because marine mammals can detect and avoid vessels (Richardson et al., 1995a; Richardson et al., 1995b) Vessels produce continuous low frequency sounds, frequently around 160 dB, that are perceptible to marine mammals; however, these noise levels quickly attenuate in the marine environment, so vessel noise should have negligible effects on marine mammals. SAE has applied for an IHA for the 2014 Proposed Action. If issued, the IHA will include appropriate exclusion zones for Level B Harassment from 160 dB airgun noise (such as described in Chapter 2).

The area of effects from operating airgun arrays often extends to 12 miles (19 km), as evidenced by bowhead whale behavior in the vicinity of operating airguns (Richardson et al., 1995b). The larger area of effects for operating airguns would act to divert most marine mammals away from an active seismic survey, long before the less intense vessel noise, becomes a concern. In the absence of active airgun arrays, the mitigations prescribed by the 2013 NMFS BO and the 2012 USFWS BO would act to reduce impacts to negligible levels of effect. The analyses for marine mammals are also predicated on SAE's compliance with the IHA and LOA that may be issued by NMFS or the USFWS, respectively, in 2014.

Airgun arrays produce pulsed sounds, typically in 8–14 second intervals, with most energy releasing in a narrow frequency range below 1 kHz. NMFS uses a 160 dB sound source level as the standard to assess Level B harassment impacts including incidental takes. PSOs would monitor the exclusion zones according to procedures outlined in the appropriate BO (NMFS, 2013; USFWS, 2012) and based on mitigation measures typically imposed by the NMFS IHA and USFWS LOA, a negligible level of effect on marine mammals is expected.

For marine mammals that do not avoid approaching vessels and resulting sound sources, operational procedures identified in the SAE 2014 plan of operations, mitigation measures in the NMFS BO (NMFS, 2013) and USFWS BO (USFWS, 2012), and typical mitigation measures in the NMFS IHA and USFWS LOA would reduce or eliminate potential effects on marine mammals. Accordingly, if PSOs observe a marine mammal entering the exclusion zone, the airgun arrays would be powered down or follow complete shut down and ramp up procedures. Power downs reduce the size of the exclusion zone and most marine mammals avoid seismic operations in open water and therefore, full shutdowns are seldom necessary.

Collisions. The absence of collisions involving industry vessels and marine mammals in the Arctic despite decades of spatial and temporal overlap suggests collision probabilities are low (NMFS, 2013). Seismic surveys move slowly, at speeds of around 5 kts and change direction slowly. As described in Chapter 2, vessels will avoid closely approaching marine mammals. Walruses and seals are quick and agile in the water making them unlikely be injured by large slow-moving vessels. No vessel/marine mammal collisions would be expected to occur as a result of the Proposed Action.

Entanglement. Entanglements of certain species (dolphin, ray, and sea turtle) have occurred in the Gulf of Mexico (GOM) as a result of ocean bottom cable surveys. None of these species occurs in Alaskan waters, and no entanglements with lines or cables during ocean bottom surveys have been recorded offshore in Alaska. There are low numbers of mammals likely to be present in the Proposed Action area, and these animals would tend to avoid noise and activity associated with the survey (as described above). In addition, the weighted lines used in this survey are designed to lie on the ocean bottom rather than float. Furthermore, NMFS and FWS were made aware of the entanglements in the GOM; they did not deem entanglement to be in an issue in Alaska. USFWS and NMFS have received LOA and IHA applications from SAE for 2014. No entanglements are anticipated to occur as a result of the Proposed Action.

Vessel Re-Fueling. A 13 barrel fuel spill is the maximum spill that could occur from the Proposed Action. A spill of this size and unchecked would disperse quickly and volatize over a relatively small geographic area. A 13 barrel spill would be unlikely to affect marine mammals. The effects of refueling spills up to 9 bbl were analyzed by NMFS (2013) and the effects were deemed negligible.

ESA-Protected Marine Mammals

Bowhead Whales.

Bowhead whales detect and respond to noises in their environment, sometimes at considerable distances. Avoidance behavior is believed to reduce injury risks to bowhead whale ear and hearing structures. The Proposed Action would occur after most bowhead whales have migrated to summer feeding grounds in the Canadian Beaufort Sea. The SAE operations plan commits to survey the northern portion of the Proposed Action area first, where waters are deeper, and to gradually conduct the survey southward, pausing during the fall bowhead whale migration and the subsistence whaling season. The Proposed Action would place the survey in very shallow waters, and as far from migrating bowhead whales as possible in an area that cannot support the presence of bowhead whales. Moreover, few bowhead whales have been observed in the Proposed Action area during decades of BOEM sponsored aerial surveys and tagging studies (Clarke et al., 2011; Quakenbush et al., 2013; Clarke et al., 2012; Clarke et al., 2013).

Effects of vessel noise on bowhead whales should be less when airguns are active, due to the increased noise and geographically larger areas of effect from airgun noise. Studies of bowhead whale responses to airgun noise indicates most bowhead whales deflect from seismic activity by about 12 miles (19 km) unless engaged in feeding or social activity. Avoidance at 12 miles would keep bowhead whales away from the Proposed Action, long before vessel noise or presence becomes detectable. Consequently, vessel presence and noise would pose very remote risks to bowhead whales when seismic surveys are conducted. During periods when airguns are inactive there is potential for vessels to strike bowhead whales; however, bowheads are capable of detecting and avoiding slow moving vessels. The 2013 NMFS BO determined the risks of vessel strikes to bowhead whales are so remote as to be discountable. Moreover, vessel noise makes bowhead whales aware of vessel locations when airguns are inactive and would provide bowhead whales the opportunity to avoid vessels, unless the whales are engaged in activities requiring their full attention. In such instances, bowheads have been known to show a great deal of tolerance to vessel presence and seismic survey activity.

Neither fuel spills or line entanglements pose a threat to bowheads, since any spent fuel would be limited in extent, disperse rapidly, and quickly volatize into the atmosphere, while node lines would be constructed of heavier than water material that sinks to the sea floor so as not to entrap whales (see also the discussion on entanglement above).

The few bowhead whales that could potentially be disturbed by the Proposed Action prior to their fall migration would be protected by mitigations outlined in the 2013 NMFS BO, and the typical mitigation measures which would be included in IHA/LOA authorization., Such mitigation measures should ensure that impacts from vessel noise and presence, airgun noise, fuel spills, and node line entanglement have negligible levels of effect. A small bowhead feeding concentration area exists north of Bodfish Island. A few individuals or small groups of bowhead whales could be encountered in this location before or after the main fall bowhead whale migration out of the Beaufort Sea. Disturbances would be brief and mitigation commitments from typical IHA/LOA authorizations, if issued, would ensure a negligible level of effects to bowhead whales.

Bearded and Ringed Seals.

Ringed and bearded seals depend on sea ice for resting during Arctic summers. The distances between the ice front and Proposed Action area during the open water season, dearth of resources, and shallow water over most of the Proposed Action area should discourage most ringed and bearded seals from visiting the Proposed Action area. The Beaufort Sea supports a limited number of bearded seals due to the restricted extent of the continental shelf. Water depths in the Proposed Action area are mostly shallow and the seabed receives a large degree of ice-gouging during spring, which typically associated with poor species diversity and richness (Craig, Griffiths, and Johnson, 1984), limiting the habitat value to bearded and ringed seals. Thus, few ringed or bearded seals should be affected, or could potentially be encountered or affected by the Proposed Action because of the poor habitat quality of the Proposed Action area.

Furthermore, the shallow waters over the lower 88% of the Proposed Action area would greatly reduce the likelihood of a seal remaining undetected by PSOs. In terms of Level B Harassment, a minor to negligible level of effect to individual seals is expected from the Proposed Action. Mitigation measures in the NMFS BO and typical mitigation measures in a NMFS IHA (such as those described in Chapter 2) would prevent Level A Harassment from occurring.

Since ringed and bearded seals are regularly hunted by Alaska Native subsistence users, seals are expected to exhibit avoidance reactions to vessel traffic and noise. Noise from vessel operations should be insufficient to produce lingering effects among -ice seals and most seals should react to the sight of vessels well before any of the noise levels can cross the 190 dB and 160 dB NMFS Level A and B thresholds by avoiding the area. Past seismic surveys conducted in the Beaufort and Chukchi Seas have had minor to negligible disturbance reactions in ice seals who often respond with “spy-hopping” activity or remain in place to observe vessels and the seismic array as they pass (Brueggeman et al., 1992; Harris, Miller, and Richardson, 2001; Miller and Davis, 2002; Funk et al., 2010; Blees et al., 2010). The 2013 NMFS BO states:

> “As described in our Exposure Analysis (Section 2.4.2.3.5), we concluded that ringed seals were not likely to be exposed to vessels in close enough proximity to cause strike. Based on the relatively small number of vessels associated with oil and gas survey activities in the Arctic, the small number of activities being authorized by BOEM, the transitory nature of vessels, the minimal overlap with icebreaking activities and the subnivean period for ringed seals, the decades of spatial and temporal overlap that have resulted in minimal recorded mortalities on ice, and no mortalities in water, and the mitigation measures in place to minimize exposure of ringed seals to vessel activities, we concluded that the probability of a BOEM authorized vessel striking an Arctic ringed seal in the Beaufort or Chukchi Sea Planning Areas sufficiently small as to be discountable.” (NMFS, 2013)

Impacts to bearded and ringed seals that could arise from the Proposed Action would be restricted to disturbance or displacement effects caused by a seal’s avoidance of vessel presence and noise, helicopter presence and noise, and airgun noise. Helicopter activity is planned for onshore and nearshore areas unreachable by foot or vessel traffic and noise from aircraft, particularly helicopters, has been known to elicit startle reactions in ringed seals. Anticipated mitigation measures as identified in Section 1.3.4 of the 2013 NMFS BO and those typically included in a NMFS IHA should prevent Level A Harassment from occurring and should limit incidents of Level B Harassment. Level B Harassment may occur but effects are expected to be brief, without any lingering or chronic effects.

There should be negligible effects to ringed and bearded seals from the Proposed Action.

Walrus.

The Proposed Action in the Colville River Delta area is unlikely to overlap in space and time with walrus activity, but it is possible that an occasional walrus, or small walrus group, may occur in the area. Impacts would be limited to disturbance and displacement from the immediate area of the seismic operation. The Proposed Action would have a negligible level of effect on Pacific walrus.

Polar Bear.

For most of the year, polar bears appear to be insensitive to noise or other human disturbances (Amstrup, 1993). Polar bears may avoid human activities, or may be drawn to investigate. Reactions vary due to circumstances, with females accompanied by cubs being very cautious and protective. Vessels in the Proposed Action area may encounter a polar bear in water, resulting in short term disturbance. Polar bears typically swim with their heads above water which decreases the likelihood of impacts on their hearing from seismic airguns. Received sound levels near the surface are substantially reduced due to pressure release effects (Amstrup, 2003; Amstrup and DeMaster, 1988). SAE's activities will include PSOs stationed on sound source vessels who would power down or shut down operations should a polar bear approach or enter the designated exclusion zone.

There is the potential for human-bear interactions as crews conduct activities on shore. SAE will implement mitigation measures to avoid or minimize interactions with polar bears as described in their wildlife interaction plan, a USFWS LOA (if issued), and the 2012 USFWS BO. The Proposed Action would have a negligible level of effect on polar bears.

Other Marine Mammals

Beluga Whale

Research indicates beluga whales could be displaced by seismic noise (Erbe and Farmer, 2000), which could result in increased energetic losses, leading to reduced fitness. However, there would be little opportunity for beluga whales to be affected by the Proposed Action because most beluga whales concentrate along the shelf break in the Beaufort Sea during the Proposed Action timeframe. Accordingly, few if any belugas should occur within the Colville River Delta or in the nearshore shallows north of the river mouth. Belugas feed on fish in deep waters over the continental shelf break, and occasionally enter coastal waters to feed on anadromous fishes or molt. The seafloor in the Proposed Action area consists of materials unsuitable for belugas to use in molting, while most of the survey area waters are too shallow for belugas to effectively forage.

Belugas, if present in the vicinity of survey activities would be affected in a manner similar to bowhead or gray whales, i.e., belugas would avoid the area unless they are engaged in feeding or social activity. If belugas are encountered during the activities, it is anticipated that the typical monitoring and operational procedures in a NMFS IHA should reduce adverse effects—including disturbance from vessel presence and noise, airgun noise, entanglements, vessel strikes, or collisions—to negligible levels for beluga whales.

Gray Whale

Gray whales are anticipated to be affected in a manner consistent with what has been described for bowhead whales. Monitoring and mitigation procedures which are identified in the 2013 NMFS BO and typically included in a NMFS IHA would reduce adverse effects, including disturbance from vessel presence, vessel or airgun sounds, or collisions to a negligible level of effect on gray whales.

Spotted Seal

The Colville River Delta supports one of the few spotted seal haulouts on the Beaufort Sea coast. The use of aircraft, boat, and work activity on and around the haulout site(s) could induce spotted seals to respond by leaving or abandoning those site(s), perhaps permanently. Richardson et al. (1995b) noted studies (Frost and Lowry 1990; Frost, Lowry, and Carroll, 1993; Rugh et al., 1993) where spotted seals on beaches moved into the water when survey aircraft approached at altitudes of up to 305-760 m (1000-2500 ft) and up to 1 km (0.62 mi) horizontally from haulouts. The seals did return to the haulout sites after aircraft departed. Richardson et al. (1995b) suggests helicopter operations elicit greater responses among seals than other aircraft. Seals at haulouts respond to the sight and sound of aircraft with increased alertness and seek safety in the water. Such behavior indicates spotted seals may become more responsive to increasing aircraft operations, especially helicopter operations.

Spotted seals may be encountered during the Proposed Action, though much less often than bearded and ringed seals. Impacts to spotted seals would be consistent with those described for bearded seals and ringed seals. Monitoring and mitigations outlined in the 2013 NMFS BO are expected to reduce adverse impacts, including disturbance from vessel presence, vessel or airgun sounds, entanglements or collisions to a negligible level of effect for spotted seals.

Due to disturbances to coastal haulout(s) in the Colville River Delta there could be minor effects to spotted seals from the Proposed Action.

Conclusion

The levels of effect of the Proposed Action should be negligible for bowhead whale, gray whale, beluga whale, ringed seals, polar bears, and walrus. Levels of effect for bearded seals would be negligible to minor, and the effects on spotted seals would be minor.

4.2.6.2. Cumulative Effects

A Cumulative impact is the impact on the environment which results from the incremental impact of a Federal action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions. The level of effects for the Proposed Action with respect to bowhead, gray and beluga whales, ringed seal, polar bears, and walrus would be negligible, the level of effect on bearded seal would be negligible to minor, and the effects on spotted seals would be minor. Past projects include marine seismic surveys and exploration drilling, but the effects of these projects were temporary. One current seismic exploration project (North Prudhoe Bay 2014 OBS Geophysical Seismic Survey) is ongoing in the same sea as the Proposed Action. While seismic activities do have potential effects on bowhead, gray and beluga whales, ringed seals, polar bears, Pacific walruses, spotted seals, and bearded seals, the impacts of the Proposed Action are likely to vary from negligible to minor depending upon the species, as described above; therefore, they would not have an additive effect with other actions in the same sea.

4.2.7. Terrestrial Mammals

4.2.7.1. Direct and Indirect Effects

In their Wildlife Interaction Plan/Procedure, SAE’s states, “Do not take any actions that would cause the animals to change course or behavior unless approved by Alaska Fish and Game.” The state of Alaska permits onshore and coastal geophysical exploration with permits issued by Alaska Department of Natural Resources (ADNR), Division of Oil & Gas under 11 AAC 96.010, and Alaska Department of Fish and Game (ADF&G), which manages terrestrial mammal populations in Alaska.

Operations in the southernmost portion of the Proposed Action area would occur on the U.S. Beaufort Sea coast, Thetis Island, and gravel/mud bars and islands in the Colville River Delta and could affect terrestrial mammals. Airgun and vessel noise should have no effect on terrestrial mammals found in Arctic Alaska; however, subsistence and sport hunting occurs throughout Arctic Alaska and many animals have learned to avoid aircraft, watercraft, and vehicles associated with hunting. Consequently, aircraft, water craft, and vehicular noise and use could affect terrestrial mammals to some degree. Foot traffic typically does not disturb the larger mammals unless approached too closely, although grizzly bears occasionally attack people on foot in Alaska.

Small mammals such as voles, shrews, lemmings, Arctic hares, etc. would be unaffected by the Proposed Action; however, Arctic foxes, grizzly bears, caribou, and muskox could be affected. With the implementation of SAE’s Wildlife Interaction Plan/Procedure and the mitigation measures typically included in ADNR and ADF&G permits, the Proposed Action would result in a negligible level of effects to terrestrial mammals, with no population-level effects.

Grizzly Bears

Grizzly bears in the Arctic are territorial, and typically require large home ranges to support the needs of each bear. Consequently, a limited number of bears should occupy onshore elements of the survey area, likely numbering less than 10 individuals excluding cubs.

Grizzly bears sometimes panic when approached by low-flying aircraft, and in such instances bears tend to head for the nearest cover such as willows, to hide until the aircraft departs. In such an event, a female grizzly could become separated from her cubs, which could lead to cub deaths. Likewise vehicles tend to panic grizzlies (Stokowski and LaPoint, 2000) which could lead to similar reactions from bears.

If project personnel afoot encounter grizzly bears, the bear would most likely depart the area; however, circumstances may induce the bear to remain and attack. If food is carried into the field by people on foot, or improperly stored in camps or staging areas, bears could be attracted from several miles away, possibly leading to conflicts. However the low bear population density in the area lessens the probability of human-bear encounters. During summer, some bears visit the lower Colville River to feed on anadromous fishes, and the occasional seal or marine mammal carcass. Consequently, the Proposed Action has the potential to create conflicts with local grizzly bears in the form of a minor level of effects from aircraft, boat, or all-terrain vehicle noise and traffic, and a moderate level of effects for any bears killed in defense of life and property by personnel on foot. However, the protocols and mitigations in the SAE's Wildlife Interaction Plan/Procedure and required by ADNR and ADF&G are would lessen the severity of all impacts from the Proposed Action to negligible or minor for grizzly bears near the survey area.

Caribou and Muskox

Caribou and muskox regularly occur in coastal areas along the Beaufort Sea coast during the Arctic summer. Muskoxen tend to remain within their herd's home territory for most of the year, whereas most caribou in the area remain on the move. Air or boat traffic associated with offshore surveys could disturb caribou using shorelines, river bars, or islands, and would most likely be limited to periods of insect harassment (ADNR, 2009, pp. 8-18).

ADNR (2009) found motor vehicle and low-flying aircraft traffic can disturb caribou, particularly those with calves. Reactions by caribou tend to be highly variable, ranging from no responses to intense, injurious, escape responses. Reactions would depended upon distance from vehicle or aircraft, type, noise levels, activity; speed of approach; aircraft altitude; frequency of disturbance; demographics of the animals; herd size; and season, terrain, and weather. Furthermore, disturbances such as helicopter operations briefly displace animals from feeding and resting areas and so may have minor impacts on caribou.

Aircraft flying under 1,000 ft. have been known to frighten and scatter caribou and muskox herds and individuals, separate cows from calves, and possibly cause individuals to injure themselves. Furthermore, caribou or muskox cow-calf separations could easily lead to the death of unprotected calves. Responses to vehicle operations can also elicit similar panic and flight responses among caribou and muskox. Such responses could lead to attempted escape or flight activity by an animal, potentially leading to the animal's injury or death. Though muskoxen occur in small, scattered herds, the larger size of caribou herds suggests panicking a large herd could have lethal consequences for weaker herd members.

ADNR (2009) encouraged lessees to maintain aircraft altitudes > 1,500 feet, or lateral distances > 1 mile from caribou or muskox concentrations, excluding takeoffs and landings, and to incorporate recommendations from the final report to the Alaska Caribou Steering Committee (Cronin et al., 1994) in operational planning. The ADNR (2009) mitigations include altitude restrictions, timing restrictions, etc., while the SAE Wildlife Interaction Plan contains safety protocols for personnel. Compliance with these plans and published mitigations should limit project effects to negligible levels on caribou and muskox.

Arctic Foxes

Arctic foxes occur throughout Arctic Alaska including the coastal areas, and barrier islands in the Proposed Action area. They are naturally curious and typically habituate to aircraft, vessel, and vehicle traffic. Arctic foxes easily habituate to human activities and are attracted to poorly stored or discarded food. If birds and bird nests are disturbed, Arctic foxes ability to accumulate and cache food could be compromised. However Arctic foxes have high fecundity and turnover rates, so adverse effects from the Proposed Action would only affect a few individuals and not their population. Consequently, the Proposed Action would have a negligible effect on Arctic foxes.

4.2.7.2. Cumulative Effects

Those portions of the Proposed Action that occur onshore or nearshore could potentially affect terrestrial mammals. However, with the implementation of SAE's Wildlife Interaction Plan/Procedure and existing ADNR and ADF&G requirements, effects would be greatly reduced and lead to an overall negligible level of effects on terrestrial mammal populations. Two BPXA seismic projects will be conducted prior to the Proposed Action in the U.S. Beaufort Sea. When added to these activities, the Proposed Action would not combine to appreciably increase the level of effect terrestrial mammals. The cumulative effect of the Proposed Action when added to other past, present, and reasonably foreseeable actions with the potential to impact terrestrial mammals is negligible.

4.2.8. Subsistence, Environmental Justice, Public Health and Economy

4.2.8.1. Direct and Indirect Effects

The Proposed Action will have negligible to minor effects on subsistence resources due its timing and location (as described in Chapter 2). Marine and terrestrial subsistence hunts undertaken by Nuiqsut hunters will be able to continue and the largest source of conflict will be from noise associated with the number of vessels working in the area and use of airguns. SAE plans to mitigate these impacts by temporarily ceasing operations during the fall bowhead whale hunt to avoid acoustical interference with the Cross Island, Kaktovik, and Barrow based hunts.

Based on the timing (July-October) and spatial location (Harrison Bay area of the U.S. Beaufort Sea) of the Proposed Action, subsistence hunting for marine mammals, birds, fish and terrestrial animals falls within the Proposed Action schedule. Subsistence hunting for bowhead whales, ringed and bearded seals, fish, geese, eider and caribou will overlap with the Proposed Action.

Cross Island, located approximately 17 miles (27 km) from the Proposed Action area, is the primary location for bowhead whaling hunting by Nuiqsut hunters and hunts occur northeast of the Proposed Action area in water depths of 50 ft (15.2 m) or greater. The Proposed Action has potential effects on marine and terrestrial subsistence hunts of Nuiqsut due to increased human activity, vessel traffic, and airguns.

Both the NMFS BO (NMFS, 2013) and the USFWS BO (USFWS, 2012) provide mitigation measures with which SAE must comply. An SAE permit from BOEM would also require that a copy of the NMFS IHA and USFWS LOA be received by BOEM prior to conducting seismic operations. Furthermore, SAE has submitted a Wildlife Interaction Plan/Procedure with which it will comply. The analyses for resources below are predicated on the implementation of the mitigation measures in these documents (typically included measures are described in Chapter 2 of this EA), which substantially reduces potential effects. Effects from the project in the U.S. Beaufort Sea should not be long-term, but limited to the season in which the seismic work is conducted: July-October 2014. There will be negligible to minor effects on subsistence activities from the Proposed Action.

Subsistence Activities

Areas of subsistence and resources harvested by Nuiqsut and Kaktovik are discussed in Section 3.2.8.1. Based on the timing and spatial location of the Proposed Action, spring bowhead whale migration would be expected to have passed to the east before SAE begins conducting the survey. However, fall migration west is anticipated September through November and falls within the Proposed Action time-frame.

The Proposed Action area is also used by Nuiqsut for hunting seals. Sealing begins in April and May and by early June hunting is concentrated at the mouth of the Colville River. Once ice is clear of the delta in late June, hunters will hunt in open boats along the ice edge from Harrison Bay to Thetis Island. During July and August, ringed and spotted seals are hunted in the lower 65 km (40 mi) of the Colville River proper.

The Proposed Action has potential to impact Nuiqsut summer marine subsistence hunts with negligible to minor effects on harvesting of bowhead whale, spotted, ringed and bearded seal, fish species and land based animals. Mitigation measures as described for a NMFS IHA and in the SAE Wildlife Interaction Plan/Procedure would protect subsistence resources. A minor level of effect would result primarily from potential effects to the seal haul-out on the Colville River Delta under State jurisdiction. Effects from the Proposed Action should not be long-term, but limited to the season in which the seismic work is conducted: July – October 2014 and resulting impacts will be negligible to minor.

Environmental Justice

SAE's plan of operation has identified mitigation measures to reduce potential impacts on subsistence activities. There may be slight disruption to subsistence based hunting during the Proposed Action period but no long-term impacts to health and well-being of Nuiqsut will result. Environmental justice impacts from the Proposed Action will be negligible to minor.

Public Health

There will be continued subsistence harvests sufficient to maintain nutritional status. SAE crews will be accommodated on ships and in existing camps, and since SAE is cooperating with NSB Communities, negligible effects will occur to public health.

Economy

The Proposed Action is short term, temporary, involves low levels of new employment and associated income, and no generation of property tax revenues will be realized by the NSB or State of Alaska. The Proposed Action is expected to have a negligible effect on employment, income, and revenue levels of the NSB.

4.2.8.2. Cumulative Effects

Subsistence

The level of effects of the Proposed Action on subsistence resources is negligible to minor. When considered in combination with other past, present, and reasonably foreseeable actions, effects on subsistence resources remain negligible to minor. Past projects include seismic surveys and exploration drilling, but the effects of these projects were temporary and no longer impact subsistence resources.

While seismic and exploration projects do have potential effects on subsistence resources, the additive impact of the Proposed Action is likely to be negligible because the duration of the project is limited. Therefore, projects occurring concurrently in the U.S. Beaufort Sea may have negligible to minor additive effects on subsistence resources.

Environmental Justice

The Proposed Action is short-term and will have no measurable effects on human health and the environment. Therefore, the contribution of the Proposed Action to cumulative impacts on human health and the environment would be negligible.

Public Health

The Proposed Action is short-term and will have no measurable effects on NSB routines or community functions related to health. There will be no long-term consequences for health and well-being from this action. Cumulative impacts to public health will be negligible.

Economy

The Proposed Action is temporary, involving low levels of new employment and no generation of property tax revenues to the NSB or State of Alaska. Cumulative impacts on employment, income, and revenue levels of the NSB will be negligible.

4.2.9. Archaeological Resources

4.2.9.1. Direct and Indirect Effects

This Proposed Action is nearly identical with an SAE 2013 Proposed Action that was withdrawn after potential archaeological impacts were evaluated by BOEM and SHPO, except that it includes a larger land mass east of Oliktok Point. The eastern boundary of the 2013 proposal terminated at the tip of Oliktok Point and the eastern boundary of the 2014 proposal terminates eastward between Milne Point and Kavearak Point, southwest of Pingok Island (part of the Jones Island Group).

In the marine environment, the Proposed Action will use ocean bottom recording nodes/geophones weighing 65-lbs each that do not require cables. In 2013, the SHPO concurred with BOEM’s finding that emplacing these recorders on the seabed would not affect historic properties.

On land, 15-lb nodes will be placed on the ground surface, and the geophones will be manually inserted 6-8 inches into the ground. Lathes will also be inserted into the ground. There are documented archaeological sites on marine navigation charts and USGS quadrangle maps. BOEM requested archaeological reports for this strip of land from SAE and was informed that an archaeological survey by a qualified and experienced archaeologist is scheduled to begin in June 2014. SAE will use standard mitigation measures of avoidance through placing a minimum 300-ft flagged buffer around each site discovered in the area. These locations will also be entered into SAE’s Tiger Navigation data base to ensure avoidance. SAE does not intend to stage seismic field work until August or September 2014.

BOEM corresponded with SHPO on May 30, 2014 and copied all tribal entities that the agency found that no historic properties would be affected as long as the archaeological survey and flagging of cultural resources precedes seismic work so these sites can be avoided.

4.2.9.2. Cumulative Effects

Due to the timing, size of nodes, and short duration of this survey, and the conclusion above that operations will have no effect on historic resources west of Oliktok Point, the Proposed Action should add no incremental effects on archaeological resources to those produced by past, present, or reasonably foreseeable future activities in the Proposed Action area. Lands east of Oliktok Point are not included in this assessment as the data are not yet available for analysis.

5.0 CONSULTATION AND COORDINATION

5.1. Endangered Species Act Consultation

Section 7(a)(2) of the ESA requires each Federal agency to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the adverse modification of designated critical habitat. The BOEM consults with USFWS and NMFS for listed species under each Service's jurisdiction.

BOEM determined that SAE's Proposed Action is within the scope of activities analyzed in the USFWS programmatic Biological Opinion (USFWS, 2012) and the NMFS programmatic Biological Opinion (NMFS, 2013), as explained below. Therefore, BOEM has fulfilled its ESA obligations for the Proposed Action, and no further consultation is required for ESA-listed species.

5.1.1. USFWS Administered ESA-Listed Species

BOEM determined that SAE's Proposed Action is within the scope of activities analyzed in the May 8, 2012 USFWS issued programmatic Biological Opinion to BOEM for oil and gas leasing and exploration activities in the U.S. Beaufort and Chukchi Seas (USFWS, 2012). To avoid and minimize impacts to ESA-listed birds, BOEM shall require SAE to conduct the Proposed Action in accordance with appropriate Reasonable and Prudent Measures/Terms and Conditions of the 2012 USFWS BO and discussed in Section 2.2.3 – Mitigation and Monitoring of Marine and Coastal Birds. A small number of polar bears may be present in the Proposed Action area. SAE is expected to obtain a Letter of Authorization (LOA) from USFWS for incidental take of polar bear under the Marine Mammal Protection Act (MMPA). If an LOA is issued, it will also constitute incidental take authorization (ITA) for BOEM under the ESA.

Pacific walrus, a candidate species, was not included in the 2012 USFWS BO and consultation is not required by law. Pacific walrus presence in the area of the Proposed Action is unlikely. ESA only requires Federal agencies to conference on actions likely to jeopardize the continued existence of an affected species. BOEM finds that the Proposed Action is unlikely to jeopardize the continued existence of the Pacific walrus.

5.1.2. NMFS Administered ESA-Listed Species

BOEM determined that the Proposed Action is within the scope of activities analyzed in the NMFS programmatic Biological Opinion issued to BOEM for oil and gas leasing and exploration activities in the U.S. Beaufort and Chukchi Seas for certain ESA-listed whales and seals (NMFS, 2013). Bowhead whales, bearded seals, and ringed seals would likely be present in the Proposed Action area. SAE is expected to obtain an IHA from NMFS for non-lethal harassment under the MMPA. If an IHA is issued, it will also constitute an ITA for BOEM under the ESA.

5.2. Essential Fish Habitat Consultation

The Magnuson-Stevens Fishery Conservation and Management Act (16 USC 1801-1884) mandated the identification of Essential Fish Habitat (EFH) for managed species and requires that Federal agencies consult with NMFS on actions that may adversely affect EFH. BOEM and NMFS completed consultation under separate correspondence with the NMFS EFH Consultation response letter dated June 9, 2014.

5.3. Archaeological Resources

The BOEM consulted with SHPO regarding effects that might result from the Proposed Action. BOEM made a finding that no historic properties would be affected, as the Proposed Action would occur after SAE's archaeological survey and establishment of buffers around all cultural resources to ensure avoidance. The SHPO provided concurrence on June 17, 2014.

5.4. Public Involvement

Public participation regarding SAE's Proposed Action has been provided for through a combination of public notification of BOEM's receipt of the application and a public notice of EA preparation. On April 16, 2014, BOEM posted to the BOEM Alaska website a request for public input on preparation of this Environmental Assessment for a 2014 Geological and Geophysical (G&G) Permit to Conduct Seismic Survey Activity in the Beaufort Sea. Comments were accepted at http://www.regulations.gov through midnight May 8, 2014. The request, which closed without receiving any public comment, is available to view at: http://www.regulations.gov/#!docketDetail;D=BOEM-2014-0040.

5.5. Reviewers and Preparers

The persons responsible for the review of the SAE permit application and supporting information and analysis, and preparation of this EA are listed below:

Name	Title	Contribution
Gene Augustine	Biologist	ESA Consultation
Scott Blackburn	Supervisory Environmental Protection Specialist	Project Manager
Jerry Brian	Socioeconomic Specialist	Economy
Chris Campbell	Sociocultural Specialist	Archaeological Resources and State Historic Preservation Office Consultation
Christopher Crews	Wildlife Biologist	Terrestrial and Marine Mammals
Jeff Denton	Ecologist	Marine Mammals-Polar Bear and Walrus
Nancy Deschu	Fishery Biologist	Water Quality, Fish and Essential Fish Habitat, and EFH Consultation
Dan Holiday	Wildlife Biologist	Lower Trophic Levels, Cumulative Effects
Virginia Raps	Meteorologist	Air quality, Climate Change
Mark Schroeder	Wildlife Biologist	Marine and Coastal Birds
Pete Sloan	Geologist	Geologist
Caryn Smith	Oceanographer	Oil / Fuel Spills, Sea Ice and Sea State
Bill Swears	Technical Writer / Editor	Technical Writer / Editor / Federal Docket Manager
Jennifer Youngblood	Sociocultural Specialist	NEPA Coordinator , Subsistence, Environmental Justice, Public Health and Economy

Glossary

Airgun: An airgun is a device that releases compressed air into the water column, creating an acoustical energy pulse with the purpose of penetrating the seafloor.

Exclusion Zone: Also synonymously referred to as safety zones, exclusion zones are the areas around the seismic-survey-sound source within designated sound-level isopleths wherein marine mammals may be exposed to sounds that are considered a Level A take by NMFS. The exclusion zones are based on sound levels of 180 dB (for cetaceans and walrus) and 190 dB (for ice seals and polar bears). Exclusion zones for Pacific walrus and polar bear are established by the USFWS. The exclusion zones must be clear of marine mammals prior to survey commencement, and must remain free of marine mammals during survey operations.

Harassment: The MMPA defines “harassment” as “any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) 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 [Level B harassment].”

Isopleth: A line on a map connecting points at which a given variable has a specified constant value. For seismic surveying, isopleths connect points of equal sound level (e.g., 160 dB, 180 dB, 190 dB).

Power-down Procedure: Reduction of the sound output of the airgun array to a level that would avoid exposing any marine mammal to the 180 or 190 dB (depending upon the species) exclusion zone.

Protected Species Observer (PSO): Formerly Marine Mammal Observer (MMO). PSOs are trained observers whose responsibilities are to observe, record, and inform the vessel crew of any sighted protected species. PSOs sole vessel duties include watching for and identifying marine mammals; recording their numbers, distances, and reactions to survey operations; and documenting “take by harassment” as defined by NMFS and/or USFWS.

Ramp-up Procedure: Ramp-up of an airgun array consists of a gradual increase in sound level and a step-wise increase in the number and total volume of airguns firing until the full volume is achieved. The intent of ramp-up is to “warn” marine mammals in the vicinity of the airguns and to allow sufficient time for those animals to leave the area and avoid any potential injury or impairment of their hearing. Under normal conditions, animals sensitive to these activities are expected to move out of the area. Seismic surveys, including airgun testing or tuning, use the ramp-up procedures described below to allow whales and other marine mammals to depart the exclusion zone before seismic surveying begins.

Ramp-up procedures during seismic survey operations are as follows.

- Visually monitor the entire full array exclusion zone and adjacent waters for the absence of marine mammals for at least 30 min before initiating ramp-up procedures. If no marine mammals are detected, (15 min for ice seals and polar bears or 30 min for baleen whales and Pacific walrus), ramp-up procedures may be initiated.
- Initiate ramp-up by firing a single airgun, preferably the smallest in terms of energy output (dB) and volume.
- Continue ramp-up by gradually activating additional airguns over a period of at least 20 min, but no longer than 40 min, until the desired operating level of the airgun array is obtained.

Safety Zone: see Exclusion Zone.

Shut-down Procedure: Airgun operations may not be conducted when marine mammals are present within the exclusion zone. If a marine mammal is seen swimming toward the exclusion zone, the airguns may first be powered down to avoid exposing the marine mammal to the 180/190 dB level, depending on species. If the animal reaches the single airgun exclusion zone, the array must be shut down. Likewise, if a marine mammal surfaces within single airgun exclusion zone, the seismic survey must be shut down. If the airgun array is shut-down for any reason during darkness or poor weather, it may not be re-energized until conditions allow for the exclusion zone to be effectively monitored.

Start-up Procedure: Start-up is the initiation of airgun activity preparatory to ramp-up (either initial operation in the survey area, or subsequent to a shut-down). Start-up of airgun operations may not commence unless the 180 dB exclusion zone has been visible for at least 30 min prior to start-up, and no marine mammals are observed within the exclusion zone for 15 min (ice seals and polar bears) or 30 min (baleen whales and Pacific walrus). If the array is shut-down pursuant to observation of a marine mammal, airgun operations may resume after the mammal has been observed to clear the exclusion zone for single airgun actuation or no marine mammals are observed within the exclusion zone for 15 min (ice seals and polar bears) or 30 min (baleen whales and Pacific walrus).

Take/Taking: The term “take” under the MMPA means “to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal” (MMPA Section 3(13)). Take, as defined by the ESA, means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (ESA Section 3(19)).

Under the MMPA, the ‘taking’ of marine mammals, incidental or otherwise, without a permit or exemption is prohibited, with a few exceptions. One such exception (as stated in Sections 101(a)(5)(A) and (D)) is for the incidental, but not intentional, “taking,” by U.S. citizens, while engaging in an activity (other than commercial fishing) of small numbers of marine mammals of a species or population stock provided that the taking will have a negligible impact on such species or stock, will not have an unmitigable adverse impact on the availability of such species or stock for taking for subsistence uses, and the permissible methods of taking and requirements pertaining to the mitigation, monitoring, and reporting are set forth. Additionally, pursuant to Section 101(a)(5)(D) of the MMPA monitoring plans are required to be independently peer reviewed where the project may affect the availability of a species or stock for taking for subsistence uses.

In the 1982 amendments to the ESA, the "incidental take permit" process was established under section 10(a)(1)(B) of the ESA to allow for the "incidental take" of endangered and threatened species of wildlife by non-Federal entities. Incidental take is defined by the ESA as take that is "incidental to, and not the purpose of, the carrying out of an otherwise lawful activity."

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APPENDIX A

LEVEL OF EFFECTS DEFINITIONS

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Appendix A - Table of Contents

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1.0 INTRODUCTION

This appendix defines and explains the levels of effect used in the SAExploration Inc. (SAE) Ocean Bottom Node (OBN) G&G Seismic Survey Application #14-02 EA to evaluate potential environmental impacts. Impacts are described in terms of frequency, duration, general scope, and/or size and intensity. Each level considers such factors as the nature of the impact, the spatial extent, recovery times, and the effects of mitigation. The terms negligible, minor, moderate, and major are used to describe the relative degree or anticipated level of effect of an action on a specific resource. Following each term listed below for a specified resource are the general characteristics used to determine the anticipated level of effect. For each term, best professional judgment was used to evaluate the best available data concerning the affected resource.

For each resource, a “significance threshold” is also provided. Adverse impacts that do not meet the significance threshold are considered “not significant.” Required mitigation measures may reduce otherwise “significant” impacts to a level of “not significant.”

The absence of a significant effect does not equate to “no effect.” As shown in the four-category scale, and in the numerous environmental analyses that BOEM has undertaken, effects from activities can be adverse and noticeable before they reach the significance threshold. Furthermore, in the cumulative effects analysis, BOEM analyzes the combined effects of projected activities with other actions, because BOEM recognizes that effects that individually do not reach this significance threshold may exceed that significance threshold when considered collectively.

2.0 LEVELS OF EFFECT

2.1. Air Quality

The levels of effect applied to the air quality analysis are based on the results of two levels of analyses, the emission inventory, and if required, the more rigorous ambient air analysis based on computer dispersion modeling.

2.1.1. Significance Threshold

A significant effect on air quality is determined when:

1. Project-related emissions cause an increase in pollutant concentrations over the nearest onshore area of at least 20 square kilometers that
    a. Exceeds half of any of the National Ambient Air Quality Standards (NAAQS) (except for ozone); or
    b. Exceeds half of the maximum allowable increase for any pollutant for the Prevention of Significant Deterioration (PSD) for a Class II area under 40 CFR 52.21(c) or 18 AAC 50.020(b); or
    c. Is expected to exceed half the ozone NAAQS based on an analysis of the potential increase in the ozone precursor emissions of volatile organic compounds (VOC) and nitrogen oxides (NO_X); or
2. Design concentrations violate the NAAQS or if applicable, the Alaska Ambient Air Quality Standards (AAQS).

2.1.2. Level of Effects

Negligible

- Emission rates would be less than 100 tons per year for VOCs and all pollutants regulated under the NAAQS, and, if applicable, the Alaska AAQS.

Minor

- Emission rates would be equal to or greater than 100 tons per year for VOCs and all pollutants regulated under the NAAQS, and, if applicable, the Alaska AAQS.

Moderate

- Project-related emissions cause pollutant concentrations of at least one pollutant to exceed one-half of the PSD maximum allowable increases; or
- Project-related emissions cause pollutant concentrations of at least one pollutant to exceed one-half of the NAAQS, and, if applicable, the Alaska AAQS; or
- Increases in emissions of NO_X and VOC would result in the formation of ozone to a level that would be expected to exceed one-half the ozone NAAQS.

Major

- Design concentrations of at least one pollutant would equal or exceed one-half the NAAQS, and, if applicable, one-half the Alaska AAQS; or
- Increases in emissions of NO_X and VOC would result in the formation of ozone to a level that would be expected to equal or exceed the ozone NAAQS.

2.2. Water Quality

The levels of effect applied to water quality analysis consider the context and intensity of impacts, EPA's NPDES permitting program, and criteria under 40 CFR 125.122:

1. The quantities, composition and potential for bioaccumulation or persistence of the pollutants to be discharged.
2. The potential transport of such pollutants by biological, physical or chemical processes.
3. The composition and vulnerability of the biological communities which may be exposed to such pollutants, including the presence of unique species or communities of species, the presence of species identified as endangered or threatened pursuant to the Endangered Species Act, or the presence of those species critical to the structure or function of the ecosystem, such as those important for the food chain.
4. The importance of the receiving water area to the surrounding biological community, including the presence of spawning sites, nursery/forage areas, migratory pathways, or areas necessary for other functions or critical stages in the life cycle of an organism.
5. The existence of special aquatic sites including, but not limited to marine sanctuaries and refuges, parks, national and historic monuments, national seashores, wilderness areas and coral reefs.
6. The potential impacts on human health through direct and indirect pathways.
7. Existing or potential recreational and commercial fishing, including finfishing and shellfishing.
8. Any applicable requirements of an approved Coastal Zone Management plan.
9. Such other factors relating to the effects of the discharge as may be appropriate.
10. Marine water quality criteria developed pursuant to section 304(a)(1).

2.2.1. Significance Threshold

Significant effect on water quality is determined by any of the following: (1) the action is likely to violate its National Pollution Discharge Elimination System permit; (2) in the event of an accidental spill of crude oil or refined oil, total aromatic hydrocarbon or total aqueous hydrocarbon criteria for the Alaska marine or fresh-water quality standards are exceeded; or (3) the action is otherwise likely to introduce changes in the physical, chemical, or biological characteristics of a waterbody which cause an unreasonable degradation of the marine environment as defined at 40 CFR 125.121 and determined in accordance with 40 CFR 125.122.

2.2.2. Level of Effects

Negligible:

- Temporary and localized impacts to water quality that do not cause an unreasonable degradation under 40 CFR 125.122.

Minor:

- Long-term and/or widespread impacts to water quality that do not cause an "unreasonable degradation" under 40 CFR 125.122.

Moderate:

- Impacts to water quality that exceed NPDES permit criteria or cause a temporary or localized "unreasonable degradation" under 40 CFR 125.122.

Major:

- Impacts to water quality that cause long-term and widespread "unreasonable degradation" under 40 CFR 125.122.

2.3. Lower Trophic Organisms

2.3.1. Significance Threshold

An adverse impact that results in a decline in abundance and/or change in distribution requiring three or more generations for the indicated population to recover to its former status.

2.3.2. Level of Effects

Negligible:

- No measurable impacts. Population-level effects are not detectable.
- Localized, short-term disturbance or habitat effect experienced during one season that is not anticipated to accumulate across multiple seasons.
- No population level impacts to reproductive success or recruitment are anticipated.
- Mitigation measures are implemented fully and effectively or are not necessary.

Minor:

- Population-level effects are not detectable.
- Widespread annual or chronic disturbances or habitat effects not anticipated to accumulate across 1 year, or localized effects that are anticipated to persist for more than 1 year.
- Mitigation measures may be implemented on some, but not all, impacting activities, indicating that some adverse effects are avoidable.
- Unmitigatable or unavoidable adverse effects are short term and localized.

Moderate:

- Disturbances could occur, but not on a scale resulting in population-level effects.
- Widespread annual or chronic disturbances or habitat effects could persist for more than one year and up to a decade.

- Widespread implementation of mitigation measures for similar activities may be effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are short term and widespread, or long term and localized.

Major

- Disturbances occur that result in measurable population-level effects.
- Widespread seasonal, chronic, or effects from subsequent seasons are cumulative and are likely to persist for more than 1 decade.
- Mitigation measures are implemented only for a small portion of similar impacting activities, but more widespread implementation for similar activities could be more effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are widespread and long lasting.

2.4. Fish

2.4.1. Significance Threshold

An adverse impact that results in a decline in abundance and/or change in distribution requiring three or more generations for the indicated population to recover to its former status.

2.4.2. Level of Effects

Negligible:

- No measurable impacts. Population-level effects are not detectable.
- Localized, short-term disturbance or habitat effect experienced during one season that is not anticipated to accumulate across multiple seasons.
- No mortality or impacts to reproductive success or recruitment are anticipated.
- Mitigation measures are implemented fully and effectively or are not necessary.

Minor:

- Population-level effects are not detectable. Temporary, nonlethal adverse effects to some individuals.
- Widespread annual or chronic disturbances or habitat effects not anticipated to accumulate across 1 year, or localized effects that are anticipated to persist for more than 1 year.
- Low mortality levels may occur, measurable in terms of individuals or <1% of the local post-breeding fish populations.
- Mitigation measures may be implemented on some, but not all, impacting activities, indicating that some adverse effects are avoidable.
- Unmitigatable or unavoidable adverse effects are short term and localized.

Moderate:

- Mortalities or disturbances could occur, but not on a scale resulting in population-level effects.
- Widespread annual or chronic disturbances or habitat effects could persist for more than 1 year and up to a decade.
- Some mortality could occur but remains limited to a number of individuals insufficient to produce population-level effects.

- Widespread implementation of mitigation measures for similar activities may be effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are short term and widespread, or long term and localized.

Major

- Mortalities or disturbances occur that have measureable and thus significant population-level effects.
- For fishes, the anticipated mortality is estimated or measured in terms of tens of thousands of individuals or >20% of a local breeding population and/or >5% of a regional population, which may produce short-term, localized, population-level effects.
- Widespread seasonal, chronic, or effects from subsequent seasons are cumulative and are likely to persist for more than 1 decade.
- Mitigation measures are implemented only for a small portion of similar impacting activities, but more widespread implementation for similar activities could be more effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are widespread and long lasting.

2.5. Marine and Coastal Birds

2.5.1. Significance Threshold

Threatened and Endangered Species: An adverse impact that results in a decline in abundance and/or change in distribution requiring one or more generation for the indicated population to recover to its former status.

All Other Marine and Coastal Birds: An adverse impact that results in a decline in abundance and/or change in distribution requiring three or more generations for the indicated population to recover to its former status.

2.5.2. Level of Effects

Negligible

- Localized short-term disturbance or habitat effect experienced during one season that is not anticipated to accumulate across one year.
- No mortality is anticipated.
- Mitigation measures implemented fully and effectively or are not necessary.

Minor

- Widespread annual or chronic disturbances or habitat effects not anticipated to accumulate across one year, or localized effects that are anticipated to persist for more than 1 year.
- Anticipated or potential mortality is estimated or measured in terms of individuals or <1% of the local post-breeding population.
- Mitigation measures are implemented on some, but not all, impacting activities, indicating that some adverse effects are avoidable.
- Unmitigatable or unavoidable adverse effects are short-term and localized.

Moderate

- Widespread annual or chronic disturbances or habitat effects anticipated to persist for more than one year, but less than a decade.

- Anticipated or potential mortality is estimated or measured in terms of tens or low hundreds of individuals or <5% of the local post-breeding population, which may produce a short-term population-level effect.
- Mitigation measures are implemented for a small proportion of similar impacting activities, but more widespread implementation for similar activities likely would be effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are short-term but more widespread.

Major

- Widespread annual or chronic disturbance or habitat effect experienced during one season that would be anticipated to persist for a decade or longer.
- Anticipated or potential mortality is estimated or measured in terms of hundreds or thousands of individuals or <10% of the local post-breeding population, which could produce a long-term population-level effect.
- Mitigation measures are implemented for limited activities, but more widespread implementation for similar activities would be effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are widespread and long lasting.

2.6. Marine Mammals

2.6.1. Significance Threshold

Threatened and Endangered Species: An adverse impact that results in a decline in abundance and/or change in distribution requiring one or more generation for the indicated population to recover to its former status.

All Other Marine Mammals: An adverse impact that results in a decline in abundance and/or change in distribution requiring three or more generations for the indicated population to recover to its former status.

2.6.2. Level of Effects

Negligible:

- No measurable impacts and no population-level effects.
- May cause brief behavioral reactions such as temporary avoidances of or deflections around an area.
- Localized, short-term disturbance or habitat effects experienced during one season are not anticipated to accumulate across multiple seasons.
- No mortality or detectable impacts to reproductive success or recruitment are anticipated.
- Mitigation measures are fully implemented or are not necessary.

Minor:

- Low but measurable impacts with no population-level effects.
- A small number of mortalities are unlikely but possible.
- May cause behavioral reactions such as avoidances of or deflections around an area.
- Localized, disturbance or habitat effects experienced during one season may accumulate across subsequent seasons, but not over one year.
- Mitigation measures are fully implemented or are not necessary.

Moderate:

- Mortalities or disturbances could occur, but no detectable population-level effects.
- A small number of mortalities are likely, but not to an extent resulting in detectable population level effects.
- Adverse impacts to ESA-listed species could occur.
- Widespread annual or chronic disturbances or habitat effects could persist for more than one year and up to a decade.
- Widespread implementation of mitigation measures for similar activities may be effective in reducing the level of avoidable adverse effects.
- Unmitigated or unavoidable adverse effects may be short term and widespread, or are long term and localized.

Major:

- Mortalities or disturbances occur that have detectable population-level effects.
- Mortality might occur at or above the estimated Potential Biological Removal[1] (PBR) as a result of the proposed action.
- Widespread seasonal or chronic effects are cumulative and are likely to persist for more than one decade.
- Mitigation measures are implemented only for a small portion of similar impacting activities, but more widespread implementation for similar activities could be more effective in reducing the level of avoidable adverse effects.
- Unmitigatable or unavoidable adverse effects are widespread and long lasting.

2.7. Terrestrial Mammals

2.7.1. Significance Thresholds

An adverse impact that results in a decline in abundance and/or change in distribution requiring three or more generations for the indicated population to recover to its former status. Any major level of effects is significant.

2.7.2. Level of Effects

Negligible:

- No adverse impacts to individuals. Temporary, nonlethal adverse effects could affect some individuals.
- Localized, short-term disturbance or habitat effects may be experienced during one season but not across multiple seasons.
- No impacts to reproductive success or recruitment are anticipated.
- Mitigation measures are implemented fully and effectively or are unnecessary.

Minor:

- Population-level effects remain undetectable, however, a small number of individuals could experience long-term adverse effects or mortality.
- Widespread annual or chronic disturbances, habitat effects, and localized effects are not anticipated to accumulate beyond 1 year.

- Mitigation measures may be implemented on some, but not all, impacting activities, indicating that some adverse effects are unavoidable.
- Moderate:
- Population impacting mortalities or disturbances are detectable, but are insufficient to result in population level effects.
- Widespread annual or chronic disturbances or habitat effects should persist from 1-10 years.
- Widespread implementation of mitigation measures for similar activities may effectively reduce the level of adverse effects.
- Unmitigable or unavoidable adverse effects are short term but widespread, or are long term and localized.

Major:

- Mortalities or disturbances occur that have measurable population level effects.
- Widespread seasonal, chronic, or effects from subsequent seasons are cumulative and are likely to persist for more than 10 years.
- Mitigation measures are only implementable for a small proportion of similar impacting activities, but more widespread implementation for similar activities could be more effective in reducing the level of avoidable adverse effects.
- Adverse effects are unmitigable, widespread, and lingering.

2.8. Sociocultural Systems

Sociocultural systems include social organization, cultural values, and institutional arrangements.

2.8.1. Significance Threshold

A disruption of social organization, cultural values, and/or institutional arrangements with a tendency towards displacement of existing social patterns.

2.8.2. Level of Effects

Negligible:

- Periodic disruption of social organization, cultural values, and/or institutional arrangements occurs without displacement of existing social patterns.

Minor:

- Disruption of social organization, cultural values, and/or institutional arrangement occurs for a period of less than one year, without a tendency toward displacement of existing social patterns.

Moderate:

- Chronic disruption of social organization, cultural values, and/or institutional arrangements occurs for a period of more than one year, without a tendency toward displacement of existing social patterns.

Major:

- Disruption of social organization, cultural values, and/or institutional arrangements with a tendency towards displacement of existing social patterns.

2.9. Subsistence

2.9.1. Significance Threshold

Adverse impacts which disrupt subsistence activities, or make subsistence resources unavailable, undesirable for use, or only available in greatly reduced numbers, for a substantial portion of a subsistence season for any community.

2.9.2. Level of Effects

Negligible: Subsistence resources could be periodically affected with no apparent effect on subsistence harvests.

Minor: Adverse impacts to subsistence activities are of an accidental and/or incidental nature and limited to a short-term (within one season or the duration of the project).

Moderate: Adverse impacts which disrupt subsistence activities, or make subsistence resources unavailable, undesirable for use, or only available in greatly reduced numbers, for a substantial portion of a subsistence season for any community.

Major: Adverse impacts resulting in one or more important subsistence resources becoming unavailable, undesirable for use, or available only in greatly reduced numbers for any community.

2.10. Economy

The effects levels used for this analysis focus on the impacts associated with the Proposed Action on socioeconomic systems, including employment, personal income, and revenues accruing to the local, state, and federal government.

2.10.1. Significance Threshold

Economic effects that would cause important and sweeping changes in the economic well-being of the residents or the area or region. Local employment is increased by 20% or more for at least 5 years.

2.10.2. Level of Effects

Negligible

- No measurable effects beyond short term, periodic impacts.

Minor

- Adverse impacts to the affected activity or community are avoidable with proper mitigation.
- Impacts would not disrupt the normal or routine functions of the affected activity or community. Economic systems would be impacted for a period of up to 1 year.
- Once the impacting agent is eliminated, the affected activity or community will return to a condition with no measurable effects from the proposed action without any mitigation.

Moderate

- Impacts to the affected activity or community are unavoidable. Proper mitigation would reduce impacts substantially during the life of the project.
- Effects on economic systems would be unavoidable for a period longer than 1 year.
- The affected activity or community would have to adjust somewhat to account for disruptions due to impacts of the project.

- Once the impacting agent is eliminated, the affected activity or community will return to a condition with no measurable effects from the proposed action if proper remedial action is taken.

Major

- Impacts to affected community are unavoidable.
- Proper mitigation would reduce impacts somewhat during the life of the project.
- The affected activity or community would experience unavoidable disruptions to a degree beyond what is normal.
- Once the effect producing agent is eliminated, the affected activity or community may retain measurable effects of the proposed action indefinitely, even if remedial action is taken.

2.11. Public Health

2.11.1. Level of Effects

Negligible

- Infrequent minor acute health problems, not requiring medical attention.
- No measurable effects on normal or routine community functions.
- No long-term consequences for Public Health or well-being.

Minor

- Public Health affected, but the effects would not disrupt normal or routine community functions for more than one week.
- Effects would not occur frequently.
- Effects would not affect large numbers of individuals.
- Effects could be avoided with proper mitigation.

Moderate

- Adverse effects on Public Health occurring for brief periods of time that do not result in or incrementally contribute to deaths or long-term disabilities.
- Effects can be prevented, minimized, or reversed with proper mitigation.
- Effects could occur more frequently than minor events, but would not be frequent.

Major

- Effects on Public Health would be unavoidable and would contribute to the development of disabilities, chronic health problems, or deaths.
- Alternatively, occurrence of minor health problems with epidemic frequency.
- Effective mitigation might minimize the adverse health outcomes but would not be expected to reverse or eliminate the problem.

2.12. Environmental Justice

Executive Order 12898 requires Federal Agencies to evaluate whether proposed projects would have “disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low income populations.”

2.12.1. Significance Threshold

The significance threshold for Environmental Justice is when minority or low-income populations experience disproportionate, high adverse human health or environmental effects from the proposed action. Disproportionately high adverse impacts are those impacts which exceed the significance thresholds for subsistence or sociocultural effects for minority populations or low income populations.

2.12.2. Level of Effects

The levels of effect for Environmental Justice correspond to the levels of effects for subsistence, sociocultural, or public health effects as experienced by minority populations or low income populations.

2.13. Archaeology

2.13.1. Level of Effects

Negligible

- This category equates to No Historic Properties Affected as defined by 36 CFR 800.4(d)(1), the Code of Federal Regulations that promulgates Section 106 of the National Historic Preservation Act of 1966 as amended.

Minor

- This category equates to a finding of No Historic Properties Affected when the Agency identifies a potential conflict within an Area of Potential Effect due to the presence of a geomorphological feature and revises the plan to avoid it prior to consultation with the State Historic Preservation Officer.

Moderate

- This category equates to a finding of No Adverse Effect as defined by 36 CFR 800.5(b) when the SHPO identifies a conflict that requires a change in plan to avoid effects on an Historic Property as defined by 36 CFR 800.16(l)(1&2).

Major

- This category equates to a finding of Adverse Effect as defined by 36 CFR 800.5(C) requiring mitigation and a Memorandum of Agreement.

[1] Marine mammal stock management under the MMPA is based on a theoretical concept called Potential Biological Removal (PBR). The PBR is defined as the maximum number of animals, not including natural mortalities, which may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustained population. An optimum sustained population is defined as the number of animals which will result in the maximum productivity of the population or the species, keeping in mind the carrying capacity of the habitat and the health of the ecosystem. For example, as the bowhead whale population continues to grow, it continues to approach its carrying capacity. Contemporary population ecology suggests that at carrying capacity, a stable population is achieved when mortality equals productivity.

The PBR is calculated as the product of the minimum population estimate, one-half the theoretical productivity rate, and a “recovery factor”. For example, the current estimate for the rate of increase for the bowhead whale stock (3.3%) should not be used as an estimate of maximum productivity because the population is currently being harvested and because the population has recovered to population levels where the growth is expected to be significantly less than maximum productivity. For the Western Arctic bowhead whale stock, the population size is estimated to be 12,631 (estimated in 2004), the theoretical productivity rate is 0.2, and the recovery factor is 0.5. Schweder (2009) estimated the yearly growth rate to be 3.2% from 1984- 2003 using a sight-resight analysis of photographs. Koski et al. (2010) provided an estimate of 12,631 95% CI: 7,900-19,700 bowheads derived from sight-resight results from aerial photographs sampling in 2003-2004. A spring survey conducted in 2011 was successful and data therefrom is in the process of being analyzed. The PBR is generally only used by the NMFS to guide decisions regarding the allowable removal of individual animals from a stock.

The conceptual PBR is used in the level of effects to identify a threshold whereby maximum population growth is sustained or not. If an anticipated effect could result in a loss of whales that exceeded the PBR, this would be inferred to be a population-level effect. In reality, given the conservative values used to derive the PBR, the loss of marine mammals that exceeded calculated PBR could be entirely consistent with a stable population.

APPENDIX B

CUMULATIVE EFFECTS SCENARIO

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1.0 PAST, PRESENT AND REASONABLY FORESEEABLE FUTURE ACTIONS

The Council on Environmental Quality (CEQ) Regulations define cumulative effects at 40 CFR 1508.7:

> *Cumulative impact* is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. (40 CFR 1508.7)

This appendix provides a description of past, present and reasonably foreseeable future actions in the Chukchi and Beaufort Seas, which may contribute to cumulative impacts of oil and gas activities in these areas.

2.0 IMPACT SOURCES

The main sources of impacts which could have a cumulative impact with the proposed action on the resources in the Arctic OCS are: (1) marine vessel traffic, (2) aircraft traffic, (3) subsistence and other community activities, (4) scientific research activities, and (5) oil and gas-related activities.

2.1. Marine Vessel Traffic

Past marine vessel traffic has been associated with subsistence hunting, oil exploration, research, and military activities. Weather and ice have traditionally limited marine vessel traffic in the Proposed Action area to July through September.

The number of marine vessels in both the Beaufort and Chukchi Seas has increased in recent years due to advances in the technology of ice strengthening and ice breaking capacities of marine vessels, changes in ice cover and classifications of ice, increases in use of both the Northeast Passage over Russia and the Northwest Passage through Canada for commercial and tourist voyages, and increased interest in scientific and economic pursuits in the area. Reasonably foreseeable traffic in the region includes small craft involved in the fall whaling hunt at Barrow and Wainwright; USCG vessels; cargo vessels; other supply ships, tugs, and barges; cruise ships; and vessels associated with scientific endeavors. The USCG estimates that from 2008 to 2010 the number of vessels in the Arctic increased from around 100 to more than 130, and the number of transits through the Bering Strait increased from around 245 to more than 325 (USCG, 2011). The estimated number of miles of non-seismic vessel traffic in the Chukchi Sea for July through October increased from approximately 2,000 miles in 2006 to more than 11,500 miles in 2010 (Marine Exchange of Alaska, 2011). Vessel tracks from 2009 indicate vessel transits in the vicinity of Barrow and Wainwright are traditionally concentrated along the coast (Marine Exchange of Alaska, 2011).

Marine vessels are the greatest contributors of anthropogenic sound introduced to the Chukchi Sea. Sound levels and frequency characteristics of vessel sound generally are related to vessel size and speed. Larger vessels generally emit more sound than do smaller vessels. Same size class vessels travelling at higher rates of speed generally emit more sound than the same vessels travelling at lesser speeds. Vessels underway with a full load, or vessels pushing or towing loaded non-powered vessels, generate more sound than unladen vessels in a similar size class. The most common sources of marine vessel mechanical components that generate sound waves are propulsion engines, generators, bearings, pumps, and other similar components. Operations and navigation equipment, including fathometers and sonar equipment, are also inclusive of onboard mechanical components that cumulatively create and propagate sound into the marine environment through the vessel hull. The most intense level of sound pressure introduced into the water from an underway marine vessel originates from cavitation associated with the energy of spinning propellers. Moored vessels can generate sound from the operation of engines and pumps. Cranes or other similar operational equipment performing construction activities or other work functions may transmit sound directly to the marine environment through the air-water interface or indirectly through propagation of sound waves through hulls or other support structures.

2.2. Aircraft Traffic

Air traffic has increased in recent years, mostly from increases in academic and commercial ventures, and increases in military operations. Aircraft traffic in the Arctic includes fixed wing and helicopter flights for research programs and marine mammal monitoring operations; cargo flights for supplies to villages and for commercial ventures including oil and gas related activities (such as crew changes and supply flights); flights for regional and inter-village transport of passengers; air-ambulance and search and rescue emergency flights; general aviation for the purpose of sport hunting and fishing or flightseeing activities; and multi-governmental military flights. An average of 306 commercial flights per month occurred from Wainwright airport between July and October, 2000 to 2008 (Bureau of Transportation Statistics, 2009).

2.3. Subsistence Activities

Subsistence hunting and other community activities associated with regional native villages such as Wainwright and Point Lay have persisted for millennia, and are expected to continue during the period of Proposed Action. Marine traffic associated with subsistence hunting consists of small craft used during fishing, seal hunting, and whale hunts. Vessel traffic associated with other community activities consists primarily of supply barges traveling close to shore, within state waters. Overall, vessel traffic associated with native village activities within the Proposed Action area is expected to be very low.

2.4. Scientific Research Activities

A considerable scientific research effort by governmental, non-governmental, and academic organizations operating from marine vessels and aircraft occurs annually in the Beaufort Sea and Chukchi Sea. The programs conducted by these organizations are generally expected to have ended for the season, or end for the season during October, but may produce cumulative impacts on resources analyzed for the Proposed Action. Marine environmental baseline studies involve deployment of oceanographic equipment for collecting water and sediment samples, and use of nets and trawls for fish sampling and collection of phytoplankton, zooplankton, benthic invertebrates, and pelagic invertebrates. Also continuing will be observations of marine and coastal birds and marine mammals using standardized survey transect methods and passive acoustic monitoring. Metocean buoys and acoustic wave and current meters will continue to be deployed for studies of physical oceanography and climate. Previous environmental assessments, such as the environmental assessment for Shell’s Beaufort Sea marine research program, describe the techniques used and the effects of these programs in detail (USDOI, BOEMRE, 2011).

2014 BOEM ANIMIDA III (AK-11-14b). The Arctic Nearshore Impact Monitoring in Development Area (ANIMIDA) and continuation of ANIMIDA (cANIMIDA) started in 1999 and has provided baseline data and monitoring results for chemical contamination, turbidity, Boulder Patch productivity, and subsistence whaling in the vicinity of oil industry development in the Beaufort Sea OCS. Northstar and Liberty prospects were monitored prior to development, and Northstar was monitored into development and production. Activities include both nearshore and offshore components, both concentrating in the region north and west of Camden Bay. Nearshore components are achieved by small vessel support in the open water season. Larger vessel support will be needed in offshore Camden Bay collections along the Beaufort Sea shelf break. Primary biological/contaminant field surveys should occur in the open-water period, with some effort during breakup with high river flow, and at least once during the ice-covered season. Sediment and biota sampling will be scheduled such that stations sampled in eastern, central, and western Beaufort in ANIMIDA and cANIMIDA will be resampled at least once and the new deeper eastern Beaufort Region stations around Sivulliq and Torpedo would be sampled at least twice. Focus will be on oil and gas development potential contaminants in sediments and benthic biota, and distribution and abundance of benthic biota.

2014 BOEM ANIMIDA III: Boulder Patch and Other Kelp Communities in the Development Area (AK-11-14a). The Boulder Patch kelp bed surveys and monitoring will be conducted using small vessel support in the open water season in the Stefansson Sound region to the north and west of Camden Bay. Kelp production will be measured using established or comparable techniques. Oceanographic measurements shall include ambient light intensity and total suspended solids using established or comparable techniques. Data will be combined with the existing long-term dataset. The extent of kelp in Camden Bay will be surveyed and geographic information systems (GIS) maps constructed of kelp and implied (boulder and or hard bottom) kelp beds in the study area.

2014 BOEM Distribution and Abundance of Select Trace Metals in Chukchi and Beaufort Sea Ice (AK-13-03-04). The concentrations of certain trace metals are significantly elevated in sea ice relative to seawater, as indicated by results of previous studies in Antarctica and the Bering Sea. Consequently, sea ice melt has been shown to increase concentrations of some elements in surface waters, but the processes controlling the retention and subsequent release of trace metals in sea ice are not well understood. Offshore surface seawater and aerosols samples will be collected on board the R/V Mirai in collaboration with the Japanese Agency for Marine-Earth Science and Technology (JAMSTEC). Snow will be collected onboard the ship opportunistically during snow events. A total of ~80-100 ice core samples will be collected from 10 stations during the sea ice sampling effort in Camden Bay. This sampling will involve travel by snow machine from Kaktovik/Barter Island to Camden Bay during April-May, 2014.

2014 BOEM Satellite Tracking of Bowhead Whales: Habitat Use, Passive Acoustic and Environmental Monitoring (AK-12-02). This ongoing study will track the movements and document the behavior of bowhead and gray whales using satellite telemetry. Tagging operations will focus on locations nearby St. Lawrence Island during the months of April and May; Barrow during the months of May and September/October; and in Canada during July and August. Only smaller vessels used by tagging crews will be involved. Bowhead whale vocalization rates and ambient noise levels will be documented using an acoustic tag to develop analysis of call rates relative to behavior and disturbance. Tags equipped with environmental sensors will be deployed to monitor, summarize, and transmit ambient oceanographic conditions as bowheads migrate.

2014 BOEM Aerial Surveys of Arctic Marine Mammals Project (AK-11-06). ASAMM aerial surveys are conducted in the western Beaufort and northeastern Chukchi Seas (68°N-72°N latitude and 140°W-169°W longitude), extending from the coast to a maximum of approximately 315 km offshore, encompassing 230,000 km^2. Two teams are required to cover the study area: one team, based out of Barrow, Alaska, surveys the northeastern Chukchi Sea and the other team, based out of Deadhorse, Alaska, surveys the western Beaufort Sea. Fixed-wing, twin-turbine Aero Commander aircraft were used for all surveys in 2012. These aircraft have a 5.5-hour flight endurance and are outfitted with bubble windows for downward visibility. Line-transect surveys are flown every day, weather and logistics permitting, at an altitude of 1,200 ft in the Chukchi Sea and 1,500 ft in the Beaufort Sea. The ASAMM project is conducted by the National Marine Mammal Laboratory (NMML), funded by BOEM, and permitted through NFMS and the USFWS. Daily reports from the 2013 field season as well as previous years' reports are available on the NMML website at http://www.afsc.noaa.gov/NMML/cetacean/bwasp/index.php

2014 BOEM Characterization of the Circulation on the Continental Shelf Areas of the Northeast Chukchi and Western Beaufort Seas (AK-12-03a). This project will coordinate and collaborate with other research projects in the area (BOEM, WHOI, industry, etc.) to synthesize and integrate all available physical oceanographic data collected at the junction of the Beaufort and Chukchi Seas north of Barrow, Alaska. Various vessels will be used to deploy and retrieve buoys and slocum gliders during the open-water season of 2013, most likely in September. This study will involve using a suite of instrumentation including: ADCPs, CTDs, Ice Profiling Sonar (IPS5), gliders, surface drifters and HF radars. Long Range HF radar systems presently deployed along the Chukchi coast at Point Lay, Wainwright and Pt. Barrow will be modified to increase the maximum observable range to approximately 250 km to capture the summer surface current flow over a larger area of the Chukchi shelf and around Hanna Shoal. A planned HF radar deployment at Cape Simpson (CIAP funds) will capture surface current flow along the western Beaufort shelf and slope and within Barrow Canyon. Gliders, surface drifters, moored ADCPs and towed CTDs will collect data on depth and time dependent current, temperature and salinity structure. Ice Profiling Sonar and moored ADCPs will be used to calculate ice drift and velocity. Sea ice extent will be obtained from satellite information, while drifting buoys will be crucial for computing flow trajectories and diffusivities. Data from the ADCPs, CTDs, glider deployments, HF radars, planned drifter measurements and available industry data will be synthesized to acquire a comprehensive characterization of the circulation in the study area.

2014 BOEM U.S.-Canada Transboundary Fish and Lower Trophic Communities (AK-12-04). The survey will sample fish, invertebrates, and related biological and oceanographic habitat characteristics between longitudes 141° and 147° in the U.S. and into Canadian waters to ~138° (across the Canadian border to Herschel Island and the Mackenzie canyon) during the 2013 open water season. This survey will expand the scope and reach of a Beaufort Sea Pilot Fish Survey conducted in 2008. Methodologies will follow those from the 2008 survey and the ongoing BOEM Central Beaufort Sea Fish Survey, modified in consideration of lessons learned from the earlier work. Sampling will deploy gear types such as beam trawl (10m wide), otter trawl, Isaacs-Kidd, and bongo nets. This study will include additional field surveys in both the under-ice and open water seasons to provide a better understanding of variability and collect additional habitat characteristics; collect invertebrates in both the water column and benthos; collect CTD data to document hydrographic structure; and collect and analyze ecological (e.g. energetics, isotope, genetic and otolith) samples for a foodweb model.

2014 Pacific Arctic Group (PAG). Ongoing activities in the general Beaufort Sea and Chukchi Sea regions include multinational efforts carried out by the Pacific Arctic Group (PAG). Organized under the International Arctic Science Committee (IASC), the PAG mission is to serve as a Pacific Arctic regional partnership to plan, coordinate, and collaborate on science activities of mutual interest to the Arctic region. The Diversified Biological Observatory is a multi-national cooperative effort coordinated by the PAG, with the United States, Canada, Russia, Japan, China, and Korea contributing cruise data from past, ongoing, and planned research programs. The programmatic sampling includes continuation of collections from prior and existing research stations, including BOEM-funded projects. Focus is on five geographical research areas within the Bering Sea, Bering Strait, Chukchi Sea, and Beaufort Sea. This work includes the synthesis of studies in fields including physical oceanography, marine chemistry, biological oceanography and marine biology (primary productivity, zooplankton, phytoplankton, ice algae, epontic, pelagic, and benthic collections), and marine mammal and marine bird ecology (PAG, 2011).

2.5. Oil and Gas Related Activities

Past oil and gas related activities in the Beaufort Sea and Chukchi Sea OCS include exploration wells, exploration seismic surveys, shallow geologic hazards surveys, geotechnical sampling programs, baseline biological studies and surveys, biological, chemical and physical oceanography monitoring programs, and other environmental studies and sampling programs including ongoing work funded by industry for the purpose of understanding the environment within and outside the project areas.

Current reasonably foreseeable oil and gas related activities in the Arctic OCS during 2014 include:

- SAExploration Holdings Inc. (SAE) three dimensional (3D) on-ice seismic survey in the Colville River Delta area of the Alaskan Beaufort Sea during the winter of 2014. (G&G

Seismic Survey Application #14-01): February 15 – May 31, 2014. Project would not overlap temporally or geographically with the Proposed Action area.

- Chukchi Sea Environmental Studies Program (CSESP) research efforts in the region encompassing the Conoco Phillips lease areas in the Chukchi Sea. The CSESP projects would not occur geographically with the Proposed Action.
- BPXA 2014 Winter Geotechnical and Seabottom Investigation: March 2014 through early May 2014. Project will not occur temporally with the Proposed Action.

2.6. Climate Change and Ocean Acidification

Climate change is an ongoing consideration in evaluating cumulative effects on environmental resources of the Arctic region (NOAA, 2011). It has been implicated in changing weather patterns, changes in the classification and seasonality of ice cover, ocean surface temperature regimes, and the timing and duration of phytoplankton blooms in the Chukchi Sea. These changes have been attributed to rising carbon dioxide ($CO_{2)}$ levels in the atmosphere and corresponding increases in the CO_2 levels of the waters of the world's oceans. These changes have also led to the phenomena of ocean acidification (IPCC, 2007; Royal Society, 2005). This phenomenon is often called a sister problem to climate change, because they are both attributed to human activities that are leading to increased CO_2 levels in the atmosphere. The capacity of the Arctic Ocean to uptake CO_2 is expected to increase in response to climate change (Bates and Mathis, 2009). Further, ocean acidification in high latitude seas is happening at a more advanced rate than other areas of the ocean. This is due to the loss of sea ice that increases the surface area of the Arctic seas. The resultant exposure of surface water lowers the solubility of calcium carbonate, resulting in lower saturation levels of calcium carbonate within the water that in turn leads to lower available levels of the minerals needed by shell-producing organisms, such as pteropods, foraminifers, sea urchins, and molluscs (Fabry et al., 2009; Mathis, Cross, and Bates, 2011).

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APPENDIX C

AIR QUALITY

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Appendix C – Air Quality

The Proposed Action requires the use of marine vessels with diesel-powered engines that may affect local onshore air quality. The vessels' propulsion and auxiliary engines emit primarily gases of nitrogen oxides (NOx), sulfur dioxide (SO_2), and carbon monoxide (CO) that are potentially harmful to human health and welfare. This appendix describes the methods used to estimate the projected emissions due to the Proposed Action, and includes the Bureau of Ocean Energy Management (BOEM), Office of Environment's assessment of the transport and dispersion of pollution that might occur. The Proposed Action area is shown in Figure C-1

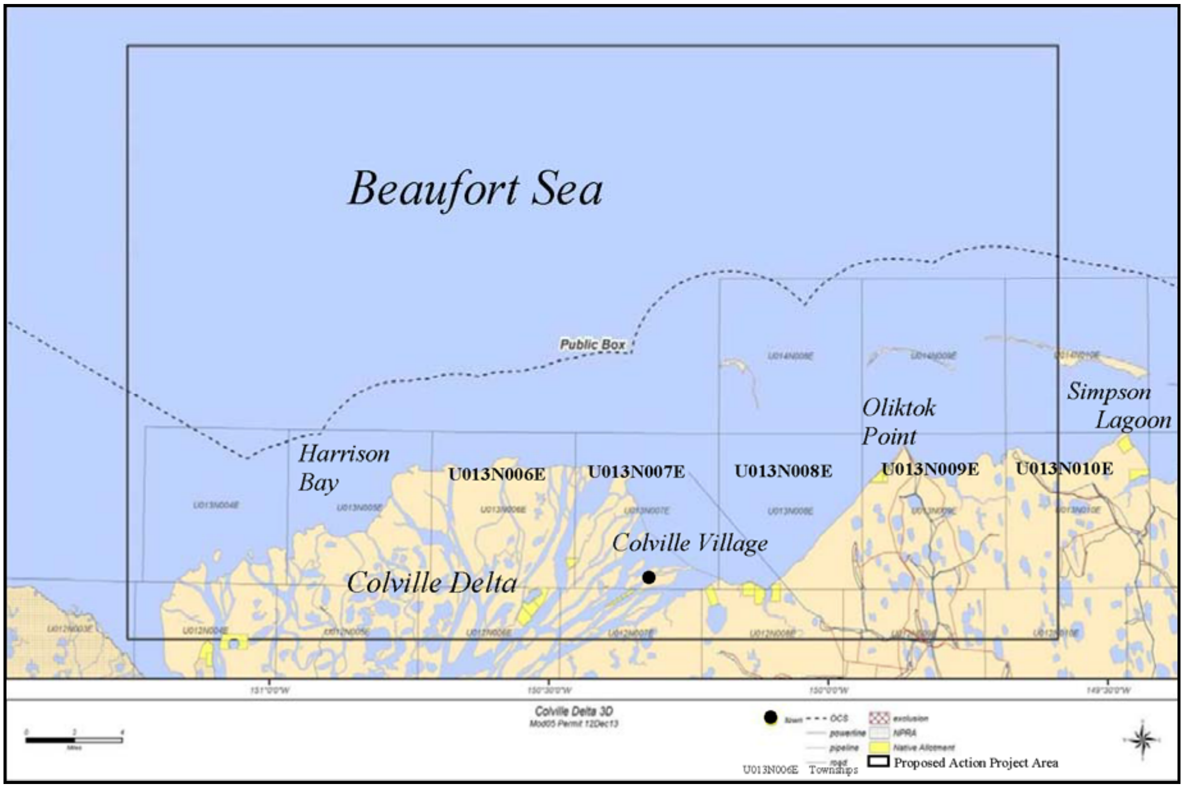

Figure C-1. Proposed Action area. *The 2014 SAE 3-D Seismic Survey for the Colville River Delta of the Beaufort Sea OCS Planning Area. This figure highlights the location of Townships, U013N006E – U013N010E.*

Source: SAExploration 2014 Colville Delta 3D Seismic Survey Plan of Operation.

Survey source vessels, supported by smaller boats and ships, will cruise a grid of parallel lines (patch layout) while acquiring seismic data.[1] The plan is to acquire data within each of the 17 Townships[2] outlined within the Proposed Action area in **Figure C-1**.

C-1. EXISTING AIR QUALITY ON THE ALASKA NORTH SLOPE

The air emissions caused by the Proposed Action will affect the eastern portion of the Alaska North Slope adjacent to the Beaufort Sea (Eastern NS) where air quality is considered a clean resource (EPA, 40 CFR Part 81). A map defining the Eastern NS, along with relevant towns and geographical features is provided in **Figure C-2.**

Figure C-2. Delineation of the Alaska Eastern North Slope (Eastern NS). *Figure illustrates the towns of Nuiqsut, Prudhoe Bay (Deadhorse), Kuparuk, Barter Island, and Kaktovik Alaska, and the Colville River Delta.*

Source: Climate Story Tellers. 2010. Available on the Internet at http://www.climatestorytellers.org/stories/harvard-ayers-chie-sakakibara-inupiaq-people-ask/

A region's air quality is a measure of the health and safety of the air comprising the lower atmosphere, particularly very near the ground. Long-term air quality is, in part, a function of the local wind conditions combined with the output of emission sources in the vicinity. As described in the following subsections, the Eastern NS has persistent winds and relatively few emission sources.

1.1. Wind Speed over the Alaska Eastern North Slope

Anything other than completely calm winds will transport a plume of exhaust gases to downwind locations. How far the gases will travel and the concentration of the gases at landfall depend, in part, on the wind speed, as the concentration within the plume decreases with increased wind speed and distance (Wichmann-Fiebig, 2011). The Eastern NS is a vast open area that provides little to slow down winds moving in from open water (Spall, Pickart, Fratantoni, et al., 2007). The average wind speed at Nuiqsut, Deadhorse, and Barter Island, Alaska, are illustrated in **Figure C-3**.

The mean annual wind speed for these locations[3] along the Eastern NS averages 10.9 miles per hour (mph)(4.9 meters per second (m/s), or 9.5 knots), defined on the Beaufort Wind Scale as a gentle breeze (Beaufort, 1805).[4] Average wind for the same locations during the period proposed for operation of the seismic survey would be slightly higher, 11.8 mph (5.3 m/s or 10.3 knots), a gentle to moderate breeze.[5] The record maximum wind speeds highlighted in Figure C-3 show moderate to fresh[6] breezes over the same locations (16 mph/13.9 knots to 22 mph/19.1 knots) in July, September, and October. Winds of this scale could transport emissions from the survey ships and other sources to destinations miles from the source in a short period of time. Thus, sustained winds that prevail over the Eastern NS will disperse and mix emissions. Accumulation and buildup of pollutants in a specific area would be difficult. Dispersion will be more pronounced the further out to sea the survey ships travel. The movement of the ships, and the itinerant and temporary nature of the ships' movements while cruising the survey grid, will also enhance the dispersion process.

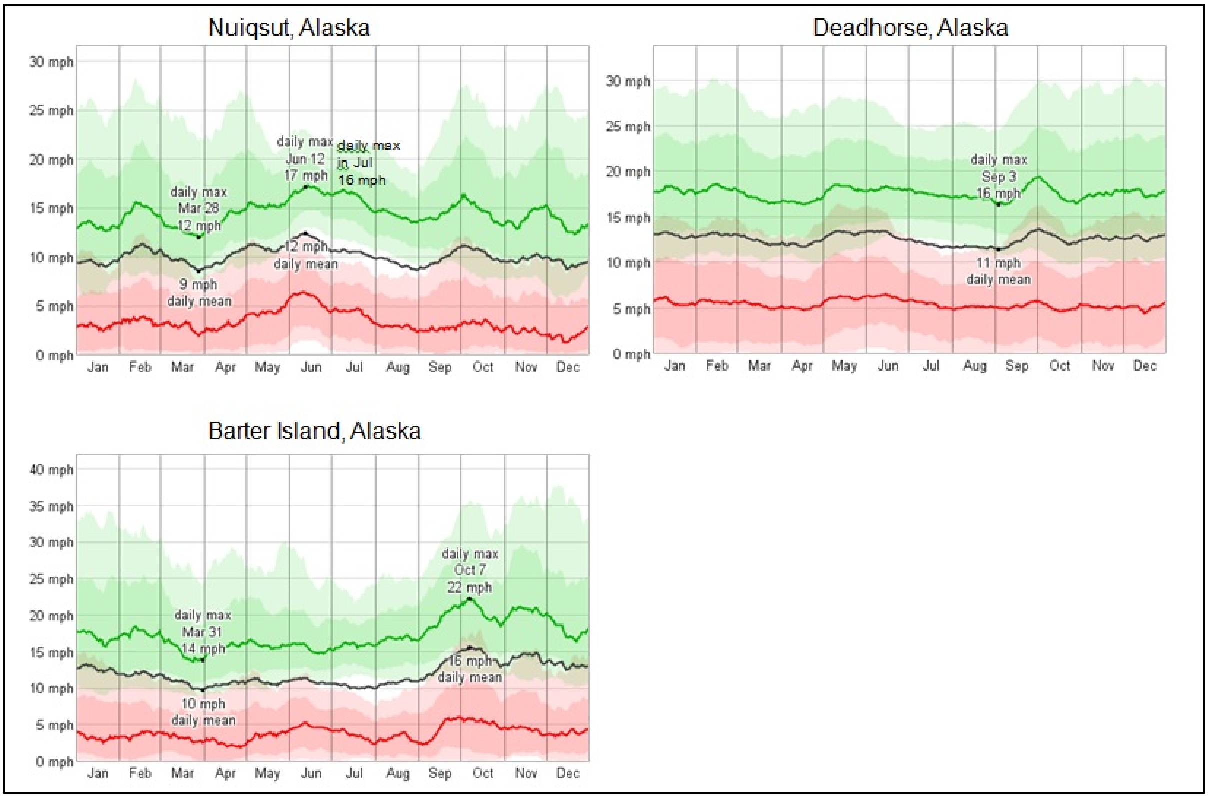

Figure C-3. Average Wind Speed. *Average daily minimum (red or lower), maximum (green or upper), and average (black or middle) wind speed for Nuiqsut, Alaska, Deadhorse, Alaska, and Barter Island, Alaska.*

Source: Cedar Lake Ventures, Inc.: WeatherSpark.
http://weatherspark.com/averages/33044/Nuiqsut-Alaska-United-States
http://weatherspark.com/averages/33051/Deadhorse-Alaska-United-States
http://weatherspark.com/averages/32900/Barter-Island-Alaska-United-States

1.2. Air Emissions Sources Existing on the Alaska Eastern North Slope

The Eastern NS lacks ample emission sources to overcome the effect of the wind, which disperses what few emission sources exist across the Coleville River Delta, including Colville Village. In addition, pollutant monitoring devices reveal no pollutant concentrations that exceed Federal standard from sources located within the more populated and industrial areas of Alpine and Prudhoe Bay.

The 2008 National Emission Summary for the North Slope Borough is available in the report, Alaska Department of Environmental Conservation (ADEC) 2011 Emissions, Meteorological Data, and Air Pollutant Monitoring for Alaska's North Slope (ADEC, 2011). The inventory provided in the report includes emissions from oil and gas development and production in Prudhoe Bay and Alpine, Alaska. The inventory includes mobile sources, waste disposal, fuel combustion of natural gas and oil, and fugitive emissions from construction. The same document also includes the ADEC 2005 Rural Communities emission inventory.

The ADEC is required by Federal law to submit a statewide point-source emission inventory to the Environmental Protection Agency (EPA) every three years. The ADEC point source inventory can be accessed online at https://myalaska.state.ak.us/dec/air/airtoolsweb/EmissionInventory.aspx.

A report that describes the Alaska Rural Communities Emission Inventory is available online at http://www.epa.gov/region10/pdf/tribal/wrap_alaska_communities_final_report.pdf

Industrial activities in the North Slope are comprised mostly of oil production and transport. The most densely located sources are in and around Prudhoe Bay, the largest oil field in North America, and Alpine, located eight miles north of Nuiqsut, Alaska.

The inventory of projected 2018 emissions was included in the ADEC report to account for expected changes in pollutant source activity, such as population, and changes in technology, such as emission controls. The inventory shows there were relatively few emission sources located on the coastline of the North Slope, and there was no indication that the number of sources would be expected to increase in the foreseeable future. Consequently, the Coleville River Delta and Colville Village enjoy clean air that does not violate any of the National Ambient Air Quality Standards (NAAQS) that define healthful outside ambient air, summarized in **Table C-1.**

Table C-1. National Ambient Air Quality Standards.

Pollutant	Primary Standards		Averaging Period	Secondary Standards
	ppm	µg/m^3		
Carbon Monoxide (CO)	9	10,000	8-hour	None
	35	40,000	1-hour	
Lead (Pb)		0.15	Rolling 3-Month Average	Same as Primary
Nitrogen Dioxide (NO_2)	.053	100	Annual	Same as Primary
	.10	188	1-hour	None
Particulate Matter (PM_{10})		150	24-hour	Same as Primary
Particulate Matter ($PM_{2.5}$)		12.0	Annual	15.0 µg/m^3
		35	24-hour	Same as Primary
Ozone (O_3)	0.075		8-hour	Same as Primary
Sulfur Dioxide (SO_2)	0.075	196	1-hour	1300 µg/m^3 3-hour

Note: Parts per million is ppm, and µg/m^3 is micrograms per cubic meter, units that define healthful pollutant concentrations of pollutants in the lower atmosphere.

Source: 40 CFR Part 50.

Ambient air monitoring data recorded on the North Slope are available from the industrial and commercial oil companies such as British Petroleum – Alaska (BPXA) and Shell Oil Company. The monitors recorded values that are lower than any of the NAAQS. The highest pollutant concentrations recorded are summarized in **Table C-2**, along with the 2010 EPA Region 10 average values for background concentrations for Nuiqsut, Alaska.

C-2. METEOROLOGY AFFECTING AIR QUALITY ON THE ALASKA NORTH SLOPE

Meteorological conditions other than wind speed will affect the dispersion of emissions caused by the Proposed Action. Prevailing wind direction will show where the pollutants are likely to affect the Eastern NS. Temperatures in the area will determine how buoyant the emissions may become at the point of exhaust. The hours of daylight, a unique characteristic of Alaska’s North Slope, along with the vertical temperature profile, will indicate the degree of stability in the lower atmosphere, where instability causes mixing and dispersion of pollutants. And precipitation trends are important as particles can be taken out of the air by rain and snow.

Table C-2. Ambient Air Concentration Monitoring at Nuiqsut, Alaska.

Pollutant	NAAQS (µg/m3)	Averaging Period	Nuiqsut – ADEC Maximum Data[1/]		Nuiqsut – EPA Region 10[2/] 2010 Average Background Concentrations
			Value	Year	
Carbon Monoxide (CO)	10,000	8-hour	No data	---	1094
	40,000	1-hour	No data	---	1742
Lead (Pb)	0.15	Rolling 3-Month Average	No data	---	No data
Nitrogen Dioxide (NO_2)	100	Annual	11.3	2004	11
	188	1-hour	88.4	2004	94
Particulate Matter (PM_{10})	150	24-hour	119.4	2005	53
	50	Annual	8.5	2003	No data
Particulate Matter ($PM_{2.5}$)	15	Annual	No data	---	4
	35	24-hour	No data	---	17
Ozone (O_3)		8-hour	80.4	2005	
Sulfur Dioxide (SO_2)	196	1-hour	31.4	2005	14
	1300	3-hour	18.3	2005	180
	365	24-hour	7.9	2005	15
	80	Annual	No data	---	4

Note: Data provided is the latest data available. There is no lead monitoring on the North Slope.

1/ Highest concentrations recorded through monitoring using methods not necessarily the same as for background concentrations due to the different time periods the data was recorded.

2/ Background concentrations provided by EPA Region 10 for the Shell Offshore Inc. Permit No. R10OCS/PSD-AK-2010-01 based on monitoring using industry monitoring equipment.

Sources: Alaska Department of Environmental Conservation. 2011. Emissions, Meteorological Data, and Air Pollutant Monitoring for Alaska's North Slope. Table 6.1 for Nuiqsut.EPA. 2010. Supplemental Statement of Basis for Proposed OCS Prevention of significant Deterioration Permits Nobile Discoverer Drillship – Shell Offshore Inc. Beaufort Sea Permit No. R10OCS/PSD-AK2010-01. Table 5 Background Values for Use with M9odeled Impacts Onshore Locations (Nuiqsut).

2.1. Wind Direction

Winds over the Eastern NS prevail from the east northeast during the period proposed for the seismic survey, particularly during July and August. Toward September and October, winds will pick up more frequently from the south, particularly over Nuiqsut, Alaska, as shown in **Figure C-4.**

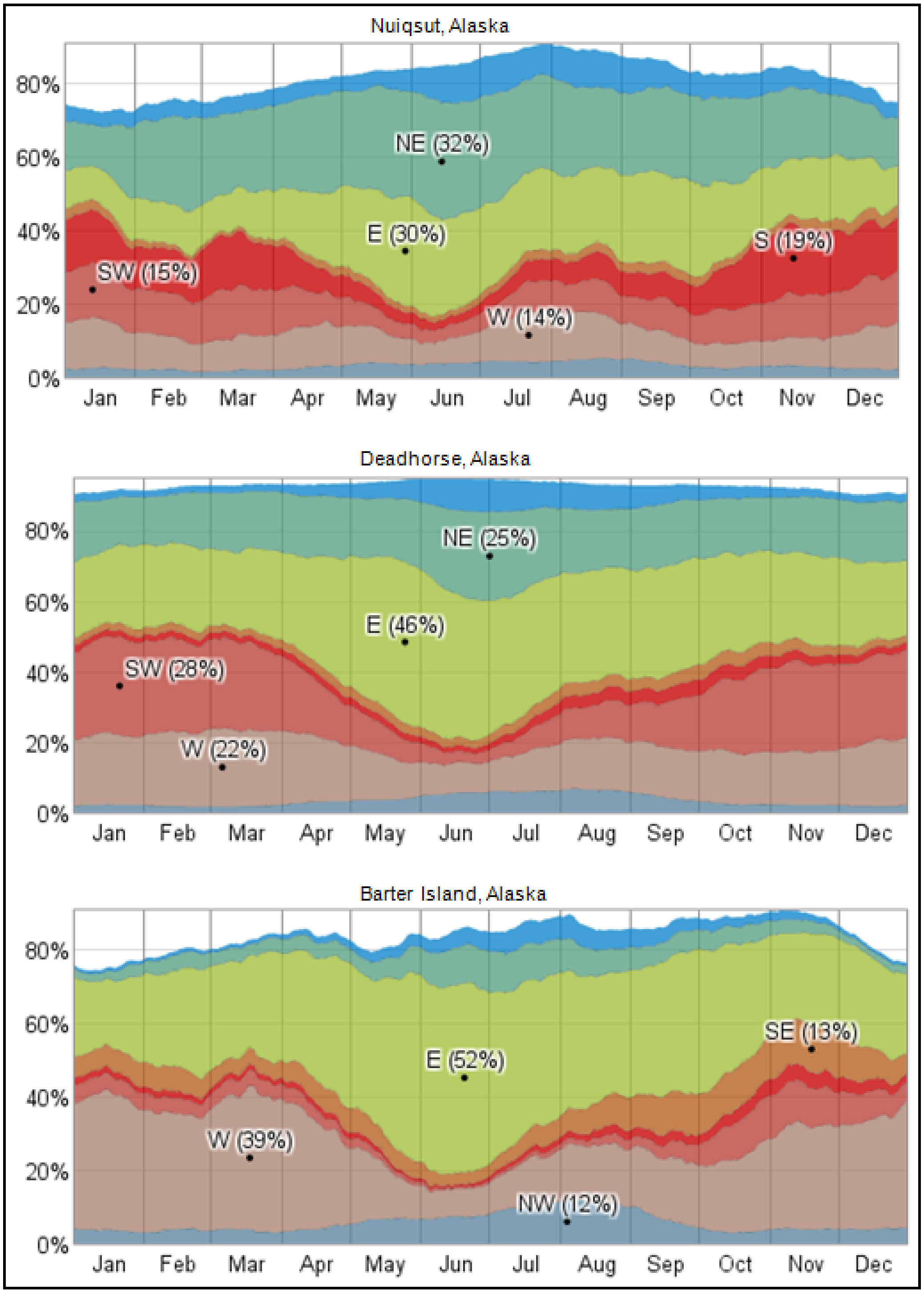

Figure C-4. **Average Wind Direction.** *Fraction of time with various wind directions at Nuiqsut, Alaska, Deadhorse, Alaska, and Barter Island, Alaska.*

Source: Cedar Lake Ventures, Inc., "WeatherSpark."
http://weatherspark.com/averages/33044/Nuiqsut-Alaska-United-States
http://weatherspark.com/averages/33051/Deadhorse-Alaska-United-States
http://weatherspark.com/averages/32900/Barter-Island-Alaska-United-States

A multiyear meteorological study suggests the trend for wind patterns on the North Slope are influenced by the Brooks Range (Veltkamp & Wilcox, 2007). The study shows that regardless of whether the winds are from the east or west, the flow over the eastern portion of the Beaufort Sea coastline is influenced by the Brooks Range, which can effect wind direction as far as 30 miles offshore along the area extending from Camden Bay to Mackenzie Bay. The incidence of wind channeling is strongest on the eastern coastline near Barter Island. Influence from the mountain range decreases to the west and shows little impact west of Barrow where wind direction in the Chukchi Sea is influenced more by surface pressure systems.

The prevailing winds from the east northeast will transport emissions to locations over the coastline, particularly over the Colville River Delta and Coleville Village. Landfall is most likely from emissions originating from the southernmost Townships U013N006E, U013N007, U013N008, U013N009, and U013N010E, being closer to shore. However, given the wind speeds, emissions originating from the affected Townships will be diffused and dispersed, both horizontally and vertically, and mixed with the surrounding air in the lower atmosphere, with little opportunity to accumulate and buildup onshore. When winds shift to a southerly flow, the emissions from the ships' engines will be transported out to sea, and will not affect the Eastern NS coastline.

2.2. Temperature

Temperatures on the Eastern NS are moderated by the marine influences of the Beaufort Sea, which is strongest in the summer. The influence diminishes in the colder months. However, even when the Beaufort Sea is frozen, the marine influence, however slight, is present. The marine effect on the coastline diminishes with the distance inland. As a result, the temperatures inland are much colder than on the coastline.

The warm season on the Eastern NS lasts from June through the middle of September, and the Proposed Action will encounter moderately cool temperatures. In middle September, the temperatures will start falling rapidly both at night and during the day. Profiles of the average daily low and high temperatures in Nuiqsut, Alaska, Deadhorse, Alaska, and Barter Island, Alaska, are shown in **Figure C-5**.

Moderate but cool[7] temperatures will prevail during the beginning of the survey and fall rapidly later in the survey. During July and August the daily high temperatures will average in the 50s with lows in the middle to upper 30s. By the middle of September, daily low temperatures will begin to drop below freezing and by October 1st, so will the daily high temperatures. By the end of October, daily highs will be in the upper teens and daily low temperatures will be around zero at Nuiqsut and Deadhorse, but colder to the east, around 10 degrees Fahrenheit (deg. F) at Barter Island, Alaska. Freezing and even frigid temperatures will occur through October.[7]

Because diesel engines, such as those aboard the survey ships, convert fuel into energy by using compressed air to burn diesel fuel, gases at the point of exhaust is hot, ranging from 1,000 to 1,200 deg. F (Engineering Toolbox Online, accessed 2014). Clearly, the temperature of the engines' exhausts are greater than the surrounding air, which causes the plume of exhaust to be buoyant, rise, disperse, and mix with the cleaner air. Thus, the cooler and cold temperatures on the Eastern NS enhance the dispersion conditions of the atmosphere. Also, there is not a large temperature difference between the daily high and daily low temperature over the period of time when the survey will take place. As such, the temperature is not causing a change in dispersion conditions at night as compared to the daytime.

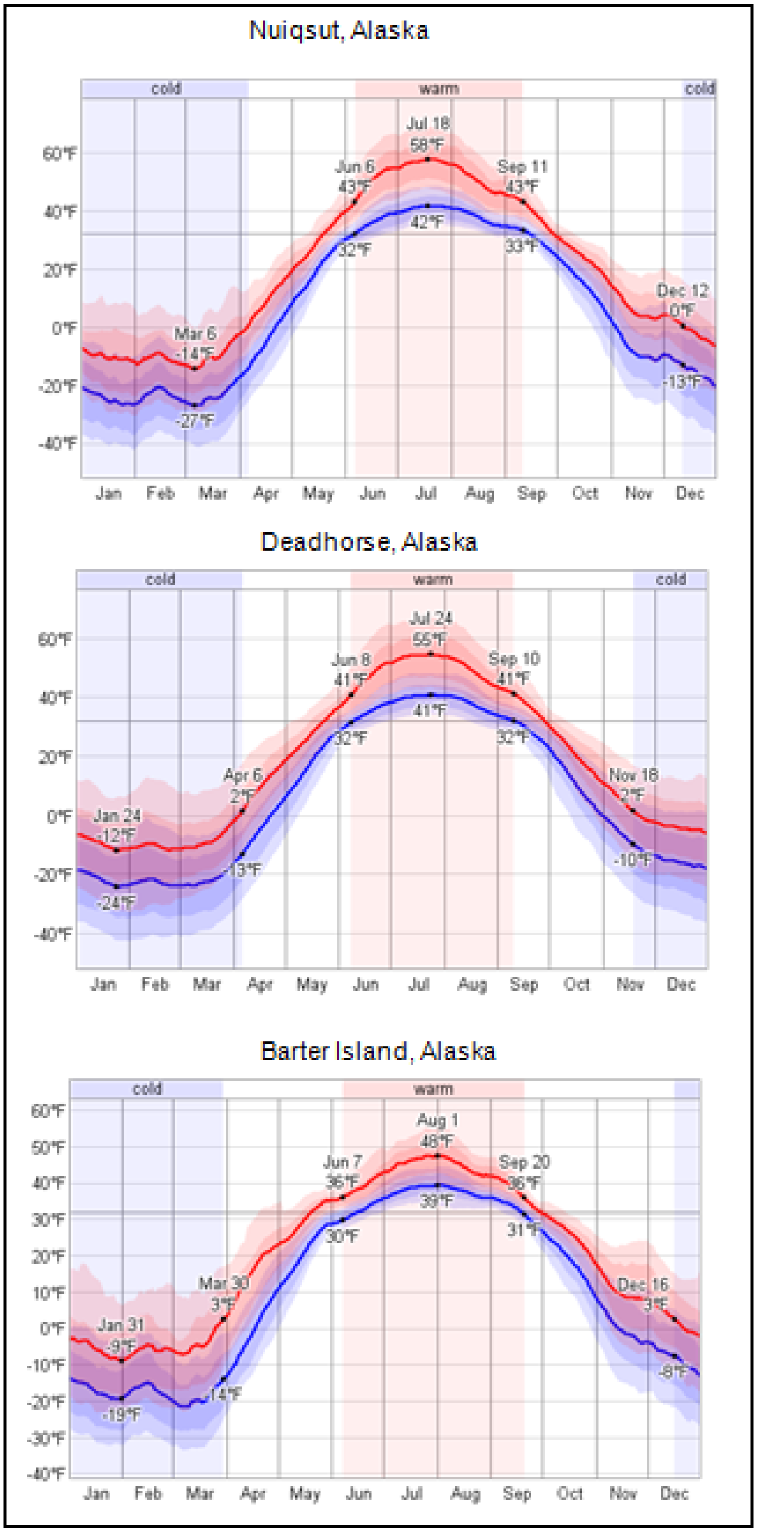

Figure C- 5. Average Temperature. *Daily high and low temperatures at Nuiqsut, Alaska, Deadhorse, Alaska, and Barter Island, Alaska.*

Source: Cedar Lake Ventures, Inc.: WeatherSpark.

http://weatherspark.com/averages/33044/Nuiqsut-Alaska-United-States
http://weatherspark.com/averages/33051/Deadhorse-Alaska-United-States
http://weatherspark.com/averages/32900/Barter-Island-Alaska-United-States

A unique characteristic of the Alaska North Slope is the seasonal variation in hours of sunlight. The seismic survey will begin during a time of 24-hour sunlight during most of July. However, the solar insulation will be slight[8] even during the time of 24-hour sunlight. The sun will be 38-39 degrees above the horizon in July and August, just 5.78 degrees above the horizon in September, and will sink below the horizon, -5.79 degrees by October (University of Toledo, accessed May 7, 2014).

By the middle of August there will be almost 19 hours of sunlight each day, with the sun rising at 3:49 a.m. and setting at 10:03p.m. (all sunrise and sunset times are Alaska Standard Time). In September the number of sunlight hours will begin to decrease more rapidly. By the end of October there will be only 6-7 hours of daylight, with the sun rising at 9:23 a.m. and setting at 3:51 p.m. (USNO, 2014).

2.3. Atmospheric Stability

Atmospheric stability is a function of wind speed, solar insulation, and cloudiness and refers to the vertical motion of the atmosphere, meaning whether air is rising or sinking. Unstable air has vertical motion that allows pollutants to rise and disperse vertically while wind disperses horizontally, decreasing pollutant concentrations. Stable air has little or no vertical motion, referred to as subsidence (descending air). Stable air does not allow pollutants to rise, and winds that are usually light in stable air, inhibit dispersion. The pollutants are trapped near the ground increasing pollutant concentrations at the surface.

Cloudiness inhibits solar radiation, and skies will be cloudy during much of the seismic survey. With partly cloudy to cloudy skies in July, overcast skies will quickly become more prevalent through August, and continue for nearly the entire two remaining months of the survey (Cedar Lake Ventures, accessed May 5, 2014). Generally, overcast skies will become less prominent as the survey moves east to near Barter Island, Alaska.

Using the Pasquill-Gifford stability method, and with the horizontal wind speed of 11.8 mph (5.3 m/s), the average stability of the atmosphere over the Eastern NS would be slightly unstable (class C) in July and August to neutral (class D) in September and October (University of Toledo, accessed May 7, 2014). Stability Class C indicates the atmosphere is suitable for vertical mixing and dispersing pollutants.

2.4. Liquid and Frozen Precipitation

The highest measured amount of liquid precipitation occurs in the months of July and August.[9] Over an inch of liquid precipitation can be expected in August tapering off to around one-half inch by October, as shown in **Figure C-6**. However, by October, much of the precipitation will fall as snow.

Profiles of the 2013 daily liquid precipitation in Nuiqsut, Alaska, Deadhorse, Alaska, and Barter Island, Alaska, are shown in Figure C-7.[10] Even in small amounts, precipitation is expected to occur nearly every day during the survey, particularly as the seismic survey moves east toward Barter Island, Alaska. Rain decreases concentrations of air pollutants as the gases are “precipitated” out of the atmosphere, but less so for snow.

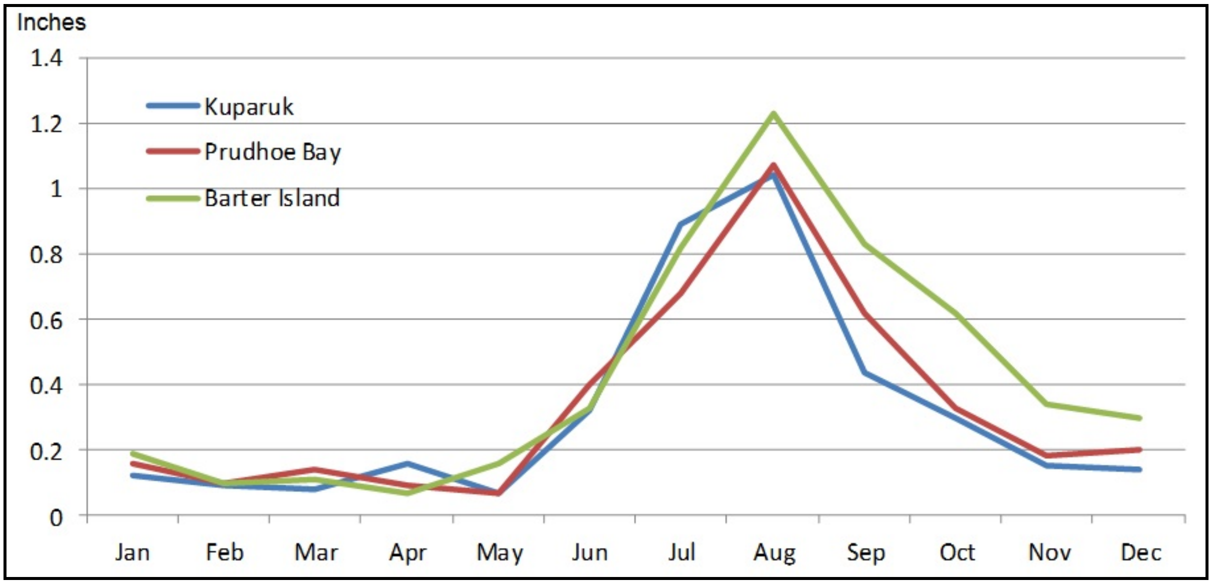

Figure C- 6. Average Monthly Precipitation (liquid and frozen). *Average monthly normal precipitation amounts, tabulated by the National Climatic Data Center (NCDC), for the years 1981-2010 for Kuparuk, Alaska, Prudhoe Bay, Alaska, and Barter Island, Alaska.*

Source: Western Region Climate Center. Kuparuk: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ak5136
Prudhoe Bay: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ak7780
Barter Island: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ak0558

Based on the meteorology and historical climate of the Eastern NS during the time period proposed for the seismic survey, conditions are suitable for mixing and dispersion of pollutants. The temperatures are cool enough to be much less than the temperature of the exhaust from the diesel engines causing the plumes of emissions to be buoyant, at least initially, and rise at the source, mixing and expanding in the surrounding air. In the slightly unstable atmosphere, the plumes will then be picked up by the wind and mixing will continue with the surrounding air. The plumes will expand both vertically and horizontally, all factors of favorable conditions to reducing pollutant concentrations. Rain, occurring often during the project, will further reduce pollutant concentrations by precipitating some of the larger particle emissions out of the air.

The east northeast winds will transport emissions from the survey ships to locations south southwest of the ships' positions. As such, emissions from ships operating the survey in Townships just offshore, such as U013N006E, U13N007E, U013N008E, U013N009E, and U013N010E (see Figure C-1), will drift over the onshore areas on and in the vicinity of the Colville River Delta, and Colville Village. However, due to the itinerant and temporary nature of survey operations, the winds, slightly unstable air, and precipitation, there is little opportunity for pollutants from the survey ships to accumulate and buildup in concentrations that could cause an exceedance of the NAAQS on the Eastern NS, including in populated or sensitive areas, whether individually or cumulatively with other emission sources in the area.

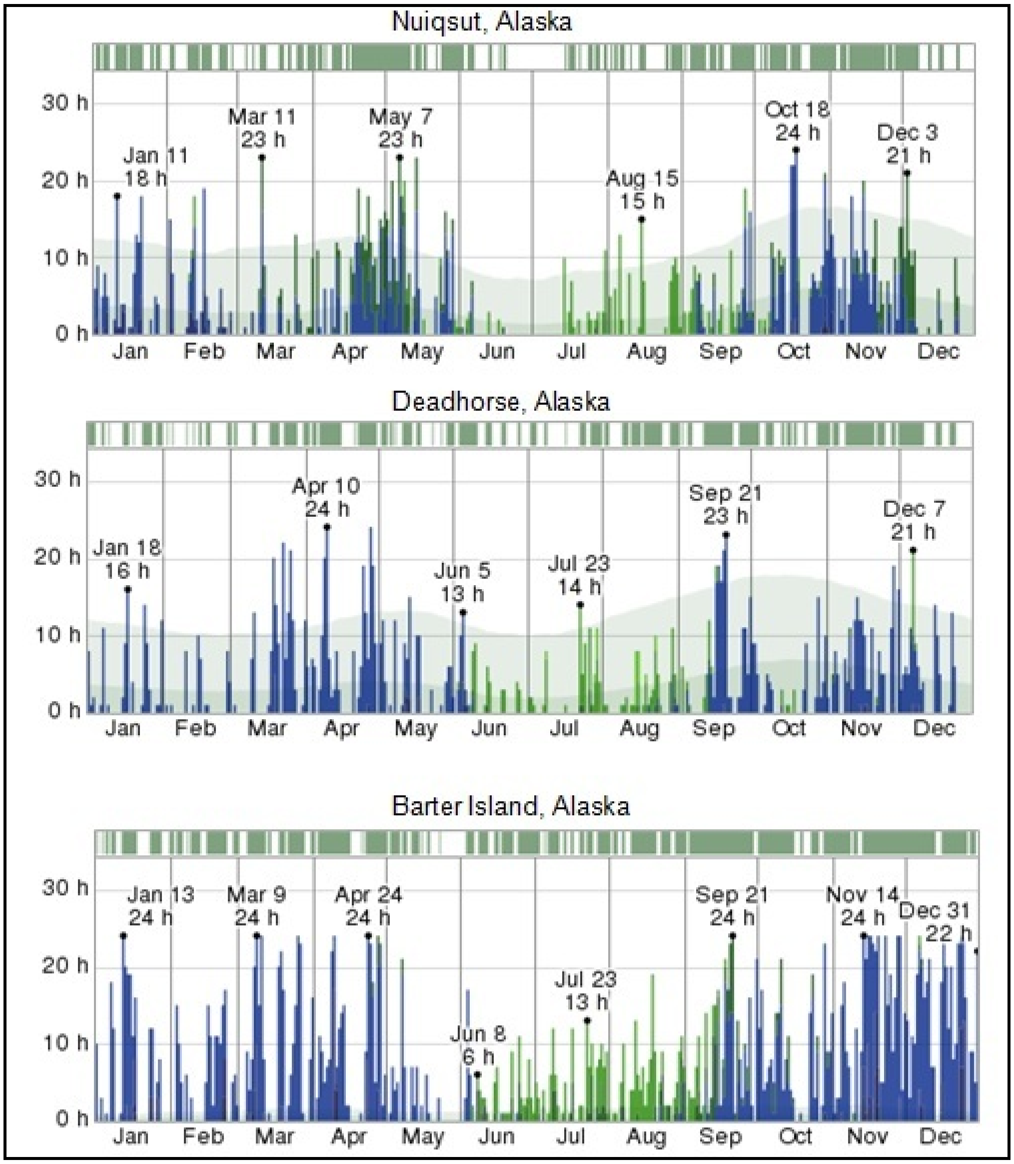

Figure C-7. Precipitation Reports for 2013 (liquid and frozen). *Daily number of hourly observed precipitation reports during 2013 at Nuiqsut, Alaska, Deadhorse, Alaska, and Barter Island, Alaska. Green is liquid precipitation and blue is frozen. The faint shaded area in the background indicate average daily normal precipitation, except for Barter Island, which is missing the average data; refer to Figure C-6 for the Barter Island average monthly precipitation. The bar at the top of each graph is green if any precipitation was observed that day and white otherwise.*

Source: Cedar Lake Ventures, Inc.: WeatherSpark.
http://weatherspark.com/history/33044/2012/Nuiqsut-Alaska-United-States
http://weatherspark.com/history/33051/2013/Deadhorse-Alaska-United-States
http://weatherspark.com/history/32900/2013/Barter-Island-Alaska-United-States

C-3. REGULATORY APPLICABILITY

Outside air becomes a regulatory concern when harmful gases and other air contaminants build up in the lower atmosphere sufficient to cause measurable damage to human health, wildlife, or property (Monks, Granier, & Stohl, et al., 2009). Air quality regulations that may be relevant to a proposed action involving offshore oil and gas exploration, development, and production are established by the

EPA, pursuant to the Clean Air Act, BOEM, U.S. Federal maritime regulations, and the International Community under the International Convention of the Prevention of Pollution from Ships (hereafter referred to as MARPOL).

3.1. Clean Air Act National Ambient Air Quality Standards (NAAQS)

The Environmental Protection Agency (EPA) established the NAAQS to serve as the benchmark for determining when the potential for harm exists over land from emissions from any source. The NAAQS represent the numerical limits (criteria) above which concentrations of the most common air pollutants may be harmful to human health and welfare. Pollutant concentrations are expressed in terms of mass per volume, or micrograms per cubic meter of air ($\mu g/m^3$). The NAAQS are updated periodically by the EPA and are available on the EPA Website at http://www.epa.gov/air/criteria.html.

The six common (criteria) air pollutants that the EPA regulates through the NAAQS are:

- Carbon monoxide (CO);
- Nitrogen oxides (NO_x), including nitrogen dioxide (NO_2);
- Sulfur oxides (SO_x), including sulfur dioxide (SO_2);
- Fine particulate matter ($PM_{2.5}$);
- Coarse particulate matter (PM_{10});
- Ozone; and
- Lead.

The EPA requires the NAAQS to be attained and maintained, and has given authority to State governments, through their State Implementation Plans (SIPs), to regulate through permitting and control, mainly of stationary sources of emissions. The regulations for controlling stationary emission sources are distinctly different from regulations applicable to mobile sources, such as the ships used for the proposed survey.

Emissions from a single stationary source tend to affect the same downwind location on a consistent basis over a period of time due to the prevailing wind, such as from an oil and gas development and production platform. Whereas emissions from mobile sources, such as ships conducting a seismic survey, are dispersed over a much larger area as the continuously moving source approaches and then moves farther away from a location. Emissions from the survey vessels proposed for the survey are mobile, itinerant, and temporary and moving progressively further out to sea increasing the distance for pollutants to disperse before reaching land.

While a single mobile source is not likely to cause an accumulation of pollutants in a single location sufficient to exceed the NAAQS, when there are scores of mobile sources concentrated in a relatively small area, such as a highway corridor during rush hour, Federal standards are, on occasion, exceeded. Thus, the EPA requires that engines on vehicles, or in this case vessels, be controlled at the point of manufacture, which reduces emissions not only in crowded corridors (highways or shipping routes), but anywhere the mobile sources are operated, thus reducing emissions on a long-term, local, and regional scale. In a similar way, the EPA has a coordinated strategy to focus efforts to reduce emissions from large marine vessels, on ships flagged in both the United States and in other countries.

3.2. BOEM Air Quality Regulatory Program and Clean Air Act

The BOEM Air Quality Regulatory Program (AQRP) does not apply to the seismic survey vessels or any other emission sources or emissions resulting from the Proposed Action (30 CFR Part 550 subpart C). The AQRP applies only to a facility, as defined under 30 CFR 550.105, which requires a facility to be permanently or temporarily attached to the seabed for the purpose of oil and gas exploration, development, and production. Anything more or different is beyond the limited authority of BOEM and the AQRP (42 USC 1334(a)(5)). The EPA rule for the Prevention of Significant Deterioration (PSD) and the requirement for a Title V permit under the Clean Air Act as given under 40 CFR Part 55, also are not applicable to the Proposed Action.

3.3. MARPOL - International Control of Pollution from Ships

Reports from the EPA and U.S. Congress concur that large ships similar in size to container ships, tankers, and cruise ships are not trivial contributors to regional and global air pollution (EPA, 2013; Copeland, 2008). According to the EPA, pollution from large marine diesel engines is expected to contribute more than 2.1 million tons of NO_x emissions each year by 2030, and increase $PM_{2.5}$ emissions to 170,000 tons per year (EPA, 2013).

Emissions from the main propulsion engines onboard ocean-going vessels, including those operating on the OCS, are controlled at the point and time of manufacturer (OEM, Original Equipment Manufacturer) and must meet emission standards imposed by the International Maritime Organization (IMO). The IMO is the United Nations specialized agency with responsibility for maritime safety and security, and is concerned with the prevention of marine pollution from ships. Established in 1959, the IMO includes the United States as a signatory country and the EPA is a participant on the U.S. delegation to the IMO. In 1973, IMO adopted the MARPOL Convention to minimize specific types of pollution of the seas (IMO, 2013).

3.3.1. MARPOL, International Convention of the Prevention of Pollution from Ships

MARPOL (the acronym for "marine pollution") refers to the International Convention on the Prevention of Pollution from Ships, which established a set of agreed-upon standards and criteria (conventions) intended to minimize and prevent pollution from ships. MARPOL consists of six annexes (documents), where each describes regulations for pollution prevention at sea, and where each annex is specifically dedicated to rules and regulations of a particular harmful contaminant, substance, or material. The IMO (2010) annexes include strategies for the prevention of pollution by:

- Oil from ships (Annex I in 1983)
- Noxious liquid substances in bulk (Annex II in1983)
- Harmful substances carried by sea in packaged form (Annex III in1992)
- Sewage pollution by ships (Annex IV in 2003)
- Garbage pollution from ships (Annex V, revised for 2013)
- Prevention of air pollution from ships (Annex VI revised in 2010) (IMO, 2013)

The provisions of each annex are legally binding and enforceable only after ratification by member countries (signatories) whose combined gross tonnage reflects at least half of the world's gross tonnage. When sufficiently ratified, MARPOL applies to all vessels operating in U.S. waters as well as ships operating within 200 nautical miles of the coast of North America (IMO, 2013).

3.3.2. MARPOL Revised ANNEX VI

MARPOL Revised Annex VI (Annex VI) was ratified by 59 countries, including the U.S., representing approximately 84 percent of the world's gross tonnage. As such, the provisions of Annex VI became legally binding and enforceable beginning July 1, 2010 (IMO, 2010). Hence, U.S. OEMs of specific marine diesel engines are now required to meet the Annex VI emission standards for NO_x, on new engines, and the fuel used in the engines must reduce emissions of SO_x. Engines not subject to the emission standards of Annex VI may be subject to standards set forth in the previous versions of the annex. Large ships of a foreign flag are obliged to meet the standards imposed by the U.S. when navigating within U.S. jurisdictional waters. In addition to emission standards at the manufacturer, Annex VI includes requirements for the certification and operation of vessels and engines, as well as fuel quality used in vessels in the waters of the U.S.

Ships of signatory countries constructed on or after January 1, 1990 but prior to January 1, 2000, or when a major rebuild was completed during this time, must comply with the Tier 1 NO_x emission limits given in **Table C-3**.

Table C-3. MARPOL Annex VI NO_x Emissions Limits.

Tier	Date Enforced	NO_X Emission Limit in g/kW-hr, where n=rpm		
		n < 130	130 ≤ n < 2000	n ≥ 2000
I	2000	17	$45 \cdot n^{-0.2}$	9.8
II	2011	14.4	$44 \cdot n^{-0.23}$	7.7
III	2016	3.4	$9 \cdot n^{-0.2}$	1.96

Source: Det Norske Veritas (DNV). 2005. Marpol 73/78 Annex VI: Regulations for the prevention of Air Pollution from Ships – Technical and Operational Implications. Regulation 13 Tier I: Current Limits.

3.3.3. U.S. 1980 Act to Prevent Pollution from Ships to Implement MARPOL

The international nature of maritime shipping makes implementation and enforcement of marine engine emission standards challenging. Following ratification of a MARPOL annex, each nation that is a signatory to the annex must enact domestic laws to implement the standards and ensure certification and compliance with the laws of the other signatory nations related to ships' emissions. Certification of marine propulsion and auxiliary engines to the pollution prevention standards is the responsibility of the country where the ship is registered, referred to as the "flag state." In response, the U.S. enacted the 1980 Act to Prevent Pollution from Ships (1980 APPS). The 1980 APPS is a U.S. Federal law enacted to implement the provisions of MARPOL and any ratified annexes. The 1980 APPS "gives the U.S. Coast Guard (USCG) the authority to develop regulations and enforce MARPOL standards." (Council on Foreign Relations, 2013). The 1980 APPS applies to all U.S. flagged ships operating anywhere in the world and, "…to all foreign flagged vessels operating in navigable waters of the U.S. or while at port under U.S. jurisdiction;" the 1980 APPS is codified at 33 USC 1901 (USLegal, 2013). The regulatory mechanism established in the 1980 APPS to implement MARPOL and its annexes is separate and distinct from the Clean Air Act, other U.S. Federal environmental laws, and Federal agency regulations. The provisions of the 1980 APPS do not apply to any warship, naval auxiliary, ships of the Department of the Navy, or ships operating during a time of war or a declared national emergency.

3.3.4. EPA and U.S. Coast Guard Enforcement of MARPOL

The EPA issued guidance to establish terms under which the USCG and the EPA mutually cooperate in the implementation and enforcement of Annex VI as implemented by the 1980 APPS. The EPA and USCG entered into a Memorandum of Understanding (MOU) on June 27, 2011, that includes inspections, investigations, and enforcement actions if a violation is detected. Efforts to ensure compliance include oversight of marine fuelling facilities, onboard compliance inspections, and reviews of records. The USCG or EPA may bring an enforcement action for a violation, which may result in criminal and/or civil liability. The memorandum is available at http://www.epa.gov/enforcement/air/documents/policies/mobile/annexvi-mou062711.pdf (EPA, 2012b). The EPA and USGC also issued a Joint Letter to ship owners, ship operators, shipbuilders, marine diesel engine manufacturers, and marine fuel suppliers to inform them of the 1980 APPS and the requirements of Annex VI (EPA, 2012a).

3.3.5. U.S. Required Certifications and Examinations for MARPOL Annex VI

Each diesel engine regulated under Annex VI aboard U.S. flagged vessels must have an Engine International Air Pollution Prevention (EIAPP) certificate. The certificate is issued by the EPA serves as documentation that the engine meets the Annex VI NO_X standard. Some vessels are also required to have an International Air Pollution Prevention (IAPP) certificate issued by the USCG. Ship operators must also maintain records onboard documenting compliance with the emission standards and fuel requirements. Non-U.S. flagged ships are subject to examination under Port State Control while operating in U.S. waters.

C-4. PROPOSED EMISSION SOURCES

This analysis considers three types of emission sources. The sea-going vessels proposed to conduct the seismic survey offshore, helicopters used for crew and supply transport, and use of surface vehicles to transport crew, staff, and equipment while onshore.

4.1. Proposed Survey Vessels

Eight vessels are proposed to be used in the Proposed Action. Two large source vessels for seismic data acquisition, two ships for node equipment deployment and retrieval, a housing vessel, a crew transport vessel, and two bowpickers. The first of the source vessels identified by SAExploration for the survey is the M/V *Peregrine*. The M/V *Peregrine* is pictured in **Figure C-8**.

Figure C-8. M/V Peregrine seismic source vessel.

Source: http://www.mvperegrine.com/our_vessels_peregrine.html

The M/V *Peregrine* has three main Cummins 2006 QSL9 marine diesel propulsion engines, each rated at 302.0 kW (405 hp), a total of 1215 hp. The engine is certified to the IMO Tier II NO_x emission standards set by Annex VI Regulation 13. The auxiliary engine aboard the M/V *Peregrine* is assumed to be similar to a Cummins QSC8.3-305 diesel auxiliary engine with a rating of 227.4kW (305 hp). There is no information indicating the auxiliary engine will be certified under Annex VI. As such, EPA AP-42 emission standards are applied. Specifications for the engines are found on the Cummins Website at http://cumminsengines.com/showcase-item.aspx?id=71&title=QSL9+for+Recreational+Marine&#overview and http://www.engine-trade.com/product/cummins-qsc8.3-305(2100rmp)-diesel-engine-for-engineering.htm.

The second seismic vessel is assumed to be similar to the M/V *Arctic Wolf*, which is substituted for the M/V *Maxime* proposed by SAExploration, for which no information was available. The M/V *Arctic Wolf* is pictured in **Figure C-9**. The M/V *Arctic Wolf* is assumed to have one main Caterpillar 3512B marine diesel propulsion engine rated at 1,678 kW (2,250 hp). The engine is certified to the IMO Tier II NO_x emission standards set by Annex VI Regulation 13. The auxiliary engine aboard the M/V *Arctic Wolf* is assumed to be similar to a Cummins QSC8.3-305 diesel auxiliary engine with a rating of 227.4kW (305 hp). There is no information indicating the auxiliary engine will be certified under Annex VI. As such, EPA AP-42 emission standards are applied. Specifications for the engine are found on the Caterpillar and Cummins Websites:
http://www.cat.com/en_US/products/new/power-systems/marine-power-systems/commercial-propulsion-engines/18370846.html, and
http://www.engine-trade.com/product/cummins-qsc8.3-305(2100rmp)-diesel-engine-for-engineering.htm.

Figure C-9. M/V *Arctic Wolf* substituted for the M/V *Maxime* seismic source vessel.
Source: http://www.ocean-explorers.com/oceanx/b_on/wolfpics.htm

The first of the deployment and retrieval vessels identified by SAExploration for the survey is the M/V *Miss Diane*. The M/V *Miss Diane* is pictured in **Figure C-10**. The M/V *Miss Diane* has two John Deere main engines assumed to be similar to the 6090SFM75-M5 rated at 325 kW (550 hp). The engine is certified compliant to the Tier II NOx emission standards set by Annex VI Regulation 13. The auxiliary engine aboard the *M/V Miss Diane* is assumed to be similar to a John Deere Series 6135H diesel generator engine with a rating of 311kW (417 hp). There is no information indicating the auxiliary engine will be certified under Annex VI. As such, EPA AP-42 emission standards are applied. Specifications for the engines are found on the John Deere Website at
http://www.deere.com/en_US/docs/engines_and_drivetrain/specsheet/MAR/6090SFM75_A.pdf and
http://search.deere.com/DDC/en_US/JDPS/?binning-state=product_category%3d%3dIGS%0Aemissions_level%3d%3dTier-3%0Apowertech_family%3d%3dPowerTech%20Plus%0A&

Figure C-10. M/V Miss Diane to be used for deploying and retrieving nodes.
Source: http://www.mvperegrine.com/our_vessels_miss_dianne.html

The additional ship proposed for deploying and retrieving nodes, the *M/V Mark Stevens* is similar to the *M/V Miss Diane*, and is pictured in **Figure C-11**. Like the *M/V Miss Diane*, the M/V *Mark Stevens* is assumed to operate two John Deere main propulsion engines similar to the 6090SFM75-M5 rated at 325 kW (550 hp). The engine is certified compliant to the Tier II NOx emission standards set by Annex VI Regulation 13. The auxiliary engine aboard the M/V *Mark Stevens* is assumed to be similar to a John Deere Series 6135H diesel generator engine with a rating of 311kW (417 hp). There is no information indicating the auxiliary engine will be certified under Annex VI. As such, EPA AP-42 emission standards are applied. Specifications for the engines are found on the John Deere Website at http://www.deere.com/en_US/docs/engines_and_drivetrain/specsheet/MAR/6090SFM75_A.pdf and http://search.deere.com/DDC/en_US/JDPS/?binning-state=product_category%3d%3dIGS%0Aemissions_level%3d%3dTier-3%0Apowertech_family%3d%3dPowerTech%20Plus%0A&.

The housing vessel proposed by SAExploration will be similar to the *Qualifier 105*, as pictured in **Figure C-12**. The Qualifier 105 is powered by three Detroit Series 60 marine propulsion engines, each rated at 317 kW (425 hp), and Detroit Engines reports the engine is certified compliant to the Tier II NOx emission standards set by Annex VI Regulation 13. The generator is assumed to be similar to a John Deere 6090S, 222 kW (298 hp) engine. There is no information indicating the auxiliary engine will be certified under Annex VI. As such, EPA AP-42 emission standards are applied. Specifications for the engines are found on the Detroit Diesel and John Deere Websites at http://extranet.detroitdiesel.com/Public/specs/4sa450ev0310.pdf and http://www.deere.com/en_US/docs/engines_and_drivetrain/specsheet/MGS/6090SFM75_E_1500.pdf

Figure C-11.M/V *Mark Stevens*. *The Mark Stevens or a similar vessel will deployand retrieve nodes.*
Source: http://www.mvperegrine.com/our_vessels_mark_steven.html

Figure C-12. M/V *Qualifier 105*. *The Qualifier, or similar vessel, used to house crew.*
Source: http://www.supportvesselsofalaska.com/our-vessels/qualifier-105/

The crew transport vessel proposed by SAExploration will be similar to a 27-foot Armstrong CAT, pictured in **Figure C-13** for use as a crew transport vessel. The Armstrong CAT is assumed to be powered by two Yanmar diesel 6CXBM-GT 265 kW (360 hp) engines. There is no information indicating the boat ultimately used by SAExploration for a crew transport vessel will be certified under Annex VI. As such, EPA AP-42 emission standards are applied. The specifications for the propulsion engine is on the Yanmar Website at http://www.yanmarmarine.com/theme/yanmar/uploadedFiles/Brochures/100x210%20Brochure_CHS%20Marine%20Product%20handbook%20for%20web.pdf

Figure C-13. **Armstrong CAT.** *The 27-foot Armstrong CAT or a similar vessel, to house survey crew***.**
Source: http://www.alaskaboatbrokers.com/commercial_listings_detail.php?id=1640

The bowpickers proposed by SAExploration will be similar to an All American Twin Jet Bowpicker, substituted for the *F/V Sleep Robber* and the *Maxine*, for which no information was available. The boat is pictured in **Figure C-14**. The two bowpickers are assumed to be powered by twin Volvo TAMD63A 242 kW (325 hp) diesel engines. There is no information indicating the boats ultimately used by SAExploration for bowpickers will be certified under Annex VI. As such, EPA AP-42 emission standards are applied. The specifications for the bowpicker is on the Alaska Boats Website at http://alaskaboat.com/boat.php?bid=bp156.

Figure C-14. **Twin Jet All American Bowpicker.** *32 x 14 ft, or similar vessel***.**
Source: http://alaskaboat.com/boat.php?bid=bp156

4.2. Marine and Auxiliary Diesel Engines

The projected emissions inventory of marine and auxiliary engine emissions was prepared using EPA-approved methodologies provided in the Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data (EPA, 2000). Emissions from operation of the vessels' engines were calculated using the standard EPA method of applying the output power (horsepower) to the emission factors, which are expressed as grams per horsepower-hour (grams/hp-hr), and applying the number of total operating hours. The emission factors are summarized in **Table C-4**. The emission rates allow the quantity of each pollutant to be calculated based on the operating power of the vessels' engines, which was reported to be 50 percent in the SAExploration Plan of Operation. However, a power load of 77 percent was applied to be more conservative and reflect a worst case scenario. The power load reflects the use of the vessels at various modes of operation, such as maneuvering to turn around at the end of grid lines, slow cruise along grid lines and during data acquisition, and normal and fast cruise as needed.

Table C-4. EPA AP-42 Emission Factors for Marine and Auxiliary Engines.

Pollutant	Emission Factors (pollutant per power unit)1/ grams/hp-hr 2/
CO	3.030
NO_X 3/	14.000
PM 4/	1.000
SO_X 5/	1.468
VOC 6/	1.120

Note: AP-42 is the EPA database of emission factors. All emission factors are from the AP-42 unless noted with the revolutions per minute (rpm), used for MARPL Annex VI emission factor calculations.
1/ Based on engines without any pollution control devices or technologies.
2/ All emission factors are AP-42 for engines less than 600 hp, reflecting the worst-case emissions.
3/ Assumes all NOX are comprised of NO2.
4/ Assumes all particulate matter is defined as PM10.
5/ Assumes all SOX in the fuel is converted to SO2.
6/ Defined as the total organic compounds.
Source: EPA. 2000. Air Pollution Report 42, Compilation of Air Pollutant Emission Factors, Fifth Edition, Volume I for Internal Combustion Sources (Chapter 3, Table 3.3-1 for engines less than 600 hp).

The emission factors in Table C-4 were applied to the specific equipment aboard the vessels using modeling assumptions derived from the EPA Air Pollution Report 42, Compilation of Air Pollutant Emission Factors, Fifth Edition, Volume I for Internal Combustion Sources (Chapter 3, Table 3.3-1 for engines less than 600 hp) (EPA, 2000). The emission factors are higher than emissions from a Annex VI certified engine. The actual emissions from the ships that are Annex VI certified would be less than the rate reported in this analysis. The ship-specific data is summarized in **Table C-5**.

All the ships are assumed to operate engines 24 hours per day, for 60 days, as proposed in the survey plan, or 1,440 hours. Project details assumed for the preparation of the marine engine emissions' analysis:

- Survey activities span 60 days from July through October, 2014;
- 24-hour per day schedule throughout the 60 days assumed for all ships;
- 2 source vessels for data acquisition, assuming similar types of vessels; and
- 6 support vessels, assuming similar types of vessels.

Table C-5. Marine Vessel Engine Power Output Specifications.

Ship and Operational Use	Type and Number of Engines		Power Output Rating (hp)	Total Power Output (kw/hp)
R/V Peregrine **–** Specified by SAExploration				
Source Vessel	Main Engines	(3) Cummins QSL9	1,215 hp	1,133.5/1,520p
	Auxiliary Engines	(1) Cummins QSC8.3-305	305 hp	
M/V ***Arctic Wolf*** **–** or similar vessel				
TBD Source Vessel	Main Engines	(1) Caterpillar 3512B	2,250 hp	1,905.3/2,555
	Auxiliary Engines	(1) Caterpillar QSC8.3-305	305 hp	
M/V ***Miss Diane*** **–** Specified by SAExploration				
Node equipment deployment and retrieval	Main Engines	(2) John Deere 6090SFM75-M5	1,100 hp	1,131.2/1,517
	Auxiliary	(1) John Deere 6135h	417 hp	
M/V ***Mark Stevens*** **–** Specified by SAExploration				
Node equipment deployment and retrieval	Main Engines	(2) John Deere 6090SFM75-M5	1,100 hp	1,131.2/1,517
	Auxiliary	(1) John Deere 6135h	417 hp	
Qualifier 105 – or similar vessel				
Mitigation/Housing Vessel	Main Engines	(3) Detroit Series 60	1,275 hp	1,173.0/1,573
	Generator	(1) John Deere 6090S	298 hp	
27-Foot Armstrong CAT– or similar vessel				
Crew Transport Vessel	Main Engines	(2) Yanmar 6CXBM-GT	720hp	536.9/720
All American Twin Jet Bowpicker – similar to the SAExploration-specified *F/V Sleep Robber*				
Bow Picker	Main Engines	(2) Volvo TAMD63A	650 hp	484.7/650
All American Twin Jet *Bowpicker* – similar to the SAExploration-specified *Maxine*				
Bow Picker	Main Engines	(2) Volvo TAMD63A	650 hp	484.7/650

Sources: Refer to the images of each ship and the discussion for references to the type of ship and the engine specifications.

4.3. Helicopters

Helicopter engine emissions were projected using the Federal Aviation Administration's Emissions and Dispersion Modeling System (EDMS) v.5.1.3. The following modeling assumptions were used in the analysis:

- Helicopters assumed based at Deadhorse, Alaska, maximum 9 flights per the 60 days.
- Sikorsky S3 Sea King assumed, which was designed to support the offshore oil industry[11].
- Mixing height assumed 1,500 feet above sea level.

Emissions from helicopters focus on the takeoff and landings cycles of the aircraft, referred to as Landing and Takeoffs (LTOs), and include takeoff, approach, and taxi time. Two LTOs are required for one round trip. The emissions occurring during flight are not considered because the emissions occur more than 1,000 feet above sea level, which does not impact surface pollutant concentrations. Each LTO of the Sikorsky S3 Sea King produces 0.14 tons of CO, the controlling pollutant; this means that for each LTO, there are higher emissions of CO than any other pollutant analyzed. Each

LTO emits only 0.572 pounds of NO_x emissions. This is because the turboshaft engine uses a kerosene based fuel that has lower NO_x emissions and higher CO emissions.

The Proposed Action is assumed to require service of a helicopter once weekly, or nine round trips (18 LTOs). Use of the Sea King up to 75 LTOs, at least 37 round trips, is necessary to produce just one short ton of CO emissions, and only 0.021 short tons of NO_x. While SAExploration is uncertain exactly how many helicopter trips will be necessary, the number is likely less than 37 round-trips over the 60-day survey period of operation. The emission factors applied to each LTO of the Sea King, and the times operating in the various modes, are summarized in **Table C-6**.

Table C-6. Helicopter Emission Factors and Operating Modes.

Helicopter Operational Mode and Operating Time-in-Mode per LTO			Sikorsky S-3 Sea King Emission Factors (grams pollutant per kilogram of fuel burned, g/kg)			
			CO	VOC	NOx [3/]	SOx [1/ and 4/]
Takeoff	0.025	minutes	7.03	1.71	8.79	1.29
Approach	6.2	minutes	11.2 - 142.4[2/]	1.0 – 80.9	1.5-6.9	1.29
Taxi	8.0	minutes	140.6	79.9	1.5	1.29

Note: No particulate matter emissions are available for this helicopter.

Each LTO is comprised of takeoff, approach, and taxi; two LTOs is a round trip.

1/ Assumes fuel sulfur content of 0.068 percent.

2/ Several thrust levels are required during the minutes of approach. The emission factors provide the range of rates for each pollutant.

3/ Assumes all NOX are comprised of NO2.

5/ Assumes all SOX in the fuel is converted to SO2.

Source: FAA. Emissions and Dispersion Modeling System (EDMS) v. 5.1.3.

4.4. Surface Vehicles

Predicting exactly what vehicles would be used onshore, or how many miles the vehicles would be driven is difficult to predict. The analysis of surface-vehicle emissions focuses on the miles driven to generate at least one short ton of emissions from the controlling pollutant, which is NO_x; meaning that for each mile driven, there are higher emissions of NO_x than for any other pollutant analyzed. Emissions of NO_x are higher due to the use of diesel fuel. Each mile driven by the assumed 15 vehicles emits less than one pound of NO_x gases so the projected inventory of emissions from surface vehicles will be relatively low. The following modeling assumptions were used in the analysis:

- Diesel transit bus assumed for transporting personnel and equipment while onshore.
- Assume 15 buses are used, 35 miles per hour, model year 2000 or older, diesel fuel.
- EPA MOBILE 6 emission factors.
- Average daily temperature: 26°F (Deadhorse, Alaska).
- Average daily high temperature: 41°F (Deadhorse, Alaska).
- Average daily low temperature: 35°F (Deadhorse, Alaska).

Temperature information is necessary to run the EPA MOBILE 6 emission factor program. The FAA EDMS was used for the calculation of vehicle emissions. The seismic survey is assumed to require service of 15 buses, or a similar vehicle manufactured in or before model-year 2000. This approach will yield higher emissions for a worst-case scenario. Use of the 15 vehicles driven up to 4,500 miles, is necessary to produce just one short ton of NO_x emissions, and produces only 0.18 short tons of CO. While SAExploration is uncertain exactly how many vehicles or vehicle-miles will be necessary, the number is likely less than 4,500 miles over the 60-day survey period of operation. The emission factors applied to each vehicle-mile for each vehicle are summarized in **Table C-7**.

Table C-7. Vehicle Emission Factors.

Source	MOBILE 6 Emission Factors (grams pollutant per vehicle-mile)					
	CO	VOC	NO_x [2/]	SO_x [1/ and 3/]	PM_{10}	$PM_{2.5}$
15 Buses, 35 miles per hour, diesel fuel, model year 2000	2.414	0.200	13.724	0.016	0.162	0.135

1/ Assumes no restriction for fuel sulfur content.
2/ Assumes all NOX are comprised of NO_2.
3/ Assumes all SOX in the fuel is converted to SO_2.
Source: FAA. Emissions and Dispersion Modeling System (EDMS) v. 5.1.3.

C-5. PROJECTED EMISSIONS INVENTORY

An inventory of projected emissions was prepared that reflects the worst-case scenario of operation of the several vessels proposed for use by SAExploration, together with emissions from aircraft (helicopters) and surface vehicles needed onshore. Emissions from these sources would not occur if not for the implementation and operation of the seismic survey. As there would be no baseline of marine, aircraft, or vehicle emissions associated with the no-action alternative, the projected emissions should be considered the total net emissions increase caused by the Proposed Action. The inventory includes an evaluation of the following pollutants:

- CO.
- NO_x, where emissions of NO_x are assumed to be made up entirely of NO_2.
- SO_2, where emissions of SO_2 are assumed to include Sox.
- Particulate matter (where emissions of PM are assumed to include both $PM_{2.5}$ and PM_{10}).
- Volatile organic compounds (VOC).

Although a criteria pollutant, an assessment of ozone emissions is not included in the analysis. This is because ozone is not emitted directly by a source; rather ozone is formed through the secondary photochemical reaction between emissions of the precursor pollutants, NO_x and VOC, and sunlight. As such, an inventory of NO_x and VOC emissions is provided and serves as an indicator of potential ozone development. Diesel fuel contains no lead, a criteria pollutant; thus, the analysis did not include projected emissions of lead.

The data from Table C-4, Table C-5, Table C-6, and Table C-7 were used to calculate total projected emissions, which are summarized in **Table C-8** - *Projected Emissions Inventory*.

The primary criteria pollutants caused by engines operated on the survey vessels are NO_2, SO_2, and CO. Emissions of NO_2 emissions are caused by the high pressures and temperatures during the combustion process, whereas emissions of CO, PM, and VOC are due to incomplete combustion. Ash and metallic additives in the fuel contribute to the content of PM_{10} in the exhaust. Emissions of SO_2 are mainly linked to the sulfur content of the fuel rather than any combustion variable. Low sulfur content is also the reason for relatively low emissions of PM_{10}. Emissions from the combined operation of the proposed vessels have the potential to exceed 100 tons per year for emissions of NO_x. The remaining pollutants are less than 100 tons per year and are considered *de minimis*.

Table C-8. Projected Emissions Inventory.

Proposed Ships, Aircraft, and Onshore Sources of Emissions	Emissions (tons for the total project)				
	PM_{10} [1/]	SO_x	NO_x	VOC	CO
M/V *Peregrine*	1.86	2.72	25.99	2.08	5.62
M/V *Arctic Wolf* (substitute)	3.12	4.58	43.68	3.49	9.45
M/V *Miss Diane*	1.85	2.72	25.93	2.07	5.61
M/V *Mark Stevens*	1.85	2.72	25.93	2.07	5.61
Qualifier 105 (substitute)	1.92	2.82	26.89	2.15	5.82
Armstrong CAT	0.88	1.29	12.31	0.98	2.66
All American (sub for *F/V Sleep Robber)*	0.79	1.17	11.11	0.89	2.41
All American (sub for *Maxine*)	0.79	1.17	11.11	0.89	2.41
Helicopter Flights	--- [2/]	0.012	0.021	0.594	1.060
Onshore Surface Vehicles	0.022	0.001	1.021	0.015	0.180
Total	**13.08**	**19.20**	**184.0**	**15.23**	**40.83**

Note: Columns may not sum exactly due to rounding.

[1/] PM_{10} is the total of PM10 plus $PM_{2.5}$ emissions

[2/] PM emissions data is unavailable for turboshaft engines.

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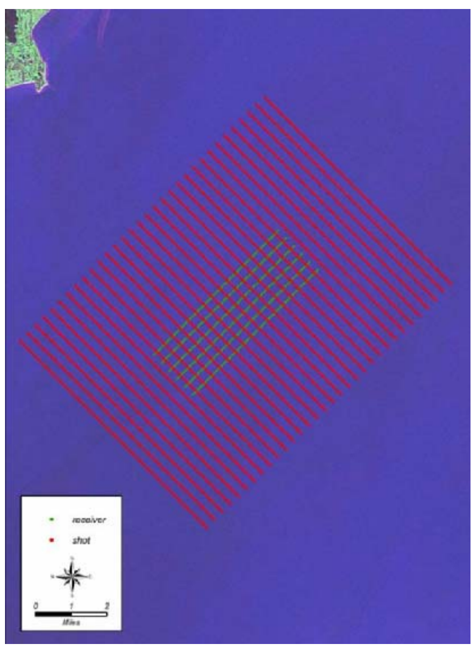
[1] Recording patch, or patch layout, is a plotted map of lines along which source vessels cruise while acquiring seismic data using airguns attached to the vessel. The same recording patch layout is used within each surveyed Township. Refer to Figure 3 - *Example of Patch Layout* - in the 2014 SAExploration Plan of Operations.



[2] Townships, plotted on a map, are part of the Bureau of Land Management (BLM) Public Land Survey System (PLSS). The PLSS identifies land parcels, particularly for rural, wild, or undeveloped land.

[3] Climatology for the cities and towns of Nuiqsut, Deadhorse, and Barter Island, Alaska, was applied as representative of the wind climatology over the Eastern North Slope adjacent to the Beaufort Sea.

[4] Beaufort Wind Scale - gentle breeze - defines conditions where light flags are extended and leaves and small twigs are constantly moving. On the water are large wavelets, and crests begin to break with scattered whitecaps.

[5] Beaufort Wind Scale - moderate breeze - defines conditions where dust, leaves, and loose paper lifts, and small tree branches move. On the water small waves form (1 to 4 feet), becoming longer with numerous whitecaps.

[6] Beaufort Wind Scale - fresh breeze - defines conditions where small trees in leaf begin to sway. On the water moderate waves form (4 to 8 feet), taking longer form, with many whitecaps and some sea spray.

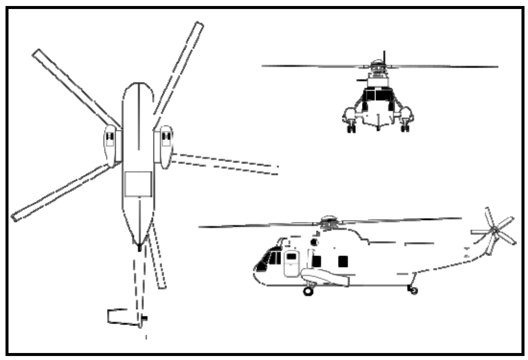
[7] Cool temperatures are 50 to 65 deg. F, cold temperatures are 32 to 50 deg. F, freezing temperatures are 15 to 32 deg. F, and frigid temperatures are below 15 deg. F.

[8] Slight solar insolation is defined as the sun being less than 35 degrees in the sky, with cloudy skies; moderate solar insulation is defined as a few broken clouds or a clear sky and the sun 35 degrees to 60 degrees above the horizon; and strong solar insulation defines a clear sky with the Sun higher than 60 degrees.

[9] Climatology for the cities and towns of Kuparuk, Prudhoe Bay, and Barter Island, Alaska was applied.

[10] Graphs of daily precipitation in 2012 were obtained for Nuiqsut, Deadhorse, and Barter Island, Alaska, whereas specific measures of average monthly liquid precipitation was obtained for Kuparuk, Prudhoe Bay, and Barter Island, Alaska (*see* Endnote 9).

[11] Sikorsky S61 helicopter is assumed by Bureau of Ocean Energy Management for the Proposed Action. Also known as the Sikorsky S61 Sea King, the helicopter can carry 30 passengers and crew. The craft is available in the FAA EDMS database, and was used for the project emissions from helicopter flights. The Sea King operates two General Electric T58-GE-10 turboshaft enignes, each with 1,400 hp.



Source: America's NAVY – United States Navy Fact File H-3 Sea King Helicopter. 2009. Available on the Internet at http://www.navy.mil/navydata/fact_display.asp?cid=1200&tid=300&ct=1.