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Environmental Assessment

Shell Offshore Inc.
2010 Outer Continental Shelf Lease Exploration Plan
Camden Bay, Alaska

Beaufort Sea Leases OCS-Y-1805 and 1941

Prepared by

Office of Leasing and Environment
Alaska OCS Region

MMS U.S. Department of the Interior
Minerals Management Service

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Appendix A. Analysis of Accidental Oil Spills

1.0 PURPOSE AND NEED

1.1 Purpose of the Proposed Action

Shell Offshore Inc. (Shell) submitted to the Minerals Management Service (MMS) an Exploration Plan (EP) (*2010 Outer Continental Shelf Lease Exploration Plan, Camden Bay, Alaska*, dated June 2009; deemed submitted August 10, 2009; amended September 18, 2009) (Shell Offshore Inc., 2009a) to conduct exploration drilling to evaluate the oil and gas resource potential of two of the company's Outer Continental Shelf (OCS) leases north of Point Thompson near Camden Bay in the U.S. Beaufort Sea. Shell acquired these leases through OCS Lease Sales 195 (March 2005) and 202 (April 2007). Under OCS leasing regulations at 30 CFR 256 and operating regulations at 30 CFR 250.180, a lease expires at the end of its primary lease term unless the lessee is conducting operations on the lease. Shell's leases have a primary lease term of ten years (30 CFR 256.37). Shell's exploration of their Beaufort Sea leases would be consistent with the overall objectives of the Outer Continental Shelf Lands Act (OCSLA) to determine the extent of the oil and natural gas resources of the OCS at the earliest practicable time.

Shell proposes to drill two exploration wells on these leases during the July-October 2010 open-water-drilling season. One well would be drilled on each of two distinct oil and gas prospects named by Shell as "Sivulliq" (NR 06-04 Flaxman Island, block 6658, OCS-Y-1805) and "Torpedo" (NR 06-04 Flaxman Island, block 6610, OCS-Y-1941) (Figures 1-1 and 1-2). The drilling operations would be conducted using the M/V *Frontier Discoverer (Discoverer)*, a modern drillship that has been retrofitted and ice reinforced for operations in Arctic OCS waters. The wells would be drilled consecutively. Shell has indicated the Torpedo prospect is their primary target and would be drilled first, if ice conditions permit.

Shell has submitted the EP under MMS operating regulations at 30 CFR 250 Subpart B. In support of the EP, Shell submitted an environmental impact analysis (EIA) (Shell Offshore Inc., 2009b), a revised Beaufort Sea Regional oil discharge prevention and contingency plan (ODPCP) for the 2010 drilling program (Shell Offshore Inc., 2009c), environmental information and reports, site-specific geohazards survey data and assessment, mitigation measures, and other project-specific information pursuant to 30 CFR 250.212 and 227. Shell also submitted, with the EP, a project-specific Plan of Cooperation (POC) to reduce potential conflicts with subsistence activities, a description of their Cultural Awareness and Health, Safety, Security, and Environment (HSSE) Awareness Programs, and other information as required MMS regulations and by lease stipulations.

The MMS has completed technical and environmental review of the EP and supporting information to ensure the proposed activities would be conducted in a manner that is consistent with protection of the human, marine, and coastal environments.

In accordance with the National Environmental Policy Act (NEPA), Council on Environmental Quality (CEQ) regulations at 40 CFR 1501.3(b) and 1508.9, Department of the Interior (DOI) regulations implementing NEPA at 43 CFR Part 46, and DOI policy in Section 516 of the Department of the Interior Manual (DM) Chapter 15 (516 DM 15), we have prepared an EA to determine whether the proposed action may result in significant effects (40 CFR 1508.27) that could trigger the CEQ criteria for preparation of an environmental impact statement (EIS) and to assist MMS planning and decisionmaking. In keeping with CEQ regulations at 40 CFR 1506.5(a),(b) (see below) and the intent of MMS operating regulations at 30 CFR 250.227, we have reviewed, evaluated, and verified the information and analysis provided in Shell's EIA, which we used to prepare this EA. A list of MMS staff responsible for reviewing, evaluating, and verifying the information submitted by Shell is in Section 4 of this EA.

Sec. 1506.5 Agency responsibility.

(a) Information. If an agency requires an applicant to submit environmental information for possible use by the agency in preparing an environmental impact statement, then the agency should assist the applicant by outlining the types of information required. The agency shall independently evaluate the information submitted and shall be responsible for its accuracy. If the agency chooses to use the information submitted by the applicant in the environmental impact statement, either directly or by reference, then the names of the persons responsible for the independent evaluation shall be included in the list of preparers (Sec. 1502.17). It is the intent of this paragraph that acceptable work not be redone, but that it be verified by the agency.

(b) Environmental assessments. If an agency permits an applicant to prepare an environmental assessment, the agency, besides fulfilling the requirements of paragraph (a) of this section, shall make its own evaluation of the environmental issues and take responsibility for the scope and content of the environmental assessment.

1.2 Previous Applicable NEPA Analyses and Biological Opinions

The National Environmental Policy Act (NEPA) mandates that Federal agencies conduct an environmental review of certain Federal projects. The NEPA review is required at each stage of the OCSLA process. The level of NEPA review depends on the OCSLA stage (516 DM 15), the scope of the proposed activities, and the agency's findings on the potential effects of the proposed activities.

The MMS has completed numerous NEPA reviews of Arctic OCS activities. In recent years, these NEPA reviews relevant to the proposed activities have included the following:

- Draft Environmental Impact Statement – Beaufort and Chukchi Sea Planning Areas Oil and Gas Lease Sales 209, 212, 217, and 221 (OCS EIS/EA MMS 2008-0055) (USDOI, MMS, 2008) (hereafter "Arctic Multiple-Sale Draft EIS").
- Environmental Assessment – Shell Offshore Inc., Beaufort Sea Exploration Plan, 2007-2009 (OCS EIS/EA MMS 2007-009) (USDOI, MMS, 2007).
- Environmental Assessment – Proposed Oil & Gas Lease Sale 202, Beaufort Sea Planning Area and Finding of No New Significant Impacts (OCS EIS/EA MMS 2006-001) (USDOI, MMS, 2006a) (hereafter "Sale 202 EA").
- Environmental Assessment – Proposed Oil & Gas Lease Sale 195, Beaufort Sea Planning Area and Finding of No Significant Impacts (OCS EIS/EA MMS 2004-028) (USDOI, MMS, 2004) (hereafter "Sale 195 EA").
- Final Environmental Impact Statement – Beaufort Sea Planning Area Oil and Gas Lease Sales 186, 195, and 202 (OCS EIS/EA MMS 2003-001) (USDOI, MMS, 2003) (hereafter "Beaufort Sea Multiple-Sale EIS").

These documents are on the MMS website at http://www.mms.gov/alaska/ref/EIS_EA.htm. Relevant sections of these documents are summarized and incorporated by reference in this EA. This EA tiers from the Beaufort Sea Multiple-Sale EIS.

This EA also summarizes and incorporates by reference relevant information and analyses from the following documents:

- Environmental Assessment and Finding of No Significant Impact for the Shell Offshore, Inc. Incidental Harassment Authorization to Take Marine Mammals Incidental to Conducting an Offshore Drilling Project in the U.S. Beaufort Sea Under the Marine Mammal Protection Act

(USDOC, NOAA, NMFS, 2007a).

- NMFS Biological Opinion for Oil and Gas Leasing and Exploration Activities in the U.S. Beaufort and Chukchi Seas, Alaska and Authorization of Small Takes Under the Marine Mammal Protection Act (USDOC, NOAA, NMFS, 2008). (http://www.mms.gov/alaska/ref/BioOpinions/2008_0717_bo.pdf)
- FWS Biological Opinion for Mineral Management Service's Proposed Beaufort Sea Natural Gas and Oil Lease Sale 186 (USDOI, FWS, 2002). (http://www.mms.gov/alaska/ref/EIS%20EA/BeaufortMultiSaleFEIS186_195_202/2003_001vol4.pdf)
- FWS Biological Opinion for Beaufort and Chukchi Sea Program Area Lease Sales and Associated Seismic Surveys and Exploratory Drilling (USDOI, FWS, 2009). (http://www.mms.gov/alaska/ref/BioOpinions/2009_0903_BO4BFCK.pdf)
- Shell Offshore Inc. 2010 Outer Continental Shelf Lease Exploration Plan, Camden Bay, Alaska, dated June 2009 (Shell Offshore Inc., 2009a) (http://www.mms.gov/alaska/ref/ProjectHistory/Shell_BF/2009_final_EP_camden_bay.pdf)

1.3 Statutory Framework

Shell's proposed exploration drilling activities are subject to an established regulatory framework that includes Federal and State regulations as they relate to OCS leases and oil and gas exploration activities. Some, but not all, of the statutory framework governing the exploration program is described below.

Outer Continental Shelf Lands Act and MMS Operating Regulations

The OCSLA establishes a four-stage process for exploration and development of the OCS: (1) a five-year leasing program for the OCS; (2) individual lease sales; (3) exploration; and (4) development and production. The MMS conducts appropriate NEPA review at each stage.

The MMS is responsible for regulating and monitoring the oil and gas operations on the Federal OCS. The MMS regulates operations to promote orderly exploration, development, and production of mineral resources; and to prevent harm or damage to, or waste of, any natural resource, any life or property, or the marine, coastal, or human environment. Regulations for on-lease oil and gas operations are specified in 30 CFR 250. Regulations for oil-spill prevention and response are specified in 30 CFR 254.

Prior to any exploration activities being conducted on a lease, an EP and supporting information must be submitted to MMS for review and approval. Supporting information includes environmental information, archeological report, biological report, other environmental data determined necessary, and an analysis of offshore and onshore impacts that may occur as a result of the activities.

The MMS has completed both technical and environmental review of activities proposed in Shell's EP, including evaluation for geohazards and manmade hazards, archeological resources, endangered species, sensitive biological features, water and air quality, oil-spill response, and other uses of the OCS.

The MMS has reviewed the proposed activities for compliance with applicable lease stipulations. Lease stipulations are enforceable measures intended to mitigate potential impacts. Shell's actions in compliance with the applicable lease stipulations are presented in Section 2.3.10 of this EA.

The MMS issues Notices to Lessees and Operators (NTLs) to provide clarification, description, or interpretation of OCS regulations or standards. The NTLs provide guidelines on the implementation of lease stipulations or regional requirements, and provide industry with a better understanding of the scope and meaning of regulations by explaining MMS' intent of requirements. A listing of the Alaska Region's NTLs is published on the Alaska Region website at: http://www.mms.gov/alaska/regs/NTLs.htm.

Shell is not proposing to use any new or unusual technology (Shell Offshore Inc., 2009a:Section 2c). Shell must conduct operations in accordance with MMS' comprehensive and stringent regulations for safety and pollution prevention, which generally are requirements for best available and safest technology [30 CFR 250.107(c)]. Lessees are required to take precautions to keep all exploratory well drilling under control at all times.

Prior to conducting drilling operations under an approved EP, the operator is required to submit and obtain approval for an Application for Permit to Drill (APD). The APD requires detailed information about the drilling program to allow evaluation of operational safety and pollution-prevention measures. The MMS will not approve an APD until all conditions of EP approval have been met.

Endangered Species Act

The Endangered Species Act (ESA) requires the protection and conservation of threatened and endangered species and the habitat in which they live. The Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS) administer the ESA. Section 7 of the ESA governs inter-agency cooperation and consultation for oil and gas activities, including exploration. Through this consultation process, the FWS and NMFS set terms and conditions and make conservation recommendations for OCS activities to minimize potential adverse impacts to listed species and critical habitats. It is the responsibility of MMS to ensure that measures to protect endangered and threatened species are implemented and followed.

The MMS formally consulted NMFS, Alaska Region, on the potential effects of OCS oil and gas leasing and exploration on the Beaufort Sea and Chukchi Sea. NMFS provided a Biological Opinion (BO) for *Oil and Gas Leasing and Exploration Activities in the U.S. Beaufort and Chukchi Seas, Alaska and Authorization of Small Takes Under the Marine Mammal Protection Act* (USDOC, NOAA, NMFS, 2008). The BO considers the effects of oil and gas leasing and exploration on threatened and endangered species under the jurisdiction of NMFS. The NMFS concluded the described actions are not likely to jeopardize the continued existence of the fin, humpback, or bowhead whale.

The MMS formally reinitiated consultation with FWS on the potential effects of OCS oil and gas leasing and exploration in the Beaufort and Chukchi Seas. The FWS provided a BO for *Beaufort and Chukchi Sea Program Area Lease Sales and Associated Seismic Surveys and Exploratory Drilling* dated September 3, 2009 (USDOI, FWS, 2009). The FWS concluded that it is unlikely that seismic survey and exploratory drilling activities will violate section 7(a)(2) of the ESA. The FWS determined that adverse effects onto listed species are anticipated. In the BO, FWS provided incidental take authorization for listed eiders and requires incidental take of polar bears to be authorized under the MMPA.

Under the ESA, no incidental take of a protected species is authorized unless MMS receives an Incidental Take Statement (ITS) from NMFS and FWS. Any approval of Shell's EP will be a conditional approval. Under the conditional approval, an APD will not be approved and commencement of activities will not be authorized until MMS has received ITSs from both NMFS and FWS.

Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) establishes Federal responsibility to conserve marine mammals. The NMFS has jurisdiction over whales and seals, including the bowhead whale, gray whale, beluga whale, minke whale, humpback whale, harbor porpoise, bearded seal, ringed seal, ribbon seal, and spotted seal. The FWS has jurisdiction over the polar bear and Pacific walrus.

The MMPA prohibits the "taking" of a marine mammal without a permit or exemption. Section 101(a)(5)(D) of the MMPA establishes an expedited process by which citizens of the United States can apply for an authorization to incidentally take small numbers of marine mammals by harassment. The term "take" under the MMPA means "to harass, hunt, capture, kill or collect, or attempt to harass, hunt, capture, kill or collect." Except with respect to certain activities not pertinent here, 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]. Incidental take will be granted if the Service finds that the taking will have a negligible impact on the species or stock(s) and will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses. The authorization sets for the permissible methods of taking and requirements pertaining to the mitigation, monitoring, and reporting of such takings. The MMPA authorizations require that operators conduct monitoring, which should be designed to result in an increased knowledge of the species and an understanding of the level and type of takings that result from the authorized activities.

Shell has applied for an Incidental Harassment Authorization (IHA) from NMFS (dated May 7, 2009; Shell Offshore Inc., 2009a:Appendix E) and a Letter of Authorization (LOA) from FWS (dated May 7, 2009; Shell Offshore Inc., 2009a:Appendix F) as part of their exploration program. Any approval of Shell's EP will be a conditional approval. Under the conditional approval, an APD will not be approved and commencement of activities will not be authorized until Shell's receipt of all necessary permits and authorizations including an IHA from NMFS and an LOA from FWS.

Shell has developed a site-specific monitoring program and adopted mitigation measures specifically designed to prevent or minimize any incidental harm to marine mammals. Those measures are summarized in Section 2.3.11 of this EA.

Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) mandates that a State with an approved Coastal Zone Management (CZM) plan reviews certain OCS activities to ensure they are conducted consistent with the State's approved plan. The Alaska Coastal Management Program (ACMP) implements the CZMA and requires projects in Alaska's coastal zone, including potential shore bases and projects that require an OCS Plan, to be reviewed for consistency with Statewide standards. The ACMP Coastal Project Questionnaire and Certification Statement are necessary for the Alaska Department of Natural Resources, Division of Coastal and Ocean Management coordination and review. A copy of Shell's Coastal Project Questionnaire and Certification Statement is included as Section 15 of the EP (Shell Offshore Inc., 2009a:Section 15). As part of MMS' review process, the EP and supporting environmental information were sent to the ACMP for consistency-certification review and response. Any approval of Shell's EP will be a conditional approval. Under the conditional approval, an APD will not be approved and commencement of activities will not be authorized until Shell's receipt of all necessary permits and authorizations including Shell's receipt of consistency concurrence from the State of Alaska.

Clean Air Act

The Clean Air Act (CAA) (43 U.S.C. § 7401, et seq.) governs air pollutant emissions and requires the Environmental Protection Agency (EPA) and the States to carry out programs to ensure attainment of the

National Ambient Air Quality Standards (NAAQS). The CAA regulations at 40 CFR Part 50 require certain facilities that emit criteria pollutants (nitrogen dioxide, sulfur dioxide, small-diameter particulate matter, ozone, carbon monoxide, and lead) or hazardous substances to obtain a permit establishing limits on the types and amounts of emissions, governing operating parameters for pollution control and monitoring devices, and monitoring and record-keeping requirements.

MMS regulations at 30 CFR 250.218 and 250.303 require detailed air quality information to be submitted with an EP. On September 4, 2009, MMS required Shell to amend the EP to fully meet MMS regulatory requirements for air quality information. Shell submitted additional information in an amendment to the EP on September 18, 2009.

Shell submitted a Prevention of Significant Deterioration (PSD) permit application to EPA on May 29, 2009, for emissions from the *Discoverer* and from support vessels. Issuance of the EPA permit would authorize air emissions from the proposed activities and sets emission limitations and other provisions to ensure that the permitted emissions will have no adverse effect on public health, and all health-based NAAQS will be met. Shell must implement best available control technology (BACT) and comply with provisions of the required air quality permits.

The MMS finding on air emissions is pursuant to MMS regulatory requirements and not a finding on the EPA PSD permit. The MMS has reviewed and assessed the air emissions information submitted by Shell. The air emissions information meets MMS regulatory requirements in 30 CFR 250.218, 250.224, and 250.225, and was assessed under 30 CFR 250.218 and 250.303. Any approval of Shell's EP will be a conditional approval. Under the conditional approval, an APD will not be approved and commencement of activities will not be authorized until Shell's receipt of all necessary permits and authorizations including Shell's receipt of the required PSD permit.

The MMS air quality regulations at 30 CFR 250.302, 250.303, and 250.304 were promulgated as mandated by section 5(a)(8) of OCSLA. The 1990 Clean Air Act Amendments (CAAA) directed the EPA to regulate air emissions from OCS sources located offshore of States along the Pacific, Arctic, and Atlantic coasts, and along the Gulf Coast off the State of Florida to the east of longitude 87º30'W. The applicable part of the statute is Section 328 of the CAA (42 U.S.C. §7627). Section 328(a)(1) states in part: "The authority of this subsection shall supersede section 5(a)(8) of the Outer Continental Shelf Lands Act (OCSLA) but shall not repeal or modify any other Federal, State, or local authorities with respect to air quality." The EPA promulgated implementing regulations at 40 CFR 55 on September 4, 1992. Thus, EPA has jurisdiction regarding air quality permits on the Alaska OCS.

Clean Water Act

The Clean Water Act (CWA) has several sections or programs applicable to activities in offshore waters, including U.S. Coast Guard (USCG) implementing regulations (33 CFR Part 151).

The EPA has promulgated regulations (40 CFR 125) to ensure OCS lessees do not create conditions that will pose an unreasonable risk to public health, life, property, aquatic life, wildlife, recreation, navigation, commercial fishing, or other uses of the ocean. Operational discharges are regulated by the EPA through the National Pollution Discharge Elimination System (NPDES) program. The EPA's NPDES Arctic General Permit for Offshore Oil and Gas Operations on the OCS and contiguous State Waters (Permit Number AKG-28-0000) authorizes certain discharges from oil and gas exploration facilities located in or adjacent to the Beaufort Sea and establishes effluent limitations, monitoring requirements, and other conditions. Permitted discharges related to exploration drilling and logistics include drilling fluids and cuttings, deck drainage, sanitary waste, blowout-preventer fluid, uncontaminated ballast water, and bilge water (EPA, 2006).

Shell has submitted Notices of Intent (NOIs) to EPA requesting authorization for the *Discoverer* to discharge liquid wastes regulated under the NPDES General Permit at the Torpedo (lease block 6610) and Sivulliq (lease block 6658) drill sites (NOIs dated May 7, 2009; Shell Offshore Inc., 2009a:Appendix C). Any approval of Shell's EP will be a conditional approval. Under the conditional approval, an APD will not be approved and commencement of activities will not be authorized until Shell's receipt of all necessary permits and authorizations including Shell's receipt of the required NPDES permits.

The Oil Pollution Act

The Oil Pollution Act of 1990 (OPA) establishes a program governing removal of spilled oil and requiring planning for and responding to oil spills. Under OPA and MMS regulations at 30 CFR 254, Shell is required to develop an Oil Discharge Prevention and Contingency Plan (ODPCP) as a fundamental component of the proposed exploration drilling program.

Shell's Beaufort Sea Regional Exploration ODPCP is a regional oil-spill-response plan that demonstrates Shell's capabilities to prevent, or rapidly and effectively manage, oil spills that may result from exploratory drilling operations. Despite the extremely low likelihood of a large oil-spill occurring during exploration, Shell has designed its response program for a regional capability of responding to a range of spill volumes that increase from small operational spills up to and including a Worst Case Discharge (WCD) scenario from an exploration well blowout, as required under 30 CFR 254.47. Shell's program is based on a WCD scenario that meets the response planning requirements of the State of Alaska and Federal oil-spill-planning regulations.

The ODPCP includes information regarding Shell's regional oil-spill organization and dedicated response assets, potential spill volumes, and sensitive environmental resources. The ODPCP also details Shell's spill-prevention programs, including personnel training and the procedures and management practices to prevent discharges. The spill response information addresses personnel and equipment mobilization from various locations, equipment operating characteristics, and the availability of additional response resources, both onsite and offsite.

Shell has updated and revised the Regional ODPCP to include information specific to the well sites, including worst-case oil-spill estimates, a worst-case oil-spill scenario, and modeling results.

Cultural Resource Regulations

The Archaeological Resource requirements are contained in MMS operational regulations under 30 CFR 250.194. The technical requirements for the archaeological resource surveys and reports that may be required under the regulations are detailed in the Alaska OCS Region NTL 05-A02 and NTL 05-A03.

Information to Lessees (p) *Archaeological and Geologic Hazards Reports and Surveys* in the Final Notice of Sale for both Beaufort Sea Sale 195 and Beaufort Sea Sale 202 specified the blocks for which an archaeological report would be required. Section III.C.4.a of the Beaufort Sea Multiple-Sale EIS identified blocks having high potential for the occurrence of archaeological resources. Shell's proposed drill sites are not on blocks listed in the ITL.

Under Section 106 of the National Historic Preservation Act, MMS consults with the Alaska State Historic Preservation Office (SHPO) for OCS activities during the pre-lease process. Section 106 consultation for the Beaufort Sea Planning Area was completed in conjunction with completing the Beaufort Sea Multiple-Sale EIS and again recently in conjunction with the Arctic Multiple-Sale Draft EIS (SHPO concurrence dated September 24, 2008).

The MMS's review of the site-specific geophysical data indicates that there are no historic properties at Shell's proposed drill sites. The MMS forwarded this finding to the SHPO and received concurrence from SHPO on October 2, 2009.

Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (NANPCA) (16 U.S.C. 4701-4751) as amended by the National Invasive Species Act of 1996 (NISA).

Potential vectors for introducing invasive species into the marine environment are ballast-water discharge, hull fouling, and equipment placed overboard (e.g., anchors, seismic airguns, hydrophone arrays, ocean-bottom-survey cables). The USCG developed regulations (33 CFR 151) that implement provisions of the NABPCA and NISA. Vessels brought into State of Alaska or Federal waters would be subject to current Coast Guard regulations at 33 CFR 151, which are intended to reduce the transfer of invasive species. Section 151.2035 (a)(6) requires the "removal of fouling organisms from hull, piping, and tanks on a regular basis and dispose of any removed substances in accordance with local, State, and Federal regulations." Shell's proposed activities must comply with the Coast Guard regulations. All vessels equipped with ballast water tanks must develop and maintain Ballast Water Management Plans. Ballast replacement is required by the International Maritime Organization and it must be accomplished before entering U.S. waters and reporting to the Captain of the Port, or going from one Captain of the Port zone to another. In addition, the Beaufort Sea poses harsh and frigid environmental conditions that are believed to impose major and difficult challenges to invasive species that might be introduced into the region's waters by vessels or equipment. Therefore, the likelihood of introducing invasive species from the proposed activities is considered to be very low, and this issue is not considered further in this EA.

2.0 PROPOSED ACTION AND ALTERNATIVE

2.1 Background

Shell proposes to drill two exploration wells, one on the Sivulliq prospect and one on the Torpedo prospect, near the Camden Bay area of the Beaufort Sea OCS Planning Area (Figures 1-1 and 1-2). Twelve exploration wells have been drilled in the immediate vicinity of Shell's proposed exploration wells. Nine of the twelve wells were drilled during the open-water period using floating drilling units. Two of these wells, drilled in 1985 and 1986, were on the Sivulliq Prospect (previously named the Hammerhead Prospect). One of the Hammerhead wells was determined to be producible under MMS regulations (30 CFR 250.115). The MMS estimated the reservoir contains 100-200 million barrels of oil (USDOI, MMS, 2006b, *Beaufort Sea Planning Area (Alaska) – Province Summary, 2006 Oil and Gas Assessment*) (http://www.mms.gov/alaska/re/reports/2006Asmt/BSGA/Beaufort%20Sea%20Province%20Summary-2006%20Assessment.pdf).

2.2 Alternatives

Alternative 1 –Proposed Action

The proposed action is to drill two exploration wells on oil and gas leases Shell acquired in Federal Beaufort Sea OCS lease sales in 2005 and 2007. One well would be drilled on each lease into two distinct oil and gas prospects named by Shell as "Sivulliq" and "Torpedo." Shell proposes a single season of exploration drilling activities at two drill sites during the months of July through October 2010. Shell's proposed activities include a mid-drilling-season break in activities to avoid conflicts with the fall subsistence bowhead whale hunts of the villages of Kaktovik and Nuiqsut.

Shell would drill from the *M/V Frontier Discoverer* (*Discoverer)*. The *Discoverer* has state-of-the-art drilling and well-control equipment. The *Discoverer* would be supported by additional vessels for ice management, anchor handling, crew transport and supplies, and spill response. Additional vessels would implement Shell's marine mammal monitoring and mitigation plan and support scientific research efforts. Shell states that all of the vessels are ice-class and specifically equipped for operating in Arctic waters.

Alternative 2 – No Action

Under this alternative, MMS would disapprove Shell's proposed exploration drilling activities. This alternative would delay or preclude Shell from evaluating the potential hydrocarbon resources of two leases acquired under OCS Lease Sales 195 and 202.

2.3 Description of the Proposed Action

2.3.1 Overview

Shell's proposal, as detailed in the EP (Shell Offshore Inc., 2009a), is to use a single drillship, the *Discoverer*, to complete a single season of exploration drilling activities at two offshore locations near the Camden Bay area in the Beaufort Sea. A single well would be drilled on each of two distinct oil and gas prospects named by Shell as "Sivulliq" and "Torpedo." Shell's proposed activities would be conducted during the summer open-water season. Arctic waters are inaccessible to floating drilling units for up to nine months of the year because of pack ice. The Sivulliq drill site is 16 mi offshore in 107 ft of water.

The Torpedo drill site is 22 mi offshore in 120 ft of water. Each drill site has been surveyed by Shell and determined not to contain any shallow hazards or archaeological and historical resources.

The activities are planned to begin on or about July 10, 2010. Shell's plans include a mid-drilling-season break in activities to accommodate fall subsistence bowhead whaling. All operations would be suspended beginning August 25 and all vessels, including the drillship, would proceed from the project area to the northwest and remain north of latitude 71.25° N. and west of longitude 146.4° W. during the bowhead whale hunts (Figure 1-1) or would leave the Beaufort Sea entirely. Activities may be resumed after completion of the subsistence hunts and extend through October 31, 2010, depending on ice and weather.

Once the *Discoverer* is mobilized to a drill site and securely anchored to the seafloor, drilling operations would commence. The Sivulliq well would take approximately 34 days to drill. The Torpedo well would take approximately 40 days to drill. Each well would be plugged and abandoned in accordance with MMS requirements upon completion of drilling.

Shell's proposed operations must comply with applicable Federal, State, and local laws, regulations, and lease and permit requirements. The MMS retains the specific authority to require additional mitigation, including shut down, as appropriate to respond to actual conditions encountered. In addition, Shell would have trained personnel and monitoring programs in place to ensure such compliance. The MMS and other Federal regulatory agencies would maintain continuing oversight of all of Shell's exploration activities. The following are the major applicable permits and authorizations that collectively impose mandatory requirements to ensure safety, protect the environment, avoid interference with subsistence resources and activities, and mitigate potential adverse impacts:

- National Pollutant Discharge Elimination System Permit (NPDES) under the Clean Water Act from the EPA. The EPA NPDES Arctic General Permit for Offshore Oil and Gas Operations on the OCS and contiguous State Waters Permit Number AKG-28-0000 impose limitations on permissible discharges. Shell has submitted Notices of Intent (NOIs) to EPA requesting authorization for the *Discoverer* to discharge liquid wastes regulated under the NPDES General Permit at the Torpedo (lease block 6610) and Sivulliq (lease block 6658) drill sites (NOIs dated May 7, 2009; Shell Offshore Inc., 2009a:Appendix C).
- Air Quality Permit under the Clean Air Act from the EPA. The EPA's air quality permits limit and regulate air emissions to protect ambient air quality. Shell submitted an application for a Prevention of Significant Deterioration (PSD) permit for their 2010 exploration program to the EPA on May 29, 2009.
- Incidental Harassment Authorization (IHA) from NMFS regulating the incidental non-lethal harassment of protected species under the Marine Mammal Protection Act (MMPA) Shell has applied for an IHA from NMFS (dated May 7, 2009; Shell Offshore Inc., 2009a:Appendix E).
- Letter of Authorization (LOA) from FWS regulating the incidental non-lethal harassment of protected species under MMPA. Shell has applied for an LOA from FWS (dated May 7, 2009; Shell Offshore Inc., 2009a:Appendix F).
- Nationwide Permit No. 8 coverage from the U.S. Army Corps of Engineers (USACE) for compliance with the provisions of fairway regulations (33 CFR 322.5(l)) and effects on navigation and national security (33 CFR 322.5(f)) under the Rivers and Harbors Act.
- Coastal Consistency Concurrence under the CZMA from the State of Alaska, certifying that Shell's proposed activities are consistent with the enforceable standards of the Alaska Coastal Management Program (ACMP), including the enforceable standards of the North Slope Borough Coastal Management District. A copy of Shell's Coastal Project Questionnaire and Certification Statement is in the EP (Shell Offshore Inc., 2009a:Section 15.0). Concurrent with MMS' review

process, the EP and supporting environmental information were sent to the State for consistency-certification review and response.

Shell's proposed compliance with applicable OCS lease stipulations is documented in the EP and includes the following supporting information submitted with the EP:

- Shell has proposed an environmental orientation program (Shell Offshore Inc., 2009a:Section 11.0) that informs Shell personnel and contractors regarding applicable laws and compliance obligations (Lease Stipulation 2, Sales 195 and 202);
- Marine Mammal Monitoring and Mitigation Plan (4MP) (Shell Offshore Inc., 2009a:Appendix J) to avoid impacts to marine mammals and collect scientific data on marine mammal species (Lease Stipulation 4, Sales 195 and 202);
- Plan of Cooperation (POC) (Shell Offshore Inc., 2009a:Appendix B) to coordinate exploration activities with Alaskan Native subsistence activities to avoid unreasonable interference with subsistence resources and activities (Lease Stipulation 5, Sales 195 and 202); and
- Shell's Alaska Fuel Transfer Operating Conditions and Procedures (Shell Offshore Inc., 2009a:Section 9.0, Attachment 9.0-4) (Lease Stipulation 6, Sales 195 and 202).

Under this EP, Shell would employ personnel and contractors experienced in operating in the Arctic OCS and would train employees in Federal and State laws regulating field operations. Shell has committed in its EP to local hire, local contracting, and local purchasing to the maximum extent possible.

2.3.2 Drill Sites and Operating Environment

Shell proposes exploration drilling on lease OCS-Y-1805 at planned drill site Sivulliq N, and on lease OCS-Y-1941 at planned drill site Torpedo H (Figures 1-1 and 1-2). The Sivulliq drill site and the Torpedo drill site are located on the continental shelf north of the Camden Bay area of the Beaufort Sea. Sediment at both locations is composed predominately of silty sands and mud. The water depth is approximately 107 ft (33 m) at Sivulliq and 120 ft (37 m) at Torpedo. The seafloor at both of these locations has been extensively ice gouged.

The Sivulliq N (Flaxman Island NR06-04 Official Protraction Diagram block 6658) drill site is located at latitude 70°23'29.5814" N., longitude 145°58'52.5284" W.

- 16 miles (26 km) north of Point Thompson
- 47 mi (75 km) from Cross Island
- 60 mi (97 km) from West Dock
- 58 mi (93 km) from Deadhorse
- 60 mi (97 km) from Kaktovik
- 118 mi (190 km) from Nuiqsut

The Torpedo H (Flaxman Island NR06-04 Official Protraction Diagram block 6610) drill site is located at latitude 70°27'01.6193" N., longitude 145°49'32.0650" W.

- 22 mi (35 km) north of Point Thompson
- 50 mi (81 km) from Cross Island
- 64 mi (103 km) from West Dock
- 64 mi (103 km) from Deadhorse
- 55 mi (89 km) from Kaktovik
- 125 mi (201 km) from Nuiqsut

The two communities in closest proximity to the planned exploration activities are: Kaktovik (aka Barter Island) to the east and Nuiqsut to the west. Deadhorse, the logistics and support base for North Slope oil and gas operations, is located between the drill site locations and Nuiqsut to the west. The existing shore facilities at West Dock and facilities at Deadhorse would support the exploration activities.

Seafloor Conditions at the Drill Sites

The MMS regulations (30 CFR 250.214) require shallow hazards assessment be conducted prior to drilling or installing mobile drilling units for oil and gas activities. Geophysical surveys conducted over the sites are analyzed to identify shallow hazards and conditions that would pose engineering constraints. A hazard is defined as a feature or condition that presents difficulties that cannot be easily mitigated by design, implementation, or procedures. A constraint is defined as a feature or condition that presents difficulties but can be mitigated by design, implementation, or procedures. Shell also collected shallow cores for geochemical and geotechnical studies. A summary of the shallow-hazards assessment is presented in the EP (Shell Offshore Inc., 2009a:Section 3). A short chronology and summary of pertinent shallow-hazards surveys and assessments are presented here.

In 1985-1986, Union Oil Company conducted shallow-hazards surveys at Sivulliq (Hammerhead) and in the proximity of Sivulliq and Torpedo drill sites. In 2006, Shell collected shallow-hazards data at the Sivulliq N drill site.

In 2007, Shell contracted Geo LLC to conduct shallow-hazards across the Torpedo prospect. The following parameters were assessed and analyzed for both shallow hazards and engineering constraints.

- Bathymetry
- Ice gouging
- Buried channels
- Seafloor obstructions
- Surficial sediments
- Permafrost
- Faulting
- Seismicity
- Shallow gas
- Gas hydrates
- Water column anomalies
- Archaeological features

In 2008, the historic hazard survey data was augmented with bathymetric data and data collected by remotely operated vehicle during the shallow-hazards surveys conducted by Geo LLC. These data were collected in accordance with Notice to Lessees (NTL-A005).

Copies of the shallow-hazards reports for portions of the Sivulliq and Torpedo prospects were submitted to MMS under separate cover in June 2007, March 2008, and March 2009. These reports are titled:

- Exploration Wellsites Clearance Assessments, Sivulliq Prospect, Beaufort Sea, Alaska, prepared by Geo LLC
- 2007 Exploration Wellsites Geohazards Assessments, Sivulliq Prospect, Beaufort Sea Alaska, Addendum 1, prepared by Geo LLC
- Exploration Wellsites Geohazards Assessments, Torpedo Prospect, Beaufort Sea, Alaska, prepared by Geo LLC
- Shallow Hazards Assessment, Sivulliq G, V, W and Supplemental N Wellsites, Blocks 6658, 6659, 6708, and 6709, Flaxman Island Area, Beaufort Sea Alaska, Report No. 27.2008-2266, prepared by Fugro Geoconsulting, Inc.
- Shallow Hazards Assessment, Torpedo, A, B, G, and H Wellsites, Blocks 6609 and 6610, Flaxman Island Area, Beaufort Sea, Alaska, Report No. 27.2008-2267, prepared by Fugro Geoconsulting, Inc.

The supplemental Fugro report assessed the following shallow-hazards parameters: Manmade infrastructure

- Seafloor conditions
- Stratigraphy and structure
- Permafrost
- Shallow gas
- Gas Hydrates

Sivulliq Prospect. Based on the assessments of 1985-1986 and the 2007 shallow hazards survey data, the planned Sivulliq N drill site is determined to be free of manmade and geologic risks. The more recent shallow hazards results for the Sivulliq N drill site did not identify any shallow hazards or constraints other than ice gouging. The installation of a mudline cellar (MLC) at the Sivulliq N drill site would mitigate this constraint. The MLC would be sufficiently deep (approximately 37 ft [11.2 m]) to ensure that, if the drill site were to be temporarily abandoned during an emergency, wellhead equipment would be below the maximum ice-scour depth of 8.2 ft (2.5 m). The wellhead equipment would thereby be protected from the maximum anticipated ice-keel scour.

The MMS has reviewed the data and reports and concurs with Shell's findings that no shallow hazards occur at the proposed Sivulliq N drill site. The MMS concurs with Shell's finding that there are no indications of historic sites or prehistoric archaeological resources at the proposed Sivulliq N drill site. The MMS also reviewed the seafloor survey for potential seafloor habitat and benthic communities. No unique seafloor habitat or benthic communities were identified at the proposed Sivulliq N drill site.

Torpedo Prospect. Drill site Torpedo H was studied during the shallow-hazards surveys conducted in 2007-2008 by Geo LLC. The shallow hazards surveys identified no manmade or geologic risks. The more recent shallow hazards results for the Torpedo H drill site did not identify any shallow hazards or constraints other than ice gouging. The installation of a MLC at the Torpedo H drill site would mitigate this constraint. The MLC would be sufficiently deep (approximately 37 ft [11.2 m]) to ensure that, if the drill site were to be temporarily abandoned during an emergency, wellhead equipment would be below the maximum ice-scour depth of 4.1 ft (1.3 m). The wellhead equipment would thereby be protected from the maximum anticipated ice-keel scour.

The MMS has reviewed the data and reports and concurs with Shell's findings that no shallow hazards occur at the proposed Torpedo H drill site. The MMS concurs with Shell's finding that there are no indications of historic sites or prehistoric archaeological resources at the proposed Torpedo H drill site.

The MMS also reviewed the seafloor survey data for potential seafloor habitat and benthic communities. No unique seafloor habitat or communities were identified at the proposed Torpedo H drill site.

Expected Weather Conditions at the Drill Sites

The Beaufort Sea coastal winds usually are easterly and strongly influenced by channeling due to the Brooks Range to the south. In the eastern portion of the Beaufort Sea around Barter Island, westerly winds become more frequent in the summer and fall months (USDOI, MMS, 2007a); however, the most prevalent wind direction within the project area during the drilling season of July through October is easterly to northeasterly (USDOI, MMS, 2003). Average wind speed at the Barter Island area is about 11 mph (10 knots) during the summer months (WRCC, 2009). A multiyear meteorological study, including stations at Badami, Endicott, Northstar, Cottle Island, and Milne Pointe, provides a data trend for the months of July through October. The average wind speed from 2001 to 2005 was approximately 15.5 mph (13 knots) with the average low around 9.5 mph (8 knots) and the average high around 41 mph (37 knots) (Veltkamp, B. and J.R. Wilcox, 2007).

The lack of natural wind barriers results in unrestricted winds in the Alaskan Arctic. Gusting winds are more frequent between September and November. Along the coast, gale-force winds (greater than 39 mph [34 knots]) are frequent, and wind velocities of hurricane strength (greater than 74 mph [64 knots]) have been recorded for this region. Although rare in April, May, and June, occasional high-wind events and sudden storms have been reported (USDOI, MMS, 2007a). An analysis of high-wind events in Barrow from 1955-2000 indicates that the extreme winds in the fall have decreased slightly and the winds in the summer have increased slightly (Lynch et al., 2004). With little warning, sudden and extreme storms can occur in the Alaskan Beaufort Sea (J. Ningeak in USDOI, MMS, 1990c). (See also USDOI, MMS, 2003, 2004, 2006a, and 2008.)

Expected Ice Conditions at the Drill Sites

The sea-ice descriptions in Arctic Multiple-Sale Draft EIS (USDOI, MMS, 2008) and the Shell EIA (Shell Offshore Inc., 2009b) are incorporated by reference and salient points are summarized as follows. There are three general forms of sea ice in the project area: (1) landfast ice, which is attached to the shore, is relatively immobile, and extends to variable distances offshore; (2) stamukhi ice, which is grounded and ridged ice; and (3) pack ice, which includes first-year and multiyear ice, which moves under the influence of winds and currents. The proposed drill sites are seaward of the typical extent of landfast ice during the time of operations. Stamukhi ice is not anticipated in the project area at the time of operations. Pack ice could move into the project area during the time of operations due to wind or currents. In 2008 and 2009, Shell deployed buoys near the project area. While the overall trend of the buoy movement was to the northwest, the buoys recorded periods with little to no movement or movement back to the east or southeast.

The arctic sea ice is undergoing rapid changes. There are reported changes in sea-ice extent, thickness, distribution, age, and melt duration. In general the sea-ice extent is becoming much less in the arctic summer (Figure 2-1) and slightly less in winter, and the decline in sea-ice extent is increasing. The thickness of arctic ice is decreasing. The distribution of ice is changing, and its age is decreasing. The melt duration is increasing. These factors lead to a decreasing perennial arctic ice pack. It generally is thought that the Arctic will become ice free in the summer, but at this time there is considerable uncertainty about when that would happen. (See also USDOI, MMS, 2003, 2004, 2006a, and 2008.)

2.3.3 Drillship, Support Vessels, and Aircraft

Shell would conduct drilling operations using the *Discoverer* and the latest drilling technologies and techniques. The *Discoverer* is a modern drillship retrofitted for operating in Arctic OCS waters. The *Discoverer* has state-of-the-art drilling and well-control equipment. The drillship *Discoverer* would be attended by a minimum of six vessels that would be used for ice management, anchor handling, oil spill response, refueling, resupply, and servicing. The ice management vessels would consist of an icebreaker and an anchor handler. The icebreaker would be located at a distance of several miles or more away from the drill site. The vessel would be supported by an auxiliary ice management vessel that would also serve as anchor handling vessel. A berthing vessel would stay on site. The oil spill response (OSR) vessels would include an ice-capable oil spill response barge (OSRB) and associated tug, a tank vessel for storage of any recovered liquids, and associated smaller workboats. The OSRB, supported by its own tug vessel with a full complement of crew and spill-response equipment, would be staged near the *Discoverer*.

The other support vessels and aircraft would be deployed to the site as needed. A re-supply ship would travel from West Dock to the drilling vessel as needed. Additional vessels would implement Shell's marine mammal monitoring program (4MP) (Shell Offshore Inc., 2009a:Appendix J) and support scientific research efforts. There would be two flights per day by a support helicopter from the shore base to the drill site. An aircraft would be used for overflights for 4 hours per day, 4 days per week.

Table 2.2-1 in the EIA (Shell Offshore Inc., 2009b) lists the specifications of the drilling and support vessels Shell is proposing to use. In addition, Shell provides estimates for trip frequency and duration for each vessel and aircraft (Shell Offshore Inc., 2009a:Appendix E, Table 1-1). Shell states that all support vessels would be ice-class and specifically equipped for operating in arctic waters.

The *Discoverer* is a true floating drilling vessel (drillship), which means it mobilizes under its own power. The *Discoverer* is a 514 ft (156 m) moored drillship with drilling equipment on a turret. The *Discoverer* is winterized for service in the arctic offshore environment. It can be moved off the drill site in a matter of hours with the help of its anchor handler. It is a self-contained drilling unit with full accommodations for a crew of up to 124 persons (quarters, galley, and sanitation facilities).

The *Discoverer* would have approximately 74 total drilling days in the project area. Drilling days for the Torpedo H drill site are estimated at 40 days. Drilling days for the Sivulliq N drill site are estimated at 34 days. The days onsite for the Torpedo and Sivulliq drill sites include five days for constructing the MLC, one day to set anchors, one day to remove anchors, and one day to move. Transit speed of the *Discoverer* is 8 knots.

Shell's Critical Operations and Curtailment Plan (COCP) (Shell Offshore Inc., 2009a:Section 9.0 b) addresses the methods by which Shell would cease, limit, or not initiate specific critical operations due to environmental conditions that may be encountered at the drill sites.

Helicopter traffic is planned to both prospect sites. Most personnel transfers and some logistics support of the drilling program would be by helicopter. Helicopters would be used for crew changes. Work rotations would be based on 28-day shifts. Helicopter trip frequency is estimated at two to three trips per week. The shorebase at Deadhorse airport would have bunks for 50 people. At the shorebase, there would be a regular staff of ten persons, plus approximately 20 aircraft personnel.

During Government-to-Government meetings held by MMS in 2007, an inland helicopter route was identified as a measure to lessen potential interference with subsistence caribou hunting along the coast. Shell has incorporated this measure in their proposed activities.

Fixed-wing aircraft would be used for marine mammal monitoring. Aerial monitoring would enhance the monitoring of vessel-based marine mammal observers (MMOs) and acoustic monitoring. Shell's aerial monitoring program is described in the 4MP (Shell Offshore Inc., 2009a:Appendix J).

Aircraft travel would be controlled by Federal Aviation Administration approved flight paths and would comply with flight restrictions imposed by the Sale 195 lease stipulations regarding sensitive biological areas. A flight altitude of 1,500 ft (457 m) would be maintained by all non-marine mammal monitoring flights to minimize impacts on marine mammals. As indicated in the EP, Shell would implement flight restrictions prohibiting aircraft from flying within 1,000 ft (300 m) of marine mammals or below 1,500 ft (457 m) altitude (except during takeoffs and landings or in emergency situations) while over land or sea.

Figure 2-2 depicts the helicopter routes to both drill sites. From the Mary Sachs Entrance, the boat and helicopter flight paths are direct to Torpedo or to Sivulliq. The vessel route to Torpedo prospect site would follow the helicopter route, but it is not shown on the figure to avoid confusion (i.e., two dashed lines with different colors along the same path).

2.3.4 Discharges and Waste Management

The general NPDES permit AKG-28-0000 (EPA, 2006) for the offshore areas of Alaska, including the Beaufort Sea, authorizes discharges from oil and gas exploration facilities. The Arctic general permit restricts the seasons of operation, discharge depths, and areas of operation, and has monitoring requirements and other conditions. The EPA regulations (40 CFR 125.122) require a determination that the permitted discharge will not cause unreasonable degradation to the marine environment. The *Discoverer* is permitted under the NPDES for the Beaufort and would be the sole drilling vessel used for exploration. Under the NPDES General Permit AKG-28-0000, eleven separate effluent streams are allowed for the *Discoverer*. Each effluent stream, and the associated projected amount of discharge, is listed in Table 4.1.7-1 of the EIA.

Shell would use water-based drilling fluids. Shell estimates that 2,761 and 2,881 barrels (bbl) of water-based drilling muds, respectively, would be used at the Sivulliq N and Torpedo H drill sites. Drilling fluid volumes and chemistry would comply with NPDES General Permit conditions.

During the 2010 drilling season, the *Discoverer* would be used to construct the MLCs, set casing, and drill up to two wells each to total depth. Shell would recycle drilling muds (e.g., use those muds on multiple wells), to the extent practicable based on operational considerations (e.g., mud properties cannot be used further after they have deteriorated a certain amount), to reduce discharges from its operations. At the end of each drilling phase, the used drilling fluids would be transported to another well for reuse, if feasible, or discharged into marine waters in conformance with NPDES permit conditions. Shell's EIA indicates that up to 1,500 bbl of drilling cutting and fluids would be stored on board the drillship, if feasible (Shell Offshore Inc., 2009b:Table 2.3.2-1 footnote). At the end of the season, excess water-based fluid, approximately 1,500 bbl (238 m^3), would be pre-diluted to a 30:1 ratio with seawater and then discharged into marine waters in conformance with NPDES permit conditions. In the event the storage space for drill cuttings is exceeded on the *Discoverer*, the NPDES Arctic General Permit allows for discharge of drill cuttings and used drilling fluids to ambient waters of the Beaufort Sea at each drill site.

Wastes include cement slurry, drainage waters, and domestic wastewaters. Certain discharges are made through the drillship's disposal caisson (Shell Offshore Inc., 2009b:Table 4.1.7-1). The base of the discharge caisson while drilling is 19.6 ft (6.0 m) below mean sea level.

Cement would be used to set the steel casing in the wellbore and to plug the well after it has been drilled to depth. Drainage waters include rainfall landing on the deck surfaces of the drillship, and wash-down water generated when cleaning portions of the deck. Domestic wastewaters include gray water, which is effluent from showers, laundry, and liquid galley wastes, and black water from treated sewage. Cement slurry, drainage waters, and black water are discharged (after sanitation treatment) according to the conditions and limitations of the NPDES General Permit.

The volumes of liquid/fluid, slurry, and cuttings expected to be generated and the rates at which they would be discharged are indicated in Tables 2.3.2-1 and 2.3.2-2 of the EIA.

A list of the components that may be added to the drilling fluid is summarized in Table 2.3.2-3 of the EIA. The component list and the associated volumes account for drilling needs at various depths from the MLC to total depth for both the Sivulliq N and Torpedo H wells.

The discharge from the water cooling unit is expected to be 2.5 ˚F (1.4 ˚C) above ambient temperature. Seawater temperature is expected to reach ambient temperature within 450 ft (137 m) of the drillship.

Solid wastes (trash) would be segregated and disposed of or recycled at approved disposal or recycling facilities on land. Solid food wastes would be incinerated onboard. Shell would use either the Oxbow Landfill in the greater Prudhoe Bay area or would contract the services of Phillips Service in Anchorage.

Hazardous waste and used oil would be stored onboard in approved containers and then transferred by boat to an approved disposal site.

2.3.5 Emissions

Emissions from the *Discoverer* and support vessels would be authorized through an air quality permit issued by EPA under the Clean Air Act (CAA).

The activities described in the EP are defined as temporary facilities under 30 CFR 250.302. Shell has committed to applying emission reduction measures in their proposed activities. Shell's BACT measures are equivalent to the BACT requirements in the EPA proposed Chukchi Sea Permit Number R10OCS/PSD-AK-09-01 for the *Discoverer*. As the agency with jurisdiction over air quality on the Alaska OCS, EPA will include final BACT requirements upon promulgation of a permit for Shell's Beaufort Sea operations. The MMS will not approve an APD and commencement of activities will not be authorized until Shell's receipt of the required air quality permit. The MMS has determined that Shell's emission reduction measures achieve BACT required under MMS regulations for temporary OCS facilities. The modeling described under MMS regulations at 30 CFR 250.303(e) is to determine whether projected emissions may trigger the need for emission controls. For temporary facilities, the required emission controls are BACT (30 CFR 250.303(h)). With BACT incorporated in the proposed activities, it is not necessary for modeling to be performed to determine whether BACT is needed (30 CFR 250.303(a) states: "the lessee shall comply with the requirements of this section as necessary).

Shell's BACT and emission reduction measures (Shell Offshore Inc., 2009b:Section 4.1.6) include:

- The primary generators on the *Discoverer* would be retrofitted with selective catalytic reduction devices to reduce NOx emissions by over 90 percent; and with catalytic oxidation devices to reduce CO, VOCs, and fine particulate matter by at least 60 percent.
- All remaining engines on the *Discoverer* would either be Tier 3 (low emissions) or would be retrofitted with closed crankcase ventilation and would have improved maintenance to minimize emissions.
- Maximum sulfur content of diesel fuel combusted by the support vessels would be limited to a maximum of 0.19 percent by weight; and the maximum sulfur content of diesel fuel combusted by the *Discoverer* would be limited to 0.0015 percent by weight.
- Limiting the MLC compressors to 2 of the 3 while the *Discoverer* is occupying a drill site, and only using emergency equipment during emergencies.
- Limiting daily cementing, logging, and cranes to 30 percent of combined engine capacity
- The *Discoverer* may occupy drill sites, in aggregate, a maximum of 168 calendar days and any one drill site a maximum of 84 calendar days during any year.

The drillship *Discoverer* would be attended by a minimum of six vessels that would be used for ice management, anchor handling, spill response, refueling, resupply, and servicing. The primary sources of the emissions by the *Discoverer* drillship and support vessels would be combustion engines including the vessel engines, generators, compressors, draw works, and pumps. Emission units on the *Discoverer* are associated primarily with the generation of electricity, compressed air, and hydraulic energy to support drilling. All others are secondary and related to general purpose heating, transfer of materials about the deck, pumping of cement, incineration of (primarily) domestic waste, and other small emission sources. All emission units on the *Discoverer* would use diesel with sulfur content at or below 15 parts per million.

The six main generator engines on the *Discoverer* would be equipped with selective catalytic reduction systems (SCR) to reduce emissions of NO_x as well as CO and VOC. The air compressor engines would meet EPA Tier 3 emission standards. The hydraulic power units, cranes, cementing, and logging units would have catalytic diesel particulate filters to reduce emissions of volatile organics, carbon monoxide, and hydrocarbon particulate matter. The operator would manage the power of the generators so that the average load over the lifetime of the project would not exceed 80%. The compressors, hydraulic power units, and cranes are assumed to operate a maximum of 63 days for the season. The incinerator would operate a maximum of 12 hours per day. The sulfur content of all engines on the *Discover*, except the propulsion engines, would be limited to 15 parts per million. The sulfur content of fuel used by support vessels would be 0.19%.

Ice-management activity accounts for more than 90 percent of support vessels' emissions; thus, total emissions would be lower in favorable ice conditions. The remainder of emissions would be generated from the production of electricity, compressed air, and hydraulic pressure to support drilling; incineration of solid waste; and as a low-volume deliberate by-product ("ammonia" slip) from air pollution control equipment to reduce oxides of nitrogen. Emissions generated from the proposed activities would include nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), small-diameter particulate matter such as PM_{10} and $PM_{2.5}$, and lead (Pb). The project would generate lesser quantities of volatile organic compounds (VOCs), hazardous air pollutants (HAPs), and ammonia, as well as CO_2.

Shell performed air quality modeling using the ISC-PRIME model in a screening mode using the range of meteorological parameters in SCREEN3. While this model is not on EPA's list of recommended models, MMS finds the ISC-PRIME is sufficiently conservative to be used in lieu of the Offshore and Coastal Dispersion (OCD) model. There are insufficient data available to apply the OCD model, which requires a long-term record of offshore wind speed and direction, air temperature, and sea-surface temperature. The ISC-PRIME model is intended for modeling land-based emissions. With the range of meteorological input data that were used by Shell, the ISC-PRIME model is likely to result in higher modeled concentrations. Moreover, dispersion over land is more limited than over water because of lighter winds and a more stable atmosphere. The MMS considers the ISC-PRIME model acceptable to use in the screening mode.

Estimates of the total annual potential emissions for the *Discoverer* and support vessel sources are provided in Table 2.3.3-1 of the EIA (Shell Offshore Inc., 2009b). Support-vessel emissions are included only when the vessel is within 25 mi (40 km) of the drillship. The project total annual HAPs are estimated at about one ton per year, which is below the EPA 25-ton per year major source threshold. Although there would be 122 possible drilling days between June 10 and October 31, 2010, Shell's modeling of project emissions are based on a maximum 168-day drilling season.

Shell also performed a cumulative impact analysis by including emissions from existing sources over a wide area. Concentrations were within the PSD Class II incremental limits and the national ambient air quality standards.

2.3.6 Sound Generation

When an ice-management vessel is transiting open water, the sound generated is less than when the vessel is managing or breaking ice. The greatest sound generated during ice-breaking operations is produced by cavitations of the propeller as opposed to the engines or the ice on the hull (Richardson et al. 1995a)

Sounds generated by the *Discoverer* have not yet been directly measured and noise propagation measurements are not yet available. However, measurements of sounds from a similar drillship, *Northern Explorer II*, were performed at two different times and locations in the Beaufort Sea (Miles et al., 1987; Green, 1987). During acoustic data collection, there was a support vessel idling in the vicinity of the drill rig (Miles et al., 1987; Green, 1987). These measurements provide source levels for modeling noise propagation from the *Discoverer*. Source levels for the *Discoverer* were estimated based on its similarity to the *Northern Explorer II.* The *Northern Explorer II* was used as a proxy source for the *Discoverer*. A comparison of the key specifications for the two drillships is provided in Table 5-1 of Shell's Application for NMFS IHA (Shell Offshore Inc., 2009a:Appendix E).

In 2007, JASCO modeled sound-level radii for the *Northern Explorer II* for the two locations, the Sivulliq B site (now withdrawn) and Sivulliq N site. The Shell's sound modeling is summarized in Shell's IHA and LOA applications (Shell Offshore Inc., 2009a:Appendixes E and F, respectively).

Modeled sound-level radii indicate that the sound from the *Discoverer* would not exceed the 180 dB "safety" radius for cetaceans specified by NMFS (USDOC, NOAA, NMFS, 2007a). The ≥160-dB radius for the drillship was modeled to be 172 ft (52.5 m); the ≥120-dB radius was modeled to be 4.6 mi (7.4 km). The NMFS uses the 160-dB rms isopleth to indicate where Level B harassment begins for acoustic sources (USDOC, NOAA, NMFS, 2007a). The area estimated to be exposed to ≥160 dB around the *Discoverer* operating at either of the planned drill sites is ~0.01 km^2. Sound verification would be conducted soon after the *Discoverer* is onsite and at the beginning of drilling. Sound radii will be adjusted based on the field measurements.

Ice-management activities may be necessary in early July or towards the end of operations in late October, if ice is present. Little to no ice management is expected to occur during the bowhead migration. Based on measurements in Greene (1987), sounds produced by an icebreaker, the *Robert Lamonte*, actively managing ice in this area were estimated to fall below 160 dB rms at <100 m from the vessel and to fall below 120 dB rms at ~8 km from the vessel. For estimation purposes, Shell assumed that most ice-management activities would occur at a distance of 10-15 km from the drilling operation and that one-third of that distance band would be exposed to ≥160 dB rms at some point by those activities. This area lies outside of the area exposed to ≥160 dB rms by the *Discoverer*. Waters are ≤40 m deep in areas that may be exposed to sounds ≥160 dB by both the *Discoverer* and ice-management activities. The ice-management area is 10-15 km around the drill site. The ice-management area plus the area an additional 8 km beyond the ice-management area potentially would be exposed to sounds levels of ≥120 dB rms by any ice-management activities.

Shell would verify the modeled sound-level radii though field measurements. Acoustic monitoring would measure the sound decibels produced by drilling activities, including variations with time, distance, and direction from the drillship. Acoustic monitoring would measure the sound levels produced by support vessels, including ice-management vessels. Drilling and vessel sounds would be measured and recorded using two methods, which may be used separately or together. The first method employs hydrophones mounted on the seafloor around the drilling vessel. This system would be located within 1,640-3,281 ft (500-1,000 m) from the drilling vessel. These hydrophones would feed real-time sound data to the drillship. An activity log would correlate sound levels with vessel activities. The second method for recording sound levels would employ additional hydrophone systems at various distances and locations around operations. Acoustic data from the second system would be stored digitally for later retrieval. Drilling sound monitoring equipment would be deployed soon after the *Discoverer* is onsite and before drilling commences.

Helicopters would be used for air support and crew changes. The level and duration of sound received underwater from helicopters depends on altitude and water depth. Received sound level decreases with increasing altitude. At an altitude of 1,000 ft (305 m), there were no measured sound levels at a water depth of 121 ft (37 m) (Richardson et al., 1989, citing Green, 1985).

Aircraft would not operate below 1,500 ft (457 m) unless the aircraft is engaged in marine mammal monitoring, approaching, landing, or taking off; providing assistance to a whaler; or in poor weather (low ceilings) or any other emergency situations. Aircraft engaged in marine mammal monitoring would not operate below 1,500 ft (457 m) in areas of active whaling; such areas would be identified through communications with established Communication Centers. Except for airplanes engaged in marine mammal monitoring, aircraft would use a flight path that keeps the aircraft at least 5 mi (8 km) inland until the aircraft is directly south of its offshore destination; then at that point, it would fly directly north to its destination. As a result of community input during Government-to-Government meetings held by MMS for Shell's 2007 EP, the inland helicopter route was developed to mitigate potential interference with subsistence caribou hunting along the coast.

2.3.7 Local Hire

Shell has several programs that involve the training and subsequent hiring of local residents. These programs include the following:

- Marine Mammal Observer (MMO) program
- Subsistence Advisor (SA) program
- Communication and Call Centers (Com Centers) program

The MMO program employs, among others, local Inupiat residents to monitor and document marine mammals in the project area. The MMOs participate in intensive training for marine mammal identification and documentation, and in computer use and health and safety regulations.

The SA program recruits a local resident from each village to communicate local concerns and subsistence issues from residents to Shell. The SA speaks with other village members and documents subsistence information. Shell may use that information to develop appropriate mitigation measures to address issues related to subsistence activities and avoid potential conflicts with exploration activities.

The Com Center program involves hiring one or two individuals from each of the Beaufort Sea and Chukchi Sea villages. These individuals monitor and relay radio transmissions between subsistence vessels and industry vessels. This sharing of information is intended to reduce or eliminate the potential conflict between subsistence users and industry vessels.

In the EP, Shell has committed to efforts to hire and train local residents for the exploration program. Providing these employment opportunities to local residents creates the potential for positive economic benefits to the communities most affected by Shell's activities. These efforts also would provide a conduit for communication between Shell and residents.

2.3.8 Analysis of Accidental Oil Spills

For purposes of this EA analysis, no large spills (≥1,000 bbl) or very large (≥150,000 bbls) crude oil spills are estimated, based on calculations and analyses (Appendix A), from the proposed exploration drilling activities. (Note that MMS' definition of a large spill (≥1,000 bbl) used in this analysis is different from the definition of large spill (≥48 bbl) used in the EIA.) This estimate is based on: (1) the low rate of OCS exploratory drilling well-control incidents spilling fluids per well drilled; (2) since 1971 no large spills have occurred from exploratory drilling well-control incidents while drilling more than 14,000 wells; (3) the low number of exploration wells being drilled from this proposal; (4) no crude oil would be produced; and (5) the history of exploration spills on the Arctic OCS, all of which have been small, as documented in EA Appendix A.

Based on the points listed above, the most likely size spill that might occur would be a small (<1,000 bbl) spill. For purposes of analysis, we chose a 48-bbl fuel-transfer spill, as identified in Shell's Beaufort Sea

ODPCP (Shell Offshore Inc., 2009c) Summary of Potential Discharges, for a representative spill size in MMS' small category. A summary of the potential discharges is shown in Appendix A Table A-1 and analyzed Appendix A of this EA.

To judge the effect of a 48-bbl diesel-fuel oil spill, we estimate how much oil would evaporate, how much oil would be dispersed, and how much oil would remain after a certain time period. A 48-bbl diesel-fuel spill could evaporate and disperse in less than 3 days (EA Appendix A Table A-4).

The SINTEF model fate and behavior estimates of a 48-bbl (7.6 m^3) fuel spill do not include the mitigating effects of potential containment and recovery operations to remove spilled product. Pre-booming of fuel barges or vessels prior to transfer operations would be used in accordance with MMS lease stipulations, USCG requirements, and Shell's operating procedures. Response equipment and trained personnel deploy recovery equipment for the control and removal of product spilled into the environment mitigating the impacts of a small spill.

Should a 48-bbl diesel-fuel spill occur, the spill would be localized and persist less than 3 days.

2.3.9 Oil Spill Prevention and Contingency Planning

As required by both Federal and State regulations, Shell has developed and would implement a comprehensive ODPCP (Shell Offshore Inc., 2009c) during its exploration drilling operations. The ODPCP must be reviewed and approved by both Federal and State regulators to ensure that Shell has the spill-response resources necessary to respond to any spill that might occur.

Shell has designed its response program based on a regional capability of responding to a worst case discharge (WCD) from an exploration well blowout. A dedicated oil-spill-response vessel (OSRV) would be staged in the vicinity of the drilling vessel when critical drilling operations into hydrocarbon-bearing zones are underway and possess sufficient capacity to provided containment, recovery, and storage for the initial operational period. An arctic oil storage tanker (OST) would arrive at the recovery site to provide interim storage of recovered fluids. The OST would possess sufficient capacity to store all recovered liquids from a 30-day blowout. Additionally, an oil-spill-response barge (OSRB) would arrive at the drill site with sufficient capacity relieving the OSRV to offload recovered fluids. Skimming and lightering operations would be conducted on a 24-hour-rotation basis (one OSRV or OSRB skimming while the other transits and lighters its recovered fluids to the OST). Additional personnel may be transported via helicopter or vessel from a land- or vessel-based staging area.

Shell's primary response action contractors are Alaska Clean Sea (ACS) and Arctic Slope Regional Corporation Energy Services - Response Operations, LLC (AES-RO). The AES-RO's response personnel and oil-spill-response equipment would be maintained on standby while critical drilling operations into hydrocarbon-bearing zones are underway; and provide offshore response operations in the unlikely event of an oil-spill incident. The ACS provides manpower and equipment resources from Deadhorse for Beaufort Sea spill containment and recovery. The ACS and AES-RO would conduct response activities using the AES-RO *Response Tactics Manual* as defined in the ACS *Technical Manual*.

2.3.10 Compliance with Lease Stipulations

Shell's leases were obtained under the Beaufort Sea Oil and Gas Lease Sale 195 on March 30, 2005, and the Beaufort Sea Oil and Gas Lease Sale 202 on April 18, 2007. Identical lease stipulations were included in both sales. A summary of the lease stipulations and Shell's planned actions to comply with each stipulation is provided below. The full text of the stipulations is on the MMS website http://www.mms.gov/alaska/cproject/beaufortsale/Sale202/FNOS/FNOS202package.htm. The MMS' analysis of the effectiveness of the stipulations can be found in the Beaufort Sea Multiple-Sale EIS ((USDOI, MMS, 2003:Section II.H.1).

Stipulation No. 1 - Protection of Biological Resources

If biological populations or habitats that may require additional protection are identified in the lease area by the RS/FO, the RS/FO may require the lessee to conduct biological surveys to determine the extent and composition of such biological populations or habitats. The RS/FO shall give written notification to the lessee of the RS/FO's decision to require such surveys.

Shell Actions: As required by 30 CFR 250.214, and as specified in MMS Alaska OCS Region NTL 05-A01, Shell acquired shallow-hazards surveys over the planned drill sites. The surveys data includes detailed bathymetry and identification of seafloor features through the use of subbottom profilers and side scan sonar methods.

Recently acquired shallow-hazards survey data over the Sivulliq N and Torpedo H drill sites in 2006, 2007, and 2008 did not identify any special benthic communities at these drill sites. Hard-bottom biological communities have high species diversity and provide valuable habitat for fish and invertebrates. To date, no confirmed boulder patch-type habitat has been identified at either of the planned drill sites. No other biological resources that require additional protection were found. The MMS has reviewed the submitted survey data and assessments, and concurs with Shell's conclusions.

During 2008, Shell commissioned both biological and chemical studies of water and sediment samples at and around the proposed drill sites (Shell Offshore Inc., 2009a:Section 5.0a).

To establish a baseline data set in advance of future oil and gas exploration, samples were collected in and around the planned Sivulliq N drill site (12 locations), around the 1985 Hammerhead well (10 locations), along a possible pipeline corridor (5 locations), and at random in the project area (19 locations). The sample locations and a more detailed account of the results of the sampling are discussed in the EIA (Shell Offshore Inc., 2009b:Section 16.0).

The following samples types were collected:

- Seafloor surface sediment samples
- Sediment cores, 3- 4 in (8-10 cm) in length
- Hydrographic profiles and water samples

Stipulation No. 2 - Orientation Program

The lessee shall include in any exploration or development and production plans submitted under 30 CFR 250.203 and 250.204 a proposed orientation program for all personnel involved in exploration or development and production activities (including personnel of the lessee's agents, contractors, and subcontractors) for review and approval by the RS/FO. The program shall be designed in sufficient detail to inform individuals working on the project of specific types of environmental, social, and cultural concerns that relate to the sale and adjacent areas. The program shall address the importance of not disturbing archaeological and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals and provide guidance on how to avoid disturbance. This guidance would include the production and distribution of information cards on endangered and/or threatened species in the sale area. The program shall be designed to increase the sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which such personnel would be *operating. The orientation program shall also include information concerning avoidance of conflicts with subsistence, commercial fishing activities, and pertinent mitigation.*

Shell Actions: Shell has provided a proposed orientation program for Shell and contractor personnel involved in Shell's exploration activities. Shell must submit a final 2010 orientation program to MMS for review prior to approval of an APD. All Shell and contractor personnel involved in field exploration activities would attend the orientation training annually. All other Shell and contractor personnel would attend the orientation program at least once at the time they join the team. Shell would maintain a record, not to exceed five years, of all personnel who attend the program, including relevant attendee and program information.

Shell's orientation program addresses environmental, social, and cultural concerns specific to the project area. The program is designed to increase sensitivity and understanding by Shell and its contractors of community values, customs, and lifestyles of the local communities, and how to avoid conflicts with subsistence activities. The program stresses the importance of not disturbing local communities, archaeological resources, and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals, and provides guidance on how to avoid disturbance of these resources.

Shell's Cultural Awareness Program addresses the following:

- Alaska Native Ethnic Composition
- Brief history of land claims
- Formation of regional corporations, and region within which Shell is working
- History of the North Slope
- Cultural diversity
- Comparison of cultural values of Alaskan Natives vs. non-Natives
- Patterns of language
- Communication skills and body language
- Guidelines on cultural artifacts
- Local community values and customs
- Whaling

Shell's Health, Safety, Security, and Environment (HSSE) Awareness Program addresses the following:

- Shell's HSSE Commitment
- Intervention policy
- Journey Management requirements
- Personal Protective Equipment requirements
- General Alaska Venture Hazards, such as earthquakes and volcanoes
- Medical emergencies
- Security
- North Slope Safety requirements
- Shell Alaska Venture Standards and Procedures
  - Cold Climate Work Standard
  - Firearms Use in Wildlife Confrontations
  - Procedure for Vessel-to-Vessel Personnel Transfers
- Incident Reporting
- Environmental Awareness
  - Endangered Species Act (ESA) – Major Provisions
  - Endangered and threatened species
  - MMPA of 1972
  - Marine mammal interactions
  - Sensitive Habitats on the North Slope
  - Wildlife interactions
  - Prohibited activities of hunting, trapping, and fishing
  - Environmental requirements for air, spills, and waste
  - Environmental training

Stipulation No. 3 - Transportation of Hydrocarbons

This stipulation is not applicable to the activities described in the EP.

Stipulation No. 4 - Industry Site-Specific Bowhead Whale Monitoring Program

Lessees proposing to conduct exploratory drilling operations, including seismic surveys, during the bowhead whale migration would be required to conduct a site-specific monitoring program approved by the RS/FO; unless, based on the size, timing, duration, and scope of the proposed operations, the RS/FO, in consultation with the North Slope Borough (NSB) and the Alaska Eskimo Whaling Commission (AEWC), determine that a monitoring program is not necessary. The RS/FO would provide the NSB, AEWC, and the State of Alaska a minimum of 30 but no longer than 60 calendar days to review and comment on a proposed monitoring program prior to approval. The monitoring program must be approved each year before exploratory drilling operations can be commenced.

Shell Actions: Shell submitted a copy of their Marine Mammal Monitoring and Mitigation Plan (4MP), which is also included in Shell's application for an IHA (Shell Offshore Inc., 2009a:Appendix E). Shell's 4MP is a combination of active monitoring of the project area and the implementation of mitigation measures designed to minimize project impacts to marine resources. The 4MP describes a site-specific bowhead whale monitoring program. The MMS has determined that the level and scope of the 2010 monitoring program would enable Shell to assess when bowhead whales are present in the vicinity of the proposed lease operations and the extent of behavioral effects on bowhead whales because of the operations. A summary of key components of the 4MP is presented below.

Marine Mammal Observers: The presence of MMOs onboard all vessels would be a core component of compliance with the 4MP. The drillship, ice-management vessels, and all other support vessels would have MMOs on duty during drilling operations to monitor for marine mammals and to advise on mitigative measures. All support vessels would have MMOs on duty during transit and other related activities. If marine mammals are observed within or about to enter specific safety radii around the proposed drilling operation, mitigation would be initiated by vessel-based MMOs. The MMOs would be responsible for collecting basic data on observations of marine mammals and birds and for advising on appropriate mitigation measures. Observations made by MMOs serve as the primary basis for estimation of impacts to marine mammals and birds.

Aerial Monitoring Program: The main goal of the aerial monitoring program is to monitor marine mammal populations and movements in support of the vessel-based 4MP during the 2010 drilling program. Aerial monitoring, designed primarily for detecting cetaceans, would be used to identify any large-scale distributional changes of cetaceans relative to the activities and add to the existing database on the abundance and distribution of observed species.

Acoustic Recorders: The acoustic program would characterize the sounds produced by the drilling activities and support vessels, and document the potential reactions of marine mammals in the project area, particularly bowhead whales, to those sounds and activities. A combination of acoustic recorder technologies would be used to document the overall distribution of marine mammals in the project area; the distribution of marine mammals in relation to drilling activities; to add clarity to drilling sound levels, character, and propagation; and to document presence of marine mammals. This would be accomplished by deploying several acoustic recorder buoys in a wide area surrounding the planned drill sites.

Sound Modeling: Sound modeling is required for the proposed activities. Shell's sound modeling is summarized in Shell's IHA and LOA applications (Shell Offshore Inc., 2009a:Appendixes E and F, respectively). The size of the 180 and 190 dB re 1 μPa (rms) safety radii were modeled. These radii would be used to initiate mitigation during initial drilling activities, at which time an acoustics contractor would measure underwater sound propagation from the drilling activities to empirically determine the size of safety radii (see *Sound Source Verification* below). Additional modeling using field data would be done during the 2010 drilling season. The sound data would enable Shell to refine sound-level thresholds and use the thresholds to more accurately define marine mammal take estimates.

Sound Source Verification: Field measurement sound-propagation profiles of the drillship and support vessels would be conducted during operations.

Stipulation No. 5 - Plan of Cooperation

Exploration and development and production operations shall be conducted in a manner that prevents unreasonable conflicts between the oil and gas industry and subsistence activities (including, but not limited to, bowhead whale subsistence hunting). Prior to submitting an exploration plan or development and production plan (including associated oil-spill contingency plans) to MMS for activities proposed during the bowhead whale migration period, the lessee shall consult with the directly affected subsistence communities, Barrow, Kaktovik, or Nuiqsut, the NSB, and the AEWC to discuss potential conflicts with the siting, timing, and methods of proposed operations and safeguards or mitigating measures which could be implemented by the operator to prevent unreasonable conflicts. Through this consultation, the lessee shall make every reasonable effort, including such mechanisms as a conflict avoidance agreement, to assure that exploration, development, and production activities are compatible with whaling and other subsistence hunting activities and would not result in unreasonable interference with subsistence harvests.

Shell Actions: Lease Stipulation 5 requires that all exploration operations be conducted in a manner that prevents unreasonable conflicts between oil and gas activities and subsistence resources and subsistence hunting activities of the residents of the North Slope. Specifically, Lease Stipulation 5 requires the operator to consult directly with potentially affected North Slope subsistence communities, the NSB, and the AEWC. Consultation is "to discuss potential conflicts with the siting, timing, and methods of proposed operations and safeguards or mitigating measures which could be implemented by the operator to prevent unreasonable conflicts." Lease Stipulation 5 requires the operator to document its contacts and the substance of its communications with subsistence stakeholder groups during the operator's consultation process. The requirements of Lease Stipulation 5 parallel requirements for incidental take authorizations from FWS and NMFS under MMPA.

Shell's Plan of Cooperation (POC) (Shell Offshore Inc., 2009a:Appendix B *2010 Plan of Cooperation, Camden Bay, Alaska*) identifies the measures Shell has developed and would implement during its proposed 2010 exploration drilling program to minimize any adverse effects on the availability of marine mammals for subsistence uses. The POC details Shell's communications and consultations with local communities concerning its proposed 2010 exploration drilling program, potential conflicts with subsistence activities, and means of resolving any such conflicts. Summaries of the substance of Shell's communications, and responses thereto, are included in the POC. A summary of Shell's POC meetings is provided is also provided below. Table 4.2-1 of Appendix B of the EP provides a list of public meetings attended by Shell as it developed its POC (Shell Offshore Inc., 2009a:Appendix B). Attachment B of Appendix B of the EP provides tables summarizing the feedback at each meeting, Shell's responses to the feedback, and any mitigation measures developed using information received during the meetings (Shell Offshore Inc., 2009a:Appendix B). Attachment B of Appendix B also includes copies of the sign-in sheets from the meetings and the presentation materials used at the meetings (Shell Offshore Inc., 2009a:Appendix B). The MMS concludes that methods of proposed operations, safeguards and mitigation measures detailed in the 2010 POC and EP meet the requirements of Stipulation 5 (Lease Sales 195 and 202). The mitigation measures in the POC would be requirements of plan approval and are assumed to be part of the proposed activities for the analysis in this EA.

In preparation for its proposed 2010 Camden Bay exploration drilling program (and proposed Chukchi Sea exploration drilling program), Shell engaged in an active consultation program with both Federal and

State regulatory agencies, as well as local governments and interested residents of the NSB communities. Consistent with Shell's obligations under Lease Stipulation 5, as well as the requirements of the FWS and NMFS under MMPA, Shell has communicated and consulted extensively with North Slope subsistence groups and their representatives and has committed to continuing to build on these relationships.

Affected subsistence communities that were consulted regarding Shell's 2010 proposed activities include Barrow, Kaktovik, Wainwright, Kotzebue, Kivalina, Point Lay, and Point Hope. Beginning in early January 2009, Shell held one-on-one meetings with representatives from the NSB and Northwest Arctic Borough (NWAB), subsistence-user group leadership, and Village Whaling Captain Association representatives. Several one-on-one meetings were also held throughout the villages.

Shell presented the proposed project to the NWAB Assembly on January 27, 2009; to the NSB Assembly on February 2, 2009; and to the NSB and NWAB Planning Commissions on March 25, 2009. Meetings were also scheduled with representatives from the AEWC, and presentations on proposed activities were given to the Iñupiat Community of the Arctic Slope and the Native Village of Barrow.

Shell attempted to meet individually with Whaling Captains and hold a community meeting in Nuiqsut; however, the scheduled meeting was cancelled per the Mayor's request. Shell subsequently sent correspondence to all post office box holders in Nuiqsut on February 26, 2009, indicating its willingness to visit and have dialogue on the proposed plans.

Shell began meeting with stakeholders specifically on the 2010 Camden Bay EP in July 2009. Shell plans to hold additional consultation meetings in May 2010 with the affected communities and subsistence user groups, the NSB, and NWAB to discuss the mitigation measures included in the EP and POC. Shell also plans to conduct post-operation consultations with the various subsistence stakeholder groups.

The POC may be supplemented to reflect additional engagements with local subsistence users and any additional or revised mitigation measures that are adopted as a result of those engagements.

In addition, Shell has publically stated it is committed to a Conflict Avoidance Agreement process and has demonstrated this by making efforts to negotiate an agreement every year it has planned activities.

Stipulation No. 6 - Pre-Booming Requirements for Fuel Transfers

Fuel transfers (excluding gasoline transfers) of 100 barrels or more occurring 3 weeks prior to or during the bowhead whale migration would require pre-booming of the fuel barge(s). The fuel barge must be surrounded by an oil-spill-containment boom during the entire transfer operation to help reduce any adverse effects from a fuel spill. This stipulation is applicable to the blocks and migration times listed in the stipulation on Industry Site-Specific Bowhead Whale-Monitoring. The lessee's oil-spill-contingency plans must include procedures for the pre-transfer booming of the fuel barge(s).

Shell Actions: Shell's fuel-transfer plan – *Alaska Fuel Transfer Operating Conditions and Procedures* – is included as Attachment 9.0-4 in EP Section 9.0 (Shell Offshore Inc., 2009a:Section 9.0). The fuel-transfer plan establishes special operating conditions and procedures for vessel-to-vessel fuel transfers. The fuel-transfer plan affirms that booming equipment would be deployed for all fuel oil transfers. Shell's fuel-transfer plan does not fully comply with the requirement of the lease stipulation to surround the fuel barge. The U.S. Coast Guard previously expressed concerns about the appropriateness and safety of encircling the fuel barge or vessel, as required by Lease Stipulation 6. As a condition of approval, Shell would be required to either modify their fuel-transfer plan to comply with the stipulation or provide justification of how their proposed alternative configuration would provide an equivalent level of response preparedness.

Stipulation No. 7 - Lighting of Lease Structures to Minimize Effects to Spectacled and Steller's Eiders

In accordance with the Biological Opinion for the Beaufort Sea Lease Sale 186 issued by the Fish and Wildlife Service (FWS) on October 22, 2002, and FWS' subsequent amendment of the Incidental Take Statement on September 21, 2004, lessees must adhere to lighting requirements for all exploration or delineation structures so as to minimize the likelihood that migrating spectacled or Steller's eiders would strike these structures. Lessees are required to implement lighting requirements aimed at minimizing the radiation of light outward from exploration/delineation structures to minimize the likelihood that spectacled or Steller's eiders would strike those structures. These requirements establish a coordinated process for a performance based objective rather than pre-determined prescriptive requirements. The performance based objective is to minimize the radiation of light outward from exploration/delineation structures.

Shell Actions: Lighted vessels and structures in open waters pose a collision risk to many species of birds. Growing scientific evidence indicates some bird species are attracted to light sources, which may increase the risk of bird strikes. Most related studies conclude that increased darkness coupled with inclement weather increases attraction by birds to lighted vessels and structures. Birds drawn to light often become disoriented and collide with these structures, which may result in injury and death.

Although the proposed drill sites are not within the area where Lease Stipulation No. 7 applies, Shell's *Bird Strike Avoidance and Lighting Plan, Camden Bay, Alaska* (lighting plan) (Shell Offshore Inc., 2009a:Appendix G) outlines Shell's bird strike avoidance strategy for drilling operations near Camden Bay for 2010. Emphasis is on the prevention of bird strikes into the drillship by threatened spectacled eiders (*Somateria fischeri*) and Steller's eiders (*Polysticta stelleri*). Given that the planned exploration drilling is outside the area where a lighting plan is required by MMS, the chances of bird strikes to the drillship are considered to be low. This low probability of bird strikes would be reduced further by Shell's implementation of the lighting modifications as specified in their lighting plan. In addition, if a bird strike is observed and the cause is believed to be at least in part due to lighting of the drillship, then reporting the bird strike and the conditions under which it occurred would help in better understanding the risks of bird strikes associated with the drillship.

2.3.11 Other Mitigation

Some of the additional mitigation measures Shell has adopted and would implement during its 2010 exploration drilling operations are presented below. Shell presented their planned mitigation measures to community leaders and subsistence users starting in January 2009 and Shell states that the measures have since evolved in response to comments and concerns expressed during the consultation process.

Protection of Subsistence Activities

To minimize any cultural or resource impacts to subsistence whaling activities from its exploration operations, exploration drilling activities at the Sivulliq or Torpedo drill sites are planned to begin on or about July 10 and run through October 31, 2010, with a suspension of all operations beginning August 25, 2010, for the Nuiqsut (Cross Island) and Kaktovik subsistence bowhead whale hunts. The *Discoverer* and support vessels would leave the project area and would return to resume activities after the Nuiqsut (Cross Island) and Kaktovik subsistence bowhead whale hunts conclude. Activities would extend through October 31, 2010, depending on ice and weather. In addition to the adoption of this suspension measure, Shell would implement the following additional mitigation measures to ensure coordination of its activities with local subsistence users to minimize further the risk of impacting marine mammals and interfering with the subsistence hunt:

- To minimize impacts to marine mammals and subsistence activities, the drillship and support vessels traversing north through the Bering Straight would transit through the Chukchi Sea along a route that allows for the highest degree of safety regarding ice conditions and sea states. Those vessels that can safely travel outside of the polynya zone would do so. If it is necessary for any vessel to move into the polynya zone, Shell would notify the local communities of any changes in transit routes.
- Shell has developed a Communication Plan and would implement the plan before initiating exploration drilling operations to coordinate activities with local subsistence users as well as Village Whaling Associations to minimize the risk of interfering with subsistence activities, and keep current as to the timing and status of the bowhead whale migration, as well as the timing and status of other subsistence hunts. The Communication Plan includes procedures for coordination with Communication and Call Centers to be located in coastal villages along the Chukchi and Beaufort seas during Shell's proposed activities in 2010.
- Shell would employ local Subsistence Advisors from the North Slope subsistence communities to provide consultation and guidance regarding the whale migration and subsistence hunt. There would be a total of nine subsistence advisor-liaison positions (one per village, including Shishmaref and Kivalina), to work approximately 8 hrs/day and 40 hrs/week through Shell's 2010 exploration project. The subsistence advisor would advise ways to minimize and mitigate potential impacts to subsistence resources during the drilling season. Responsibilities include reporting any subsistence concerns or conflicts; coordinating with subsistence users; reporting subsistence-related comments, concerns, and information; and advising how to avoid subsistence conflicts. Shell is developing a subsistence advisor handbook to specify position work tasks in more detail. In the EP, Shell indicates that this handbook would be completed before commencement of operations. The MMS will direct Shell to include, in its training material and handouts, instructions for the Subsistence Advisors to call MMS is there are issues that are not being resolved to the satisfaction of the Subsistence Advisor. The MMS will also notify the communities that MMS can be contacted directly.
- Aircraft would use a flight path that keeps the aircraft at least 5 mi (8 km) inland until the aircraft is directly south of its offshore destination, then at that point it would fly directly north to its destination. The specified inland helicopter route is intended to mitigate potential interference with caribou subsistence hunting along the coast.

Protection of Marine Mammals

Marine mammal mitigation measures would use MMOs to minimize disturbance to marine mammal resources and interference with the subsistence hunt of those resources. The MMOs would be stationed on all drilling and support vessels to monitor the exclusion zone (areas within isopleths of certain sound levels for different species) for marine mammals. The MMOs would initiate mitigation measures when appropriate. The MMOs would visually survey inside the exclusion zone (area within isopleths of specific sound level for different species) and operational zones (areas of prescribed proximity that may require avoidance measures for marine mammals). For vessels in transit, if a marine mammal is sighted from a vessel within its acoustic or operational safety radii, the Shell vessel would take appropriate mitigation measures, which may include reducing speed, changing course to avoid the animals, avoiding multiple course changes, avoiding separating members from a group, or minimizing activities. Specifically, moving vessels would avoid polar bears, walrus, and groups of whales by a distance of 1,500 ft (457 m), and would reduce speed if within 900 ft (274 m) of other marine mammals. Full activity would not be resumed until all marine mammals are outside of the exclusion zone and there are no other marine mammals likely to enter the exclusion zone. The complete MMO protocol is included in the 4MP (Shell Offshore Inc., 2009a:Appendix J).

Shell's Aerial Survey Program described in the 4 MP (Shell Offshore Inc., 2009a:Appendix J) would enhance the monitoring of onboard MMOs and acoustic monitoring. Aerial surveys would begin 5-7 days prior to field operations and continue 5-7 days after operations at a site are complete. Aerial surveys would occur daily during operations, subject to weather and flight conditions, and follow predetermined survey grids tailored for Shell's specific operations. Each survey flight would have two monitors seated at bubble windows (to facilitate downward viewing) on either side of the aircraft. Aerial monitors would be in real-time communication with operating vessels. Aerial monitors would advise vessels of the presence of marine mammals in the project area and collect data on the distribution, numbers, and movements of marine mammals near the drilling vessel and support vessels.

Anchored vessels would remain at anchor and continue ongoing operations if approached by a marine mammal. The anchored vessel would remain in place and continue ongoing operations to avoid possibly causing avoidance behavior by suddenly changing sound energy conditions.

While onsite, the drillship would remain at anchor and continue ongoing operations if approached by a marine mammal (i.e., no predetermined "real-time" mitigation would be implemented for anchored vessels). Modeled sound radii indicate that the drillship would not exceed the 180 dB "safety" radius for cetaceans specified by NMFS (USDOC, NOAA, NMFS, 2007a). Additionally, these modeled results indicate a relatively small "zone of disturbance" of approximately 172 ft (52.5 m) around the drillship where sound may reach levels above 160 dB. The NMFS uses the 160-dB rms isopleth to indicate where Level B harassment begins for acoustic sources (USDOC, NOAA, NMFS, 2007a).

Aerial monitors would record data on observable effects, if any, to migrating whales (e.g., the distance between the operations and the whale(s)).regulatory reporting requirements.

In compliance with MMS' Information to Lessees (ITL) clause (k) for OCS Lease Sales 195 and 202, Shell provided a plan to mitigate potential effects to polar bears, Pacific walrus, and grizzly bears (Shell Offshore Inc., 2009a:Appendix F *Polar Bear, Pacific Walrus, and Grizzly Bear Avoidance and Human Encounter/Interaction Plan*).

In addition, Shell would implement the following measures to further minimize disturbance to marine mammals (Shell Offshore Inc., 2009b:Section 4.3.3):

- A marine mammal monitoring protocol;
- Aircraft will not operate within 1,500 ft (457 m) of whale groups;
- Aircraft and vessels would not operate within 0.5 mi (800 m) of walrus or polar bears when observed on land or ice;
- Vessel speed to be reduced during inclement weather conditions to avoid collisions with marine mammals;
- When within 900 ft (274 m) of marine mammals, vessels will reduce speed, avoid separating member from a group and avoid multiple course changes;
- Vessel speed will be reduced during inclement weather conditions to reduce the potential for collisions with marine mammals; and
- A polar bear culvert trap would be established for oil-spill response needs near Point Thompson or Kaktovik prior to drilling.

Pollution Prevention Measures

In addition to the maintenance and implementation of its ODPCP, Shell would implement the following additional measures to further minimize the chance of an oil spill that might impact marine mammals and interfere with the subsistence hunt:

- Shell has established and would follow transit routes that avoid known fragile ecosystems and critical habitat areas to reduce the possibility of impacting those resources in the unlikely event of a vessel accident that resulted in a diesel spill.
- Shell has developed and would implement an Ice Management Plan (IMP) (Shell Offshore Inc., 2009a: Section 9.0) to ensure real-time ice and weather forecasting to identify conditions that might put operations at risk and modify its activities accordingly. The IMP also contains ice-threat classification levels depending on the time available to suspend drilling operations, secure the well, and escape from advancing hazardous ice.
- Shell has developed and would implement a Critical Operations and Curtailment Plan (COCP) (Shell Offshore Inc., 2009a: Section 9.0), which establishes protocols to be followed in the event potential hazards, including ice, are identified in the vicinity of the drilling operations (e.g., ice floes, inclement weather, etc.). Like the IMP, the COCP threat classifications are based on the time available to prepare the well and escape the location. The COCP also contains provisions for not initiating certain critical operations, if there is insufficient time available before the arrival of the hazard at the drill site.
- Shell has engineered each of its exploration wells (hole sizing, mud program, casing design, casing cementing depth, wellhead equipment, etc.) specifically to minimize the risk of uncontrolled flows from the wellbore due to casing or other equipment failures.
- Shell requires its drilling supervisors, toolpushers, drillers, and assistant drillers to hold an International Association of Drilling Contractors (IADC) WellCap (or equivalent) certificate showing mastery of well-control procedures and principles, and its crews must participate in regular training and drills in kick control to minimize the risk of a well-control event that might lead to a spill.
- Shell would use state-of-the-art automatic kick-detection equipment, including pit-volume totalizers, a flow detector, and various gas detectors placed about the rig, to provide early warning of a potential well-control event.
- The blowout preventer Shell would install on the high-pressure wellhead housing on the 20-in conductor casing on each exploration well includes redundant mechanical barriers to provide multiple means of closing in the well to prevent an oil flow to the surface.
- Shell would install multiple barriers, including manual and automated valves, on the drilling rig to prevent flows from coming up the drill string.
- Shell has developed and would implement a Well Control Contingency Plan (WCCP) (Shell Offshore Inc., 2009a: Section 9.0) in the extremely unlikely event of a well-control event to minimize the risk of oil coming in contact with the water. As part of the WCCP, Shell would prepare a Relief Well Drilling Plan for each location in advance of spudding the well to ensure that a relief well can be started quickly to kill the well.
- Shell has developed and would implement a Fuel Transfer Plan (FTP) (Shell Offshore Inc., 2009a: Section 9.0), which requires, among other things, the deployment of containment boom prior to any refueling operation.
- Shell would station and maintain its OSRVs in the immediate vicinity of its drilling operations to ensure timely response to any spill event.

Shell also may enter into agreements with other operators to coordinate and/or cooperate in monitoring, scheduling, or other aspects of the program to minimize impacts, maximize returns (in the form of information gathered), and share costs.

3.0 DESCRIPTION OF THE ENVIRONMENT AND ANALYSIS OF ENVIRONMENTAL CONSEQUENCES

3.1 Introduction

The area in which Shell proposes to conduct exploratory drilling operations is located offshore of Point Thompson in the Camden Bay area of the Beaufort Sea OCS. The potential effects of exploratory drilling activities in the Beaufort Sea Planning Area were assessed in recent MMS NEPA documents. The areawide descriptions of the environmental and analyses of potential effects were included the Beaufort Sea Multiple-Sale EIS for OCS Lease Sales 186, 195, and 202 (USDOI, MMS, 2003), which was updated in the 2004 EA for Sale 195 (USDOI, MMS, 2004), and updated further in the Sale 202 EA (USDOI, MMS, 2006a). This EA tiers from the Beaufort Sea Multiple-Sale EIS. Relevant information and analyses in these documents are summarized and incorporated by reference in this EA, as needed. The Arctic Multiple-Sale Draft EIS (USDOI, MMS, 2008) provides MMS' most recent description of the environment and analysis of the potential effects of Arctic OCS activities. Portions of the Arctic Multiple-Sale Draft EIS are summarized and incorporated by reference.

In 2006, Shell submitted an EP to conduct exploration activities similar to, but larger in scope than, the activities in the current proposed action. In 2007, MMS completed an EA and issued a FONSI for the Shell Offshore Inc., 2007-2009 Beaufort Sea Exploration Plan (USDOI, MMS, 2007b). In 2007, NMFS completed an EA and issued a FONSI for the *Shell Offshore, Inc. Incidental Harassment Authorization to Take Marine Mammals Incidental to Conducting an Offshore Drilling Project in the U.S. Beaufort Sea Under the Marine Mammal Protection Act* (USDOC, NOAA, NMFS, 2007a). The environmental documentation for the prior plan is incorporated by reference in this EA where applicable.

The NMFS Biological Opinion for *Oil and Gas Leasing and Exploration Activities in the U.S. Beaufort and Chukchi Seas, Alaska and Authorization of Small Takes Under the Marine Mammal Protection Act* (USDOC, NOAA, NMFS, 2008) provides a comprehensive description of the physical, geographical, and biological environment; the description and biology of the marine mammal species under NMFS' jurisdiction; and analysis of the potential effects of OCS activities on marine mammals species under NMFS' jurisdiction.

The FWS Biological Opinion for *Beaufort and Chukchi Sea Program Area Lease Sales and Associated Seismic Surveys and Exploratory Drilling* (USDOI, FWS, 2009) provides a comprehensive description of the physical, geographical, and biological environment; the description and biology of the ESA-listed species under FWS' jurisdiction; and analysis of the potential effects of OCS activities on ESA-listed under FWS' jurisdiction.

Additional information on the environment at the proposed drill sites and on the potential effects of the proposed activities on environmental resources is provided in the EIA (Shell Offshore Inc., 2009a:Appendix H; also cited as Shell Offshore Inc., 2009b), Shell's IHA application to NMFS dated May 7, 2009 (Shell Offshore Inc., 2009a:Appendix E); and Shell's LOA application to FWS (Shell Offshore Inc., 2009a:Appendix F).

Information from the above documents has been reviewed, summarized, updated, and incorporated, as needed and appropriate, in this EA. Relevant sections of the above documents are cited, summarized, and incorporated by reference, as appropriate.

3.2 Alternative 1: Biological Resources

The environmental conditions at the proposed drill sites as described in Shell's EIA do not deviate from the general conditions described in Beaufort Sea Multiple-Sale EIS (USDOI, MMS, 2003). There are no indications from recent studies or site-specific information that the prospect areas differ from what was generally described in Beaufort Sea Multiple-Sale EIS (USDOI, MMS, 2003). No sensitive seafloor biological communities or habitats have been identified at the proposed drill sites.

3.2.1 Levels of Effects for Biological Resources

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.
- For mammals or birds, mortality is not anticipated.
- For fishes, 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 whales, mortality might occur above the estimated Potential Biological Removal (PBR).
- The action may adversely affect an endangered or threatened species or its habitat in a way that has been deemed to be critical under the Endangered Species Act of 1973.
- 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.

Screening Analysis for Potentially Affected Biological Resources

The mechanisms of effects to biological resources from the proposed activities during the July-October operational timeframe in the vicinity of the project area are expected to be the same as those analyzed in the Beaufort Sea Multiple-Sale EIS (USDOI, MMS, 2003). The analyses in the Beaufort Sea Multiple-Sale EIS and Shell's EIA (Shell Offshore Inc., 2009b) were reviewed to determine expected level of effects form the types of activities proposed in the EP and the presence or absence of biological resources during the July-October operational timeframe in the vicinity of the project area. Tables 3.2.1-1, 3.2.1-2, and 3.2.1-3 below indicate the expected impact levels of the proposal on the biota in the vicinity of the Torpedo and Sivulliq prospects based on the analyses in the Beaufort Sea Multiple-Sale EIS and Shell's EIA. The expected levels of effects indicated in the following tables apply only to effects. This first step in the screening analysis assumes that all species are present. The expected presence or absence of considered species is considered in the "Presence and Habitat Use Analysis" below. For more detailed analyses, refer to MMS 2003-001(USDOI, MMS 2003) and Shell EIA (Shell Offshore Inc., 2009b). The likelihood of large hydrocarbon spills occurring was analyzed in and summarized in EA Section 2.3.8 and EA Appendix A and determined not to be a reasonably foreseeable outcome of the proposed action.

Screening for Potential Effects on Mammals

Table 3.2.1-1. Effects analysis determinations for mammal species that may occur in the vicinity of the project area. Effects are described as NG = negligible, MN = minor, MO = moderate, MJ = major, and * = effect after mitigation. Determinations were based on existing analyses in USDOI, MMS (2003), and Shell Offshore Inc. (2009b), and incorporated more recent information from other sources, as appropriate.

Species	Vessel Traffic	Vessel Noise	Aircraft Traffic	Aircraft Noise	Drilling Noise	Icebreaking/Ice Management	Vessel Mooring and MLC Construction	Drill Cuttings and Drilling Mud Discharges	Other Permitted Discharges	Small Liquid Hydrocarbon Spills	Air Pollutant Emissions	Cumulative Effects
Marine Mammals												
Bearded Seal	NG*	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG*
Beluga Whale	MN*	MN	NG	NG	NG	MN	NG	NG	NG	NG	NG	MN
Bowhead Whale	MN*	MN	NG	NG	MN	MN	NG	NG	NG	NG	NG	MN
Gray Whale	MN*	MN	NG	NG	NG	MN	NG	NG	NG	NG	NG	MN
Harbor Porpoise	NG	NG	NG	NG	NG	MN	NG	NG	NG	NG	NG	MN
Humpback Whale	MN*	MN	NG	NG	MN	NG	NG	NG	NG	NG	NG	MN
Killer Whale	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Narwhal	MN*	MN	NG	NG	NG	NG	NG	NG	NG	NG	NG	MN
Pacific Walrus	NG*	NG	NG*	MN*	NG	NG	NG	NG	NG	NG*	NG	MN*
Polar Bear	MN*	MN	MN*	MN	NG	MN	NG	NG	NG	NG*	NG	MN*
Ribbon Seal	NG*	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG*
Ringed Seal	NG*	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG*
Spotted Seal	NG*	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG*
Terrestrial Mammals												
Central Arctic Caribou Herd	NG	NG	NG*	NG*	NG	NG	NG	NG	NG	NG*	NG	NG*
Porcupine Caribou Herd	NG	NG	NG*	NG*	NG	NG	NG	NG	NG	NG*	NG	NG*
Grizzly Bear	NG	NG	NG*	NG*	NG	NG	NG	NG	NG	NG	NG	NG
Other Furbearers	NG	NG	NG*	NG*	NG	NG	NG	NG	NG	NG	NG	NG

The Beaufort Sea Multiple-Sale EIS (USDOI, MMS, 2003:Section IV.C.4.a(2)(a)2) concluded that "Drilling-mud disposal will not affect the major prey, zooplankton, or fish or their habitats." Suspended solids discharged from the drillship are expected to produce a plume with acute toxicity levels out to about 60 ft (20 m). More than 90% of solids are expected to precipitate out of the water column within 650 ft (200 m) from the discharge point (Shell Offshore Inc., 2009b). Assuming uniform mixing, a maximum 2.5^{o}F increase in water temperature is expected in the plume out to a distance of 450 ft (137 m) from the discharge point (EA Section 2.3.4). Shell (Shell Offshore Inc., 2009b) acknowledges strong, stable stratification of the thermocline occurs at the project locations during the summer. Deeper, colder strata could resist mixing with the warmer discharge from the disposal caisson, forcing the discharged water to disperse in the upper layers of the thermocline over a much larger area than predicted. Still, the area of potential disturbance is expected to remain small. Thus the thermal, chemical, and particulate disturbances are expected to reflect the small spatial area of the modeled discharge plume.

Waterborne contaminates associated with the discharge plume may affect marine vertebrates through ingestion or filtration. Because of the relatively small discharge plume and the plume's proximity to the drillship, we expect mobile invertebrates, fishes, marine mammals, and birds to avoid the area affected by the discharge plume, thereby avoiding exposure. With the exceptions of fourhorn sculpin and arctic flounder, Arctic marine fishes are migratory and are not considered to be residents at the proposed drill sites (USDOI, MMS, 2003; Shell Offshore Inc., 2009b). Benthic organisms under the discharge plume are most likely to be exposed to drill cuttings and other heavy materials. The likelihood of marine mammals or birds ingesting benthic organisms or fishes contaminated by discharges associated with the proposed activities is very low. Marine mammals or birds that feed on benthic invertebrates, sculpin, or flounder in the project area might ingest some organisms with very low levels of contamination. Impacts related to discharges are expected to be minor and localized. No population-level effects are expected for any species that occur in the proposed activity areas. Because no species are expected to experience measureable population-level effects from any discharges or temperature changes related to the proposed action, we conclude that there should be a negligible level of effects for drill cuttings and drilling mud discharges, and other permitted discharges listed in EIA Tables 3.2.1-1 thru 3.2.1-3.

Anthropogenic sound in the marine environment can affect marine mammals. The Beaufort Sea Multiple-Sale EIS (USDOI, MMS, 2003:Sections IV.C.5.a(1)(a) and IV.C.7.a(2)(a)1)c) concluded:

- Overall, bowhead whales exposed to noise-producing activities such as vessel and aircraft traffic, drilling operations, seismic surveys, and construction activities most likely would experience temporary, nonlethal effects.

- The primary sources of noise and disturbance of ringed, bearded and spotted seals; polar bears; and beluga and gray whales would come from the air and marine traffic associated with Beaufort Sea oil development.

- Boat traffic or icebreakers (for offshore platforms in the Far Zone) could briefly (few days) disturb some marine mammals within a lead system and may temporarily interrupt the movements of beluga and gray whales and seals or temporarily displace some animals when vessels pass through an area. However, there is no evidence to indicate that vessel traffic would block or delay marine mammal migrations.

Modeled sound radii indicate that the sound associated with the proposed drilling operations from the *Discoverer* would not exceed the 180-dB level. Sounds from drilling are modeled to reach 160 dB at 172 ft (52.5 m) from the drillship, and the 120-dB sound level is modeled to occur at 4.6 mi (7.4 km) (see EA Section 2.3.6). During summer, bowhead whales may be found feeding throughout the Beaufort Sea and belugas primarily follow the continental shelf break and the ice edge. During the fall westward migration starting in late August/early September, belugas and bowhead whales migrate through the U.S. Beaufort Sea in a corridor that extends to at least 100 mi (161 km) offshore (Figures 3-1 and 3-2). Considering the limited size of the area potentially affected by the proposed activities relative to the total area of the Beaufort Sea OCS, MMS expects no measureable population-level effects for most marine mammals. Consequently drilling sounds in the marine environment are expected to result in a negligible level of effects to most marine mammals, other than cetaceans, in the vicinity of the project area.

Vessel traffic related to the proposed activities would be limited to summer and autumn. Ice-management activities are likely to occur throughout the drilling period and icebreaking activities could occur during Shell's departure from the project area in late autumn.

Screening for Potential Effects on Birds, Benthic and Pelagic Invertebrates

Table 3.2.1-2. Effects analysis determinations for avian species and invertebrates that may occur in the vicinity of the project area. Effects are described as NG = negligible, MN = minor, MO = moderate, MJ = major, and * = effect after mitigation. Determinations were based on existing analyses in USDOI, MMS (2003) and Shell Offshore Inc. (2009b), and incorporate more recent information from other sources, as appropriate.

Species	Vessel Traffic	Vessel Noise	Aircraft Traffic	Aircraft Noise	Drilling Noise	Icebreaking	Vessel Mooring and MLC Construction	Drill Cuttings and Drilling Mud Discharges	Other Permitted Discharges	Small Liquid Hydrocarbon Spills	Air Pollutant Emissions	Bird - Ship Collisions	Cumulative Effects
Birds													
Common Eiders	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	MN*	MN
Gulls, Jaegers, Terns	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
King Eiders	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	MN*	MN
Long-tailed Ducks	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	MN*	MN*
Pacific Loon	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Red-throated Loon	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Scoter Spp.	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Spectacled Eiders	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	MN*	MN*
Steller's Eiders	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	MN*	MN*
Yellow-billed Loon	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG*	NG	NG	NG
Invertebrates													
Benthic and Pelagic Invertebrates	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG

Because of the distance between the proposed drill sites and any breeding, brood rearing, or preferred foraging habitat for birds and the localized area of potential disturbance related to the proposed activities, nearshore aggregations of birds are not expected to be affected. Because of the distance from colonies, nesting, and brood-rearing areas and because water depths in the project area render the substrate and benthic invertebrates unusable by some species, the occurrence of waterfowl and seabirds (jaegers, gulls, terns, etc.) in the vicinity of the proposed activities is expected to be sporadic and very low density.

Table 3.2.1-2 identifies bird-ship collisions as the only measureable source of impact to spectacled eiders and long-tailed ducks. Consequently, only spectacled eiders and long-tailed ducks will be analyzed further in this document and only in the context of bird-ship collisions. The effects analyses for exploratory drilling evaluated in Beaufort Sea Multiple-Sale EIS (USDOI, MMS, 2003), the Sale 202 EA

(USDOI, MMS, 2006a), and Shell's EIA (Shell Offshore Inc., 2009b) are incorporated by reference.

As noted in Table 3.2.1-2 below, all bird species, excepting eiders and long-tailed ducks, are expected to experience negligible levels of direct, indirect, and cumulative effects from the proposed action because few if any are expected to occur in the project area within the zones of measureable levels of noise, temperature changes, water depths, or discharges.

Screening for Potential Effects on Fishes

Table 3.2.1-3. Effects analysis determinations for fish species that may occur in the vicinity of the project area. Effects are described as NG = negligible, MN = minor, MO = moderate, MJ = major, and * = effect after mitigation. Determinations were based on existing analyses in USDOI, MMS (2003) and Shell Offshore Inc. (2009b), and incorporate more recent information from other sources, as appropriate.

Species	Vessel Traffic	Vessel Noise	Aircraft Traffic	Aircraft Noise	Drilling Noise	Icebreaking	Vessel Mooring and MLC Construction	Drill Cuttings and Drilling Mud Discharges	Other Permitted Discharges	Small Liquid Hydrocarbon Spills	Air Pollutant Emissions	Cumulative Effects
Fishes												
Arctic Char	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Arctic Cisco	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Arctic Cod	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Arctic Flounder	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Broad Whitefish	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Capelin	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Chum Salmon	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Dolly Varden	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Fourhorn Sculpin	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Humpback Whitefish	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Least Cisco	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Pink Salmon	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
Saffron Cod	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG

Marine, anadromous, and diadromous fishes that could occur in the vicinity of the proposed drilling locations are noted in Table 3.2.1-3. There are no known key reproductive, or feeding areas within a reasonable distance of the proposed Torpedo and Sivulliq drill sites. The progeny of arctic ciscos spawning in Northern Canada are sometimes carried west into the central and western Beaufort Sea by ocean currents, and in doing so, might be affected by the proposed action. However Arctic ciscos use nearshore habitats to grow to maturity so any smolt swept into the OCS waters have a lower likelihood of survival. Moreover each prospect is a relatively tiny point in the Beaufort Sea with a very limited area of potential effects to fishes, so any impacts to Arctic cisco smelt that may occur are expected to affect only an infinitesimally small percentage of the overall population. Consequently, a negligible level of effects determination was made for these populations.

Presence and Habitat Use Analyses

Tables 3.2.1-4, 3.2.1-5, and 3.2.1-6 below provide species population estimates, the status of each species under the ESA, the number of individuals expected to occur near the project, and habitat preferences.

Ribbon seals, narwhals, killer whales, harbor porpoises, and humpback whales are rarely documented in the Beaufort Sea, and any sightings are believed to lie outside the species' expected range. For this reason, they are considered anomalous occurrences and are not analyzed further. Available scientific information indicates that species such as Pacific walrus, spotted seals, gray whales, Steller's eiders, spectacled eiders, and salmon are not expected to occur in large numbers in the vicinity of this project.

Presence and Habitat Use Analyses for Mammals

Table 3.2.1-4. Population information and habitat use for marine and terrestrial mammal species that may be exposed to the effects of the proposed action. ESA Status: N = not listed, C = candidate, T = threatened, E = endangered, and S = species of concern. Anticipated Number of Exposures: * = speculative number based on general biological assumptions.

Species	Population Size	Anticipated Number/Max. Population Density of Individuals at Project Site	ESA Status	Area Habitat Preferences During Open Water Season (information sources are USDOI, MMS (2003) and Shell EIA (2009) unless otherwise noted)
Marine Mammals				
Bearded Seal	Unreliable estimate of 250,000 - 300,000 in Bering/Chukchi/ Beaufort Seas as reported in Angliss and Allen, 2009.	3 or 0.0362 seals/km^2 at 160 dB (NMFS, 2007) or 76 at ≥ 120 dB and 13 at ≥ 160 dB (Shell, 2009b).	C	Over continental shelf with 70% - 90% ice cover and between 20 and 100 nautical miles offshore. May remain near ice, or in open waters.
Beluga Whale	39,258 Bering/Chukchi /Beaufort Seas as reported in Angliss and Allen, 2009.	1 or 0.0135 belugas/km^2 at 160 dB (NMFS, 2007) or 157 at ≥ 120 dB and 41 at ≥ 160 dB (Shell, 2009b).	N	Usually follow lead systems and nearshore areas in spring migration. Summer habitat use is segregated with older males using the continental shelf break and heavy ice, while females with young prefer shallower water over the shelf. Belugas migrate westward along the shelf during their fall migration.
Bowhead Whale	10,545 Western Arctic Stock as reported in Angliss and Allen, 2009.	488 or 0.0256 bowheads/km^2 at 160 dB (NMFS, 2007) or 1,994 at ≥ 120 dB and 20 at ≥ 160 dB (Shell, 2009b).	E	Feeding over deep water and in shallow waters in U.S. Beaufort Sea. May be found feeding near drill site locations. Spring migration into U.S. Beaufort Sea is typically farther offshore, north of proposed drill sites. The drill sites are in the fall migration path.
Gray Whale	18,813 Eastern Pacific/Stock as reported in Angliss and Allen, 2009.	1 or 0.0001 gray whales/km^2 at 160 dB (NMFS, 2007) or 5 at ≥ 120 dB and 5 at ≥ 160 dB (Shell, 2009b).	N	Waters over continental shelf.
Harbor Porpoise	48,215 Bering/Chukchi Seas as reported in Angliss and Allen, 2009.	1 or 0.0002 porpoises /km^2 at 160 dB (NMFS, 2007)	N	Considered rare and extralimital.
Humpback Whale	961 Pacific/Bering Seas as reported in Angliss and Allen, 2009.	0 (extralimital)	E	Considered rare and extralimital.
Killer Whale	<314 Bering Sea as reported in Angliss and Allen, 2009.	0 (extralimital)	N	Open water and ice front, some coastal areas. Not known to use Beaufort Sea.
Narwhal	<5	0 (extralimital)		Considered rare and extralimital. Prefer deeper waters over continental shelf breaks. Sometimes accompany beluga whales.
Pacific Walrus	Unreliable Estimates	<5	C	Uncommon in area. Usually forage over continental shelf.
Polar Bear	20,000 - 25000 worldwide (FWS 2009) Biological Opinion)	0 (USDOI, FWS, 2009)	T	Areas of sufficient sea ice cover North of the project location from July thru October. Some may be in open water transiting between sea ice and the coast. Females with young, and sub adults may occur onshore.
Ribbon Seal	Unreliable estimate of 90,000 – 100,000 in Bering/Chukchi Seas as reported in Angliss and Allen, 2009.	0 (extralimital)	N	Pelagic waters in the Bering and Chukchi Seas. Individuals have been rarely documented in Beaufort Sea.
Ringed Seal	Unreliable estimate of 249,000 in Bering, and Chukchi Seas as reported in Angliss and Allen, 2009.	42 or 0.7094 seals/km^2 at 160 dB (NMFS, 2007) or 1,486 at ≥ 120 dB and 263 at ≥ 160 dB (Shell, 2009b).	C	Shallow waters over continental shelf.
Spotted Seal	Unreliable estimate of 59,214 Bering/Chukchi Seas as reported in Angliss and Allen, 2009.	1 or 0.0149 seals/km^2 at 160 dB (NMFS, 2007) or 6 at ≥ 120 dB and 5 at ≥ 160 dB (Shell, 2009b).	C	Seasonal visitor to Beaufort Sea. Shallow waters over continental shelf.
Terrestrial Mammals				
Central Arctic Caribou Herd	31,857 Alaska	0	N	Coastal areas are used for insect relief.(Griffith et al. 2002)
Porcupine Caribou Herd	110,000-115,000 ANWR/Yukon	0	N	Most caribou from the Porcupine herd calve near the coast in May/June, moving back into the Brooks Range Foothills in July (Griffith et al., 2002, Caikoski, 2008).
Grizzly Bear	Mostly stable at 269 bears in GMU 26C (Lenart, 2007)	0	N	Ubiquitous throughout Game Management Unit 26C in low densities.
Other Furbearers	Variable. None are reported to be in any danger. (Szepanski, 2007)	0	N	Ubiquitous throughout Game Management Unit 26C in low to moderate densities (Szepanski, 2007).

Angliss and Allen (2009) characterize the population estimates for ice seals (ringed, ribbon, bearded, and spotted seals) as unreliable or tentative, and ice seal populations are known to be in the tens to hundreds of thousands for each species across the Arctic. Ice seals are associated with sea ice for all or part of the year. Although some species of ice seals tend to remain near the ice edge during the summer months, they frequently occur regularly in open water, particularly during the summer. Because Shell's site-specific seafloor surveys and biological studies indicate there are no unique features in this project area of special significance to marine mammals, MMS determined that additional population studies of these species are not required for this site-specific analysis.

Typical cetacean and pinnipeds species briefly visiting the project area during the proposed time period of operations are expected to be migrating or feeding bowhead whales; ringed and bearded seals; and the occasional gray whale, walrus, spotted seal, or pod of beluga whales. The project area lies in migration corridor for the fall migration of bowhead and beluga whales and to the west of Camden Bay.

Presence and Habitat Use Analyses for Birds

Table 3.2.1-5. Population information and habitat use for avian species that may occur in the vicinity of the proposal area. ESA Status: N = not listed, C = candidate species, T = threatened species, and E = endangered species.

Species	Population Size	Anticipated Number/Max. Population Density of Individuals at Project Site	ESA Status	Area Habitat Preferences During Open Water Season (information sources are MMS (2003) and Shell EIA (2009) unless otherwise noted)
Birds				
Common Eiders	1,936 on Alaska's North Slope (Dau and Larned, 2007).	0.13/km^2 (Fischer and Larned, 2004; Fischer, Tiplady, and Larned, 2002)	N	In general, common eiders were concentrated in shallow waters (<10 m), with the highest densities occurring in segments between Oliktok point and Prudhoe Bay and between Tigvariak Island and Brownlow Point (Fischer and Larned, 2004)
Gulls, Jaegers, Terns	Trend Data and various population indices (Larned et al. 2009)	0.02/km^2 (Fischer and Larned, 2004; Fischer, Tiplady, and Larned, 2002)	N	Varies with food availability near the water surface.
King Eiders	12,000 (Larned and Balogh, 1997; Larned et al., 2001). 12,896 Larned, Stehn, and Platte (2006).	0 (Flint et al. 2001; Fischer, Tiplady, and Larned, 2002)	N	Water depths <20 m (Fischer and Larned, 2004)). between the Colville River and Prudhoe Bay, southeast of Teshekpuk Lake and a large area near Atqasuk (Larned, Stehn, and Platte, 2006)
Long-tailed Ducks	116,400 (Sea Duck Joint Venture, 2003).	0.12/km^2 (Fischer and Larned, 2004; Fischer, Tiplady, and Larned, 2002)	N	Water depths <66 m (Robertson and Savard, 2002)..Most long-tailed ducks migrate within 45 km of shore (roughly along the 20-m isobath), infrequent observations of long-tailed ducks in pelagic waters occur in late September (Divoky, 1987).
Pacific Loon	31,699 (Larned et al., 2009)	0.05/km^2 (Fischer and Larned, 2004; Fischer, Tiplady, and Larned, 2002)	N	Water depths <46 m (Lehtonen, 1970). Most common in $\leq$20-m depths (Johnsgard, 1987)
Red-throated Loon	2,425 (Larned et al., 2009)	0	N	Prefer shallow nearshore waters. (Johnsgard, 1987)
Scoter Spp.		0.08/km^2 (Fischer and Larned, 2004; Fischer, Tiplady, and Larned, 2002)	N	Forage in 6-30 ft of water (Bellrose, 1980)
Shorebirds	Variable	0	N	Shorelines, lagoons, bays, estuaries, river deltas
Spectacled Eiders	33,587 on Alaska's Arctic Coastal Plain (Stehn et al., 2006	1 (USDOI, FWS, 2009)	T	Lovvorn, et al (2000) indicated spectacled eiders prefer water depths 40-60 m. The USDOI, FWS (2006) determined they prefer depths to 30.5 m and mostly migrate over the 20-m isobath. Based on telemetry data for molt migration in the Chukchi Sea, male spectacled eiders migrate an average of 35 km offshore, and females fly an average of 60 km offshore.
Steller's Eiders	576 (Stehn and Platte, 2009).	<1 (USDOI, FWS, 2009; Flint et al., 2001); expected densities were 0.0045 birds/km^2 (USDOI, FWS, 2007).	T	Range extends to Prudhoe Bay. Prefer foraging in nearshore water depths down to 9 m (USDOI, FWS, 2002). Not known to occur east of Deadhorse, AK. They mostly migrate over the 20-m isobath (USDOI, FWS, 2006). The greatest breeding densities on the North Slope occur near Barrow (Quakenbush et al., 2002); although they do not breed every year when present (Suydam, 1997a).
Yellow-billed Loon	4,892 as reported in Shell (2009b). <5000 (Earnst et al., 2005).	0 (Fischer, Tiplady, and Larned, 2002)	C	Most nesting occurs in NPR-A. Nearshore areas and wetlands. Fisher and Larned (2004) found most using water depths < 32 ft (10 m) (Johnsgard, 1987)

Post-breeding spectacled eider drakes using the Beaufort Sea migrate within 7 km of the coast (median distance; Troy, 2003; Petersen, Larned, and Douglas, 1999) enroute to molting areas in the Chukchi Sea or Russia. Movement between North Slope breeding areas and the primary molting area in Ledyard Bay typically takes several weeks, indicating several stops along the way in the Beaufort and Chukchi seas. The physiological importance of the stops during this extended migration is undetermined, but these stops could be very important to molt timing and survival during and after the molt. Smith Bay appears to be a site of concentrated use by female eiders (Troy, 2003) in the Beaufort Sea.

Paired male Steller's eiders depart the North Slope after the nest is initiated in mid- to late June. Because Steller's eiders occur in such low numbers on the North Slope, it is difficult to observe large migrations by males after nest initiation or post-nesting females and young-of-the-year, as is the case with king and common eiders. It might be reasonable to expect that their movements would be loosely bounded by the distance of ice from shore and the water depth. It is unlikely that Steller's eiders would be farther than 24 km offshore, because the water depth would be beyond their diving capability and the males likely would be traveling over sea ice. Only 20 Steller's eiders were counted during migration counts conducted from Point Barrow fall 2002 through spring 2004 (Suydam et al., 2008).

Most breeding female common eiders and their young begin to migrate to molt locations in late August and September, although large numbers of female common eiders were observed molting in the eastern Beaufort Sea in Canada near Cape Parry and Cape Bathurst (Johnson and Herter, 1989). Johnson, Wiggins, and Wainwright (1992) observed between 1,125 and 2,031 common eiders in early September during aerial surveys in 1989 and 1990 during the molt period. After the molt is completed, some common eiders move offshore into pelagic waters, but most eiders remain close to shore (Divoky, 1987).

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 shallow waters (<10 m), 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 seaward. Our most recent information indicates that male common eiders begin leaving the Beaufort Sea beginning in late June and are gone by late August or early September, and most females are gone by late October to early November. When traveling west along the Beaufort Sea coast, approximately 90% of the common eiders migrate within 48 km (29.8 mi) of the coast; 7% migrate 13-16 km (8 -9.9 mi) from shore, roughly along the 17-20 m isobath (Johnson and Herter, 1989, citing Bartels, 1973).

Satellite telemetry was used to determine that most king eiders spent more than 2 weeks staging offshore in the Beaufort Sea prior to migrating to molt locations in the Bering Sea (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). 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) zone offshore of Barrow and Oliktok Point. In 1999 and 2000, these flocks were in waters >10 m (32 ft) deep but were found in the shallow (<10 m) 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).

In late June and early July, most male and non-breeding female long-tailed ducks migrate to coastal molting areas. Typical migration distances offshore for long-tailed ducks occur within 45 km of shore (roughly along the 20-m isobath), infrequent observations of long-tailed ducks in pelagic waters occur in late September (Divoky, 1987). Molting long-tailed ducks are flightless for a 3- to 4-week period and breeding females molt on freshwater lakes during the last phases of duckling development before departing the North Slope in fall (Johnson and Herter, 1989). Most long-tailed ducks migrate within 45 km of shore (roughly along the 20-m isobath); infrequent observations of long-tailed ducks in pelagic waters occur in late September (Divoky, 1987).

Yellow-billed loons may occur in the project area; however, they begin nesting in coastal lakes around mid-June, remaining in nearshore areas and wetlands until their fall migration in late August thru mid-September (Shell Offshore Inc., 2009b). 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 NPR-A, it is likely that there are fewer than 1,000 nesting pairs, because some of the 3,300 are non-breeders. Additionally, there are approximately 1,500 yellow-billed loons, presumably juvenile non-breeders 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 North Slope breeding grounds and nearshore marine habitat (Earnst et al., 2005). Because of the location of the project area in relation to their lifecycle requirements, we do not expect yellow-billed loons to occur in the vicinity of the proposed actions.

Through discussions among MMS staff biologists early in the analytical process, the presence of shorebirds at or near the project area was determined to be highly unlikely (Schroeder, Denton, and Crews, 2009, pers. commun.). Consequently, a zero population density of shorebirds in the project area is expected, and no impacts to shorebirds are expected. Analysis of potential impacts to shorebirds is not further analyzed in this EA.

Aerial surveys for bird use of offshore and coastal waters in the western Beaufort were conducted (Fischer and Larned, 2004) up to 62 mi (100 km) offshore for the MMS. The areas surveyed were between Cape Halkett and Brownlow Point in June, July, and August 1999 and 2000 and between Point Barrow and Demarcation Point in July 2001. About 90% of the birds observed were sea ducks; mostly long-tailed ducks, king eiders, and scoters. Densities of most species decreased with distance from shore except for king eiders, where densities were higher in deeper offshore waters. Mean distance offshore for king eiders was 10 mi (16.5 km), with 81% occurring more than 6.2 mi (10 km) from shore. However, densities of king eiders were higher in shallow (less than 32.8 ft [10 m]) and mid-depth (32.8-65.6 ft [10-20 m]) waters between Barrow and Oliktok Point than in other study areas to the east. King eiders were not present in mid-depth and deep (> 65.6 ft [20 m]) waters in the eastern part of the study area, despite large open-water areas. The waters in the Torpedo and Sivulliq prospect areas vary from 107-128 ft (32.5-39 m) (Shell Offshore Inc., 2009b), putting these sites beyond the surveyed distribution and habitat preferences of king eiders and most other sea ducks.

Oceanographic expeditions in the Beaufort and Chukchi seas found gulls, kittiwakes, jaegers, and terns far from shore and in pack ice (Harwood et al., 2005). The northernmost sightings consisted of black-legged kittiwakes and ivory gulls 460 mi (740 km) from shore in an area of pack ice. Gulls, kittiwakes, and fulmars were numerous 37-62 mi (60-100 km) northwest of Barrow at the Northwind Ridge area and near Barrow Canyon. Likewise, gulls and kittiwakes were often found along the Chukchi Sea shelf break. Divoky (1983) observed the pelagic area (>20-m water depth) avian diversity consisted primarily of surface-feeding species (gulls, terns, phalaropes, and jaegers), with little use by diving species such as loons or sea ducks, except as a migratory area. The nearshore waters (<20-m water depth) hosted large numbers of long-tailed ducks, loons, and migrating eiders, with low densities of surface feeders relative to what was found in pelagic waters.

Consequently, we have concluded that most avian species are not likely to occur in the environs of either prospect area, at least not in any large numbers based on the results of Fisher et al. (2004) and their habitat-use limitations (as noted in Table 3.2.1-5) indicating their absence from the project area or unsuitability of the project area for their habitat preferences. Most sightings should be the occasional individual and not large aggregations. Of all the species analyzed, only the spectacled eiders, common eiders, king eiders, a few long-tailed ducks, an a few sea birds may face the potential of being impacted by the proposed action. However, seabirds such as gulls, terns, and jaegers fly at higher altitudes than do sea ducks; moreover, they are gliders, usually flying at slower speeds than do sea ducks, which fly quickly and at low altitudes. The slower speeds and higher altitudes used by seabirds are expected to provide more reaction time, allowing seabirds to avoid striking ships under most conditions. Spectacled eiders were included in the analysis on the premise that their habitat requirements permit their use of the project area, that their presence may not have been detected in previous surveys due to their scarcity, and the possibility that they may have been noted as "UNEI" or unknown eider in Table 28 of Fisher et al. (2004). The water depths in the project area are much too deep for foraging by Steller's eiders. Moreover, Steller's eiders are not known to occur regularly east of Deadhorse and Prudhoe Bay (USDOI, FWS, 2002).

Presence and Habitat Use Analyses for Fishes

Table 3.2.1-6. Population information and habitat use for fishes species that may occur in the vicinity of the proposal area. ESA Status: NL = not listed, C = candidate species, T = threatened species, and E = endangered species.

Species	Population Size	Anticipated Number/Max. Population Density of Individuals at Project Site	ESA Status	Area Habitat Preferences During Open Water Season (information sources are MMS (2003) and Shell EIA (2009) unless otherwise noted)
Fishes				
Arctic Char	No Estimates	No Estimates	NL	Anadromous
Arctic Cisco	No Estimates	Abundant	NL	Diadromous
Arctic Cod	No Estimates	57.9 / 1,000 m^3	NL	Marine. Sea ice cover or shallow nearshore areas during ice-free season.
Arctic Flounder	No Estimates	0-67 / day catch rate	NL	Marine. Usually in $\leq$20-m water depth.
Broad Whitefish	No Estimates	Abundant	NL	Diadromous. Fresh and brackish waters.
Capelin	No Estimates	8.2 per m^3	NL	Marine. Shallow ($\leq$ 3 m) water depth in coastal estuarine areas within 5 mi (8 km) from coast.
Chum Salmon	No Estimates	Very low	NL	Anadromous
Dolly Varden	No Estimates	Occasional	NL	Anadromous. Nearshore zones within 1,650 ft (500 m) of the coast.
Fourhorn Sculpin	No Estimates	0.12 per 1,000 m^3	NL	Marine
Humpback Whitefish	No Estimates	No Estimates	NL	Diadromous. Freshwater systems and coastal zones.
Least Cisco	No Estimates	Low, tapering off in July	NL	Diadromous. Within 330 ft (100 m) of the coast
Pink Salmon	No Estimates	Very low	NL	Anadromous
Saffron Cod	No Estimates	Very abundant	NL	Marine. Cooler, deeper waters.

No population estimates are available for the fishes listed in Table 3.2.1-6, because U.S. Beaufort Sea fish stocks lack the impetus of a large fishing industry that demands extensive population studies and monitoring by NOAA and NMFS. Although there are no population estimates, there is information available on the presence of fish species in various habitats. Completed studies indicate some fish species, such as salmon, have a very limited presence and are only in the larger river systems flowing into the U.S. Beaufort Sea, as shown in EIA Table 3.5.2-1 (Shell Offshore Inc., 2009b). No successful reproduction of these populations is documented in these studies.

Because of the limited information on fish species in the Beaufort Sea Planning Area, MMS considered whether additional studies of fish would be necessary to determine the potential for significant effects for this site-specific analysis. Although information on continental-shelf fish species in the Arctic is limited compared to other regions of Alaska, there is sufficient information to evaluate the effects of the proposed action, which would include benthic habitat disturbance, noise, and turbidity. The area of benthic disturbance would be limited temporally and spatially. Fish species that are mobile would be able to avoid the disturbances in the project area and the associated temporary effects of turbidity and noise. Benthic disturbances from the drilling activities would likely affect few individuals of any species. Shell conducted extensive seafloor and shallow geologic surveys and collected shallow cores for geochemical and geotechnical studies. None of the site studies indicated that the seafloor environment at the proposed drill sites is in any way unique in the area. If during the exploration, unique benthic habitats, species, or communities are found, the occurrence will be reported to MMS and per the requirements of Lease Stipulation 1, Shell's activities would be modified if necessary to protect those resources. Based on this information, MMS believes that additional fish studies are not needed at this time for adequate site-specific analysis prior to this proposed action.

The EIA (Shell Offshore Inc., 2009b) summarized the effects of noise on fishes in Section 4.1.12, explaining fishes may react to sound levels ≥120 dB and that drillship noise typically falls between 90 dB and 138 dB, depending on distance from the noise source. The EIA states that the ice-management vessels can produce sounds ranging from 174-184 dB, or 10-15 dB higher if actively breaking/moving ice. Such sound levels could motivate fishes to temporarily avoid these areas; however, no measurable population-level effects on fishes are anticipated from the proposed activities. The overall effect of the proposed activities on fishes is expected to be negligible in light of the temporary, non-lethal, effects that are not expected to affect fish populations in a measureable way.

The Department of Commence approved the Arctic Fishery Plan for the U.S. Arctic in August 2009 (NPFMS, 1990). The Salmon Fishery Management Plan for Coastal Alaska, approved in 1990 (NPFMC, 1990) applies to the five Pacific salmon species in the Alaska Chukchi and Beaufort Seas. The Arctic Fishery Management Plan (2009) identifies three commercial target species: Arctic cod, saffron cod, and snow crab (opilio crab). The Arctic Fishery Plan also describes eight ecosystem component species that "are thought to be, should conditions allow, commercially viable." These ecosystem component species are: yellowfin sole, Alaska plaice, flathead sole, Bering Flounder, starry flounder, capelin, rainbow smelt, and blue king crab. The general distribution for adult and late juvenile Arctic cod essential fish habitat (EFH) covers the entire Arctic Fishery Plan Area, which includes both the Chukchi and Beaufort seas. Considering the mobility of fishes, the limited areal extent of disturbance associated with the proposed activities, and broad area of the Arctic cod EFH, MMS has determined the proposed activities would have no to negligible effects on EFH.

Identification of Biological Resources Requiring Further Evaluation

The data from EA Tables 3.2.1-1 thru 3.2.1-6 were analyzed for level of effects, the anticipated number/maximum population density of individuals at the project site, and habitat preferences. This information was then combined, evaluated in relation to the impact levels specified in EA Section 3.2.1, and the result entered into EA Table 3.2.1-7. Species that could potentially be affected by the proposed action are analyzed further, and those that are not at risk have been excluded from further consideration and analysis. Table 3.2.1-7 indicates whether or not a species was excluded from further analysis and, if so, the rationale for the exclusion. For some species, the level of effects are not reasonably expected to be more than negligible, meaning that it is extremely unlikely that any detectable population-level effects would result from the proposed activities. Species that could experience greater than negligible level of effects progress into the next level of analysis. Beluga, bowhead, and gray whales; Pacific walrus; polar bear; long-tailed ducks; and eiders are further analyzed.

Tables 3.2.1-4 and 3.2.1-7 indicate the project area is considered outside the range (extralimital) of one ice seal species and the other seal species are expected to experience a negligible level of effects from the proposed activities. Under the methodology used in this analysis, these species would be “screened out” for further analysis in this EA; however, because NMFS intends to use much of MMS’ environmental analysis in their NEPA compliance for MMPA authorization for the proposed activities, we have included these species in this evaluation.

Both Steller’s and spectacled eiders were included in the FWS Biological Opinion (BO) (USDOI, FWS, 2009) covering exploratory activities in the Beaufort and Chukchi seas by the petroleum industry and so will be further analyzed under the effects of bird strikes although there are no known breeding populations near the project area.

Table 3.2.1-7. Species included and excluded from subsequent effects analysis.

Species	Excluded from further analysis?	Reason for Exclusion
Marine Mammals		
Bearded Seal	N	ESA
Beluga Whale	N	--
Bowhead Whale	N	--
Gray Whale	N	--
Harbor Porpoise	Y	EO
Humpback Whale	Y	EO
Killer Whale	Y	EO/LE
Narwhal	Y	EO
Pacific Walrus	N	--
Polar Bear	N	--
Ribbon Seal	Y	EO/LE
Ringed Seal	N	ESA
Spotted Seal	N	ESA
Terrestrial Mammals		
Central Arctic Caribou Herd	Y	LE
Porcupine Caribou Herd	Y	LE
Grizzly Bears	Y	LE
Other Furbearers	Y	LE

EXCLUSION CRITERIA

N = No. Species has not been excluded from further analysis in this EA.
Y = Yes. Species has been excluded from further analysis

EO = Extralimital Occurrence.

LE = Negligible Level of Effects (between July and October in the vicinity of the proposed action).
ESA =Analysis because of ESA status or Pending ESA review

Species	Excluded from further analysis?	Reason for Exclusion
Birds		
Scoter Spp.	Y	LE
Common Eiders	Y	LE
Gulls, Jaegers, Terns	Y	LE
King Eiders	Y	LE
Long-tailed Ducks	N	--
Red-throated Loon	Y	LE
Pacific Loon	Y	LE
Shorebirds	Y	LE
Spectacled Eiders	N	--
Steller's Eiders	N	--
Yellow-billed Loon	Y	LE
Fishes		
Arctic Char	Y	LE
Arctic Cisco	Y	LE
Arctic Cod	Y	LE
Arctic Flounder	Y	LE
Broad Whitefish	Y	LE
Capelin	Y	LE
Chum Salmon	Y	LE
Dolly Varden	Y	LE
Fourhorn Sculpin	Y	LE
Humpback Whitefish	Y	LE
Least Cisco	Y	LE
Pink Salmon	Y	LE
Saffron Cod	Y	LE

3.2.2 Proposed Action Mitigation for Biological Resources

Shell incorporated extensive mitigation in their proposed activities to lessen or alleviate the impacts associated with exploratory drilling on wildlife species. These measures are summarized in EA Sections 2.3.9 and 2.3.10. Shell describes their proposed mitigation measures in EP Appendix E (IHA application to NMFS); EP Appendix F (LOA application to FWS including Shell's Polar Bear, Pacific Walrus, and Grizzly Bear Avoidance and Encounter Interaction Plan); EP Appendix G (Bird Strike Avoidance and Lighting Plan); and EP Appendix J (Marine Mammal Monitoring and Mitigation Plan. These proposed mitigations are in addition to or may be amended by measures required under MMPA authorizations and the ESA consultations administered by NMFS and the FWS. Shell's mitigation measures related to discharges, emissions, and spills are summarized in EA Section 2.3.4, EA Section 2.3.11, and Shell's ODPCP. The mitigation measures from the EP listed below are pertinent to species protection and are assumed in the analyses.

Vessel Traffic and Noise

- Shell will not operate vessels within 0.5 mi (800 m) of polar bears.
- To minimize impacts on marine mammals and subsistence-hunting activities, the drillship and support vessels traversing north through the Bering Strait will transit through the Chukchi Sea along a route that allows for the highest degree of safety regarding ice conditions and sea states.
- Marine Mammal Observers (MMOs) shall be posted on ships to ensure that support vessel activities do not disturb marine mammal resources or the subsistence hunt of those resources.
- The MMOs will be stationed on all drilling and support vessels to monitor the exclusion zone (areas within isopleths of certain sound levels for different species) for marine mammals.
- For vessels in transit, if a marine mammal is sighted from a vessel within its relative safety radius, the Shell vessel will reduce activity (e.g., reduce speed and/or change course) and sound energy level to ensure the animal is not exposed to sound above the safety level for that species. Full activity will not be resumed until all marine mammals are outside of the exclusion zone and there are no other marine mammals likely to enter the exclusion zone.
- When within 900 ft (274 m) of marine mammals, vessels will reduce speed, avoid separating members from a group, and avoid multiple course changes.
- Vessels will not operate within 0.5 mi (800 m) of walrus.
- Vessel speed to be reduced during inclement weather conditions to avoid collisions with marine mammals.
- When within 1,000 ft (300 m) of walrus in water, vessels will reduce speed and avoid multiple changes of direction.

Aircraft Traffic and Noise

- Shell will implement flight restrictions prohibiting aircraft from flying within 1,000 ft (330 m) (horizontal distance) of marine mammals or below 1,500 ft (457 m) altitude (except during takeoffs and landings or in emergency situations) while over land or sea.
- Aircraft shall not operate below 1,500 ft (457 m), unless the aircraft is engaged in marine mammal monitoring, approaching, landing or taking off, or unless engaged in providing assistance to a whaler or in poor weather (low ceilings) or any other emergency situations.
- Aircraft engaged in marine mammal monitoring shall not operate below 1,500 ft (457 m) in areas of active whaling; such areas to be identified through communications with the Com Centers. Aircraft will not operate within 1500 ft (457 m) of whale groups.
- Except for airplanes engaged in marine mammal monitoring, aircraft shall use a flight path that keeps the aircraft at least 5 mi (8 km) inland until the aircraft is directly south of its offshore destination, at which point it shall fly directly north to its destination.
- Helicopters primarily will fly direct routes (except to avoid severe weather), which will reduce the spatial area potentially disturbed. Planned routes also avoid areas of known polar bear dens.
- Aircraft and vessels will not operate within 0.5 mi (800 m) of walrus or polar bears when observed on land or ice. When polar bears are seen by aircraft, the aircraft will use alternative routes to avoid disturbing the bear.

- Regular overflight surveys and support vessel surveys for marine mammals will be conducted to monitor prospect areas.
- Mitigation to reduce bird disturbances will include flight path selection, flight altitudes, and flight timing to avoid those times that large concentrations of birds are present in the vicinity of the Deadhorse airport or the drillship.
- The helicopter flight path will be along the coastline at 1,500 ft (457 m) altitude approximately 5 mi (8 km) from the coastline to a point at which the helicopters will turn and fly generally perpendicular to the coastline, past Point Thompson, through the Mary Sachs Entrance, and on to the drill site, reducing disturbances to nearshore birds and by overflights of any barrier island.

Drilling Noise

- Anchored vessels, including the drilling vessel, will remain at anchor and continue ongoing operations if approached by a marine mammal. An approaching animal not exhibiting avoidance behavior is assumed to be curious and not harassed. The anchored vessel will remain in place and continue ongoing operations to avoid a flight or alarm response from the animal elicited by suddenly changing sound-energy conditions.

Bird-Ship Collisions

- Installing shading and directing light inward and downward to living and work structures to minimize light radiating from the drillship. Shell is planning to reduce or shade light output from:
  - Derrick lights, deck lighting, doorway and stairway lighting, and pipe rack lighting – lights will be shaded to direct light downward and inward and/or the wattage reduced.
  - Crane boom lights – lights will remain unshielded for safety during crane operations.
  - Heliport lighting – lights will be dimmed or shut off when not in use.
  - Escape pod lighting – lights will be dimmed when not in use.
  - Navigation and clearance lights – no changes will be made due to safety concerns.
  - Lights from windows – shades will be used during darkness.
- Where applicable, replacing some lights with “ClearSky” light technology to reduce the amount of red light output. ClearSky lighting emits fluorescent light with a unique light spectrum without the long-wavelength (red) components. This technology is produced by Philips Lighting. Studies indicate that removing the long wavelength components of the spectrum reduces the visual and orientation impact on birds (Marquenie, 2007).
- Conducting an assessment of the movements of bird flocks in the proximity of the drillship using the radar equipment available onboard the drillship. One aspect of the assessment will be to monitor and compare bird movements during periods of good and poor visibility. Radar will be used to perform bird-movement monitoring, because visual observations may not be possible during periods of poor visibility, such as at night or during foggy conditions.
- Shell has committed to a bird-strike monitoring program that record and report bird strikes and conditions under which they occur (e.g., vessel lighting configuration), providing the FWS with data for risk assessment of bird strikes related to operational activities, weather conditions, and response of eiders and other migratory birds to drillship lighting.

Operations

- Solid food wastes will be incinerated onboard the drillship, eliminating the wastes as a potential attractant for polar bears.

3.2.3 Effects Analysis for Biological Resources

Only species that may experience potential effects with a magnitude greater than negligible (see Section 3.2.1) are further analyzed in this document. The following analyses scrutinize the effects of impacts rated minor, moderate, or major. More in-depth analyses can be found in Beaufort Sea Multiple-Sale EIS (USDOI, MMS, 2003) the Arctic Multiple-Sale Draft EIS (USDOI, MMS, 2008). Additional information can also be found in the Sale 195 and Sale 202 EAs (USDOI, MMS, 2004, 2006a). We have determined that no unique or noteworthy resources or seafloor habitats occur in the vicinity of the proposed drill sites.

Aircraft Traffic and Noise

Richardson et al. (1995a) document reactions of ringed seals concealed in subnivean (below snow on ice) lairs varied with aircraft altitude and lateral distance (Kelly, Quakenbush, and Rose, 1986). The noise in a ringed seal den is reduced by snow (Cummings, Holliday, and Bonnet, 1983); however, radio-telemetry indicated some seals left the ice when a helicopter was at an altitude of 1,000 ft (<305 m) within a 1.25-mi (2-km) lateral distance. Counts of ringed seal calls in water suggests that seal abundance in one area subjected to low-flying aircraft and other disturbances was similar to that in less disturbed areas (Calvert and Stirling, 1985). The proposed activities would occur during the open-water season after seals have pupped and molted, fast ice has melted away, and flowing ice has retreated north and away from the project area. Shell has incorporate measures to reduce the likelihood of impacts to marine mammals including restricting aircraft to above 1,500 ft (457 m), unless the aircraft is engaged in marine mammal monitoring, approaching, landing or taking off; and conducting regular aerial and vessel surveys to monitor for marine mammals prospect areas (see EA Section 3.2.2). Therefore, we conclude aircraft traffic and noise would have a negligible level of effect on ice seals.

Although most polar bears attempt to remain offshore on the pack ice during the ice-free season, an increasing number are observed on the coast as loss of sea ice and availability of whale carcasses continue. As reported in USDOI, FWS (2009), repeated overflights by helicopters could disturb polar bears; however, behavioral reactions by non-denning polar bears are expected be brief with no long-term impacts on individuals and no impacts on the population. Shell has incorporate measures to reduce the likelihood of impacts to marine mammals including restricting aircraft to above 1,500 ft (457 m), unless the aircraft is engaged in marine mammal monitoring, approaching, landing or taking off; helicopter routes planned avoid areas of known polar bear dens; use of alternative routes when polar bears are seen by aircraft to avoid disturbing the bears, and specifying that aircraft will not operate within 0.5 mi (800 m) of polar bears when observed on land or ice (see EA Section 3.2.2). Therefore, we conclude aircraft traffic and noise would have a negligible level of effect on polar bears

Few Pacific walrus are known to use the project area or the central and eastern Beaufort Sea. While a few walrus might occur near the project area, they would likely be in the water, foraging on the seafloor, or swimming along the water surface. Shell has committed to maintaining a 1,500 ft altitude for aircraft flying in support of the proposed activities. Because of the 1,500 ft altitude, a lack of sea ice, and the low numbers of Pacific walrus expected in the project, a minor level of effect on Pacific walrus is expected form the proposed activities.

Vessel Traffic and Noise

A startle response of belugas was observed in a study by Fraker, Sergeant, and Hoek (1978), in which vessels moved through areas with a high concentration of whales. Reactions of beluga whales to vessels varies among individuals and the amount of avoidance exhibited by individuals would depend upon the amount of previous exposure to moving vessels and level of importance of the need for an individual to be in the same area of vessel traffic (Finley and Davis, 1984). In some studies, more intense reactions to large vessels were seen, but these observations were made in deep water (Finley et al., 1990; LGL and Greenridge, 1996). Such reactions are not expected in the relatively shallow waters of the project area (USDOI, MMS, 2003; Shell Offshore Inc., 2009b), because most belugas will be feeding in the deeper waters along the ice front and the continental shelf break, far to the north and away from the project area.

Bowhead whales react to the approach of vessels at greater distances than they react to most other activities. Most bowheads exhibit avoidance of vessel traffic, although reactions are less dramatic to slower moving vessels and vessels that are not approaching the animals directly (NMFS, 2008). According to Richardson and Malme (1993), most bowheads begin to swim rapidly away when vessels approach rapidly and directly. Avoidance usually begins when a rapidly approaching vessel is 1-4 km (0.62-2.5 mi) away. A few whales may react at distances from 5-7 km (3.1-4.3 mi), and a few whales may not react until the vessel is <1 km (<0.62 mi) away. Received noise levels as low as 84 dB re 1 µPa or 6 dB above ambient may elicit strong avoidance of an approaching vessel at a distance of 4 km (2.5 mi) (Richardson and Malme, 1993) (USDOI, MMS, 2008, incorporated by reference).

In the Canadian Beaufort Sea, bowheads observed in vessel-disturbance experiments began to orient away from an oncoming vessel at a range of 2-4 km (1.2-2.5 mi) and to move away at increased speeds when approached closer than 2 km (1.2 mi) (Richardson and Malme, 1993). Vessel disturbance during these experimental conditions temporarily disrupted activities and sometimes disrupted social groups, when groups of whales scattered as a vessel approached.

In their analysis of Shell's 2007-2009 EP, NMFS determined that bowhead whale reactions to icebreaking and non-icebreaking ice management are expected to be variable. Generally, bowheads are expected to avoid areas of active icebreaking and ice management by 1.2-15.5 mi (2-25 km) (USDOC, NOAA, NMFS, 2008).

Bogoslovskaya, Votrogov, and Sememova (1981) observed avoidance behaviors by gray whales when vessels came within 980 ft (300 m), but saw no reaction to vessels further away. In a study by Schulberg, Show, and Van Schoik (1989), many gray whales showed no deflection or change of behavior until vessels came within 98 ft (30 m). Underwater sound also may cause whales to avoid vessels moving within their immediate area, and gray whales are expected to exhibit avoidance of vessels in close proximity (USDOI, MMS, 2008, incorporated by reference).

Shell measures for protection of biological resources (EA Section 3.2.2), include specific measures to minimize adverse effects to cetacean from vessels related to the proposed action. Therefore, we conclude that vessel traffic and noise from the proposed action are expected to result in negligible effects on any cetaceans in the project area.

Polar bears may be stressed by energy expenditures related to avoiding or investigating vessels in the lead systems or traffic on ice. Encounters are much less likely to occur during the open-water season when the proposed activities would occur, because most polar bears remain in the active ice zone (USDOI, FWS, 2009). Shell has submitted and committed to the measures in their Polar Bear, Pacific Walrus, and Grizzly Avoidance and Human Encounter/Interaction Plan (Shell Offshore Inc., 2009a:Appendix F). In addition, Shell has incorporate measures to reduce the likelihood of impacts to polar bears (EA Section 3.2.2), include vessels will not operate within 0.5 mi (800 m) of polar bears and when within 900 ft (274 m) of marine mammals, vessels will reduce speed, avoid separating members from a group, and avoid multiple course changes. Therefore, impacts to polar bears from vessel traffic associated with the proposed drilling operations are expected to be minor.

Walrus may avoid moving vessels, with most reactions occurring within 0.29 mi (0.46 km) (Richardson et al., 1995a) or they may approach vessels out of curiosity. Shell has submitted and committed to the measures in their Polar Bear, Pacific Walrus, and Grizzly Avoidance and Human Encounter/Interaction Plan (Shell Offshore Inc., 2009a:Appendix F). Shell's measures for protection of biological resources (EA Section 3.2.2), including a 0.5 mi (800 m) exclusion zone around observed walrus for vessels in transit, are expected to reduce contacts with and minimize adverse effects to walrus. Because of the timing of the project, the low number of walrus expected to occur in the central Beaufort Sea, and Shell's commitment to avoid walrus, vessel traffic and noise from the proposed action are expected to result in negligible effects on Pacific walrus.

Richardson (1995a) found that vessel noise does not seem to strongly affect pinnipeds (seals, sea lions, fur seals, and walrus) that are already in the water. Richardson went on to explain that seals on haulouts sometimes respond strongly to the presence of vessels and at other times appear to show considerable tolerance of vessels, and (Brueggeman et al., 1992; as reported in Richardson, 1995a) observed ringed seals hauled out on ice pans displaying short-term escape reactions when a ship approached within ¼ - ½ mile. We expect the proposed mitigations (i.e. 800-m buffers, etc.) to lessen the impacts of vessel traffic on seals for the duration of the project to a negligible level of effect.

The impact of vessel traffic on marine mammals is expected to be transient and localized. A minor level of effects on belugas, bowhead, gray whales, and polar bears is expected from vessel traffic and noise associated with the proposed activities. Negligible effects are expected for ice seals and walrus, because the proposed activities would occur during the open-water season when any seals or walrus using the area should be loafing, foraging, or transiting through the area. Very few walrus are known to use the central Beaufort Sea.

Drilling Noise

Belugas are believed to have poor hearing of sounds below 1 Hz, the range of most drilling activities, but have shown some behavioral reactions to lower sounds. Brewer et al. (1993, as cited in Shell Offshore Inc., 2009b) observed belugas within 2.3 mi (3.7 km) of the drilling unit *Kulluk* during drilling. Belugas primarily use high-frequency sounds to communicate and locate prey; therefore, masking by low-frequency sounds associated with drilling activities is not expected to occur (Gales, 1982, as cited in Shell Offshore Inc., 2009b). If the distance between communicating whales does not exceed their distance from the drilling activity, the likelihood of potential impacts from masking would be low (Gales, 1982, as cited in Shell Offshore Inc., 2009b). At distances greater than 660-1,300 ft (200-400 m), recorded sounds from drilling activities did not affect behavior of beluga whales, even though the sound energy level and frequency were such that it could be heard several kilometers away (Richardson et al., 1995b). This exposure resulted in whales being deflected from the sound energy and changing behavior. These brief changes are expected to be temporary and are not expected to affect whale population (Richardson et al., 1991; Richard et al., 1998). Brewer et al. (1993, as cited in USDOI, MMS, 2008) observed belugas within 2.3 mi (3.7 km) of the drilling unit *Kulluk* during drilling. The more detailed discussion of this information provided in the USDOI, MMS (2008) Arctic Multiple-Sale Draft EIS is incorporated by reference. Some beluga whales may avoid the area in the vicinity of the drilling operations because of noise; however the effect is expected to be negligible.

Bowhead reaction to drillship-operation noise is variable. Individuals whose behavior appeared normal have been observed on several occasions within 10-20 km (6.2-12.4 mi) of drillships in the eastern Beaufort Sea, and there have been a number of reports of sightings within 0.2-5 km (0.12-3 mi) from drillships (Richardson et al., 1985a; Richardson and Malme, 1993). On several occasions, whales were well within the zone where drillship noise should be clearly detectable by them. In other cases, bowheads may avoid drillships and their support vessels at 20-30 km (see below and USDOI, MMS, 2003).

Richardson and Malme (1993) point out that the data suggest stationary, continuous noise sources, such as stationary drillships, elicit less dramatic reactions with bowheads than mobile noise sources. Most observations of bowheads tolerating noise from stationary operations are based on opportunistic sightings of whales near ongoing oil-industry operations, and it is not known whether more whales would have been present in the absence of those operations. Other cetaceans seem to habituate somewhat to continuous or repeated noise exposure when the noise is not associated with harmful events, implying that bowheads may habituate to certain, non-threatening noises.

The distance at which bowheads may react to drillships is difficult to gauge, because some bowheads would be expected to respond to noise from drilling units by changing their migration speed and swimming direction to avoid closely approaching these noise sources. For example, in the study by Koski and Johnson (1987), one whale appeared to adjust its course to maintain a distance of 23-27 km (14.3-16.8 mi) from the center of the drilling operation. Migrating whales apparently avoided the area within 10 km (6.2 mi) of the drillship, passing both to the north and to the south of the drillship. The study detected no bowheads within 9.5 km (5.9 mi) of the drillship, and few were observed within 15 km (9.3 mi). The study concluded that bowheads appeared to avoid the offshore drilling operation during their fall migration in 1986.

In another study, Richardson et al. (1995b) concluded:

> …migrating bowheads tolerated exposure to high levels of continuous drilling noise if it was necessary to continue their migration. Bowhead migration was not blocked by projected drilling sounds, and there was no evidence that bowheads avoided the projector by distances exceeding 1 kilometer (0.54 nautical miles). However, local movement patterns and various aspects of the behavior of these whales were affected by the noise exposure, sometimes at distances considerably exceeding the closest points of approach of bowheads to the operating projector.

The disparity in results from these two studies indicate that variable responses of bowhead whales to drilling activities have been noted since at least 1987.

Richardson et al. (1995b) reported that bowhead whale avoidance behavior has been observed in half of the animals when exposed to 115 dB re 1 μPa rms broadband drillship noises. However, reactions vary depending on the whale activity, noise characteristics, and the physical situation (Richardson and Greene, 1995). The study concluded that the demonstrated effects were localized and temporary and that playback effects of drilling noise on distribution, movements, and behavior were not biologically significant, leading the MMS to conclude that drilling activity should have a minor level of effects on bowhead whales. Moreover, offshore drilling operations have occurred in the Beaufort Sea over the past several decades. In this time, the Western Arctic Stock of bowhead whales has concurrently increased to a number (10,545) estimate that may approach the bowhead whale carrying capacity of the Beaufort and Chukchi seas (Allen and Angliss, 2009).

The effects of offshore drilling on ringed seals in the Beaufort Sea were investigated in the past (Frost and Lowry, 1988; Moulton et al., 2003). Frost and Lowry (1988) concluded that local ringed seal populations were less dense within a 2-nautical mile buffer of manmade islands and offshore wells that were being constructed in 1985-1987. Moulton et al. (2003) found less marked differences in ringed seal densities on the same locations to be higher in years 2000 and 2001 after a period of habituation. Conceptually, it appears that ringed seals may be somewhat disturbed by drilling operations for a period of time, until the activity has been completed. Adult ringed seals eventually seem to habituate to long-term effects of drilling, artificial island construction, and continuous operations that cumulatively created a much greater level of disturbance than what we expect from this project. This project will produce continuous sounds for about 74 days before the drilling convoy leaves the project area to “possibly” return after whaling has concluded. Because of the short duration of the proposed activities, nondescript site characteristics, and the observed effects of offshore drilling on seals, we do not anticipate measureable population level effects to occur. Consequently, a negligible level of effects is expected to result from drilling noise.

By withdrawing from the project area from August 25 until after completion of Nuiqsut’s and Kaktovik’s subsistence bowhead whaling, Shell would avoid potential impacts to a portion of the migrating Western Arctic bowhead whale population.

The effects of drilling noise from the proposed activities on bowhead whales is expected to be minor, possibly resulting in some temporary deviations in migratory path in the vicinity of drilling operations. Some beluga whales and seals may avoid drilling operations, but the impacts are expected to be very brief and negligible.

Icebreaking and Ice Management

While observing the response of beluga whales to icebreakers, Finley and Davis (1984) reported avoidance behavior when icebreaker vessels approached at distances of 22-31 mi (35-50 km). Belugas are thought to have poor hearing below 1 Hz, the range of most drilling activities, but have been seen showing some behavioral reactions to the sounds (USDOI, MMS, 2008, incorporated by reference).

Brewer et al. (1993) reported that in fall 1992, migrating bowhead whales avoided an icebreaker-accompanied drillship by 25+ km. The ship was icebreaking almost daily. Richardson et al. (1995a) noted that in 1987, bowheads also avoided another drillship with little icebreaking. Response distances may vary, depending on icebreaker activities and sound-propagation conditions. Based on models in earlier studies, Miles, Malme, and Richardson (1987) predicted that bowhead whales likely would respond to the sound of icebreakers at distances of 2-25 km (1.24-15.53 mi) from the icebreakers. That study predicts roughly half of the bowhead whales show avoidance response to an icebreaker underway in open water at a range of 2-12 km (1.25-7.46 mi) when the sound-to-noise ratio is 30 dB. The study also predicts that roughly half of the bowhead whales would show avoidance response to an icebreaker pushing ice at a range of 4.6-20 km (2.86-12.4 mi) when the sound-to-noise ratio is 30 dB.

Richardson et al. (1995b) concluded that exposure to a single playback of variable icebreaker sounds can cause statistically, but probably not biologically, significant effects on movements and behavior of migrating whales in the lead system during the spring migration east of Point Barrow. The study indicated the predicted response distances for bowheads around an actual icebreaker would be highly variable; however, for typical traveling bowheads, detectable effects on movements and behavior are predicted to extend commonly out to radii of 10-30 km (6.2-18.6 mi) and sometimes to 50+ km (31.1 mi). It should be noted that these predictions were based on reactions of whales to playbacks of icebreaker sounds in a lead system during the spring migration, and are subject to a number of qualifications that should not be the case in this proposal because the proposed action is for the ice-free season. However, infrasounds (sound at a range of frequencies below that of human hearing) that may be associated with icebreakers were not adequately represented in playback transmissions. Bowhead whales likely can hear or detect infrasounds (Richardson et al., 1995b).

Richardson et al. (1995b:322) summarized:

> The predicted typical radius of responsiveness around an icebreaker like the *Robert Lemeur* is quite variable, because propagation conditions and ambient noise vary with time and with location. In addition, icebreakers vary widely in engine power and thus noise output, with the *Robert Lemeur* being a relatively low-powered icebreaker. Furthermore, the reaction thresholds of individual whales vary by at least ±10 dB around the "typical" threshold, with commensurate variability in predicted reaction radius.

Richardson et al. (1995b:xxi) stated that:

> If bowheads react to an actual icebreaker at source to noise and RL values similar to those found during this study, they might commonly react at distances up to 10-50 km from the actual icebreaker, depending on many variables. Predicted reaction distances around an actual icebreaker far exceed those around an actual drillsite…because of (a) the high

source levels of icebreakers and (b) the better propagation of sound from an icebreaker operating in water depths 40+ m than from a bottom-founded platform in shallower water.

Although bowhead whales react to icebreaking and ice-management activities, the timing of this project during the open-water season, the low likelihood of the presence of large amounts of sea ice, and the short duration of this project lead the MMS to conclude that icebreaking and ice-management activities are expected to have a minor level of effect on the bowhead whale population in the Beaufort Sea. The response of gray whales to icebreaking and ice-management activities is expected to be similar to that of bowhead whales.

Polar bears are known to run from sources of noise and the sight of icebreakers. During the open-water season, most polar bears remain offshore on the pack ice and are not normally present in the project area. Any encounters between a polar bear and icebreakers associated with this project are expected to elicit transitory short-term behavioral reactions in polar bears (USDOI, FWS, 2009b). Polar bears may be temporarily drawn to or avoid icebreaker traffic with a minor level of effects.

Reeves (1998) noted that some ringed seals have been killed by icebreakers moving through fast-ice breeding areas, and that the passing icebreakers could have far-reaching effects on the stability of large areas of sea ice; however this project would occur during the open-water season after sea ice retreats well north of the project area and the fast ice has melted way. Moreover, the pupping and molting seasons for all ice seals end well in advance of the project timeframe. Few seals are expected to be in the area or exposed to the proposed activities. Consequently, a negligible level of effect should arise from icebreaking activities.

Walrus near moving icebreakers exhibited avoidance behavior in a monitoring project during drilling in the Chukchi Sea (Brueggeman et al., 1990). During icebreaking, walrus moved 12-16 mi (20-25 km) from the operations to areas where sound energy levels approached ambient levels (USDOI, MMS, 2008, incorporated by reference). Walrus did not show an avoidance reaction when vessels were anchored or drifting and did not appear affected by drilling sound. This was confirmed by the sightings of walrus near prospects during drilling operations (Shell Offshore Inc., 2009b).

Icebreakers, particularly those transiting through the Beaufort Sea, could have a minor effect on walrus herds hauled out on ice or in water. Ice-management may temporarily cause a few walrus foraging or resting in the Beaufort Sea to avoid the area of operations. However icebreakers temporarily alter habitat, which could benefit walrus by opening up new areas, or cause additional stress by fragmenting large ice floes where walrus haul out to rest. Moreover, this project is planned for the open-water season and extensive icebreaking and ice-management activity is not anticipated. Because of the timing of the project, the low number of Pacific walrus using the project area, and the short duration of the proposed action, we expect a negligible level of effect on Pacific walrus.

Impacts to beluga, bowhead, and gray whales from icebreaking and ice-management activities associated with the proposed action are not expected to exceed a minor level of effect. Impacts to ice seals, polar bears, and Pacific walrus from icebreaking activity associated with the proposed action are expected to be negligible.

Bird-Strikes (Collisions)

Marine birds risk collisions with vessels at night due to attraction and subsequent disorientation from high-intensity lights. Sea ducks are particularly vulnerable to collisions with vessels, primarily because they tend to fly quickly and low over the water. Johnson and Richardson (1982) documented that 88% of eiders migrating to molting areas along the Beaufort Sea coast flew below an estimated 10 m (32 ft), and over 50% flew below 5 m (16 ft). Eiders leaving the North Slope travel day or night. Movement rates (birds/hour) did not differ between night and day, but movement rates and velocities were higher on nights with good visibility (Day et al., 2004). A number of factors may reduce the height at which eiders migrate, including wind speed and direction, weather (i.e., fog or rain), and lighting (day vs. night) conditions (Day et al., 2005).

Day, Prichard, and Rose (2005) completed a 4-year study of bird migration and collision avoidance at Northstar Island. The authors used bird radar to assess the reaction of migrating eiders and other birds to collision-avoidance lights located on the production structure. The authors reported that the lights were not so strong that they disrupted eider migration, but the eiders did slow down and diverted their flight paths from the island.

Thirty common eiders, 6 king eiders, and 13 long-tailed ducks were killed due to collisions with Northstar and Endicott islands in the Alaskan Beaufort Sea during fall migrations in 2001-2004 (Day et al., 2005). This total was collected over a relatively narrow window (80 days total spread over 4 years) of the fall migration and, thus, probably underestimates total collision loss during fall migration. The greatest potential for collision impacts occurs where structures are in nearshore or coastal areas where birds, particularly eiders and long-tailed ducks, are known to migrate.

The risk of bird strikes by Steller's and spectacled eiders on the drillship and support vessels is very low and the impacts from such events are anticipated to be negligible because few, if any, threatened eiders are expected to be present in the project area during the drilling period. Using a generic strike rate of 0.4 spectacled strikes per well year (USDOI, MMS, 2003), we calculated that as many as 0.16 spectacled eiders (calculated as = 0.40 (spectacled eider strike rate) x 0.4 years (duration of exploration) x 1 (number of operating drillships) might be taken during Shell's planned single-year drilling season. The strike rate is an estimate based on eider populations and data collected from 1 year at a single location and previously used in the FWS BOs (USDOI, FWS, 2002 and 2009) and in the Beaufort Sea Multiple-Sale EIS (USDOI, MMS, 2003). We rounded the value of 0.16 spectacled eiders up to a whole number value of 1. The water depths in the project area range between 32 and 40 m, placing both locations outside of the spectacled and Steller's eider maximum diving/foraging depths of 30.5 and 9 m, respectively.

Moreover, the locations are too far offshore and in water depths too deep (>30 m) to interfere with the coastal flight paths of most eider species. While most king and common eiders nest in the Canadian Arctic Archipelago the sheer numbers of migrating birds passing by the project area could result in some collisions. The risk of collisions would be highest if the drillship and associated vessels are in the area of the 20-m isobath during fall migration; however, as stated previously, the proposed drill sites are in deeper waters (Shell Offshore Inc., 2009b), putting them outside of the water depths preferred as migration routes by king and common eiders. Also the fall migration of common eider females and their young to molting areas occurs between late August and Early September, a time when the drillship and associated support vessels plans to depart the area, greatly reducing potential collision risks to common eiders. A no jeopardy determination by the FWS (USDOI, FWS, 2009) was completed, indicating a negligible to minor level of effect on spectacled and Steller's eiders is expected to result from the proposed action.

Long-tailed ducks are prone to collisions with structures and vessels, and they frequently venture farther from shore. The diving capacity of long-tailed ducks would allow them to forage on the seafloor on both project locations so that vessels conducting exploratory drilling could pose a threat to long-tailed ducks, especially if the vessels were using high-intensity work lights while operating during darkness or inclement weather. Shell's preventative measures (Shell Offshore Inc., 2009a:Appendix G) are expected to mitigate the impacts to a negligible level.

3.2.4 Overall Conclusion on Effects to Biological Resources

With the mitigation included in the proposed activities, a low number of avian mortalities could occur, but those numbers would be insufficient to measurably affect any bird populations, even those ESA-listed species (USDOI, FWS, 2009). The water depths in the project area place the area outside of the spectacled and Steller's eider maximum diving/foraging depths. The water depths in the project area are within diving capacity of long-tailed ducks; thus, long-tailed may occur in the project area. Support vessels using high-intensity work lights while operating during darkness or inclement weather could pose a threat to long-tailed duck. Shell's lighting measures (Shell Offshore Inc., 2009a:Appendix G) are expected to mitigate the impacts to a negligible level. No population-level effects to marine or coastal birds are expected from the proposed activities.

Any polar bears, seals, or walrus in the proposed project area would be transiting open water and unlikely to remain in the area. We conclude that a few polar bears, Pacific walrus, ringed seals, and bearded seals may be negligibly affected by drilling. We expect Shell's Polar Bear, Pacific Walrus, and Grizzly Bear Avoidance and Human Encounter/Interaction Plan (Shell Offshore Inc., 2009a:Appendix F) to greatly lessen the impacts of vessel and ice-management traffic on any walrus and polar bears. No population-level effects to polar bears, seals, or walrus are expected from the proposed activities.

During July, August, and September, the project locations are expected to be mostly ice-free; thus the need for icebreaking or ice management should be infrequent once the vessels reach the project site. The presence of an icebreaker is a safety precaution in the event of an anomalous ice-related occurrence, and to assist the drillship in exiting the area if large amounts of ice pose a navigational hazard. We expect a few beluga, gray, and bowhead whales may experience short-term effects up to a moderate level of effect from ice-management activities and any necessary icebreaking activities. Individual beluga and bowhead whales are expected to avoid areas with sound levels greater than 100 dB during sound-generating activities, displaying a great deal of variation in their avoidance distances and the degree of their reactions. No population-level effects to beluga, gray, and bowhead whales are expected from the proposed activities.

We conclude that no population-level effects to bird, mammal, or fish species are anticipated as a result of the proposed exploration drilling or support activities such as icebreaking; waste, sediment and water discharges; aircraft traffic and noise; vessel noise and traffic; mooring and MLC construction; air pollution; or small liquid hydrocarbon spills. With the mitigations incorporated in the proposed activities, most species occurring in the vicinity of the Torpedo and Sivulliq prospects are expected to be affected negligibly or at most to a minor level. Moreover, the exploration activities and impacts expected as a result of this proposal do not present substantially different circumstances from those anticipated in the prior EIS to which this EA tiers. The impacts from exploration drilling activities, particularly those involving threatened and endangered species, have been fully analyzed in prior environmental documents (USDOI, MMS, 2003, 2006a; USDOI, FWS 2006b, 2009).

3.2.5 Additional Mitigation for Biological Resources

Recommended Additional Mitigation

- All vessels should maintain cruising speed not to exceed 9 knots while transiting the Beaufort Sea. This measure would reduce the risk of ship-whale collisions.

- The Marine Mammal Observers on vessels underway in the Beaufort Sea should monitor the ocean waters near the ship for surfacing whales. If a surfacing whale is observed within 300 ft (100 m) of the ship, the ship should disengage propellers to avoid potential propeller injury to the whale (prop strike) and, to a lesser degree, collision. Propellers should remain disengaged until the whale moves beyond 300 ft (100 m) from the ship. Safety of the vessel and its personnel shall take precedence over this measure.

Mitigation Considered and Not Recommended

- If the aerial monitoring detects 12 or more bowhead whales or 4 bowhead whale cow/calf pairs within an acoustically-verified 120-dB monitoring zone, Shell must reduce sound pressure levels in the drilling area. (As stated in EA Sections 2.3.11 and Shell EP Appendix J 4MP, Shell's proposed activities already incorporate aerial monitoring around the drillship.)

The MMS considered this mitigation measure, because NMFS required a similar measure in the 2007 IHA for Shell's 2007-2009 Beaufort Sea EP. The NMFS measure was intended to reduce potential impacts to bowhead whales to the lowest level practicable.

Disturbance or behavioral effects to marine mammals from underwater sound may occur after the exposure to sound at distances greater than the "safety" radii (Richardson et al., 1995a). The NMFS assumed that marine mammals exposed to underwater pulsed sound levels ≥160 dB rms have the potential to be disturbed behaviorally. Safety and disturbance zones for marine mammals around continuous sound sources, such as drilling operations, have not been well established by the NMFS.

In their EA for Shell's 2007-2009 Beaufort Sea EP (USDOC, NOAA, NMFS, 2007a), NMFS stated:

> Based upon the findings of two workshops (HESS, 1998; Gentry, 1999), NMFS provides guidance for the establishment of "safety radii" for marine mammals around acoustic sources. The safety radii are customarily defined by NMFS as the distances within which received pulse levels are ≥180 dB re 1 microPa (rms) for cetaceans and ≥190 dB re 1 microPa (rms) for pinnipeds. These safety criteria are based on an assumption that lower received levels will not injure these animals or impair their hearing abilities, but that higher received levels might have a potential for such effects.

The NMFS 2007 EA (USDOC, NOAA, NMFS, 2007) cites preliminary information from a 2006 Canadian seismic survey on the behavior of a tagged bowhead whale to support the requirement for a 120-dB mitigation zone. Later analysis of this information (Citta et al., undated poster presentation) clearly documented a single interaction with an active seismic vessel and concluded that the interaction only temporary disrupted the whale's behavior. Both MMS and NMFS concluded that the cited information is not applicable to exploration drilling activities.

There are almost two decades of history for exploration drilling in the Beaufort Sea. From 1981 to 2002, 30 wells were drilled in the Beaufort Sea. Seven of these wells were drilled in the Camden Bay area, with another five wells completed nearby. Two of these historic wells were on the Sivulliq prospect. The available scientific information shows that the Western Arctic Stock bowhead whale population has increased at an annual rate of 3.4-3.5% over the last few decades during which the 30 wells were drilled in the Beaufort Sea. It is well established that the population rate increase exhibited by the population is indicative of a healthy marine stock (Angliss and Allen, 2009).

The MMS concludes that the best available science does not indicate that the 120 dB mitigation requirement is warranted.

As summarized in Richardson (1995) and Richardson and Malme (1993):

> Bowheads seem most responsive when the sound level increases or when a noise source first starts up, e.g., when a boat is rapidly approaching, during a brief playback experiment, or when migrating whales are swimming toward a noise source. Although limited, the data suggest that stationary industrial activities producing continuous noise, e.g. stationary drillships and dredges, result in less dramatic reactions by bowheads than do moving sound sources, particularly ship…. Some other cetaceans seem to habituate partially to continuous or repeated noise exposure when the noise is not associated with pursuit, hunting or other harmful events (e.g., Jones and Swartz 1984, Watkins 1986, Atkins and Swartz 1989). This along with habituation phenomena in other animals (Thorpe 1963), suggests that bowheads will habituate to certain noises that they learn are non-threatening.

Richardson and Malme (1993) stated that "many comments in literature indicate baleen whales may react most strongly to changing, or increasing noise levels (Miles, Malme, and Richardson, 1987)." Changing or perhaps shutting down the noise output from a drillship may actually elicit a more profound response from passing bowheads than would a continuous level of noise. The additional level of protection to bowheads from this measure would be at best slight.

- Implement and monitor bubble curtain technology to greatly alleviate the propagation of noise in the water column, greatly lessening the impacts of drilling noise on cetaceans and pinnipeds.

The MMS does not believe that the low levels of potential effects of the drilling activities, as planned, would justify a need for such mitigation.

Additional Background: The sound-reduction potential of a bubble train curtain is supported by some research and bubble curtains may have promise in relation to attenuation of seismic airgun sound propagation. A recent paper (Ayers, Jones, and Hannay, 2009) estimated transmission loss of airgun array sounds by about 21 dB for plane sound waves incident perpendicular to a bubble curtain. Since airguns are not part of the proposed activities, the degree of effectiveness such mitigation would bring to the proposed activities is unknown. Introducing such mitigation for this project could potentially impart noise variability and effects that would otherwise not occur.

3.3 Alternative 1: Subsistence Activities, Employment, and Community Health

Subsistence activities are a central element in the NSB socioeconomic system. The socioeconomic composition of the NSB is a blend of traditional subsistence activities; State, Federal and Native corporation services and jurisdictions with unique benefits and pressures that are a part of life in the Arctic. The following sections of the EA addresses specific components of these socioeconomic resources that are most relevant to the communities of Kaktovik and Nuiqsut: subsistence, employment, and community health. Kaktovik is a coastal community 60 mi (96.5 km) from the project area. Nuiqsut is 118 mi (201 km) west of the project area and about 20 mi (32 km) inland from the coast along the Colville River. Cross Island, from which Nuiqsut hunters base their bowhead whaling activities, is 47 mi (75 km) southwest of the project area. Concerns regarding short- or long-term effects the proposed project may have on the biological species upon which the local residents depend for subsistence will be found in the appropriate sections describing the biology, water quality, or air quality of this Environmental Assessment. For example, concerns about bowhead whale deflection, effects on coastal fish habitats, sensitivity of beluga whale to noise, effects of air emissions on human health and the like are beyond the scope of the subsistence analysis and are addressed in the appropriate sections in this EA.

3.3.1 Levels of Effects and Existing Environment for Subsistence Activities

Subsistence activities are assigned the highest cultural values by the Iñupiaq Eskimo of the North Slope and provide a sense of identity in addition to being an important economic pursuit. Subsistence is viewed by Alaskan Natives not just as an activity that is imbedded in the culture; it is viewed as the very culture itself (Wheeler and Thornton, 2005). The bowhead whale is a subsistence resource of paramount importance, and, consequently, descriptions of the social organization pertaining to the crew, the hunt, quantity, and distribution of the whale dominate subsistence discourse about the North Slope Iñupiaq Eskimo communities.

Bowhead whaling traditions underscore the central values and activities for the Iñupiat of the North Slope. Bowhead whale hunting strengthens family and community ties and the sense of a common Iñupiat heritage, culture, and way of life, and provides a strength, purpose, and unity in the face of rapid change (USDOI, MMS, 2008; EDAW/AECOM, 2007). Although bowhead whaling traditions are unquestionably significant, harvest of other wild resources, including caribou, fish, avian species, and other marine mammals also are important to the local inhabitants to provide a variety in the diet and nutrition or to provide nutritional needs if few or no bowhead whales are taken.

Shell would suspend all activity and withdraw from the prospects during the Nuiqsut and Kaktovik bowhead whale hunt, out of consideration of the importance of the resource to the Iñupiat of Kaktovik and Nuiqsut. Shell would suspend all activity by August 25 and withdraw north to lat. 71^{o} (Figure 1-1) in the Beaufort Sea and would only resume after Kaktovik and Nuiqsut have completed fall bowhead whaling. Shell may continue until October 31. Alternatively, Shell may leave the Beaufort Sea altogether by August 25.

The discussion below is limited to subsistence harvest of resources taken in the summer from July 10-August 25 and autumn in September and October when Shell may be actively working the Camden Bay prospects.

Shell's proposed Camden Bay activities at the Sivulliq and Torpedo prospects present the potential to affect subsistence users at two Iñupiat communities: Nuiqsut, which lies 118 mi southwest of the leases, and Kaktovik, which lies 60 mi southeast of the leases. Barrow lies 298 mi west of the proposed project area. Cross Island, from which Nuiqsut whalers launch their bowhead whale hunt, is 47 mi (75 km) southwest of the proposed project.

Shell proposes to drill two wells, one at the Torpedo prospect and one at the Sivulliq prospect. Shell proposes to mobilize by July 10, 2010, when sea ice is generally not as extensive as in the spring, reducing the likelihood of requiring the use of the icebreaker and after most bowhead whales have migrated eastward to feed. Regular crew rotation and ancillary support would be provided by helicopters flown from Deadhorse.

Shell's helicopters would fly a prescribed route previously agreed to with local residents of Nuiqsut and Kaktovik during MMS' 2007 Government-to-Government meetings to lessen effects on subsistence activities. This route crosses the coast over State lands about 10 mi west of the mouth of the Canning River, just off the west tip of Flaxman Island (Figure 2-2). Helicopters would be required to fly at an altitude of between 1,500 and 1,000 ft, weather permitting, to reduce or eliminate effects to land and sea mammals and the people who hunt them for subsistence purposes.

An ice-management vessel would be present to be used, if necessary, when the drill rig travels to the proposed drill sites. The drilling would occur for a relatively short duration (about 6 weeks). When drilling is suspended on August 25, the borehole would be plugged and abandoned per MMS requirements. All vessels, including the drillship, would withdraw from the area until whaling crews from both Nuiqsut, at Cross Island, and Kaktovik have completed fall bowhead whaling. There would be no overflights or industrial marine traffic during the bowhead whale hunt, and no subsidiary effects that might affect subsistence harvest, such as wastewater discharge in the migratory bowhead route during this time. Work may resume after completion of the Cross Island and Kaktovik bowhead whale hunts for up to another 6 weeks, or until October 31, 2010, depending on ice and weather.

Levels of Effects for Subsistence

In evaluating the potential adverse effects from OCS activities, MMS examines both the magnitude and duration of disruption. For the site-specific analysis in this EA, we used the following four categories of impact levels ranging from negligible to high:

Negligible:
> Periodic, short-term effects that have no consequent effects to subsistence resources or harvests as the lowest level of effect.

Minor:
> One or more subsistence resources would be affected for up to 1 year (1 harvest season), but none of these resources would become unavailable, undesirable for use, or experience population reductions.

Moderate:
> Although one of more subsistence resources would be unavailable, undesirable for use, or experience population reductions for a period up to 1 year (1 harvest season), with subsistence harvests being affected for that period, the affected subsistence resources and harvests would be expected to recover completely if proper mitigation is applied or proper remedial action is taken once mitigation is implemented.

High:
> The affected subsistence resources and harvests would not be expected to fully recover, even if proper mitigation is applied during the life of the proposed action, or even if proper remedial action is taken once the impacting agent is eliminated.

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

Nuiqsut

This discussion focuses on the subsistence activities, related subsistence resources, and subsistence distribution levels that generally occur during the period of Shell's proposed operation in the Beaufort Sea, from mid-July through October 31, with a self-imposed withdrawal from the area and suspension of activity from August 25 until Nuiqsut and Kaktovik have completed bowhead whaling.

Summer Months (July-August): During summer, the people of Nuiqsut harvest whitefish, primarily along channels of the Colville River. They also harvest Arctic char, dog salmon, pink salmon, and the spotted seals that follow the fish upriver. Waterfowl are hunted, as are summer caribou (Galginaitis et al., 1984). Residents stated that the best caribou hunting took place in summer, and coastal areas are the most productive for caribou hunting. People prefer the use of boats to access caribou, because the capacity of a boat is sufficient for hauling the meat back to the village. Although seal is not a preferred meat for human consumption, people use the oil as a condiment. Seals are hunted in nearshore waters during this time. There was general agreement that the best place to harvest them is off the Colville delta (Impact Assessment Inc., 1990a). These activities occur more than 100 mi from the drill sites.

Late Summer through early Autumn (August 25-end of September): Bowhead whaling takes precedence over any other subsistence activity, and occurs only in the fall. The 2008 Cross Island bowhead whale hunting season started earlier than any other, with the first crew arriving on August 29, and lasted for 14 days, including days set aside for traveling, butchering, weather days, and scouting days. The captains agreed to stop whaling on September 9, because the four landed whales were considered enough. Whale strikes occurred at an average distance of 10.5 km (6.5 mi) from Cross Island. The shorter 2008 season compares with the 21-day season in 2006 and the 27-day season in 2005. Over the past 7 years of reported monitoring (2001-2008), the majority of the bowhead whales have been harvested in the northeast quadrant off Cross Island (Impact Assessment Inc., 2009a).

In recent years, the Cross Island whalers focus exclusively on taking bowhead whales. They do not hunt for belugas, and crew members must ask for permission from the whaling captain to kill a polar bear that might be in the vicinity of the harvested whale carcasses because it would entail hours away from the bowhead whale hunt (Impact Assessment Inc., 2009a). Although, because of to scheduling and logistical conflicts, it is not currently expedient for Nuiqsut hunters to hunt beluga and polar bear at Cross Island, it does not mean that the people have abandoned these subsistence resources, and they may resume using them in the future (Sverre Pedersen, 2009, pers. commun.).

Late Autumn-Early Winter (end of bowhead whale hunt through October 31): When people again mobilize after the bowhead whale hunt, they direct their subsistence efforts inland to hunt caribou, moose, and avian species, and to fish. By this time, the caribou have migrated away from the coast, and the whitefish runs are strong. In a typical year, Nuiqsut residents expend their greatest effort fishing under the ice of the river channels to catch cisco and small whitefish (Impact Assessment Inc., 1990a).

Kaktovik

Summer Months (July-August): During summer, the people of Kaktovik engage in community-based subsistence fishery. Most households gillnet at beach sites on Barter Island near Kaktovik, where the primary fish harvested is sea run Dolly Varden, or char. In fact, "Kaktovik" means "place where people fish on the beach" (Leffingwell, 1919). Some Kaktovik households also fish to the east, where the primary fish harvested is Arctic cisco. Some households have fished westward in the Canning River, but the main level of effort is on Barter Island. In 2002, one of two years actively censused, 79% of the households fish in summer (Pedersen and Linn, 2005).

Caribou also are a significant resource taken during the summer months. A peak harvest time is in July, when hunters selectively hunt fat bulls along the coast. Over a 4-year period, researchers determined that the summer hunt represented about 40% of caribou taken on an annual basis. During the years of systematic harvest documentation, caribou were taken as far west as the Canning River. Traditional caribou hunting grounds were delineated on maps by Kaktovik residents for researchers. Close to one-third of the depicted area lay west of the Canning River (Pedersen and Coffing, 1984; Coffing and Pedersen, 1985). Additional resources harvested in the summer include waterfowl and seal (Impact Assessment Inc., 1990b).

Late Summer through early Autumn (August 25-end of September): As at Nuiqsut, the bowhead whaling effort takes precedence over any other subsistence activity, and occurs only in the fall. Although the Nuiqsut Cross Island bowhead whale hunt is well documented as part of monitoring and mitigation efforts stemming from petroleum development, less is known about the Kaktovik bowhead whale hunt.

Whaling crews use Kaktovik as their home base, leaving the village and returning on a daily basis. The core whaling area is within 12 mi of the village with a periphery ranging about 8 mi farther, if necessary. This core whaling area is about 48 mi from drill sites. The extreme limits of the Kaktovik whaling limit would be the middle of Camden Bay to the west. The timing of the Kaktovik bowhead whale hunt roughly parallels the Cross Island whale hunt (Impact Assessment Inc, 1990b; SRB&A, 2009:Map 64). The Shell EIA (Shell Offshore Inc., 2009b) describes hunting of beluga whales from Kaktovik. As best as can be ascertained, about one beluga is harvested annually in conjunction with the bowhead whale hunt, but most households obtain beluga through exchanges with other communities.

Late Autumn-Early Winter (End of Bowhead Whale hunt through October 31): As at Nuiqsut, when people again mobilize after the bowhead whale hunt, they direct their subsistence efforts inland to hunt caribou, moose, Dall sheep, and avian species, and to fish. In the fall/winter, the people fish inland under river ice using nets, mainly catching Dolly Varden, Arctic cisco, and some lake trout (Impact Assessment Inc, 1990b; Pedersen and Lind, 2005; Pedersen and Coffing, 1984).

Barrow

The Iñupiat of Barrow harvest bowhead whale in the fall of each year. Their hunt is localized around Point Barrow, and tends to run later than the Cross Island whale hunt season, occasionally lasting into October (Burwell and Newbury, no date).

3.3.2 Proposed Action Mitigation Measures for Subsistence Activities

Shell incorporated extensive mitigation in their proposed activities to lessen or alleviate the impacts associated with exploratory drilling on subsistence activities. The most important of these is the complete suspension of activity and withdrawal from the project area several days prior to the traditional start of the bowhead whale hunt. Work would not resume on-site until after Kaktovik and Nuiqsut captains terminate the hunt. Another important mitigation measure is committing to a flight pattern crossing overland in an area that receives the least amount of use by Nuiqsut and Kaktovik subsistence users during the summer months, and stating that helicopters would fly at an altitude of between 1,500 and 1,000 feet, weather permitting. These measures are summarized in Sections 2.3.10 and 2.3.11 of this EA. Shell describes their proposed migration measures in EP (Shell Offshore Inc., 2009a:Appendix B (Plan of Cooperation), Appendix E (IHA application to NMFS), Appendix F (LOA application to FWS, and Appendix J (Marine Mammal Monitoring and Mitigation Plan)). Shell's mitigation measures related to discharges, emissions, and spills are summarized in EA Section 2.3.4, EA Section 2.3.11, and Shell's ODPCP (Shell Offshore Inc., 2009c).

3.3.3 Effects Analysis for Subsistence Activities

The areas of subsistence use by the communities of Nuiqsut or Kaktovik are discussed in EA Section 3.3.1 above. No documented subsistence activities have occurred at the proposed offshore drill sites (S.R. Braund and Assocs., 2009). The proposed overland helicopter route crosses an area that is recognized as being subsistence territory occasionally used by the Iñupiat of Kaktovik and Nuiqsut. Past use has been prolonged and consistent, as evidenced by the numerous house sites, camps, and other cultural features that dot the landscape (Impact Assessment Inc., 1990a and 1990b; Pedersen and Coffing, 1984).

An important consideration in assessing potential effects on subsistence activities is that most of Shell's activities would occur in the summer from mid-July until late August. This is the time during which the Iñupiat from Kaktovik and Nuiqsut fish. Most Kaktovik residents fish the beaches at or east of the village; in the past, some have fished the Canning River. The people of Nuiqsut fish the Colville River.

Summer fishing would not be affected by drilling and associated vessel or helicopter traffic. Drilling would occur out of range of fishers, about 20 mi offshore, and helicopter traffic would transect a prescribed route about 10 mi west of the Canning River. The proposed exploration would have either no effect or a negligible effect on the summer fishery as long as Shell adheres to the plan for overland flights, deployment from Deadhorse, and drilling about 20 mi offshore and works from 6-12-weeks. Short- and long-term effects on Nuiqsut and Kaktovik fisheries are considered to be non-existent to negligible.

Hunting caribou or seals during summer would be unaffected by drilling or associated vessel traffic. Helicopter traffic would pass overland on a prescribed route about 10 mi west of the mouth of the Canning River at an altitude of between 1,000 and 1,500 ft. This would have a negligible effect on hunting bull caribou or seals. The only possible effect would be if a hunter takes aim at a caribou or seal immediately below the prescribed helicopter route, and a flight passed overhead below 1,000 ft in altitude due to weather. In that case, the prey might become skittish and flee. The chance of this occurring is remote, because the area under consideration for the helicopter route was established by industry through discussions as it receives little use by Kaktovik or Nuiqsut subsistence harvesters. Current hunting localities based on (a) the distance from either community and the high cost of fuel; and (b) the proximity of on-shore petroleum development (Impact Assessment Inc., 1990a and 1990b; Pedersen and Coffing, 1984). Thus, the helicopter flight, deployment from Deadhorse, and drilling about 20 mi offshore also would have a negligible effect on subsistence users from Kaktovik and Nuiqsut. Short- and long-term effects on Nuiqsut and Kaktovik subsistence hunting of caribou or seals are considered to be non-existent to negligible since the proposed project is estimated to last from 6-12-weeks.

All air and vessel traffic and drilling associated with the proposed exploration would be suspended for the duration of the Nuiqsut and Kaktovik bowhead whale hunt from August 25 until both communities reach their quotas and/or stop the hunt. There would be no auditory disturbance, refueling, or wastewater discharge at Sivulliq or Torpedo, no effect on the whale hunt harvest, or any other subsistence activity that would occur during this period. Short- and long-term effects on hunting for bowhead whales, beluga whales, or other any other subsistence resources are considered to be non-existent as long as Shell withdraws north or west of the migratory path of bowhead whales during the Nuiqsut and Kaktovik whale hunts.

Bowhead whaling at Barrow (about 300 mi west of the proposed drill sites) may continue into October. It is unlikely any disturbance or deflection of bowhead whales by the proposed activities would affect whales as they migrated past Barrow. Short- and long-term effects on the Barrow subsistence hunt is expected to be non-existent to negligible because of the distance of the project area from Barrow.

After the Nuiqsut and Kaktovik bowhead whale hunts, subsistence activities at both communities move inland away from the coast. During this time, people net fish under the river ice; shoot migratory waterfowl on the wing; hunt for moose, caribou, and mountain sheep (the latter by Kaktovik hunters); and trap furbearers. Kaktovik hunters and furbearer trappers use the foothills of the Brooks Range (Impact Assessment Inc., 1990b; Pedersen and Coffing, 1984). Short- and long-term effects on late fall to early winter subsistence activities are considered to be negligible to minor, as long as Shell alters the flight path from the interior to closer to the coast and maintains an altitude of 1,000-1,500 ft, deploys from Deadhorse, and drills only the 2 prospects about 20 mi offshore, ceasing operations by October 31, 2010.

No large (≥1,000 bbl) or very large (≥150,000 bbls) crude oil spills are estimated to occur from the proposed activities (see EA Section 2.3.8 and Appendix A). The oil-spill analysis has determined that there is a low chance for an accidental small oil spill that likely would be operational in nature. For the purpose of this analysis, a 48-bbl fuel transfer spill was chosen. A 48-bbl diesel spill would evaporate and disperse in less than 3 days. As required by Lease Stipulation 6, oil-spill containment booms would be deployed during any refueling activity, and would contain a small oil spill if one should occur.

The perception that oil-spill contamination of subsistence foods, particularly marine mammals or fish, might be of concern to the Iñupiat at Nuiqsut and Kaktovik in terms of potential effects on health. Because subsistence activities do not occur in the vicinity proposed drilling and any associated spill source and because no fuel transfer is expected during transit between the Beaufort and Chukchi seas, the short- and long-term effects of the analyzed small spill on subsistence activities are expected to be negligible to minor.

If Shell relocates to the Chukchi, they would do so either at the end of August before the bowhead whale hunt or between mid- to late September after the bowhead whale hunt. This would result in an immediate cessation of helicopter flights from Deadhorse. As can be seen from reviewing the above analysis, helicopter flights have a greater potential to have adverse effects on subsistence hunting than drilling operations at the proposed drill sites. Vessel noises would not be discernable from shore or nearshore waters, where subsistence hunting for seals occurs. Therefore, relocating the operation from the Beaufort Sea to the Chukchi Sea would have a nonexistent to negligible effect on short- and long-term subsistence hunting at Nuiqsut and Kaktovik.

3.3.4 Overall Conclusion on Effects to Subsistence Resources

With the mitigation incorporated by Shell, effects on subsistence undertaken by Nuiqsut and Kaktovik residents are expected to be negligible. Mitigation measures include:

- Complete removal from the drill site from August 25 until after Nuiqsut and Kaktovik whaling captains have completed their 2010 bowhead whale hunts; coordination and consultation with a single point of contact, the Subsistence Advisor hired in each community.
- Adherence to communication protocols; use of marine mammal observers on-board vessels; crew rotation and air freight handled out of Deadhorse;
- Helicopter flights from Deadhorse to the proposed drill sites at an altitude of 1,000-1,500 ft in altitude except landing, take-off, and during poor weather.
- Helicopter flights running eastward inland away from the coast until suspending work August 25.
- Helicopter flights running eastward north, closer to the coast if resuming work after the bowhead whale hunt.
- Helicopter flight path following a prescribed route crossing the coast about 10 mi west of the mouth of the Canning River.
- Deploying booms each time refueling occurs to contain any small fuel spill.

Mitigation measures may not alleviate the perception that a small oil spill or regulated wastewater discharge might contaminate subsistence resources, particularly marine mammals or fish that could concern the Iñupiat of Nuiqsut and Kaktovik in terms of potential effects on health (EA Section 3.7, below). However, this analysis demonstrates that due to the short duration of the proposed activity, which would last from 6-12 weeks, the proposed project poses no more than a negligible effect to subsistence activities, as long as the above mitigation measures are followed. Moreover, the exploration activities and impacts expected as a result of this proposal do not present substantially different circumstances from those anticipated in the prior EIS to which this EA tiers. The impacts from exploration drilling to subsistence activities have been fully analyzed in prior environmental documents (USDOI, MMS, 2003, 2006a).

3.3.5 Additional Mitigation for Subsistence Resources

Recommended Additional Mitigation

- If Shell resumes exploration drilling in the Beaufort Sea after the bowhead whale hunt, Shell must meet with the communities of Kaktovik and Nuiqsut to ascertain if it would be preferable to relocate the helicopter route closer to the coast or offshore to avoid localities where subsistence harvest is taking place. Before August 25, the helicopter route is directed inland on the eastward leg to avoid effects on subsistence. After the fall bowhead whale hunt, the subsistence activities of the Iñupiat of Nuiqsut and Kaktovik move from the coast to the interior, with both groups using the foothills south of Deadhorse. Relocating the helicopter route away from seasonally used subsistence activity areas could reduce impacts to subsistence harvesters and effects on inland subsistence activities in the remote likelihood that bad weather required flights to travel at a lower altitude.

3.3.6 Employment

This analysis focuses on the sociocultural effects of local employment associated with the proposed activities on Nuiqsut, Kaktovik and, to a lesser extent, Barrow.

Even with the potential employment associated with the proposed activities, it appears that employment opportunities for local residents, especially Alaskan Natives, would remain comparatively low in oil-industry-related jobs on the North Slope.

Changes in local employment may affect community sociocultural systems. The levels of effects for impacts to sociocultural systems are defined below.

Negligible:
: Periodic, short-term effects with no measurable effects on normal or routine community functions, the lowest level of effect.

Minor:
: Sociocultural systems being affected for a period up to 1 year, but effects would not disrupt routine community functions and could be avoided with proper mitigation.

Moderate:
: Effects on sociocultural systems would be unavoidable for a period longer than 1 year. Affected normal or routine community functions would have to adjust somewhat to account for impact disruptions, but they would be expected to recover completely if proper mitigation is applied during the life of the proposed action or proper remedial action is taken once the impacting agent is eliminated.

Major:
: Effects on sociocultural systems would be unavoidable, and normal or routine community functions would experience disruptions to a degree beyond what is normally acceptable. Once the impacting agent is eliminated, affected community functions may retain measurable effects, even if proper remedial action is taken.

Shell's proposed exploration drilling would offer employment to a small number of local NSB residents. The MMO program would employ local Inupiat residents to monitor and document marine mammals in the project area. The Subsistence Advisor program would recruit a local resident from each village to communicate local concerns and subsistence issues from residents to Shell. Shell's Com Center program would involve hiring one or two individuals from each of the Beaufort and Chukchi Sea villages. Although the number of local residents employed for the proposed activities is expected to be small and the effect to be negligible at the community level, qualitatively the loss of employment due to delay or deferral of exploration during the 2010 season would be significant to individual at risk of losing his or her job.

Goods and services would be obtained from local village contractors, when available, during the duration of the project. The proposed activities are short term and temporary, and so are expected to have a negligible effect on economy of Kaktovik, Nuiqsut, and Barrow.

3.3.6 Community Health

The health and welfare of the residents of the NSB is a primary concern in any activity, and Shell's commitment to the review and analysis of project activities affirms this is a priority. The project activities are offshore, of limited duration, and would be performed according to all applicable statutes and regulations from a number of Federal, State, and local jurisdictions and agencies. This project would have no adverse impact on the health of NSB residents, and specifically the communities of Kaktovik and Nuiqsut.

The following analysis addresses the factors most likely to affect community health.

All activities associated with the EP would be staged from existing infrastructure located in Deadhorse, Prudhoe Bay, and West Dock areas. Goods and services would be obtained from local village contractors, when available, during the duration of the project. These business interactions are not expected to adversely affect community health. Please refer to EA Section 3.3.6 on local hire for additional discussion.

The air quality for the Beaufort Sea Planning Area is considered to be relatively pristine with concentrations of regulated air pollutants well within the National Ambient Air Quality Standards (NAAQS) and State of Alaska ambient air quality standards (18 AAC 50). The EPA air permit requirements are intended to ensure that Shell's emission levels remain low enough to prevent harm to human health and the environment at all operating scenarios, including the worst-case highest hourly, enforceable emission rate from the *Discoverer* and its support vessels. By demonstrating compliance with the applicable NAAQS, AAAQS, and PSD increment standards at the edge of the *Discoverer*, in the immediate vicinity of its support vessels, and at the Beaufort Sea shoreline, the air quality impact analysis prepared for Shell's EPA permit application shows that Shell would not have a significant adverse impact at the nearest villages along the Beaufort Sea coast, Nuiqsut and Kaktovik. Please refer to EA Section 3.4 on air quality for additional discussion.

Emissions from the proposed Shell exploration activities are not expected to significantly deteriorate the existing good air quality of the Beaufort Sea and adjacent coastal areas of the North Slope. Air quality impacts from the proposed activities are expected to be negligible to minor and short term. Therefore, emissions from the proposed activities are not expected to have any effect on the health of the nearest coastal villages.

Existing water quality of the OCS is good due to the remoteness, active ecological system, and the limited presence of human (anthropogenic) inputs. Existing contaminants occur at very low levels in arctic waters and sediments and do not pose an ecological risk to marine organisms in the OCS (USDOI, MMS, 2008). Anthropogenic water discharges potentially can effect changes in local marine water quality, such as impeding or changing existing natural properties and processes, increasing sedimentation, higher water temperature, lower dissolved oxygen, degradation of aquatic habitat structure, and loss of fish and other aquatic populations. Please refer to Section 3.5 on water quality for additional discussion.

The impact of NPDES-permitted discharges associated with Shell's project is expected to be negligible and temporary. Main discharges include sanitary and domestic wastes. Minor discharges include non-contact cooling water, ballast water, desalination wastes, and deck drainage. Increases in turbidity and biological and chemical oxygen demand are expected near the discharge site, but the effects are expected to be temporary and minor, and have no effect on marine mammals and fishes or associated subsistence harvests. These effects would be limited to within 330 ft (100 m) of the discharge location. Therefore, discharges from the proposed activities are not expected to have any effect on the health of the nearest coastal villages.

3.4 Alternative 1: Air Quality

The air quality for the Beaufort Sea Planning Area is considered to be relatively pristine with concentrations of regulated air pollutants well within the National Ambient Air Quality Standards (NAAQS) and State of Alaska ambient air quality standards (18 AAC 50). Because concentrations of criteria pollutants are far less than Federal and State standards, the North Slope and adjacent offshore area are classified as an attainment area under the Clean Air Act.

Air quality at the proposed drill sites is within the NAQQS and State of Alaska ambient air quality standards (AAAQS). The applicable NAAQS and Prevention of Significant Deterioration (PSD) increment standards are presented in EIA Table 4.2.2-1 (Shell Offshore Inc., 2009b). The EPA requires Shell to demonstrate compliance with these standards near the single drillship and not at the shoreline.

The primary sources of the emissions by the *Discoverer* drillship and support vessels would be combustion engines including the vessel engines, generators, compressors, draw works, and pumps. Emissions generated from the proposed exploration activities would include nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), small-diameter particulate matter such as PM_{10} and $PM_{2.5}$, and lead (Pb). The project would also generate lesser quantities of volatile organic compounds (VOCs), hazardous air pollutants (HAPs), ammonia, and CO_2.

Most of the emissions would be generated from the combustion of diesel fuel for power production from the movement of the ice-management and OSR vessels. Ice-management vessel activity would account for more than 90% of support vessels' emissions; thus, total emissions would be lower in favorable ice conditions.

Shell's ambient air quality impact analysis is based on the worst-case, short-term, enforceable emissions rate for NO_x, SO_2, PM_{10}, and $PM_{2.5}$. The analysis has been conducted over the highest hourly emission rate for all the project emission units from the *Discoverer* and its support vessels. Shell's analysis used a conservative meteorological screening data set, background ambient concentration data, and a conservative screening dispersion model, each of which received the informal approval of EPA modeling staff. Shell's analysis also included the contribution of emissions from nearby sources. By demonstrating compliance with the applicable NAAQS, AAAQS, and PSD increment standards at the edge of the *Discoverer*, in the immediate vicinity of its support vessels, and at the Beaufort Sea shoreline, the preliminary air quality impact analysis prepared for Shell's EPA permit application shows that Shell would not have a significant adverse impact at the nearest villages along the Beaufort Sea coast, Nuiqsut and Kaktovik.

The EPA air permit requirements are intended to ensure that Shell's emission levels remain low enough to prevent harm to human health and the environment at all operating scenarios, including the worst-case highest hourly, enforceable emission rate from the *Discoverer* and its support vessels. Emissions from the proposed Shell exploration activities are not expected to significantly deteriorate the existing good air quality of the Beaufort Sea and adjacent coastal areas of the North Slope. Air quality impacts from the proposed activities are expected to be negligible to minor and short term.

Although EPA has not established regulations for greenhouse gases/carbon dioxide (GHG/CO_2) emissions control, EPA recently proposed a regulation for large sources of >25,000 tons CO_2 equivalent per year to report annual GHG emissions beginning in the 2010 reporting year (EPA, 2009). The proposed exploration activities may exceed the 25,000-ton CO_2-equivalent reporting threshold, depending on the required level of ice-management activity to keep the *Discoverer* and its crew safe from hazardous sea-ice conditions. Shell's preliminary CO_2 emissions inventory indicates the *Discoverer* CO_2 emissions would be less than the 25,000 tons per year threshold with the combined *Discoverer* and support vessels CO_2 emissions approaching almost 60,000 tons per year. The projected CO_2 emissions for *Discoverer* and its support vessels combined would account for approximately 0.1% of the Alaska 2005 total statewide estimated GHG of 53 million tons and 0.4% of the Alaska 2005 Statewide oil and gas industry estimated GHG of 15 million tons. The projected CO_2 emissions from the proposed exploration activities would be negligible in comparison to the Alaska 2005 total statewide and Alaska oil and gas industry GHG/CO_2 emissions.

3.5 Alternative 1: Water Quality

Water quality is a term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose. The constituents of water in the marine environment mainly are composed of naturally occurring substances derived from the atmospheric, terrestrial, and other aquatic (freshwater and marine) environments. However, the constituents may include manmade substances and a few naturally occurring ones at toxic concentrations—pollutants.

Potential impacts to water quality may occur as a result of the permitted discharges from vessels and drillships. Several factors at the time of discharge can play a role in how water quality is affected: hydrological conditions, depth at which the discharge is made, rate of the discharge, composition of the discharge, and concentration of contaminants.

The general NPDES permit AKG280000 (EPA, 2006) for the offshore areas of Alaska, including the Beaufort Sea, authorizes discharges from oil and gas exploration facilities. The Arctic general permit restricts the seasons of operation, discharge depths, and areas of operation, and has monitoring requirements and other conditions. The EPA regulations (40 CFR 125.122) require a determination that the permitted discharge will not cause unreasonable degradation to the marine environment. Unreasonable degradation of the marine environment means: (1) significant adverse changes in ecosystem diversity, productivity, and stability of the biological community within the area of discharge and surrounding biological communities; (2) threat to human health through direct exposure to pollutants or through consumption of exposed aquatic organisms; or (3) loss of aesthetic, recreational, scientific, or economic values, which is unreasonable in relation to the benefit derived from the discharge.

Shell acknowledges that intense, stable density stratification develops in the Beaufort Sea, including the prospect areas, during the summer ((Shell Offshore Inc., 2009b). The profile for temperature and salinity near the Sivulliq Prospect indicates a very sharp thermocline with a gradient exceeding 2^oC at approximately 16 m depth (EIA:Table 3.2-5). The profile for temperature and salinity near the Torpedo Prospect, indicates two thermoclines with gradients exceeding 2^oC; the first thermocline is at 3-5 m depth and the second at approximately 21 m depth (EIA:3.2-6). In addition, a strong halocline is seen at 5-8 m depth near the Torpedo Prospect with a gradient of more than two salinity units (EIA:3.2-6).

Both modeling and field studies have shown that discharged drilling fluids are diluted rapidly in receiving waters (Ayers, Sauer, and Steubner, 1980: Ayers, et al., 1980; Brandsma et al., 1980; NRC, 1983; O'Reilly et al., 1989; Nedwed, Smith, and Brandsma, 2004; Smith, Brandsma, and Nedwed, 2004; Neff, 2005). The dilution rate is strongly affected by the discharge rate; the NPDES General Permit limits the discharge of cuttings and fluids to 750 bbl/hr (89 m^3/hr).

Suspended solids discharged from the drillship are expected to produce a plume with acute toxicity levels out to about 60 ft (20 m). More than 90% of solids are expected to precipitate out of the water column within 650 ft (200 m) from the discharge point (Shell Offshore Inc., 2009b). Assuming that uniform mixing would occur, a maximum 2.5^{o}F increase in water temperature is expected in the plume out to a distance of 450 ft (137 m) from the discharge point (EA Section 2.3.4).

The dilution rates used in Shell's analysis appear to use the entire water column as the receiving volume. Strong stratification could severely inhibit vertical mixing in the water column so discharges to the upper layer could be retained in the upper 20 m of water. Deeper, colder strata could resist mixing with the warmer discharge from the disposal caisson, forcing the discharged water to disperse in the upper layers of the thermocline over a much larger area than predicted. Still, the area of potential disturbance is expected to remain small. Strong winds and storm events can disrupt such stratification, facilitating mixing. Stratification would be quickly reestablished when winds relax. Overall, the thermal, chemical, and particulate disturbances are expected to reflect the small spatial area of the modeled discharge plume.

The discharges listed in Shell EIA Table 4.1.7-1 (Shell Offshore Inc., 2009b) have associated stipulations and effluent limitations that are defined within the general NPDES Permit. The stipulations and effluent limitations are designed to ensure that State water quality standards and criteria are not exceeded and that wastewater treatment processes used are the best available, allowing for technology and economic limits. Although the general permit requires that commingled discharges are subject to "the most stringent effluent limitations for each individual discharge," aggregate effects from the combination of multiple types of discharge could be more severe than for the individual discharges.

Of the eleven identified project discharge streams, Shell has determined that three of the discharge streams have the potential to affect water quality: 1) spent drilling fluids; 2) cuttings from water-based intervals; and 3) excess cement. These discharges would be regulated under the general NPDES Permit to meet the water quality standards at the point of discharge.

The release of existing sediments and drilling muds has the potential to temporarily increase total suspended solids (TSS) in the water column, which can decrease the amount of light penetrating the water column. A full discussion of the sediment plume created by drilling activities is discussed in Shell EIA Section 4.1.8. Shell EIA Table 4.1.7-2 (Shell Offshore Inc., 2009b) shows modeled TSS in the water column around the discharge point.

Localized impacts on temperature, salinity, and pH are possible, especially under certain conditions. Heavy metals are not a major concern in the water column because, although they may accumulate in sediments over time, many of the elements of concern (e.g., chromium, mercury, barium) are present in insoluble forms and are unlikely to migrate from sediments into the water column.

Increases in turbidity and biological and chemical oxygen demand are expected near the discharge site. These effects on water quality are expected to be limited to within 330 ft (100 m) of the discharge location and be short term and temporary.

The discharge from the water-cooling unit is expected to be 2.5 ˚F (1.4 ˚C) above the ambient temperature and is expected to reach an ambient temperature within 450 ft (137 m) of the drillship. The temperature effect is expected to be short term and temporary.

Diesel and free oil would cause mostly surface impacts; detectable quantities of oil on the water surface would be a violation of the general NPDES permit and a result of an unintentional release. Total aromatic hydrocarbons (TAHs) are soluble in the water column, and would be present in detectable concentrations only if a violation (unintentional release) of the general NPDES permit occurred. Localized impacts from Biochemical Oxygen Demand, fecal coliform, and TSS (total suspended solids; turbidity) may be realized, but only if the general NPDES permit is violated.

A small fuel spill (48 bbl or less), such as a spill during a refueling operation, is the most likely spill scenario during the proposed activities (EA Section 2.3.8 and Appendix A). Nearly 100% of such a fuel spill is estimated to evaporate or disperse to very low levels within 48 hours. Light refined products, such as diesel, are narrow-cut fractions that have low viscosity and spread rapidly into thin sheens. Based on the viscosity of the diesel fuel to be used by Shell, the maximum area of the sea with diesel on the surface in an uncontained 48-bbl spill (i.e., no pre-booming) would be about 20-200 acres (0.1-0.8 km^2), depending on sea state and weather conditions.

The constituents of these oils are light to intermediate in molecular weight and can be readily degraded by aerobic microbial oxidation. Diesel is so light that it is not possible for the oil to sink and pool on the seafloor. Diesel dispersed in the water column can adhere to suspended sediments, but this generally only occurs in coastal areas with high TSS loads (NRC, 2003), and this would not be expected to occur at the drill sites to any appreciable degree. Diesel oil in the water column is readily and completely degraded by naturally occurring microbes, generally in 1-2 months.

Discharges from Shell's proposed activities would occur over relatively short periods of time (weeks). Impacts to water quality from permitted discharges are expected to be localized and short term. Because the discharges would be regulated through Section 402 of the CWA, to ensure compliance with state water-quality standards, impacts to water quality are expected to be temporary and minor.

Water column effects from a small spill likely would be restricted to a small area and have a duration of less than 1 week. Effects would be minimized by booming during refueling, which would reduce the surface area of a spill and allow for recovery. Therefore, effects of any small spill on water quality would be expected to be minor and short term.

3.6 Alternative 2

Under Alternative 2 (No Action), Shell's EP would be disapproved, and the proposed exploration activities would not occur. Disapproval of the EP could result in the delay or elimination of activities and potential impacts. Disapproval of the EP could result in lost opportunities for discovery and production of oil and gas resources and any associated economic benefits.

Under Alternative 2, no impacts to the physical environment or biological resources would occur from the proposed activities. No impacts to the subsistence activities would occur from the proposed activities. The potential economic benefits for local North Slope residents described in EA Section 3.3.4 above would not be realized.

3.7 Cumulative Effects

3.7.1 Background

Cumulative impacts can result from individually minor but collectively significant actions taking place over time. The scope of the cumulative impacts for this analysis is the incremental impact from the proposed exploration activities plus the aggregate effects of other activities that are known or reasonably expected to occur in the same timeframe (July-October 2010) and in the vicinity of the proposed activities, and to have potential effects on the same environmental resources

The cumulative effects from OCS activities plus past, current, and reasonable foreseeable activities in the Arctic OCS and adjacent areas have been assessed in several recent MMS NEPA documents. Cumulative effects analyses were included the Beaufort Sea Multiple-Sale EIS for OCS Lease Sales 186, 195 and 202 (USDOI, MMS, 2003), which was updated in the 2004 EA for Sale 195 (USDOI, MMS, 2004) and updated further in the Sale 202 EA (USDOI, MMS, 2006a). The level and types of activities proposed in Shell's EP (Shell Offshore Inc., 2009a) are within the range of activities described and evaluated in the Beaufort Sea Multiple-Sale EIS and EA's for Sales 195 and 202.

In 2007, MMS completed an EA and issued a FONSI for the Shell's 2007-2009 Beaufort Sea Exploration Plan (USDOI, MMS, 2007b). In 2007, NMFS completed an EA and issued a FONSI for the Shell Offshore, Inc. Incidental Harassment Authorization to Take Marine Mammals Incidental to Conducting an Offshore Drilling Project in the U.S. Beaufort Sea Under the Marine Mammal Protection Act (USDOC, NOAA, NMFS, 2007). Both EA's included cumulative analysis for Shell's proposed 2007-2009 exploration activities. The Arctic Multiple-Sale Draft EIS (USDOI, MMS, 2008) provides MMS's most recent cumulative analysis of the potential effects of Arctic OCS activities.

The analysis below incorporates information from the documents cited by reference, and updates information as needed.

The main sources of cumulative impacts associated with this EP are: (1) vessel traffic; (2) aircraft traffic; (3) oil and gas activities in federal and state waters; and (4) miscellaneous associated activities.

Shell does not intend to conduct exploratory seismic surveys in the Beaufort Sea OCS during the 2010 open-water season. The MMS is unaware of any industry plans to conduct exploration seismic surveys or site clearance activities in the vicinity of Shell's Camden Bay exploration drilling operations during 2010.

3.7.2 Cumulative Effects under Shell's Beaufort Sea and Chukchi Sea EPs

Shell has proposed exploration drilling in 2010 on their leases in both the Beaufort and Chukchi Seas. Shell proposes using the same drillship and support vessels for both operations. Weather and/or ice conditions in the Chukchi and Beaufort seas, as well as conditions at the specific proposed drilling locations, would ultimately dictate Shell's operations. Given (1) the short open-water-drilling season for Arctic operations, even assuming Shell encounters no adverse weather and/or ice conditions or other unanticipated delays; (2) Shell's commitment to cease activities by October 31 in both the Beaufort and Chukchi seas; (3) Shell's commitment to suspend exploratory drilling activity in the Beaufort Sea during the Kaktovik and Nuiqsut bowhead whale subsistence hunts; and the time required to transit between the Beaufort Sea and Chukchi Sea project areas, Shell could not drill more than three of the proposed wells in the Beaufort and Chukchi seas combined (Shell, Letter to Secretary of the Interior Salazar dated June 24, 2009).

The proposed Beaufort Sea and Chukchi Sea project areas are more than 400 mi apart. The MMS estimates a minimum of 48 hours (2 days) to plug and abandon a well. Shell estimates 1 day to retrieve the anchors prior to the drillship moving off site. The transit speed of the *Discoverer* is 8 knots (9.2 mph); therefore, about 2 days would be required to transit between the Beaufort Sea project area and the Chukchi Sea project area. Shell estimates 5 days for construction of the MLC at a drill site, and 1 day to set anchor before drilling could begin. Based on this information, there would be at least 11 days between the end of drilling operations in one project area and the commencement of drilling operations in the other project area.

Discharges and emissions associated with drilling at the two project areas would not overlap in time or space. Sound generated during transition form the Beaufort Sea to the Chukchi Sea (site-abandonment operations, transit, MLC constructing, setting anchors, and drilling) would be continuous at varying sound levels but the sound from various stages would not overlap in time or space.
Sound generated from Shell's proposed 2010 exploration drilling activities in the Chukchi Sea could not occur simultaneously with sound from the proposed Camden Bay EP because the same vessels, including the drillship, would be used for both drilling operations. Sound from the two exploration drilling operations would be separated in time and space and would not cumulatively affect the same resources. Because of the time required for transition of the drillship from one project area to the other, which is longer than the travel time for migrating species, the same animals would not be expected to be exposed to sound from both drilling operations and individual animals would not be expected to be exposed to long periods of sound from the vessels in transit.

Effects related to proposed activities under the two EPs would not be cumulative because of the distance between the proposed Beaufort Sea and Chukchi Sea project areas and the limited areal and temporal extent of impacting factors associated with the proposed activities. Because of time required for transition between drilling operations and associated sound, discharges, and emissions at one project area and those beginning in the other project area, individual migrating animals are not expected to sequentially encounter operations in both seas.

The oil-spill analysis has determined that there is a low chance for an accidental small oil spill Shell's proposed activities in both the Beaufort and Chukchi seas. Therefore, if a small spill occurred in both seas, they would be separated by time and space. A small oil spill likely would be operational in nature, such as a hose rupture. For the purpose of this analysis, a 48-bbl fuel-transfer spill was chosen, and it is anticipated that it would last less than 3 days on the surface of the water. Booms would be on site and predeployed, if a small oil spill should occur, to contain the spill in a localized area to facilitate cleanup. A 48-bbl diesel spill would evaporate and disperse in less than 3 days. The short- and long-term effects on subsistence activities are considered to be low to insignificant because subsistence activities are not performed in the vicinity of the proposed drilling, or any associated spill; however, the perception that oil-spill contamination of subsistence foods, particularly marine mammals or fish, might be of concern to the Iñupiat of Nuiqsut and Kaktovik in terms of potential effects on health. As described in the oil-spill analysis section, there is no likelihood of fuel-transfer spills occurring during vessel transit from the Beaufort to the Chukchi seas because there would be no refueling during transit.

3.7.2 Other Cumulative Activities and Effects

Vessels are expected to be the greatest anthropogenic contributors to sound introduced to the Beaufort Sea during the timeframe of the proposed activities. Sound levels and frequency characteristics of vessel sound energy underwater generally are related to vessel size and speed. Larger vessels generally emit more sound than smaller vessels, and those underway with a full load, or those pushing or towing a load, are noisier than unladen vessels. The primary sources of sounds are engines, bearings, and other mechanical parts. The sound from these sources reaches the water through the vessel hull. Other than during icebreaking activities, the loudest sounds from vessels are made by the spinning propellers. Navigation and other vessel-operation equipment also generate subsurface sounds.

Other than vessels associated with the proposed activities, vessel traffic in the project area is expected to include vessels used for fishing and hunting, icebreakers, Coast Guard vessels, and supply ships and barges. Vessel traffic in the project area is expected to be limited. Most vessels are expected to transit through the Camden Bay area within 12.5 mi (20 km) of the coast. During ice-free months (June-October), barges are used for supplying the local communities, Alaskan Native villages, and the North Slope oil-industry complex at Prudhoe Bay with larger items that cannot be flown in on commercial air carriers. Usually, one large fuel barge and one supply barge visit the villages per year and one barge per year traverses through the Arctic Ocean to the Canadian Beaufort Sea.

Vessel strikes with marine mammals in the Arctic Ocean are rare, in part because overall vessel traffic in the Alaska Beaufort Sea is very limited. The potential transit of the vessels, including the drillship, from Camden Bay to a proposed Chukchi Sea drill site would not substantially increase the risk of vessel strikes to marine mammals or birds because of the slow speed of the vessels, mitigation measures in Shell's 4MP (Shell Offshore Inc., 2009a:Appendix J), and mitigation measures in Shell's Lighting Plan (Shell Offshore Inc., 2009a:Appendix G).

The proposed exploration drilling activities are short term, and potential effects other than noise are expected to be short-term and highly localized. Ice management is expected to be the greatest sound energy source during the proposed activities. The proposed activities would occur only during the open-water season and ice-management activities would occur only as necessary. Noise associated with the proposed activities is expected to have some adverse impacts on marine mammals. With mitigation measures incorporated in the activities proposed in Shell's EP, no effects or negligible to minor adverse effects to coastal and marine birds, marine mammals, and fish are expected. The incremental contribution to cumulative impacts from the proposed activities on biological resources is expected negligible.

With the mitigation incorporated by Shell, subsistence activities undertaken by Nuiqsut and Kaktovik residents are expected to receive at most negligible effects, and the incremental contribution to cumulative impacts from the proposed activities on subsistence for Nuiqsut and Kaktovik residents is expected to be negligible.

Ice conditions and subsistence hunting are expected to have a greater impact on migration and survival of belugas, bowhead whales, and walrus than vessel traffic (USDOI, MMS, 2003). A minor level of effect on these marine mammals is expected from vessel traffic and noise associated with the proposed action.

Sources of emissions in the area are generators in villages, transportation, and industrial sources at existing oil production facilities onshore and in State waters. During spring and winter, winds transport pollutants from industrial Europe and Asia across the Arctic Ocean to arctic Alaska (Rahn and Glen, 1982). These pollutants cause a phenomenon called arctic haze.

Shell anticipates operating a single drillship in the Beaufort Sea in 2010. The applicable NAAQS and PSD increment standards are presented in Shell EIA Table 4.2.2-1 (Shell Offshore Inc., 2009b). The EPA requires Shell to demonstrate compliance with these standards near the single drillship and not at the shoreline. Shell performed cumulative emissions modeling by including emissions from existing sources over a wide area. The modeling results indicate that concentrations of emissions from the cumulative sources would be within the PSD Class II incremental limits and the national ambient air quality standards.

Any emissions generated from Shell's proposed 2010 exploration drilling activities in the Chukchi Sea could not occur simultaneously with emissions from the proposed Beaufort Sea exploration activities (the same vessels, including the drillship, would be used for both drilling operations if both EP's were to be approved). Emissions from the two exploration drilling operations would be separated in time and space and would not cumulatively affect the same resources. The anticipated emissions are expected to be well below NAAQS and AAAQS at the shoreline as a result of distance from shore, permit restrictions, and dispersion. Air quality impacts from the proposed activities are expected to be negligible to minor and short term. The incremental contribution to cumulative impacts on air quality from the proposed EP activities is expected to be negligible.

Any discharges generated from Shell's proposed 2010 exploration drilling activities in the Chukchi Sea could not occur simultaneously with emissions from the proposed Beaufort Sea exploration activities (the same vessels, including the drillship, would be used for both drilling operations if both EP's were to be approved). Discharges from the two exploration drilling operations would be separated in time and space and would not cumulatively affect the same resources. Discharges from the proposed activities are expected to be localized and short term. Because the discharges would be regulated through Section 402 of the CWA, to ensure compliance with State water quality standards, impacts on water quality are expected to be temporary and minor. The incremental contribution to cumulative impacts to water quality from the proposed activities is expected to be negligible.

Climate change (Arctic warming) is an observable phenomenon in the Beaufort Sea area. Many scientists attribute this climate change, at least partly, to emissions of greenhouse gases (GHG). The exploration drilling and support activities proposed in Shell's EP are sources of GHG emissions. The projected GHG emissions from the proposed exploration activities would be insignificant in comparison to the Alaska total Statewide and Alaska oil and gas industry GHG emissions. The proposed activities would contribute a negligible amount to overall GHG emissions into the planet's atmosphere.

3.7.4 Overall Conclusion Cumulative Effects

In conclusion, negligible to minor incremental contributions to cumulative effects are expected from the exploration drilling activities as proposed in Shell's 2010 Camden Bay EP.

4.0 Consultation and Coordination

4.1 Public Review of the Exploration Plan

Pursuant to 30 CFR 250.232, MMS is required to submit a copy of the EP to the Governor of Alaska and the State coastal management agency for review and comment. On August 11, 2009, copies of the EP were sent to the Governor of Alaska and to the Office of Project Management and Permitting, which is the State's coastal management agency. The Office of the Commissioner, Alaska Department of Natural Resources (DNR), submitted the Sate of Alaska's comments on the EP (dated August 31, 2009). The DNR states, "The State of Alaska fully supports Shell's efforts to conduct exploratory drilling in the Beaufort Sea. With this plan, Shell has voluntarily taken an action that constitutes a significant reduction in the planned exploration effort that is in direct response to input they have received from North Slope residents, the North Slope Borough (NSB), and whaling groups."

By letter dated July 1, 2009, the MMS notified the Mayor of the NSB; the Mayors of Kaktovik, Nuiqsut, and Barrow; the Presidents of the Native Villages of Kaktovik, Nuiqsut, and Barrow Inupiat Traditional Government; the Inupiat Community of the Arctic Slope (ICAS); and the Alaska Eskimo Whaling Commission (AEWC) that Shell's proposed EP was anticipated to be submitted in July. The MMS acknowledged the short regulatory review schedule, offered to meet with each party, and notified that parties that MMS would be contacting their offices directly to arranging a meeting with them to discuss the EP. No request for a meeting was made.

Interest by stakeholders in Shell's proposal is high. Even before the EP was deemed submitted, MMS received requests for the preliminary draft proposal. The MMS provided copies of the preliminary draft EP and received comments on the document.

It is MMS policy and practice to distribute the EP to other Federal and State agencies, local and Tribal governments and the AEWC. On August 11 and 12, 2009, MMS distributed copies of the EP to the Mayor of the NSB; the NSB Wildlife and Planning Departments; communities and Native Villages of Kaktovik, Nuiqsut, and Barrow; ICAS; and AEWC. Copies of the EP were provided to FWS, NMFS, EPA, the Army Corps of Engineers, the U.S. Coast Guard, and the National Park Service. Copies of the EP were sent to Alaska State agencies, including the Department of Natural Resources, the Department of Environmental Conservation, and the Alaska Oil and Gas Conservation Commission. A notification letter on the availability of the EP for review was sent to third parties who previously had expressed interest in the project. Comments were requested by August 31 based on the 21-calendar-day comment period established by 30 CFR 250.232.

On August 11, 2009, MMS posted the EP to the MMS Alaska website at http://www.mms.gov/alaska/ref/ProjectHistory/Shell_BF/2009_final_EP_camden_bay.pdf. The MMS provided email notification about the posting of the EP to the MMS website to NSB, communities, tribes, and AEWC to facilitate the review process.

The MMS received comment letters on the EP from NSB, ICAS, AEWC, the Native Village of Point Hope, DNR, and consortium of environmental advocacy organizations. The comments were reviewed by MMS and considered in the completing the regulatory, technical, and environmental reviews of the EP.

The MMS arranged Government-to-Government meetings with the federally recognized Native Alaskan tribal governments during the week of August 31, 2009 (see also EA Section 4.3 below). These meetings were held to provide an opportunity for the local Alaskan Native tribal governments to discuss their comments and concerns about Shell's proposed exploration drilling activities with MMS.

4.2 Government-to-Government Consultation

Executive Order 13175, *Consultation and Coordination with Indian Tribal Governments*, requires Federal Agencies to consult with Tribal governments on Federal matters that significantly or uniquely affect their communities. In January 2001, a USDOI Alaska Regional Government-to-Government policy was signed by all the USDOI Alaska Regional Directors, including the MMS Alaska Regional Director.

The MMS has held multiple Government-to-Government consultation meetings with the Federally recognized Alaskan Native tribal governments of the North Slope to discuss the OCS program, leasing, and potential OCS activities. These meeting provide an opportunity for the tribes to provide Traditional Knowledge to MMS and to discuss concerns and questions with MMS. The meetings also provide MMS an opportunity to inform the local tribal governments about MMS activities and processes. Government-to-Government consultation meetings were held in conjunction with the Beaufort Sea Multiple-Sale EIS and the Sales 195 and 202 prelease and NEPA processes.

On August 11-12, 2009, MMS sent copies of the EP by Federal Express to ICAS and the tribal governments of Native Villages of Barrow, Nuiqsut, and Kaktovik and offered to conduct Government-to-Government consultation, if requested. In addition, in an August 11 e-mail, MMS informed the parties that the EP was being sent and specifically offered to conduct Government-to-Government meetings on the EP. The MMS contacted the tribal governments and ICAS by email and phone to arrange for Government-to-Government meetings. Meetings were held with the Native Village of Barrow on August 31, ICAS on September 1, and the Native Village of Nuiqsut on September 2. No other Government-to-Government consultations were requested.

4.3 Endangered Species Act Consultation

Section 7(a)(2) of the Endangered Species Act (ESA) requires each Federal Agency to ensure that any action that 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 MMS consults with FWS and NMFS for listed species under each Service's jurisdiction. For ESA consultation on proposed lease sales, MMS specifically requests incremental Section 7 consultation. Regulations at 50 CFR 402.14 (k) allow consultation on part of the entire action as long as that step does not violate section 7(a)(2), there is a reasonable likelihood that the entire action will not violate section 7(a)(2), and the agency continues consultation with respect to the entire action, obtaining a biological opinion (BO) for each step. Thus, at the lease sale stage, MMS consults on the early lease activities (seismic surveying, ancillary activities, and exploration drilling) to ensure that activities under any leases issued will not result in jeopardy to a listed species or cause adverse modification of designated critical habitat.

Consultation with NMFS for the Shell's proposed exploration activities is covered by the July 17, 2008, BO for Oil and Gas Leasing and Exploration Activities in the U.S. Beaufort and Chukchi Seas, Alaska and Authorization of Small Takes Under the Marine Mammal Protection Act (USDOC, NOAA, NMFS, 2008) (http://www.mms.gov/alaska/ref/BioOpinions/2008_0717_bo.pdf).

Consultation with FWS for the Shell's proposed exploration activities is covered by the September 3, 2009, BO for Beaufort and Chukchi Sea Program Area Lease Sales and Associated Seismic Surveys and Exploratory Drilling (USDOI, FWS, 2009) (http://www.mms.gov/alaska/ref/BioOpinions/2009_0903_BO4BFCK.pdf).

4.4 Marine Mammal Protection Act

Shell has applied for an Incidental Harassment Authorization (IHA) from NMFS (dated May 7, 2009; Shell Offshore Inc., 2009a:Appendix E) and a Letter of Authorization from FWS (dated May 7, 2009; Shell Offshore Inc., 2009:Appendix F) as part of their exploration program. For this EP, Shell has incorporated the mitigation measures from their 2007 exploration drilling IHA from NMFS, as well as other measures specifically designed to prevent or minimize any incidental harm to marine mammals. Those measures are summarized in Section 2.3.11 of this EA.

4.5 Essential Fish Habitat Consultation

The MMS consults on essential fish habitat (EFH) with NMFS at the lease sale stage. The most recent EFH consultation for OCS exploration activities in the Beaufort Sea was conducted concurrently with the preparation and public review of the Arctic Multiple-Sale Draft EIS. The MMS received NMFS' conservation recommendations in a letter dated June 26, 2009.

5.0 Reviewers and Preparers

In keeping with the intent of CEQ regulations (40 CFR 1506.5(a),(b)) that acceptable work by an applicant not be redone but it be verified by the agency, we have reviewed, evaluated, and verified the information and analysis provided in Shell's EIA, which we used to prepare this EA. Further as required by 40 CFR 1506.5(a),(b), we have provided the names of the MMS staff responsible for the review of Shell's EP and supporting information and analysis, and preparation of this EA.

Christy Bohl	Oil Spill Program Administrator
Chris Campbell	Sociocultural Specialist
Douglas Choromanski	Geologist, Office of Field Operations
Cleve Cowles	Regional Supervisor, Office of Leasing and Environment
Deborah Cranswick	Supervisory Environmental Specialist
Christopher Crews	Wildlife Biologist
Heather Crowley	Oceanographer/Water Quality
Kathleen Crumrine	Petroleum Engineer
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7.0 FIGURES

Figure 1-1	Proposed Action Locations (Shell Offshore Inc., 2009a:Figure 1-1).
Figure 1-2	Figure 1-2. Proposed Drillsite Locations (Shell Offshore Inc., 2009b:Figure 2.1-1).
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Figure 3-2	Bowhead Whale Sightings 1979-2007 (Shell Exploration Inc., 2009b:Figure 3.8-2).

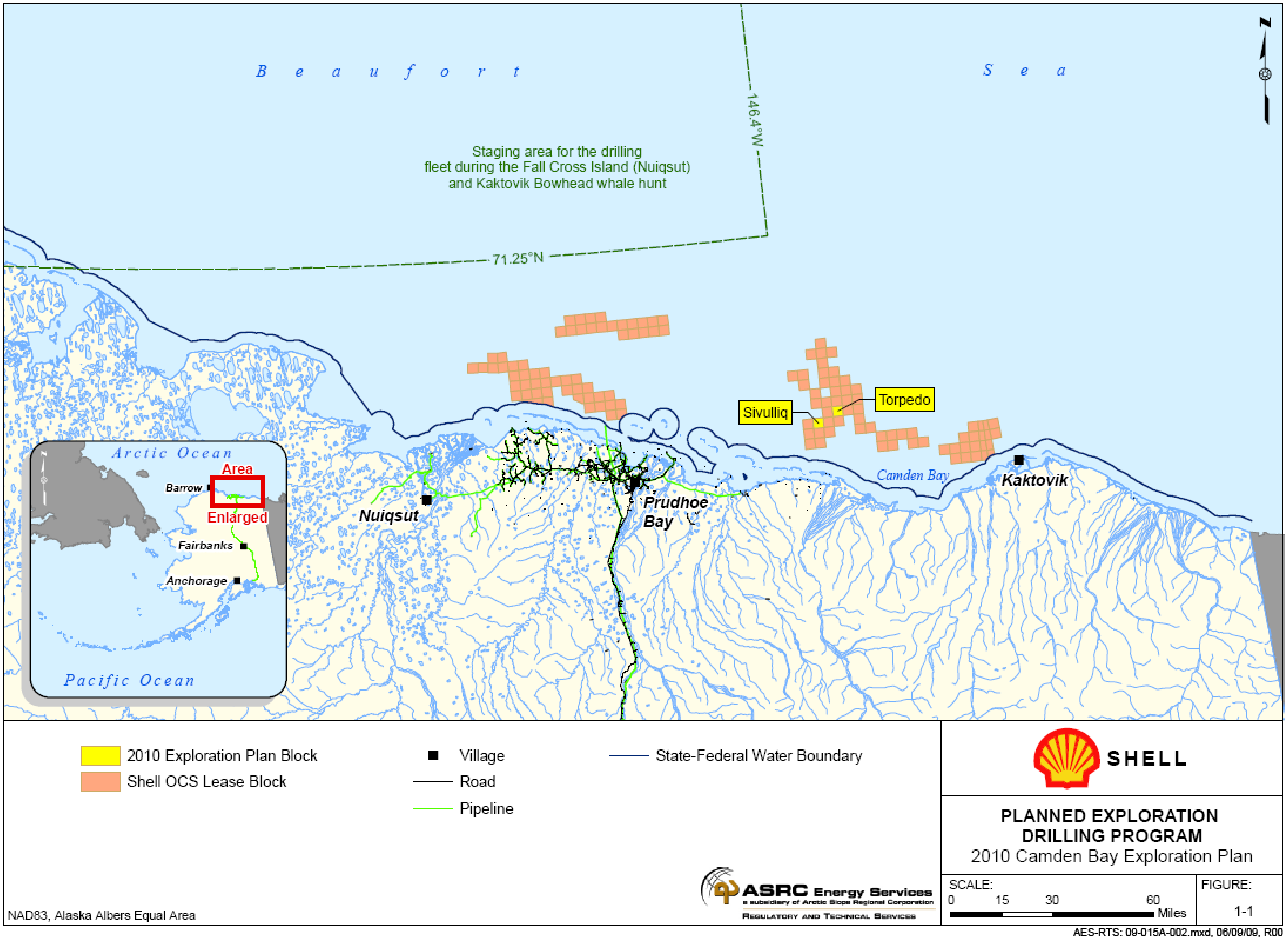

Figure 1-1. Proposed Action Locations (Shell Offshore Inc., 2009a; Figure 1-1).

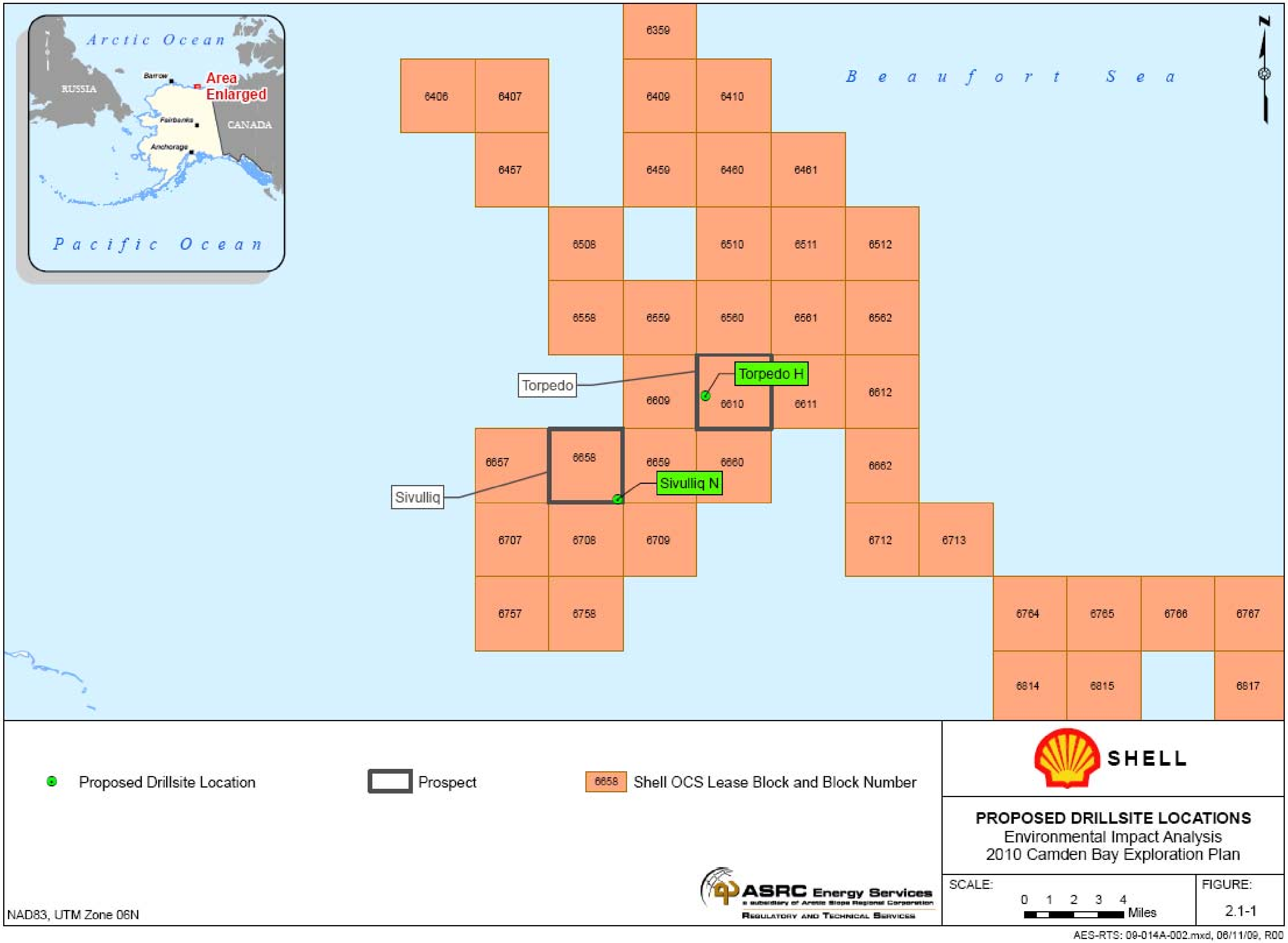

Figure 1-2. Proposed Drillsite Locations (Shell Offshore Inc., 2009b; Figure 2.1-1).

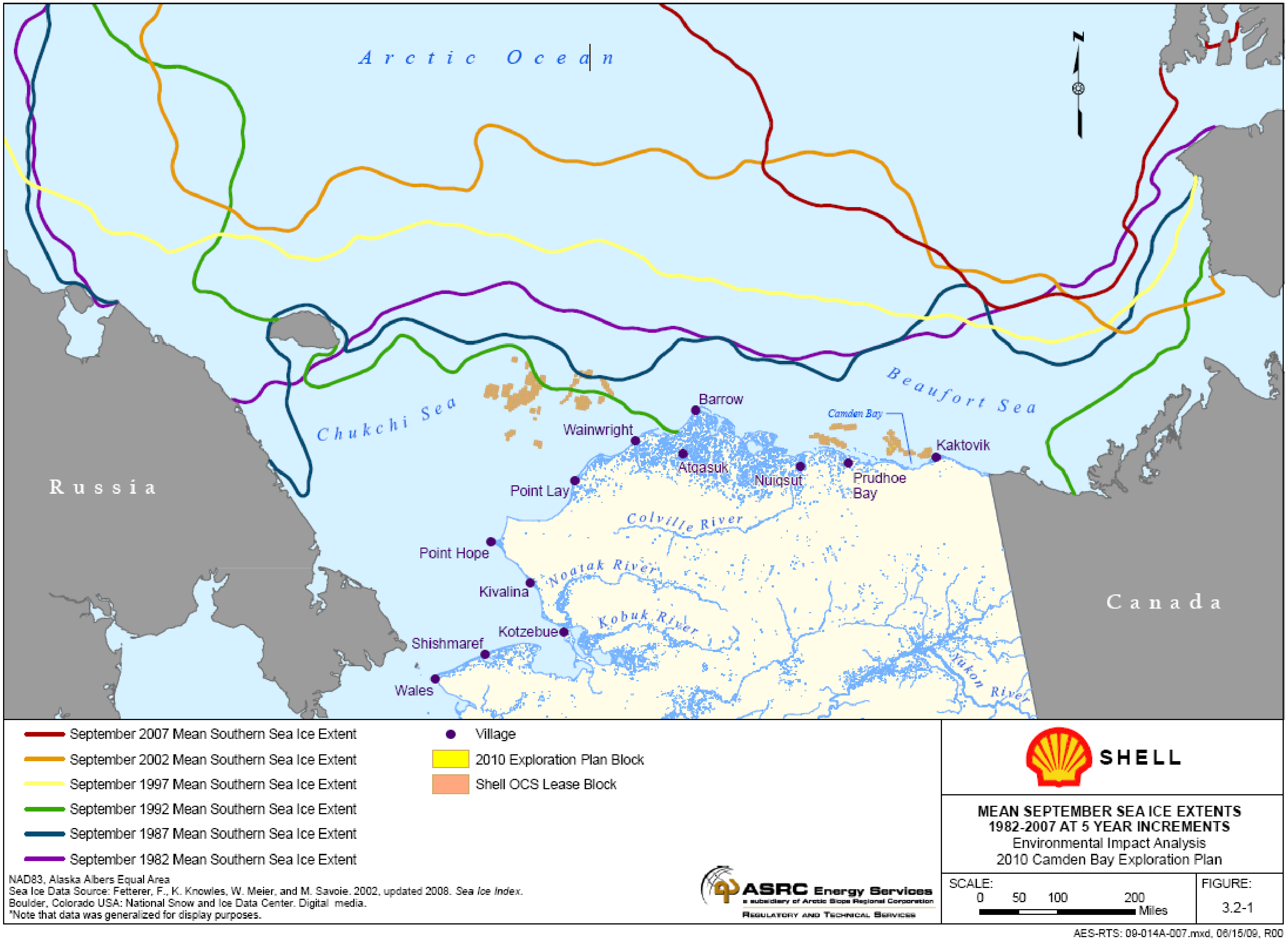

Figure 2-1. Mean September Sea Ice extents 1982-2007 at 5-Year Increments (Shell Offshore Inc., 2009b; Figure 3.2-1).

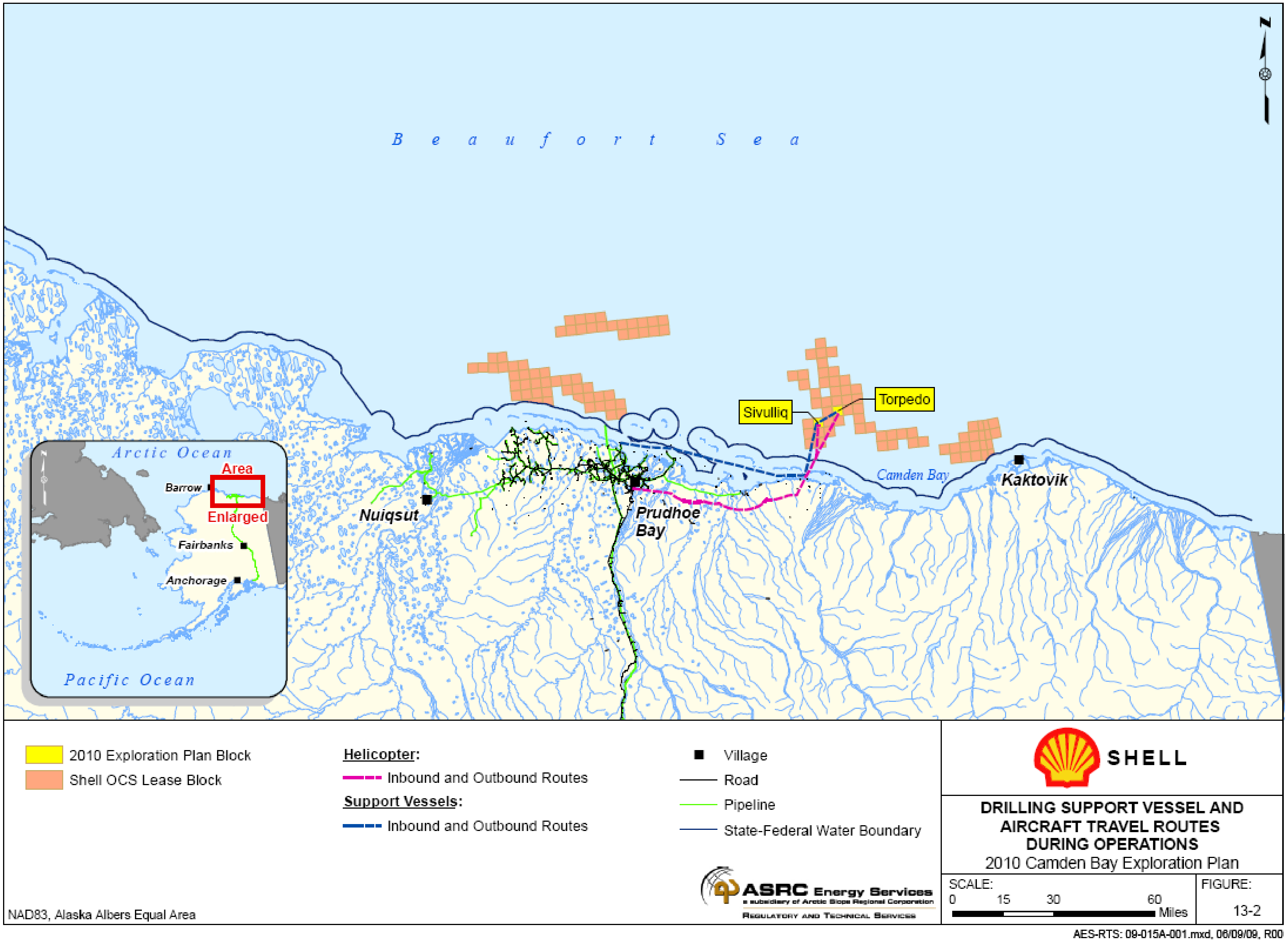

Figure 2-2. Proposed Action Locations and Support Vessel and Aircraft Travel Routes (Shell Offshore Inc., 2009a; Figure 13-2).

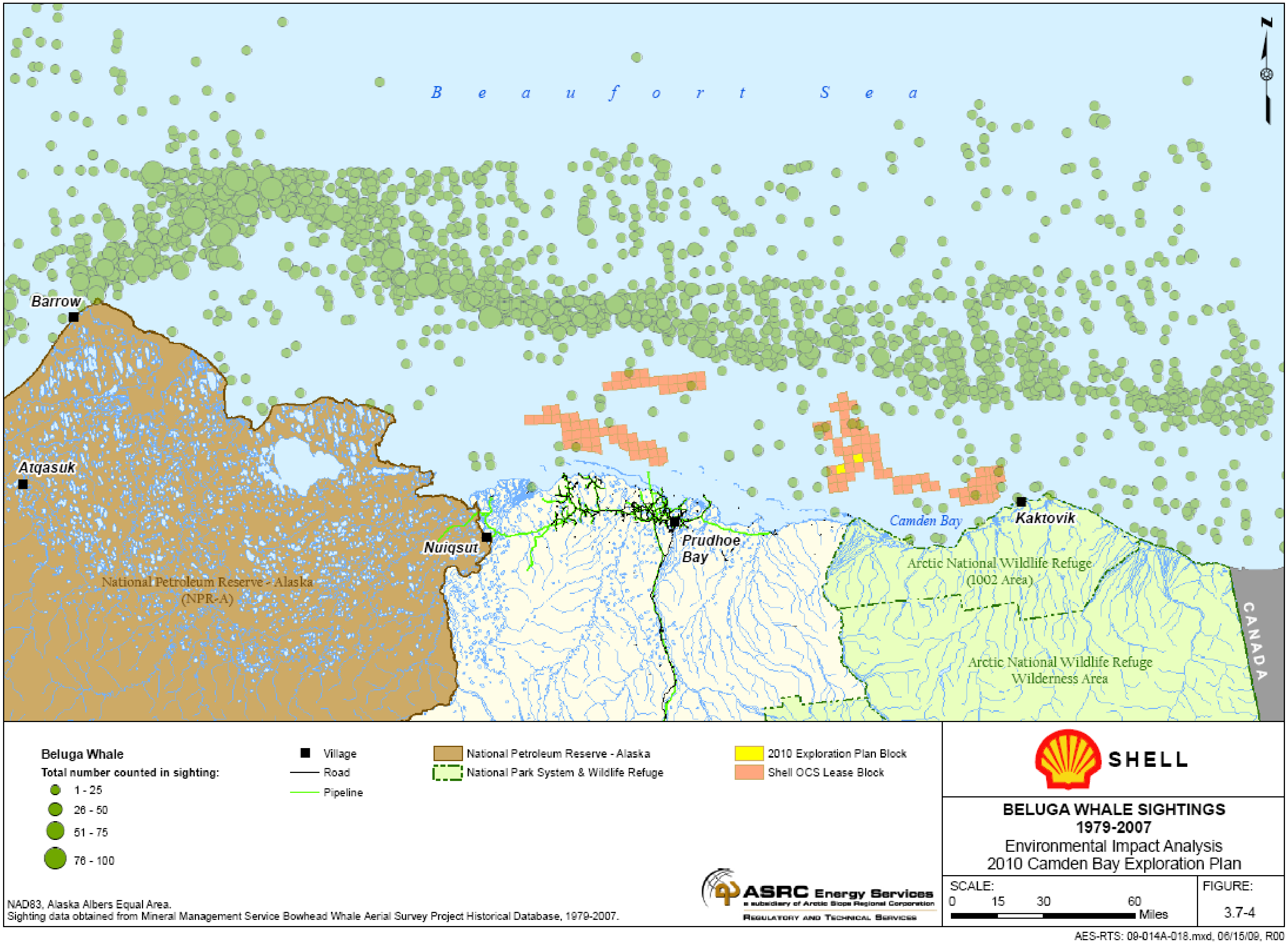

Figure 3-1. Beluga Whale Sightings 1979-2007 (Shell Exploration Inc. 2009b, Figure 3.7-4).

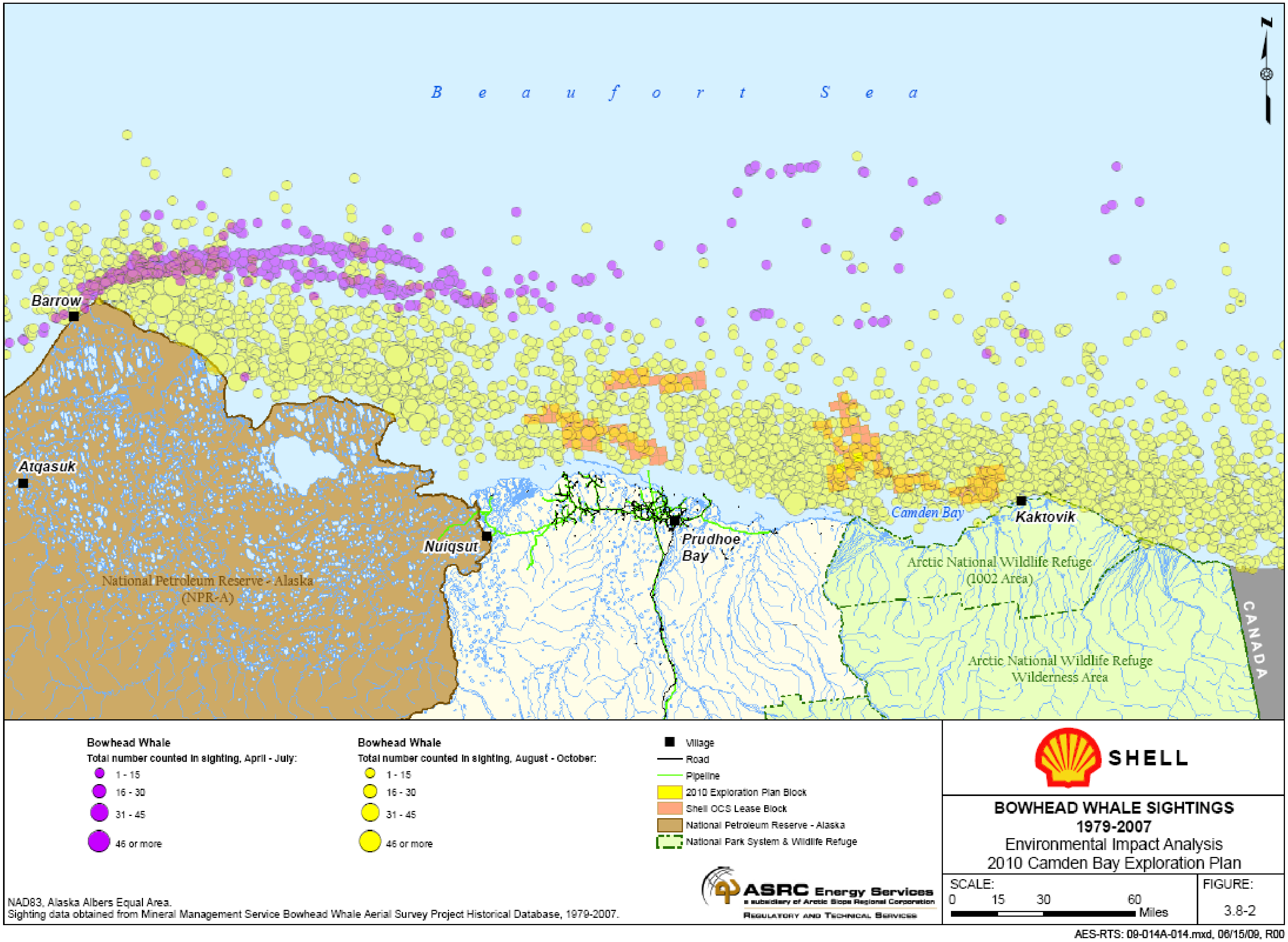

Figure 3-2. Bowhead Whale Sightings 1979-2007 (Shell Exploration Inc. 2009b, Figure 3.8-2).

Appendix A
Analysis of Accidental Oil Spills

1.0 Oil-Spill Analysis and Scenario Framework of Accidental Oil Spills in this Environmental Assessment.

This section describes the results of the oil-spill analysis. It analyzes the potential discharges, their likelihood, and the outlines the scenario framework chosen for the impact analysis of accidental oil spills. The vessel, drilling, and fuel-transfer activities in the Exploration Plan (EP) were evaluated for routine operations and accident conditions. It is not anticipated that oil spills occur as a routine activity, and, therefore are not a routine impact-producing factor. Oil spills are considered an accidental activity and are treated as an accidental impact-producing factor. An accident is an unplanned event or sequence of events that results in undesirable consequence. This document tiers from the oil-spill analysis in the Beaufort Sea Multiple-Sale EIS (USDOI, MMS, 2003) and Sales 195 and 202 EAs (USDOI, MMS, 2004, 2006), and incorporates by reference the most recent information on well-control incidents and fault-tree information from the Beaufort Sea Oil and Gas Lease Sales (Sales 209 and 217) (USDOI, MMS, 2008) and Shell Offshore Inc. (2009) Environmental Impact Analysis. Brief summaries, where relevant, are provided below; the information is updated and augmented by new material as needed.

The section below starts with the summary of estimated impact-producing factors (size, source, duration, weathering characteristics) from accidental oil spills used in this Environmental Assessment (EA) analysis. The remainder of this Appendix provides the supporting information for the estimated impact-producing factors used for accidental oil-spill analysis in this EA.

1.1 Summary: Estimated Accidental Spills by Size Categories.

For purposes of this EA analysis, no large or very large crude or diesel oil spills are estimated from exploration activities based on a review of potential discharges, historical spill and modeling data, and likelihood of occurrence. This estimate is based on the low rate of exploratory drilling well-control incidents per well drilled spilling fluids, modeled exploratory drilling well-control incidents, and the history of exploration spills on the Arctic OCS and Canadian Beaufort Sea discussed below. It is possible that a small spill could occur and is reasonably foreseeable. For purposes of analysis, we chose a 48-bbl fuel-transfer spill for the small spill size, as identified in Shell's Beaufort Sea Oil Discharge Prevention and Contingency Plan (ODPCP) summary of potential discharges.

1.1.1 Summary: Small Spills (<1,000 bbl) from Exploration Operations.

Historical Beaufort Sea and Chukchi Sea OCS exploration spill data suggest that the most likely cause of an oil spill during exploration could be operational, such as a hose rupture, and the spill could be relatively small. The largest exploration spill was approximately 20 bbl (Section 1.3.1). For purposes of analysis, a 48-bbl fuel-transfer spill was chosen as the small spill size, and it is estimated to last less than 3 days on the surface of the water, based on weathering calculations. This EA analyzes the impacts of such a small spill in each of the EA sections on impacts to specific resources. Lease Stipulation 6 and Shell's operating procedures require pre-booming during fuel transfers, which would reduce or negate adverse effects from a small fuel-transfer spill.

1.1.2 Summary: Large Spills (≥1,000 bbl) from Exploration Operations.

For purposes of Shell's proposed exploration drilling program during the 2010 open-water season, OCS historical crude and condensate spill data demonstrates that a large spill is too remote and speculative an occurrence to be considered a reasonably foreseeable occurrence of Shell's proposed exploration project. No oil will be produced. All wells will be permanently plugged and abandoned in accordance with MMS requirements on completion of drilling. Since 1971, no large spills have occurred from well-control incidents while drilling approximately 14,000 OCS exploration wells. All fuel-storage tanks will be internal to the drillship, and should an internal storage tank rupture internally, it is unlikely a large diesel fuel spill would reach water.

1.1.3 Summary: Very Large Spills (≥150,000 bbl) from Exploration Operations.

A very large oil spill from a well-control incident during OCS exploratory drilling is a similarly unlikely occurrence. There is no absence of reliable scientific data on the chance of an exploration well-control incident occurring, and further support for this conclusion is set forth below. A very large spill from a well-control incident is not a reasonably foreseeable event in connection with the exploration activities set forth in Shell's EP, and therefore, this EA does not analyze the impacts of such a worst-case scenario.

The MMS analyzed the potential impacts of a very large spill from a well-control incident (OCS EIS/EA MMS 2003-001 at IV-228 to IV-247). There are no site-specific anomalies that differentiate a very large spill release at Launch Area (LA) 12 from LA15, and the oil-spill contacts are statistically similar. Thus, MMS has analyzed the potential impacts from a very large well-control incident where fluids are released into the Beaufort Sea and incorporates that analysis by reference (see Section 1.4.2 below). This impact analysis in USDOI, MMS (2003) considers the mitigation of spill response. Shell's ODPCP response scenario addresses the potential immediate release of crude oil to the environment by a loss of well-control during drilling. Shell's ODPCP demonstrates that access to sufficient equipment and personnel needed to respond to a well blowout flow rate of 5,500 barrels of oil per day (bopd) for 30-34 days.

1.2 Oil-Spill Potential Discharge Review.

Oil spills are an issue of great public concern in relation to the offshore oil and gas industry. Etkin (2009) estimates that petroleum industry spillage has decreased over the last 40 years; 70 percent less oil is spilling since the 1970s and 54 percent less in the decade 1998-2007 from the previous.

Using information from the potential discharges, the MMS reviewed and considered available information regarding the small, large, and very large spill-size estimates and the likelihood of the potential discharges, to determine a reasonably foreseeable spill analysis to evaluate the potential impact producing factors of an accidental oil spill for this EA.

Table A-1 shows the Shell's ODPCP summary of potential discharges (Shell EIA Table 4.1.19-1) with the MMS spill-size categories listed in the left-hand column. The summary of potential discharges was divided into MMS's three spill-size categories: (1) small (≤1,000 barrels (bbl); (2) large (≥ 1,000 bbl); and (3) very large (≥150,000 bbl). Within each spill-size category, the estimated potential discharge size is considered the representative size for that size category. A 48-bbl diesel-transfer spill is in the small spill category, a 1,555-bbl diesel-fuel tank-rupture spill is in the large spill category, and the blowout worst-case discharge of 287,100 bbl is in the very large spill category. The paragraph below describes why and how Shell calculated the worst-case discharge.

1.2.1 Worst-Case Discharge Calculation for the Oil Discharge Prevention and Contingency Plan.

The MMS and State of Alaska regulations set forth how the volume for a Worst Case Discharge (WCD) calculation is determined for oil-spill-response planning. The WCD volume and storage capacities are calculated to address MMS and Alaska Department of Environmental Conservation (ADEC) need to determine the adequacy of the company's spill-response capabilities. The MMS requires (30 CFR

254.47(b) Determining the volume of oil of your worst case discharge scenario) the WCD to be based upon the daily volume possible from an uncontrolled blowout flowing for 30 days. The ADEC regulations (18 AAC 75.434) establish the Response Planning Standard (RPS) of 5,500 bbl (874 cubic meters [m^3]) of oil per day for the duration of 15 days for an exploration facility. The daily flow rate for a blowout is based on the ADEC response planning standard of 5,500 bbl per day. The MMS reviewed results from wells drilled in the area and concluded that the 5,500 bbl/day standard is appropriate; therefore, MMS concurs with using this standard for this EP. To meet both agencies' response-planning requirements, the WCD volume was calculated using ADEC's volume requirement of 5,500 bopd (874 m^3) and MMS's duration requirement of 30 days (30 CFR 254.47(b)) totaling 165,000 bbl (26,233 m^3). To determine the storage capacity requirements based on ADEC guidance, an emulsion factor of 1.54 and a percentage of free water (20 percent) have been added to the initial RPS of 165,000 bbl (26,233 m^3) for a total storage volume of 287,100 bbl (45,645 m^3).

The MMS regulations at 30 CFR 250.213(g) require a scenario for a potential blowout that will have the highest volume and maximum duration. Shell's blowout scenario provides for drilling a relief well in up to 34 days (with a resulting total spill volume of 187,000 bbl). To meet both agencies' response-planning requirements, the WCD volume has been calculated using ADEC's volume requirement of 5,500 bopd (874 m^3) and Shell's blowout scenario based on drilling a relief well in 34 days for a total of 187,000 bbl (29,703m^3). To determine the storage capacity requirements based on ADEC guidance, an emulsion factor of 1.54 and a percentage of free water (20 percent) have been added to the initial RPS of 187,000 bbl (29,703 m^3) for a total storage volume of 325,380 bbl (45,645 m^3).

Table A-1. Summary of Potential Discharges and Relation to MMS Spill Categories for Oil-Spill Analysis.

MMS Spill-Size Categories	Type	Cause	Product	Size	Duration	Prevent Potential Discharge
Small	Transfer from fuel barge to drill rig	Hose rupture	Diesel	Approximately 2,000 gallons 48 bbl (Section 1.6)	5.5 minutes (ODPCP Section 1.6)	Transfer procedures in place; minimized by the weather restrictions, during unfavorable wind or sea conditions. Transfers are announced in advance; and verbal communication, in combination with visual inspection, is the best method of discharge detection. Booming is in place during transfer.
Large	Diesel Tank	Tank rupture	Diesel	1,555 bbl	Minutes to hours	The diesel tanks are internal to each drilling vessel rather than deck-mounted, where the potential for marine spills is much greater. As a result, a scenario involving tank rupture has not been included in the oil-spill-response plan, but will be monitored as part of an ongoing tank inspection program.
Very Large	Blowout	Uncontrolled flow at the mudline	Crude oil	287,100 – 325,380 bbl including emulsion and free water	30-34 days (refer to ODPCP Page 1-26)	Blowout prevention equipment and related procedures for well-control. Layer I includes proper well planning, risk identification, training, routine tests, and drills on the rig. Layer II includes early kick detection and timely implementation of kick-response procedures. Layer III involves the use of mechanical barriers, including, but not limited to, blowout preventers, casing, and cement. Testing and inspections are performed to ensure competency. ODPCP Section 2.1.8 Drilling a relief well (ODPCP Page 1-26)

1.3 Historical and Modeled Oil Spills

The following sections review the historical and modeled information on crude and condensate spills from exploration operations and well-control incidents during all drilling operations. The historical and model data indicate it is unlikely to have a large or very large oil spill from a well-control incident during drilling or other exploration operations.

1.3.1 Historical Refined and Crude Spills from Exploration Operations on the Beaufort and Chukchi Outer Continental Shelf and Canadian Beaufort.

The MMS estimates the chance of a large (≥1,000 bbl) oil spill from exploratory activities to be very low. On the Beaufort Sea and Chukchi Sea OCS, the oil industry drilled 35 exploratory wells. During the time of this drilling, industry has had 35 small spills totaling 26.7 bbl or 1,120 gallons (gal). Of the 26.7 bbl spilled, approximately 24 bbl were recovered or cleaned up. Table A-2 shows the exploration spills on the Beaufort Sea and Chukchi Sea OCS. All the explorations spills on the Beaufort Sea and Chukchi Sea OCS have been small, with the largest spill approximately 20 bbl. Based on the historical spill data, small spills of diesel, refined fuel, or crude oil may occur. Shell estimates a small spill size of 48 bbl for a transfer of diesel fuel during refueling operations in their potential discharge estimates. The MMS estimates a small spill is a reasonably forseeable scenario during exploratory drilling in the Beaufort Sea. These small spills often are onto containment on vessels, platforms, facilities, or gravel islands, or onto ice, and may be cleaned up.

Table A-2 shows no large exploration spills occurred on the Beaufort Sea and Chukchi Sea OCS. One large exploration spill occurred in the Canadian Beaufort Sea from an exploration well site, when the island eroded during a storm and a facility fuel tank was damaged, spilling approximately 2,440 bbl of diesel P-50 fuel oil (Hart Crowser, 2000). Diesel tanks in this proposal are internal to the drillship and erosion would not be a causal factor for a large oil spill. If the internal diesel fuel tanks on the ship failed or leaked, it is unlikely a large spill would reach water.

1.3.2 Historical Crude and Condensate Oil Spills from Well-Control Incidents on the OCS and Alaska North Slope.

The Gulf of Mexico and Pacific OCS data show that a large spill likely would not be from a well-control incident. We consider well-control incidents that result in pollution to the environment to be very unlikely events. Well-control-incident events often are equated with catastrophic spills; however, in recent years very few well-control-incident events have resulted in spilled oil, and the volumes spilled often are small. All five of the well-control-incident events ≥1,000 bbl in the OCS database occurred between 1964 and 1970 (Table A-3). Following the Santa Barbara well-control incident in 1969, amendments to the OCS Lands Act and implementing regulations significantly strengthened safety, inspection, and pollution-prevention requirements for OCS offshore activities. Well-control training, redundant pollution-prevention equipment, and subsurface safety devices are among the provisions that were adopted in the regulatory program.

From 1971-2007, 228 exploration and development well-control incidents occurred, on the OCS while drilling approximately 38,000 wells and producing 15 billion barrels (Bbbl) of oil (Table A-3). This includes all well-control incidents, whether they caused pollution or not. From 1971-2007, 35 of those 228 well-control incidents from exploration and development wells resulted in spills of crude or condensate, with the amount of oil spilled ranging from <1 bbl to 350 bbl in any one individual spill. The total volume spilled from the 35 well-control incidents is approximately 1,800 bbl. The crude and condensate volume spilled from well-control incidents was approximately 0.00001% of the volume produced. There were no spills ≥1,000 bbl from exploration and development well-control incidents in the last 37 years on the OCS.

This section summarizes information from well-control incidents that occurred during drilling from 1992 through 2006 on the OCS and includes all well-control incidents from drilling, even if no pollution occurred to the environment. This information is compared with the previous study conducted for drilling well-control incidents that occurred from 1971 through 1991 (Izon, Danenberger, and Mayes, 2007). This information shows a downward trend in the number of drilling well-control incidents per well drilled from 1992-2006 compared to 1971-1991.

The data analyzed was incident reports submitted by OCS oil and gas operators and from MMS accident investigation reports. Between 1992 and 2006, 39 well-control incidents occurred, compared with 87 during the time period of the previous study (1971-1991). Overall, the rate of drilling well-control incidents per well drilled improved during the period. The current 15-year study period had a drilling well-control incident rate of one for every 387 wells drilled, compared with a rate of one well-control incident for every 246 wells drilled during the previous study period.

Overall, the current period saw an improvement (decrease) in well-control-incident duration. Like the previous study, a significant number of well-control-incident events were of short duration. During the current study, 49% of the well-control incidents stopped flowing in 24 hours or less, compared with 57% during the previous study. In the current study, 41% lasted between 1 and 7 days, compared with 26% during the previous study. There were fewer well-control incidents that lasted more than 7 days. The well-control incident with the longest duration during the current study period was 11 days, compared with more than 30 days in the previous period (Izon, Danenberger, and Mayes, 2007).

The U.S. Gulf of Mexico OCS blowout frequencies, as reported by Holand (1997), range from 5.9×10^{-3} blowouts per well drilled for exploratory drilling to 3.9×10^{-3} blowouts per well for development. As Holand's exploration blowout frequencies included blowouts of all types, the frequencies for a blowout resulting in oil reaching the environment are significantly less. Of the total blowouts reported by Holand (1997), gas releases accounted for 77% of the total of blowouts, gas/liquid mixtures 14%, and uncontrolled liquid flows involved 3%.

Izon, Danenberger, and Mayes (2007) report a well-control-incident rate for exploration well drilling of one for every 297 wells drilled, for a frequency of 3.4×10^{-3}. The development well drilling rate is one for every 470 wells drilled, for a frequency of 2.1×10^{-3} (Izon, Danenberger, and Mayes, 2007). Both the exploration and development well-control incident drilling frequencies reflect a decline in well-control incidents over recent years. Again, these blowout frequencies included blowouts of all kinds and frequencies for a blowout resulting in oil reaching the environment are significantly less.

The blowout record for the Alaska North Slope remains the same as reported previously in USDOI, MMS (2003) and summarized herein. Of the 10 blowouts, 9 were gas and 1 was oil. The oil blowout in 1950 resulted from drilling practices that are no longer used. A third study confirmed that no crude oil spills ≥100 bbl from blowouts occurred from 1985-1999 (Hart Crowser, Inc., 2000). The remaining blowouts released dry gas or gas condensate only, resulting in minimum environmental impact (NRC, 2003).

Scandpower (2001) used statistical blowout frequencies modified to reflect specific field conditions and operative systems at Northstar in the Beaufort Sea. This report concludes that the blowout frequency for drilling the oil-bearing zone is 1.5×10^{-5} per well drilled. This compares to a statistical blowout frequency of 7.4×10^{-5} per well (for an average development well). This same report estimates that the frequency of oil quantities per well drilled for Northstar for a spill >130,000 bbl is 9.4×10^{-7} per well.

Table A-2. Exploration Spills on the Beaufort Sea and Chukchi Sea OCS.

Lease No.	Sale Area	Operator	Date	Time 24 Hr	Facility	Substance	Amt. (Gal)	Cause of Spill	Response Action	Amount Recover-ed (gal)
0344	71	Sohio	7/22/1981	11:00	Mukluk I sland	Diesel	0.50	Leaking line on portable fuel trailer	Sorbents used to remove spill. Contaminated gravel removed.	0.05
0344	71	Sohio	7/22/1981	14:00	Mukluk Island	Diesel	1.00	Overfilled fuel tank on equipment	Sorbents used to remove spill. Contaminated gravel removed.	1.00
0280	71	Exxon	8/7/1981		Beaufort Sea I	Hydraulic Fluid	1.00	Broken hydraulic line on ditch witch.	Fluid picked up with shovels.	1.00
0280	71	Exxon	8/8/1981		Beaufort Sea I	Trans. Fluid	0.25	Overfilling of transmission fluid.	Fluid picked up and placed in plastic bags.	0.25
0280	71	Exxon	1/11/1982		Beaufort Sea I	Hydraulic Fluid	0.50	Broken hydraulic line.	Fluid picked up and stored in plastic bags.	0.50
0280	71	Exxon	1/11/1982		Alaska Beaufort Sea I	Diesel	3.00	Overfilled catco 90-3 tank.	Fluid picked up.	3.00
0280	71	Exxon	1/17/1982		Beaufort Sea I	Diesel	1.00	Tank on catco 90-14 overfilled.	Fluid picked up and stored in plastic bags.	1.00
0280	71	Exxon	1/21/1982		Beaufort Sea I	Hydraulic Fluid	0.25	Broken hydraulic line on ditch witch.	Fluid picked up.	0.25
0371	71	Amoco	3/16/1982	N/A	Sandpiper Gravel Island	Unknown	1.00	Seeping from Gravel Island.	Sorbent pads.	Unknown
0849	87	Union Oil	9/4/1982	14:00	Canmar Explorer II	Unknown	1.00	Transfer of test tank from drillship to barge.	None	None
0871	87	Shell Western	9/5/1982	18:55	Canmar Explorer II	Light Oil	0.50	Washing down cement unit, drains not plumbed to oil/water seperator.	None	None
N/A	87	Shell	9/14/1982	19:00	Canmar II Drillship	Diesel	30.00	Tank vent overflowed during fuel transfer.	Deployed sorbent pads and pump.	30.00
0191	BF	Exxon	11/11/1982	10:00	Beechey Pt. Gravel Is.	Lube Oil	1.00	Loader tipped over lube oil drum	Oil cleaned up with sorbents. Contaminated gravel removed	1.00
0191	BF	Exxon	1/15/1983	10:00	Beechey Pt. Gravel Is.	Diesel	0.12	Fuel truck spilled diesel as it climbed a 40 degree ramp to island	Sorbents used and contaminated gravel removed	0.12
0191	BF	Exxon	1/23/1983	9:00	Beechey Pt. Gravel Is.	Hydraulic Fluid	2.50	Hydraulic line on backhoe broke	1 gallon in water. Boom deployed with sorbents, Contaminated gravel removed	2.50
0191	BF	Exxon	8/29/1983	6:30	Beechey Pt. Gravel Is.	Hydraulic Fluid	0.20	Hydraulic line on backhoe broke	Spill contained on island surface. Sorbents used and contaminated gravel removed.	0.25
0196	BF	Shell	8/30/1983		Ice Road to Tern Island	Hydraulic Fluid	10.0	Broken hydraulic line on rollogon	Unknown	Unknown
0191	BF	Exxon	2/26/1985	17:30	Beechey Pt. Gravel Is.	Hydraulic Fluid	0.37	Hydraulic line broke	Contaminated Snow Removed	0.37
0196	BF	Shell	3/1/1985	1:30	Ice Road to Tern Island	Hydraulic Fluid	3.00	Hydraulic line broke	Unknown	3.00
0191	BF	Exxon	3/2/1985		Beechey Pt. Gravel Is.	Gasoline	0.01	Operational Spill	Snow shoved into plastic bag.	0.01
0191	BF	Exxon	3/4/1985		Beechey Pt. Gravel Is.	Waste Oil	2.00	Drum of waste oil punctured	Snow recovered	2.00
0196	BF	Shell	3/4/1985	15:30	Tern Gravel Island	Crude Oil	1.00	Well Separator overflowed, crude oil escaped	Line boom deployed	Unknown
0196	BF	Shell	3/6/1985	16:30	Tern Gravel Island	Crude Oil	15.00	Test burner was operating poorly	Containment Boom deployed	Unknown
0196	BF	Shell	9/24/1985	16:00	Tern Gravel Island	Crude Oil	2.00	Oil released from steam heat coil when Halliburton tank moved	Sorbents and hand shovel used	2.00
0191	BF	Shell	10/4/1985	8:45	Enroute to Tern Gravel Island	Jet fuel B	800.00	Wire sling broke during helicopter transport of fuel blivits	Contaminated Snow Removed. Test holes drilled with no fuel below snow.	Unknown
0196	BF	Shell	10/29/1985	14:00	Tern Gravel Island	Crude Oil	2.00	Test oil burner malfunction	Contaminated snow removed	2.00
0196	BF	Shell	6/27/1986	13:30	Tern Gravel Island	Crude Oil	3.00	Test oil burner malfunction	Spray picked up with sorbents. Bladed up dirty snow.	2.00
0943	87	Tenneco	1/24/1988	13:00	SSDC/MAT	Gear oil	220.0	Helicopter sling failure during transfer of drums to SSDC	Scooped up contaminated snow and ice	220.0
1482	109	SWEPI	7/7/1989	3:00	Explorer III Drillship	Hydraulic fluid	10.0	Hydraulic line connector	Sorbent pads	0.84
1092	97	AMOCO	10/1/1991	2:00	CANMAR Explorer	Hydraulic fluid	2.00	Hydraulic line rupture	None	None
0865	87	ARCO	7/24/1993		Beaudril Kulluk	Diesel	0.06	Residual fuel in bilge water	None	None
0866	87	ARCO	9/8/1993	18:30	CANMAR Kulluk	Hydraulic fluid	1.26	Seal on shale shaker failed	None	None
0866	87	ARCO	9/24/1993		CANMAR Kulluk	Fuel	4.00	Fuel transfer in rough weather	3 gallons on deck of barge recovered, none in sea	3.00
1597	124	ARCO	10/31/1993		CANMAR Kulluk	Fuel	0.50	Released during emptying of disposal caisson	None	None
1585	124	BP Alaska	1/20/1997		Ice Road to Tern Island	Diesel, Hydraulic Fluid	10.5	Truck went through ice; fuel line ruptured	Scooped up contaminated snow and ice. Some product entered water	Unknown

Table A-3. Number of Well-Control Incidents with Pollution per Year in the Gulf of Mexico and Pacific OCS Regions.

f			Condensate/Crude Oil Spilled (Barrels)			Production	Drilling				Workover/ Completion	Well Type	Well Type	Wells Drilled
Year	Total Number of Incidents	I ncidentswith Condensate/ Crude Oil	Production, Workover, Completion, P&A	Drilling	Total Exploration and Development	Total	Total	Exploration	Development	Unknown	Total	Development	Exploration	Total
1956	1	0	—	—	0	—	1	—	—	1	—	198	44	242
1957	1	0	—	—	0	—	1	—	—	1	—	311	55	366
1958	2	1	Minimal	—	Minimal	—	1	—	—	1	1	198	62	260
1959	1	0	—	—	0	—	1	—	—	1	—	225	95	320
1960	2	0	—	—	0	1	1	—	—	1	—	285	134	419
1961	0	0	—	—	0	—	—	—	—	0	—	340	127	467
1962	1	0	—	—	0	—	1	—	—	1	—	368	156	524
1963	1	0	—	—	0	—	1	—	—	1	—	379	202	581
1964	8	3	10,280#	100	10,380	5	3	—	—	3	—	493	218	711
1965	5	2		1.688	1,688	1	4	—	—	4	—	637	178	815
1966	2	2	Minimal	Minimal	Minimal	—	1	—	—	1	1	604	280	884
1967	2	1	Minimal	—	Minimal	0	—	—	—	—	2	611	297	908
1968	8	0	—	—	0	1	6	—	—	—	1	679	310	989
1969	3	3	—	82,500	82,500	1	2	—	1	1	—	630	233	863
1970	3	3	83,000	—	83,000	1	1	—	—	1	1	652	217	869
56-70	**40**	**15**	**93,280**	**84,288**	**177,568**	**10**	**24**	**0**	**1**	**17**	**6**	**6,610**	**2,608**	**9,218**
Major Regulatory Changes to Outer Continental Shelf Lands Act														
1971	6	2	460	—	460	2	2	1	1	—	2	573	264	837
1972	6	1	2	—	2	1	4	2	2	—	1	577	301	878
1973	3	0	0	—	0	—	3	2	1	—	—	550	308	858
1974	6	2	275	—	275	3	2	1	1	—	1	494	344	838
1975	7	0	0	—	0	—	5	4	1	—	2	541	326	867
1976	6	0	—	—	0	1	5	1	4	—	—	810	295	1105
1977	9	1	2	—	2	1	4	3	1	—	4	888	352	1240
1978	11	0	0	—	0	—	7	3	4	—	4	864	324	1188
1979	5	0	0	—	0	—	5	4	1	—	—	811	351	1162
1980	8	1	1	—	1	2	4	3	1	—	2	835	367	1202
1981	10	4	64	—	64	1	3	1	2	—	6	907	354	1261
1982	9	0	0	—	0	—	5	1	4	—	4	862	412	1274
1983	12	1	—	2	2	—	10	5	5	—	2	781	399	1180
1984	5	0	—	—	0	—	4	3	1	—	1	773	598	1371
1985	6	1	50	—	50	0	4	3	1	—	2	682	536	1218
1986	2	0	—	—	0	—	1	—	1	—	1	460	272	732
1987	8	2	61	—	61	3	2	2	—	—	3	464	420	884
1988	4	1	5	—	5	1	2	1	1	—	1	460	571	1031
1989	12	0	—	—	0	3	7	2	3	2 *	2	524	471	995
1990	7	3	18	—	18	0	3	1	2	—	4	580	504	1084
1991	8	1	—	0.8	0.8	—	6	2	2	2*	2	457	334	791
1992	3	1	—	100	100	—	3	3	—	—	—	347	223	570
1993	4	0	—	—	0	—	4	1	3	—	—	593	357	950
1994	1	0	—	—	0	—	—	—	—	—	1	621	427	1048
1995	1	0	—	—	0	—	1	1	—	—	—	710	388	1098
1996	4	0	—	—	0	—	2	1	1	—	2	726	453	1179
1997	5	0	—	—	0	—	4	1	3	—	1	859	540	1399
1998	7	3	1.5	—	4.2	2	2	1	1	—	3	643	497	1140
1999	5	1	125	—	125	—	3	1	2	—	2	664	371	1035
2000	9	3	—	200.5	200.5	—	8	5	3	—	1	936	443	1379
2001	10	1	1	—	1	2	5	1	4	—	3	853	411	1264
2002	6	1	350 #	—	350	2	3	1	2	—	1	633	309	942
2003	5	2	10	—	10	2	2	1	1	—	1	539	354	893
2004	5	3	2.5	16.4	18.9	—	2	2	—	—	3	554	362	916
2005	4	0	—	—	0	—	4	3	1	—	—	457	355	812
2006	2	0	10	—	10	—	1	1	—	—	1	350	414	764
2007	7					1	2	2			4	316	300	616
71-07	**228**	**35**	**1,438.00**	**319.70**	**1,760.40**	**27**	**134**	**70**	**60**	**4**	**67**	**23,694**	**14,307**	**38,001**

Source: USDOI, MMS, Accident Investigation Board (2008). **Notes:** 1. Databases and incident reports frozen as of August 4, 2008; 2007 data not finalized, 2. # = hurricane-related; * sulphur blowouts.

1.3.3 Historical Exploration Well-Control Incidents on the OCS and Canadian Beaufort.

Thirty-five (35) exploration wells were drilled between 1982 and 2003 in the U.S. Chukchi and Beaufort seas. Historically, no exploration drilling blowouts occurred as a result of the Chukchi Sea and Beaufort Sea OCS exploration drilling, nor have any occurred from the approximately 98 exploration and deep stratigraphic test wells drilled within the Alaska OCS.

One exploration drilling blowout of gas has occurred on the Canadian Beaufort. Up to 1990, 85 exploratory wells were drilled in the Canadian Beaufort Sea, and one shallow-gas blowout occurred. A second incident was not included at the Amaluligak wellsite with the Molikpaq drill platform. This resulted in a gas flow through the diverter, with some leakage around the flange. The incident does not qualify as a blowout by the definition used in other databases and, therefore, was excluded (Devon Canada Corporation, 2004).

From 1971-2007, industry has drilled approximately 172 exploration wells in the Pacific OCS, 51 in the Atlantic OCS, 14,006 in the Gulf of Mexico OCS, and 98 in the Alaska OCS, for a total of 14,307 exploration wells. From 1971-2007, there were 70 well-control incidents during exploration drilling. Of those 70 well-control incidents, four resulted in crude or condensate oil spills of 200, 100, 11, and 0.8 bbl, respectively (Table A-3). No large spills (≥1,000 bbl) have occurred from 1971-2007 during exploration drilling. Therefore, approximately 14,000 exploration wells have been drilled, and four small spills resulted in crude or condensate reaching the environment from well-control incidents during exploration drilling (Table A-3).

1.3.4 Modeled Exploration Well-Control Incident Frequencies.

Bercha (2006, 2008) developed an oil-spill occurrence fault-tree model to estimate the oil-spill rates associated with oil and gas operations for Arctic OCS locations. The information from Bercha (2006, 2008) was used in the USDOI MMS (2006, 2008) oil-spill analyses in the Beaufort Sea.

Because limited historical spill data for the Arctic exist, Bercha modified the existing base data using fault trees to arrive at oil-spill frequencies for future exploration, development, and production scenarios. For offshore exploration drilling, Bercha (2008) used historical oil well blowout statistics derived from Holand (1997) for non-Arctic drilling operations and Scandpower's (2001) blowout frequency assessment for Northstar to estimate the expected size and frequency of spills. Bercha reported the historical spill frequency for non-Arctic exploration well drilling as 3.42×10^{-4} per well for a blowout ≥150,000 bbl (23,848 m^3).

To model the historical data variability for Arctic exploration well blowouts, Bercha applied a numerical simulation approach to develop the probability distribution for blowouts of 150,000 bbl (23,848 m^3) or greater, and arrived at a frequency ranging from a low of 1.5×10^{-4} per well to a high of 6.97×10^{-4} per well. The expected value for a blowout of this size was computed to be 3.94×10^{-4} per well (Bercha 2008). To address causal factors associated with blowouts, Bercha applied adjustments for improvements to logistics support and drilling contractor qualifications that resulted in lower predicted frequencies for Arctic drilling operations. No fault-tree analysis or unique Arctic effects were applied as a modification to existing spill causes for exploration, development, or production drilling frequency distributions. For exploration wells drilled in analogous water depths to planned Beaufort Sea wells (30-60 m), Bercha (2008) the estimated, adjusted frequency is 6.12 per 10^{-4} per well for a blowout sized between 10,000 bbl(1,590 m^3) and 149,000 bbl (23,689 m^3) and 3.54×10^{-4} per well for a blowout >150,000 bbl (23,848 m^3).

1.3.5 Historical Worldwide Very Large Spills from Well-Control Incidents.

Very large spills happen very infrequently, and there are limited data for use in our statistical analysis and predictive efforts. The chance of a very large spill occurring is very low. The largest spill from a well-control incident in Federal OCS waters is 80,000 bbl, approximately half the size of the starting value of the very large category, and it occurred in 1969. One other spill >50,000 bbl has happened since offshore drilling began in the United States. All five of the well-control-incident events ≥1,000 bbl in the OCS database occurred between 1964 and 1970 (Table A-3). Following the Santa Barbara well-control incident in 1969, amendments to the OCS Lands Act and implementing regulations significantly strengthened safety, inspection, and pollution-prevention requirements for OCS offshore activities. Well-control training, redundant pollution-prevention equipment, and subsurface safety devices are among the provisions that were adopted in the regulatory program. Since 1970, no OCS well-control incidents ≥1,000 bbl have occurred.

Because there have been no spills greater than 150,000 bbl in U.S. waters, the MMS looked elsewhere for data on spills of that size or larger. Therefore, we evaluated worldwide data to estimate the chance of very large spills occurring (USDOI, MMS, 2002). The spill information used was based on spills from other countries that do not have the regulatory standards that are enforced on the U.S. OCS. In addition, some drilling practices used elsewhere either are not practiced here or are against outer continental shelf regulations. An exploration well called IXTOC is in Mexican waters and not on the Gulf of Mexico OCS. For IXTOC, the blowout came about because the operator lost circulation in the well and decided to remove the drill pipe from the well prior to re-establishing circulation and not keeping the well full as the drill pipe was removed. Under MMS regulations, an operator would not be allowed to remove the drill string without ensuring that the well is under control and sufficient mud volume is kept in the well.

Internationally from 1979 through 1996, five oil-well blowouts greater than or equal to 10 million gal. (238,000 bbl) have occurred (Cutter Information Corp., 1997; DeCola, 2000). Five of the blowouts >10 million gal. mostly were the result of either war or drilling practices that oil companies do not now use and may not use under MMS regulations in the United States. During this same time period, there were roughly 470 Bbbl of oil produced worldwide (British Petroleum, 2001). These data provide a rate of about 0.01 blowouts ≥10 million gal. per billion barrels produced.

1.4 Oil-Spill Analysis Framework.

There are three potential size categories of oil spills in connection with exploratory work in this proposed action: (1) a large spill (≥1,000 bbl) from operations; (2) a very large spill (≥150,000 bbl) from a well-control incident; and (3) a small spill (<1,000 bbl). Historical and modeling data demonstrates that the probability of a large spill occurring during exploration is insignificant and, therefore, this EA does not analyze the impacts of large spills from exploration operations. The occurrence of a very large spill resulting from a well-control is similarly improbable. Nonetheless, this EA incorporates by reference the MMS's prior analyses of the impacts of a large and very large oil spill. See discussion in Section 1.4.2 below. It is likely a small spill could occur during exploration activities.

1.4.1 Small Oil Spills.

This section provides the analysis framework of a small oil spill used for the determination of impacts in this EA. Historical Beaufort Sea and Chukchi Sea OCS exploration spill data suggest that the most likely cause of an oil spill during exploration could be operational, such as a hose rupture, and the spill could be relatively small. For purposes of analysis, a 48-bbl fuel-transfer spill was chosen as the size spill in the small category, based on historical experience and oil-spill analysis. It is estimated to last less than 3 days on the surface of the water, based on weathering calculations. In terms of timing, a small spill from the operations could happen at any time from July to October during exploration operations. We assume that the vessel would not retain any oil. We assume that, depending on the time of year, a small spill reaches the following environments:

- vessel and then the water
- open water or open water and ice

The analysis of a small spill examines the weathering of the estimated spill. In our weathering analysis, we estimate the following fate of the diesel fuel without cleanup. Tables A-4 summarizes the results we estimate for the fate and behavior of diesel fuel in our analysis of the effects of oil on environmental and social resources.

We outline our assumptions for a small spill to provide a consistent analysis of spill impacts by resource. We base the analysis of effects from small oil spills on the following assumptions.

- One small spill occurs.
- The spill size is 48 bbl.
- All the oil reaches the environment; the vessel or facility absorbs no oil.
- The spill starts within Launch Area 15.
- There is no cleanup or containment. Containment and cleanup is analyzed separately as mitigation.
- The spill could occur at any time of the operations (July–October).
- The spill weathering is as we show in Table A-4, and the spill lasts less than 3 days on the water.
- The time and chance of contact from an oil spill are calculated from an oil-spill-trajectory model
- The chance of contact is analyzed from the location where it is highest when determining effects.

Modeling Simulations of Oil Weathering.

To judge the effect of a small oil spill, we estimate information regarding how much oil evaporates, how much oil is dispersed, and how much oil remains after a certain time period. We derive the weathering estimates of diesel fuel oil from modeling results from the SINTEF Oil Weathering Model Version 3.0 (Reed et al., 2005) for up to 30 days. Table A-4 summarizes the results we estimate for the fate and behavior of a 48-bbl diesel fuel spill. This estimate is slightly more conservative than the estimate in the EP Table 4.1.19-3 which used the ADIOS model and a water temperature 2 degrees higher. Both models provide a reasonable estimated range of the fate and behavior of diesel fuel under slightly different environmental conditions. Based on modeling simulations and response experience, a small, 48-bbl oil spill will be localized and short term.

Table A-4. Fate and Behavior of a Hypothetical 48-Barrel Diesel Fuel Oil Spill.

	Summer Spill[1]						
Time After Spill in Hours	1	2	3	6	12	24	48
Oil Remaining (%)	96	91	84	65	31	4	0
Oil Dispersed (%)	3	7	12	28	57	79	83
Oil Evaporated (%)	1	2	4	7	12	17	17
Thickness (mm)	0.7	0.5	0.5	0.3	0.1	0.1	0

Note: For the EA the small spill size is a 48-bbl diesel spill

Notes:
Calculated with the SiINTEF oil-weathering model Version3.0 of Reed et al. (2005) and assuming diesel fuel no 2.
1 Summer (July through September), 12-knot wind speed, 2 degrees Celsius, 0.4-meter wave height.

1.4.2 Previous Analysis of Very Large and Large Accidental Oil Spills.

The chance of a very large spill (≥150,000) is very low, but its potential effects were analyzed in USDOI, MMS (2003) Section IV.I Low-Probability, Very Large Oil Spill. The spill scenario was based on a 15,000-bbl flow-rate for 15 days totaling 225,000 bbl. In the unlikely event of a very large accidental oil spill, the potential for major impacts exist as was identified in USDOI, MMS (2003). There are no site-specific anomalies that differentiate a very large spill release in LA12, previously analyzed, from one in LA15, and the oil spill contacts are statistically similar. No new major effects from a very large spill are identified from this proposal.

The chance of a large (≥1,000) spill is low, but the potential consequences were analyzed in USDOI, MMS (2003) section IV.C.; USDOI, MMS (2006); and section 4.4 USDOI, MMS (2008). Based on OCS median spill sizes, the MMS estimated a 1,500-bbl diesel or crude oil spill from a facility or a 4,600 -bbl crude oil spill from a pipeline for purposes of analyzing a large spill size (Anderson and LaBelle, 2000). The conditional probabilities estimated by the Oil-Spill Risk Analysis (OSRA) model (expressed as percent chance) of a spill ≥1,000 bbl contacting environmental resource areas or land segments within a given time frame from launch areas (LA1-18) and pipeline segments (P1-11) assuming a spill occurs are discussed in USDOI, MMS (2003, 2004, 2006). In the unlikely event of a large accidental oil spill, the potential for major impacts exist from a large accidental oil spill as identified in previous analyses (USDOI, MMS, 2003, 2008). No new major effects from a large spill are identified from this proposal.

Launch Area 15 Conditional Probabilities. The conditional probabilities (expressed as percent chance) from LA 15 (USDOI, MMS, 2003: Tables A2-1-A2-54 and A2-73-A2-90) are statistically representative of the lease blocks cited in the Shell EP. The chance of a large spill contacting, assuming a large spill occurs, is summarized specifically for the LA15 and is inclusive in the conditional probability discussions in USDOI, MMS (2003, 2004, 2006) cited above. The estimated conditional probabilities do not factor in pre-booming or spill response; these are considered mitigation, and is analyzed and discussed as such in the impact sections of each resource. A successful or partially successful spill response would reduce the chance of spill contact or make contact nonexistent.

Probabilities in the following discussion, unless otherwise noted, are summer or winter conditional probabilities estimated by the OSRA model (expressed as percent chance) of a spill ≥1,000 bbl contacting environmental resource areas (ERAs) or land segments (LSs) within a given timeframe from LA15 assuming a spill occurs (USDOI, MMS, 2003: herein summarized as Tables A-5 and A-6).

Summer 3 Days. The OSRA model estimates a <0.5-28% chance of a spill ≥1,000 bbl contacting ERAs 29-37 (mean distance from coast of bowhead whale migration corridor). The chance of contacting ERAs 56-58, 80, and 84 (ice/sea segments) is <0.5-55%. The chance of contacting ERA6 (Cross and No Name Islands) is <0.5 %. The chance of contacting ERA 4 (Cross Island ERA) is 1%. The chance of contacting ERA43 (Nuiqsut Subsistence Area) is 1%. The chance of contacting ERAs 9, 11, or 12 (Stockton, Maguire, Flaxman Islands) is<0.5-1%. The chance of contacting individual LSs is <0.5 except for LS42 (Point Hopson & Sweeney, Staines River) and 43 (Brownlow Point, Canning River), which have a 1% chance of contact. The chance of contacting grouped land segment (GLS) 138 (Arctic National Wildlife Refuge LSs 43-51) is 1%.

Summer 10 Days. The OSRA model estimates a <0.5-32% chance of a spill ≥1,000 bbl contacting ERAs 29-37 (mean distance from coast of migration corridor). The chance of contacting ERA6 (Cross and No Name Islands) is 1%. The chance of contacting barrier islands ERAs 3-16 is <0.5-2%. The chance of contacting ERA43 (Nuiqsut Subsistence Area) is 4%. The chance of contacting individual LSs 39-46 is 1-2%. The chance of contacting GLS 138 (Arctic National Wildlife Refuge) is 6%.

Summer 30 Days. The OSRA model estimates a <0.5-34% chance of a spill ≥1,000 bbl contacting ERAs 29-37 (mean distance from coast of migration corridor). The chance of contacting barrier islands ERAs 3-16 is 1-5%. The chance of contacting ERA44 (Kaktovik Subsistence Area) is 12%. The chance of contacting ERA69 (Harrison Bay/Colville Delta) is <0.5-16%. The chance of contacting ERA3 (Thetis and Jones Islands) is <0.5-23%. The chance of contacting individual LSs 37-49 is <0.5-4%. The chance of contacting GLS 138 (Arctic National Wildlife Refuge) is 15%.

Winter 3 Days. The OSRA model estimates a <0.5-7% chance of a spill ≥1,000 bbl contacting ERAs 29-37 (mean distance from coast of migration corridor). The chance of contacting ERAs 56-58, 80, and 84 (ice/sea segments) is <0.5-51%. The chance of contacting ERA79 is 2%. The chance of contacting barrier islands (ERAs 3-16) is <0.5%. The chance of contacting ERAs 43-44 (Nuiqsut or Kaktovik Subsistence Area) is <0.5%. The chance of contacting all individual LSs is <0.5. The chance of contacting GLS 138 (Arctic National Wildlife Refuge) is <0.5%.

Winter 10 Days. The OSRA model estimates a <0.5-7% chance of a spill ≥1,000 bbl contacting ERAs 29-37 (mean distance from coast of migration corridor). The chance of contacting barrier islands (ERAs 3-16) is <0.5%. The chance of contacting ERA43 (Nuiqsut Subsistence Area) is <0.5% and ERA44 (Kaktovik Subsistence Area) is <0.5-3%. The chance of contacting ERA69 (Harrison Bay/Colville Delta) is <0.5-1%. The chance of contacting ERA3 (Thetis and Jones Islands) is <0.5-3%. The chance of contacting individual LSs 46 (Arey Island, Barter Island), 47 (Kaktovik), or 48 (Griffin Point, Oruktalik Lagoon) is <0.5-1%. The chance of contacting GLS 138 (Arctic National Wildlife Refuge) is <0.5-7%.

Winter 30 Days. The OSRA model estimates a <0.5-8% chance of a spill ≥1,000 bbl contacting ERAs 29-37 (mean distance from coast of migration corridor). The chance of contacting ERA6 (Cross and No Name Islands) is <0.5%. The chance of contacting ERAs 15-16 (Arey and Barter Islands, Bernard, Jago and Tapkaurak Spits) is <0.5-3%. The chance of contacting ERA43 (Nuiqsut Subsistence Area) is <0.5-1%. The chance of contacting ERA44 (Kaktovik Subsistence Area) is <0.5-4%. The chance of contacting ERA69 (Harrison Bay/Colville Delta) is <0.5-2%. The chance of contacting ERA3 (Thetis and Jones Islands) is <0.5-3%. The chance of contacting individual LSs 46 (Arey Island, Barter Island), 47 (Kaktovik), or 48 (Griffin Point, Oruktalik Lagoon) is <0.5-2%. The chance of contacting GLS 138 (Arctic National Wildlife Refuge) is <0.5-11%.

Table A-5. Annual, Summer, and Winter Conditional Probabilities (Expressed as Percent Chance) that an Oil Spill Starting at LA15 Will Contact a Certain Land Segment or Group of Land Segments Within 3, 10 or 30 Days Assuming a Spill Occurs, Beaufort Sea Sales 186, 195, and 202.

		Annual			Summer			Winter		
ID	**Land Segment Name**	**3 Days**	**10 Days**	**30 Days**	**3 Days**	**10 Days**	**30 Days**	**3 Days**	**10 Days**	**30 Days**
37	Milne Point, Simpson Lagoon	:	:	:	:	:	2	:	:	:
38	Kuparuk River	:	:	:	:	:	1	:	:	:
39	Point Brower, Prudhoe Bay	:	:	:	:	1	1	:	:	:
41	Bullen Point, Point Gordon, Reliance Pt	:	:	:	:	1	1	:	:	:
42	Point Hopson, & Sweeney, Staines River	:	1	1	1	2	2	:	:	1
43	Brownlow Point, Canning River	:	1	1	1	2	3	:	:	1
44	Collinson Point Konganevik Point	:	:	:	:	1	1	:	:	:
45	Anderson Point, Sadlerochit River	:	:	1	:	1	2	:	:	:
46	Arey Island, Barter Island,	:	:	1	:	1	2	:	:	:
47	Kaktovik	:	:	1	:	1	4	:	:	:
48	Griffin Point, Oruktalik Lagoon	:	:	1	:	:	2	:	:	:
49	Angun Pt., Beaufort Lagoon	:	:	:	:	:	1	:	:	:
ID	**Grouped Land Segment Name**	**3 Days**	**10 Days**	**30 Days**	**3 Days**	**10 Days**	**30 Days**	**3 Days**	**10 Days**	**30 Days**
	Teshekpuk Lake Special Area (NPR-A)	:	:		:	:	1	:	:	1
	Arctic National Wildlife Refuge	:	2	5	1	6	15	:	1	2

Notes: ** = Greater than 99.5 percent; : = less than 0.5 percent; LA = Launch Area, Rows with all values less than 0.5 percent are not shown.

Table A-6. Annual, Summer, and Winter Conditional Probabilities (Expressed as Percent Chance) that an Oil Spill Starting at LA15 Will Contact a Certain Environmental Resource Area Within 3, 10, and 30 Days, Beaufort Sea Sales 186, 195, and 202.

ID	Environmental Resource Area Name	Annual			Summer			Winter		
		3 Days	10 Days	30 Days	3 Days	10 Days	30 Days	3 Days	10 Days	30 Days
—	Land	1	3	8	2	10	23	:	1	3
3	Thetis and Jones Islands	:	:	1	:	1	3	:	:	:
4	Cottle & Return Islands, West Dock	:	:	1	:	1	3	:	:	:
5	Midway Islands	:	:	1	:	1	2	:	:	:
6	Cross and No Name Islands	:	:	1	:	1	3	:	:	:
7	Endicott Causeway	:	:	:	:	1	1	:	:	:
8	McClure Islands	:	1	1	:	2	3	:	:	1
9	Stockton Islands	:	1	1	1	2	3	:	:	1
11	Maguire Islands	:	1	1	1	2	2	:	:	:
12	Flaxman Island	:	1	1	1	2	3	:	:	:
13	Barrier Islands	:	:	1	:	1	2	:	:	:
14	Anderson Point Barrier Island	:	:	:	:	1	1	:	:	:
15	Arey and Barter Islands, Bernard Spit	:	1	2	:	2	5	:	:	:
16	Jago and Tapkaurak Spits	:	:	1	:	1	5	:	:	:
17	Angun and Beaufort Lagoons	:	:	:	:	:	1	:	:	:
28	Beaufort Spring Lead 10	:	:	1	:	:	:	:	:	2
31	Ice/Sea Segment 3	:	:	:	:	:	1	:	:	:
32	Ice/Sea Segment 4	:	1	2	:	1	5	:	:	1
33	Ice/Sea Segment 5	2	4	5	5	9	13	1	2	2
34	Ice/Sea Segment 6	12	14	14	28	32	34	7	7	8
35	Ice/Sea Segment 7	:	1	3	1	5	10	:	:	1
36	Ice/Sea Segment 8	:	:	1	:	1	5	:	:	:
37	Ice/Sea Segment 9	:	:	:	:	:	1	:	:	:
43	Nuiqsut Subsistence Area	:	1	3	1	4	8	:	1	1
44	Kaktovik Subsistence Area	:	1	3		5	12	:	:	:
54	Ice/Sea Segment 16a	:	:	3	:	:	2	:	:	3
55	Ice/Sea Segment 17	:	3	11		2	7	:	3	12
56	Ice/Sea Segment 18a	14	29	34	12	22	27	14	32	37
57	Ice/Sea Segment 19	52	59	61	55	63	66	51	58	60
58	Ice/Sea Segment 20a	:	6	15	1	10	21	:	5	12
59	Ice/Sea Segment 21	:	:	3	:	:	6	:	:	2
61	Ice/Sea Segment 23	:	:	:	:	:	1	:	:	:
67	Ice/Sea Segment 16b	:	:	2	:	:	2	:	:	2
69	Harrison Bay/Colville Delta	:	:	:	:	:	1	:	:	:
70	ERA 3	:	:	2	:	:	2	:	:	2
71	Simpson Lagoon	:	:	1	:	1	3	:	:	:
72	Gwyder Bay	:	:	:	:	:	1	:	:	:
74	Cross Island ERA	1	2	4	1	4	8	:	2	2
75	Water over Boulder Patch 1	:	1	1	:	1	2	:	:	1
76	Water over Boulder Patch 2	:	1	1	:	2	3	:	:	1
77	Foggy Island Bay	:	:	:	:	1	1	:	:	:
78	Mikelson Bay	:	:	:	:	:	1	:	:	:
79	ERA 4	3	5	6	5	9	11	2	3	4
80	Ice/Sea Segment 18b	7	14	16	12	22	27	5	11	12
81	Simpson Cover	:	:	:	:	1	1	:	:	:
82	ERA 5	1	3	5	2	9	14	:	1	2
83	Kaktovik ERA	:	2	5	1	5	13	:	1	2
84	Ice/Sea Segment 20b	:	4	8	:	10	21	:	2	4
85	ERA 6	:	:	:	:	:	1	:	:	:

Notes: ** = Greater than 99.5 percent; : = less than 0.5 percent; LA = Launch Area, Rows with all values less than 0.5 percent are not shown.

Assuming a spill occurs, the chance of a large spill contacting the group of land segments representing Arctic National Wildlife Refuge ranges from 1 percent during summer to <0.5 percent during winter within 3 days from LA15. The SINTEF Oil Weathering Model estimates that within approximately 48 hours a small 48-bbl diesel fuel spill will evaporate and disperse. Based on the weathering characteristics it is likely 48-bbl diesel fuel spill would dissipate before reaching the land segments representing Arctic National Wildlife Refuge. Lease Stipulation 6, pre-booming requirements for fuel transfers, provides further mitigation to reduce the chance of an oil spill contacting the land segments representing Arctic National Wildlife Refuge. This stipulation provides for booming during fuel transfers ensuring a 48-bbl diesel fuel spill would be contained, localized and cleaned up. Shell's, Alaska fuel transfer - operating condition and procedure, also addresses weather and spill response, so not to prevent the deployment of spill containment boom and oil recovery vessels from carrying out an effective response in the event of a spill.

Given the: (1) low chance of a large spill contacting, assuming one occurs; (2) the low chance of a 48-bbl diesel fuel spill persisting for 3 days; and (3) the likely containment and cleanup of a 48-bbl diesel fuel spill because the requirements of Lease Stipulation 6 and the Shell's Alaska fuel-transfer operating conditions and procedures; the grouped land segments, representing the Arctic National Wildlife Refuge, are not estimated to be contacted from a 48-bbl diesel fuel spill occurring at the Torpedo H or Sivulliq N drill sites.

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