Alaska Outer Continental Shelf

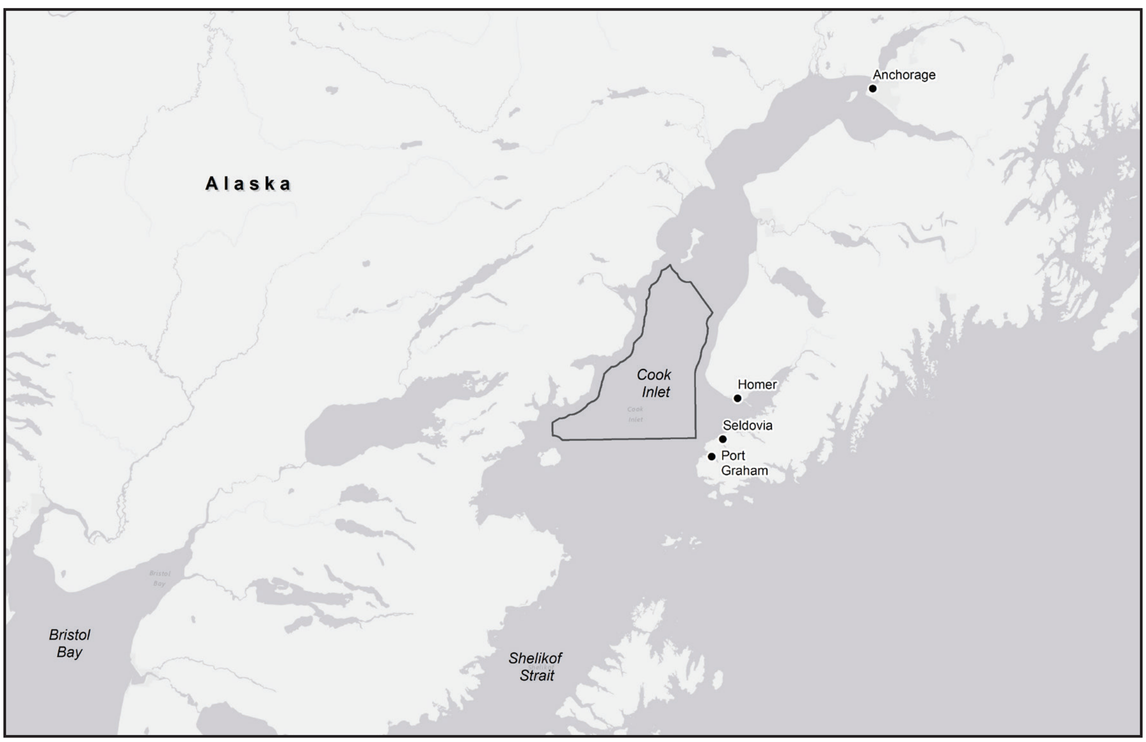
OCS EIS/EA
BOEM 2016-004

Cook Inlet Planning Area

Oil and Gas Lease Sale 244
In the Cook Inlet, Alaska

Draft Environmental Impact Statement

Volume 2. Chapters 5-7 and Appendices



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

June 2016

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Prepared by
Bureau of Ocean Energy Management
Alaska OCS Region

Cooperating Agency
National Park Service

U.S. Department of the Interior
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Alaska OCS Region

June 2016

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Chapter 5

Cumulative Effects

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Chapter 5. CUMULATIVE EFFECTS

5.1. Introduction

This chapter analyzes the potential cumulative impacts of Lease Sale 244. A cumulative impact is defined by NEPA regulations as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR 1508.7).

Cumulative impacts are assessed by determining the incremental impact of a proposed action when added to the effects of past, present, and reasonably foreseeable future activities in the vicinity of the project. The ultimate goal of identifying potential cumulative effects is to provide for informed decisions that consider the total effects (direct, indirect, and cumulative) of the project alternatives. As suggested by the CEQ handbook "Considering Cumulative Effects Under the National Environmental Policy Act" (CEQ, 1997b), the following types of effects are considered in this chapter:

- Additive – the sum total impact resulting from more than one action
- Countervailing – adverse impacts that are offset by beneficial impacts; and
- Synergistic – when the total impact is greater than the sum of the effects taken independently

Cumulative effects may result from the incremental accumulation of similar effects or the synergistic interaction of different effects. Repeated actions may cause effects to build over time, or different actions may produce effects that interact to produce cumulative impacts greater than (or less than) the sum of the effects of the individual actions.

The cumulative analysis in this EIS focuses on the Proposed Action (Alternative 1). Cumulative effects of the other action alternatives will be similar to the cumulative effects identified for the Proposed Action, because all of the action alternatives are presumed to entail the same amount of oil and gas activity. However, the analysis does not include instances where mitigations proposed in the other action alternatives would serve to reduce potential cumulative impacts. The No Action alternative does not require a separate cumulative effects analysis under NEPA, as the lease sale would not be held and there would be no incremental contribution to the past, present, or reasonably foreseeable future activities already described in this chapter.

To keep the cumulative analysis useful and manageable, the analysis focuses on activities that are reasonably foreseeable, that overlap geographically with the proposed Lease Sale Area or other areas affected by the Proposed Action, and that have effects of greatest concern.

5.1.1. Temporal and Geographic Scope of the Analysis

The first step in the cumulative effects analysis was to define the temporal and geographic scope. A time period of 40 years was selected based on the E&D Scenario presented in Section 2.4. The geographic scope focuses on the proposed Lease Sale Area for Lease Sale 244, which consists of the northern portion of the Cook Inlet Planning Area, as shown in Chapter 2. However, the cumulative effects analysis included all Federal and state waters and shorelines of Cook Inlet from Anchorage to the southern entrances of Cook Inlet. This area was expanded for individual resources as appropriate (e.g., to include towns, private lands, and communities, or to include the watershed for anadromous fishes). For large spill impacts, the analysis considered the full range of waters, land segments (LSs), grouped land segments (GLSs), and environmental resource areas (ERAs) estimated to be contacted (1% chance or greater) by a large spill within 30 days from the Proposed Action (Appendix A).

5.1.2. Past, Present, and Reasonably Foreseeable Activities

For the cumulative effects analysis, BOEM identified past, present, and reasonably foreseeable future actions and their effects on the marine, coastal, and human environments. The locations of many of these projects and activities are shown in Figure 5.1.2-1.The categories of activities considered for the cumulative effects analysis are listed in Table 5.1.2-1 and described in subsequent sections.

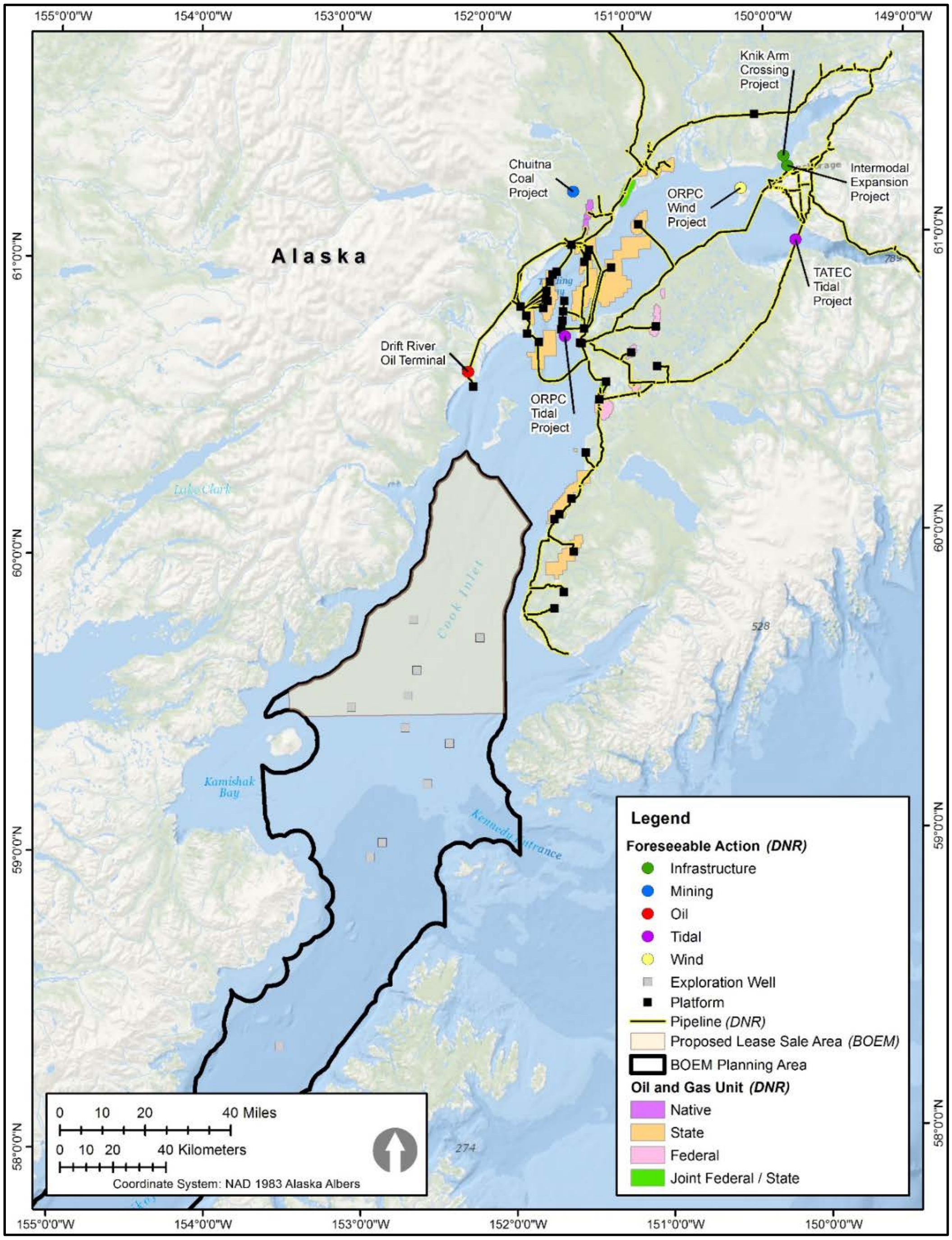

Figure 5.1.2-1. Site-Specific Past, Present, and Reasonably Foreseeable Future Actions. ***BOEM identified and considered these in the cumulative effects analysis.***

Table 5.1.2-1. Past, Present, and Reasonably Foreseeable Future Activity Categories Considered.

Category	Description	Past	Present	Future
Oil and gas activities (non-Lease Sale 244)	Oil and Gas exploration, development, and production in state and Federal waters and state onshore	X	X	X
Renewable energy projects	Fire Island Wind Project Turnagain Arm Tidal Energy Project	X	X	X
Mining projects	Chuitna Coal Project Diamond Point Rock Quarry Pebble Mine Port and Terminal Donlin Gold Mine Proposed Natural Gas Pipeline	X	X	X
Marine transportation	Shipping in Cook Inlet	X	X	X
Ports and terminals	Port expansion projects (Anchorage, Port MacKenzie) Routine port operations	X	X	X
Knik Arm Crossing Project	Bridge construction near Anchorage	--	--	X
Submarine cable projects	AKORN Fiber Optic Cable United Utilities Fiber Optic Cable	X	X	X
Wastewater discharges	Permitted point-source discharges such as municipal wastewater and seafood processing	X	X	X
Persistent contaminants and marine debris	Contaminants such as PCBs and pesticides; floating debris from ocean-based and land-based activities	X	X	X
Dredging and marine disposal	Routine maintenance dredging of ports	X	X	X
Military activities	Joint Base Elmendorf-Richardson (JBER)	X	X	X
Fishing activities	Commercial, recreational and subsistence fishing	X	X	X
Climate change	Global changes due to GHG emissions	X	X	X

Note: X = applicable during the time period; -- = not occurring during the time period.

5.1.2.1. Oil and Gas Activities (Non-Lease Sale 244)

Federal Waters

There have been five OCS lease sales in Cook Inlet. The most recent (Lease Sale 191) was held in 2004, with no bids received. Thirteen exploratory wells have been drilled in Cook Inlet OCS waters, with no commercial discoveries. There are no existing OCS leases in this area. Exploration history is discussed in Section 2.4.2.

Lease Sale 244 is the only OCS lease sale in Cook Inlet that is included in the OCS Oil and Gas Leasing Program for 2012-2017 (USDOI, BOEM, 2012). The Five-Year Program for 2017-2022 is currently in development (USDOI, BOEM, 2016) and will be finalized in 2017. The Proposed 2017-2022 Program (PP) was made available for public comment on March 18, 2016 (81 *FR* 14881). The PP schedules three potential lease sales off the coast of Alaska, and identifies one potential sale each in the Beaufort Sea (2020), Cook Inlet (2021), and Chukchi Sea (2022) Planning Areas. The potential Cook Inlet sale scheduled for 2021 is in a program area that includes only the northern portion of the Cook Inlet OCS Planning Area. This program area is similar to the area identified in the Lease Sale 244 Area ID and analyzed under the Proposed Action here.

To inform the cumulative effects analysis, BOEM assumes that exploration, development, and production could occur from a reasonably foreseeable future lease sale in the Cook Inlet Planning Area. Based on the Area ID for Lease Sale 244, and the area identified in the 2017-2022 PP, BOEM expects that this will be an area of focus in potential future lease sales.

State Waters and Onshore

Upper Cook Inlet is a mature basin with extensive exploration and development onshore and in state waters over the past 50 years. Oil and gas discoveries in upper Cook Inlet cover an estimated 11,400 km^2 (4,400 mi^2), and extend from Kachemak Bay north to the Susitna River. The area includes oil fields in offshore Cook Inlet, the west shore of Cook Inlet, and the western half of the Kenai Peninsula (ADNR, 2009b).

As of December 2013, a total of 1,106 wells had been drilled in the course of exploration and development activities in Cook Inlet state lands and waters, of which 433 are classified as plugged and abandoned. An additional 22 new wells were drilled by Hilcorp Alaska, LLC in 2014 (AOGA, 2015). Commercial production of oil and gas has occurred from approximately 41,644 ha (102,903 ac) in the area. Approximately 40,234 line km (25,000 line mi) of 2D seismic surveys and 3,367 km^2 (1,300 mi^2) of 3D seismic surveys have been performed (ADNR, 2015a).

Leasing and Exploration Licensing

As of December 2013, approximately 0.45 million ha (1.1 million ac) were under lease from the State of Alaska in the Cook Inlet area, including 175,563 ha (428,884 ac) onshore and 281,885 ha (696,552 ac) offshore (ADNR, 2015a). The State of Alaska's Five Year Program for 2015 through 2019 proposed one sale annually in the Cook Inlet Areawide sale area (ADNR, 2015f), the most recent of which was held in May 2015 (ADNR, 2015g). The 2016 lease sale was scheduled for May 4, 2016 but was cancelled because no bids were received (Earl, 2016).

The 2015-2019 Cook Inlet Areawide lease sale area (Figure 5.1.2-2) includes state waters and submerged lands in upper Cook Inlet as well as extensive state-owned uplands. The sale area is approximately 1.7 million ha (4.2 million ac), divided into 815 tracts ranging from 259 to 2,331 ha (640 to 5,760 ac) (ADNR, 2016b). The Cook Inlet 2014 Areawide sale resulted in leasing of 32 tracts, totaling 33,800 ha (83,521 ac)(ADNR, 2014i). The 2015 Cook Inlet Areawide sale resulted in leasing of 7 tracts totaling 9,632 ha (23,800 ac)(ADNR, 2015g).

In 2014, the State of Alaska issued an exploration license in southwest Cook Inlet covering an area of approximately 68,400 ha (169,000 ac) (ADNR, 2014a) (Figure 5.1.2-3). The exploration license issued to Cook Inlet Energy LLC carries a primary license term of 4 years and is adjacent to the proposed Lease Sale Area for Lease Sale 244.

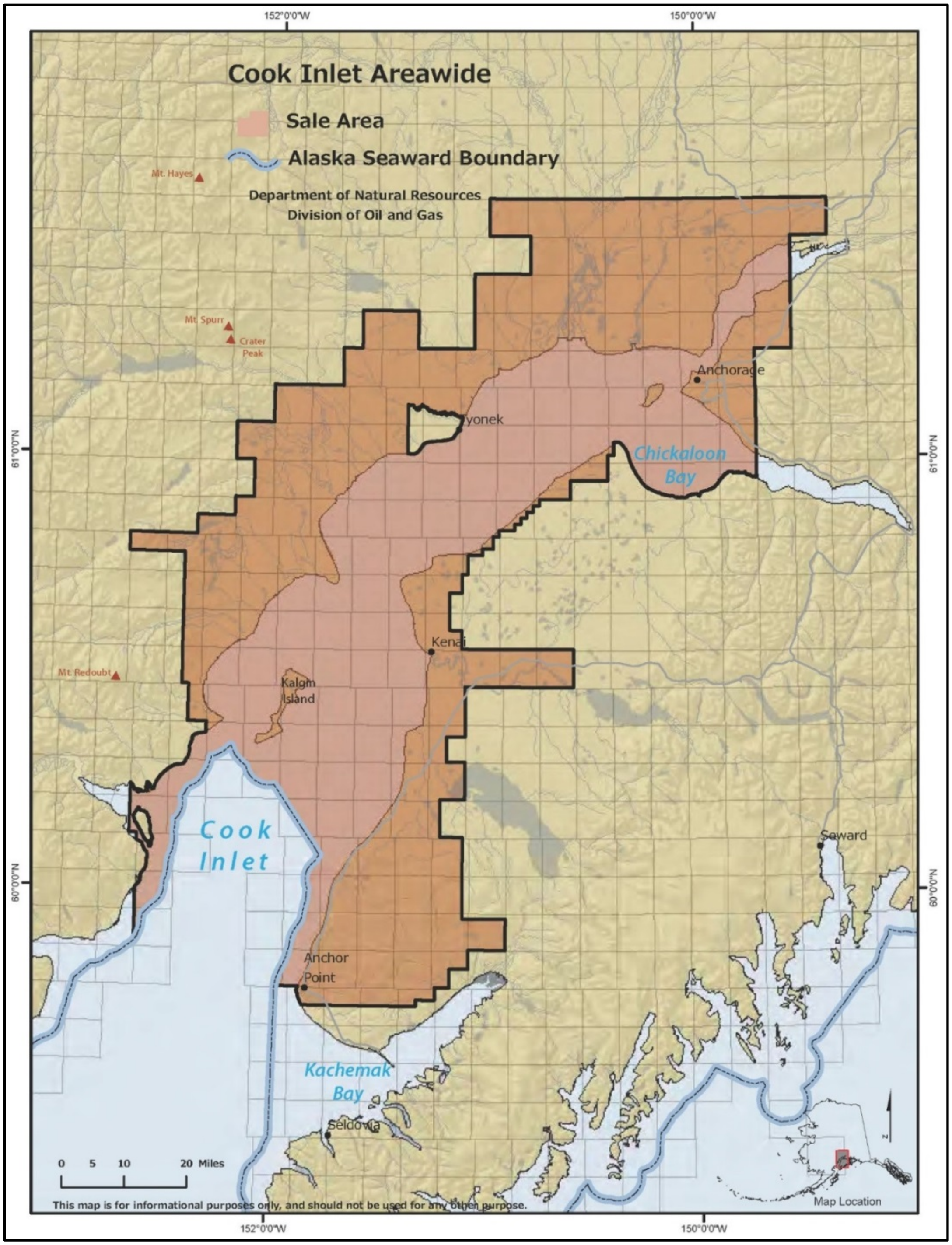

Figure 5.1.2-2. Alaska Department of Natural Resources Cook Inlet Area-Wide Lease Sale Area. ***Includes State Waters and Submerged Lands in Upper Cook Inlet as well as Extensive State-Owned Uplands.***

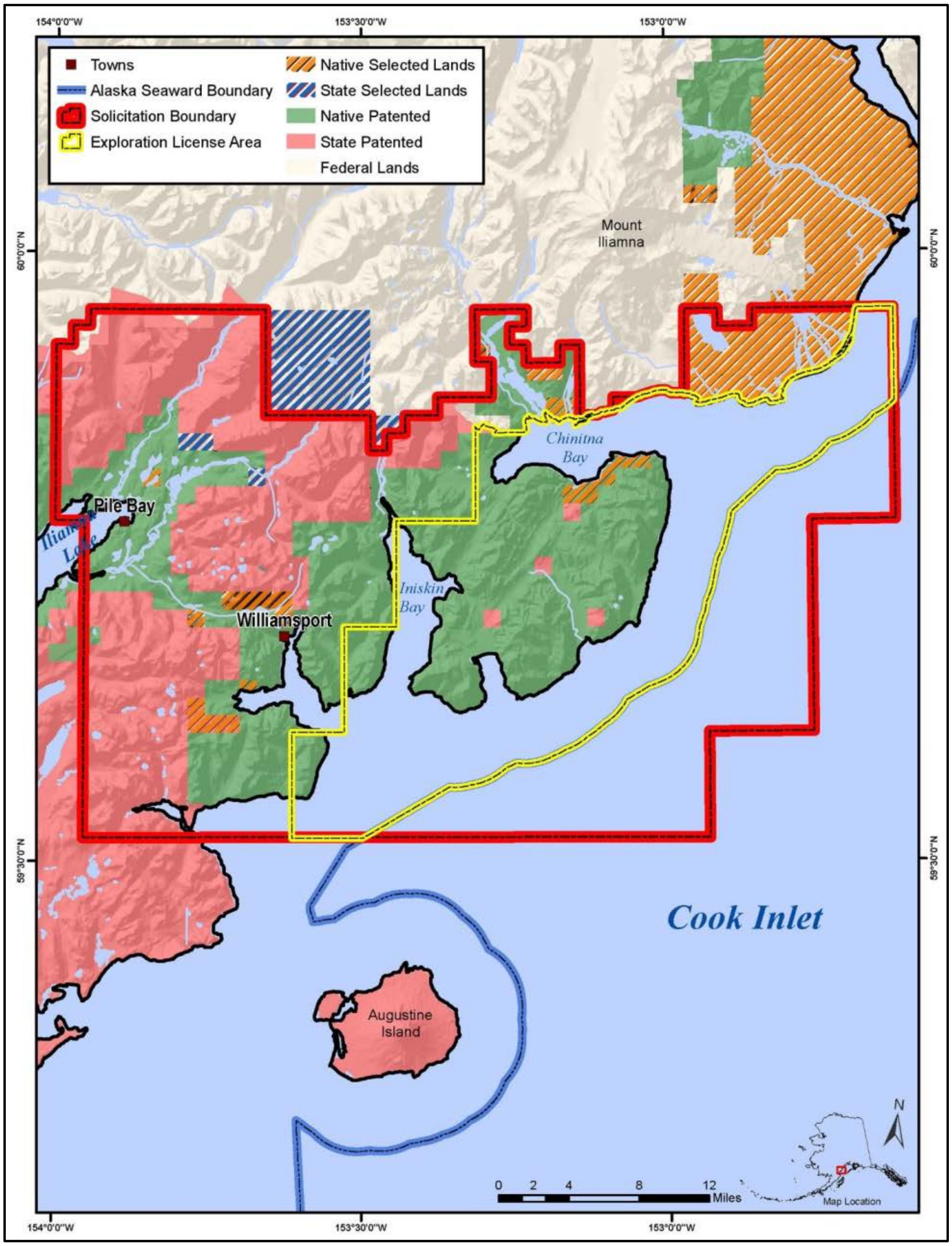

Figure 5.1.2-3. State-Issued Exploration License in Southwest Cook Inlet. ***License covers an area of approximately 68,390 hectares (ha) (169,000 acres (ac)) (ADNR, 2014a).***

Existing Infrastructure

There are approximately 30 active oil and gas units in the Cook Inlet region (ADNR, 2015a, 2016b). Active state units include Cosmopolitan, Ninilchik, Redoubt, South Middle Ground Shoal, Kitchen Lights, Trading Bay, Granite Point, West MacArthur River, North Cook Inlet, Beluga River, Nicolai Creek, and Stump Lake (Figure 5.1.2-4).

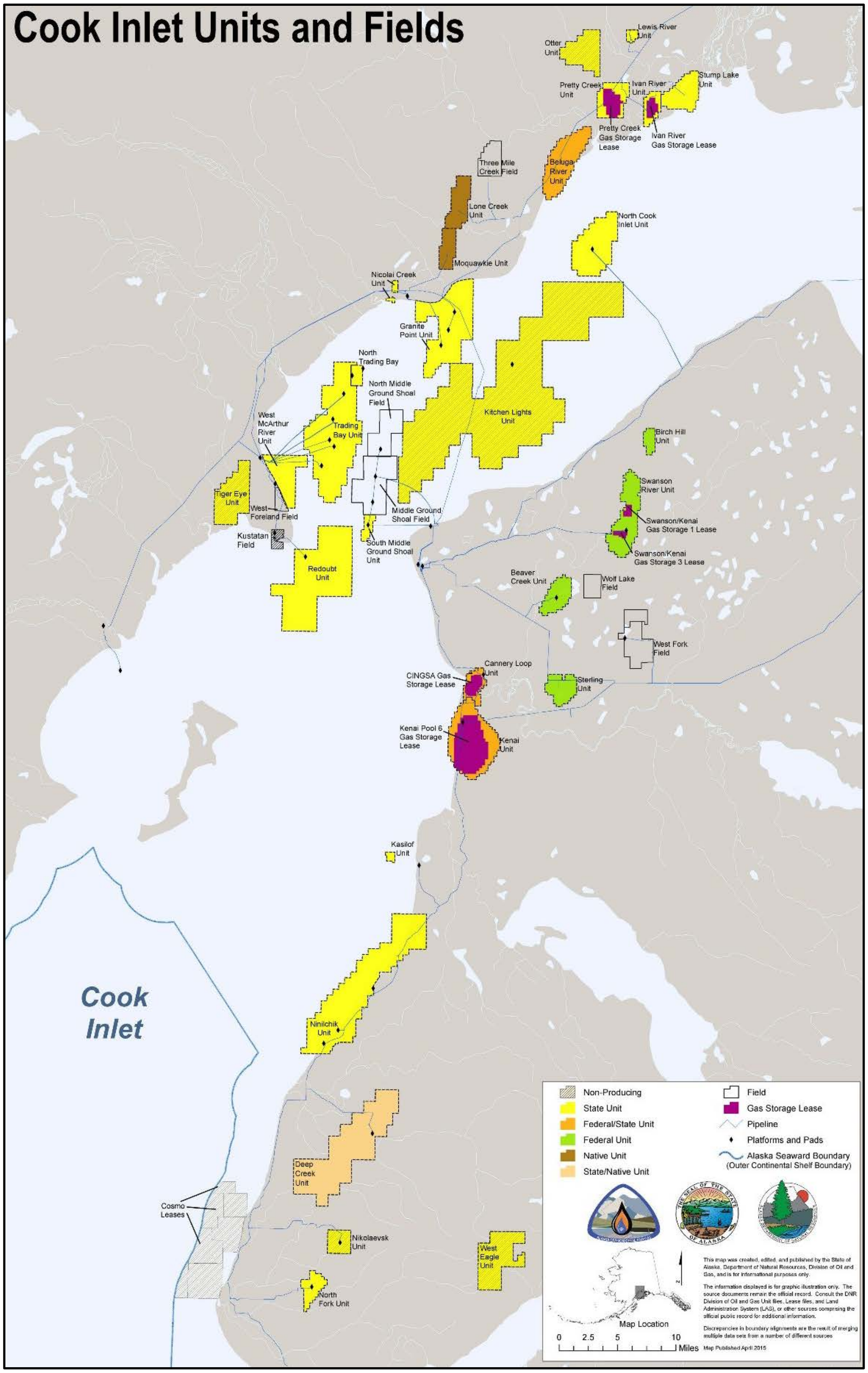

Figure 5.1.2-4. State Regulated Active Oil and Gas Units in the Cook Inlet Region ***(ADNR, 2016b).***

Existing infrastructure in upper Cook Inlet includes 17 offshore platforms in state waters, associated oil and gas pipelines, and onshore processing and support facilities (AOGA, 2015; Crowley Solutions, 2015). As of December 2013 there were approximately 365 km (227 mi) of undersea pipelines in Cook Inlet, including 126 km (78 mi) of oil pipelines and 240 km (149 mi) of gas pipelines (ADNR, 2015a) (Figure 5.1.2-5). An additional 16 mi of subsea gas pipeline was installed in summer 2015 at the Kitchen Lights Unit (Crowley Solutions, 2015). Crude oil production is handled through the Trading Bay Production Facility, located on the west side of Cook Inlet, which pipes crude oil to the Drift River Oil Terminal. Almost all Drift River crude oil is transported across Cook Inlet by tankers to the Tesoro Refinery in Nikiski and is consumed within Alaska. The Tesoro Refinery produces gasoline and gasoline blendstocks, jet fuel, diesel fuel, heavy fuel oils, propane, and asphalt.

Jet fuel, gasoline, and diesel are transported to the Port of Anchorage and the Anchorage International Airport through a common-carrier pipeline (AOGA, 2015). Crude oil is delivered by double-hulled tankers through Cook Inlet and by pipeline from Cook Inlet and the Kenai Peninsula. The refinery also supplies Tesoro’s network of gas stations throughout Alaska. Natural gas is processed through several plants in Nikiski and transported by pipeline to Anchorage or Girdwood for domestic consumption, or processed at the Kenai LNG plant and exported to Japan (ADNR, 2015a).

Present and Reasonably Foreseeable Future Activities

The Cook Inlet basin has produced 8,308 Bcf of gas and 1.35 Bbbl of oil as of December 31, 2014 (the most recent date for which data are available), and the ADNR Division of Oil & Gas estimates there is approximately 1,183 Bcf of proved and probable gas reserves remaining, excluding possible reserves and contingent resources (e.g., discovered undeveloped fields such as Kitchen Lights and Cosmopolitan) (Munisteri, Burdick, and Hartz, 2015). Activities have increased since 2010 when Alaska passed the Cook Inlet Recovery Act, expanding the capital credits available to Cook Inlet producers and clearing the way for the construction of a natural gas storage facility. As large companies moved out of Alaska, smaller independent companies moved in and began operating. These companies drilled new wells and upgraded their newly acquired platforms (AOGA, 2015). Since the revitalization effort began, there has been an 80% increase in Cook Inlet oil production (AOGA, 2015). Figure 5.1.2-6 highlights past, present, and reasonably foreseeable future oil and gas activities in Cook Inlet state waters as of November 2015. Selected projects are discussed in the following subsections.

Cosmopolitan Unit

The Cosmopolitan Unit development is located on the Kenai Peninsula, offshore and north of Anchor Point, and covers approximately 5,837 ha (14,423 ac) of state lands within five state oil and gas leases. The field was discovered in the 1960s and, following five previous producers, BlueCrest acquired the leases in 2012-2014 (ADNR, 2015b). On June 26, 2015 the ADNR Division of Oil and Gas approved, in part, a proposed Cosmopolitan Unit Formation submitted by BlueCrest (ADNR, 2015b).

As part of its application for unit formation, BlueCrest submitted a unit Plan of Development (Initial POD) discussing proposed activities from September 2014 through December 2015, which included seven offshore state leases and development of two state leases, drilling of one vertical well offshore to delineate subsurface oil and gas zones (ADNR, 2015b). In its approval of the unit formation, ADNR removed two of the offshore state leases and approved development plans through December 31, 2015. Because the Initial POD did not describe development plans for the other leases in the Cosmopolitan Unit beyond 2015, ADNR required a second POD to be submitted by October 2, 2015, with which BlueCrest complied via submission of a Lease Plan of Operations (ADNR, 2015b, 2015h). ADNR approved the second plan on February 6, 2015. Long-term plans include construction of facilities (including processing facility, oil storage, seawater treatment plant, warehouse, office, a

50-man camp, and expansion of an existing on-shore production pad) and drilling up to 33 wells from the pad (ADNR, 2015h). In March 2016, ADNR received an amendment application from BlueCrest for the Cosmopolitan Unit Plan of Operations (ADNR, 2016c). The application proposes to drill at total of four delineation wells (amended from three, the first well having been drilled in 2013). Drilling would start with one well in 2016 and the remaining wells would be drilled by the end of 2018. Drilling of these exploration phase wells would be done using a jack-up rig (ADNR, 2016c; NMFS, 2016). ADNR is in the process of considering this amendment (ADNR, 2016d). BlueCrest struck first oil at the Cosmopolitan unit on March 31, 2016 (Chandler, 2016).

In April 2016, the Regulatory Commission of Alaska approved an expansion of Enstar Natural Gas Company's service area to include a natural gas pipeline connecting to the Cosmopolitan Unit. 3,283-ft-long transmission gas line will connect the field's onshore facilities to the closest point on Enstar's gas transmission pipeline network at Anchor Point (Bailey, 2016).

In October 2015 BlueCrest submitted an IHA application to NMFS for the drilling of up to three wells at the Cosmopolitan Unit over the course of approximately 135 days. In their draft environmental assessment NMFS determined that acoustic stimuli generated by rig towing, pipe driving, and vertical seismic profiling would have the potential cause behavioral disturbances to marine mammals in the proposed project area (NMFS, 2016). NMFS is in the process of developing a proposed IHA for the BlueCrest application.

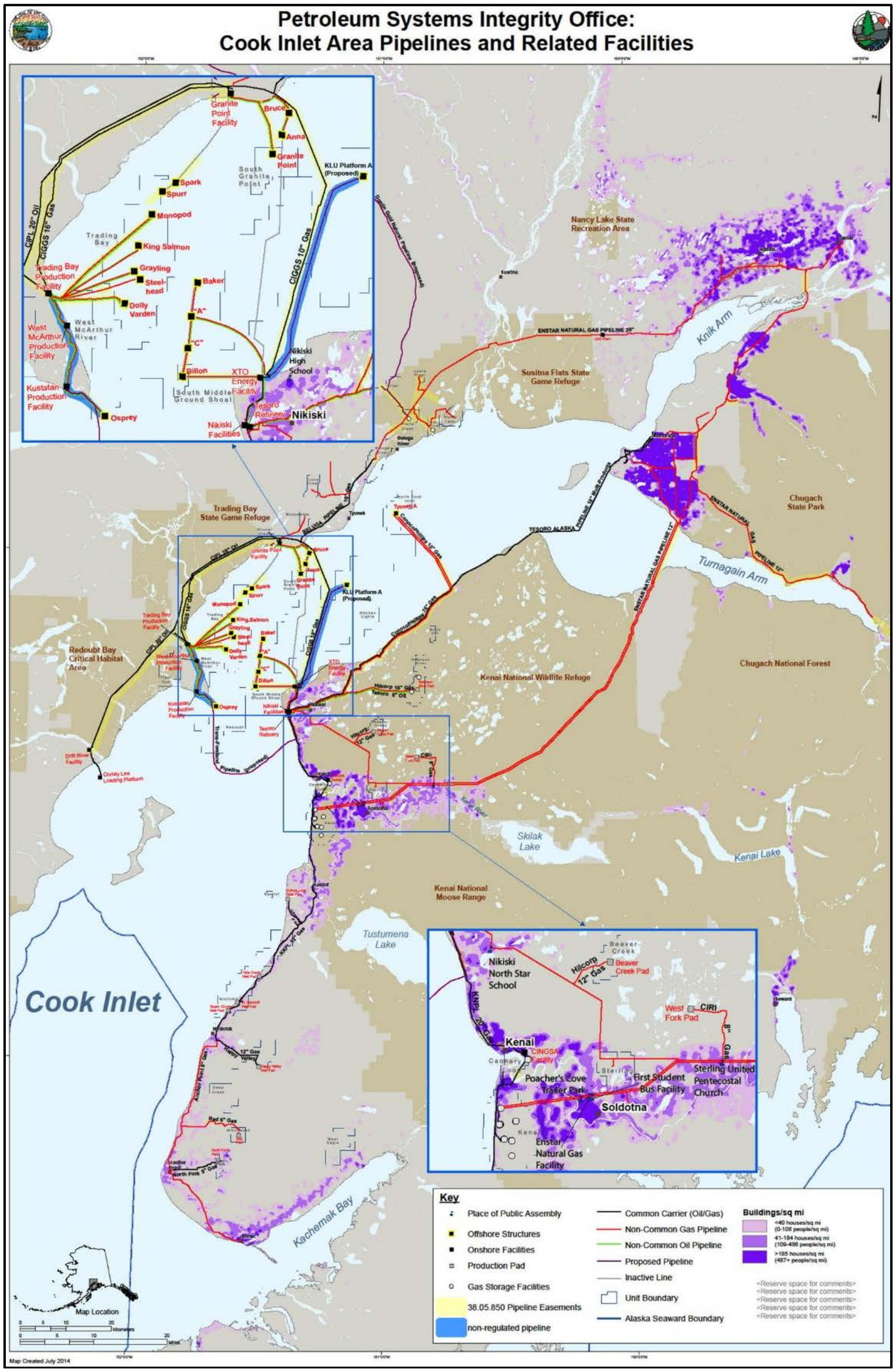

Figure 5.1.2-5. Existing Oil and Gas Infrastructure in Upper Cook Inlet. *Includes 17 Offshore Platforms in State Waters, Associated Oil and Gas Pipelines, and Onshore Processing and Support Facilities.*

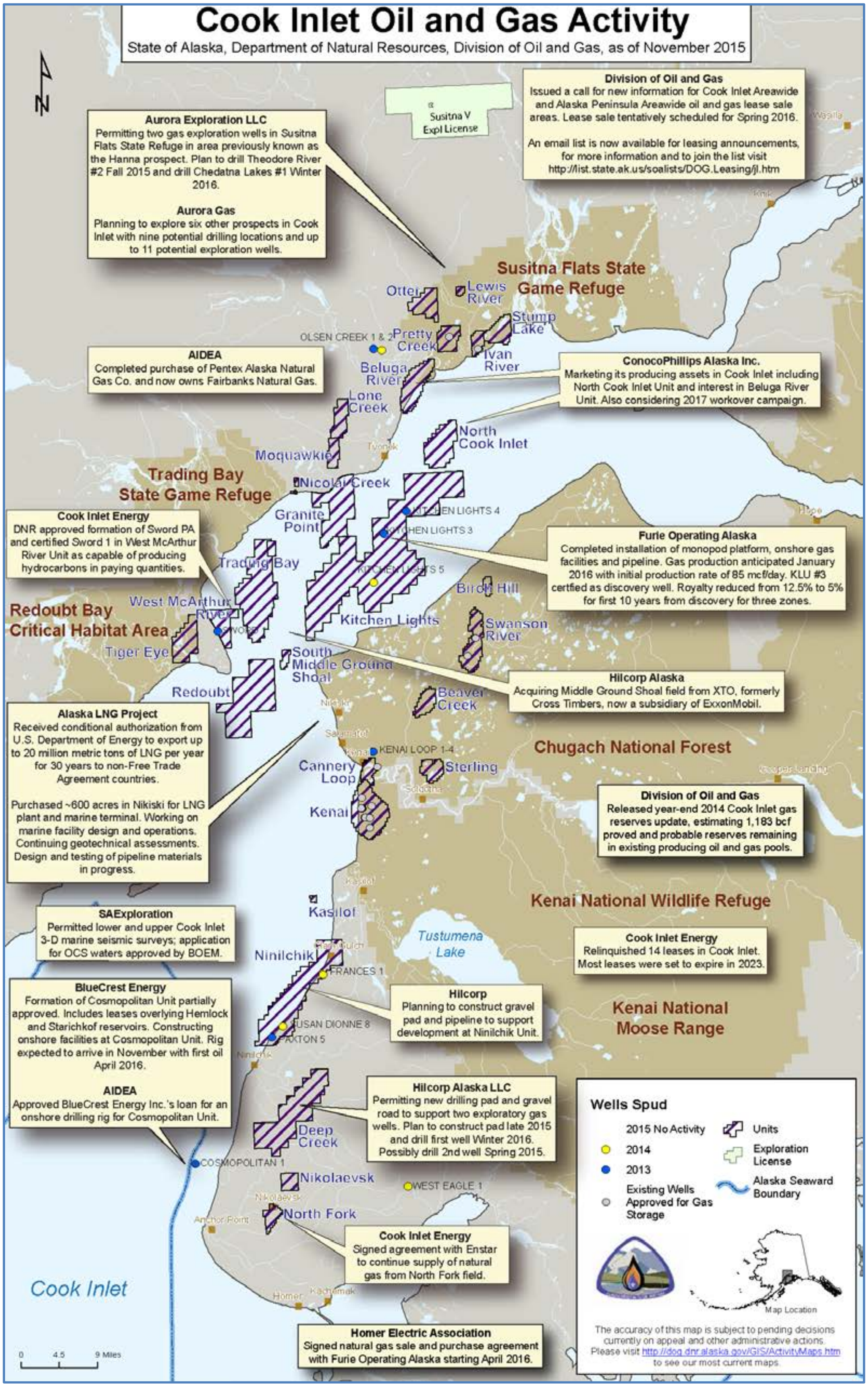

Figure 5.1.2-6. State Regulated Oil and Gas Activities in Cook Inlet. *(State regulated present and reasonably foreseeable future as of November 2015).*

Kitchen Lights Unit

Kitchen Lights is a large gas field located northwest of Boulder Point, near Nikiski on the Kenai Peninsula. Furie Operating Alaska, LLC (2015) is developing the Kitchen Lights Unit (KLU), including an offshore "monopod" production platform installed in 2015 approximately 16 km (10 mi) northwest of Boulder Point. A subsea pipeline carries gas from the platform to a shore-based facility that processes Kitchen Lights gas. Utility-grade gas from the facility on the Kenai Peninsula is delivered into a nearby section of the south-central Alaska gas transmission pipeline network (Bailey, 2015).

The Kitchen Lights field currently produces from a single well, the KLU No. 3 well that Furie drilled in 2013. Furie has filed a new Plan of Operations with ADNR for the Kitchen Lights unit (Bailey, 2016b). The new plan indicates that the company anticipates drilling two gas field development wells in 2016 and another two development wells during the period of April 2017 to October 2018 using a jack-up rig that was delivered to Cook Inlet in 2016 (Bailey, 2016c). The plan also envisages the completion of up to 10 exploration wells in the unit over the next five years, using the same rig (Bailey, 2016b).

Ninilchik Unit

The Ninilchik unit follows the coastline in the area south of Kasilof in the southern Kenai Peninsula. Chevron discovered a gas field in the Tyonek formation in the area in June 1961 (Lidji, 2015b). Hilcorp Alaska, LLC acquired the Ninilchik unit in 2013 and drilled at least 10 exploration wells at the unit between 2013 and 2014 (Lidji, 2016a). All of the surface locations for well drilling and other activities are onshore. In December 2014, the ADNR Division of Oil & Gas approved a Unit Plan of Operations application from Hilcorp Alaska, LLC to construct a new gravel pad, Blossom Pad, and an access road within the Ninilchik Unit on the east side of Cook Inlet (ADNR, 2014h). In March and June 2015, Hilcorp was issued drilling permits at two locations, and as of July 2015, Ninilchik had produced 171.6 Bcf (Lidji, 2015b). While the 2015 drilling program proposed drilling three wells, Hilcorp completed one well and partially completed another. Permitting issues delayed the construction of a new pad from which the third well was to be drilled. Hilcorp has asked the state to defer any contraction of leases at either the Deep Creek unit or the Ninilchik unit until 2017 as the company works to continue, and in some cases finalize, exploration activities (Lidji, 2016a).

Deep Creek Unit

To date, all existing developments have occurred in the northern half of the Deep Creek unit. The state believes the southern half could also contain considerable resources and has been trying to spur exploration for many years (Lidji, 2016a).

Hilcorp acquired the unit in 2012 began permitting a pad and an accompanying four-well appraisal program in June 2014 to target a shallow gas accumulation. By early 2015, the project had yet to move into operation. In a 2015 plan of development, Hilcorp said it would extend the program. The state deferred contraction until May 31, 2016, but only if Hilcorp completed the exploration project during that time (Lidji, 2016a).

The state approved a plan of operations for the exploration well in November 2015 and CIRI provided associated permits for operations on its land. But Hilcorp ultimately deferred the program, "in part due to delays associated with permitting," the company told state officials in a March 2016 plan of development.

"Hilcorp remains committed to building the road and pad required to drill the [exploration] well, but cannot commit to drilling this exploratory prospect under the current economic and market climate," the company said the plan of development (Lidji, 2016a). The company asked the state and CIRI to defer contraction until May 31, 2017.

Instead of drilling, Hilcorp plans to commission a 2-D seismic survey in the southern end of the unit for the second quarter of 2016. Combined with existing 3-D seismic, the survey could allow Hilcorp identify other opportunities in the southern end of the unit (Lidji, 2016a).

With the exploration well on hold, Hilcorp instead spud the Happy Valley B-17 well in late November 2015. The directional well started within the participating area but extended beyond its northern boundary. The company expects the well to sustain commercial production, although final testing and completion depends on administrative matters currently under review with the Alaska Oil and Gas Conservation Commission. If the well is commercial, Hilcorp might drill a B-18 well to further delineate the region (Lidji, 2016a).

Redoubt Unit

Pan American Petroleum Corp. discovered the Redoubt Shoal oil field in 1968 with the Redoubt Shoal Unit No. 2 well. The unit includes the Osprey platform and the Kustatan production facilities. The Redoubt unit and the platform were offline when Cook Inlet Energy LLC acquired the prospect in 2009. The company brought the facilities back into production beginning in mid-2011and has been focusing in recent years on maintenance and repair of existing facilities (Lidji, 2015b).

Cook Inlet Energy completed one side-tract well in September of 2015 approximately 2.5 miles southwest of the Osprey platform. A well test confirmed the presence of oil. The company identified two other oil-bearing fault blocks at the unit, although plans for delineating those Northern and Southern blocks are vague and dependent on economics, according to the company, which hoped to start drilling by April 2017 (Lidji, 2015b). However, in October 2015 Cook Inlet Energy LLC.'s parent company, Miller Energy Resources Ltd., filed for reorganization with the U.S. Bankruptcy Court of Alaska (Lidji, 2015b). The reorganization was accepted in February 2016, although Cook Inlet Energy and its affiliated companies will continue to operate their fields (DeMarban, 2016a). No further information is available. No further information is presently available on what, if any, impact the reorganization may have on future exploration, development, and production of the Redoubt unit.

Trading Bay Unit, McArther River Field and North Trading Bay Unit

At the southern end of the west side of Cook Inlet, Hilcorp operates three offshore fields: the Trading Bay unit and the nearby McArthur River field and the North Trading Bay unit. Hilcorp currently manages Trading Bay and McArthur River through a single plan of development and appears to desire even greater unity among the three offshore fields (Lidji, 2015b). Since acquiring these assets, Hilcorp has been conducting reservoir engineering and geological studies to identify future opportunities. This work is scheduled through 2017 (Lidji, 2015b).

The Trading Bay unit and McArthur River field are home to the Grayling, Dolly Varden and King Salmon platforms - all named for types of fish common to Alaska waters. In 2014, Hilcorp commissioned the built-for-purpose HAK No. 1 rig for these platforms (Lidji, 2015b). In March 2016 the Alaska Oil and Gas Conservation Commission (AOGCC) permitted development well A-27RD2 at the Trading Bay unit (AOGCC, 2016b).

In 2014, the company drilled one well at the McArthur River field. The company also performed 19 workover projects. In October 2014, Hilcorp drilled the A-31 exploration well from its Monopod platform at the neighboring Trading Bay field. The well encountered "productive hydrocarbons" in some zones (Lidji, 2015b).

The North Trading Bay unit has the Spark and Spurr platforms. Chevron discovered the accumulation in the Hemlock and "G" formation participating area in 1965 with the Trading Bay No. 1A well and brought the unit online in 1968. The platforms have been light-housed since in 1992, aside from an attempt at gas production from Spark in 2007 (Lidji, 2015b).

North Middle Ground Shoal Field, Middle Ground Shoal Field, and South Middle Ground Shoal Field

In the center of the Cook Inlet, Hilcorp operates three neighboring and related offshore fields: North Middle Ground Shoal and its Baker platform, South Middle Ground Shoal and its Dillon platform and Middle Ground Shoal and its “A” and “C” platforms (Lidji, 2015b). Hilcorp purchased the fields from XTO in 2015.

The state approved a plan in 2012 for abandoning the lighthoused Baker platform at North Middle Ground Shoal, but Hilcorp amended the plan later in the year. The company had decided to reactivate the platform for gas exploration. A workover program in 2013 returned the existing BA-14 well to production. Now, the well provides fuel gas to the Middle Ground Shoal field (Lidji, 2015b).

Middle Ground Shoal was the first offshore oil completion in Alaska, according to the American Association of Petroleum Geologists. Shell Oil discovered Middle Ground Shoal in 1963. By the time Shell sold the field to XTO-predecessor Cross Timbers Oil Company production was already decreasing. However Middle Ground Shoal remains important economically. The field accounts for approximately one-eighth of total Cook Inlet oil production (Lidji, 2015b).

Although Hilcorp neither drilled nor worked over any wells at North Middle Ground Shoal in 2014 and 2015, the company completed a reservoir study in 2014 to determine the future of oil production at the field. The company is in the early stages of planning a seven-well workover program that would finish by the end of 2016.

Previous operator Unocal decommissioned the Dillon platform at the South Middle Ground Shoal unit in 2003. Hilcorp has been undertaking a multiyear study to evaluate the possibility of reactivating the platform in mid-2018, pushed back from a prior deadline of mid-2016. The delay would allow Hilcorp to complete its activities at North Middle Ground Shoal. The study includes re-mapping relevant horizons, compiling well histories, building reservoir simulation models and potentially shooting a 3-D seismic survey. Hilcorp performed no drilling or well work in 2014 and 2015 (Lidji, 2015b).

Granite Point Unit

Mobil Oil Corp. discovered the offshore Granite Point oil field in 1965. The following year, the company installed three platforms - from south to north Granite Point. Sustained production began in 1967. Since acquiring the Granite Point unit Hilcorp has been working over wells from the three existing platforms (Lidji, 2015b).

Beluga River Unit

ConocoPhillips became operator of the Beluga River field in 1986 and owned a 33 percent working interest ownership in the field, alongside independent producer Hilcorp Alaska LLC and utility Anchorage Municipal Light & Power (Lidji, 2015b).

ConocoPhillips conducted an expensive development campaign at the field between 2008 and 2012. The program included drilling six wells and upgrading compression in an attempt to improve deliverability. The company appears to be done drilling new wells for the time being and is focusing on smaller maintenance activities to improve performance. Through 2014, Beluga River had 14 producing wells (one less than in 2013), 10 shut-in wells (one more than in 2013) and two disposal wells (Lidji, 2015b).

In April 2016, the Regulatory Commission of Alaska approved the purchase by electricity utilities Municipal Light & Power and Chugach Electric Association of ConocoPhillips’ one-third share of the Beluga River field (Bailey, 2016a).

Nicolai Creek Unit

Aurora Gas, LLC brought the Nicolai Creek No. 11 well online in late 2009 and drilled the Nicolai Creek No. 10 well in 2011 (Lidji, 2015b). The results of those wells prompted Aurora to drill the Nicolai Creek No. 13 and No. 14 wells in August and July 2013, respectively. Based on the previous wells, the company had expected those two wells to yield an average production bump of 3 million cubic feet per day, according to Aurora Gas President Ed Jones, but "neither of the development wells resulted in commercially viable accumulations of hydrocarbons and were plugged and abandoned," according to a plan of development for the year ending in October 2014 (Lidji, 2015b).

In its 2015 plan of development, Aurora proposed drilling a Nicolai Creek No. 12 well to gather more information about deeper sands encountered in the No. 10 well but AOGCC records through May 2016 show no permit for the well (AOGCC, 2016a, 2016b; Lidji, 2015b).

Kasilof Unit

Marathon Oil Co. brought the Kasilof unit into production in November 2006, using a 17,000-ft extended reach dual-lateral well drilled from an onshore pad. After initial drilling proved the producing area to be smaller than expected, Marathon requested a major contraction at the unit, to 329 ac down from 13,289 ac (Lidji, 2015b).

Of the three wells in the Kasilof participating area - Kasilof No. 1, Kasilof South No. 1 and KAS-1 - only the seasonally produced KAS-1 has ever been reliably productive.

After suspending operations at Kasilof in 2013 and 2014, Hilcorp had committed to either return the dormant unit to production or relinquish it. As of March 2016, the company plans to relinquish the unit by May 31, 2016 (Lidji, 2015b).

Exploration Seismic Surveys

SAExploration, Inc. (SAE) has proposed to conduct 3D OBN seismic surveys over several years in state and Federal waters in Cook Inlet. The survey area is divided into two units (upper and lower Cook Inlet). The total potential survey area is 3,934 km^2 (1,519 mi^2); however, only a portion (currently unspecified) of this area will be surveyed – no more than 777 km^2 (300 mi^2) in a given year.

In January 2015, SAE (2015) submitted an IHA application to NMFS for a 2015 survey covering a period of 160 days. The exact location of the 2015 survey was not specified; the coverage during each year's survey depends on the data acquisition needs of SAE's clients. NMFS (2015b) prepared an EA and issued an IHA covering the period between May 13, 2015 and May 12, 2016 (80 *FR* 29162, May 20, 2015).

In October 2015, SAE submitted an IHA application to NMFS for a similar survey proposed for the months of March through December 2016. In their draft environmental assessment NMFS determined that acoustic stimuli generated by seismic airguns would be a primary potential cause of behavioral disturbances to marine mammals in the proposed project area (NMFS, 2016). NMFS is in the process of developing a proposed IHA for the SAE application.

ExxonMobil Geophysical and Geotechnical Survey

In 2015, ExxonMobil Alaska LNG LLC (EMALL) conducted a geophysical and geotechnical survey in Cook Inlet to investigate the technical suitability of a pipeline corridor across Cook Inlet and potential marine terminal locations near Nikiski. The proposed activity occurred over 84 days during the open water season after August 14, 2015. On August 21, 2015, NMFS issued an IHA for the survey (80 *FR* 50990, August 21, 2015). The following specific aspects of the proposed activities were determined to likely result in the take of marine mammals: use of a seismic airgun, subbottom profiler (compressed high-intensity radiated pulse (CHIRP) and boomer), and possibly a vibracore. In

October 2015 EMALL submitted an application for an IHA for the taking of marine mammals incidental to a similar geotechnical and geophysical survey proposed to occur over 102 days between March 2016 and November 2016 (81 *FR* 6375, February 5, 2016). On February 5, 2016, NMFS published a proposed IHA for public comment. A final IHA has not been published to date.

Cook Inlet Natural Gas Storage Alaska

In an effort to stabilize production and supply, Alaska authorized the framework for a natural gas storage facility in Cook Inlet (AOGA, 2015). The Cook Inlet Natural Gas Storage Alaska (CINGSA) is Alaska's first commercial underground storage facility that can be filled when production is high, and drawn down when peak commercial energy demands hit. Construction on five horizontal wells was completed in December 2011; the first gas injections took place in April 2012, and the first gas withdrawals occurred in November 2012 (CINGSA, 2012). Four utility companies currently use the facility for storage: ENSTAR, which owns 46% of the 18 billion cubic feet of gas in the CINGSA reservoir, Chugach Electric Company, which owns 10.5%, Anchorage Municipal Light & Power, which owns 8.3%, and Homer Electric Association, which owns 0.694% (Boettger, 2015). While drilling in 2012 to add storage space to its reservoir, CINGSA unexpectedly broke into a previously unknown sealed well from which 14.6 Bcf of gas leaked into the existing reservoir (Boettger, 2015). In December 2015 the Regulatory Commission of Alaska ruled that the profits from the sale of 2 Bcf of the unexpectedly discovered gals will be shared according to the percentage of the gas that each company owns in the facility (Boettger, 2015). CINGSA expects the storage facility to have an operational life of 30 years (Boettger, 2015).

Alaska LNG Project

The Alaska LNG Project is an industry proposal to build an 800-mi long gas pipeline to transport gas from the Alaska North Slope to Cook Inlet, where it would be processed at a proposed liquefaction plant in Nikiski (Alaska LNG, 2015). Up to 20 million mt of LNG could be exported annually under an Energy Department license that has been issued (Platts, 2016). In March 2015, the FERC issued a Notice of Intent to prepare an EIS for the project. In March 2016, the Alaska LNG project announced that it would delay filing its formal application with FERC until mid-November 2016 (Platts, 2016). Presently, preliminary front-end engineering and design work are expected to be complete by the end of 2016 with a front-end engineering and design decision in 2017 and final investment decision in 2019 or 2020 (Platts, 2016). Because the project is in the early stages of the permitting process and environmental analysis has not yet begun, it is considered not reasonably foreseeable and will not be included in the cumulative analysis.

5.1.2.2. Renewable Energy Projects

Renewable energy projects include the Fire Island Wind project and two tidal energy projects in development.

Fire Island Wind Project

Fire Island Wind LLC (2015) owns and has operated a 17.6-megawatt (MW) wind turbine project on Fire Island since 2012, 4.8 km (3 mi) off the coast of Anchorage, Alaska. An underwater transmission line connects the wind farm to the Anchorage power grid. Currently, the 11 wind turbines located on Fire Island have the capacity to power approximately 6,500 homes. Fire Island Wind has the capacity to expand to a total of 33 turbines with a generation capacity of 52.8 MW (CIRI, 2016). Plans to construct 11 additional wind turbines were put on hold in 2015 due to a lack of industry interest in purchasing power from Fire Island Wind LLC (Caldwell, 2015).

Tidal Energy Projects

With their large dynamic range, the tides in Cook Inlet could be an important renewable power source for the region (Coil, Hoagland, and Higman, 2012). Studies currently are underway to quantify the resource and identify the best locations. A pilot project, the Cook Inlet Tidal Energy Project near Nikiski, is in the early stages of planning and development.

Turnagain Arm Tidal Energy Corporation (TATEC) (2012) proposes to build a 240-MW tidal power plant in Cook Inlet with a potential for expansion to 1,200 MW. The proposed project would consist of an 13-km (8-mi) long tidal fence between Fire Island and Point Possession, including twenty-four 10-MW turbines; a 3.2-km (2-mi) long, 1.6-km (1-mi) wide water storage tank attached to the tidal fence; one control building/substation onshore near Anchorage and one near Point Possession; a 29-km (18-mi) long submerged transmission line connecting the tidal fence to the existing Chugach Electric Association substation at Point Woronzof in Anchorage; a new substation at Point Possession; and a 45-km (28-mi) long above-ground transmission line running parallel to an existing Homer Electric Association (HEA) transmission line corridor and extending from Point Possession to the existing HEA Nikiski substation.

TATEC held a 3-year preliminary permit for the project site from 2010 to 2013, and FERC (2014a) approved a 2-year continuation in February 2014, however, progress on the project has stalled due to funding issues and the continuation has now expired. In 2015 the ADNR Division of Mining, Land and Water closed TATEC’s permit application for performing study work (TATEC, 2015). TATEC’s most recent progress report to FERC (for the period of August 1, 2015 through January 31, 2016) indicates that if funding becomes available they will refile for a new preliminary permit with FERC (TATEC, 2016).

5.1.2.3. Mining Projects

Four proposed mining projects are considered in the cumulative effects analysis: the Chuitna Coal Project, the Diamond Point Rock Quarry, the Pebble Mine Port and Marine Terminal and the proposed natural gas pipeline for the Donlin Gold Mine.

Chuitna Coal Project

The Chuitna Coal Project was originally proposed in the 1980s by PacRim Coal, LP (PRC) as a coal export development, including an active coal mine combined with a new marine terminal to assist export. The proposed project is located between Beluga and Tyonek on the northwest shore of Cook Inlet. An EIS was prepared in the late 1980s to address environmental concerns under NEPA, but construction of the project did not begin. Due to the delay in construction, and changes in regulatory processes, the EPA determined that a supplemental EIS would be needed in 2006. The supplemental EIS is in progress with a tentative publication date and the start of Draft Supplemental EIS public review process of June 2016 (Chuitna Coal Project, 2016).

Diamond Point Rock Quarry

Diamond Point LLC has proposed to develop a granite quarry at Diamond Head, near the convergence of the Cottonwood and Iliamna Bays on the western shore of Cook Inlet. The plan includes extensive modification of the shoreline to construct a staging area and dock facility (USFWS, 2012d). The project is not currently in active construction, but it is included in the cumulative assessment as a reasonably foreseeable future development.

Pebble Mine Port and Marine Terminal

In 2011, the Pebble Partnership submitted plans for the development of a large-scale copper, gold, and molybdenum mine at the Pebble Mine location in the Bristol Bay watershed west of Cook Inlet. In addition to the mine, the proposed construction would include a new marine terminal and deepwater port on the shores of Iniskin Bay to facilitate the transportation of mine products. The Pebble Limited Partnership (2011) prepared an environmental baseline document (EBD) to characterize the physical, biological, and social environment associated with the project. In 2014, the EPA proposed to restrict the use of certain waters in Bristol Bay for the disposal of dredged or fill material associated with mining the Pebble deposit (EPA, 2014b). The Pebble Mine project is currently on hold due to pending litigation, but it is included in the cumulative assessment as a reasonably foreseeable future project.

Donlin Gold Mine Proposed Natural Gas Pipeline

Donlin Gold proposes to construct a 14-inch-diameter steel pipeline to transport natural gas approximately 315 miles from an existing 20-inch gas pipeline tie-in near Beluga, Alaska, to the mine site power plant. The pipeline would require one compressor station at Milepost (MP) 0.4. Except for two above-ground fault crossings, each approximately 1,300 feet long, the pipeline would be buried within a ROW of 51-foot width on BLM-managed lands and 50-foot distance elsewhere. The pipeline would be designed to deliver up to 73 million standard cubic feet per day (MMscfd) of natural gas, at a maximum allowable operating pressure (MAOP) of 1,480 pounds per square inch gauge (psig) for 30 years. Electrical power for the compressor station at MP 0.4 would be supplied by a 25-kilovolt (kV) transmission line running north from the Beluga Power Plant to the metering station for approximately 7.7 miles, then the short distance of approximately 0.4 miles northwest to the gas compressor station at MP 0.4.

The USACE initiated the NEPA process for the proposed Donlin Gold Mine in December 2012. A draft EIS was made available for public comment November 27, 2015 through April 30, 2016. The USACE is currently in the process of producing a final EIS, which is anticipated to be published early in 2017 (USACE, 2015).

5.1.2.4. Marine Transportation

As discussed in Section 3.4.3, Cook Inlet is a regional hub of marine transportation throughout the year. Vessel types include cargo ships, tankers, tugs, cruise ships, commercial fishing boats, and research vessels. Cook Inlet includes six deep-draft ports (Anchorage, Port MacKenzie, Nikiski Industrial Facilities, Port of Homer, City of Seldovia, and Drift River Oil Terminal) and several light-draft ports (e.g., Port Graham, Tyonek, Williamsport). The Port of Anchorage is the third largest port in Alaska, is designated as a USDOD National Strategic Port, and provides services to approximately 75% of the total population of Alaska.

According to a 2012 study of vessel traffic in Cook Inlet, most vessel traffic moves along north-south transit lines, with deep-draft vessels generally using the east side of the inlet (Cape International Inc., 2012; Figure 3.4.3-1). Eighty percent of large ship operations were made by only 15 vessels that regularly call at Homer, Nikiski, or Anchorage. Tankers occasionally transit east to west between Nikiski and the Drift River Terminal Facility. OSVs account for much of the commercial large vessel activity outside of the traditional north-south track lines. OSV track lines show an almost circular pattern northwest of Nikiski. Commercial fishers and suppliers use cross-inlet traffic routes to reduce travel distance from Cook Inlet locales to the Bristol Bay region. Landing craft and other small vessels travel between Homer and Williamsport during the summer. Kachemak Bay is a frequent and preferred port of refuge for ships and tugs during bad weather and had the highest level of traffic activity in Cook Inlet in 2010 (Cape International Inc., 2012).

For the cumulative effects analysis, it is assumed that activity levels will remain flat or show only moderate increases (1.5% to 2.5% annually) due to population growth and post-recession improvements to the economy (Cape International Inc., 2012).

5.1.2.5. Ports and Terminals

The largest port facilities in Cook Inlet are Anchorage, Port MacKenzie, Tyonek, Nikiski, Drift River, Kenai, Anchor Point, and Homer. The Port of Anchorage, located along the lower Knik Arm, is a deep-draft facility that accommodates barges and ships of all types (although cruise ships are infrequent). It is the main port of entry for the south-central and interior regions of Alaska. Port MacKenzie is a barge port located at the head of Cook Inlet along the Knik Arm across from the Municipality of Alaska. Port MacKenzie completed the second phase of its development, which includes a deep-draft marine port as discussed in a separate subsection later. The Tyonek/North Foreland's Dock is a light-draft port located on the west side of Cook Inlet.

The Nikiski industrial terminals are located on the east side of Cook Inlet, between Homer and Anchorage. Three side-by-side deep-draft moorages extend approximately 1.6 km (1 mi) from Tesoro's Kenai pipeline pier at the north end of the complex to the Agrium wharf at the south end; the ConocoPhillips Alaska LNG pier lies between them. The Nikiski terminals include docks for tugs, drilling rig tenders, and OSVs. The Kenai LNG plant owned by ConocoPhillips Alaska is currently the only LNG export operation in the U.S. Currently, the export license for ConocoPhillips LNG is through February 19, 2018 to export about 40 billion cubic feet of natural gas over a two year period (ADNR, 2015d; DiSavino, 2016).

The Drift River Oil Terminal is located approximately 37 km (23 mi) west-southwest of Nikiski on the western shore of Cook Inlet. It is mainly used as a loading platform for shipping crude oil collected via pipeline from various production platforms in the inlet. The docking facility is connected to a shore-side tank farm (with a storage capacity >1 MMbbl) and is designed to accommodate tankers in the 150,000-ton class. Tank ships moor at the terminal while loading crude oil, then transport it to Tesoro's Kenai pipeline at Nikiski, where the oil is offloaded and refined.

The Port of Homer is located in Kachemak Bay. It consists of a boat harbor, two deep-draft docks, two deep-draft moorages, and one deep-draft anchorage. It also has three shallow-draft docks. Alaska Marine Highway System ferries and USCG cutters are moored at the port year-round; cruise ships call from May through September. There is a pilot "embarkation station" west of the Homer spit in Kachemak Bay that is used by ships and tugs as they wait for favorable weather conditions in the inlet or the Gulf of Alaska (Cape International, Inc., 2012).

There is a 6-m (20-ft) draft dock at the City of Seldovia. Moorages accommodate the Alaska Marine Highway System ferries and are available for fuel barges and small passenger vessels. There are shallow-draft facilities at Port Graham (receiving fuel oil barges and fishing vessels) and Williamsport (in Iliamna Bay) (Cape International, Inc., 2012).

The Alaska Marine Highway System, part of the National Highway System, runs along the south-central coast of Alaska, the eastern Aleutian Islands, southeast Alaska, and British Columbia (Canada) to Bellingham, Washington. Portions of the highway operate in Cook Inlet from Anchorage, Homer, and Seldovia, and various other ports in the Gulf of Alaska.

Activities and vessel calls at ports, harbors, and terminals in Cook Inlet are likely to increase over the next 40 to 50 years as several port expansion projects are completed and economic activity increases. Activities associated with port facilities contribute to cumulative effects on air and water quality, the acoustic environment, marine and coastal habitats, marine and coastal fauna (e.g., fish, marine mammals, birds), commercial and sport fisheries, sociocultural systems (e.g., local economies, subsistence), and cultural resources (if present).

Important IPFs from routine operations include noise, engine emissions, fuel spills (from marine vessels), permitted discharges to air and water, pollutant releases via surface water runoff, oil spills, hazardous spills and releases, accidental explosions or fires, cooled water releases (from the LNG plant), wildlife collisions with infrastructure and marine vessels, and collisions among marine vessels.

Port of Anchorage Modernization Project

A planned modernization project for the Port of Anchorage will replace two general cargo terminals and two petroleum terminals to ensure seismic resilience over a 75-year life cycle (Port of Anchorage, 2015). The project will enable the port to accommodate larger ships in the future by increasing the harbor depth from 11 to 14 m (35 to 45 ft). New ship-to-shore container cranes will increase reach across wider vessels. The expansion project was initiated in 2003 but delayed due to construction and design problems as well as lawsuits. A test pile program was completed in 2015 and dredging activities commenced in late March, 2016 (Zak, 2016). As of May 2016, the Port of Anchorage Modernization Project website indicates that main construction will begin in 2017 and continue through 2019 or later (Port of Anchorage, 2016).

Port MacKenzie Expansion and Development

The Matanuska-Susitna Borough (2015) recently conducted expansion of Port MacKenzie, located on the southwest shore of Knik Arm. The port expansion included a new terminal building, a 366-m (1,200-ft) deep-draft dock, and a newly expanded bulkhead barge dock. Activities and impacts from the expansion project that are relevant to the cumulative effects analysis include seafloor and habitat disturbance, sedimentation, air pollutant emissions, noise from pile driving and construction vessels, and increased vessel traffic from port operations.

The Port MacKenzie Master Plan outlines land use designations and provides guidelines for future port improvements and development through 2031 (Matanuska-Susitna Borough, 2015). Two notable projects relevant to the cumulative effects analysis are the Port MacKenzie rail extension and a proposed LNG project.

The proposed rail extension is a joint project between the Matanuska-Susitna Borough and the Alaska Railroad Corporation (ARRC) that involves the construction and operation of a new rail line to connect Port MacKenzie to the ARRC's main line south of Houston, Alaska. Project construction began in 2012 with an anticipated completion date in late 2017. The rail extension will provide improved rail transportation between Port MacKenzie and interior Alaska (Port MacKenzie Rail Extension Project, 2015). An EIS was completed in March 2011. Potential cumulative effects addressed by the EIS included adverse effects to surface water and wetland resources, biological resources, cultural and historic resources, climate and air quality, and land use (Surface Transportation Board, 2011).

Resources Energy Inc. (2015) is proposing to construct and operate an LNG terminal at Port MacKenzie. Resource Energy Inc. is currently in the planning phase of the project, with engineering design and permit applications planned for 2016. Pending approval by the FERC and USDOE, including completion of an EIS or EA, anticipated plant operation would begin in 2020. Because there is no detailed project plan or permit application at this time, the Port MacKenzie LNG plant is not included in the cumulative analysis.

Salix, Inc. is proposing to build an LNG plant at Port MacKenzie as part of the Alaska Industrial Development and Export Authority's Interior Energy Project. This LNG plant would produce 100,000 gallons of liquefied natural gas a day, converting natural gas delivered from Cook Inlet (DeMarban, 2016b). The objective of the proposed project is to establish a viable, expanded supply of natural gas to Fairbanks for heating buildings and generating electricity. Following front end engineering and design, a decision on whether to move into development is expected in June 2016, if the AIDEA board decides to progress the project (Bailey, 2016d). Because there is no detailed project plan or permit application at this time, the Salix LNG plant is not included in the cumulative analysis.

5.1.2.6. Knik Arm Crossing Project

The Knik Arm Crossing is a State of Alaska Department of Transportation & Public Facilities (DOT&PF) project to construct a toll bridge over Cook Inlet's Knik Arm, connecting Anchorage with the Matanuska-Susitna Borough, Alaska's fastest-growing region (Knik Arm Crossing Project, 2015). The crossing was first envisioned in 1923 by railroad engineers looking for a more direct route to the gold fields in interior Alaska. Since that time, the idea has been revisited repeatedly. In 2003, Alaska formed a corporation within the DOT&PF and the Knik Arm Bridge and Toll Authority to pursue development of the bridge. The Knik Arm Bridge and Toll Authority (2007) completed an EIS in 2007, and the Federal Highway Administration issued an ROD in 2010. In 2014, the project management, including design, permitting, and construction, was transferred to DOT&PF; a reevaluation of the final EIS was released in 2015 (DOT&PF, 2015). Construction has not yet begun and is expected to require 4 years. The Alaska DOT is seeking Federal funding for the project (Kelly, 2016).

5.1.2.7. Submarine Cable Projects

Two submarine cable projects were identified for the cumulative analysis. Additional information about submarine cables is provided in Section 3.4. Most of the impacts associated with the submarine cable projects occurred during the construction phase and are assumed to include disturbance of seafloor and shoreline habitats, vessel traffic, underwater noise, and air pollutant emissions. Little or no environmental impact is expected during routine cable operation.

AKORN Fiber Optic Cable

The Alaska-Oregon Network (AKORN), an undersea fiber optic cable system connecting Anchorage, Alaska to Florence, Oregon, began construction in 2007. As part of AKORN, a segment of undersea fiber optic cable was installed from Nikiski to Anchorage (Alaska Communications, 2015). The submarine cable was buried to a depth of 1.25 m (4.1 ft) in the seafloor with landing points in Nikiski and Point Woronzof in Anchorage. AKORN was completed in 2009, providing reliable high-speed, high-performance fiber optic cable service to Alaska.

United Utilities Fiber Optic Cable

In 2011, United Utilities Inc., a subsidiary of General Communication Inc. (GCI), installed a fiber optic cable within Cook Inlet, Iliamna Bay, and other areas of southwest Alaska that runs through the proposed Lease Sale Area. The system uses a combination of the fiber optic cable and a series of microwave repeater towers to provide broadband service to the Bristol Bay and Yukon-Kuskokwim Delta regions of southwest Alaska. The cable is buried in the seafloor and its location is shown on navigational charts.

5.1.2.8. Wastewater Discharges to Cook Inlet

The major point sources of pollution in Cook Inlet include discharges from municipal wastewater treatment plants (e.g., Anchorage), seafood processors, and the petroleum industry. Also included are offshore discharges from drilling activities and marine vessels. Most of these activities would remain at present levels for the foreseeable future and are not expected to affect the overall water quality in Cook Inlet.

Wastewater discharges are regulated within the 3-mile limit of state waters through the Alaska Pollutant Discharge Elimination System (APDES) program administered by the ADEC. The APDES is Alaska's implementation of the EPA's NPDES program, which was transferred to state control in four phases from 2008 to 2012 (ADEC, 2012). Phase I (2008) included domestic discharges, log storage and transfer facilities, seafood processing facilities, and hatcheries. Phase II (2009) included Federal facilities, stormwater, wastewater pre-treatment programs, and non-domestic discharges.

Phase III (2010) included mining activities. Phase IV (2012) included wastewater permitting for the oil and gas industry, pesticides, munitions, and other facilities.

Wastewater discharges are regulated in the Federal waters of Cook Inlet OCS under a NPDES General Permit that is issued by EPA. Discharges under a General Permit for exploration typically include sanitary waste, domestic waste, drilling fluids, drilling cuttings, and deck drainage. The Proposed Action would contribute minor to moderate impacts to water resources in addition to the impacts from past, present and reasonably foreseeable actions.

Non-point sources of pollution include stormwater and snowmelt that runs over land or through the ground, entraining pollutants and depositing them into the inlet. The Cook Inlet watershed is home to two-thirds of Alaska's population; therefore, the quality of runoff in the watershed is heavily influenced by human activity. The most common forms of pollution in Alaska's urban runoff include fecal coliform, sedimentation, and petroleum. Snow disposal into the marine environmental also introduces oil, grease, antifreeze, chemicals, trash, animal waste, salt, and sediments (e.g., sand, gravel, suspended and dissolved solids). Non-point source management programs under Section 319 of the CWA regulate these pollutant sources. The EPA and NOAA (2015f) co-administer the state Coastal Non-Point Pollution Control Programs under Section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990. Point and non-point source discharges to Cook Inlet are expected to continue and could increase over the next 40 years based on projected increases in population and development along Cook Inlet.

5.1.2.9. Persistent Contaminants and Marine Debris

Persistent contaminants are natural and man-made substances introduced to the environment that are resistant to natural degradation; these include various heavy metals (e.g., mercury, cadmium, lead, chromium) as well as herbicides, pesticides, PCBs, and dioxin. Because they do not degrade naturally, these substances are capable of long-range transport and may bioaccumulate in the tissues of ecological and human receptors. Sources of persistent contaminants include permitted discharges and surface runoff (with suspended sediments) from agricultural, industrial, or urban areas as well as atmospheric deposition.

Marine debris is defined as "any persistent, manufactured, or processed solid material that is directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment" (NOAA, 2015e). Marine debris in Cook Inlet could include ocean-based materials such as fishing gear, oil and gas industry items (e.g., plastic drill pipe thread protectors, hard hats, gloves, 55-gallon storage drums), and lost vessel cargo. Materials from land-based sources can also find their way into Cook Inlet waters via blowing winds, waves washing ashore, littering, dumping in rivers and streams, and industrial losses. Weather also plays a role as stormwater flows along streets and the ground carrying litter into storm drains; high winds, heavy rains, tsunamis, and tidal surges also are capable of dispersing solid objects into marine waters. The presence of marine debris in the waters and sediments of Cook Inlet contributes to cumulative effects on the same resources as described for persistent contaminants. Important impacts of marine debris include entanglement in or ingestion of debris by marine wildlife; habitat damage; vessel damage and navigation hazards; and aesthetic impacts (NRC, 2008; NOAA, 2015e).

5.1.2.10. Dredging and Marine Disposal

As authorized by the Rivers and Harbors Act of 1958, the U.S. Army Corps of Engineers (USACE) conducts annual maintenance dredging projects to prevent shoaling at several locations within Cook Inlet, including in Anchorage Harbor (in Knik Arm), Homer Small Boat Harbor, and Ninilchik Harbor (Tencza, 2015). The Energy and Water Appropriations Act of 2005 authorized maintenance dredging of Cook Inlet Navigational Channel in upper Cook Inlet which began in 2013 (USDOD, USACE, 2014a).

Dredging in Anchorage Harbor occurs during the ice-free season, beginning in the spring, continuing into the summer when shoaling is greatest, and ending in the fall. Operations typically use a clamshell (with or without a small hopper dredge) and barge. Dredged material from the harbor is tested for various contaminants (e.g., pesticides, PCBs, petroleum hydrocarbons, volatile and semi-volatile organics, heavy metals) and, if below applicable thresholds, moved by barge and tug to a deepwater site south of the project, where it is dispersed by tidal activity (USDOD, USACE, 2014b).

At Homer Small Boat Harbor, dredging typically occurs in September. Dredging is conducted with a hydraulic cutterhead and pipeline suction dredge. Dredged materials are tested for various contaminants, then conveyed via portable pipeline (from the floating dredge plant) to a bermed site on the pit where they are used to maintain the site's integrity. Because the harbor is located within the Kachemak Bay Critical Habitat Area, a CWA Section 404 permit is required for dredging (USDOD, USACE, 2014c).

Dredging at Ninilchik Harbor (in lower Cook Inlet) usually occurs between December and mid-May (or as soon as possible to avoid conflicts with the incoming salmon run). Material is hydraulically dredged (from a floating plant with a hydraulic cutterhead) or removed with a bulldozer. Dredged material from the basin is tested for various contaminants and, if below applicable thresholds, conveyed by pipeline to a beach north of the project; material bulldozed from the entrance is used as a containment dike for dredge spoils from the basin (USDOD, USACE, 2014c).

The Cook Inlet Navigation Channel was dredged for the first time in 2013 since its construction in 1999-2000 with the goal of extending the length of the channel to more than 14 km (8.7 mi) and deepening it 14 m (45 ft) to provide additional time for passage of deep-draft vessels to the Port of Anchorage. This multi-year maintenance program is conducted with a hopper dredge, and material is transported to an open water disposal site to the southeast of the channel (USDOD, USACE, 2014a).

In addition to annual maintenance dredging activities, several other dredging actions associated with ongoing and planned construction projects throughout Cook Inlet will continue and likely increase in the coming decades. These include dredging actions related to various USACE civil works projects as well as those associated with the expansion of the Port of Anchorage, the Knik Crossing Bridge (new bridge piers), the Chuitna Coal Project (new terminal near Tyonek), the Diamond Point Granite Rock Quarry (vessel dock in Cottonwood Bay), and the Pebble Mine Project (new terminal in Iniskin Bay).

5.1.2.11. Military Activities

JBER is the combination of the U.S. Air Force's Elmendorf Air Force Base and the U.S. Army's Fort Richardson. The two bases merged in 2010 based on a recommendation from the 2005 Base Closure and Realignment Commission (USDoD, U.S. Air Force, 2015). JBER is located approximately 11 km (7 mi) northeast of downtown Anchorage.

The 32,206-ha (74,641-ac) facility houses 13,310 active duty military personnel, including 4,175 Air Force; 6,300 Army; 90 Marine Corps; 135 Navy; 1,040 Army National Guard; 1,480 Air National Guard; and 90 Coast Guard (USDoD, U.S. Air Force, 2012). In addition to this main facility, JBER uses several maneuver areas, 31 training areas, numerous impact areas (artillery and mortar firing points), and major ranges (i.e., small arms ranges, demolition ranges, landing zones, and drop zones). The installation hosts the headquarters for the U.S. Alaskan Command, 11th Air Force, U.S. Army Alaska, and the Alaskan North American Aerospace Defense Command Region.

Although the various activities at JBER are land- or air-based, they could affect resources in Cook Inlet due to ongoing operations as well as historical disposal practices (e.g., sites such as Eagle River Flats contaminated by white phosphorus, currently undergoing remediation). JBER (USDoD, U.S. Air Force, 2012) has detailed its current resource management practices and compliance with environmental requirements (e.g., pertaining to monitoring and protection of threatened or endangered species) in its Integrated Natural Resource Management Plan.

For the cumulative effects analysis, JBER activities are assumed to continue at approximately current levels for the foreseeable future.

5.1.2.12. Fishing Activities

Commercial, sport, and subsistence fishing activities occur throughout Cook Inlet. These activities are described in Sections 3.3.2, 3.3.7, and 3.3.3 respectively.

Although some commercial fisheries operate year-round (e.g., clamming), others such as gillnet fisheries targeting various salmon species, are highly seasonal and occur mainly during June, July, and August. Varying harvest techniques, based on target species, are used within the commercial fishery, including pot fishing (shellfish), dredging (scallops, clams), gillnets and purse seines (herring, salmon), trawls (groundfish), and longlines (groundfish). Vessels used during the harvest range from small inland vessels to large ocean-going vessels, depending on the location of the fishery and weather conditions.

Target species for the sport fishery include Pacific halibut, Pacific salmon, and razor clam. Most sport fishing in the area is done by hired charters, guided tours, or shore-based fishing and includes saltwater and freshwater areas. Although most sport fishing is done in saltwater, freshwater charters often target king and sockeye salmon, primarily in the rivers and streams flowing into Kachemak Bay and the lower Cook Inlet. The sport fishery also includes gathering clams along the western side of the Kenai Peninsula and other areas of the Cook Inlet shoreline.

Subsistence harvesting activities occur year-round and include salmon and other fish, marine invertebrates, big and small game, marine mammals, birds and eggs, plants, and berries. Resource areas for subsistence harvest activities include terrestrial habitats, inland waters, and nearshore waters.

5.1.2.13. Climate Change

Though climate change does not currently constitute a Federal action, the CEQ (2010) issued guidance that stated GHG emissions should be considered during the NEPA process if the agency determines the assessment of climate issues is appropriate.

A discussion of climate change is presented in Section 3.1.1.1. Data collected during the past 60 years indicate the State of Alaska has warmed more than twice as fast as the rest of the U.S., with average annual air temperature increasing by 1.7°C (3°F) (Stewart et al., 2013). The IPCC (2014) workgroup projected that the globally averaged surface temperature is projected to increase by 0.3°C to 0.7°C (.54°F to 1.26°F) between 2016 and 2035, with land areas, particularly those in the Arctic latitudes, warming more rapidly.

The IPCC (2014) assessed the potential consequences of global climate change, which may be regionally or globally relevant. The report includes discussions on the sensitivity, adaptive capacity, and vulnerability of natural and human systems to climate change. Impacts that have already been observed in Alaska include earlier snowmelt, reduced sea ice, glacier retreat, warmer permafrost, drier landscapes, increased wildfires, and more extensive insect outbreaks (Chapin et al., 2014).

5.2. Analysis of Cumulative Effects

The following sections analyze cumulative effects for each of the Cook Inlet resources included in the EIS. A baseline description of resources is presented in Chapter 3, and direct and indirect impacts are evaluated in Chapter 4. The following resources are included:

- Air quality
- Water quality
- Acoustic environment
- Commercial fishing
- Subsistence harvest patterns
- Sociocultural systems

- Lower trophic level organisms
- Fish and shellfish
- Marine mammals
- Terrestrial mammals
- Marine and coastal birds
- Coastal and estuarine habitats
- Economy and population
- Public and community health
- Recreation, tourism, and visual resources
- Sport fishing
- Archaeological resources
- Areas of Special Concern
- Oil and gas and related infrastructure
- Environmental Justice

The cumulative effects analysis for Cook Inlet resources includes the Proposed Action (Lease Sale 244) as well as past, present, and reasonably foreseeable future actions as described in Section 5.1 (Table 5.1.2-1) and listed here:

- Oil and gas activities (state and Federal waters and state lands)
- Renewable energy projects
- Mining projects
- Marine transportation
- Ports and terminals
- Knik Arm Crossing Project
- Submarine cable projects
- Wastewater discharges
- Persistent contaminants and marine debris
- Dredging and marine disposal
- Military activities
- Fishing activities
- Climate change

The key characteristics of these activities are summarized in Table 5.2-1. For each category of activities, the table indicates the geographic location of the activity (i.e., whether it is located within or adjacent to the proposed Lease Sale Area or within the Cook Inlet region) and the types of impacts that are most relevant for the cumulative analysis. Most of the activity categories include past, present, and reasonably foreseeable future activities. Past and present actions generally are accounted for in the baseline environment (Chapter 3) and the analysis of direct and indirect impacts under each resource area (Chapter 4). These impacts are carried forward to the cumulative analysis, which also takes into account the effects of ongoing and reasonably foreseeable future activities and trends.

Table 5.2-1. Characteristics of Activities Considered in the Cumulative Effects Analysis.

Category	Projects Included	Geographic Location		Activities Relevant to Cumulative Effects Analysis	IPFs
		In or Adjacent to Proposed Lease Sale Area	Region		
Oil and gas activities (non-Lease Sale 244)	Oil and gas exploration, development, and production in state and Federal waters and state onshore	X (in and adjacent)	X	Essentially the same types of offshore activities associated with the Proposed Action, plus onshore exploration and development activities	Seafloor disturbance and habitat alteration Drilling discharges Other operational discharges Water intake Noise Air pollutant emissions Physical presence, including lights Trash and debris Vessel traffic Aircraft traffic and noise Employment and project spending Accidental spills

Category	Projects Included	Geographic Location		Activities Relevant to Cumulative Effects Analysis	IPFs
		In or Adjacent to Proposed Lease Sale Area	Region		
Renewable energy projects	Fire Island Wind Project Turnagain Arm Tidal Energy Project	--	X	Construction activities Routine operation of wind turbines and tidal energy generators	Seafloor disturbance and habitat alteration Coastal habitat disturbance, erosion and sedimentation Noise (including pile driving) Air pollutant emissions Physical presence Vessel traffic (construction, maintenance) Employment and project spending Accidental spills during construction
Mining projects	Chuitna Coal Project Diamond Point Rock Quarry Pebble Mine Port and Terminal	--	X	Dock/terminal construction Mineral loading operations	Seafloor disturbance and habitat alteration Coastal habitat disturbance, erosion and sedimentation Noise (including pile driving) Air pollutant emissions Physical presence of docks/loading facilities Vessel traffic (construction, operations) Employment and project spending Accidental spills during construction or operations
Marine transportation	Regional shipping traffic to/from Cook Inlet ports	X	X	Operation of crude oil tankers, LNG tankers, tugs and barges, ferries, commercial vessels, commercial fishing vessels, military vessels, USCG vessels, coal carrier, dredging vessels, cruise ships, small watercraft	Vessel traffic, Physical presence and lighting, Accidental spills from tankers or other ships
Ports and terminals	Port expansion projects (Anchorage, Port MacKenzie) Routine port operations (Anchorage, Port McKenzie, Tyonek/North Forelands, Drift River Oil Terminal, Nikiski Industrial Terminals, Port of Homer, Seldovia Harbor, Port Graham, Williamsport)	--	X	Constructions of new and expanded marine terminals; increased port usage due to improved facilities	Seafloor disturbance and habitat alteration Coastal habitat disturbance, erosion and sedimentation Noise (including pile driving) Air pollutant emissions Physical presence of docks Vessel traffic (construction, operations) Employment and project spending Accidental spills during construction or port operations
Knik Arm Crossing Project	Construction of bridge and access roads	--	X	Bridge construction activities including marine environment and both shorelines of Knik Arm	Seafloor disturbance and habitat alteration Coastal habitat disturbance, erosion and sedimentation Noise (including pile driving) Air pollutant emissions Physical presence of bridge pilings Vessel traffic (construction) Employment and project spending Accidental spills during construction

Category	Projects Included	Geographic Location		Activities Relevant to Cumulative Effects Analysis	IPFs
		In or Adjacent to Proposed Lease Sale Area	Region		
Submarine cable projects	AKORN Fiber Optic Cable United Utilities Fiber Optic Cable	-- X	X X	Cable laying and burial. Little or no activity in operation.	Seafloor disturbance and habitat alteration (cable burial) Air pollutant emissions (construction) Vessel traffic (construction)
Wastewater discharges	Permitted point-source discharges such as municipal wastewater and seafood processing (excluding oil and gas facilities)	--	X	Discharges by pipes or man-made ditches from sewage treatment plants, industrial facilities, and power generating plants	Effluent discharges (introduction of pollutants into coastal waters)
Persistent contaminants and marine debris	Contaminants such as PCBs and pesticides; floating debris from ocean-based and land-based activities	X	X	Introduction of contaminants, trash and debris into the marine environment, other than from point source discharges	Contamination of water and sediments Trash and debris (wildlife ingestion and entanglement; aesthetic impacts)
Dredging and marine disposal	Routine maintenance dredging of ports and navigation channels	--	X	Excavation by clamshell, hydraulic cutterhead, pipeline suction, or bulldozer Transport or conveyance of dredged materials (by barge or suction pipeline)	Seafloor disturbance and habitat alteration Erosion and sedimentation Noise Air pollutant emissions Physical presence of dredging vessels Vessel traffic Accidental spills
Military activities	Joint Base Elmendorf-Richardson (JBER)	--	X	Airfield and aircraft traffic Combat training center Munitions storage Community facilities and residences Communication centers Impact areas and firing ranges (onshore) Maneuver areas (onshore) Major ranges (onshore) Contaminated sites (currently undergoing remediation)	Aircraft traffic Air pollutant emissions Physical presence Noise Coastal habitat disturbance Employment and project spending Accidental contaminant releases
Fishing activities	Commercial, recreational and subsistence fishing	X	X	Operation of fishing boats; use of gill nets, seines, purse seines, trawls, dredges, pots, jigs Use of diving equipment	Vessel traffic Air pollutant emissions Noise Direct removal of resources Accidental spills

Category	Projects Included	Geographic Location		Activities Relevant to Cumulative Effects Analysis	IPFs
		In or Adjacent to Proposed Lease Sale Area	Region		
Climate change	GHG emissions from all sources	X	X	Global changes due to GHG emissions	Increasing air and water temperatures Sea level rise Altered hydrology, snow melt, glaciers Range extensions and shifts in distribution Invasive species Ocean acidification Changes in plankton blooms Changes in subsistence hunting practices Changes in community economic development and tourism activities

5.2.1. Air Quality

Cumulative impacts on air quality will result from the incremental impacts of the Proposed Action (analyzed in Section 4.3.1) when added to impacts from the ongoing and reasonably foreseeable future activities described in Section 5.1.2.

5.2.1.1. Summary of Direct and Indirect Effects

Effects of routine activities on air quality in the proposed Lease Sale Area are estimated to be minor. The only IPFs considered in this EIS that would have a measurable impact on air quality are air emissions and traffic. All emissions of airborne pollutants during oil and gas activities on the OCS, as described in Chapter 3, will increase concentrations to some extent in the region. However, due to dispersion and mixing of pollutants in the atmosphere and regulations requiring the use of emissions control technology or equipment that meets air emissions standards, measurable impacts at the nearest air quality monitoring stations will be minor to moderate. Air quality currently is not impaired in any boroughs adjacent to the proposed Lease Sale Area, and the Proposed Action would not cause any of the boroughs to be in or fall back into nonattainment for criteria pollutants. Consequently, the overall effects of routine activities on air quality would be minor.

Effects of small diesel fuel or oil spills on air quality would be minor, localized, and temporary. Effects on air quality from a large oil spill would be temporary, but could be moderate depending on the size, location, and duration of the spill and meteorological conditions such as wind speed and direction. Once cleanup efforts are completed, air quality impacts would dissipate quickly. Overall, impacts from accidental spills (small or large) are estimated to be minor.

5.2.1.2. Other Relevant Activities that Could Affect Air Quality

In addition to the activities described under the Proposed Action, there are other past, present, and reasonably foreseeable future actions that could generate emissions on or near the OCS. Activities that could generate emissions within the region during the next 40 to 50 years include ongoing oil and gas exploration, development, and production (onshore and in Alaska and surrounding waters); future exploration, development, and production activities and infrastructure (onshore and in state waters); and construction activities related to renewable energy and mining projects, marine transportation, harbors, ports and terminal operations, the Knik Arm Crossing Project (vicinity of Cook Inlet), submarine cable projects, dredging and marine disposal, military activities, and fishing activities.

Table 5.2.1-1 lists other activities that could affect air quality. Each of these activities will involve some combination of marine vessels and onshore and/or offshore stationary source equipment having diesel engines, which will create emissions impacting air quality in the localized area.

Table 5.2.1-1. Other Relevant Activities that Could Affect Air Quality.

Activity	IPF
Oil and gas activities (state waters and lands)	Air pollutant emissions
Renewable energy projects	Air pollutant emissions
Mining projects	Air pollutant emissions
Marine transportation	Air pollutant emissions
Ports and terminals	Air pollutant emissions
Knik Arm Crossing Project	Air pollutant emissions
Submarine cable projects	Air pollutant emissions
Dredging and marine disposal	Air pollutant emissions
Military activities	Air pollutant emissions
Fishing activities	Air pollutant emissions
Climate change	Increasing air temperatures and ocean acidification

5.2.1.3. Analysis of Cumulative Effects

This section discusses potential cumulative air quality impacts in onshore and offshore areas of the Cook Inlet region resulting from the incremental impacts of the Proposed Action, including non-OCS oil and gas program activities listed in Table 5.2.1-1. Impact on air quality of each of these activities will depend on the number of sources, their locations, and the duration of the activities. Climate change is not expected to have a significant impact on air quality, although increasing air temperatures and ocean acidification could result in minor impacts on air quality by affecting the dispersal of pollutants from sources related to the other listed activities.

The cumulative effects analysis considers activities associated with the Proposed Action in combination with those from ongoing and future programs. Typical oil and gas exploration and development activities include construction and operation of production platforms, exploration and production wells, and pipelines. Activities also include vehicular activity such as tanker and barge transport, survey vessel trips, and activity of support vessels and helicopters. These activities could adversely affect air quality in Alaska over the next 40 to 50 years.

Table 5.2.1-2 lists the estimated total emissions associated with the Proposed Action as well as future oil and gas activities on the OCS in Cook Inlet, projected over the next 40 years. Although the non-oil and gas activities described in Section 5.1.2 will impact air quality, their impacts will be minor compared to the estimated cumulative impacts from oil and gas activities, and are not included in the estimates. Emissions were estimated using emission factors from BOEM's 2012 Revised Offshore Environmental Cost Model (OECM) (USDOI, BOEM, 2012c). In terms of absolute amounts, the largest emissions would be NO_x, followed by CO, with lesser amounts of VOCs, SO_x, PM_{10}, and $PM_{2.5}$. The majority of emissions would come from drilling wells, support vessels, and construction of new production platforms and pipelines.

Table 5.2.1-2 Estimate of 40-Year OCS Oil and Gas Activity Air Emissions, 2017-2057.

Pollutant	Annual Emissions from Proposed Action (average in tons)	Cumulative Emissions from Scenario Oil and Gas Proposed Action (tons)
NO_x	4,356.5	174,260
SO_x	53.0	2,120
PM_{10}	234.8	9,392
$PM_{2.5}$	232.4	9,296
CO	1,958.2	78,328
VOCs	9.6	384

Although the air emissions from the Proposed Action and other past, present, and reasonably foreseeable future actions will be additive, they also will be intermittent, localized, and rapidly dispersed, so the incremental impacts of air emissions from the Proposed Action in the region would be limited and are estimated to be minor.

The Proposed Action would contribute to onshore levels of NO_2, SO_2, CO, PM_{10}, and $PM_{2.5}$, but concentrations are expected to remain well within the national standards and PSD increments. Effects from future OCS program activities are expected to remain about the same as in previous years. Conditions in Cook Inlet typically are unfavorable for significant ozone formation, so program contributions to ozone concentrations are expected to remain small. The Cook Inlet region does not have significant smog from anthropogenic emission sources, and visibility is expected to remain unimpaired as a result of regional and national programs to further reduce emissions. The contribution from the Proposed Action to visibility impairment is also expected to remain small because most impacts will occur in the offshore environment, geographically removed from other impact sources.

The cumulative impacts analysis does not analyze impacts associated with end use consumption of oil and gas resources which may be produced as a result of this lease sale. As discussed in Section 2.7.2 (Issues Considered but Not Analyzed), NEPA does not require analysis of impacts that are not a direct, indirect or cumulative effect of the Proposed Action. Furthermore, current methods and models for predicting end use impacts are too speculative and unreliable to require inclusion in this EIS. Based upon analysis in the 2012-2017 Five Year Program, BOEM’s best estimate is that even making the entire U.S. OCS unavailable for leasing would result in a decrease in consumption equivalent only to 2 months of current U.S. consumption over the course of 40-50 years. Where the qualities and quantities of fossil fuel to be produced are surrounded by so many unknowns, where no generally accepted methodology for reliably calculating end use impacts exists, and where BOEM’s findings indicate there would be little to no impact on fossil fuel consumption as a result of this lease sale, NEPA does not require an end use analysis.

The number of estimated accidental oil spills in Cook Inlet associated with the Proposed Action would represent a minor to moderate increase over the number of estimated spills from other past, present, and reasonably foreseeable future oil and gas activities and non-OCS program activities. An incremental increase in adverse air quality impacts from these spills (and in situ burning of spilled crude or diesel) would be localized and temporary (due to the oil being spread by waves and currents, thus dispersing volatile compounds to extremely low levels over a relatively large area). The incremental contribution of estimated oil spills from the Proposed Action to air quality impacts would be minor. Spill response and cleanup activities (e.g., in situ burning, use of chemical dispersants) could contribute to air quality impacts regardless of the size of spill.

5.2.1.4. Conclusion

Impacts of the Proposed Action on air quality are minor. Incremental contributions from the Proposed Action to other past, present, and reasonably foreseeable future actions will result in additive and minor impacts to air quality. The incremental contribution of the Proposed Action would represent a significant percentage of the total cumulative air emissions (Table 5.2.1-2); however, because the emissions will be intermittent, localized, and rapidly dispersed, there would be limited incremental impacts to cumulative air emissions in the region. Overall, the incremental contribution of the Proposed Action to effects estimated in the cumulative effects analysis is considered minor for air quality.

5.2.2. Water Quality

Cumulative impacts on water quality include the incremental impacts of the Proposed Action (analyzed in Section 4.3.2) when added to impacts from the ongoing and reasonably foreseeable future activities described in Section 5.1.2.

5.2.2.1. Summary of Direct and Indirect Effects

The analysis of impacts to water quality under the Proposed Action is presented in Section 4.3.2. Activities estimated to occur in the E&D Scenario that could impact water quality include seafloor disturbance from MODUs, drilling operations and other offshore infrastructure; drilling and other operational discharges from MODUs, vessels, and platforms; accidental discharge of trash and debris; and small and large accidental spills. Potential impacts to water quality from routine activities under the Proposed Action include increased total suspended solids, nutrient enrichment, metals contamination from drilling discharges, changes in temperature or salinity, contamination with chemicals from decomposition of accidentally discharged trash and debris, and contamination with hydrocarbons in the case of an accidental spill.

Impacts from routine activities are estimated to be short-term and highly localized, and overall would only result in minor impacts to water quality. Although a small spill could substantially affect water quality in the area immediately surrounding the spill, the impacts would be localized and short-term, and therefore minor overall. A large spill could result in moderate impacts due to widespread oiling and long-term contamination that could result if a spill of ≥1,000 bbl occurred.

5.2.2.2. Other Relevant Activities that Could Affect Water Quality

Cumulative impacts on water quality include the incremental impacts of the Proposed Action when added to the effects of past, present, and reasonably foreseeable future activities in the vicinity of the proposed Lease Sale Area (Table 5.1.2-1). Several activities could affect water quality, including oil and gas activities in state waters, construction of infrastructure and industrial development, and dredging and mining projects (Table 5.2-1). Any activity that disturbs the seafloor or alters seafloor habitat; that introduces drilling discharges, other operational wastes, or persistent contaminants; that adds trash and debris; or that accidentally discharges oil or other hydrocarbons will impact water quality. Many types of activities that will cause these impacts are already occurring in Cook Inlet and may be reasonably expected to occur over the 40-year span of the E&D Scenario. Additionally, anticipated climate change will influence water quality due to warmer water temperatures, water acidification, and cascading effects that could result from these changes.

5.2.2.3. Analysis of Cumulative Effects

Under the Proposed Action, seafloor disturbance impacts will result from drilling wells and placing anchors, nodes, cables, sensors, pipelines, platforms, and other equipment on the seafloor (Sections 2.4 and 4.3.2.1). Activities that cause seafloor disturbance and habitat alteration include oil and gas activities, fishing activities, renewable energy projects, mining projects, ports and terminals, the Knik Arm Crossing Project, and dredging and marine disposal. In the past, seafloor disturbance and habitat alteration were associated with development of oil and gas activities in state waters and submarine cable projects. Should decommissioning of platforms in state waters occur during the 40-year period of the E&D Scenario, the effect would be additive to activities undertaken in the context of the Proposed Action, although they would be geographically separated, expanding the areal extent of seafloor disturbance and habitat alteration in Cook Inlet. It is possible that future oil and gas exploration in state and Federal waters will occur in Cook Inlet in association with the annual state area-wide sales. Therefore, exploratory drilling may occur in stated and Federal marine waters of Cook Inlet, with attendant seafloor disturbance and habitat alteration. Incremental effects of the Proposed Action would be additive to those of other past, present, and reasonably foreseeable future actions in terms of seafloor disturbance and habitat alteration.

Other projects are estimated to occur that could cause seafloor disturbance are in areas geographically distinct from the proposed Lease Sale Area. For example, the Knik Arm Crossing Bridge could be constructed approximately 193 km (120 mi) northeast of the proposed Lease Sale Area, at the confluence of the Knik Arm and upper Cook Inlet. While there might be temporal overlap, geographic overlap within Cook Inlet would not occur. Similarly, maintenance, dredging, and expansion of the Port of Anchorage, and work at other harbor facilities in Cook Inlet, are located in inshore; they would be outside of the proposed Lease Sale Area.

Under the Proposed Action, drilling fluids and cuttings will be discharged to the seafloor surrounding the exploration and delineation wellsites (7 to 10 wells). Discharge of fluids and cuttings would cause localized and transient impacts to water quality; however, strong tidal currents in Cook Inlet are expected to quickly transport any fluids and cutting away from the point of discharge (Hannah and Drozdowski, 2005). Discharge of fluids and cuttings has occurred and will occur under other past, present, and reasonably foreseeable future activities in state and Federal waters, as described in Table 5.2-1. The Proposed Action will result in a moderate incremental increase in the discharge of fluids and cuttings; however, impacts will be localized to areas in the immediate vicinity of the wells. Wells under the Proposed Action will be >4.8 km (3 mi) from shore, while existing and potential future wells may be <4.8 km (3 mi) from shore, so impacts will be geographically and temporally dispersed.

The Proposed Action would result in increased operational discharges within Cook Inlet. Other sources of operational discharges are additional oil and gas activities as well as effluent discharges from sewage treatment plants, industrial facilities, and power-generating plants. The major point sources of discharges are from municipal wastewater treatment plants, seafood processors, and the petroleum industry. Routine operations at port facilities may add permitted discharges. Existing municipal and industrial discharges, including wastewater discharges, are generally remote from the proposed Lease Sale Area, but the effects of any additional operational discharges in Cook Inlet would have an additive effect. Due to a large number of existing sources of treated wastewater discharges in Cook Inlet and because operational discharges are regulated and require an NPDES permit for discharge, the Proposed Action will only result in a minor incremental increase in impacts estimates.

Impacts of trash and debris on water quality were deemed minor for the Proposed Action (Section 4.3.2.4). Given the regulations in place that control the introduction of trash and debris to the marine environment, only accidental introduction of trash and debris to the marine environment from vessels or platforms not associated with the Proposed Action would impact water quality. The incremental increase in trash and debris from the Proposed Action to other past, present, and reasonable foreseeable future activities in state and Federal waters would be additive, but would not result in measureable impacts.

Under the Proposed Action, water quality could be affected by oil accidentally released from platforms, pipelines, and marine vessels. Accidental oil releases could occur in Cook Inlet from a variety of other related activities, such as the domestic transportation of oil, import of foreign crude oil, and future state development of oil. Oil and gas activities will continue in state waters in Cook Inlet, which could contribute to the likelihood of accidental oil releases. Most oil spills estimated to occur under the Proposed Action are small (<50 bbl), but a large spill (≥1,000 bbl) might occur based on projections (Appendix A). The impact to water quality from an accidental spill would depend on the spill size, the type of material spilled, and the hydrodynamic and meteorological conditions at the time of the spill (see Section 4.3.2). Similar spills (small and large) could occur from state oil and gas activities as well as port and terminal expansion projects, while other activities likely would only result in small spills. Overall, accidental spills as a result of the Proposed Action likely would result in a minor (small spill) or major (large spill) incremental increase in accidental spill-related impacts.

Climate change may result in synergistic impacts to water quality by promoting warmer water temperatures and by acidifying seawater. The eustatic sea level will continue to rise due to glacial melt and seawater expansion that accompany warmer water temperatures. Salinity may be reduced in Cook Inlet, resulting in changing temperature-salinity fields that could alter estuarine and thermohaline components of regional circulation.

5.2.2.4. Conclusion

Over 40 years, the Proposed Action would impact water quality as described in Section 4.3.2. These impacts include increased turbidity and resuspension of sediment from installation of MODUs, platforms, pipelines, and other seafloor equipment; discharges of drilling fluids, cuttings, and other operational discharges; accidental discharge of trash and debris; and degradation of water quality due to an accidental spill. The overall impact of routine activities on water quality is estimated to be minor. Impacts are estimated to be minor to moderate for accidental spills, depending on size of the spill. Water quality will be affected by numerous activities, including oil and gas activities in state waters, drilling discharges, construction of infrastructure and industrial development, dredging projects, mining projects, accidental loss of trash and marine debris, and climate change. The incremental contribution of the Proposed Action to the cumulative effects analysis on water quality would be minor when routine activities and the regulation of discharges are considered. Discharges are estimated to only cause short-term and localized impacts. However, the impacts associated with a large spill could have a moderate impact on water quality in a widespread area over a long period of time.

5.2.3. Underwater Acoustic Environments

Cumulative impacts on acoustic environments will result from the incremental impacts of the Proposed Action (analyzed in Section 4.3.3) when added to impacts from the ongoing and reasonably foreseeable future activities described in Section 5.1.2.

5.2.3.1. Summary of Direct and Indirect Effects

The acoustic environment throughout Cook Inlet would be affected by activities conducted during exploration, development, production, and decommissioning as part of the Proposed Action due to the introduction of operational noise into the habitat. Table 4.2-2 provides a list of IPFs identified in association with all phases of the Proposed Action. Impacts to acoustic environments from routine operations under the Proposed Action include noise from active acoustic sources, vessel and aircraft, and drilling and equipment noise.

Overall, active acoustic sources are expected to have the most intense but shortest duration impact, whereas an overall increase in vessel activity is likely to have a chronic low-intensity impact on the acoustic environment during the 40-year period. Impacts from routine activities from the Proposed Action are estimated to be minor.

Accidental spills of all levels will have a temporary impact on the acoustic environment due to the increase in response vessel traffic and extended sampling periods during cleanup operations; however, the acoustic habitat will return to ambient after activities cease. The impacts from small or large accidental spills are estimated to be minor due to the temporary nature of the response period.

5.2.3.2. Other Relevant Activities that Could Affect Underwater Acoustic Environments

All in-water activities will introduce additional noise into the environment and will change the acoustic properties of the environment temporarily or permanently (Table 5.2.3-1). The combined activities will create a cumulative impact on the acoustic habitat within the proposed Lease Sale Area over a long period of time. The projected development will lead to activities and introduced noise that will permanently change the acoustic environment, even though these changes may vary spatially and temporally. Chronic impacts from vessel noise and routine operations will occur mainly within frequency bands <1,000 Hz. Activities that require ongoing construction or maintenance such as dredging activities, and activities that are ongoing after construction, such as activities on production platforms and wind and tidal turbines, are expected to produce low-frequency sources over the life of the installation. Activities that increase the number, size, or activity level of marine vessels will produce the most severe and long-lasting impacts on the acoustic environment.

Projects may have short-term, intensive impacts during construction with longer-term chronic impacts as a result of the project. For example, the Knik Arm Crossing may introduce significant sound sources into the environment during construction that could temporarily fragment the acoustic habitat of upper Cook Inlet from Knik Arm; and rather than the habitat returning to ambient noise conditions after construction, surface-generated sound from traffic across the bridge would introduce long-term noise into the habitat. The results from these combined impacts will produce a long-term change to the acoustic environment in Cook Inlet and the surrounding waters, increasing sound levels in low-frequency bands.

The effects of climate change on acoustic habitat may seasonally reduce sound levels that occur due to ice movement within Cook Inlet. Increases in water temperature can increase the propagation distance of sound; however, due to extreme mixing in Cook Inlet, changes in temperature are not likely to influence sound propagation substantially.

Table 5.2.3-1. Other Activities Potentially Affecting the Underwater Acoustic Environment.

Activity	Potential Effects
State Waters and Onshore Oil and Gas: Exploration, development, production, and decommissioning; Upper Cook Inlet is a mature basin with extensive exploration and development both on shore and in state waters over the past 50 years (see Section 5.1.2.1); 30 active oil and gas units, entirely or partly in state waters; Includes 17 offshore platforms, associated oil and gas pipelines, and onshore processing and support facilities; Approximately 365 km (227 mi) of undersea pipelines; onshore pipelines and access roads.	Additional oil and gas exploration and production will introduce similar noise characteristics as those introduced in Federal waters. There would be an increase in noise levels for the duration of oil and gas activities in state waters. The variations in bathymetric profile likely will affect noise propagation most notably in state waters.
Renewable Energy Projects: include the 17.6-MW Fire Island Wind Project and two tidal energy projects in development (East Foreland Tidal Energy Project and 240-MW Turnagain Arm Tidal Energy Project).	Increased vessel activity that will support renewable energy projects and low-frequency noise from post-construction operation will contribute to increased noise levels. Pile driving and active acoustic sources will produce high-intensity, temporary impacts.
Mining Projects: the Chuitna Coal Project, the Diamond Point Rock Quarry, and the Pebble Mine Port and Marine Terminal	Low-frequency, chronic impacts from increased marine vessel noise. High-intensity, temporary active acoustic sources during exploration. Moderate intensity, low-frequency noise during the mining operations.
Marine Transportation: Global shipping vessels; oil and gas vessels, cargo vessels, military vessels, supply barges, cruise ships, commercial fishing vessels, survey vessels, research vessels	Chronic impacts from increased vessel noise that will occupy low-frequency bands in the acoustic habitats.
Ports and Terminals: Largest port facilities are Anchorage, Port MacKenzie, Tyonek, Nikiski, Drift River, Kenai, Anchor Point, and Homer. Modernization project planned for Port of Anchorage; Expansion and development underway in Port MacKenzie	Chronic impacts from increased vessel noise that will occupy low-frequency bands in the acoustic habitats. Port expansions will increase noise levels temporarily due to construction and may indicate an increase in chronic noise levels due to an increase in vessel size, vessel numbers, and vessel transits.
Onshore Infrastructure Construction and Maintenance: Projects developed by community, industry (other than oil and gas), Federal and state governments, and military entities. Ports, docks, roads, gravel pads, bridges, runways, ice roads, energy projects, wastewater plants, etc.	Increased vessel activity during construction and maintenance. Improved ports may indicate an increase in vessel size, vessel numbers, and vessel transit. In water construction and preparation such as pile driving and active acoustic sources are high-intensity and have temporary impacts.
Submarine Cables: Two submarine cable projects completed.	Temporary increase in noise levels produced from support vessels, plowing, and cable laying activities will produce impacts during construction.
Dredging and Marine Disposal: The USACE conducts annual maintenance dredging projects to prevent shoaling at several locations within Cook Inlet: in Anchorage Harbor (Knik Arm), Homer Small Boat Harbor, Ninilchik Harbor, and within the Cook Inlet Navigation Channel.	Chronic low to moderate intensity sound level increases during dredging operations. This activity is considered chronic in that maintenance dredging will be required throughout the 40-year period even though individual projects will start and stop. Therefore dredging activities over the course of the analysis period will produce long-lasting noise increases in the acoustic environment.

Activity	Potential Effects
Fishing Activities: Currently extensive commercial, recreational, and subsistence fishing activities occur throughout Cook Inlet. These activities are described in Section 4.3.11 (Commercial Fishing), Section 4.3.16 (Sport Fishing), and Section 4.3.12 (Subsistence Harvest Patterns).	Vessel activity will produce an increase in noise levels surrounding the activity. Impacts likely to be the same as current impacts with no expected increase in commercial or sport fishing.

5.2.3.3. Analysis of Cumulative Effects

The acoustic environment, by definition, is the additive sound propagated from natural and anthropogenic sources. Individual sound sources may contribute only localized elevated sound levels to the acoustic habitat; however, the addition of sources listed in the table above and subsequent interaction with the physical environment may result in greater (synergistic) impacts via combined higher source levels or a wider distribution of higher sound levels. As described in Section 3.1, Cook Inlet is a noisy environment compared to the open ocean due to natural conditions and an active marine industry, including sound produced by other past, present, and reasonable foreseeable future activities (Table 5.2-1). Increased acoustic input from vessels and active sources, particularly in the low-frequency bands, is expected to result from the Proposed Action. Some of these noise sources will exceed ambient conditions but will do so only for a short period of time or will occur in areas that are geographically separated by many of the activities. The noise sources that could be expected due to a large oil spill resulting from the Proposed Action could have temporary additive impacts on the acoustic habitat by increasing the amount of low-frequency noise in the directly affected area as well as regional waters. Individual sources introduced through the Proposed Action may be the dominant contributor to noise in the environment for temporary periods; therefore, it is estimated that there will be a minor additive impact to the acoustic environment.

5.2.3.4. Conclusion

The Proposed Action would not employ anthropogenic sound sources into Cook Inlet that are different than those currently contributing noise to the acoustic habitat in or around the proposed Lease Sale Area. Intensity, duration, and local changes in the acoustic environment for each activity are likely to be minor when viewed on an individual basis. However, the Proposed Action and other relevant activities would increase the number and duration of sound sources, and could expand the spatial reach of these sound sources. Therefore, collectively, the Proposed Action will increase the long-term (chronic) sound levels within Cook Inlet through temporary activities, periodic activities, and long-term activities. Impacts to the acoustic habitat are additive due to the nature of sound propagation within the marine environment. Incremental effects on the available acoustic habitat will increase as sound sources increase in number, intensity, or duration. Frequency bands within the acoustic environment will be impacted differentially depending on the sound sources, with frequencies <1,000 Hz being impacted the most from man-made sound sources. Subsequent availability of that acoustic environment to species therefore will be diminished to varying degrees, depending on which activities are taking place and the sound propagation characteristics of the local environment. The impacts of the Proposed Action on the acoustic environment are estimated to be minor for individual routine activities and for small or large accidental spills. The incremental contribution of the Proposed Action to the cumulative effects analysis is considered minor for underwater acoustic environments.

5.2.4. Lower Trophic Level Organisms

Cumulative impacts on lower trophic level organisms will result from the incremental impacts of the Proposed Action (analyzed in Section 4.3.4) when added to impacts from the ongoing and reasonably foreseeable future activities described in Section 5.1.2.

5.2.4.1. Summary of Direct and Indirect Effects

Lower trophic level organisms and their habitats would be affected by the following factors during exploration, development, production, and decommissioning activities: disturbance and habitat alteration from structure emplacement (Daigle, 2011; Manoukian et al., 2010; Montagna, Jarvis, and Kennicutt, 2002); the addition of new substrate for colonization (Gallaway and Lewbel, 1982); smothering, anoxia, and contamination from drilling discharges (Neff, 2010); contamination from other discharges; impingement or entrainment from water intake (Choi et al., 2012); and attraction to lighting, leading to increased predation (Keenan, Benfield, and Blackburn, 2007).

Impacts from small or large accidental spills include direct toxic effects, including lethal or sublethal effects such as impacts on behavior, reproduction, growth and development, immune response, and respiration (e.g., Auffret et al., 2004; Bellas et al., 2013; Blackburn et al., 2014; Hannam et al., 2010); indirect toxic effects, including the inhibition of air-sea gas exchanges and hypoxia from the degradation of oil (Abbriano et al., 2011; Blackburn et al., 2014; Ozhan, Parsons, and Bargu, 2014); physical smothering and reduced photosynthesis (Blackburn et al., 2014; González et al., 2013; Ozhan, Parsons, and Bargu, 2014); and biomagnification/bioaccumulation of pollutants up food webs (Blackburn et al., 2014). Analysis of impacts to lower tropic level organisms in Section 4.3.4 were evaluated as minor for routine activities, minor for small spills, and moderate for a large spill.

5.2.4.2. Other Relevant Activities that Could Affect Lower Trophic Level Organisms

Cumulative impacts on lower trophic level organisms include the incremental impacts of the Proposed Action when added to the effects of past, present, and reasonably foreseeable future activities in the vicinity of the proposed Lease Sale Area (Table 5.1.2-1). All of the categories listed in Table 5.1.2-1 could impact lower trophic level organisms to varying degrees, and in a similar manner to those described for the Proposed Action (as summarized in Section 4.3.4).

Some impacts, such as vessel traffic, will occur from other activities, but only on a local scale for a short duration, and therefore will have negligible effect and will not be carried forward for analysis. Of the activities that are most likely to cumulatively impact lower trophic level organisms, disturbance and habitat alteration from structure emplacement, contamination from discharges, and exposure to oil are anticipated to have the greatest additive and synergistic impacts.

5.2.4.3. Analysis of Cumulative Effects

Seafloor disturbance and habitat alteration in the Proposed Action will result from drilling wells and placing anchors, nodes, cables, sensors, pipelines, and other equipment on the seafloor. Within Cook Inlet, two to three platforms and two oil and three gas offshore pipelines would be installed under the Proposed Action, and there would be 17 existing platforms and additional structures anticipated in the future. Other activities that will disturb the seafloor (Table 5.2-1) include the expansion of renewable energy projects, submarine cable projects, dredging and marine disposal, and fishing activities. These activities will disturb small areas temporarily, or areas that have already been subjected to disturbance.

Seafloor disturbance and habitat alteration, as described in Section 4.3.4.1, would include an initial kill-off of fauna close to the structure followed by a general recovery. Chronic local seafloor disturbance would result from subsequent movements of anchors and chains, or lines associated with floating production platforms and support vessels. However, installation of platforms and surface-laid pipelines would create hard substrate for algae and sessile invertebrate colonization. The amount of seafloor disturbance under the Proposed Action when added to the effects of past, present, and reasonably foreseeable future activities in the vicinity of the proposed Lease Sale Area will result in a minor incremental increase in impacts to lower trophic level organisms because the impacts will be geographically and temporally separated, allowing for recovery of benthic communities.

Discharge of fluids and cuttings could impact planktonic and benthic communities, but impacts to the planktonic community are unlikely to have an environmentally significant effect (Neff, 2005, 2010; NRC, 1983), and benthic communities impacted by fluids and cuttings recover quickly (Neff, 2010). Discharge of fluids and cuttings has occurred and will occur under other past, present, and reasonable foreseeable future activities, as described in Table 5.2-1. The Proposed Action will result in a minor incremental increase in the discharge of fluids and cuttings; impacts will be localized to areas in the immediate vicinity of the wells and discharge will be dispersed quickly. Wells under the Proposed Action will be >4.8 km (3 mi) from shore, while existing and potential future wells may be <4.8 km (3 mi) from shore, so impacts will be geographically and temporally dispersed, resulting in a minor cumulative impact in the Lease Sale Area.

The major waste discharges, with the exception of drilling discharges, produced under the Proposed Action include bilge, ballast, fire, and cooling water; sanitary and domestic wastes; and deck drainage. Once discharged, these wastes would contribute to degradation of water quality and impact planktonic communities. Activities and locations that contribute to these discharges include oil and gas activities in OCS and state waters, marine transportation, ports and terminals, wastewater discharges, persistent contaminants and marine debris, military activities, and fishing activities. These operational discharges are regulated and require an NPDES permit. As with discharge of drilling fluid and cuttings, waste discharges from the Proposed Action and other past, present, and reasonably foreseeable activities will be geographically and temporally separated, resulting in a minor incremental increase in terms of other operational discharges.

Water intake would occur when drawing seawater for once-through, non-contact cooling of machinery on drilling rigs under the Proposed Action, and would entrain phytoplankton and zooplankton, resulting in mortality. This also would occur for state oil and gas activities. Cooling water intake is regulated under NPDES permits to limit impacts as much as is practicable. Under the Proposed Action, impacts will be localized to areas in the immediate vicinity of the drillships (>4.8 km (3 mi)) from shore, whereas with other past, present, and reasonable foreseeable future activities, the drillships will be <4.8 km (3 mi) from shore, so impacts will be geographically and temporally dispersed, resulting in minor incremental increase of impacts.

The presence of structures and vessels and the associated lighting from the Proposed Action will affect lower trophic level organisms by attracting organisms and predators, as described in Section 4.3.4.5. Structures with lighting in the cumulative effects analysis will be associated with oil and gas operations, renewable energy projects, marine transportation, and military activities and will have similar effects. Under the Proposed Action, lighting from offshore vessels and drilling operations would be transient and localized, and would have nominal impacts on planktonic communities. Therefore, the lighting generated by two to three platforms, in conjunction with similar lighting from structures in the cumulative effects analysis, would result in a minor incremental increase in impacts to lower trophic level organisms.

Under the Proposed Action, lower trophic level organisms could be exposed to oil accidentally released from platforms, pipelines, and marine vessels. Accidental oil releases could occur in Cook Inlet from a variety of activities, such as the domestic transportation of oil, import of foreign crude oil, and state development of oil. Most of the oil released to Cook Inlet is from commercial and recreational vessels. Oil releases from all sources may expose lower trophic level organisms via direct contact or through persistent contamination of sediments. Planktonic communities would be most susceptible to adverse impacts from spills occurring offshore in surface waters, whereas benthic communities would be most susceptible to spills in coastal areas.

The majority of reasonably foreseeable spills associated with the Proposed Action are estimated to be <50 bbl, but a large spill, although unlikely to occur, is analyzed to determine the potential impacts (Appendix A). The magnitude of impacts would depend on the specific location affected, and the nature and magnitude of the accident, but could represent a large component of the overall exposure of lower trophic level organisms in Cook Inlet. Similar spills (small and large) could occur from state oil and gas activities as well as port and terminal expansion projects, while other activities likely would only result in small spills. Overall, cumulative impacts from accidental spills as a result of the Proposed Action likely would result in a minor (small spill or gas release) or moderate (large spill) incremental increase in accidental spill-related impacts. Oil spill response efforts and drills are assumed to be part of future oil and gas activities, and would have similar effects as those described in Section 4.3.4.6, which include minor impacts from mechanical recovery and in-situ burning, while dispersant effect depends on the size of the spill. Dispersants used on small spills are expected to have minor impacts, while large spills would result in moderate impacts. The additive effects of oil spill response activities associated with the Proposed Action are expected to be minor to moderate.

Climate change may result in impacts to lower trophic level organisms through habitat modification and ocean acidification. Impacts on lower trophic level organisms include direct synergistic impacts such as changes in the timing and magnitude of plankton blooms, physiological changes from altered ocean pH and temperature, and habitat modification that could occur as a result of melting ice, shoreline erosion, and sea level rise. Habitat modification will expand the range for some species, while reducing it for others. However, while the effects of climate change will be long-term, the effects that would occur during the life of the Proposed Action are estimated to negligibly impact lower trophic level organisms.

5.2.4.4. Conclusion

Lower trophic level organisms in Cook Inlet could be affected adversely by activities associated with the Proposed Action over the next 40 years. These impacts include disturbance and habitat alteration from structure emplacement, including the addition of new substrate for colonization; smothering, anoxia, and contamination from drilling and other operational discharges; impingement or entrainment from water intake; and attraction due to lighting. Overall impact of all routine activities under the Proposed Action is estimated to be minor. Impacts are estimated to range from minor to moderate for accidental spills. Lower trophic level organisms also could be affected by many other activities, including oil and gas activities in OCS and state waters, renewable energy projects, marine transportation, ports and terminals, submarine cable projects, wastewater discharges, persistent contaminants and marine debris, military activities, and climate change, resulting in a similar set of impacts.

Cumulative impacts on lower trophic level organisms in Cook Inlet from all OCS and non-OCS activities over the next 40 years are unavoidable, although mitigation could alleviate some of the impacts. Incremental contributions from the Proposed Action would result in a minor increase of impacts on lower trophic level organisms because most impacts would be localized, temporary, and not estimated to result in long-term disturbances or population-level effects.

5.2.5. Fish and Shellfish

Cumulative impacts on fish and shellfish will result from the incremental impacts of the Proposed Action (analyzed in Section 4.3.5) when added to impacts from ongoing and reasonably foreseeable future activities described in Section 5.1.2.

5.2.5.1. Summary of Direct and Indirect Effects

A detailed discussion of the direct and indirect impacts to fish and shellfish can be found in Section 4.3.5. Routine activities under the Proposed Action that may adversely affect fish, shellfish, and EFH include seafloor disturbance resulting in disturbance, damage, and burial of individual fish as well as their habitat and prey; drilling discharges causing injury and mortality, and indirectly impacting fish and shellfish through impacts to water quality; seismic surveys introducing noise-related disturbance to fish and fish habitats; water intake resulting in entrainment and impingement; and trash and debris (including non-hazardous domestic waste) introducing contaminants. Accidental activities that may affect fisheries resources include exposure to spilled oil, which could occur during routine operations. As discussed in Section 4.3.5, routine activities associated with implementation of the Proposed Action are estimated to have minor direct impacts on fish and shellfish in the vicinity of Cook Inlet. A small oil spill would have minor impacts and a large oil spill is estimated to have a moderate impact on fish and shellfish species, although it may have a major impact on some species if spilled oil affects egg and larval development, or interrupts spawning activities.

5.2.5.2. Other Relevant Activities that Could Affect Fish and Shellfish

Cumulative impacts on fish and shellfish include the incremental impacts of the Proposed Action when added to the effects of past, present, and reasonably foreseeable future activities in the vicinity of the proposed Lease Sale Area (Table 5.1.2-1).

The list of past, present, and reasonably foreseeable activities as identified in Table 5.2-1 that are the most significant sources of additive and synergistic impacts to fish and shellfish over the 40-year time period of the Proposed Action are as follows:

- Oil and gas activities (OCS waters, state waters, and lands)
- Marine transportation (includes spills)
- Ports and terminals
- Wastewater discharges
- Persistent contaminants and marine debris
- Mining activities; and
- Climate change

The listed activities will result in seafloor disturbance and habitat alteration from construction activities; contamination from drilling and operational discharges; mortality from water intake; disturbance impacts from seismic surveys, construction activities, and vessels; attraction to structures and lights; contamination from trash and debris; and contamination and habitat alteration from an oil spill and cleanup activities. Impacts also will occur from submarine cable projects, dredging and marine disposal, military activities, and fishing activities, but these activities are conducted temporarily, only on a local scale, or in areas that are already disturbed. Preliminary screening determined that the remaining activities (Table 5.1.2-1) will primarily result in disturbance impacts to a small number of fish and shellfish in a localized area for a short duration, and therefore will not be carried forward for analysis. While fishing activities will have a direct impact on fish and shellfish, the Proposed Action does not contribute to fishing activities; thus, fishing activities have been screened out for analysis. Within the activities that are most likely to impact fish and shellfish, contamination and oiling of habitats from an accidental spill, and habitat alteration and disturbance from construction activities as well as spill cleanup operations oil are anticipated to have the greatest additive impact.

5.2.5.3. Analysis of Cumulative Effects

The most significant impacts on fish and shellfish historically are from activities that disturb their habitat. Past anthropogenic impacts have included the discharge of drilling fluids and sediment from cuttings, bioaggregation and bioaccumulation of pollutants released during project activities, and habitat loss. Past and present actions that contribute to these disturbances include oil and gas exploration and development, the introduction of persistent contaminants, and the possible introduction of invasive species. Historic discharge of cuttings also poses a threat to the benthic habitat through deposition of artificial sediment on the seafloor and temporary loss of benthic organisms. Mortality and injury also are caused by the introduction of toxins and sediments into the water column due to drilling discharges. These toxins may pose a threat to pelagic and benthic organisms. Effects of past and current actions on fish and shellfish tend to be localized to areas near an activity, and so are geographically and temporally dispersed. Aquatic invasive species could pose a threat to fish and shellfish by altering habitat, competing for resources, preying on native species, or affecting the health of native species by introducing disease and pathogens. This could lead to changes in food web structure and shifts in abundance and diversity of native species. All factors directly and indirectly related to offshore oil and gas exploration in and around the proposed Lease Sale Area that have affected fish and shellfish in the past are likely to continue in the future. The potential for adverse cumulative impacts from the projected activities outlined in the Proposed Action would add to the effects on these resources through additive and synergistic cumulative impacts; however, because activities under the Proposed Action will be geographically separated (offshore) from other past, present, and reasonable foreseeable future activities (nearshore and onshore), impacts from the Proposed Action are estimated to result in minor incremental increase of impacts to fish and shellfish.

Drilling discharges resulting from the Proposed Action would add to the impacts resulting from current oil and gas activities. They are estimated have a minor additive effect on fish and shellfish due to the relatively small quantities involved, the limited area affected near a discharge point due to the high tidal currents present in Cook Inlet, and the geographic separation of drilling discharges related to the Proposed Action and those related to oil and gas activities in OCS and state waters. Other operational discharge would also have a minor additive effect, as effects would be similar to the ones described in the Proposed Action and would be geographically separated and quickly diluted by tidal actions.

Exploration surveys could be conducted anywhere throughout the proposed Lease Sale Area as part of the Proposed Action and would contribute to the existing ambient noise environment from oil and gas activities and ship traffic in Cook Inlet. Noise generated during the Proposed Action will likely be the dominant noise source in the environment during exploration (seismic surveys) and during construction of platforms; however, this noise will be geographically separated from much of the noise generated by other past, present, and reasonable foreseeable future activities. Also, while noise from activities under the Proposed Action will be intense, it will be short and will not result in long-term disturbance impacts to fish and shellfish. The Proposed Action will result in a minor incremental increase of noise-related impacts to fish and shellfish.

The physical presence of platforms (two to three) and pipelines (two) resulting from the Proposed Action will attract fish. Oil and gas platforms, docks, piers, and various other structures, which may include water intake structures, are anticipated as well. These structures could provide habitat for fish, which could have additive and synergistic effects on fish and shellfish depending on the species and type and location of habitat altered. Platforms are known to attract fish for food and shelter from predators, and some structural remains from oil and gas operations in other parts of the U.S. have been considered for EFH designation to rebuild certain stocks of fish. However, the small number of structures anticipated under the Proposed Action and the spatial separation of these structures from other past, present, and reasonable foreseeable future activities is estimated to result in a minor incremental increase in physical presence-related impacts to fish and shellfish.

The increased traffic projected as a result of the Proposed Action could create fish migration interruptions and delays. The extent of the conflicts would depend on the proximity to fish migration corridors throughout the proposed Lease Sale Area. However, relative to the existing level of vessel traffic in the proposed Lease Sale Area from activities such as oil and gas activity and marine transportation, the level of increase in vessel traffic from the Proposed Action is estimated to result in a minor incremental increase in vessel traffic-related impacts to fish and shellfish.

Increased shipping also increases the occurrence of trash and debris, small fuel spills and the possibilities of oil spills or vessel groundings, all of which would affect fish and fish habitat. The increase in marine vessel traffic and short-term underwater noise associated with the Proposed Action would contribute additive impacts associated with the planned construction, expansion, and operation of port facilities in Cook Inlet and could have a minor additive impact on the fish and shellfish. The increase in port facilities includes the Pebble Mine Port, Port of Anchorage, and Port MacKenzie. These expansions would cause an increase in marine vessel traffic, larger commercial vessel traffic, and construction vessel traffic in Cook Inlet. Increased shipping increases the occurrence of small fuel spills as well as the possibilities of oil spills or vessel groundings, all of which would affect fish and fish habitat. For these reasons, the relatively small additional contribution made by the discharges, seismic surveys, and offshore construction activities of the Proposed Action are estimated to have a minor additive effect when added to other past, present, and reasonable foreseeable future activities.

A large oil spill resulting from the Proposed Action could have additive impacts on fish and shellfish populations and habitat when added to the cumulative effects analysis. Impacts under the Proposed Action when added to the effects of past, present, and reasonably foreseeable future activities in the vicinity of the proposed Lease Sale Area could occur as a result of oil contaminating fluid flats, beaches, coastal marshes, salmon spawning rivers, and forage fish populations that utilize nearshore areas. As described in Section 4.3.5, impacts on fish and shellfish could cascade through the ecosystem with synergistic impacts as local fish stocks are forced into alternate habitats in search of alternate food supplies, migrating species are delayed or detoured to less productive spawning habitat, and local forage fish populations are impacted due to increased mortality due to effects of oil contamination. The overall cumulative effect on fisheries resources may include reduced stocks of some fisheries resources (e.g., sockeye, coho, and Chinook salmon; some semidemersal fish such as pollock; some shellfish), primarily due to the potential for overharvest of these stocks by commercial fishing activities. This effect could persist for several generations within a sub-population. Effects measurable at the population level are not likely. The effects of a large spill occurring as part of the Proposed Action would be additive to any other spill. The most likely effect would be a lengthier and prolonged recuperation period for fish and shellfish resources in the affected area.

Overall, accidental spills as a result of the Proposed Action would likely result in a minor (small spill or gas release) or moderate (large spill) incremental increase in accidental spill-related impacts. Oil spill response efforts and drills are assumed to be part of future oil and gas activities, and would have similar effects described in Section 4.3.5.8, which include minor impacts from mechanical recovery and in-situ burning, while dispersant effect depends on the size of the spill. Dispersants used on small spills are expected to have minor impacts, while large spills would result in moderate impacts. The additive effects of oil spill response activities associated with the Proposed Action are expected to be minor to moderate. Influences of climate change on fish, shellfish, and their habitat are of concern in the cumulative effects analysis. Warming ocean temperatures associated with climate change may increase plankton growth rates and generation times, and change the composition of planktonic populations in the proposed Lease Sale Area. Effects of oil and gas activity in the reasonably foreseeable future on fish and shellfish planktonic larvae and juveniles tend to be localized to areas near the activity, and so are geographically dispersed.

Climate change is likely to affect the habitat, behavior, abundance, diversity, and distribution of fish and shellfish. Several studies have examined the effects of climate change (including ocean acidification) on fish and shellfish. These studies emphasize the implications of potential northern range expansions of fish species, the effects of warming sea surface temperatures on fish biomass, possible changes in fish species complexes, effects on commercially important species, shifts in prey available and shifts in food webs, and the particular vulnerability of coastal areas in Alaska (Cheung et al., 2009; Mathis and Cross, 2014; Sherman et al., 2009). Therefore, the Proposed Action could result in a minor additive or synergistic incremental increase of climate change effects to fish and shellfish when considered in the cumulative effects analysis.

5.2.5.4. Conclusion

Over the estimated 40-year time frame of the Proposed Action, activities would cause various additive and synergistic effects on fish and shellfish populations. Even when considering activity levels from the other past, present, and reasonable foreseeable future activities, additive impacts from the Proposed Action are estimated to be relatively few in number and minor in scope. Impacts of the Proposed Action on fish and shellfish are estimated to be minor for routine activities. The additive risk of oil spills within the proposed Lease Sale Area and the resultant associated risk to fish and shellfish species populations and their associated habitat will result in a moderate incremental increase of impacts to fish and shellfish. The incremental contribution of the Proposed Action would result in a minor increase in impacts to fish and shellfish because most impacts would be localized, temporary, geographically separated, and not estimated to result in long-term disturbances or population-level effects to fish and shellfish directly or to their habitat. However, the impacts associated with a large spill could have a moderate impact on fish and shellfish populations and habitats in the area.

5.2.6. Marine Mammals

Cumulative impacts on marine mammals will result from the incremental impacts of the Proposed Action (analyzed in Section 4.3.6) when added to impacts from ongoing and reasonably foreseeable future activities described in Section 5.1.2.

5.2.6.1. Summary of Direct and Indirect Effects

A detailed discussion of the direct and indirect impacts from the Proposed Action on marine mammals is provided in Section 4.3.6. Routine activities under the Proposed Action that may adversely affect marine mammals include seafloor disturbance that could disturb or bury prey resources; drilling discharges; noise from MODUs, support vessels, or other activities; physical presence of MODUs, vessels, or other infrastructure; accidental discharge of trash and debris; vessel traffic; and aircraft traffic and noise. Potential impacts to marine mammals from routine activities under the Proposed Action include behavior disruption, sound masking, hearing loss, and physiological stress, injury, or mortality from noise; contamination to habitat or prey from drilling discharges or trash and debris; and collision with vessels resulting in mortality. Potential impacts to marine mammals related to small or large accidental spills include direct contact, resulting in stress or mortality; toxic reactions from inhalation or direct ingestion, or ingestion of contaminated prey; and fouling of baleen or fur.

5.2.6.2. Other Relevant Activities that Could Affect Marine Mammals

Cumulative impacts on marine mammals include the incremental impacts of the Proposed Action when added to the effects of past, present, and reasonably foreseeable future activities in the vicinity of the proposed Lease Sale Area (Table 5.1.2-1). Activities that could impact marine mammals are summarized in Table 5.2.6-1. Of these potential IPFs, oil and gas activities, outside of this action, and marine transportation are the most likely to affect marine mammals.

Table 5.2.6-1. Summary of Activities that may Adversely Affect Marine Mammals.

Activity	Potential Types of Effects
Oil and Gas activities (non-Lease Sale 244)	Seafloor disturbance, noise, drilling discharges, physical presence, trash and debris, vessel traffic, aircraft traffic and noise, accidental spills
Renewable energy projects	Seafloor disturbance
Fishing activities	Noise, physical presence, trash and debris, vessel traffic, accidental spills

Activity	Potential Types of Effects
Marine transportation	Noise, physical presence, vessel traffic, accidental spills
Ports and terminals	Noise, accidental spills
Dredging and marine disposal	Seafloor disturbance, physical presence, accidental spills
Military activities	Noise, physical presence, vessel traffic, aircraft traffic and noise, accidental spills.
Climate change	Habitat alteration, changes in water quality, water circulation, and food availability

5.2.6.3. Analysis of Cumulative Effects

Activities that result in seafloor disturbance under the Proposed Action could disrupt or bury prey resources for some species of marine mammals (Section 4.3.6.1). Activities with the potential to affect marine mammals that will disturb the seafloor (Table 5.2.6-1) include oil and gas activities (non-Lease Sale 244), dredging and marine disposal, and renewable energy projects.

Though prohibited, accidental release of trash and debris could occur from oil and gas activities as well as recreational and commercial fishing activities. Due to regulations and trash and debris management required for lessees, trash and debris under the Proposed Action would not measurably add to the pre-existing amounts of trash and debris regularly occurring in Cook Inlet.

Marine mammals should not be adversely affected by seafloor disturbance. Indirect impacts from seafloor-disturbing activities could include reduced water quality from increased turbidity and disturbance or burial of food resources. These indirect impacts might disturb some individual marine mammals, but it is unlikely that there would be long-term or population-level effects. Impacts from seafloor disturbance under the Proposed Action, as described in Section 4.3.6.1, would result in small periodic increases in turbidity and potential impacts to marine mammals because the limited geographical extent of areas affected. Moreover Cook Inlet, particularly upper Cook Inlet, is extremely turbid with a constant flow of glacial sediments flushing from streams through the upper and lower inlet, and into the ocean. Consequently the relatively small volumes of sediments, drill cuttings, etc. occasionally released into the lower inlet during exploration and development would be difficult, if possible to detect away from the immediate vicinity of ongoing activities. For these reasons sea floor disturbance should have no effect on marine mammals in Cook Inlet, especially when compared to the existing quantities of sediment and materials found throughout the inlet.

Under the Proposed Action, noise would contribute to impacts on marine mammals in and around the proposed Lease Sale Area. MODUs, support vessels, and all offshore equipment, including seismic survey arrays, could directly affect marine mammals via emitted noise (see Section 4.3.6.2). Anthropogenic noise is ubiquitous in Cook Inlet from oil and gas activities in state waters, shipping traffic, and recreational and commercial boating, among other sources, and will occur under activities associated with other past, present, and reasonable foreseeable future activities as outlined in Table 5.2-1. The most significant contributors to anthropogenic noise in Cook Inlet from the Proposed Action would be seismic, geohazard, and geotechnical surveys. These types of surveys may reasonably be expected to occur as a part of oil and gas activities in state waters and would not be exclusive to the Proposed Action. Because of the limited number of seismic, geohazard, and geotechnical surveys estimated to occur under the Proposed Action and the current level of anthropogenic noise in Cook Inlet from other sources, the Proposed Action would result in a minor incremental increase in impacts to marine mammals that would occur under the cumulative effects analysis, mostly during the exploration and development phases.

The presence of structures and vessels from the Proposed Action could impact marine mammals. Within Cook Inlet, two to three platforms would be constructed under the Proposed Action, and there are 17 existing platforms with additional structures anticipated in the future under the cumulative effects analysis. Structures and vessels that could affect marine mammals would be associated with oil and gas operations, fishing activities, renewable energy projects, mining projects, marine transportation, dredging and marine disposal, scientific research, and military activities. Under the Proposed Action, the presence of offshore vessels and exploratory drilling operations would be transient and localized, and platforms would be located >4.8 km (3 mi) from shore in areas geographically separate from other such structures in Cook Inlet. As marine vessels are very common in Cook Inlet, the physical presence of a limited number of structures and vessels associated with the Proposed Action would result in small periodic increases in Cook Inlet vessel traffic that would have negligible effects on marine mammals within the cumulative effects analysis, while potentially providing vertical cover and substrate for some prey species.

Vessel traffic in Cook Inlet includes cruise ships, ferries, passenger vessels, tankers, non-resident tugs, tank barges, freight and cargo ships, commercial and sport fishing vessels, military and USCG vessels, scientific research vessels, and pleasure craft. According to ADEC (2012a), more than 1,518 transits were made by cruise ships, ferries, overnight passenger vessels, tankers, non-resident tugs, tank barges, and freight and cargo ships in 2010. This number excludes commercial and sport fishing vessels, pleasure craft, or other types of vessels. A study by Cape International, Inc. (2012) estimated 480 large vessels (other than fuel barges on domestic trade) called at Cook Inlet ports in 2010. Consequently, marine mammals in Cook Inlet should be habituated to vessel traffic and noise. One to three vessel trips per week under the Proposed Action represent a relatively minute increase in vessel traffic under the cumulative effects analysis and the cumulative effects would be negligible at most.

Aircraft traffic is expected to occur in association with state oil and gas activities, scientific activities, military activities, and commercial transport of passengers and cargo. These activities are expected to continue or increase in the foreseeable future. Mostly the noise-related effect on marine mammals is brief, and transfers poorly from the air into the surface waters of Cook Inlet (Richardson et al., 1995). Observations made from low-altitude aerial surveys report behavioral responses of marine mammals are highly variable and range from no observable reaction to diving or rapid changes in swimming speed or direction (Efroymson et al., 2000; Smultea et al., 2008). NMFS and the USFWS consider that low-flying aircraft could result in Level B (behavioral) harassment (Scholik-Schlomer et al., 2011). Overall, the Proposed Action would likely result in a minor incremental increase (one to three trips per day for two to three platforms) in aircraft traffic and associated noise. The minimum altitude requirements (1,500 ft ASL) usually required the NMFS would ensure any additive effects of aircraft operations in the Proposed Action would not likely be measurable.

Accidental oil releases could occur in Cook Inlet from related activities such as the domestic transportation of oil, import of foreign crude oil, development of hydrocarbon resources in state waters, or from infrastructure projects such as port expansions that require vessels. Over the decades since oil and gas development began in Cook Inlet there have been incidents of large spills occurring in Cook Inlet, and some were much larger than either of the assumed large spill sizes for platforms or pipelines in the Proposed Action (ADNR, 2016). The lack of any chronic or major effects from such spills suggests any additive effects from one of the assumed large spill types would likewise have no significant effect. The existence of spill response infrastructure and protocols would also ensure any adverse effects to marine mammals from large oil spills would continue to have a negligible level of effects on marine mammals other than sea otters. Sea otters could still be affected with a moderate level of effects, due to their physiology and habitat requirements that might make them more vulnerable than other marine mammal species. Still the overall cumulative effects of a large oil spill within the past, present, and reasonably foreseeable future would most likely be a negligible to minor level of effects.

Direct and indirect effects of climate change may have synergistic adverse effects on marine mammals and may include increased incidence of disease (Guimarães et al., 2007), exacerbation of the effects of illness, or bioavailability of contaminants (Schiedek et al., 2007), increased ocean noise levels (Reeder and Chiu, 2010), changes to the density and distribution of prey species (Welch and

Batten, 1999; Whitney and Freeland, 1999), and habitat changes. Such changes could be partially beneficial to some species of marine mammals but detrimental to others, depending on the ability of a species to cope with the environmental changes. Such effects could affect species demographics, behavior, numbers, and distributions. The overall impact on marine mammals would vary since species such as sea otters would likely encounter difficulty foraging on bivalves, while other species such as harbor seals and Steller sea lions may experience changes in fish availability and an increase in squid or other invertebrate numbers. Much would depend on the level of ocean acidification, and what the ensuing long-term effects would be. For these reasons the additive effects of the Proposed Action on actual climate change and ocean acidification would be difficult if not impossible to measure on the global or regional scale. Consequently the Proposed Action would barely have a negligible effect on climate change in the global and local contexts because of the scale of the Proposed Action when compared to climate change, and the duration of the Proposed Action.

5.2.6.4. Conclusion

Marine mammals may be impacted by other activities, including oil and gas activities in state waters, fishing activities, renewable energy projects, marine transportation, trash and debris, military activities, and climate change. Cook Inlet – particularly near Homer, Seldovia, and Anchor Point – experiences a great deal of vessel activity during summer from recreation, commercial fisheries, barging, and other forms of commercial and scientific vessel traffic, while upper Cook Inlet regularly receives large vessel traffic at ports in Anchorage, and Port McKenzie. Because of the frequent vessel activity throughout Cook Inlet, resident marine mammals should be at least partially habituated to vessel presence and noise. Likewise major airport facilities at JBER and Anchorage International Airport, as well as smaller municipal and private airstrips scattered throughout the Cook Inlet region guarantees a large volume of air traffic occurs on a regular basis. As with vessel traffic and noise, resident marine mammals are most likely habituated to aircraft operations and noise to some degree and any additional aircraft associated with the Proposed Action would not elevate the overall effect of aircraft on marine mammals. Likewise the existing acoustic footprint in Cook Inlet suggests noise under the Proposed Action would not elevate the preexisting and future noise levels meaningfully. Other seismic, geohazard, and geotechnical surveys (related to state oil and gas activities) and other activities continue occurring in state and OCS waters and the effects of the Proposed Action should not increase the effects of those activities beyond what already exists.

The overall level of effects from the existing IPFs on marine mammals in Cook Inlet is mostly negligible, with a few such as noise being minor. The relatively small footprint of the Proposed Action would not add to the levels of effects for past, present, and foreseeable activities in Cook Inlet, with the exception of a large oil spill which could have a moderate level of effects on sea otters.

5.2.7. Terrestrial Mammals

Cumulative impacts on terrestrial mammals will result from the incremental impacts of the Proposed Action (analyzed in Section 4.3.7) when added to impacts from ongoing and reasonably foreseeable future activities described in Section 5.1.2.

5.2.7.1. Summary of Direct and Indirect Effects

Impacts to terrestrial mammals resulting from the implementation of the Proposed Action include effects due to routine operations associated with exploration and production activities as well as effects due to accidental small oil spills and a large oil spill or gas release. Routine operations estimated to impact terrestrial mammals are: (1) habitat alteration; (2) physical presence; (3) aircraft traffic and noise; and (4) onshore support activities. Overall, routine operations are estimated to have a negligible impact on terrestrial mammals; the potential impacts from a small spill are expected to have no effects; and the potential impacts of a large oil spill on terrestrial mammals are estimated to be negligible.

5.2.7.2. Other Relevant Activities that Could Affect Terrestrial Mammals

Cumulative impacts on terrestrial mammals include the incremental impacts of the Proposed Action when added to the effects of past, present, and reasonably foreseeable future activities in the vicinity of the proposed Lease Sale Area (Table 5.1.2-1). Many activities could impact terrestrial mammals in a similar manner as the Proposed Action (Table 5.2-1). These activities are currently taking place in Cook Inlet and will continue for the foreseeable future. Changes in the extent or nature of these activities could alter the impact they have on terrestrial mammals.

The most significant sources of additive and synergistic impacts to terrestrial mammals associated with activities as part of the cumulative effects analysis stem from oil and gas activities in state waters, renewable energy projects, mining projects, ports and terminals, the Knik Arm Crossing Project, and climate change. These will cause habitat alteration from construction activities as well as possible contamination and habitat alteration from a large oil spill and cleanup activities. Limited impacts also occur from activities such as marine transportation, submarine cable projects, dredging and marine disposal, military activities, and fishing activities, but these activities are conducted temporarily, on a local scale, or in disturbed areas. Preliminary screening determined the remaining activities in the cumulative effects analysis (Table 5.1.2-1) will mostly result in disturbances to a small number of terrestrial mammals in localized areas for a brief time, and so will not be carried forward for analysis. Within the activities that are most likely to impact terrestrial mammals, contamination and oiling of habitats from a large spill, and habitat alteration and disturbance from onshore construction activities and oil spill cleanup operations are expected to have the greatest additive impact.

5.2.7.3. Analysis of Cumulative Effects

The presence and construction of structures, vehicular traffic, large oil spills, and oil spill response activities, from the Proposed Action could affect terrestrial mammals. The construction of structures could result in short-term erosion and sedimentation, disturbance of prey, increases in construction activity noise, water quality changes from turbidity, wetland resource impacts, and land use changes. Within Cook Inlet, two to three platforms would be installed under the Proposed Action, and there are 17 platforms with additional structures anticipated for the future. Renewable energy and mining projects, ports and terminals projects, the Knik Arm Crossing Project, and submarine cable projects are expected and would result in structure emplacement. For example, there are 11 wind turbines located on Fire Island, with plans for 11 more. Most impacts from structure emplacement and construction activities in the cumulative effects analysis are expected to be indirect, causing displacement of animals from areas adjacent to construction activity. While some displacement would be permanent, most likely the area of displacement would amount to tens to hundreds of meters, impacting a few individual animals at most, and certainly not any populations.

The physical presence of MODUs, platforms, vessels, and pipelines associated with the Proposed Action is not likely to affect terrestrial mammals, just as existing oil and gas infrastructure in state waters has no effect on terrestrial mammals. Because structures in the Proposed Action would be located in offshore Federal waters and vessels will utilize established traffic corridors, neither exploration activities, development activities, or vessel traffic should affect terrestrial mammals. Some of the structures supporting oil and gas operations have been or will be constructed onshore, along the coast, or in nearshore areas. The geographic separation of structures in the Proposed Action ensures there would be no additive long-term level of effects on terrestrial mammals other than excluding small areas as habitat for terrestrial mammals where buildings, pipelines, and other infrastructure are constructed.

Terrestrial mammals could be exposed to large oil spills accidentally released from platforms or pipelines, and would be most susceptible to adverse impacts from spills occurring in coastal areas or that affect foraging habitats or resources. Accidental small oil releases would have no effect on terrestrial mammals unless it occurred along an onshore or nearshore section of pipeline, in which case the spill would be responded to immediately, ensuring a negligible level of effects occurs to terrestrial mammals. Large oil spills could occur in Cook Inlet from related activities such as the domestic transportation of oil, import of foreign crude oil, and state development of oil. Most of the oil released to Cook Inlet is from commercial and recreational vessels. Oil releases from all sources might potentially expose terrestrial mammals via direct contact or through the inhalation or ingestion of oil or tar deposits or contaminated prey. Impacts from spilled oil could be synergistic with other impacts to prey items of terrestrial mammals. For example, if the salmon population is substantially impacted by an oil spill, impacts on brown bears could cascade through the ecosystem with synergistic impacts as brown bears are forced into alternate habitats in search of alternate food supplies (Section 4.3.7.5).

The majority of reasonably foreseeable spills associated with the Proposed Action are <50 bbl, but a large spill >1,000 bbl could occur and the assumed size of large spills from the Proposed Action are 5,100 bbl and 1,700 bbl originating at a platform or pipeline spill respectively. The magnitude of the impacts would depend on the coastline area affected, the nature, and the magnitude of the accident. Similar spills have occurred (ADNR, 2016a) from state oil and gas activities. Overall, the Proposed Action would likely result in a negligible (small spill) or minor (large spill) incremental increase in accidental spill related impacts under the cumulative effects analysis.

Cumulatively, climate change may result in synergistic impacts to terrestrial mammals through habitat modification. Observed impacts include earlier snowmelt, reduced sea ice, glacial retreat, warmer permafrost, drier landscapes, increased wildfires, changes in the diversity and richness of ecological communities, and more extensive insect outbreaks. The region surrounding Cook Inlet could face major ecological shifts, profoundly altering habitat and populations of terrestrial mammals that add to the region’s richness and diversity. Spruce bark beetle infestations which have destroyed about half of the spruce forests on the Kenai Peninsula (ADNR, 2015e), are correlated with increasing temperatures. The volume of mortality caused by beetle infestation now exceeds the volume of growth (ADNR, 2001), and the large volume of dead trees can provide fuel for devastating fires that would further alter habitat on the Kenai Peninsula. Extensive forest fires in the late nineteenth and early twentieth centuries, combined with overhunting, led to the extirpation of caribou herds on the Kenai Peninsula (ADFG, 2003). Deforestation associated with climate change also could cause loss of suitable caribou habitat on the Kenai Peninsula. During the latter half of the twentieth century, an estimated 80% of wetland sites on the Kenai Peninsula experienced drying, and two-thirds of wetland sites decreased in size. This loss of wetlands was accompanied by a change from open, wet, and watered areas to wooded upland habitats (Klein, Berg, and Dial, 2005). Moose may benefit in the short term from an increase in post-fire browse, but over the long term, loss of wetlands might reduce moose populations, and the decrease in suitable moose and caribou habitat would locally increase stress on those populations. Such an impact that would be exacerbated by increased bear predation on young, particularly if interferes with salmon runs that local bear populations rely on. A warming climate may be devastating to some of Alaska’s salmon populations, and associated terrestrial ecosystems. Decreased glacial mass will feed less cold freshwater into area’s rivers during summer, and result in water temperature changes could jeopardize salmon spawning habitat, and health (IUCN, 2009). Increased rainfall during the winter could scour river beds, disturb redds and cause physical damage to salmon eggs and juveniles (Schoenfeld, 2014), and sedimentation could increase with increased rainfall burying redds, and smothering eggs and juveniles (IUCN, 2009). Loss of salmon runs would disrupt some nutrient cycles leading to a cascade of ecological effects.

Overall, the effects of climate change on terrestrial mammals vary between species as some might benefit from new habitats, while others might not fare as well. Similarly, some may benefit from the northward expansion or changes in prey distribution and abundance while other species may suffer from those same changes.

5.2.7.4. Conclusion

Terrestrial mammals in Cook Inlet could be adversely affected by activities associated with the Proposed Action over the 40-year period of the E&D Scenario. These impacts include behavioral disturbance and habitat loss due to the presence of vessels in nearshore areas, aircraft (noise-related disturbance), equipment and human activity (construction) as well as exposure to or loss/degradation of habitat from an accidental spill or infrastructure placement. The overall impact of all routine activities under the Proposed Action is estimated to be negligible and to range from mostly negligible levels of effect up to a minor level of effects for accidental large oil spills. Terrestrial mammals are affected by many other activities, including some oil and gas activities in state waters, renewable energy projects, mining projects, marine transportation, ports and terminals, the Knik Arm Crossing Project, submarine cable projects, military activities, fishing activities, and climate change, resulting in a similar set of impacts.

The cumulative impacts on terrestrial mammals in Cook Inlet from all OCS and non-OCS activities over the next 40 years are unavoidable. The incremental contribution of the Proposed Action to the past, present and reasonably foreseeable activities on terrestrial mammals would be a negligible level of effects. Most impacts would be localized and brief, and would not produce long-term disturbances or population-level effects. Additionally, most impacts from the Proposed Action would occur in the OCS and offshore waters, remaining geographically separate from terrestrial mammals and their habitat. However, a large spill could have a minor level of effects on some terrestrial mammal populations and habitats in the contacted areas. Oil spill response activities would reduce the effects of a large spill to a negligible to minor level of effects.

The overall level of effects from the existing IPFs on terrestrial mammals in Cook Inlet is mostly negligible, with large spill effects being minor. The relatively small footprint of the Proposed Action would not add to the levels of effects for past, present, and foreseeable activities in Cook Inlet, with the exception of a large oil spill which could have a minor level of effects on terrestrial mammals.

5.2.8. Birds

Cumulative impacts on birds will result from the incremental impacts of the Proposed Action (analyzed in Section 4.3.8) when added to impacts from the ongoing and reasonably foreseeable future activities described in Section 5.1.2.

5.2.8.1. Summary of Direct and Indirect Effects

A detailed discussion of the direct and indirect impacts from the Proposed Action on birds is provided in Section 4.3.8. Birds and their habitats would be affected by the following factors associated with routine activities during exploration, development, production, and decommissioning activities under the Proposed Action: drilling discharges, underwater noise (including active acoustic sound sources), drilling and equipment noise, vessel noise, physical presence (including lights), vessel traffic, aircraft traffic, and onshore support activities related to construction of pipeline landfalls and onshore pipelines.

Potential impacts to birds from routine activities under the Proposed Action include physiological stress or behavior disruptions due to loss of/impacts to prey resources; physiological stress, injury, and mortality from attraction to and collisions with infrastructure and vessels; injury and mortality from attraction to and incineration by gas flares; and physiological stress or behavior disruption from disturbance associated with vessel and aircraft traffic activities; and disturbance or chick and egg mortality associated with onshore support activities. Potential impacts to birds related to accidental small or large spills include the following: direct contact resulting in stress or mortality; toxic reactions from inhalation, direct ingestion, or ingestion of contaminated prey; reproductive effects; modified prey abundance; damage to and displacement from foraging or molting habitat; and disturbance, displacement, and reduced productivity from cleanup activities. As discussed in Section 4.3.8, routine activities associated with the Proposed Action are estimated to have levels of impacts on birds ranging up to moderate; small spills may have minor impacts; and large spills may have moderate to major impacts.

5.2.8.2. Other Relevant Activities that Could Affect Birds

Cumulative impacts on birds result from the incremental impacts of the Proposed Action when added to the effects from past, present, and reasonably foreseeable future activities in the vicinity of the Proposed Lease Sale Area (Table 5.1.2-1). All of the categories listed in Table 5.1.2-1 could impact birds in a similar manner to those described under the Proposed Action.

The most significant sources of impacts to birds associated with activities from past, present, and reasonably foreseeable future activities in the project vicinity (i.e., from Table 5.1.2-1) stem from oil and gas activities, renewable energy projects, marine transportation, persistent contaminants and marine debris, and climate change. Other activities were not carried forward for cumulative effects analysis because they are likely to impact birds on a local scale only (mining development and operations), or are likely to impact only a small number of birds on a local scale, often for a short duration (port, bridge, and cable projects; wastewater discharges; routine dredging and port activity; and military and fishing activities). Within the activities that are most likely to impacts birds, mortality and energetic costs associated with the presence of structures (e.g., platforms, vessels, wind turbines) and their associated lighting, and exposure to oil are anticipated to have the greatest additive impact.

5.2.8.3. Analysis of Cumulative Effects

Impacts from drilling discharges associated with the Proposed Action are expected to have negligible to minor impacts on birds. Past anthropogenic impacts from activities under the cumulative effects analysis have included the discharge of drilling fluids and sediment from cuttings, and bioaggregation and bioaccumulation of pollutants released during project activities, which can impact lower trophic invertebrate and fish prey resources of birds. Analysis in Section 5.2.5, above, explains that the potential for adverse cumulative impacts from the projected activities outlined in the Proposed Action would add to the effects on these resources through additive and synergistic cumulative impacts; however, due to the relatively small quantities involved, the limited area affected near a discharge point due to the high tidal currents present in Cook Inlet, and the geographic separation of drilling discharges related to the Proposed Action and those related to oil and gas activities in state waters, impacts from the Proposed Action are estimated to result in a minor incremental increase of impacts to fish and shellfish. Impacts associated with the Proposed Action are similarly estimated to result in minor contributions to the cumulative impacts of drilling discharges to birds. Overall, cumulative impacts to birds from drilling discharges are expected to be minor.

Underwater noise generated during the Proposed Action is associated with active acoustic sound sources, drilling and equipment, and vessels. This type of noise may result in disturbance impacts to birds, particularly seabirds and waterfowl, causing a short-term change in normal behavior, potentially disrupting feeding activities, and possibly resulting in modified prey abundance. Activities that generate underwater noise include state oil and gas activity and marine transportation. These activities are expected to continue or increase in the foreseeable future. Although noise generated as a result of the Proposed Action would likely add only a small increment to the overall (cumulative) noise levels in Cook Inlet, locally and for short periods it could represent the dominant noise in the environment. Impacts associated with active acoustic sound sources and other underwater noise associated with the Proposed Action are expected to have no more than a minor level of impact on birds. When combined with other past, present, and reasonable foreseeable future activities, underwater noise will still have no more than a minor level of impact.

The presence of structures, vessels, and the associated lighting from the Proposed Action will affect birds. Within Cook Inlet, two to three platforms will be installed under the Proposed Action. There are 17 existing platforms in upper Cook Inlet, over 25 miles to the north of the Lease Sale Area. Currently, there are 11 wind turbines located on Fire Island, with tentative plans for 11 more. Attraction of birds to these structures increases the potential for nocturnal circulation, entrapment, collision with the structures, and resultant mortality. Attraction and collision risk appear to be increased for birds during migration, and therefore siting of platforms and wind turbines in relation to migratory pathways is likely a key factor in assessing risk. Migratory pathways for some of the more vulnerable (e.g., low population) species may be more in the vicinity of the proposed Lease Sale Area than the 17 past, present, and reasonably foreseeable future platforms in upper Cook Inlet. Examples of vulnerable species include marbled godwit, which is believed to fly from the Alaska Peninsula across central and lower Cook Inlet to wintering areas in the continental United States, and Kodiak-wintering Steller's eiders, which may move from Kodiak to southwest Alaska (Rosenberg, et al., 2014). Best available evidence suggests that migratory pathways for tens of thousands of individuals of numerous species tend to funnel birds up into upper Cook Inlet before they move elsewhere across Alaska (Day et. al., 2005; ADFG, 1988). For many species, therefore, collision mortalities from the Proposed Action may represent a relatively small fraction of the potential annual collision mortality for existing and planned platforms and other structures in Cook Inlet, particularly when future potential lease sales on the OCS are also included in the cumulative effects scenario. The level of impact from collision risk from past, present, and reasonably foreseeable future platforms and wind energy project ranges from negligible to as high as moderate. The collision risk presented by the activities of the Proposed Action will cause a negligible to minor incremental increase in level of impact for non-listed species. The total level of cumulative impacts from collision risks, including the effects of the Proposed Action, is expected to remain in a range from negligible to moderate.

The situation is different for listed species because of species range. Most past, present, and reasonably foreseeable future platforms and the Fire Island Wind Project are, unlike the proposed Lease Sale Area, outside of the normal wintering range of the Steller's eider. The cumulative effects scenario does, however, include future lease sales on the OCS, potentially also within the range of the listed population of Steller's eider, and therefore potentially also ultimately posing some collision risk to the population. The platform/vessel collision risk to Steller's eider, without the platforms of the Proposed Action (or future lease sales on the OCS) would be negligible. The presence of the platforms associated with the Proposed Action (not including future lease sales on the OCS) increase the cumulative impacts for collision risks to the listed population of Steller's eiders to minor.

Very little marine debris is anticipated under the Proposed Action with adherence to current regulations. However, under the cumulative effects analysis, marine debris is anticipated and could include materials such as fishing gear, oil and gas items (e.g., plastic drill pipe thread protectors, hard hats, gloves, 55-gallon storage drums), lost vessel cargo, and land-based waste carried offshore by storms, run-off, etc. Marine debris may impact birds through attraction, entanglement and ingestion (Derraik, 2002; Laist, 1987), resulting in lethal and sublethal effects. Marine debris from the Proposed Action would likely result in a minimal incremental increase in debris, still resulting in a minor level of cumulative impacts.

Vessel and aircraft traffic and noise generated from the Proposed Action will result in no more than minor levels of disturbance-related impacts to birds. Activities under the cumulative effects analysis that generate vessel and aircraft traffic and noise include state oil and gas activity, marine transportation, and military activity. Vessel traffic in Cook Inlet consists of cruise ships, ferries, overnight passenger vessels, tankers, non-resident tugs, tank barges, freight and cargo ships, commercial and sport fishing vessels, military and USCG vessels, and pleasure craft. According to ADEC (2012a), more than 1,518 transits were made by cruise ships, ferries, overnight passenger vessels, tank ships, non-resident tugs, tank barges, and freight and cargo ships in 2010; this number does not include transits by commercial and sport fishing vessels, pleasure craft, or other types of vessels. Aircraft traffic is expected to occur in association with state oil and gas activity and military activity. While vessel and air traffic generated by the Proposed Action, particularly during the development phase of the E&D Scenario, may be minor to moderate, in the cumulative effects analysis, actual impacts to birds, which generally experience only short-term, localized, and less than severe displacement effects, are not expected to increase beyond a minor level of effect.

Birds could be exposed to oil accidentally released from platforms, pipelines, and marine vessels. They would be most susceptible to adverse impacts from spills occurring in coastal areas or those affecting feeding and nesting areas, especially in IBAs. Accidental oil releases could occur in Cook Inlet from related activities such as the domestic transportation of oil, import of foreign crude oil, and state development of oil. Most of the oil released to Cook Inlet is from commercial and recreational vessels. Oil releases from all sources may expose birds via direct contact or through the inhalation or ingestion of oil or tar deposits or contaminated prey.

The majority of reasonably foreseeable spills associated with the Proposed Action are <50 bbl, but a large spill, although unlikely to occur, is analyzed to determine the potential impacts (see Section 4.2.14). The magnitude of the impacts would depend on the specific location affected and the nature and magnitude of the accident, but it could represent a major component of the overall exposure of birds in Cook Inlet. Similar spills could occur from state oil and gas activities. Overall, the Proposed Action would likely result in a minor (small spill) or major (large spill) incremental increase in accidental spill-related impacts.

Climate change may result in synergistic adverse impacts to birds through habitat modification and ocean acidification. Certain beneficial impacts could also result, such as new habitats or earlier access to habitats for some species; however the overall impacts of climate change on birds are difficult to predict because of the complex interplay of many variables. For example, changing and varying phenologies of prey resources and bird migrations may result in increased competition or bird/prey mismatches during critical life history times (Ward et. al., 2016; Liebezeit, et. al., 2012)). Birds that depend on sea ice for some portion of their annual cycle are another example of species that could be affected by of climate change. Drying of freshwater habitats is expected to adversely affect species, such as the rusty blackbird, that depend on these as breeding habitats. In the Cook Inlet area, the cumulative impacts of climate change on birds will vary depending on species, but may eventually reach moderate levels for certain species, particularly those dependent on freshwater wetlands.

5.2.8.4. Conclusion

Birds in Cook Inlet could be adversely affected by activities associated with the Proposed Action over the 40-year period of the E&D Scenario. These impacts include physiological stress or behavior disruptions due to loss of/impacts to prey resources; stress, injury or mortality from collision with platform structures and vessels; behavioral disturbance due to the presence of and noise generated by vessels, aircraft, equipment, and human activity; and exposure to or loss/degradation of habitat from accidental spills. The overall impact of all routine activities under the Proposed Action is estimated to be moderate and to range from minor to major for accidental small or large spills. Birds are affected by many other activities, including oil and gas activities in state waters, renewable energy projects, marine transportation, marine debris from onshore and offshore activities, and climate change, resulting in similar types of impacts.

The contribution of routine activities associated with the Proposed Action to the cumulative effects analysis on non-listed birds would be minor, with resultant total cumulative impacts to birds potentially as high as moderate for some species. The contribution of the Proposed Action to the cumulative effects analysis on the listed population of Steller's eider is expected to be minor, with resultant minor cumulative impacts, because the new offshore development will be within its molting and wintering range. Most impacts would be localized and temporary and not be expected to result in long-term disturbance or population-level effects, but some potential impacts, particularly chronic direct mortality over the multi-decade lives of the platform(s), could result in long-lasting and widespread impacts to a few declining species or species with limited ranges or extreme low abundances. The impacts associated with a large spill could also result in a substantial impact on certain bird populations and important migratory, foraging, and breeding habitats in the area, resulting in major levels of impact.

5.2.9. Coastal and Estuarine Habitats

Cumulative impacts on coastal and estuarine habitats will result from the incremental impacts of the Proposed Action (analyzed in Section 4.3.9) when added to impacts from the ongoing and reasonably foreseeable future activities described in Section 5.1.2.

5.2.9.1. Summary of Direct and Indirect Effects

As discussed in Section 4.3.9, coastal and estuarine habitats will be impacted by other operational discharges, trash and debris, vessel traffic, and small and large accidental spills. Impacts to coastal and estuarine habitats from routine activities could include contamination of marine biota from operational discharges; potential contamination or death of coastal birds, mammals, or other fauna from entanglement or ingesting of marine debris; and erosion of coastal habitats from vessel wakes. Impacts from small or large accidental spills could include direct fouling of coastal embayments and beaches, resulting in reduced fitness or mortality of coastal biota. As discussed in Section 4.3.9, routine activities associated with the Proposed Action are estimated to have minor impacts on coastal and estuarine habitats in and around the proposed Lease Sale Area. A small spill could have minor impacts, though a large spill could result in major impacts due to the high toxicity of oil to coastal habitats and potentially severe oiling that could occur.

5.2.9.2. Other Relevant Activities that Could Affect Coastal and Estuarine Habitats

Cumulative impacts on coastal and estuarine habitats include the incremental impacts of the Proposed Action when added to the effects of past, present, and reasonably foreseeable future actions in and around the proposed Lease Sale Area (Table 5.1.2-1). Activities considered that could impact coastal and estuarine habitats are summarized in Table 5.2.9-1.

Table 5.2.9-1. Summary of Activities that may Adversely Affect Coastal and Estuarine Habitats.

Activity	Potential Types of Effects
Oil and gas activities (non-Lease Sale 244)	Operational discharges, trash and debris, accidental spills
Fishing activities	Trash and debris, accidental spills
Marine transportation	Trash and debris, introduction of invasive species, accidental spills
Ports and terminals	Shoreline erosion, accidental spills
Mining activities	Accidental spills, habitat alteration
Military activities	Accidental spills
Climate change	Habitat alteration, changes in water quality, water circulation, and food availability

5.2.9.3. Analysis of Cumulative Effects

The Proposed Action would result in increased operational discharges within Cook Inlet that could affect coastal and estuarine habitats by introducing wastewater rich with nutrients or other pollutants. Other sources of operational discharges are additional oil and gas activities (non-Lease Sale 244), and effluent discharges from sewage treatment plants, industrial facilities, and power-generating plants that operate in the Cook Inlet region. Routine operations at port facilities may add permitted discharges. Existing municipal and industrial discharges, including wastewater discharges, are generally remote from the proposed Lease Sale Area, but the effects of any additional operational discharges in Cook Inlet would have an additive effect. Because operational discharges are regulated and require an NPDES permit for discharge and because the high-energy environment of Cook Inlet should result in the rapid dispersion and dilution of discharges, the Proposed Action will result in negligible incremental increase on impacts from operational discharges to coastal and estuarine habitats that would occur under the cumulative effects analysis.

Although not anticipated, trash and debris may be accidentally lost overboard under the Proposed Action and could wash up in coastal and estuarine habitats where it can become snagged on benthic habitats and damage sensitive reef areas. Though prohibited, accidental release of trash and debris could occur from oil and gas activities (non-Lease Sale 244) as well as commercial and sport fishing activities. Due to regulations as well as trash and debris management required for lessees, trash and debris under the Proposed Action will result in a negligible incremental increase in impacts to coastal and estuarine habitats under the cumulative effects analysis.

Vessel traffic that will occur under the Proposed Action will consist of approximately one to three trips per week for the duration of the E&D Scenario, which could impact coastal and estuarine habitats due to habitat degradation, environmental contamination, shoreline erosion from vessel wakes, resuspension of sequestered carbon, or introduction of invasive species. Vessel traffic in Cook Inlet consists of cruise ships, ferries, overnight passenger vessels, tankers, non-resident tugs, tank barges, freight and cargo ships, commercial and sport fishing vessels, military and USCG vessels, and pleasure craft. According to NUKA Research and Planning Group, LLC. (2012), more than 1,518 transits were made by cruise ships, ferries, overnight passenger vessels, tankers, non-resident tugs, tank barges, and freight and cargo ships in 2010; however, this number does not include transits by commercial and sport fishing vessels, pleasure craft, or other types of vessels. A study by Cape International, Inc. (2012) estimated that 480 large vessels (other than fuel barges on domestic trade) called at Cook Inlet ports in 2010. Consequently, marine mammals and other resources in Cook Inlet should be reasonably accustomed to vessel traffic and the associated noises. One to three vessel trips per week under the Proposed Action represent a negligible incremental increase of impacts from vessel traffic to coastal and estuarine habitats under the cumulative effects analysis.

Coastal and estuarine habits may be contacted by small or large accidental spills that could occur under the Proposed Action. The majority of reasonably foreseeable spills that could occur under the Proposed Action are <50 bbl, but a large spill, although unlikely to occur, is analyzed to determine the potential impacts. Most small spills would not be expected to contact shore before evaporating or dispersing. However, a large spill could cause substantial oiling of sensitive coastal habitats. Similar spills (small and large) could occur from state oil and gas activities as well as port and terminal expansion projects, while other activities (Table 5.2-1) likely would only result in small spills, which would not likely substantially affect coastal and estuarine habitats. Overall, accidental spills as a result of the Proposed Action likely would result in a minor (small spill) or major (large spill) incremental increase in accidental spill related impacts on coastal and estuarine habitats under the cumulative effects analysis.

5.2.9.4. Conclusion

The activities estimated to occur under the Proposed Action will affect coastal and estuarine habitats over the 40-year period of the E&D Scenario. These impacts include contamination of marine biota from operational discharges, potential contamination of coastal fauna from entanglement or ingesting of marine debris, and erosion of coastal habitats from vessel wakes. Impacts from a large accidental spill could include direct fouling of coastal embayments and beaches, resulting in reduced fitness or mortality of coastal biota. The overall impact of all routine activities on coastal and estuarine habitats under the Proposed Action is estimated to be minor. Impacts are estimated to range from minor to major for accidental spills, depending on spill size and location. Coastal and estuarine habitats may also be affected by numerous activities estimated to occur, including oil and gas activities (non-Lease Sale 244), fishing activities, port and terminal expansions, mining activities, military activities, and climate change. Each of these activities could result in impacts similar to those discussed for the Proposed Action. Therefore, the incremental contribution of the Proposed Action to the cumulative effects analysis on coastal and estuarine habitats would be minor.

5.2.10. Economy and Population

Cumulative impacts on economy and population will result from the incremental impacts of the Proposed Action (Section 4.3.10) when added to impacts from the ongoing and reasonably foreseeable future activities, such as future OCS lease sales, described in Section 5.1.2.

5.2.10.1. Summary of Direct and Indirect Effects

Overall, the direct and indirect effects of routine activities from Cook Inlet Lease Sale 244 on the economy and population would be minor and beneficial. As discussed in Section 4.3.10, exploration, development, and production activities would generate additional employment, earnings, and revenues for local, state, and Federal governments. However, the increase in employment and earnings would be small compared to the current economy, and the population would only slightly increase. Additionally, increases would peak at year 6 of the Proposed Action and decrease thereafter.

The effects of potential spills would be insufficient to offset the overall beneficial effects. Small spills would be dealt with using routine spill prevention and response measures, and would have a negligible effect on the economy and population. Although, a large oil spill could cause short-term and localized effects to the economy, it is unlikely to affect the local population. A large oil spill could cause disruptions to the local economy, particularly to industries that depend on the damaged resources. However, the effects of a large oil spill could be somewhat broader if firms further along industry supply chains are affected. These impacts depend on issues such as the effects of cleanup operations, the response of policymakers to a spill, and the size and distribution of any compensation payments. Ultimately, a large spill of the size projected in the E&D Scenario would be cleaned up and would affect the economy during cleanup operations and for a period after the cleanup is completed. Once the cleanup is completed, the economy would likely rebound to pre-spill conditions. Consequently, the overall effects of accidental large spills on the economy and population would be minor.

5.2.10.2. Other Relevant Activities that Could Affect the Economy and Population

Cumulative impacts on the economy and population result from the incremental impacts of the Proposed Action when added to the effects from past, present, and reasonably foreseeable future activities in the vicinity of the project (Table 5.1.2-1). All of the categories listed in Table 5.1.2-1 could impact the economy and population.

Other sources of impacts on economy and population include: oil and gas activities in state waters, future OCS lease sales, renewable energy projects, mining projects, marine transportation, ports and terminals, the Knik Arm Crossing Project, military activities, fishing activities, and climate change. These could result in employment opportunities and increases in population. The oil and gas industry is anticipated to have the greatest additive impacts on economy and population.

5.2.10.3. Analysis of Cumulative Effects

Activities under the Proposed Action that will occur during exploration, development, and production would generate direct employment and earnings. In turn, the direct employment and earnings would generate indirect and project-induced employment and earnings. Together, direct, indirect, and project-induced employment and earnings would influence potential growth in the local population.

Similarly, other activities in the vicinity of the Proposed Lease Sale Area would generate employment and earnings, which would lead to increases in the local population.

As of 2010, the population of the Kenai Peninsula Borough was 55,400 (ADLWD, 2013) and the unemployment rate was 7.4% (ADLWD, 2015a). Although the Kenai Peninsula Borough has a diverse economy with five industries having at least 10% of the workforce, the economic effects of the oil and gas industry in state waters are major. Together, the North Slope and Kenai Peninsula Borough produce all of Alaska's oil; the Cook Inlet oil and gas industry accounts for approximately 37% of the Kenai Peninsula Borough's total economic output (Northern Economics, 2014). However, activities related to state oil and gas are not estimated to induce substantive growth in employment, earnings, or revenues in the Kenai Peninsula Borough in the foreseeable future.

Marine transportation, ports, and terminals will impact the economy and population. While the level of marine transportation and other activities at ports and terminals have been flat following the recession in 2009, moderate increases in vessel traffic (1.5% to 2.5% annually) are projected because of population growth, lower fuels costs, and other post-recession improvements in the economy (Cape International, Inc., 2012). In addition, completion of expansions at several ports is likely to increase activities and vessel calls at ports, harbors, and terminals over the next 40 to 50 years.

As described in Section 4.3.10, employment and spending under the Proposed Action would vary with phases of the E&D Scenario peaking in year 6 with direct employment and earnings of 230 new jobs and $25 million, respectively. However, employment and earnings would then decrease until stabilizing in year 14. The overall increase in annual employment from the Proposed Action would be <1% of the current level of employment in the area, resulting in a negligible incremental increase in employment.

The local population of the Kenai Peninsula Borough would increase slightly, but as with employment, the increase would be short-term and localized, and thus minor in nature. Project-induced growth in the Kenai Peninsula Borough's population would peak at 962 in year 6 and decrease to 222 over the long-term production phase. Considering the overall population of Kenai Peninsula Borough exceeds 55,000 people, the incremental increase in population from the Proposed Action would be minor and beneficial.

As diminished sea-ice coverage accelerates over time due to climate change, several additional disruptions to economy and population are likely to occur from altered habitat and changes in wildlife distribution, resulting in synergistic impacts. Climate change could induce regional economic and sociocultural effects through increased economic activities such as commercial fishing, sport fishing, coastal mining, renewable energy development, tourism, recreation, and marine shipping. These activities would involve increases in vessel traffic and infrastructure construction (e.g., new businesses in Anchorage), which would cause additional impacts to employment and population. Additionally, such economic activities would require substantial levels of skilled labor and high-value infrastructure, which would add new impacts to existing employment patterns, and by extension, to the population in the region. However, while the effects of climate change are expected to be long-term and widespread, the incremental and additive effects that would occur as a result of the Proposed Action during its life are not expected to impact population and economy.

Accidental oil releases could occur in Cook Inlet from other activities in the Proposed Lease Sale Area, such as the domestic transportation of oil, import of foreign crude oil, and state development of oil. Most of the oil released to Cook Inlet is from commercial and recreational vessels. The majority of reasonably foreseeable spills associated with the Proposed Action are <50 bbl, but a large spill, although unlikely to occur, is analyzed to determine the potential impacts. The magnitude of the impacts on the economy and population would depend on the specific location affected and the nature and magnitude of the accident, but it could have a long lasting and widespread impact in the form of negative public perceptions of the environment in Cook Inlet. If the public perceives the natural values of the area to be diminished and that perception (real or not) changes the public preference for living and working in the area, adverse impacts to the economy and population would result. Additionally, impacts of a spill could adversely impact natural resources that would in turn impact revenue, employment availability, commercial and sport fishing, subsistence harvest patterns, and recreation and tourism. Overall, the Proposed Action would likely result in a negligible incremental increase in impacts to population and economy for small spills and a moderate incremental increase in impacts to population and economy for large spills.

5.2.10.4. Conclusion

The Proposed Action is estimated to contribute to the overall cumulative effects on the economy and population over the 40-year period of the E&D Scenario. These impacts include increases in employment opportunities and revenue, and related increases in population tied to employment and project spending, and financial and environmental effects from a large accidental spill. The economy and population also could be affected by many other activities in the Proposed Lease Sale Area, including oil and gas activities in state waters, future OCS lease sales, renewable energy projects, mining projects, marine transportation, ports and terminals, the Knik Arm Crossing Project, fishing activities, and climate change, resulting in a similar set of impacts.

The incremental contribution of activities associated with the Proposed Action to cumulative effects on the economy and population would vary in accordance with the phase of the E&D Scenario. Cumulative impacts on the economy and population in Cook Inlet from all OCS and non-OCS activities over the next 40 years are expected to be substantial for the economy. Incremental contributions from the Proposed Action are expected to result in a minor increase of impacts on the economy and population because most employment opportunities will be temporary and are not estimated to result in long-term increases in human population.

5.2.11. Commercial Fishing

Cumulative impacts on commercial fishing will result from the incremental impacts of the Proposed Action (analyzed in Section 4.3.11) when added to impacts from the ongoing and reasonably foreseeable future activities, such as future OCS lease sales, described in Section 5.1.2.

5.2.11.1. Summary of Direct and Indirect Effects

Direct and indirect impacts to commercial fishing from the Proposed Action can be found in Section 4.3.11. Routine operations are unlikely to result in effects on overall populations of commercial fishery resources in Cook Inlet. Temporary displacement of fishery resources and fishers from localized areas could occur as a consequence of noise and activities associated with construction activities during development; there could be some highly localized long-term changes in fish densities and species diversity in the vicinity of platforms due to attraction by some invertebrate and fish species, and the physical presence of production platforms near riptide locations could have a moderate impact on the drift gillnet fishing industry. However, as a whole, routine activities under the Proposed Action are estimated to result in minor impacts to commercial fisheries. Small spills that may occur are unlikely to have an effect on commercial fishing before dilution and weathering reduced concentrations of oil in the water. Consequently, it is anticipated that small spills would have minor effects on commercial fisheries in Cook Inlet. It is anticipated that any single large spill (up to 5,100 bbl) would affect only a small proportion of a given fish population within Cook Inlet. However, large spills may cause a fishery to be closed for an entire season or more, resulting in a 100% loss during the closure period. There also would be losses due to damages to boats and gear. Overall, impacts to commercial fishing from large spills are expected to be moderate.

5.2.11.2. Other Relevant Activities that Could Affect Commercial Fishing

Cumulative impacts on commercial fishing include the incremental impacts of the Proposed Action when added to the effects of past, present, and reasonably foreseeable future activities in the vicinity of the proposed Lease Sale Area (Table 5.1.2-1). Other activities in the Proposed Lease Sale Area could impact commercial fishing in a similar manner as the Proposed Action (Table 5.2-1). These could include: seafloor disturbance and habitat alteration; noise; physical presence, including lights; trash and debris; vessel traffic; and accidental small oil spills and a large oil spill/gas release. These activities are currently taking place in Cook Inlet and will continue for the foreseeable future, and they will affect commercial fisheries by impacting fishing operations and fish populations.

Oil and gas activities, marine transportation, development of ports and terminals, dredge activities, marine disposal of dredge spoil, non-commercial fishing activities, and climate change within Cook Inlet represent sources of additive and synergistic impacts to commercial fishing in Cook Inlet. The most common direct impact to commercial fishing is associated with each activity’s potential for a long-term increase in vessels and infrastructure, a decrease in fish habitat availability, an increase in potential wastewater discharges, and an increase in accidental oil spills during operations. Impacts will occur from submarine cable projects, dredging and marine disposal, and military activities, but these activities are conducted temporarily, only on a local scale, or in areas that are already disturbed.

5.2.11.3. Analysis of Cumulative Effects

Past, present, and reasonably foreseeable future activities and impacts relevant to the cumulative effects analysis on commercial fishing include oil and gas production, future OCS lease sales, underwater noise, seafloor disturbance, marine vessel traffic, port operations, and a risk of fuel spills. For the cumulative effects analysis, non-commercial fishing activities are assumed to continue at approximately current levels for the foreseeable future.

Oil and gas activities such as drilling discharges resulting from the Proposed Action would add to the impact from current oil and gas activities. However, while additive, they are not estimated to negatively affect commercial fishing due to the relatively small quantities involved, the limited area affected near a discharge point, and the geographic separation of discharges from the Proposed Action (Federal waters) and discharges from other oil and gas operations in state waters. Exploration surveys could be conducted anywhere throughout the Proposed Lease Sale Area as part of the Proposed Action and would contribute to the existing ambient noise in the marine environment from current oil and gas activities and ship traffic in Cook Inlet. Seismic surveys, if planned and coordinated with the commercial fishing industry, are not estimated to have an additive effect on the Cook Inlet commercial fishing industry, and therefore are not expected to affect the annual landings or the value of landings for commercial fisheries.

Offshore construction of platforms and pipelines resulting from the Proposed Action are estimated to result in additive minor space-use conflicts such as competition for docking space and/or gear loss. Production facilities compete with commercial fishing interests for physical space in the ocean, and the facilities can pose hazards to fishing nets (e.g., drift gillnetting). Offshore construction could also have an additive or synergistic effect on commercial fishing. While platforms pose an obstacle to commercial fishing vessels, they also can provide structural habitat for fish. Platforms are known to attract fish for food and shelter from predators, and some structural remains from oil and gas operations in other parts of the U.S. have been considered for EFH designation to rebuild certain stocks of fish. The area occupied by the structures under the Proposed Action is small compared to the area available in Cook Inlet for commercial fishing. Because the footprint area of oil- and gas-related structures is small and easily avoided by fishing vessels, the impact on commercial fisheries is anticipated to be highly localized. Additive impacts from the Proposed Action are estimated to be relatively few in number and minor in scope. For these reasons, the relatively small additional contribution made by the discharges, seismic surveys, and offshore construction activities of the Proposed Action are estimated to have no incremental additive effect on commercial fishing.

The increase in marine vessel traffic and short-term underwater noise associated with the Proposed Action, when considered in conjunction with the expansion and operations of port facilities in Cook Inlet would have additive impacts on commercial fishing. The increases in port facilities include the Pebble Mine Port, Port of Anchorage, and Port MacKenzie. These expansions would cause an increase in marine vessel traffic, larger commercial vessel traffic, and construction vessel traffic in Cook Inlet. The increased traffic projected as a result of the Proposed Action could contribute to create temporary and additive space-use conflicts with the commercial fishing fleet. The extent of the conflicts would depend on the proximity to fishing areas throughout the Proposed Lease Sale Area. The amount of vessel traffic anticipated under the Proposed Action is not expected to incrementally contribute to the existing traffic within Cook Inlet from global shipping vessels, oil and gas vessels associated with state oil and gas activities, future OCS lease sales, cargo vessels, military vessels, supply barges, cruise ships, and survey vessels. However, the Proposed Action could incrementally increase the potential occurrence of small spills, the risk of introducing aquatic invasive species, and the possibility of vessel groundings, all of which could additively affect fish and fish habitat, and thereby commercial fishing. However, because the projected size and potential of small spills is estimated to be small for the Proposed Action, they are projected to have a minor impact on commercial fishing.

The potential effects of a large spill on the commercial fishing industry were assessed in Section 4.3.11.6. The analysis concluded that an unlikely oil spill of this magnitude that occurred in the spring could cause officials to close certain fisheries for a whole year or more because of tainting concerns. The effects of a large spill occurring as part of the Proposed Action would be additive to any other spill occurring from existing oil and gas activities. The most likely effect would be a lengthier and prolonged recuperation period for the natural resources in the affected area, including commercial fish species. Overall, the Proposed Action would likely result in minor incremental increases in impacts to commercial fishing for small spills and a moderate incremental increase in impacts to commercial fishing for large spills.

Researchers have examined the effects of climate change, including ocean acidification, on commercial fisheries. This research emphasizes the effects of warming sea surface temperatures on fish biomass; possible changes in fish species complexes; effects on commercially important calcareous species; shifts in prey availability and food webs; and the particular vulnerability of coastal areas in Alaska (Cheung et al., 2009; Mathis and Cross, 2014; Sherman et al., 2009). The cumulative impacts of all existing and future activities in Cook Inlet, including the Proposed Action, are additive to those from local and global anthropogenic activities that contribute to global climate change. Climate change is likely to affect the habitat, behavior, abundance, diversity, and distribution of populations of fish and shellfish, thereby indirectly affecting the commercial fishing industry. However, while the effects of climate change are expected to be long-term and widespread, the incremental and additive effects that would occur as a result of the Proposed Action during its life are not expected to impact commercial fishing.

5.2.11.4. Conclusion

Commercial fishing in Cook Inlet could be adversely affected by activities associated with the Proposed Action over the 40-year period of the E&D Scenario. These impacts include seafloor disturbance resulting in habitat loss for commercially important fish species; behavioral disturbance due to noise from vessels, construction activities, and seismic surveys; space-use conflicts with fishing vessels and the presence of oil and gas-related surveys, structures, and support vessels; exposure to or loss/degradation of habitat from an accidental spill; and closure of fishing grounds due to spill or cleanup operations. The overall impact of all routine activities under the Proposed Action is estimated to be minor and to range from minor to moderate for accidental spills. Commercial fishing could be affected by other activities in the Proposed Lease Sale Area, including oil and gas activities in state waters, future OCS lease sales, renewable energy projects, mining projects, marine transportation, ports and terminals, the Knik Arm Crossing Project, submarine cable projects, military activities, and climate change, resulting in a similar set of impacts.

Cumulative impacts on commercial fishing in Cook Inlet are expected from OCS and non-OCS activities over the next 40 years. The incremental contribution of the Proposed Action to effects on commercial fishing would be minor for routine activities. Incremental and additive effects are expected to result from an increase in safety zones and restricted areas related to oil and gas operations, from future OCS lease sales, an increase in the potential for accidental small spills, and a reduction in access to fishing areas due to spills. These impacts would be localized and temporary, and not be estimated to result in long-term disturbance or population-level effects to commercially important fish species. However, the additive impacts associated with a large spill could have a moderate impact on commercial fishing activities and fish populations and habitats in the area.

5.2.12. Subsistence Harvest Patterns

Cumulative impacts on subsistence harvest patterns will result from the incremental impacts of the Proposed Action (analyzed in Section 4.3.12) when added to impacts from the ongoing and reasonably foreseeable future activities, such as future OCS lease sales, described in Section 5.1.2.

5.2.12.1. Summary of Direct and Indirect Effects

Impacts to subsistence harvest patterns resulting from the implementation of the Proposed Action (analyzed in Section 4.3.12) include effects from routine operations associated with exploration and production activities and effects from accidental small oil spills and a large oil spill/gas release. Routine activities estimated to impact subsistence harvest patterns are seafloor disturbance and habitat alteration; discharges (drilling and other operational); noise; physical presence, including lights; trash and debris; vessel traffic; aircraft traffic and noise; cuttings transport and disposal; onshore support activities; and accidental small oil spills and a large oil spill/gas release. Subsistence harvest patterns may be directly or indirectly impacted by changes induced by these factors that affect the quality, quantity, distribution, availability, or abundance of biological resources used for subsistence; by changes in air or water quality, which affect the biological resources harvested by subsistence users; by real or perceived contamination from a spill, or by space-use conflicts. Overall, routine operations are estimated to have a minor impact on subsistence harvest patterns; the potential impacts from small spills are estimated to be minor; and the potential impacts of a large oil spill on subsistence harvest patterns are estimated to be major.

5.2.12.2. Other Relevant Activities that Could Affect Subsistence Harvest Patterns

Cumulative impacts on subsistence harvest patterns include the incremental impacts of the Proposed Action when added to the effects of past, present, and reasonably foreseeable future activities in the vicinity of the proposed Lease Sale Area (Table 5.1.2-1). Many activities could impact subsistence harvest patterns in a similar manner as the Proposed Action (Table 5.2-1), and result in direct and indirect impacts to subsistence resources, habitats used by subsistence species, and harvest patterns from seafloor disturbance and habitat alteration; discharges (drilling and other operational); noise; physical presence, including lights; trash and debris; vessel traffic; aircraft traffic and noise; cuttings transport and disposal; and accidental small oil spills and a large oil spill/gas release. Activities considered in the cumulative effects analysis are now taking place in Cook Inlet and will continue for the foreseeable future. Changes in the extent or nature of these activities could alter the impact they have on subsistence harvest patterns.

More than half of the state's population is located in the Cook Inlet watershed. In addition to the impacts to land and water quality and habitat losses resulting from the concentration of human population, development, and infrastructure in the region, there are ongoing and planned large-and medium-scale development projects that could cumulatively affect subsistence harvest patterns.

The analysis of cumulative effects to subsistence harvest patterns focuses on oil and gas activities in state waters, future OCS lease sales, mining projects, marine transportation, ports and terminals, the Knik Arm Crossing Project, wastewater discharges, persistent contaminants and marine debris, and climate change.

5.2.12.3. Analysis of Cumulative Effects

Several potential types of effects on subsistence harvest patterns are common in the planned and ongoing activities in Cook Inlet listed in Table 5.2-1.

There are 17 existing platforms in Cook Inlet and additional structures are anticipated in the foreseeable future that could result in seafloor-disturbing activities, and could directly or indirectly impact habitats or resources that are part of subsistence harvest patterns. Other activities could impact subsistence resources or harvest patterns through seafloor disturbance include oil and gas activities in state waters and OCS Federal waters (including future lease sales and development and production), ports and terminals, the Knik Arm Crossing Project, renewable energy projects, submarine cable projects, dredging and marine disposal, and fishing activities. Seafloor disturbance and habitat alteration occurring under the Proposed Action will result from drilling wells and placing anchors, nodes, cables, sensors, pipelines, and other equipment on the seafloor. Within Cook Inlet, two to three platforms and two pipelines would be installed under the Proposed Action. The amount of seafloor disturbance estimated to occur under the Proposed Action will result in a minor additive increase in impacts to subsistence harvest patterns because the impacts will be short-term and localized. Additionally, impacts from the Proposed Action will occur in Federal waters on the OCS, removed from areas likely to be heavily utilized for subsistence harvesting.

Drilling discharges resulting from the Proposed Action would add to the impacts resulting from current and future oil and gas activities in state waters. However, while additive, they are not estimated to negatively affect subsistence harvest patterns directly or indirectly through impacts to subsistence resources or habitats used by species important for subsistence. Drilling discharges will rapidly dilute and disperse in the high-energy environment of Cook Inlet (Neff, 2005), and drilling discharges from the Proposed Action will occur offshore – spatially separated from drilling discharges occurring from other activities in Cook Inlet. Therefore, while the incremental increase of drilling discharges from the Proposed Action may be short-term and localized, impacts from these minor additive effects to subsistence harvest patterns are expected to be negligible.

The Proposed Action would result in increased operational discharges and noise within Cook Inlet. Increased levels of operational discharges and anthropogenic noise are likely to occur from each of the projects considered in the analysis of cumulative effects. These may affect marine species abundance, distribution, and health, indirectly affecting subsistence harvest patterns. For example, the main point sources of discharges are from municipal wastewater treatment plants, seafood processors, and the petroleum industry. The dominant noise sources from other activities are seismic exploration surveys associated with state oil and gas operations, construction activities associated with multiple other projects, and marine transportation. However, the operational discharges and noise generated by these activities will largely occur outside the Proposed Lease Sale Area, and the effects of any additional operational discharges and noise in Cook Inlet are expected to be short-term and localized, and thus have a minor additive effect. Due to a large number of existing sources of treated wastewater discharges in Cook Inlet and because operational discharges are regulated and require an NPDES permit for discharge, the Proposed Action will result in a negligible incremental increase of impacts to subsistence harvest patterns from other discharges. While noise generated during the Proposed

Action will likely be the dominant noise source in the offshore environment during exploration (seismic surveys) and during construction of platforms, this noise will be geographically separated from much of the noise generated by other activities considered in this analysis and will occur in areas that are not heavily utilized for subsistence harvesting. Also, noise from activities under the Proposed Action will be intense, but of a short duration and not result in long-term disturbance impacts to fish and marine mammals that are important for subsistence. Therefore, the Proposed Action will result in a minor incremental increase of noise-related impacts to subsistence harvest patterns.

Small and large vessel traffic increases could either occur temporarily or on a long-term basis. For example, if the Chuitna Coal Project moves into construction and operation, it will require construction of a 457-m (1,500-ft) long marine coal-loading terminal into deep waters offshore Tyonek. Small vessel and barge traffic will constantly operate during construction and frequently during operations. Panamax-class deep-draft coal freight vessels – 290 m (950 ft) long and drawing 12 m (40 ft) of water – will operate through Cook Inlet on a regular basis, transporting Chuitna coal to market. Impacts to subsistence species, especially salmon, would come from the coal-loading operation and loss of anadromous streams from the coal strip mine operation. Other existing and planned Cook Inlet marine terminals are the Port of Anchorage expansion, the Point Mackenzie Terminal expansion, Iniskin Bay Port and Terminal, and Diamond Point Rock Quarry project, which will all require additional use of vessels during construction with increases in vessel traffic after completion. Additional vessel traffic in Cook Inlet consists of cruise ships, ferries, overnight passenger vessels, tankers, non-resident tugs, tank barges, freight and cargo ships, commercial and sport fishing vessels, military and USCG vessels, and pleasure craft. Vessel traffic generated by the Proposed Action will consist of approximately one to three trips per week for the duration of the Program. One to three vessel trips per week under the Proposed Action represent a negligible incremental increase in vessel traffic and associated impacts to subsistence harvest patterns.

Under the Proposed Action, subsistence harvest patterns could be impacted indirectly from exposure of harvested species to oil accidentally released from platforms, pipelines, and marine vessels. Subsistence harvesters would be most susceptible to adverse impacts from spills occurring in coastal areas. Accidental oil releases could occur in Cook Inlet from a variety of related activities, such as the domestic transportation of oil, import of foreign crude oil, and state development of oil. Oil releases from all sources may expose subsistence harvest resources to toxic contamination or perceived contamination. Spill cleanup operations could result in the closure of harvesting areas until cleanup is complete, but persistent contamination could keep areas closed for years.

The majority of reasonably foreseeable spills associated with the Proposed Action are estimated to be <50 bbl, a large spill, although unlikely to occur, is analyzed to determine the potential impacts (Appendix A). The magnitude of impacts would depend on the specific location affected, and the nature and magnitude of the accident, but could represent a large component of the overall exposure of subsistence harvest resources and habitats in Cook Inlet. Similar spills could occur from state oil and gas activities and future OCS lease sales, development, and production on OCS waters. Overall, accidental spills as a result of the Proposed Action would likely result in a negligible (small spill) or moderate (large spill) incremental increase in accidental spill-related impacts to subsistence harvest patterns.

The cumulative impacts of all existing and future activities in Cook Inlet, including the Proposed Action, are additive to those from local and global anthropogenic activities that contribute to global climate change. Climate change is likely to affect the habitat, behavior, abundance, diversity, and distribution of populations of subsistence species, thereby indirectly affecting subsistence harvest patterns. However, while the effects of climate change are expected to be long-term and widespread, the incremental and additive effects that would occur as a result of the Proposed Action during its life are not expected to impact subsistence harvest patterns.

5.2.12.4. Conclusion

Over the 40 years of the project life cycle, the Proposed Action would cause various short-term and localized and thus minor additive and synergistic effects to subsistence harvest patterns. These minor effects would be due to the potential for changes such as: (1) an increase in safety zones and restricted areas, (2) an increase in the potential for accidental oil spills, (3) a reduction in access to subsistence hunting and fishing areas due to spills, and (4) subsequent reductions to the commercial and sport fishing industries in which subsistence harvesters participate. Overall, the incremental contribution of additive effects from the Proposed Action is expected to be minor for subsistence harvest patterns.

5.2.13. Sociocultural Systems

Cumulative impacts on sociocultural systems will result from the incremental impacts of the Proposed Action (analyzed in Section 4.3.13) when added to impacts from the ongoing and reasonably foreseeable future activities, such as future OCS lease sales, described in Section 5.1.2.

5.2.13.1. Summary of Direct and Indirect Effects

The Proposed Action could impact sociocultural systems in several ways, such as disrupting the social organization or institutional formation of communities, cultural values, and economies of households and village communities. Impacts are anticipated from onshore support activities and employment and project spending, which will lead to changes in employment, personal income, demography, commodity pricing, and community prosperity. Such impacts could occur at many levels, including local community; Kenai Peninsula Borough, Municipality of Anchorage, and other regional levels; statewide levels; or in the event of a large spill, on a national level.

Impacts from routine activities under the Proposed Action are anticipated to be minor. Periods of exploration, drilling, and construction activity would likely have a localized short-term effect on communities due to potential harvest disruptions and the out-migration from communities for employment. However, the construction of shore base facilities and pipelines could result in more extensive alterations to existing sociocultural patterns. If production occurs, sociocultural impacts from potential economic revenue would be primarily beneficial in nature, if those benefits accrue at the community or regional level.

Small oil spills would float on the water surface and would disperse and weather rapidly. Potential impacts from small spills are not likely to cause sociocultural systems disruptions except as discussed in Section 4.3.12 for subsistence harvest patterns. The greatest degree of impact would occur from a large spill, which would likely cause severe tainting or perceptions of severe tainting of subsistence resources, making them unavailable or undesirable for use and creating a new impetus for broad social fragmentation and adversarial community relations. Overall, impacts from accidental spills on sociocultural systems are expected to be minor for small spills and major for a large spill.

5.2.13.2. Other Relevant Activities that Could Affect Sociocultural Systems

Cumulative impacts on sociocultural systems include the incremental impacts of the Proposed Action when added to the effects of past, present, and reasonably foreseeable future activities in the vicinity of the proposed Lease Sale Area such as onshore support activities, employment and project spending, and accidental small and large spills. All of the categories listed in Table 5.1.2-1 could impact sociocultural systems to varying degrees, and in a manner similar to those described for the Proposed Action (as summarized in Section 4.3.13).

5.2.13.3. Analysis of Cumulative Effects

IPFs associated with the Proposed Action could result in the direct disruption to local sociocultural systems in small towns and villages, and indirectly impact the systems through alteration and disruption of subsistence harvest patterns, known archaeological or cultural sites, or cultural continuity. Activities that could impact sociocultural systems are described in Section 5.1.2 and provided in Table 5.2-1. Little onshore infrastructure is anticipated under the Proposed Action (two landings for pipelines), and onshore support activities will utilize existing infrastructure that can accommodate the increased activity levels. Other activities under the Proposed Action would contribute little to overall population growth relative to other past, present, and reasonable foreseeable future activities. Because of the importance of state oil and gas operations to the Kenai Peninsula Borough, the contribution of these projects to population growth may be indistinguishable from projected baseline population growth. Current local residents would most likely fill some of the jobs created by the projects, but not a significant number because many of the positions require specialized skills. A portion of the projected population growth of the area can be allocated to new residents attracted to the area by the industry. Most of the population would reside in the Kenai Peninsula Borough’s cities, towns, and industrial enclaves.

Changes in other aspects of the south-central Alaskan economy over the life of the cumulative effects would change conditions of the sociocultural systems. It is not expected that major changes would take place in cultural orientations or other social institutions. Disruptions in existing sectors of the economy such as oil and gas production, commercial fishing, sport fishing and guided charters, tourism, logging, and agriculture from onshore support activities associated with the Proposed Action would tend to disrupt and produce stressful relations within families and local public institutions. Disruption of these activities without replacement by other economic activities producing the same or greater level of wealth consistent with the values of the area could intensify the effects. Past and present activity has helped create a diverse economic and social system. The ongoing and reasonably foreseeable future projects will contribute to sociocultural systems maintenance and continuation.

Existing oil and gas activities (in state waters and lands), marine transportation, fishing, and port- and terminal-related activities are likely to affect sociocultural systems through beneficial increases in employment and population. This is due to the scale of these activities and their proximity to communities more so than the activities under the Proposed Action or future OCS lease sales, which will require a specialized workforce for many of the positions and will only result in a relatively small number of long-term jobs. Additionally, many of the other activities will result in new infrastructure, which could disrupt local sociocultural systems in small towns and villages. Overall, the impacts to sociocultural systems from the activities under the Proposed Action are estimated to result in a negligible incremental increase in onshore support activities and employment and project spending when added to impacts from the other ongoing and foreseeable activities.

Under the Proposed Action, sociocultural systems could be impacted from exposure to oil accidentally released from platforms, pipelines, and marine vessels. Communities would be most susceptible to adverse impacts from spills occurring in coastal areas. Accidental oil releases could occur in Cook Inlet from a variety of related activities such as the domestic transportation of oil, import of foreign crude oil, and state development of oil resources. Most of the oil released to Cook Inlet is from commercial and recreational vessels. Oil releases from all sources may expose communities to toxic contamination or perceived contamination to air, water, soils, and subsistence resources. Spill cleanup workers could face potential hazards from oil byproducts, dispersants, detergents, and degreasers. Additional hazards include drowning, heat illness, cold exposure, falls, and encounters with dangerous wildlife. Any impacts to subsistence resources and known archaeological or cultural sites would likely result in adverse and synergistic impacts to communities in the area.

The majority of reasonably foreseeable spills associated with the Proposed Action are estimated to be <50 bbl, but a large spill, although unlikely to occur, is analyzed to determine the potential impacts (Appendix A). The magnitude of impacts from a spill would depend on the specific locations affected, the nature and magnitude of the accident, and the extent to which a spill disrupted subsistence activities, and could represent a large component of the overall exposure of communities in Cook Inlet. Similar spills could occur from state oil and gas activities or future OCS lease sales that led to development and production. Overall, accidental spills as a result of the Proposed Action would likely result in a negligible (small spill) or moderate (large spill) incremental increase in additive impacts.

The cumulative impacts of all existing and future activities in Cook Inlet, including the Proposed Action, are additive to those from local and global anthropogenic activities that contribute to global climate change. Climate change is likely to affect the habitat, behavior, abundance, diversity, and distribution of populations of subsistence species, thereby indirectly affecting sociocultural systems for small villages that are subsistence based. However, while the effects of climate change are expected to be long-term and widespread, the incremental, additive, and synergistic effects that would occur as a result of the Proposed Action during its life are not expected to impact sociocultural systems.

It is assumed that future OCS lease sales in the Cook Inlet region could result in the construction of additional platforms, the required vessel support and equipment operation, staffing, and miles of connecting pipelines to extract oil and gas and bring it to market. The effects to sociocultural systems from future oil and gas development and production in the OCS could range from negligible to major, depending on the time of year of each activity, whether a large spill were to occur, and to what extent and duration subsistence activities were disrupted.

5.2.13.4. Conclusion

The Proposed Action is estimated to make a minor beneficial contribution to the continuation of an important economic activity that helps maintain the existing sociocultural systems while having a negligible cumulative and adverse effect on Alaska Native sociocultural practices associated with subsistence harvest activities. Given the importance of oil and gas to the Kenai Peninsula Borough and the sizeable infrastructure from past and present development, the Proposed Action is expected to have a minor beneficial effect on existing sociocultural systems in the region. Population growth caused by incremental addition of the Proposed Action may be indistinguishable from the projected baseline population growth. Disruptions in existing sectors of the economy would tend to disrupt and produce stressful relations within families and local public institutions. The ongoing and reasonably foreseeable future activities should help maintain important existing sectors and neutralize potential disruptions from the Proposed Action. Cumulative sociocultural effects caused by small spills are expected to be negligible. The incremental increase of effects to sociocultural systems caused by large spills could be moderate if they caused long lasting and widespread disruptions to cultural values, social organization, local institutions, or subsistence harvest activities. Overall, the Proposed Action is expected to have negligible incremental beneficial and adverse effects to the existing sociocultural systems unless one or more large spills were to occur from ongoing and future activities.

5.2.14. Public and Community Health

Cumulative impacts on public and community health will result from the incremental impacts of the Proposed Action (analyzed in Section 4.3.14) when added to impacts from the ongoing and reasonably foreseeable future activities, such as future OCS lease sales, described in Section 5.1.2.

5.2.14.1. Summary of Direct and Indirect Effects

The main impacts of routine operations to public and community health through the various phases of development over the 40-year time period of the Proposed Action include air pollutant and GHG emissions, employment and project spending, and accidental spills (small and large) (Section 4.3.14). All emissions of airborne pollutants during the Proposed Action will increase concentrations to some extent in the region, potentially resulting in incidences of respiratory-related hospital admissions, cardiovascular hospital admissions, chronic bronchitis incidents in adults, bronchitis episodes in children, and restricted days outside for sensitive individuals. Direct employment and earnings; increased tax income for state and Federal taxing authorities; and population growth are also expected to occur from routine operations.

Potential impacts to public and community health related to accidental spills and response and cleanup activities (Section 4.3.14.3) include: contamination of subsistence resources and potential disruptions to subsistence activities. Analysis of impacts to public and community health in Section 4.3.14 from routine operations and small accidental spills were evaluated as minor, and were moderate for large spills.

5.2.14.2. Other Relevant Activities that Could Affect Public and Community Health

Cumulative impacts on public and community health include the incremental impacts of the Proposed Action when added to the effects of past, present, and reasonably foreseeable future activities in the vicinity of the Proposed Lease Sale Area (Table 5.1.2-1). All of the categories listed in Table 5.1.2-1 could impact public and community health to varying degrees, and in a similar manner to those described for the Proposed Action (Section 4.3.14).

The sources of additive and synergistic impacts to public and community health from other activities include: oil and gas activities in state waters, future OCS lease sales, mining projects, ports and terminals, the Knik Arm Crossing Project, marine transportation, and climate change. These impacts could result in additional disturbance to fish and wildlife and could affect air pollution, employment and project spending, and subsistence harvest activities (and indirectly public and community health) through displacement, altered habitat, threat of contamination, or other disruption to traditional social organization such as participation in subsistence and personal use salmon fisheries. These actions could generate new and beneficial economic activity in the form of employment, labor income, commodity prices, and property tax revenues, which could further impact sociocultural systems and, by extension, public and community health in both beneficial and adverse ways.

5.2.14.3. Analysis of Cumulative Effects

Activities associated with the Proposed Action that could impact public and community health through air pollutants and GHG emissions include construction and operation of production platforms, exploration and production wells, pipelines, barge transport, survey vessel trips, and activity of support vessels and helicopters. Activities that will impact public and community health are described in Section 5.1.2 and provided in Table 5.2-1. Existing oil and gas activities in state waters and lands, future OCS lease sales, marine transportation, fishing, and ports and terminal-related activities are likely to have impacts on public and community health due to their scale and proximity to communities. Other actions such as submarine cable projects, dredging and marine disposal, military activities, wastewater discharges, and marine debris are not likely to influence public and community health.

Because most activities that degrade air quality with air pollutants and GHG emissions under the Proposed Action will occur in offshore waters and are removed spatially from onshore communities, impacts would be mitigated through dilution and diffusion. The overall incremental contribution of impacts to public and community health from the Proposed Action are expected to be negligible when combined with impacts from other past, present, and reasonably foreseeable future actions. The Proposed Action is estimated to result in short-term increases in employment and earnings; result in increased tax income for state and federal taxing authorities; and result in low-level population growth. These impacts to economy and population are not estimated to be substantive and will vary with the phases of the E&D Scenario (see Section 4.3.14.2). For example, due to the modest size of exploration activities and the relatively remote nature (offshore) of the activity relative to onshore communities, impacts to public and community health would be more apparent and additive during later phases of development and production. During the exploration phase, oil and gas personnel are less likely to originate in local communities because of the short duration and specialized needs of exploration drilling jobs.

Other activities in the Proposed Lease Sale Area are expected to result in effects to public and community health through employment and project spending. These include an increase in available jobs; power generation; infrastructure such as bridges, port and terminals, submarine cables, and deepened and improved channels and ports; and a larger and more skilled labor force to support them. Increased local tax revenues from new infrastructure and a growing population would likely be used to expand capital budget projects and enhance local infrastructure and services such as health clinics or hospitals, residential housing, water and sewage treatment, power supply, communication networks, road construction and maintenance, construction of airstrips, docks, and public safety and rescue operations and are expected to collectively influence public and community health in beneficial ways.

Increased employment and population from the Proposed Action and other reasonably foreseeable future actions could lead to increased demand for public services and infrastructure in local communities. As described previously, this includes increased demand for housing, water, waste disposal and storage, electricity, telecommunications, port/dock access, roads, and additional and larger airstrips to accommodate increased air traffic from larger planes. Population increases could lead to future demographic changes as the region experiences an influx of outside people with potentially different cultural backgrounds. Other activities in the Proposed Lease Sale Area would require skilled labor and high-value infrastructure, causing synergistic effects with the Proposed Action, as much of the skilled labor and onshore infrastructure needed for the E&D Scenario would support other development.

An increase in population and corresponding demand for public services and infrastructure could cause boom and bust cycles. As the activities associated with the Proposed Action wind down, local communities could experience a net migration loss, leaving under-utilized or unused public services and infrastructure behind. Boom and bust cycles could cause inflation in local economies due to rapidly increasing wage growth and increasing prices in the area.

Overall, the impacts to public and community health from the activities under the Proposed Action are estimated to result in a negligible incremental increase in employment and project spending when added to impacts from other activities in the Proposed Lease Sale Area.

Climate change constitutes another potential source of cumulative impacts. Climate change is expected to alter important fish and wildlife habitats that could adversely impact subsistence harvest patterns. Public and community health depends on access to subsistence resources for many communities in the affected area (Sections 5.2.12 and 5.2.13). While the effects of climate change are expected to be long-term and widespread, the incremental, additive, and synergistic effects that would occur as a result of the Proposed Action during its life are not expected to impact public and community health.

Under the Proposed Action, public and community health could be impacted from exposure to oil accidentally released from platforms, pipelines, and marine vessels. Communities would be most susceptible to adverse impacts from spills occurring in coastal areas. Accidental oil releases could occur in Cook Inlet from a variety of related activities in the Proposed Lease Sale Area. These include domestic transportation of oil, import of foreign crude oil, and state development of oil resources. Most of the oil released to Cook Inlet is from commercial and recreational vessels. Oil releases from all sources may expose communities to toxic contamination and would likely result in perceived contamination to air, water, soils, and subsistence resources. Any impacts to subsistence resources would result in synergistic impacts to communities in the area.

The majority of reasonably foreseeable spills associated with the Proposed Action are estimated to be <50 bbl, but a large spill, although unlikely to occur, is analyzed to determine the potential impacts (Appendix A). The magnitude of impacts would depend on the specific location affected, the nature and magnitude of the accident, and the extent to which a large spill disrupted subsistence activities, and could represent a major component of the overall exposure of communities in Cook Inlet. Similar spills could occur from state oil and gas activities or future operations from other OCS lease sales. Overall, accidental spills as a result of the Proposed Action would likely result in a negligible incremental and additive impacts to community health from small spills and moderate incremental and additive impacts from large spills.

The incremental contribution of activities associated with the Proposed Action to cumulative effects on public and community health is expected to be minor.

5.2.14.4. Conclusion

The Proposed Action is expected to contribute to the overall cumulative effects on public and community health over the 40-year period of the E&D Scenario.

The incremental contribution of activities associated with the Proposed Action to cumulative effects on public health would vary in accordance with the type and level of impacts to air quality and economics and, to a lesser extent, subsistence harvest patterns and sociocultural systems. Cumulative impacts on public and community health in Cook Inlet from all OCS and non-OCS activities over the next 40 years are expected to occur. Incremental contributions from the Proposed Action would result in a minor increase of impacts on public and community health because additive impacts would be localized and short-term.

5.2.15. Recreation, Tourism, and Visual Resources

Cumulative impacts on recreation, tourism, and visual resources will result from the incremental impacts of the Proposed Action (analyzed in Section 4.3.15) when added to impacts from the ongoing and reasonably foreseeable future activities, such as future OCS lease sales, described in Section 5.1.2.

5.2.15.1. Summary of Direct and Indirect Effects

The effects of routine exploration, development, and production activities on private and commercial recreation and tourism would arise primarily from space-use conflicts. The overall effects of routine exploration, development, and production activities on recreation, tourism, and visual resources would be minor.

Effects to recreation and tourism are not expected from unlikely accidental releases of natural gas. Small spills would result in negligible effects to recreation and tourism, and minor effects to visual resources; effects on recreation, tourism, and visual resources from a large spill are estimated to be moderate.

While the activities would likely be noticeable to the average viewer, they are not expected to detract from the overall viewer experience. The only exceptions to this are pipelines. During construction and recovery, pipelines can produce short-term and localized visual impacts if located close to highly valued visual resources. However, when considered in the context of the entire study area, these impacts are relatively minimal. Overall, visual impacts associated with offshore oil development and production activities in the Proposed Lease Sale Area are anticipated to be minor.

5.2.15.2. Other Relevant Activities that Could Affect Recreation, Tourism, and Visual Resources

The incremental effects of the Proposed Action, in combination with past, present, and reasonably foreseeable activities identified in Section 5.1.2, could produce cumulative effects on recreation, tourism, and visual resources. The sources of additive impacts to recreation, tourism, and visual resources associated with other activities in the Proposed Lease Sale Area include oil and gas activities in state waters, future OCS lease sales, marine transportation, ports and terminals, and climate change.

The oil and gas industry is active in the Cook Inlet area as companies continue to produce oil and gas from existing wells. In addition, several companies are actively exploring for oil and gas in the Cosmopolitan Unit, Kitchen Lights Unit, Ninilchik Unit, and Redoubt Unit, and companies such as SAE, Apache, and ExxonMobil propose to conduct additional seismic surveys. Oil and gas activities on land and in state waters can produce visual impacts when proximal to shore or onshore resources. These development activities, if widespread, could result in impacts to scenic values for residents, recreationists, and tourists in the Cook Inlet region.

Although the levels of activities at ports and terminals have been flat following the recession in 2009, moderate increases (1.5% to 2.5% annually) are projected because of population growth and post-recession improvements in the economy. In addition, completion of expansions at several ports is likely to increase activities and vessel calls at ports, harbors, and terminals over the next 40 to 50 years. This period of increased activity coincides with the 40-year period of the Proposed Action. Ports and terminals can have visual impacts to water and coastal visual resources, particularly with regard to large offloading facilities that may be visible at greater distances. Nighttime visual impacts in the form of direct glare and sky glow can occur at these facilities.

The effects of global climate change are likely to combine with effects of the Proposed Action to affect recreation, tourism, and visual resources. Effects of climate change, including increasing air and ocean temperatures, rising sea level, reduced sea ice, increased wildfires, ocean acidification, and shifts in the distribution of flora and fauna, could interact with the effects of the Proposed Action. The effects of climate change already have been observed and are expected to continue over the 40-year period of the Proposed Action.

5.2.15.3. Analysis of Cumulative Effects

The past, present, and reasonably foreseeable activities identified previously could have effects on coastal-dependent and coastal-enhanced recreation and tourism if they modify a recreational site’s character or accessibility; alter the supply or demand for recreational resources; or foreclose opportunities for the occurrence, diversification, or expansion of recreational or tourism activities. Past, present, and reasonably foreseeable future activities added to the Proposed Action are not expected to modify any recreational site’s character or accessibility. Consequently, the Proposed Action would not contribute to cumulative effects to the character or accessibility of any recreational site.

The potential growth in activities and vessel calls at ports, harbors, and terminals would contribute to an increased demand for recreation and tourism. However, this growth is projected to be small (1.5% to 2.5% annually). When distributed across the entire Cook Inlet area, this level of increase would generate a minor increase in demand for recreation compared to current conditions. Employment associated with past, present, and reasonably foreseeable activities would not be large enough to induce in-migration of a sufficient number of people to increase demand for recreation or tourism. The additional employment of the Proposed Action would not displace tourists from lodging, campgrounds, or other recreational facilities; it also would not adversely affect opportunities for the expansion or diversification of recreational activities. Consequently, when considered together in the overall context of the Cook Inlet area, the Proposed Action and its projected growth in activities and vessel calls at ports, harbors, and terminals would generate minor cumulative effects to recreation and tourism during the 40 years they would overlap.

Population growth is a strong predictor of demand for recreation, especially given the importance of outdoor recreational opportunities to Alaskan residents and visitors. As noted in Section 5.2.10, the Proposed Action and past, present, and reasonably foreseeable activities would contribute little to overall population growth. Consequently, the incremental increase in growth in population associated with the Proposed Action, when added to past, present, and reasonably foreseeable activities, is unlikely to be sufficient to generate incremental and additive effects to recreation or tourism.

The projected growth in activities and vessel calls at ports, harbors, and terminals could contribute to an increase in space-use conflicts between vessels that support commercial operations and recreational vessels. However, most waterborne recreational and tourist activities in the Cook Inlet region occur in nearshore areas, especially in or adjacent to national and state parks or other special-use areas. In contrast, on-lease exploratory activities and most commercial operations for the Proposed Action would occur far enough from these areas to avoid space-use conflicts. Consequently, the overall effects of routine exploration, development, and production activities from the Proposed Action would not be additive when combined with increased vessel calls at ports, harbors, and terminals on recreation and tourism and would be minor.

Oil and gas activities (state waters and lands), future OCS lease sales, marine transportation (including spills), and climate change in combination with the Proposed Action have a higher potential for cumulative effects on recreation and tourism than other potential sources. If the combined increase in oil and gas activities and marine transportation results in repeated spills over the 40 year life of the Proposed Action, adverse cumulative effects to recreation, tourism, and visual resources could occur. Repeated spills would cause long-term cumulative effects if the public perceives recreational, tourism, and scenic values of a site or area to be diminished and that perception (real or not) changes the public’s preference for using that site.

Adverse cumulative effects to recreation, tourism, and visual resources could result if an area gains a long-term reputation as being environmentally degraded and that perception results in a decline in coastal-dependent and coastal-enhanced recreation and tourism. Sources of degradation include natural (e.g., climate change, fires, floods, erosion) and anthropogenic causes (e.g., marine debris and trash, sewage spills, oil spills). For example, various governmental agencies participate in the National Marine Debris Monitoring Program, which was established to track the problem of marine debris. Marine debris originates and cumulates from many sources, including sewage treatment plants, commercial fishing, industrial manufacturing, and various forms of vessel traffic. A greater magnitude or frequency of these causes could intensify the public perception of degradation.

Although oil spills have occurred in the past, they did not create the long-term perception of the Cook Inlet area as being undesirable or degraded as a recreational or tourism venue. The effects from the reasonably foreseeable activities, including industrial accidents and spills, likely would not create conditions that would sustain the long-term perception of the area being degraded. Therefore, the contribution of the Proposed Action activities to cumulative effects on recreation, tourism, and visual resources from spills is negligible.

In addition to potentially causing direct environmental degradation of recreational sites, climate change could affect recreation and tourism over the long term. Climate change-induced shifts in air and ocean temperatures, changes in sea level, reduced sea ice, increased ocean acidification, and shifts in the distribution of flora and fauna could affect the attractiveness and scenic values of Cook Inlet for recreation and tourism. For example, if air and ocean temperatures continue to warm, the resulting reductions in cold, snow, and ice could alter the public perception of Alaska as a generally inaccessible “last frontier”. As glaciers melt and recede from the coastline, perceptions of the rugged beauty and remoteness of the coastline could change. Cruise lines could experience a decrease in bookings as a result. The cumulative impact of the Proposed Action on climate change, which likely would extend long past the 40 years during which the Proposed Action would occur, when added to the impacts of past, present, and reasonably foreseeable future actions is estimated to be negligible.

The Proposed Action may contribute incremental cumulative impacts when added to other activities in the Proposed Lease Sale Area if those activities are in the same viewscape as the Proposed Action. For example, a vista that spans 180° would be considered a viewscape, and any development that occurs in that vista becomes a visible part of the landscape. Human activity that visually disrupts a small portion (e.g., 5° of the total 180°) might be considered a minor impact. However, when additional development expands the range or angle of visual disruption, the impact can be expected to increase. Conversely, when the development areas are clustered in a single view, this can cause visual clutter, a sense of visual disorganization. Visual clutter can increase the visual impact.

5.2.15.4. Conclusion

The Proposed Action is estimated to contribute to the overall cumulative effects on recreation, tourism, and visual resources over the 40-year period of the E&D Scenario. Recreation, tourism, and visual resources could be affected by other activities in the Proposed Lease Sale Area, including oil and gas activities in state waters, future OCS lease sales, ports and terminals, marine transportation, and climate change resulting in a similar set of impacts. The reasonably foreseeable future actions would also generate impacts to recreation, tourism, and visual resources by impacting air quality, viewscapes, and employment.

The incremental contribution of activities associated with the Proposed Action to cumulative effects on recreation, tourism, and visual resources would vary in accordance with the type and level of impacts to air quality, area economics and visual aesthetics. Growth of the tax base in the Cook Inlet region, with corresponding growth in the capital budget and government services, would provide benefits to the local community as infrastructure such as medical facilities and schools are built. Cumulative impacts on recreation, tourism, and visual resources in Cook Inlet from all OCS and non-OCS activities over the next 40 years are expected to occur. Incremental contributions from the Proposed Action would be additive to other impacts and result in a minor increase of impacts on recreation, tourism, and visual resources.

5.2.16. Sport Fishing

Cumulative impacts on sport fishing will result from the incremental impacts of the Proposed Action (analyzed in Section 4.3.16) when added to impacts from the ongoing and reasonably foreseeable future activities, such as future OCS lease sales, described in Section 5.1.2.

5.2.16.1. Summary of Direct and Indirect Effects

The analysis of impacts of the Proposed Action on sport fishing is presented in Section 4.3.16. The effects of routine activities from implementing the Proposed Action on the sport fishing community could limit access to some regular sport fishing areas and may displace some populations of species such as salmon and halibut in the short term. The effects of accidental small spills would likely be minor as the sport fishing industry has some geographic flexibility. However, a large oil spill could temporarily limit the ability of sport halibut and salmon fishers from setting out from oiled locations. Oil contacting the beaches could affect clam gathering, particularly razor clams and other types of clams along the east and west side of Cook Inlet and mussels and steamer clams in small bays in

Kachemak Bay. Consequently, the overall effects of routine activities of the Proposed Action on the sport fishing industry would be minor, while the effects of accidental spills would likely range from minor effects for small spills to moderate effects to sport fishers from large spills.

5.2.16.2. Other Relevant Activities that Could Affect Sport Fishing

The list of past, present, and reasonably foreseeable activities as identified in Section 5.1.2 that could potentially affect the sport fishing industry over the 40-year time period of the Proposed Action are:

- Oil and gas activities (state waters and lands)
- Future OCS lease sales
- Marine transportation (including spills)
- Ports and terminals; and
- Climate change

The most common direct impact to sport fishing is associated with each activity's potential for a long-term increase in vessel traffic and an increased potential for accidental oil spills during operations, which will result in space-use conflicts and area closures.

5.2.16.3. Analysis of Cumulative Effects

For the cumulative effects analysis, fishing activities are assumed to continue at approximately current levels for the foreseeable future (Romberg, 2014).

The Proposed Action would increase offshore oil and gas operations associated vessel traffic over the 40-year project time frame, adding to vessel traffic in Cook Inlet from global cargo vessels docking in the Port of Anchorage, oil and gas vessels, military vessels, supply barges, cruise ships, commercial fishing vessels, survey vessels, and research vessels. The Proposed Action would add additional marine vessel traffic, and with it the potential for groundings, increased operational discharges, fuel spills, pipeline leaks, and potential oil spills to already existing marine and land-based actions (Table 5.2-1). The size of non-oil and gas transportation-related spills is expected to be small and cause a localized impact to sport fishing. Because these spills are small, the resultant influence on sport fishing is not expected to be distinguishable from that of natural population variations. The Proposed Action would add minor incremental impacts to the sport fishing industry due to an increase in vessel traffic, an increase in operationally restricted areas to sport fishing vessels, and an accidental large spill, all of which would further temporarily restrict access to fishing areas. However, because each of these impacts is short-term, they are assumed to pose a minor cumulative impact on the sport fishing industry.

The increase in marine vessel traffic and short-term underwater noise associated with the Proposed Action would contribute additive impacts from planned construction, expansion, and operation of port facilities in Cook Inlet and could have a minor additive impact on the sport fishing industry. Increases in port facilities include the Pebble Mine Port, Port of Anchorage, and Port MacKenzie. These expansions would cause an increase in marine vessel traffic, larger commercial vessel traffic, and construction vessel traffic in Cook Inlet. The increased traffic projected as a result of the Proposed Action could create temporary additive space-use conflicts with sport fishers. The extent of the conflicts would depend on the proximity to fishing areas throughout the proposed Lease Sale Area but would most likely be localized.

Activities under the Proposed Action will result in an increased chance of oil spills within the proposed Lease Sale Area when added to other activities in the area. A spill will result in space-use conflicts for sport fishers where limited access is afforded to sport fishing areas and additive risk to sport fish species populations from mortality and contamination (or perceived contamination). However, the health of the Cook Inlet ecosystem currently is good. Past oil and gas-related spill events have occurred over a 45-year period in a dynamic circulation regime dominated by tidal flushing without causing long-term impacts to the sport fishing industry. A large oil spill may cause moderate additive impacts to the sport fishing industry through long-term and widespread loss of access to some areas due to contamination or cleanup activities. Additive impacts to sport fishing resources could occur if post-spill recovery periods are lengthened by more than one spill affecting the same coastline within a short interval.

The cumulative and additive impacts of all existing and future activities in Cook Inlet are considered to be additive to those from local and global anthropogenic activities that contribute to global climate change. Climate change is likely to affect the habitat, behavior, abundance, diversity, and distribution of populations of fish and shellfish, thereby indirectly affecting the sport fishing industry. Several studies have examined the effects of climate change (including ocean acidification) on fish and shellfish, emphasizing the implications of potential northern range expansions of fish species, the effects of warming sea surface temperatures on fish biomass, possible changes in fish species complexes, effects on commercially important species, shifts in prey availability and food webs, and the particular vulnerability of coastal areas in Alaska (Cheung et al., 2009; Mathis and Cross, 2014; Sherman et al., 2009). However, while the effects of climate change will be long-term and widespread, the effects that would occur from the Proposed Action in its lifetime are not estimated to impact sport fishing.

5.2.16.4. Conclusion

Sport fishing in Cook Inlet could be adversely affected by activities associated with the Proposed Action over the 40-year period of the E&D Scenario. These impacts include seafloor disturbance resulting in habitat loss for important fish species; behavioral disturbance due to noise from vessels, construction activities, and seismic surveys; space-use conflicts with fishing vessels and the presence of oil and gas-related surveys, structures, and support vessels; exposure to or loss/degradation of habitat from an accidental spill; and closure of fishing grounds due to spill or cleanup operations.

Cumulative impacts on sport fishing in Cook Inlet from all OCS and non-OCS activities over the next 40 years are expected to occur. The incremental and additive contribution of the Proposed Action to impacts on sport fishing would be minor. This is due to increases in safety zones and restricted areas related to oil and gas operations, an increase in the potential for accidental oil spills, and a reduction in access to fishing areas due to spills. Most impacts would be localized and temporary and not be estimated to result in population-level effects. However, the impacts associated with a large spill could have a moderate impact on commercial fishing activities and fish populations and habitats in the area.

5.2.17. Archaeological and Historic Resources

Cumulative impacts on archaeological and historic resources will result from the incremental impacts of the Proposed Action (analyzed in Section 4.3.17) when added to impacts from the ongoing and reasonably foreseeable future activities, such as future OCS lease sales, described in Section 5.1.2.

5.2.17.1. Summary of Direct and Indirect Effects

Direct effects to archaeological and historic resources include activities that come into contact with a resource or physically impact the integrity of a resource (Sections 4.3.17.1 and 4.3.17.2). Relevant activities that will occur under the Proposed Action that could impact archaeological and historic resources include the following:

- Placement of equipment associated with survey activities on the seafloor (e.g., nodes, cables, anchors)
- Seafloor sampling (e.g., gravity/piston corers, grab sampling, dredge sampling)

- Drilling activities (e.g., drilling, anchoring and operation of MODUs, placement of fixed platforms)
- Placement of pipelines both on- and offshore (via trenching or anchoring)
- Discharges of drill fluids and cuttings; and
- Oil spills

Direct impacts to archaeological and historic resources range from destabilization and degradation of the resource to physical damage, resulting in the loss of archaeological data on its construction. Artifacts could be damaged or disturbed, resulting in the loss of social information of the crew and cargo. Impacts to buried prehistoric sites include destruction of artifacts and site features as well as disturbance of the stratigraphic context of the site. Indirect impacts would include any activity that could alter the dynamics of the seafloor or currents that may adversely alter the surrounding seafloor or increase local scouring, exposing cultural resources and upsetting the equilibrium that the resource previously had with the environment, which could lead to deterioration or eventual loss of the resource and the information it contains. Impacts to onshore archaeological resources found within a pipeline corridor could include destruction of artifacts and site features as well as disturbance of the stratigraphic context of the site. Indirect and direct impacts resulting from an oil spill clean-up could include vandalism or inadvertent damage to any historic property, including previously unrecorded archaeological sites or features, found within the contaminated zone. Overall, impacts on archaeological and historic resources are estimated to be negligible from routine activities, minor from small spills, and moderate from a large spill.

5.2.17.2. Other Relevant Activities that Could Affect Archaeological and Historic Resources

Cumulative impacts on archaeological and historic resources include the incremental impacts of the Proposed Action when added to the effects of past, present, and reasonably foreseeable future activities in the vicinity of the proposed Lease Sale Area (Table 5.1.2-1). Specific IPFs from the Proposed Action that could adversely affect archaeological and historic resources include seafloor disturbances, drilling discharges, and accidental oil spills. Activities considered under the cumulative effects analysis that may impact archaeological and historic resources are summarized in Table 5.2.17-1.

Table 5.2.17-1. Activities that may Adversely Affect Archaeological and Historic Resources.

Activity	Potential Types of Effects
Oil and Gas activities (non-Lease Sale 244)	Seafloor disturbance, drilling discharges, physical presence, accidental spills
Renewable energy projects	Seafloor disturbance, physical presence, accidental spills
Mining projects	Seafloor disturbance, physical presence, accidental spills
Marine transportation	Physical presence, Accidental spills
Ports and terminals	Seafloor disturbance, physical presence, accidental spills
Knik Arm Crossing Project	Seafloor disturbance, physical presence, accidental spills
Submarine cable projects	Seafloor disturbance
Dredging and marine disposal	Seafloor disturbance, physical presence, accidental spills
Fishing activities	Accidental spills
Climate change	Shoreline erosion and coastal retreat

5.2.17.3. Analysis of Cumulative Effects

Under the Proposed Action, seafloor disturbance impacts will result from drilling wells and placing anchors, nodes, cables, sensors, pipelines, platforms, and other equipment on the seafloor. Activities that will disturb the seafloor (Table 5.2.17-1) include oil and gas activities on state lands, renewable energy projects, mining projects, port and terminal projects, the Knik Arm Crossing Project, submarine cable projects, dredging and marine disposal, and fishing activities, as described in Section 5.1.2. Many of the activities under the cumulative effects analysis will disturb areas temporarily, areas that are geographically separated from the Proposed Action, or areas that have already been subjected to disturbance.

Direct impacts to archaeological resources from activities that disturb the seafloor include physical disturbance, damage, or destruction of the artifact or prehistoric site, resulting in the loss of valuable historical data. Indirect impacts from seafloor-disturbing activities could include alteration of the dynamics of the seafloor and water currents in the vicinity of a shipwreck or prehistoric site, which can cause the surrounding seafloor to slump or may change the direction and intensity of local currents scouring and/or exposing cultural resources and upsetting the equilibrium that the resource previously had with the environment, causing deterioration or eventual loss of the resource and the information it contains.

While archaeological and historic resources are nonrenewable resources and any routine activity could have a potential long-term negative impact, the likelihood of direct impacts to archaeological and historic resources under the Proposed Action is expected to be low because all authorizations for activities taking place on the OCS would include BOEM's Guidelines for Providing Archaeological and Historic Property Information Pursuant to 30 CFR 585.

Impacts from seafloor disturbance under the Proposed Action, as described in Section 4.3.17.1, will result in a negligible incremental increase in impacts to archaeological and historic resources because authorizations will include guidance from BOEM on the identification of historic properties, and any seafloor disturbance impacts generally will be geographically separated (occur in Federal waters) from similar impacts under the cumulative effects analysis.

Under the Proposed Action, drilling fluids and cuttings will be discharged to the seafloor surrounding the exploration and delineation well sites (7 to 10 wells). Discharge of fluids and cuttings could result in the burial of archaeological and historic resources. However, because Cook Inlet is a high-energy environment, discharges are expected to be quickly transported away by strong currents (Hannah and Drozdowski, 2005). Discharge of fluids and cuttings has occurred and will occur under activities associated with the cumulative effects analysis, as described in Table 5.2-1. The Proposed Action will result in a moderate incremental increase in the discharge of fluids and cuttings. Wells under the Proposed Action will be >4.8 km (3 mi) from shore, while under the cumulative effects analysis, existing and potential future wells may be <4.8 km (3 mi) from shore, so impacts will be geographically and temporally dispersed.

The presence of structures and vessels and the associated lighting from the Proposed Action could impact onshore historic properties. Within Cook Inlet, two to three platforms will be installed under the Proposed Action, and there are 17 existing platforms with additional structures anticipated in the future. Structures and vessels in the cumulative effects analysis will be associated with oil and gas operations, renewable energy projects, mining projects, marine transportation, ports and terminals, the Knik Arm Crossing Project, dredging and marine disposal, and military activities. Under the Proposed Action, the presence and associated lighting from offshore vessels and drilling operations would be transient and localized; platforms installed would be located >4.8 km (3 mi) from shore and thus geographically separated from most of the activities occurring under the cumulative effects analysis that are likely to impact archaeological and historic resources. Therefore, the physical presence of structures and vessels associated with the Proposed Action would result in a negligible incremental increase in impacts to onshore historic properties within the cumulative effects analysis.

Under the Proposed Action, archaeological resources could be exposed to oil accidentally released from platforms, pipelines, and marine vessels, resulting in increased deterioration and damage from cleanup activities (Section 4.3.17.4). Accidental oil releases could occur in Cook Inlet from a variety of related activities, such as the domestic transportation of oil, import of foreign crude oil, and state development of oil. Most of the oil released to Cook Inlet is from commercial and recreational vessels. Oil releases from all sources may expose archaeological resources via direct contact, through persistent contamination of sediments, or during cleanup operations.

The majority of reasonably foreseeable spills associated with the Proposed Action are estimated to be <50 bbl, but a large spill, although unlikely to occur, is analyzed to determine the potential impacts (Appendix A). The magnitude of impacts would depend on the specific location affected, and the nature and magnitude of the accident, but could represent a major component of the overall exposure of archaeological resources in Cook Inlet. In the high-energy environment of Cook Inlet, the portion of small spills that had not dispersed is expected to be quickly transported away by strong currents (Hannah and Drozdowski, 2005). Similar spills (small and large) could occur from state oil and gas activities as well as port and terminal expansion projects, while other activities (Table 5.2-1) likely would only result in small spills. Overall, accidental spills as a result of the Proposed Action likely would result in a minor (small spill) or major (large spill) incremental increase in accidental spill-related impacts.

Climate change may result in impacts to archaeological and historic resources through habitat modification, storm surge, shoreline erosion, sea level rise, altered hydrology, snow melt, and glacier retreat or advances. Impacts on archaeological and historic resources include direct synergistic impacts such as habitat modification that could occur as a result of shoreline erosion and sea level rise that could destroy, flood, bury, or expose a historic site or artifact. With the safeguards already in place through the NHPA and the Federal permitting process (and BOEM Guidelines), the activities associated with the Proposed Action are unlikely to produce harmful incremental impacts. However, if an unknown site is impacted by the Proposed Action and the information that site could have provided is lost, the overall contribution to cumulative impacts to archaeological resources could be major.

5.2.17.4. Conclusion

Archaeological and historic resources in Cook Inlet could be affected adversely by activities associated with the Proposed Action over the next 40 years. These impacts include physical disturbance, damage, or destruction from structure emplacement and seafloor disturbance; burial from drilling discharges; visual impacts from physical presence and lighting; increased deterioration from contact with oil and damage from cleanup activities; additional indirect impacts could occur from climate change related habitat alteration or from alteration of the dynamics of the seafloor and water currents in the vicinity of an artifact or prehistoric site. Overall impact of all routine activities under the Proposed Action is estimated to be negligible. Impacts are estimated to range from minor to moderate for small or large accidental spills. Archaeological and historic resources also could be affected by other activities as part of the cumulative effects analysis, including oil and gas activities in state waters, renewable energy projects, mining projects, marine transportation, ports and terminals, the Knik Arm Crossing Project, submarine cable projects, dredging and marine disposal, military activities, fishing activities, and climate change, resulting in a similar set of impacts.

Cumulative impacts on archaeological and historic resources in Cook Inlet from all OCS and non-OCS activities over the next 40 years are unavoidable; however, impacts from these activities are mitigated by existing Federal and state regulations requiring pre-construction archaeological surveys. Archaeological surveys were not required throughout the Cook Inlet OCS until July 2015 when BOEM updated its guidelines to require archaeological surveying prior to any seafloor-disturbing activity (USDOI, BOEM, 2015f). As a consequence, it is possible that activities could impact an archaeological site or historical resource where site clearance surveys were not previously required. Incremental contributions from the Proposed Action would result in a minor increase of impacts on archaeological and historic resources because most impacts would be localized, temporary, geographically separated, and mitigated by safeguards already in place through the NHPA and the Federal permitting processes.

5.2.18. Areas of Special Concern

Cumulative impacts on Areas of Special Concern will result from the incremental impacts of the Proposed Action (analyzed in Section 4.3.18) when added to impacts from the ongoing and reasonably foreseeable future activities, such as future OCS lease sales, described in Section 5.1.2.

5.2.18.1. Summary of Direct and Indirect Effects

The effects of the Proposed Action on water quality would be temporally short, and water quality would recover within a 24-hour period after the discharge event or accidental release. Air pollution resulting from the Proposed Action would have a short-term and local effect. Impacts related to aircraft traffic and noise would be intermittent and short in duration, and the flight paths of aircraft from most of the Areas of Special Concern would be at least 5.6 km (3 nmi) offshore.

Overall, impacts from routine operations as a result of the Proposed Action would result in minor impacts to Areas of Special Concern. A small spill would be estimated to result in negligible impacts to Areas of Special Concern due to the distance from shore and localized area of contamination.

In the unlikely event of a large oil spill, impacts to water quality, the coastal habitats of Cook Inlet, and the areas of the eastern Aleutian Islands and southern Bristol Bay would be major.

5.2.18.2. Other Relevant Activities that Could Affect Areas of Special Concern

As outlined in Section 5.1.2 and Table 5.1.2-1, multiple activities will occur simultaneously in Cook Inlet during the proposed 40-year E&D Scenario presented in Section 2.4. Cumulative impacts could occur incrementally as a combination of impacts associated with the Proposed Action and past, present, and reasonably foreseeable future in the vicinity of Cook Inlet. The activities that may have the most cumulative effect within the proposed Lease Sale Area on Areas of Special Concern are as follows:

- Oil and gas activities (state waters and lands)
- Future OCS lease sales
- Marine transportation (includes spills)
- Wastewater discharges
- Persistent contaminants and marine debris
- Dredging and marine disposal
- Fishing activities; and
- Climate change

Small spills (<1,000 bbl) from commercial and recreational vessels or from OCS program activities (e.g., accidental releases) are not expected to affect the Areas of Special Concern. The oil and gas exploration and production activities are concentrated in the northern reaches of Cook Inlet, approximately 55.6 km (30 nmi) from the Federal lease areas identified in the Proposed Action. The oil and gas activities within state waters are operated and maintained under the same EPA and NPDES storm water effluent limitation guidelines that control storm water discharges from support facilities.

Impacts from small and large oil spills related to current and future oil and gas exploration, production, and transportation activities have the greatest potential for reaching shoreline habitats and communities in a NP, NF, NWR and NERR. In addition, ice and extreme weather events can damage pipelines and infrastructure, resulting in a release of oil. The magnitude of the impacts would depend on the specific location affected and the nature and magnitude of the activity/accident, but could represent a substantial component of the overall exposure of coastal Areas of Special Concern in the Proposed Lease Sale Area. Most of the existing oil and gas activity is within the northern reaches of Cook Inlet.

Marine transportation within Cook Inlet could produce a cumulative effect on coastal Areas of Special Concern. Marine vessel operations within Cook Inlet could directly affect Areas of Special Concern via increased vessel and aircraft traffic during all phases of the E&D Scenario. Waves generated by boats, ships, barges, and other vessels erode unprotected shorelines and accelerate erosion in areas already affected by natural processes.

Wastewater discharges within the Proposed Lease Sale Area and particularly coastal areas are regulated by state-issued or Federal NPDES permits specifically for coastal areas. In Cook Inlet, mixing, dilution, and dispersion of routine discharges with large volumes of water would occur, and any impacts on water quality would be highly localized and temporary with negligible impacts on offshore Areas of Special Concern. Routine discharges introduced into Cook Inlet waters by oil and gas activities would be diluted and dispersed by complex currents associated with the tides (diurnal tidal variations at the upper end of Cook Inlet at Anchorage can be 9 m (30 ft) (USDOI, MMS, 2000). Compliance with applicable NPDES permits and USCG regulations would prevent or minimize most impacts on receiving waters.

Marine debris could come from multiple activities and sources. Trash and debris and their effects on the environment of the proposed Lease Sale Area are described in Section 4.2.8. The EPA and BOEM require vessels involved in exploration and development activities and offshore structures to provide waste management plans to properly dispose of trash and debris. Other sources of marine debris can occur from oil and gas development in state waters, domestic transportation of oil, foreign crude oil imports, commercial fishing, commercial and recreational vessel traffic, dredging/material disposal, and recreation and tourism. The described activities would occur throughout Cook Inlet and add to the marine debris impacts.

Dredging activities within Cook Inlet could produce some cumulative impacts during maintenance and port development dredging related to the ports and harbors located in Anchorage, Port MacKenzie, Tyonek, Nikiski, Drift River, Kenai, Anchor Point, and Homer. Dredging in relation to maintenance and expansion activities and the disposal of dredged materials reduces water quality within the vicinity of these operations and, depending on the tidal currents and local circulatory patterns, can have a negative impact on contiguous habitats.

Commercial, sport, and subsistence fishing activities occurring throughout Cook Inlet as described in Sections 3.3.2, 3.3.7, and 3.3.3, respectively. Fishing activities occur within freshwater and marine habitats and include local fishers from the Kenai Peninsula, other Alaskans (from outside the Kenai Peninsula), and vessels operated by non-residents of Alaska. Sport fishing is supported by Alaska residents and non-residents, utilizing offshore charter boats and freshwater guides, which translates into a large sport fishing guide industry for the Alaskan economy. Sport fishing generally is practiced using hook-and-line fishing methods. Commercial fisheries generally are practiced using industrial-scale fishing methodologies, which can have negative impacts on the benthic and coastal habitats if not monitored and managed properly. Some of the techniques that can have a negative impact on the marine environment are trawling, clam dredging, and longline fishing.

Climate change and its effect on the environment are presented in Sections 3.1.1.1 and 5.1.2.13. Climate change is one of the most important IPFs relative to Areas of Special Concern for the synergistic and cumulative effects it could have on the habitats within the Cook Inlet Areas of Special Concern. Water quality will be impacted through accelerated melting of glaciers and the resultant sediment loads and from lower pH levels and concomitant ocean acidification that may affect invertebrate assemblages in Cook Inlet and the Gulf of Alaska.

5.2.18.3. Analysis of Cumulative Effects

Section 4.3.18 identified potential direct and indirect effects of the Proposed Action on Areas of Special Concern in the proposed Lease Sale Area. This section identifies the cumulative effects that activities from the Proposed Action could have on Areas of Special Concern when added to impacts from other activities in the Proposed Lease Sale Area described in Section 5.1.2.

Areas of Special Concern would be affected by the following factors during exploration, development, production, and decommissioning activities: vessel traffic; wastewater discharges, including sanitary wastes, gray water, cooling water (for LNG facilities and power plants), and other miscellaneous discharges (e.g., bilge, ballast, and fire water; deck drainage); operational discharges from exploration, development, production wells, and production structures such as drilling fluids (i.e., SBF and WBF), cuttings, and produced water (although many of these contaminants are re-injected or brought to shore for disposal); and seafloor- and land-disturbing activities such as drilling, infrastructure emplacement, pipeline trenching, onshore construction, and structure removal. The effects from these activities on Areas of Special Concern include wave action, resulting in shoreline erosion and loss of habitat, and introduction of contaminants. Similar activities would occur from previous and future lease sales during the life of the program.

Cumulative impacts on coastal and estuarine habitats result from the incremental impacts of the Proposed Action when added to impacts from ongoing and reasonably foreseeable future actions, including those of ongoing and future OCS programs and other non-OCS program activities. Other ongoing and reasonably foreseeable future actions contributing to cumulative impacts in Cook Inlet are summarized in Table 5.1.2-1 and discussed in this section, as applicable.

Vessel traffic associated with the Proposed Action may cause additive accelerated rates of erosion to shorelines along inlets, channels, and harbors and may result in increased sediment re-suspension in wetland habitats from wake-induced waves and propeller wash. OCS program-related service vessel traffic in Cook Inlet could be as high as three to six trips per week (156 to 312 trips per platform per year) over the 40-year period, all of which are associated with the Proposed Action. Extensive non-OCS program marine traffic also occurs in Cook Inlet, including that related to crude oil and finished product transport, LNG and ammonia carriers, tugs and barges, ferries, commercial fishing vessels, military and USCG vessels, a coal carrier, dredge vessels, cruise ships, and small watercraft. Fuel barge traffic is minimal. An estimated 480 large vessels (other than fuel barges on domestic trade) called at Cook Inlet ports in 2010 (Eley, 2012). These activities can be reasonably expected to continue into the future, resulting in additive cumulative impacts on coastal Areas of Special Concern from vessel traffic.

Routine OCS activities potentially affecting the coastal portions of Areas of Special Concern include placement of structures, pipeline landfalls, operational discharges and wastes, and vessel and aircraft traffic. Potentially affected NPs, NFs, NERRs, and NWRs are shown in Figure 3.3.9-1. Onshore oil facilities are permissible only on private acreage within NP lands. All of the NPs, National Monuments, and national wildlife refuges contain privately held acreage, and development of onshore oil support facilities is possible in these areas. However, it is assumed that pipeline landfalls, shore bases, and waste facilities would not be located within onshore state and Federal parks, lands and preserves because of the special status and protections afforded these areas. Consequently, there would be no direct impacts from these activities on any NPs or NWRs in the Proposed Lease Sale Area. Existing support services and facilities are expected to be used to support activities under the Proposed Action. New facilities and pipeline landfalls would be built, or existing facilities expanded, only where necessary in the proposed Lease Sale Area. It is assumed that new onshore facilities, structures, and pipeline landfalls would be subject to additional evaluations under NEPA and that they would be sited to avoid NPs and NWRs and to limit impacts on estuarine and coastal habitats, resulting in negligible additive impacts.

Routine vessel-associated discharges that could directly affect coastal water quality and indirectly affect Areas of Special Concern in coastal areas are regulated by state-issued or Federal NPDES permits specifically for coastal areas. Operational discharge of drilling fluid, cuttings, and produced water will not occur in coastal waters of the Cook Inlet Planning Area under the Proposed Action, and impacts to coastal Areas of Special Concern will be avoided, resulting in negligible additive cumulative impacts.

Dredging activities in relation to maintenance and expansion activities and the disposal of dredged materials would reduce water quality within the areas of these activities through siltation and increased turbidity in the water column. The impacts related to the potential dredging operation in Anchor Point, Kenia, and Homer could have negative impacts on the water quality near the northern extent of the Proposed Lease Sale Area. Dredging activities and water quality issues from Port MacKenzie, Port of Anchorage, Tyonek, and Nikiski likely would not affect the water quality within the Proposed Lease Sale Area. Turbidity siltation effects from the dredging operations in these ports would be negligible when considering the size of the ports and distance from the Proposed Lease Sale Area.

The impacts due to commercial and sport fishing in Cook Inlet are correlated with the debris and waste left by fishers and commercial vessels and the impacts related to fuel and fuel oil discharged from vessels operated by individuals, guides, charter boats, and commercial vessels. Other impacts may be related to coastal impacts from vessel disturbing the seafloor, creating prop scares within eelgrass beds, damaging the kelp canopy, and anchoring within or on the outer margins of marsh habitat. Commercial fishing activities such as trawling and clam dredging can impact and greatly disturb the seafloor. In considering the limited areas to be impacted by the proposed exploration and development activities within Cook Inlet and the impacts generated by fishing activities the cumulative effects from the Proposed Action, Lease Sale 244 is not expected to contribute to these adverse effects.

Under the Proposed Action, coastal Areas of Special Concern (i.e., NPs, NFs, NWRs, and NERRs) could be exposed to oil accidentally released from platforms, pipelines, and vessels over the next 40 years, and spills could result in accidental oil releases from a variety of non-OCS-related activities, including domestic transportation of oil, importing foreign crude oil, and development of oil production under state programs. Impacts to coastal Areas of Special Concern could result from oiling of the shoreline and mechanical damage during the cleanup process. In addition, natural seepage of oil along the western coastal areas of the inlet may occur (ADNR, 2014a). BOEM has estimated 450 small crude and refined oil spills could occur during the 33-year oil and natural gas production period, an average of 13 spills per year over the lifetime of the Proposed Action (Section 4.3.18.5). Small spills would be diluted and degraded by natural processes and are not likely to affect coastal areas. Oil spills in ice-covered waters during winter months generally are contained within a much smaller area (compared to spills in open water) because weathering (i.e., spreading, evaporation, and migration) is much slower and some oil may solidify. While such factors have proven to be favorable for most response strategies, the presence of ice can complicate response efforts. Oil from spills that becomes trapped under ice will result in localized degradation of water and sediment quality and persist in the environment (Buist et al., 2008; Payne, McNabb, and Clayton, 1991). Based on the estimated number of small spills and the relatively small quantities of oil to be spilled, the impacts generated by the exploration and development activities from the Proposed Action are estimated to result in negligible additive and synergistic adverse impacts.

The majority of reasonably foreseeable spills associated with the Proposed Action are estimated to be <50 bbl, but a large spill, although unlikely to occur, is analyzed to determine the potential impacts

(Appendix A). The magnitude of impacts would depend on the specific location affected, and the nature and magnitude of the accident, but could represent a substantial component of the overall exposure of Areas of Special Concern in Cook Inlet. This is primarily due to the potential of severe oiling of coastlines of Areas of Special Concern. Similar large spills could occur from state oil and gas activities and future OCS lease sales. Overall, accidental large spills as a result of the Proposed Action could result in major incremental and additive impacts to Areas of Special Concern.

5.2.18.4. Conclusion

Areas of Special Concern in the proposed Lease Sale Area would be affected by various activities associated with the program over the next 40 years and activities resulting from ongoing lease activities. These include marine vessel traffic related discharges, operational discharges, seafloor- and land-disturbing activities, and accidental oil spills. In addition to OCS activities, non-OCS activities that could affect Areas of Special Concern include marine vessel traffic (and wakes), tankering, oil and gas activities in state waters, municipal and industrial wastewater discharges, dredging operations, marine debris, impacts from fishing, accidental spills, and climate change. Due to existing protections, it is anticipated that the impacts to coastal Areas of Special Concern would be minimized. Development of OCS onshore facilities within these areas is considered unlikely, making impacts from onshore activities in the Proposed Action unlikely. Impacts could include an additive effect on shoreline erosion due to increased vessel traffic in inshore waters. Accidental spills that may occur during the Proposed Action could result in a moderate incremental contribution to cumulative impacts on Areas of Special Concern, depending on spill frequency, location, and volume; the type of product spilled; weather conditions; effectiveness of cleanup operations; impacts related to removal and remediation of oil spills and other environmental conditions at the time of the spill. A large spill (≥1,000 bbl) resulting from any of these activities and affected by synergistic or magnifying factors described could result in major impacts to the Cook Inlet Areas of Special Concern. Overall, the incremental contribution of the Proposed Action to effects on Areas of Special Concern is expected to be minor.

5.2.19. Oil and Gas and Related Infrastructure

Cumulative impacts on oil and gas and related infrastructure will result from the incremental impacts of the Proposed Action (analyzed in Section 4.3.19) when added to impacts from the ongoing and reasonably foreseeable future activities described in Section 5.1.2.

5.2.19.1. Summary of Direct and Indirect Effects

Overall, the effects of routine activities from the Proposed Action on oil and gas and related infrastructure would be negligible. Impacts from small spills on oil and gas and related infrastructure would be negligible due to the high-energy environment of Cook Inlet resulting in small spills being rapidly diluted and dispersed. A large spill could result in minor impacts to oil and gas and related infrastructure, primarily due to temporary area closures as a result of spill cleanup operations that could impact supply vessels rigs, or other infrastructure in Cook Inlet. A detailed discussion on estimated direct and indirect impacts to oil and gas and related infrastructure from the Proposed Action can be found in Section 4.3.19.

5.2.19.2. Other Relevant Activities that Could Affect Oil and Gas and Related Infrastructure

Activities considered under the cumulative effects analysis that may impact oil and gas and related infrastructure include oil and gas activities (non-Lease Sale 244), renewable energy projects, submarine cable projects, dredging and marine disposal, and fishing activities (Table 5.2.19-1).

Table 5.2.19-1. Activities that may Adversely Affect Oil and Gas Related Infrastructure.

Activity	Potential Types of Effects
Oil and Gas activities (non-Lease Sale 244)	Seafloor disturbance accidental spills
Marine transportation	Accidental spills
Renewable energy projects	Seafloor disturbance, accidental spills
Submarine cable projects	Seafloor disturbance
Dredging and marine disposal	Seafloor disturbance, accidental spills
Fishing activities	Accidental spills

Renewable energy in Cook Inlet is currently limited to the Fire Island Wind Project located 4.8 km (3 nmi) offshore Anchorage. Additional wind energy projects are likely in Cook Inlet over the next 40 years. Further, with the second highest tidal range in North America, Cook Inlet is recognized as having potential to develop tidal energy sources. One such project that has been proposed since 2012 is the Turnagain Arm Tidal Energy Project, described in Section 5.1.2.2. Depending on crude oil prices, both wind and tidal renewable energy projects could become economically and politically viable to the point that they replace some of the current hydrocarbon production, thereby impacting associated infrastructure.

Marine transportation and associated oil spills could impact oil and gas and related infrastructure due to the risk of vessel collisions or accidents. Such collisions and any resulting oil spill could cause impacts to existing oil and gas and related infrastructure through direct damage from collisions with structures or support vessels, or through area closures for cleanup operations, which could impede certain oil and gas-related activities. Future port and terminal expansions could have impacts on oil and gas and related infrastructure. During the construction phase, impacts associated with vessel movements and logistics services could occur, but these impacts should be small in scale and of short duration.

5.2.19.3. Analysis of Cumulative Effects

Seafloor disturbance and habitat alteration occurring under the Proposed Action will result from drilling wells and placing anchors, nodes, cables, sensors, pipelines, and other equipment on the seafloor. Within Cook Inlet, two to three platforms and one onshore and two offshore oil pipelines and one onshore and three offshore gas pipelines would be installed under the Proposed Action. There are 17 existing platforms in Cook Inlet and additional structures are anticipated in the foreseeable future that could result in bottom disturbing activities and could impact existing pipelines, submarine cables, or other oil and gas and related infrastructure. Other activities that could impact oil and gas and related infrastructure by means of seafloor disturbance include oil and gas activities (non-Lease Sale 244), future OCS lease sales, the expansion of renewable energy projects, submarine cable projects, dredging and marine disposal, and fishing activities. The amount of seafloor disturbance estimated to occur under the Proposed Action will result in a minor additive increase in impacts to oil and gas and related infrastructure since the impacts will be geographically and temporally separated from impacts from other activities in the Proposed Lease Sale Area. Authorizations for activities occurring under the Proposed Action will include guidance to perform shallow hazard evaluations for OCS exploration and development drilling “Shallow Hazards Survey and Evaluation for OCS Exploration and Development Drilling” (NTL 2005-A01). BOEM guidance will mitigate potential impacts to oil and gas and related infrastructure and guidance to perform accurate and compliant pipeline rights-of-way shallow hazards geophysical evaluations, surveys, and reporting procedures for the Alaska OCS Region “Shallow Hazards Survey and Evaluation for Alaska OCS Pipeline Routes and Rights-of-Way” (NTL 2005 A-02).

Accidental spills could impact oil and gas and related infrastructure through exposure to oil accidentally released from platforms, pipelines, and marine vessels. Routine activities at existing oil and gas facilities could be affected if spills resulted in area closures. The magnitude of impacts on oil and gas and related infrastructure from accidental oil spills under the Proposed Action would depend on the specific location affected, and the nature and magnitude of the accident. Similar spills could occur from state oil and gas activities and future OCS lease sales. Overall, accidental spills as a result of the Proposed Action are expected to have minor incremental impacts from small spills and major incremental impacts from large spills on oil and gas activities and related infrastructure.

5.2.19.4. Conclusion

Existing oil and gas and related infrastructure could be impacted by bottom disturbing activities or a large accidental spill associated with the Proposed Action. Oil and gas and related infrastructure could also be similarly impacted by other activities, including oil and gas activities (non-Lease Sale 244), future OCS lease sales, the expansion of renewable energy projects, submarine cable projects, dredging and marine disposal, and fishing activities. Incremental contributions from the Proposed Action would result in a minor increase in impacts to oil and gas and related infrastructure because impacts are expected to be localized and short-term and temporally separated from impacts occurring from other activities in the Proposed Lease Sale Area.

5.2.20. Environmental Justice

Cumulative impacts on environmental justice communities will result from the incremental impacts of the Proposed Action (analyzed in Section 4.3.20) when added to impacts from the ongoing and reasonably foreseeable future activities, such as future OCS lease sales, described in Section 5.1.2.

5.2.20.1. Summary of Direct and Indirect Effects

Effects on environmental justice communities from large spills associated with the Proposed Action and alternative actions are analyzed in detail in Section 4.3.20.

Anticipated major effects from large oil spills would most likely produce disproportionately high and adverse impacts on environmental justice communities because of their reliance on subsistence foods and because effects of large oil spills to subsistence harvest patterns and sociocultural systems are expected to be adverse and severe, and thus major. Oil-spill contamination of subsistence foods and adverse effects to community well-being from distress and disruptions to social patterns and community cohesiveness are the main concerns regarding potential effects on human health for environmental justice communities. Impacts of large spills to public and community health are expected to be adverse, long lasting, and widespread, and thus moderate for the Kenai Peninsula Borough as a whole. The moderate effects of large spills on public and community health are expected to be disproportionately high and adverse for environmental justice communities due to contamination and perceived contamination of subsistence foods and related psychological stress.

The likelihood of a large spill occurring and affecting subsistence resources and harvest areas is relatively small; nevertheless, in the event that a large oil spill occurred and contaminated essential subsistence resources and harvest areas, disproportionately high and adverse effects could occur when impacts from contamination of the shoreline, tainting concerns, response and cleanup disturbance, climate change, and disruption of subsistence practices are factored together. A large spill is expected to have disproportionately high and adverse effects on Alaskan Native peoples living in environmental justice communities contacted by a large spill.

5.2.20.2. Other Relevant Activities that Could Affect Environmental Justice

Other activities that could affect environmental justice communities in the Cook Inlet area during the 40-year time period of the Proposed Action are described in Section 5.1.2. Categories of activities considered for the cumulative effects analysis are listed in Table 5.1.2-1 and described in Section

5.1.2. The locations of many of these projects and activities are shown in Figure 5.1.2-1. The activities identified in Table 5.2.20-1 include other past, present, and reasonably foreseeable future actions most likely to have adverse impacts on environmental justice communities.

Table 5.2.20-1. Other Relevant Activities that Could Affect Environmental Justice Communities.

Activity	Potential Types of Effects
Oil and gas activities (non-Lease Sale 244)	Air pollutant emissions Vessel traffic Accidental spills
Marine vessel traffic	Fuel spills Disturbance of onshore and marine wildlife
Ports and terminals	Coastal habitat disturbance, erosion and sedimentation Air pollutant emissions Physical presence of docks Accidental spills during construction or port operations
Climate change	Changes in food availability Habitat alteration

Other sources of impacts to environmental justice communities include: oil and gas activities in state waters, future lease sales in the OCS, marine transportation, ports and terminals, and climate change. Large oil spills are anticipated to have the greatest impacts on environmental justice communities because they are more dependent on wild food production and distribution than predominantly nonminority communities.

Oil and gas exploration and development has occurred onshore and in state waters of upper Cook Inlet over the past 50 years. Current infrastructure in upper Cook Inlet includes 17 offshore platforms in state waters, associated oil and gas pipelines, and onshore processing and support facilities. A total of 1,106 wells have been drilled in the course of exploration and development activities in Cook Inlet; 433 wells are classified as plugged and abandoned (ADNR, 2015a). Under the Proposed Action, it is anticipated that as many as 76 exploration and production wells will be drilled with the installation of two to three platforms. A key assumption upon which the Proposed Action is based is that the existing onshore infrastructure serving the proposed Lease Sale 244 area has sufficient capabilities to support future production from the Proposed Action without requiring major expansion efforts or modifications. If this is not the case and onshore support facilities need to be further developed as part of the Proposed Action, impacts to environmental justice communities could occur from such development.

The categories of marine transportation and ports and terminals include activities of a similar nature to the Proposed Action. Most vessel traffic in Cook Inlet moves along north-south transit lines, with deep-draft vessels generally using the east side of the inlet. Eighty percent of large ship operations were made by only 15 vessels that regularly call at Homer, Nikiski, or Anchorage (Cape International Inc., 2012). The Port of Anchorage is planning a modernization project that will increase the harbor depth from 10.7 m (35 ft) to 13.7 m (45 ft), enabling the port to accommodate larger ships. The level of vessel traffic expected during the 40-year life of the Proposed Action would be minimal compared to overall vessel traffic in Cook Inlet and would not be expected to have any disproportionately high and adverse impact on environmental justice communities.

Climate change is a regionally and globally relevant issue. During the past 60 years, data indicate that Alaska has warmed more than twice as fast as the rest of the U.S. (Stewart et al., 2013). Climate change may result in impacts to environmental justice communities through increasing air and water temperatures, sea level rise, and ocean acidification. While the effects of climate change will be long-term, the effects that would occur in the life of the Proposed Action are not expected to impact environmental justice communities.

5.2.20.3. Analysis of Cumulative Effects

Cumulative effects to environmental justice communities could occur as a result of impacts to subsistence harvest activities, which depend on fish, wildlife, habitats, and economic factors. Potential cumulative effects from O&G activities on the area's fish, wildlife, and habitats could affect subsistence uses. Potential cumulative effects to these resources are discussed in preceding sections. Potential cumulative effects on subsistence harvest patterns, which are important to low income and minority communities, are discussed in Section 5.2.12.

A large oil spill could decrease resource availability and accessibility, and create or increase concerns about food safety, which could result in severe effects on subsistence harvesters that could linger for many years. Subsistence harvests of fish and wildlife by residents of rural Alaska Native communities and by residents in larger rural communities declined by as much as 70% after the 1989 Exxon Valdez Oil Spill (Fall and Utermohle, 1999). However, within 2 years of the spill, subsistence harvests and participation had returned to pre-spill levels, although communities closest to the spill lagged behind. Changes did result, including a reduction in the availability of many species, opportunities to teach subsistence skills to young people were lost, and concerns remained about food safety (Fall and Utermohle, 1999).

The number of estimated accidental oil spills in Cook Inlet associated with the Proposed Action would represent an increase over the number of estimated spills from ongoing and future OCS programs and non-OCS program activities. The incremental increase in adverse impacts to environmental justice communities from estimated small spills would be minor. The incremental increase in adverse impacts to environmental justice communities from an estimated large spill could be disproportionately high and adverse if they disrupt subsistence activities, make subsistence resources unavailable or undesirable for use, or only available in greatly reduced numbers for a substantial portion of a subsistence season.

While the effects of climate change will be long-term, the Proposed Action is estimated to make a negligible contribution, and the effects that would occur in the life of the Proposed Action are not estimated to impact environmental justice communities.

5.2.20.4. Conclusion

The incremental increase in adverse impacts to environmental justice communities from an estimated large spill could be disproportionately high and adverse if they disrupt subsistence activities, make subsistence resources unavailable or undesirable for use, or only available in greatly reduced numbers for a substantial portion of a subsistence season. The cumulative impacts of the Proposed Action are additive, these cumulative impacts are not interactive with other actions, and therefore are neither synergistic nor countervailing.

Chapter 6

Consultation and Coordination

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Chapter 6. CONSULTATION AND COORDINATION

6.1. Development of the Proposed Action and Environmental Impact Statement

On March 27, 2012, BOEM issued a RFI for Lease Sale 244 (77 *FR* 18260) to determine the level of industry interest and whether that interest is focused on a few blocks or prospects or on a larger portion of the planning area. After determining that there was sufficient interest from industry, BOEM decided to continue with the lease sale process. In August 2012, the Secretary of the Interior issued the Final OCS Oil and Gas Leasing Program for 2012-2017. That document presented USDOI's decision to schedule a sale in the Cook Inlet OCS Planning Area. BOEM identified the area for the proposed lease sale and issued its decision on November 27, 2013 (Orr, 2013).

6.1.1. Scoping

The NEPA process began with the NOI to prepare an EIS for the proposed Cook Inlet OCS Lease Sale 244, published in the Federal Register on October 23, 2014 (79 *FR* 63437), enabling BOEM to proceed with the pre-sale process. The NOI served to announce the beginning of the scoping process designed to identify issues and concerns related to the proposed lease sale. The NOI also provided information regarding the five public scoping meetings held during the comment period.

The purpose of the public meetings was to solicit comments on the scope of the EIS, identify issues to be analyzed, and identify possible alternatives and mitigation measures. In addition to accepting oral and written comments at meetings, BOEM accepted written comments by mail and through www.regulations.gov. The public comment period closed on December 8, 2014. BOEM received a total of 26 written comment forms. Of those, three were from Federal Government agencies, three from environmental groups, two from Alaska Native tribes or tribal associations, one from other organizations, and 17 from individuals.

Many issues and mitigating measures suggested for the previous Cook Inlet Planning Area lease sale remained relevant to this proposed lease sale. All of the information received has been considered in preparing this Draft EIS. Information regarding scoping can be found on the BOEM Lease Sale 244 website.

6.1.2. Draft Environmental Impact Statement

The Draft EIS evaluates potential impacts from the Proposed Action and alternatives, utilizing information received during the scoping process. Following issuance of the Draft EIS, BOEM will, in accordance with 30 CFR 556.26, hold public hearings to solicit comments on the document. An announcement of the dates, times, and locations of the public hearings are included in the Notice of Availability for the Draft EIS. A copy of the public hearing notice is included with the Draft EIS mailed to the parties listed in **Section 6.4**, posted on the BOEM website, and published in local newspapers.

6.1.3. Final Environmental Impact Statement

When the public comment period ends, all comments will be reviewed and responses to each will be developed. The Final EIS will then be prepared, incorporating relevant changes resulting from comments. All comments and corresponding responses will be included as an appendix to the Final EIS. The Final EIS will then be distributed to the public.

6.1.4. Record of Decision

A ROD will be issued no less than 30 days after the Final EIS is made available and a NOA is published in the Federal Register. The ROD will be a concise summary of the decision made by BOEM from the alternatives presented in the Final EIS. The ROD will state the decision and rationale for the decision.

The ROD also will describe the implementation of any measures intended to avoid effects from the chosen alternative. Once the ROD is published, public involvement in the EIS process is considered complete.

6.2. Consultation

BOEM has engaged, or will engage, in a number of consultation and coordination processes with Alaska Native tribes, ANCSA Corporations, and Federal regulatory agencies regarding the proposed Lease Sale 244. Below is a brief summary of how BOEM is satisfying its responsibilities under various Federal regulatory processes and Executive Orders.

6.2.1. Tribal Consultation

Executive Order (E.O.) 13175 established regular and meaningful consultation and collaboration with tribal officials in the development of Federal policies that have tribal implications, to strengthen the United States government-to-government relationships with Indian tribes (to include Alaska Native tribes and communities) and reduce the imposition of unfunded mandates upon Indian tribes when developing Federal policies with tribal implications. The order requires the head of each agency to designate an official "with principal responsibility for the agency's implementation" of the order.

Since implementation of E.O. 13175, the USDOI has established a Tribal Consultation Policy. Secretarial Order 3317 updated the USDOI's policy on consultation with Indian tribes in compliance with E.O. 13175. In summary, Secretarial Order 3317 states that USDOl officials must demonstrate a meaningful commitment to consultation "by identifying and involving Tribal representatives in a meaningful way early in the planning process," and that consultation aims to create effective collaboration emphasizing "trust, respect, and shared responsibility...".

Consistent with E.O. 13175 and implementing USDOI directives, BOEM already has met with the local Tribal Governments of Seldovia, Nanwalek, and Port Graham. Government-to-Government meetings also were held with the Seldovia Village Tribe and Nanwalek Village Tribe, and by teleconference with the Port Graham Tribal Council.

BOEM initiated Government-to-Government tribal consultations by delivering letters to Tribes whose members could be affected by activities related to the proposed Lease Sale, including:

- Ninilchik
- Kenai
- Nikiski
- Eklutna
- Tyonek
- Chickaloon
- Kodiak
- Old Harbor
- Ouzinkie

6.2.2. Government to ANCSA Corporation Consultation

On August 10, 2012, the USDOI issued the Policy on Consultation with ANCSA Corporations. In this policy, USDOI restated a provision of ANCSA requiring that "[t]he Director of the Office of Management and Budget [and all Federal agencies] shall hereafter consult with Alaska Native corporations on the same basis as Indian tribes under E.O. 13175." Additionally, the policy “distinguishes the Federal relationship to ANCSA corporations from the government-to-government relationship between the Federal Government and federally recognized Indian Tribes... and [states that] this Policy will not diminish in any way that relationship...”. The possibility for a Cook Inlet Sale 244 requires BOEM to consult with the affected Tribes and communities (including local and regional governments) and with the ANCSA corporations.

BOEM initiated the Government-to-ANCSA corporation consultations through letters to ANCSA corporations potentially affected by activities related to the proposed Lease Sale, including:

- English Bay Corporation
- Port Graham Corporation
- Kenai Natives Association, Incorporated
- Ninilchik Natives Association, Inc.
- Chickaloon-Moose Creek Native Association, Incorporated
- Salamatof Native Association, Incorporated
- Eklutna, Inc.
- Seldovia Native Association, Incorporated
- Tyonek Native Corporation
- Natives of Kodiak, Incorporated
- Leisnoi, Inc.
- Old Harbor Native Corporation
- Ouzinkie Native Corporation

6.2.3. Endangered Species Act Section 7 Consultation

The Endangered Species Act (ESA; 16 U.S.C. § 1531), provides a program for the conservation of threatened and endangered plants and animals and the ecosystems on which they depend. Section 7(a)(2) of the 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.With respect to this proposed lease sale, BOEM is consulting with USFWS and NMFS (the “Services”) for listed species. For ESA consultation on proposed lease sales in Alaska, BOEM and BSEE specifically request incremental Section 7 consultations. 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 BO for each step. Accordingly, at the lease-sale stage (see Figure 1.3.1-1 in Chapter 1 for an illustration of the four stages in OCSLA), BOEM evaluates 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. BOEM and BSEE would then reinitiate consultation for any proposed development and production activities.

6.2.4. Essential Fish Habitat Consultation

The Magnuson-Stevens Fishery Conservation and Management Act (as amended) requires Federal agencies to consult with NMFS regarding actions that may adversely affect designated Essential Fish Habitat (EFH). BOEM is currently preparing an EFH assessment that will identify any adverse effects to designated EFH from potential oil and gas exploration activities in the proposed Lease Sale Area. This assessment will be provided to NMFS prior to releasing a Final EIS.

6.2.5. Section 106, National Historic Preservation Act Consultation

Section 106 of the NHPA (36 CFR part 800), “Protection of Historic Properties,” as amended through 2004, requires that Federal agencies having direct or indirect jurisdiction over a proposed Federal, federally assisted, or federally licensed undertaking, prior to approval of the expenditure of funds or the issuance of a license, take into account the effect of the undertaking on any district, site, building, structure, or object included in or eligible for inclusion in the National Register of Historic Places (NRHP). The Advisory Council on Historic Preservation (ACHP), which administers Section 106, has issued regulations (36 CFR part 800) defining how Federal agencies are to meet the statutory responsibilities. The head of a Federal agency shall afford the ACHP a reasonable opportunity to review and comment on an action.

BOEM and BSEE have instituted procedures to optimize the likelihood that authorized OCS activities contribute to the preservation and enhancement of historic properties and archaeological resources. BOEM and BSEE have published guidelines (NTL 2000-A03 (superseded by NTL 2005-A03)) for performing archaeological surveys on the Alaskan OCS.

BOEM recognizes that a lease sale constitutes an undertaking under Sec.106 of the NHPA but is not the type of activity that has the potential to cause effects on historic properties, and thus would not require formal SHPO consultation. Subsequent project- and site-specfic consultations will occur if they are a type of activity that has the potential to cause effects on historic properties for any proposed exploration, development, and production activities.

6.2.6. Coastal Zone Management Act Consistency

The federally approved Alaska Coastal Management Program (ACMP) expired on June 30, 2011. Consequently, Federal agencies are not required to provide the State of Alaska with CZMA Consistency Determinations or Negative Determinations pursuant to 16 U.S.C. § 1456(c)(1) and (2), and 15 CFR part 930, subpart C (76 *FR* 39857, July 7, 2011).

6.3. Cooperating Agencies

BOEM is the lead agency for the preparation of this EIS. Following the guidelines at 40 CFR 1501.6 and 1508.5 from the CEQ, BOEM invited qualified government entities to become cooperating agencies for the preparation of the proposed Lease Sale 244 EIS. The National Parks Service (NPS) participated as a formal cooperating agency on the Draft EIS. Other key agencies that provided input included the Bureau of Safety and Environmental Enforcement (BSEE), the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), U.S. Army Corps of Engineers (USACE), U.S. Coast Guard (USCG), U.S. Environmental Protection Agency (USEPA), and the State of Alaska's Governor's office. BOEM will continue to coordinate with other Federal and state agencies throughout the NEPA process.

6.4. Distribution of the Draft Environmental Impact Statement

The following is a list of Federal, State, Tribal, and local government agencies; academic institutions; members of the oil and gas industry, corporations, other organizations, and libraries who received a printed or CD copy of the Draft EIS. All others on BOEM's mailing list were notified by a post card regarding how to obtain a copy.

Table 6-1. Organizations, Entities, and Individuals Who Received Physical Copies of the Draft EIS.

Federal - Executive Branch	
Bureau of Indian Affairs - Regional Director, Anchorage	**Department of Defense** - US Army Corps of Engineers
Bureau of Land Management - Alaska State Director; Anchorage District Office	**Department of Homeland Security** - US Coast Guard, Anchorage, AK
Bureau of Ocean Energy Management - Regional Directors for the Gulf of Mexico and Pacific OCS Region	**Department of the Interior** - Office of Environmental Policy & Compliance, Anchorage, AK; Special Assistant to the Secretary of the Interior, Anchorage, AK
Bureau of Safety & Environmental Enforcement - Regional Director, Alaska; Environmental Enforcement Division, Anchorage AK	**National Park Service** - Regional Director; Superintendent, Katmai National Park and Preserve
Department of Commerce - National Oceanic and Atmospheric Administration; National Marine Fisheries Service - Alaska Regional Office, Regional Administrator; Resource Ecology & Fisheries Mgmt; National Ocean Service, Policy, Planning & Analysis Division; Office of Response & Restoration; Scientific Support Coordinator for Alaska; NEPA Coordination & Compliance; Alaska Fisheries Science Center - National Marine Mammal Lab; Emergency Response Division; Auke Bay Laboratory	**US Geological Survey** - Regional Director; Director, Alaska Science Center
	US Fish & Wildlife Service – Headquarters; Director, Region 7; Chief, Endangered Species Branch; Assistant Regional Director, Subsistence, and Fisheries and Habitat Conservation; Migratory Bird Management, Endangered Species Branch; Kodiak National Wildlife Refuge
Federal - Legislative Branch	
Honorable Daniel Sullivan, Senator	Honorable Lisa Murkowski, Senator
Honorable Don Young, House Representative	

Federal - Administrative Agencies and Other Agencies	
Environmental Protection Agency - Alaska Operations Office	North Pacific Fisheries Management Council
Marine Mammal Commission	
State of Alaska	
Office of the Governor, Juneau, AK; Policy Director, Special Counsel Associate Director State-Federal Relations, Washington, DC; Office of Management and Budget, Division of Governmental Coordination;	**Dept of Fish & Game** - Wildlife Conservation Division; Subsistence Division; Region II, H & R Chief; Division of Sport Fish
Dept of Community & Regional Affairs - Commissioner	**Dept of Natural Resources** - Commissioner; Office of Project Management & Permitting; Director, Division of Oil & Gas; Citizens' Advisory Commission on Federal Areas
Dept Of Environmental Conservation - Northern Alaska District Office; Division of Water; Anchorage District Office	**State Pipeline Coordinator**, Joint Pipeline Office, Anchorage, AK
Tribal Governments	
Native Village of Chickaloon	Native Village of Ninilchik
Native Village of Kenaitze	Native Village of Port Graham
Native Village of Knik	Native Village of Seldovia
Native Village of Nanwalek	Native Village of Tyonek
Alaska Native Associations and Corporations	
Afognak Native Corporation	English Bay Native Corporation
Alaska Federation of Natives	Koniag, Inc.
Chugach Alaska Corporation	Ninilchik Traditional Council
Chugach Development Corporation	Ouzinkie Native Corporation
Chugachmuit	Port Graham Corporation
Cook Inlet Regional Corporation	Seldovia native Association, Inc.
Cook Inlet Tribal Council	Tyonek Native Corporation
Local Governments	
Anchor Point Chamber of Commerce	City of Seldovia
City of Homer	Kenai Peninsula Borough
City of Kachemak	Ninilchik Chamber of Commerce
City of Kenai	

6.5. Preparers, Reviewers and Supporting Staff

Table 6.-2 lists the primary individuals involved, their professional position, and their role in preparing and reviewing the EIS.

Table 6-2. List of the Primary Individuals Contributing to Development and Analysis in the Draft EIS.

Name	Education/Expertise	Contribution
CSA Ocean Sciences Inc.		
William R. Sloger, Jr.	M.S., Environmental Studies; M.S., Civil Engineering; B.S., Civil Engineering; 25 years of experience	Project Manager, Co-Author Chapters 1, 3, 4, and 6
Robert (Bo) Douglas	B.S., Civil Engineering; B.S., Marine Biology; 25 years of experience	Deputy Project Manager, Co-Author Chapters 2 and 3
Neal Phillips	Ph.D., Ecology; M.S., Marine Studies; B.A., Biological Sciences; 38 years of experience	Author Chapter 2, Co-Author Chapter 5, Science Editor
John Tiggelaar	M.S., Biology; B.A., Biology; 7 years of experience	Co-Author Chapters 2, 4, and 5, Science Editor
Jodi Harney	Ph.D., Geology and Geophysics; M.S., Marine Science; B.S., Biology; 20 years of experience	OSRA/Spill Coordinator, Chapter 5 Co-Author, Science Editor
Mary Jo Barkaszi	M.S., Biological Oceanography; B.S., Biology; 29 years of experience	Co-Author Chapters 3, 4, and 5 (Marine Acoustics)
Jeff Martin	B.S., Applied Mathematics; 5 years of experience	Project Data Management, Science Editor

Name	Education/Expertise	Contribution
Brian Balcom	M.S., Biology; B.S., Biological Sciences; 39 years of experience	Science Editor
Robert B. Cady	M.S., Oceanography; B.S., Marine Biology; 15 years of experience	Co-Author Chapters 3, 4, and 5 (Marine and Coastal Birds, Lower Trophic Organisms)
Tony Martin	M.S., Biology; B.S., Marine Biology; 22 years of experience	Co-Author Chapters 3, 4, and 5 (Areas of Special Concern), Science Editor
Ben Harkanson	M.S., Marine Biology; B.S., Biology; 16 years of experience	Co-Author Chapters 3, 4, and 5 (Terrestrial Mammals)
Kim Olsen	B.S., Oceanographic Technology; 31 years of experience	Science Editor
David B. Snyder	M.S., Marine Biology and Ichthyology; B.S., Zoology; 27 years of experience	Author EFH Appendix
Patrick W. Connelly	M.S., Biology; B.A., Biology; 12 years of experience	Co-Author Chapter 3 (Areas of Special Concern)
Mark S. Fonseca	Ph.D., Integrative Biology; M.S., Environmental Sciences; B.S., Resource Development; 38 years of experience	Science Editor
Jeffrey Landgraf	M.S., Marine Biology; B.S., Marine and Field Biology; 13 years of experience	Co-Author Chapter 5
Ashley A. Pittman	B.S., Marine Biology; B.S., Anthropology; 5 years of experience	Biological Assessment
Virginia DeLong	20 years of experience	Appendix E, Literature Cited
John Thompson	M.S., Marine Biology; B.S., Biology; 41 years of experience	Co-Author Chapter 3 (Water Quality, Physiography, Bathymetry, and Geology, and Public and Community Health)
Eddie Hughes	M.S., Oceanography: 21 years experience	Co-Author Chapters 3, 4, and 5 (Public and Community Health)
Kristen L. Metzger	M.A., Library and Information Science; B.A., Library Science/Education; 40 years of experience	Administrative Record, Librarian
Melanie L. Cahill	B.S., Marine Sciences; 10 years of experience	Data Management, Document Management
Stephanie Urquhart	5 years of experience	Support Services Manager
Deborah Murray	5 years of experience	Document Processor
Tammy Johnson	1 year of experience	Document Processor
Kim Dunleavy	A.A.S., Electrical Engineering; 26 years of experience	Technical Editor
Sarah Franklin	M.A., Geography; M.S., Natural Resources Ecology & Management; B.S., Ecology; 9 years of related experience, GISP	GIS Analyst
Brent Gore	M.A., Geography; B.A., Geography; 7 years of experience	GIS Technician
Brian Diunizio	B.S., Biology; 2 years of related experience	GIS Technician
Dustin Myers	B.S., Marine Biology; 2 years of related experience	GIS Technician
Southeastern Archaeological Research, Inc. (SEARCH)		
Raymond Tubby	M.A., Maritime History; B.A., Anthropology; 14 years of experience	Co-Author Chapters 3, 4, and 5 (Archaeological Resources)
Leah Colombo	M.A. Maritime Archaeology, B.A. Marine Geology; 7 years of experience	Co-author Chapter 3 (Archaeological Resources)
ESS Group, Inc.		
Mike Feinblatt	B.S., Mechanical Engineering; 24 years of experience	Co-Author Chapters 3, 4, and 5 (Air Quality), and Appendix C

Name	Education/Expertise	Contribution
Gordon Perkins	B.L.A., Landscape Architecture, A.A.; 15 years of experience	Co-Author Chapters 3, 4, and 5 (Visual Resources)
Mike Ernsting	B.S., Environmental Engineering; 4 years of experience	Co-Author Chapters 3, 4, and 5 (Air Quality), and Appendix C
John Purdum	B.S., Meteorology; 33 years of experience	Co-Author Appendix C
PCCI		
Frank Marcinkowski	Graduate Studies in Ocean Sciences; B.S. in Chemical Engineering; Over 30 years of experience in all aspects of environmental and regulatory support	Co-Author Chapters 3, 4, and 5 (Oil and Gas Infrastructure)
Justin Wilson	B.S. in Environmental and Agricultural Sciences; 16 years of experience	Co-Author Chapters 3, 4, and 5 (Oil and Gas Infrastructure)
Owl Ridge Natural Resources Consultants		
David Cameron	B.A. Biology; M.S. Terrestrial Ecology; 36 years of experience	Co-Author Chapters 3, 4, and 5 (Economy and Population, and Recreation and Tourism)
Michael Stanwood	M.S. Mineral Economics; B.A. Psychology; 41 years of experience	Co-Author Chapters 3, 4, and 5 (Economy and Population)
Glen Ruckhaus	B.A. Geology; 33 years of experience	Review/QA/QC Chapters 3, 4, and 5 (Economy and Population, and Recreation and Tourism)
Roger Marks	B.S. Financial Economics; B.A. Accounting; 38 years as a petroleum economist	Co-Author Chapters 3, 4, and 5 (Economy and Population)
Northern Land Use Research Alaska		
Richard Stern	Ph.D. Anthropology; M.A. Anthropology; B.A. Anthropology; 30 years of experience	Co-Author Chapters 3, 4, and 5 (Subsistence Harvest Patterns and Sociocultural Resources)
Jason Rodgers	Ph.D. Archaeology; M.A. Marine Archaeology; 15 years of experience	Co-Author Chapters 3, 4, and 5 (Archaeological Resources)
48 North Solutions		
Jan Brandt	M.S., Urban and Regional Planning; 19 years of experience	Co-Author Chapters 3, 4, and 5 (Fish and Shellfish, Commercial Fishing, Sport Fishing)
Cam Fisher	M.S., Marine Science; 17 years of experience	Co-Author Chapters 3, 4, and 5 (Fish and Shellfish, Commercial Fishing, Sport Fishing)
Bruce Mavros	M.Sc., Zoology; 26 years of experience	Co-Author Chapters 3, 4, and 5 (Fish and Shellfish, Commercial Fishing, Sport Fishing)
Alaska Ecological Resources		
Jen Dushane Garner	Ph.D. Student Marine Biology; 9 years of experience	Co-author Chapters 3, 4, and 5 (Marine Mammals, Coastal and Estuarine Habitats)
Willow Hetrick	M.S., Natural Resources and Environmental Management; 7 years of experience	Co-author Chapters 3, 4, and 5 (Marine Mammals, Coastal and Estuarine Habitats)
Independent Individual Contractors		
Ann Isley	Ph.D., Oceanography; M.S., Oceanography; B.S., Geosciences and Modern Languages; 31 years of experience	Co-author Chapters, 3, 4, and 5 (Water Quality, Geology), Technical Editor
Luis M. Lagera, Jr.	Ph.D., Environmental Sciences (Ecology); M.S., Biological Sciences; B.S., Zoology; 20 years of experience	Chapters 3, 4, and 5 (Physiography, Bathymetry, Geology and Public and Community Health) and Chapter 5 (Water Quality), Science Editor

Name	Education/Expertise	Contribution
Pam Jones	B.S., Business Administration; 15 years of experience	Technical Editor
Natalie C. Kraft	M.E.M., Coastal Environmental Management; B.S., Marine Science/Biology; 5 years of experience	Technical Editor
Bureau of Ocean Energy Management		
Gene Augustine	Interdiciplinary Biologist	Water Quality, Coastal and Estuarine Habitats
Susan Banet	Chief, Resource Analysis Section	E&D Scenario Development
Jerry Brian	Socioeconomic Specialist	Economics
Jeffrey Brooks	Sociocultural Specialist	Sociocultural Systems, Subsistence Harvest Patterns, Public and Community Health, Environmental Justice, Recreation, Tourism, and Visual Resources, Sport and Commercial Fishing, Areas of Special Concern
Chris Campbell	Sociocultural Specialist	Archaeology
Chris Crews	Wildlife Biologist	Marine and Terrestrial Mammals
Lorena Edenfield	Fisheries Biologist	Fish and Lower Trophic Organisms
Maureen de Zeeuw	Wildlife Biologist	Birds
Melanie Hunter	NEPA Coordinator	Review
Betty Lau	Chief, Resource Evaluation Section	E&D Scenario Development
Carla Langley	Cartographic Specialist	GIS Map Production
Frances Mann	Chief, Envionmental Analysis Section II	Review
Virgilio Maisonet-Montanez	Meteorologist	Air Quality and Oceanography
Caron McKee	Project Coordinator	Project Management/Review Coordination
Sharon Randall	Chief, Environmental Analysis Secion I	Review
Virginia Raps	Meteorologist	Climate and Air Quality
Jill Marie Seymour	Wildlife Biologist	Marine Mammals
Caryn Smith	Oceanographer	Sea Ice, Hydrocarbon Release Scenarios
William Swears	Technical Writer/Editor	Document Preparation

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APPENDIX A

Accidental Spills (Oil Spills and Gas Releases Information, Models and Estimates)

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Appendix A. Accidental Oil Spills and Gas Releases

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Accidental Oil Spills and Gas Releases: Information, Models, and Estimates

BOEM analyzes hypothetical oil spills and gas releases from oil and gas activities and their relative impact to environmental, economic, and sociocultural resources and resource areas and the coastline. Each of these hypothetical spills or releases has varying potential to result from offshore oil and gas exploration, development and production in the Lease Sale 244 Action Area. BOEM makes a set of assumptions that collectively form an oil spill and gas release scenario. This consistent set of scenario information is used to formulate the potential oil spill and gas release effects from oil and gas activities in a consistent and logical manner throughout Chapters 4 and 5 of this EIS.

It is not anticipated that oil spills occur as a routine activity. Therefore, oil spills are not considered a routine impact-producing factor (IPF). Oil spills are considered accidental events, and the Clean Water Act and the Oil Pollution Act include both regulatory and liability provisions that are designed to reduce damage to natural resources from oil spills. Therefore, oil spills are treated as an accidental IPF. An accident is an unplanned event or sequence of events that results in an undesirable consequence. In this analysis the undesirable consequence is an oil spill or gas release in the environment.

This Appendix discusses the technical information used to develop the set of assumptions for purposes of oil spill or gas release analysis over the entire life of the exploration and development scenario (Scenario). The information about these accidental oil spills or gas releases includes estimates of the:

- Sources of accidental spills or gas releases that may occur
- Number of spills or releases that may occur and their chance of occurring
- Spill sizes
- Weathering and fate of spills
- Offshore locations to which large spills might travel due to the effects of winds, currents and ice
- Duration of large spill travel
- Length of coastline affected by large offshore spills
- Likelihood of one or more offshore large spills occurring and contacting locations of environmental, social or economic resources or resources areas

Oil spills are divided into two general activity categories and two general spill-size categories. These divisions reflect a difference in the ways information about the spills is derived and used. The two general activity categories considered in oil-spill analysis are:

- Exploration and delineation
- Development, production, and decommissioning

The two general spill-size categories considered in oil-spill analysis are:

- Small spills, those less than less than (<) 1,000 barrels (bbl)
- Large spills, those greater than or equal to (≥) 1,000 bbl, meaning that 1,000 bbl is the minimum threshold size for a large spill
  - A subset of large oil spills is called very large oil spills (VLOS), which are spills (≥) 120,000 bbl.

A small spill (<1,000 bbl) would not be expected to persist on the water long enough for the model to follow its path in a trajectory analysis. Therefore, for small spills, BOEM estimates the type of oil and the number and size of spill(s).

Large spills are those spills that are ≥1,000 bbl and would persist on the water long enough for the model to follow its path in a trajectory analysis. To judge the effect of a large oil spill, BOEM estimates the general source(s) of a large oil spill (such as a pipeline, platform or well), the location and size of the spill, the type and chemistry of the oil, how the oil will weather (naturally degrade in the environment), how long it will remain prior to naturally degrading, and where it may go. BOEM also estimates the mean number of large spills and the chance of one or more large spills occurring over the exploration, development, production, and decommissioning life of the Scenario. BOEM simulates the paths (trajectories) that large oil spills could take to estimate the chance of a large spill contacting a specific portion of shoreline or offshore resource area. BOEM then combines the chance of a spill contacting a portion of shoreline or resource area with the chance of one or more large spills occurring at all to estimate the chance of one or more large spills both occurring and contacting a shoreline or offshore resource area over the life of the Scenario.

Estimating large oil-spill occurrence or large oil-spill contact is an exercise in mathematical probabilities. Uncertainty exists regarding whether exploration or development will occur at all and, if it does, the location, number, and size of potential large oil spill(s) and the wind, ice, and current conditions at the time of a spill(s). Although some of the uncertainty reflects incomplete or imperfect data, a considerable amount of uncertainty exists simply because it is difficult to predict events 39 years into the future.

A VLOS is analyzed separately from large oil spills due to its lower level of probability. The technical analysis of a VLOS event is meant to assist BOEM and the Secretary of the Interior in evaluating low-probability, high-impact events. The scenario and impacts discussed for a VLOS analysis should not be confused with the scenario and impacts anticipated to result from routine activities or from accidental events related to the Proposed Action or its alternatives. This is due to the very low mathematical frequency associated with VLOS events.

In the following subsections, BOEM describes the rationale for the assumptions used in oil-spill analyses, which combine project-specific information, modeling results, statistical analysis, four decades of experience modeling hypothetical oil spills, and professional judgment. The information, models, and assumptions about large spills are discussed in Sections A-1 through A-4. Small spills are discussed in Section A-5. Gas releases and a VLOS are discussed in Section A-6 and Section A-7, respectively.

A-1. Accidental Offshore Large Oil Spills

The following discussion provides the context for the sources of oil in the sea. With the exception of rare events like the Deepwater Horizon (DWH), discharges of oil in the sea have declined over the years, even as petroleum consumption has increased (USCG, 2012a, b; USEIA, 2014). Possible causes for the decline in oil discharges include passage of the Oil Pollution Act of 1990 (OPA 90), technology improvements, and implementation of safety-management systems that implement practical risk-reduction interventions.

Between 1971 and 2013, Outer Continental Shelf (OCS) operators produced almost 18 billion barrels (Bbbl) of oil. During this period (excluding the DWH spill which is a rare event) there were 2,844 spills ≥1 barrel that totaled approximately 174,000 bbl spilled. This equals 0.001% of the total bbl of oil produced during that period, or about 1 barrel spilled for every 103,200 bbl produced. This record has improved over time. During the more recent period between 1999 and 2013, almost 8.0 Bbbl of oil were produced and there were 645 spills that totaled approximately 39,000 bbl spilled. This is equal to 0.0005% of the total of bbl of oil produced, or approximately 1 barrel spilled for every 204,700 bbl produced. For typical OCS oil spills, the record of OCS oil spills into the environment is improving.

The inclusion of rare events like the DWH spill in the record requires sophisticated analysis due to the small number of events. The U.S. Coast Guard (USCG) noted that the DWH volume is 86% of all discharges by volume recorded for U.S. waters in the preceding 37 years (USCG, 2012b), ending in 2009. These rare events are small in number and are not well handled using standard statistics such as average probabilities. Several recent papers and analyses have identified various methods for estimating the frequency of these rare events (Abimbola, Khan and Khakzad, 2014; Ji, Johnson, and Wikel, 2014; Khakzad, Khan, and Paltrinieri, 2014; USDOI, BOEM, 2016; Figure 3.3-1). The mathematical analysis of very large spills, like the DWH spill, is detailed in Section A.1.2.3.

A-1.1. Large Spill Size, Source, and Oil-Type Assumptions

Table A.1-1 shows the general size categories, source of a large spill(s), type of oil, size of spill(s) in bbl, and the total volume BOEM assumes in the analysis of oil-spill effects in Chapter 5 of this EIS for the Lease Sale 244, Alternatives 1, 3a, 3b, 3c, 4, 5, or 6.

A-1.2. OCS Large Oil-Spill Sizes

Large OCS spills have a minimum size, or threshold value, of 1,000 bbl, but the spill size could be larger. Table A.1-1 shows the assumed large spill sizes used in the effects analysis of a large OCS spill for the Sale 244 Action Area.

The large OCS spill-size assumptions BOEM uses are based on reported spills in the Gulf of Mexico and Pacific OCS because no large spills (≥1,000 bbl) have occurred on the Alaska or Atlantic OCS from oil and gas activities. BOEM uses the median OCS spill size as the likely large spill size (Anderson, Mayes, and LaBelle, 2012) because it is the most probable size for that spill-size category. The Gulf of Mexico and Pacific OCS data show that a large spill most likely would be from a pipeline or a platform. The median size of a crude oil spill ≥1,000 bbl from a pipeline on the OCS over the last 15 years is 1,720 bbl, and the average is 2,771 bbl (Anderson, Mayes, and LaBelle, 2012). The median spill size for a platform on the OCS over the entire record from 1964-2010, is 5,066 bbl, and the average is 395,500 bbl (Anderson, Mayes, and LaBelle, 2012). As previously discussed, outliers such as the DWH spill volume skew the average and the average is not a useful statistical measure. For purposes of this analysis, BOEM uses the median spill size, rounded to the nearest hundred shown below, as the likely large spill sizes for purposes of analysis:

	OCS Pipeline	OCS Platform
Assumed Large Spill Size (bbl)	1,700	5,100

A-1.2.1. Source and Type of Large Oil Spills

The source is considered the place from which a large oil spill could originate. For Cook Inlet, the sources of large spills are divided generically into production platforms, wells, and pipelines (Anderson, Mayes, and LaBelle, 2012). The places where a large spill could occur are based on the Exploration and Development Scenario (Chapter 2.4). Platform sources include spills from wells or from diesel fuel tanks located on platforms. Large offshore pipeline spills include spills from the riser and from the offshore pipeline to the shore. Large onshore pipeline spills include spills from shore to the processing facilities or distribution centers.

The types of oil spilled from platform spills are assumed to be crude oil or diesel oil. Large oil pipeline spills are assumed to be crude oil.

Crude oils vary in properties and crude oil spills behave in different ways based on their properties. A medium crude oil similar to crude oils representative of Trading Bay within the Cook Inlet Region is used for this analysis. Crude oil samples recovered from wells within Cook Inlet State waters are characterized by a range of American Petroleum Institute (API) gravity, which is a measure of how heavy or light the oil is compared to water. The crude oils in the Cook Inlet Region are estimated to range from API gravities of 20 to 40°. Given the existing information from crude oil samples recovered from Alaska state wells, BOEM chose the lower end of the range of API gravities which generally weather and degrade more slowly than higher API gravities.

A-1.2.2. Onshore Large Oil Pipeline Spills

Epstein (2002) looked at oil and gas pipeline data in the Cook Inlet watershed from 1997-2001. Epstein (2002) contains final volumes that are not included in the State of Alaska, Department of Environmental Conservation (2002a) database of initial reports. No onshore pipeline crude oil spills

≥1,000 bbl occurred during this time. There is one crude and produced water spill reported ≥1,000 bbl. Unocal's estimate of the total volume of produced fluids discharged is 228,648 gallons (5,444 bbl). Of this total volume, Unocal has estimated that approximately 95% was produced water (217,224 gallons; 5,172 bbl) and 5% was crude oil (11,424 gallons; 272 bbl) (State of Alaska, Dept. of Environmental Conservation, 1999). The Sienkiewicz and Wondzell (1992) report was deemed relatively reliable for offshore spills, but lack of reported onshore spills suggests missing data. The small number of large spills and the quality of the data make the Cook Inlet data unsuitable for quantitative estimates of spill size or frequency for large onshore spills for the entire duration of production (1957-2015).

The U.S. Department of Transportation (USDOT), Office of Pipeline Safety Research and Special Programs Administration keeps information about distribution and transmission accident and incident data online (USDOT, 2015a, b, c). The Hazardous Liquid Accident Data (2004-2013) was analyzed to estimate crude-oil spills ≥1,000 bbl for onshore pipelines. The Pipeline and Hazardous Materials Safety Administration (PHMSA) hazardous liquid incident database covering a fixed period of time was filtered by commodity type and spill volume to obtain a subset of data specific to crude oil pipeline systems. Summary statistics were generated for the 74 crude oil spills ≥1,000 bbl identified. The median crude oil-spill size is 2,540 bbl and the average is 5,325 bbl. For purposes of analysis, BOEM uses the median spill size as the likely spill size for the analysis of large onshore transmission pipeline spills adjacent to the Cook Inlet OCS. The spill size is rounded to the nearest hundred, resulting in an estimate of 2,500 bbl for an onshore pipeline spill.

A-1.2.3. Historical Loss of Well-Control Incidents on the OCS, North Sea, and Cook Inlet

USDOI, BOEMRE (2011; Appendix B; Table B-1), USDOI, BOEM, (2012a; Figure 4.3.3-1.), Bureau of Land Management (USDOI, BLM) (2012; Appendix G), IAOGP (2010), Bercha Group Inc. (2014a) and Ji, Johnson, and Wikel (2014) detail the loss of well control (LOWC) incidents on the OCS and/or North Sea, and discuss the analysis of their frequencies. The loss of well control occurrence frequencies, per well, are on the order of 10^{-3} to 10^{-6}. The occurrence frequencies depend upon the operation or activity, whether the LOWC was a blowout or well release, and whether there was oil spilled.

In general, historical data show that LOWC events escalating into blowouts and resulting in oil spills are infrequent and that those resulting in large accidental oil spills are even rarer events (Anderson, Mayes, and LaBelle, 2012; Bercha, 2014a, Izon et al. 2007, Ji, Johnson, and Wikel, 2014; Robertson et al., 2013; USDOI, BOEMRE, 2011; USDOI, BOEM, 2016). From 1964 to 2010 there were 283 well control incidents, 61 of which resulted in crude or condensate spills (USDOI, BOEM, 2012a; Table 4.3.3 1). From 1971 to 2010, fewer than 50 well control incidents occurred. Excluding the volume from the DWH spill, the total spilled volume was less than 2,000 bbl of crude or condensate. The largest of the 1971-2010 spills—other than the DWH event—being 350 bbl. The DWH event was the only VLOS to occur between 1971 and 2010 (USDOI, BOEM, 2012a). During that same time period, more than 41,800 wells were drilled on the OCS and almost 16 Bbbl of oil were produced.

Few exploration wells involve LOWC incidents and even fewer result in a spill. From 1971-2010 Industry drilled 223 exploration wells in the Pacific OCS, 46 in the Atlantic OCS, 15,138 in the Gulf of Mexico OCS, and 84 in the Alaska OCS, for a total of 15,491 exploration wells. During this period, there were 77 well control incidents associated with exploration drilling. Of those 77 well control incidents, 14 (18%) resulted in oil spills ranging from 0.5 bbl to 200 bbl, for a total 354 bbl, excluding the estimated volume from the DWH spill. These statistics show that, while approximately 15,000 exploration wells were drilled, there were a total of 15 loss-of-well-control events that resulted in a spill of any size: 14 were small spills and one was a large spill (≥1,000 bbl) that resulted from a blowout. That one large/very large spill was the DWH.

The Norwegian SINTEF Offshore Blowout Database, where risk-comparable drilling operations are analyzed and where worldwide offshore oil and gas blowouts are tracked, supports the conclusion that blowouts are rare events (IAOGP, 2010; DNV, 2010a, b; DNV, 2011). Blowout frequency analyses of the SINTEF database suggest that the highest risk operations are associated with exploration drilling in high–pressure, high-temperature conditions (DNV, 2010a, b; DNV, 2011) that are not expected to occur in the Cook Inlet Planning Area. However, as the 2010 DWH spill illustrates, there is a very small chance for a very large oil spill to occur and to result in unacceptable impacts (U.S. CSB, 2014).

The risk of an unlikely or rare event, such as a loss of well control incident, is determined using the best available historical data. The 2012-2017 Five-Year Program Final PEIS (USDOI, BOEM, 2012a) provides a detailed discussion of the OCS well control incidents and risk factors that could contribute to a long duration LOWC. Risk factors include geologic formation and hazards; water depth and hazards, geographic location (including water depth); well design and integrity; loss of well control prevention and intervention; scale and expansion; human error; containment capability; response capability; oil types and weathering/fate; and specific regional geographic considerations, including oceanography and meteorology.

Quantifying the frequency of VLOSs from a loss of well control event is challenging as relatively few large oil spills that can serve as benchmarks have occurred on the OCS (Scarlett et al., 2011). Based on an analysis of this historic data from both the 1971-2010 (the modern regulatory era) and the 1964-1971 time frames, the frequency of a loss of well control occurring and resulting in a VLOS of different volumes was determined (USDOI, BOEM, 2016, Figure 3.3-1). This analysis, which is set forth in the 2017-2022 Five-Year Program Draft PEIS, was used to calculate the frequency (per well) of a spill exceeding 120,000 bbl, which is the VLOS volume assumed for the purpose of analysis in this EIS. This frequency was determined to be $>10^{-4} – <10^{-5}$ (USDOI, BOEM, 2016, Figure 3.3-1).

The record for Cook Inlet blowouts is not validated but is presented as the best available information based on newspaper accounts and other available information. No oil spills due to blowouts were identified in either the spill data or the newspaper accounts. A minimum and perhaps a maximum of eight natural gas blowouts occurred in Cook Inlet. The following identifies the eight gas blowouts:

Date Start Date End	Location	Company	Well Name	Well Type	Medium	Kill Method	Notes	References
1962	Onshore		Beluga River 212-35	Development	Natural Gas			ADN, 2008
6/10/-7/24/1962	Offshore Middle Ground Shoal	Pan American Petroleum Corporation	Cook Inlet State No. 1	Exploration	Natural Gas			ADN, 2008, AOGCC, 2010
8/23/-10/23/1963	Offshore Middle Ground Shoal	Pan American Petroleum Corporation	Cook Inlet State 17589 No. 1	Exploration	Natural Gas	Relief Well, No. 1-A	Burned	ADN, 2008
1965	Onshore		Moquawkie No 1.	Exploration	Natural Gas	--		ADN, 2008
2/11/-3/1967	Onshore	Marathon Oil Company	Beaver Creek No. 1	Development	Natural Gas	Bridged		ADN, 2008
5/23/-5/26/1985	Offshore	Union Oil Company	Grayling Platform	Development	Natural Gas, Water, Drilling Mud	Bridged		ADN, 2008
12/20/-12/28/1987	Offshore	Marathon Oil Company	Steelhead Platform Well M-26	Development	Natural Gas, Water, Coal, and Rocks	Relief Well Started, Bridged		ADN, 2008
9/28/-9/29/2008	Onshore	Aurora Gas	Moquawkie No. 4	Development	Natural Gas, Drilling Mud 11,000 gallons	Drilling Mud		ADEC, 2008; ADN, 2008

A-1.2.4. Historical Crude Oil Spills Greater than or Equal to 1,000 Barrels in Cook Inlet

This section presents the available information on Cook Inlet crude oil spills from pipelines or platform facilities. Oil-spill records are not complete for the entire production period of Cook Inlet (1957 to present); however, this section provides some information about the nature of oil spills from production facilities and pipelines in Cook Inlet State waters. USDOI, MMS (2003) Appendix A, Section A.1.b outlines historic spill information and has been updated by State of Alaska, Department of Environmental Conservation spill records from the Cook Inlet and Kodiak Island Subareas (ADEC, 2015).

A-1.2.4.1. Historical Crude- and Refined-Oil Spills Greater than or Equal to 1,000 Barrels from Offshore Cook Inlet Pipelines

Three spills ≥1,000 bbl are listed in the Sienkiewicz and Wondzell (1992) database. The pipeline spills in 1966 and 1967 also are listed in Gulf Canada Resources, Inc. (1982). They are shown as follows:

Year of Spill	Company Platform	Size of Spill (bbl)	Cause of Spill
1966	Shell Platform A	1,400	Pipe Rupture
1967	Shell Platform B	1,400	Pipe Rupture
1968	Shell Platform B	1,000	Pipe Rupture

The BOEM searched for spills ≥1,000 bbl in the above mentioned sources. The other available sources listed do not list crude-oil spills ≥1,000 bbl from production facilities or offshore pipelines. These databases should have included such spills if they occurred.

For purposes of analysis, the records are not complete enough for quantitative analysis. From the available records, it does not appear as though any platform spills ≥1,000 bbl have occurred. At a minimum and perhaps a maximum, three spills ≥1,000 bbl from pipelines occurred in Cook Inlet State waters. The cause of the three spills was due to vortex shedding. Pipelines installed in areas with high currents, such as Cook Inlet, normally will exhibit vortex-induced vibrations set up by the near seabed current flow. Such vibrations pose a potential fatigue-damage problem. From 1965-1976, there were 14 vortex failures, including the three large spills described previously. Industry designed a program to prevent and eliminate vortex shedding. Annual surveys of the pipeline are performed, and sand or cement bags are placed at 50-foot intervals and 1 foot off the bottom (Visser, 2002).

A-1.2.4.2. Historical Crude- and Refined-Oil Spills Greater Than or Equal to 1,000 Barrels from Tankers and Motor Vessels

Eight spills ≥1,000 bbl are listed in the Sienkiewicz and Wondzell (1992) database or Wagner, Murphy and Behlke (1969). They are as follows:

Year	Vessel Name	Location of Spill	Type of Spill	Size of Spill (bbl)
1966	Tanker Vessel	Nikiski	Diesel	2,000
1966	Tanker Vessel	Nikiski Dock	Oil	1,000
1967	T/V EVJE	Fire Island Area	Jet Fuel	6,000-10,000
1967	T/V Washington Trader	Drift River Terminal	Crude Oil	1,700
1976	USNS Sealift Pacific	Nikiski	JP-4	9,420
1984	M/V Cepheus	Near Anchorage	Jet A	4,286
1987	T/V Glacier Bay	Near Kenai	Crude Oil	3,100
1989	Lorna B	Nikiski	Diesel	1,547-1,714

In addition to the previously mentioned tanker spills, there were at least two documented spills from outside the Cook Inlet area that have drifted into Cook Inlet. The first spill was from an unidentified source documented by the Federal Water Pollution Control Administration (1970). The suspected source of the spill was from a tank vessel dumping ballast and slop at sea, which was a common practice at that time. No oil-spill volume is estimated. Based on the estimated number of dead birds and the length of coastline oiled, BOEM estimates this spill was ≥1,000 bbl. This spill impacted lower Cook Inlet, including the Barren Islands, Kodiak Island, and Shelikof Strait. The second documented tanker spill was the T/V *Exxon Valdez*. This spill drifted into the northern Gulf of Alaska, lower Cook Inlet and Shelikof Strait. It is estimated that approximately 1-2% of the spill entered lower Cook Inlet reaching as far north as Anchor Point.

A-2. Behavior and Fate of Crude Oils

There are scientific laboratory data and field information from accidental and research oil spills about the behavior and fate of crude oils. BOEM discusses the background information on the fate and behavior of oil in subarctic environments and its behavior and persistence properties along various types of shorelines. BOEM also makes several estimates about environmental parameters to perform modeling simulations of oil weathering that are specific to the large spills BOEM estimates for analysis purposes.

A-2.1. Generalized Processes Affecting the Fate and Behavior of Oil

Several processes alter the chemical and physical characteristics and toxicity of spilled oil. Collectively, these processes are referred to as weathering or aging of the oil. The major oil-weathering processes are spreading, evaporation, dispersion, dissolution, emulsification, microbial degradation, photochemical oxidation, and sedimentation to the seafloor or stranding on the shoreline (Payne et al., 1987; Boehm, 1987; Fingas, 2011; Lehr, 2001; USDOI, MMS, 2007, Figure A.1-2).

Along with the physical oceanography and meteorology, weathering processes determine the oil's fate in the environment. Potter et al. (2012), Dickins (2011), and Lee et al. (2011) reviewed the state of fate and behavior of oil in ice and documented the relevant studies; some of which were detailed in the USDOI, MMS (2007) Lease Sale 193 FEIS, Appendix A, 2.1. Collectively, 40 years of research underpin the available science on fate and behavior of oil in open water and ice.

Further research on the fate of oil spills and oil dispersants is ongoing. Gong et al. (2014) documents the relationship between sediment particle size and concentration, oil properties, and salinity characteristics and their contribution to the formation and characteristics of oil sediment-particulate-material aggregates. Beegle-Krause et al. (2014) reviewed the literature on the fate of either mechanically or chemically dispersed oil under ice and determined that under-ice turbulence was a key variable. Turbulence would tend to keep oil droplets in suspension but is significantly reduced under ice fields and oil droplets do not remain in suspension. Further research is also ongoing within Industry (Mullin, 2014) and government.

The potential volume of oil entrained in the interstitial space of the sea ice crystal fabric was studied using salinity and temperature data from Barrow, Alaska. Petrich, Karlsson, and Eicken (2013) found oil entrainment increases from January to May. Entrainment may reach approximately 20% of the potential oil volume pooled beneath sea ice.

Fingas and Hollebone (2014) conclude that the behavior of oil in ice can be modeled based on previous research. However, they stress that new available technologies for measurement have the potential to move the science forward. Initial studies suggest oil spreads differently when spilled in young ice (frazil, nilas, or pancake). Wilkinson et al. (2014) documented oil penetrating frazil ice and frazil ice inhibiting brine channel migration. Waves were a controlling factor in the spread of oil associated with young ice.

Natural indigenous microbial organisms inhabit subarctic waters and sea ice brine channels. McFarlin et al. (2011a, b; 2014) studied crude oil biodegradation under cold and light-limiting conditions using indigenous microbes collected from the Beaufort and Chukchi seas. Biodegradation occurred down to -1º C. Bagi et al. (2014) also suggests that biodegradation capacity in cold seawater may not be inherently lower than the biodegradation capacity of microbes in temperate seawater.

A-2.2. Oil-Spill Persistence

Oil spill persistence on water or on the shoreline can vary widely, depending on the size of the oil spill, the environmental conditions at the time of the spill, the substrate of the shoreline and, especially in the case of portions of Cook Inlet, ongoing shoreline erosion. Persistence on water and then on shorelines is discussed below.

A-2.2.1. On-water Oil-Spill Persistence

In this analysis, BOEM conservatively assumes 1,700- and 5,100-bbl crude oil spills could last up to 30 days on the water as a coherent slick. After that, the weathering process (Section 2.1) would degrade the oil on the surface of the water, making it hard to track. During higher wind speeds and wave heights, spills of these sizes may dissipate more quickly.

A-2.2.2. Shoreline Type, Oil Behavior, and Persistence

The Lower Cook Inlet/Shelikof Strait shoreline oil-retention characteristics were surveyed by Michel, Jordana, and Ballou (1986); Domeracki et al. (1981); Ruby et al. (1979); and Michel and Ballou (1986). Gundlach et al. (1990) published a dataset summarizing shoreline characteristics from the above reports into seven numbered environmental sensitivity index (ESI) types for Cook Inlet/Shelikof Strait. For each land segment, the percentage of each ESI type by length is shown in Table A.1-2. In general, the higher the ESI number, the longer the oil is estimated to persist in that type of substrate. In 2001, Cook Inlet Regional Citizens Advisory Council conducted a demonstration project applying a coastal habitat inventory method called ShoreZone. That protocol continues today and provides useful information on shoreline type and information to estimate persistence (Harper and Morris, 2014).

Stranded-oil persistence results from oil remaining after cleanup or in locations where cleanup may cause more environmental damage than if the oil were left in place. The coastal environments adjacent to the OSRA study area are similar to and, in some cases, are the same coastal environments contacted by Exxon Valdez Oil Spill in Prince William Sound and the Gulf of Alaska. Therefore, shoreline-oil persistence and weathering in Prince William Sound provides an analogy for how oil may weather if an oil spill contacted the coastal areas adjacent to the planning area. However, Cook Inlet and Shelikof Strait have more wave exposure and energy, which may accelerate weathering processes or hinder it due to boulders armoring the substrate (Irvine, Mann and Short, 1999, 2006; Short et al., 2007). Some of the coastal environments adjacent to the study area were previously oiled from the Exxon Valdez spill. Re-oiling from another spill would affect oil persistence and weathering.

The coastal environment adjacent to the study area has approximately 49% exposed rocky shore. The ESI predicts short-term effects for exposed rocky shores. During the Exxon Valdez oil spill, most exposed rocky shorelines showed little to no oil persistence besides staining and scattered tar blotches (Gundlach et al., 1990). On a small scale, however, these rocky shorelines are indented and fractured, creating numerous pockets. Some rocky shorelines are sheltered from wave and wind direction. On some exposed rocky shores sheltered to wind and waves, heavy oil concentrations were found eight months after the Exxon Valdez spill (Gundlach et al., 1990).

The study area has about 31% mixed sand and gravel beaches and 12% gravel beaches. The ESI predicts oil mixing deeply (less than 10 centimeters up to a meter) in well-sorted sand and gravel, gravel material, and especially deep burial along the berm. Mixed sand and gravel beaches were a shore type affected by the Exxon Valdez spill (Gundlach et al., 1990). Gravel beaches pose a special problem because of the potential for deep oil burial and the persistence of subsurface oil for decades (Hayes, Michel, and Noe, 1991; Hayes and Michel, 1999; Irvine, Mann, and Short, 1999, 2006; Michel et al., 1991; Michel and Hayes, 1993a, 1993b; Owens, 1991, 1993). Gravel beaches enhance oil accumulation through burial by accretion features and the formation of asphalt pavement, and the armoring of the gravel beach impedes erosion (Hayes, Michel and Noe, 1991; Michel and Hayes, 1993a, 1993b).

The study area has approximately 2% coarse-grained-sand beaches. The ESI predicts oil deposition primarily high on the beach face and potential deep burial along the berm. Oil persistence depends on the wave energy, with sheltered areas harboring oil for years to decades (Prince, Owens and Sergy (2002). The ESI predicts longer persistence on coarse- rather than fine-grained-sand beaches. On fine-grained-sand beaches in Katmai, oil remained on or near the surface (Gundlach et al., 1990). Clay-oil flocculation is identified as a process on fine-grained-sand beaches that accelerates weathering and prevents asphalt-pavement formation, thereby reducing oil persistence (Bragg and Yang, 1993).

Exposed tidal flats make up approximately 3% of the study area. The ESI predicts that most oil would be pushed across the tidal flat onto adjacent shores. The high sensitivity rating is due to the biological components using the tidal flat. Coarse cobbles on the tidal flat can cause oil to persist for several months (Gundlach et al., 1990).

Adjacent to the study area, less than 1% is marshes. This coastal environment has the highest ESI ranking of 8. The ESI predicts long-term persistence for marshes due to the sheltered nature of the shoreline or the fine-grained sediments. Recent examination of past spills continues to confirm the long term persistence of oil for marshes (Reedy et al. 2002; Wang et al., 2001). The Exxon Valdez oil spill data indicate long-term persistence (Gundlach et al., 1990).

A-2.3. Oil-Spill Toxicity

Oil-spill toxicity occurs through the mode of narcosis (state of stupor or unconsciousness) caused by monocyclic aromatic hydrocarbons crossing the cell membranes as well as oil being ingested by or coating an organism. Studies on the Exxon Valdez Oil Spill in Prince William Sound revealed that larger and more persistent polycyclic aromatic hydrocarbons (PAHs) in sediments are linked to long-term effects (Peterson et al., 2003). Oil-spill toxicity is discussed in the effects of spills on each resource section.

Studies following the Deepwater Horizon (DWH) event examined the impacts of oil-dispersant usage. Rico-Martinez, Snell, and Shearer (2013) found that toxicity testing with various species of marine rotifer revealed that, when the dispersant COREXIT 9500A (which was used during the DWH spill to disperse the oil in an attempt to reduce its toxicity) was well mixed with crude oil, the toxicity increased as much as 52-fold. Without mixing, the effect was decreased to 27.6 fold. The authors noted that the rotifer strain from the Gulf of Mexico was most tolerant to oil from the Macondo well. The authors described the effect as synergistic. However, other authors have noted that the increased toxicity of COREXIT 9500A plus crude oil is actually due to the oil itself (Wu et al., 2012) because the dispersant helps the oil dissolve into the water phase and then become more bioavailable. Furthermore, Chakraborty et al. (2012) found that COREXIT 9500 was not toxic to indigenous microbes and that various components of the COREXIT 9500 were degraded. This is part of the ongoing debate that exists with the use of dispersants as a response tool. Dispersants help make the oil more bioavailable so that the oil is subject to increased degradation, including biodegradation; however, oil that is more bioavailable may also be more toxic to some species.

Gardiner et al. (2013) and deHoop et al. (2011) studied the relative sensitivity of cold-water species to oil components and to physically and chemically dispersed oil. In both of these studies, a small number of cold-water species fell within the range of sensitivities of commonly tested species, mostly of temperate climates. Bejarano, Clark, and Coelho (2014) suggest improvements to toxicity testing to make the results useful across species and geographic locations for better information to further management decisions on dispersant use.

A-2.4. Assumptions about Large Oil-Spill Weathering

To run the oil weathering model (OWM) using a consistent framework, several assumptions are made regarding the type of oil, the size of the spill, the environmental conditions, and the location of the spill. The following assumptions are used to estimate weathering of a large oil spill:

- The crude oil properties will be similar to crude oil of 20-25º API for the Action Area
- The diesel oil properties will be similar to a typical diesel for the Action Area
- The size of the diesel fuel spill is 5,100 bbl
- The size of the crude spill is 1,700 or 5,100 bbl
- There is no reduction in the size of spill due to cleanup; instead cleanup is considered separately as either mitigation or disturbance

- The wind, wave, temperature and ice conditions are as described
- The spill is a surface spill or a shallow (less than 70 m) subsea spill that reaches the water surface quickly
- The properties predicted by the OWM model are those of the thick part of the slick
- The spill occurs as an instantaneous spill over a short period of time
- The fate and behavior are as modeled (Tables A.1-3 through 5)
- The oil spill persists for up to 30 days in open water

Uncertainties exist, such as:

- The actual size of an oil spill or spills, should they occur
- Whether the spill is instantaneous or chronic
- The location of the spill
- Wind, current, wave, and ice conditions at the time of a possible oil spill
- The crude, or diesel oil properties at the time of a possible spill

A-2.5. Modeling Simulations of Oil Weathering

To judge the effect of a large oil spill, BOEM estimates information regarding how much oil evaporates, how much oil is dispersed, and how much oil remains after a certain time period. BOEM derives the weathering estimates of crude oil, and diesel fuel from modeling results from the SINTEF Oil Weathering Model (OWM) Version 4.0 (Reed et al., 2005) for up to 30 days.

A-2.5.1. Oils for Analysis

The crude oil used in the analysis is a medium crude oil. A medium crude oil was chosen for simulations of oil weathering for the Sale 244 Action Area, because it is a crude oil that falls within the category of 20-25° API oils estimated to occur in the Sale 244 Action Area. BOEM used a typical marine diesel fuel.

A-2.5.2. Crude Oil and Diesel Fuel Simulations of Oil Weathering

This section discusses the simulation of oil weathering. BOEM uses the SINTEF OWM to perform oil weathering simulations. The SINTEF OWM has been tested with results from three full-scale field trials of experimental oil spills (Daling and Strom, 1999; Brandvik et al., 2010).

The simulated medium crude oil-spill sizes are 1,700 bbl or 5,100 bbl. The diesel-oil-spill size is 5,100 bbl. BOEM simulates two general scenarios: one in which the oil spills into open water and one in which the oil freezes into the ice and melts out into 50% ice cover.

For the Sale 244 Action Area, BOEM assumes open water is April through November, and a winter spill could occur into open water or broken ice. BOEM assumes the spill starts at the surface or quickly rises to the surface in the shallow waters of the Sale 244 Action Area. For open water, BOEM models the weathering of the spills as if they are instantaneous spills. For the broken ice spill scenario, BOEM models the entire spill volume as an instantaneous spill. Although different amounts of oil could melt out at different times, BOEM took the conservative approach, which was to assume all the oil was released at the same time. BOEM reports the results at the end of 1, 3, 10, and 30 days.

For purposes of analysis, BOEM looks at the mass balance of the large oil spill: how much is evaporated, dispersed, and remaining. Tables A.1-3 through 5 summarizes the results BOEM assumes for the amount evaporated, dispersed, and remaining for a diesel fuel or crude oil. The results are considered in BOEM's analysis of the effects of oil on environmental, social and economic resources or resource areas. In general, diesel fuel will evaporate and disperse in a short period of time (3-10 days). The higher the wind speeds, the more rapidly the evaporation and dispersion occur. Crude oils tend to evaporate and disperse more slowly, especially if the oils become emulsified. Crude oil properties vary, and these are representative ranges of how different light crudes may weather.

The medium crude oil contains a relatively moderate amount of high molecular-weight compounds. In weathering tests, approximately 10-24% of its original volume evaporated within 1 and 30 days, respectively, at both summer and winter temperatures. At the average wind speeds over the Sale 244 Action Area during summer, dispersion is slower, ranging from 3-56% (Tables A.1-4 and 5) than during winter in open water. However, at higher wind speeds during winter (e.g., 15 m/s wind speed) the oil spill will be almost removed from the sea surface within a day through evaporation and dispersion. Dispersion is very slow during the winter in the presence of broken ice.

A-3. Estimates of Where a Large Offshore Oil Spill May Go

BOEM studies how and where large offshore spills move by using an oil-spill trajectory model with the capability of assessing the probability of oil-spill contact to environmental resource areas (ERA), known as the Oil-Spill Risk Analysis (OSRA) model (Smith et al., 1982; Ji, Johnson, and Li, 2011). The “Large” oil spill means spills with a threshold size of ≥1,000 bbl. This model analyzes the likely paths of slightly less than 800,000 simulated oil spill trajectories in relation to biological, physical, and sociocultural resource areas that BOEM generically calls environmental resource areas (ERAs). The trajectory is driven by the wind, sea ice, and current data from a coupled ocean model. The locations of environmental resource areas, including sociocultural resource areas, islands, and the coast within the model study area, are used by OSRA to tabulate the percent chance of oil-spill contact to these areas. A full report is found within Ji, Johnson and Smith (In preparation, 2016).

A-3.1. Inputs to the Oil-Spill Trajectory Model

There are several inputs necessary to run the oil-spill trajectory model and to assess the probability of oil-spill contact to environmental resource areas, boundary segments, and land segments, including the following:

- Study area
- Subarctic seasons
- Location of the coastline
- Location of environmental resource areas
- Location of land segments and grouped land segments
- Location of boundary segments
- Location of hypothetical launch areas
- Location of hypothetical pipelines and transportation assumptions
- Current information from a general circulation model
- Wind information

A-3.1.1. Study Area and Boundary Segments

Map A-1 (Maps are found in section A.1, Tables and Maps) shows the study area used in the oil-spill trajectory analysis. It extends from 147º W to 160º 15’W and 55º 15’ N to 61º 15’ N. The OSRA model has a resolution of 245 m by 256 m and a total of 8 million grid cells in the study area. The study area is formed by 16 offshore boundary segments and the Cook Inlet, Kodiak, Alaska Peninsula, and Gulf of Alaska coastline. The boundary segments are vulnerable to spills in both summer and winter. The study area is chosen to be large enough to allow most hypothetical oil-spill trajectories to develop without contacting the boundary segments through as long as 30 or 110 days.

A-3.1.2. Trajectory Analysis Periods

The OSRA model launches a hypothetical oil-spill trajectory from a hypothetical location called a launch point (described in detail in Section 3.1.5) starting on day 1 in 1999, and it continuously launches the trajectory every day for a total of 10 years (1999-2009). Therefore, a total of 799,350 trajectories are launched over this time period. The trajectories are driven by the hourly wind, and ice or current data from a coupled ocean model with 10 years (1999-2009) of simulation (described in detail in Section A-3.1.6 and Danielson et al., In press), and are computed on an hourly basis.

BOEM defines three time periods for the trajectory analysis of large oil spills. These periods are the months when trajectories are started and the chance of contact is tabulated. BOEM calls these three periods annual, summer, and winter. Shown below are the three time periods that trajectories were started and the months that make them up.

Sale 244 Action Area	Annual	Summer	Winter
	January-December	April-October	November - March

The annual period is from January 1 to December 30. The summer period is from April 1 through October 31 and generally represents open water or subarctic summer. The winter period is from November 1 through March 31 and represents subarctic winter. The choice of this seasonal division was based on meteorological, climatological, and biological cycles and consultation with BOEM, Alaska OCS Region analysts.

A-3.1.3. Locations of Environmental Resource Areas

Environmental resource areas (ERAs) represent areas of social, economic, or biological resources or resource habitat areas. BOEM, Alaska OCS Region analysts designate these ERAs. The analysts work with specialists in other federal and state agencies, academia and various stakeholders who provide scientific information as well as local and traditional knowledge about these resources. For biological resources, ERAs are determined by several factors including density, important habitat, and life history features. While multiple species may occur within an ERA, ERAs are assigned to those species for which there is sufficient information to confidently identify the area as important. The analysts also designate in which months these ERAs are vulnerable to spills, meaning the time period those resources occupy or use that spatial location. For example, birds migrate and may be there only from May to August. While species rare to the area or with limited sightings may preclude representation by specific ERAs the discussion of oil-spill impacts in Chapter 4 considers impacts to those species present in the area should an accidental large spill occur.

There are 155 ERAs. Maps A-2a, A-2b, A-2c, A-2d, A-2e, A-2f, A-2fg, and A-2h show the locations of the 155 ERAs. These resource areas represent concentrations of wildlife, habitat, subsistence-use areas, and subsurface habitats. The names or abbreviations of the ERAs and the general resource they represent are shown in Table A.1-6. Information regarding the general and specific ERAs for birds, whales, subsistence resources, marine mammals, and lower trophic resources is found in Tables A.1-7, 8, 9, 10, 11, and 13, respectively. Anadromous fish, terrestrial mammals and parks and special areas are not represented by ERAs but are represented by Grouped Land Segments (GLSs) shown in Tables A.1-12, 14, 15, and 17 and discussed below in section A-3.1.4. BOEM also includes Land as an additional ERA. Land is the entire study area coastline and is made up of all the individual land segments (LSs) 1 through 112, described below.

A-3.1.4. Location of Land Segments and Grouped Land Segments

The coastline was further analyzed by dividing the Cook Inlet, Kodiak, Alaska Peninsula, and Gulf of Alaska coastline into 112 LSs. Some LSs were added together to form larger geographic areas and were called GLSs. All of the onshore, coastal environmental resource locations were represented by one or more partitions of the coastline. The study area coastline is partitioned into 112 LSs of approximately 12-15 miles (20-25-kilometers) in length. The partitions are formed by creating straight lines between two points projected onto the coast; therefore, the actual miles of shoreline represented by each land segment may be greater than 15 miles, depending upon the complexity of the coastal area.

The LS identification numbers (IDs) and the geographic place names within the LS are shown in Table A.1-16. Maps A-3a, A-3b, A-3c, and A-3d show the location of these 112 LSs. Land segments are vulnerable to spills in both subarctic summer and winter. The GLSs, their names, and the individual LSs that make them up are shown in Table A.1-17. Maps A-4a and A-4b show the location of these 51 GLSs. Grouped land segments are vulnerable to spills based on the time periods shown in Table A.1-17. Anadromous fish, terrestrial mammals and parks and special areas represented by group land segments are shown in Tables A.1-12, 14, and 15.

A-3.1.5. Location Hypothetical Launch Areas and Pipelines

For this analysis, the launch areas (LAs) and pipeline segments (PLs) are hypothetical locations which have been reduced to the Sale 244 Area ID. They are not meant to represent or suggest any particular development scenario. If and when any commercial hydrocarbons are discovered, detailed development scenarios would be engineered, designed, reviewed, and evaluated by industry, BSEE, BOEM and other applicable regulatory agencies.

Map A-5 shows the location of the six hypothetical LAs (1-6) and four hypothetical PLs (1-4) where large oil spills could originate if they were to occur. Pipeline locations are entirely hypothetical. They are not meant to represent four proposed pipelines or any real or planned pipeline locations. They are distributed throughout the sale area to evaluate differences in oil-spill trajectories from different locations.

Hypothetical launch points were spaced at one per lease block plus two additional launch points for pipelines leading to shore. Hypothetical launch points were spaced 4.8 km in the east-west and north-south direction. At this resolution, there were 219 total launch points in space, grouped into the six LAs (1-6) and four PLs (1-4) representing the Sale 244 Action Area.

A total of 3,600 trajectories were simulated from each of 219 launch points over the 10 years of wind and ice or ocean current data, for a total of 799,350 trajectories. The results of these trajectory simulations were combined to represent platform/well spills from 6 LAs (Map A-5). Pipeline spills were represented by trajectories from each launch point along each PL (1-4, Map A-5).

For the Sale 244 Action Area Alternatives 1, 3a, 3b, 3c, 4a, 4b, 5, or 6, BOEM assumes no large oil spills occur during exploration activities. Development/production activities for the Sale 244 Action Area could occur in any of the LAs (1 through 6) or along any of the PLs (1 through 4). Table A.1-18 shows the assumptions about how the hypothetical launch areas were assumed to be serviced by hypothetical pipelines.

A-3.1.6. Ocean Current and Ice Information from a General Circulation Model

BOEM uses the results from a coupled ocean general circulation model to simulate oil-spill trajectories (Danielson et al., In press). The wind-driven and density-induced ocean-flow fields and the ice-motion fields are simulated using a three-dimensional, coupled, ice-ocean hydrodynamic model (Danielson et al., In press). The main research tool is a state-of-the-art coupled ocean/sea ice model based on the Regional Ocean Modeling System (ROMS). ROMS is a terrain-following, finite volume (Arakawa C-grid) model with the following advanced features; high-order, weakly dissipative algorithms for tracer advection; a unified treatment of surface and bottom boundary layers (Large, McWilliams, and Doney, 1994), and atmosphere-ocean flux computations based on the ocean model prognostic variables using bulk formulae (Fairall et al., 2003; Large and Yeager, 2009). The vertical discretization is based on a terrain-following coordinate system with the ability to increase the resolution near the surface and bottom boundary layers. The ROMs model includes a wetting and drying algorithm appropriate for the large tidal range in upper Cook Inlet (Oey et al., 2007). ROMS has been coupled to a sea-ice model (Budgell, 2005) consisting of the elastic-viscous-plastic (EVP) rheology (Hunke and Dukowicz, 1997) and the Mellor and Kantha (1989) thermodynamics. The ice module is fully explicit and implemented on the ROMS Arakawa C-grid and is therefore fully parallel using Message Passing Interface, just as ROMS is. The model also includes frazil ice growth in the ocean being passed to the ice (Steele, Mellor, and McPhee, 1989). It currently follows a single ice category, which exhibits accurate results in a marginal ice zone such as Cook Inlet.

A-3.1.7. Wind Information

BOEM uses the Modern Era Retrospective Analysis for Research and Applications (MERRA) wind fields provided by Danielson et al. (In press). The wind data are from 1999-2009 and was interpolated to the coupled ocean model grid at three-hourly intervals.

A-3.1.8. Large Oil-Spill Release Scenario

For purposes of this trajectory simulation, all spills occur instantaneously. For each trajectory simulation, the start time for the first trajectory was the first day of the season (winter or summer) of the first year of wind data (1999) at 6 a.m. Greenwich Mean Time (GMT). The summer season consists of April 1-October 31, and the winter season is November 1-March 31. Each subsequent trajectory was started every day at 6 a.m. GMT.

A-3.2. Oil-Spill Trajectory Model Assumptions

The oil-spill trajectory model assumptions are as follows:

- Large oil spills occur in the hypothetical launch areas or along hypothetical pipeline segments
- Operators transport the produced oil through pipelines
- A large oil spill reaches the water surface within a short period of time due to the shallow water depths
- Large oil spills persist long enough for trajectory modeling for up to 30 days
- Large oil spills occur and move without consideration of weathering. The oil spills are simulated each as a point with no mass or volume. The weathering of the oil is estimated separately in the stand-alone SINTEF OWM model
- Large oil spills occur and move without any cleanup. The model does not simulate cleanup scenarios. The oil-spill trajectories move as though no booms, skimmers, or any other response action is taken
- Large oil spills stop when they contact the mainland coastline or large islands

Uncertainties exist, such as:

- The actual size of the large oil spill or spills, should they occur
- Whether the large spill reaches the water
- Whether the large spill is instantaneous or a long-term leak
- The wind and current conditions at the time of a possible large oil spill
- How effective response or cleanup is
- The characteristics of crude or diesel oil at the time of the large spill
- How a Cook Inlet crude or diesel oil will spread
- Whether or not development and production occurs

A-3.3. Oil-Spill Trajectory Simulation

The trajectory-simulation portion of the OSRA model consists of many hypothetical oil-spill trajectories that collectively represent the mean surface transport and the variability of the surface transport as a function of time and space. The trajectories represent the Lagrangian motion that a particle on the surface might take under given wind, ice, and ocean-current conditions. Hundreds of thousands of trajectories are simulated to give a statistical representation, over time and space, of possible transport under the range of wind, ice, and ocean-current conditions that exist in the OSRA study area.

Trajectories are constructed to produce an oil-transport vector. For cases where the ice concentration is below 80%, each trajectory is constructed using vector addition of the ocean current field and 3.5%

of the instantaneous wind field—a method based on work done by Huang and Monastero (1982), Smith et al. (1982), and Stolzenbach et al. (1977). For cases where the ice concentration is 80% or greater, the model ice velocity is used to transport the oil. Equation 1 shows the components of motion simulated and used to describe the oil transport for each trajectory:

1. $U_{oil} = U_{current} + 0.035\ U_{wind}$ or
2. $U_{oil} = U_{ice}$

Where:

U_{oil} = oil drift vector

$U_{current}$ = current vector (when ice concentration is <80%)

U_{wind} = wind speed at 10 m above the sea surface

U_{ice} = ice vector (when ice concentration is ≥80%)

The wind-drift factor was estimated to be 0.035, with a variable drift angle ranging from 0º-25º clockwise. The drift angle was computed as a function of wind speed according to the formula in Samuels, Huang, and Amstutz (1982). The drift angle is inversely related to wind speed.

The trajectories age while they are in the water. For each day that the hypothetical spill is in the water, the spill ages—up to a total of 30 days. While the spill is in the ice (≥80% concentration), the aging process is suspended. After coming out of the ice, that is melting into open water, the trajectory ages to a maximum of 30 days.

A-3.3.1. Results of the Oil-Spill Trajectory Simulation

A-3.3.1.1. Conditional Probabilities: Definition and Application

The chance that a large oil spill will contact a specific ERA, LS, GLS, or BS within a given time of travel from a certain location (LA or PL) is termed a conditional probability. The condition is that BOEM assumes a large spill occurs. Conditional probabilities assume a large spill has occurred and the transport of the spilled oil depends only on the winds, ice, and ocean currents in the study area. Conditional probabilities are reported for three seasons (annual, summer, and winter) and five time periods (1, 3, 10, 30, and 110 days). Conditional probabilities are expressed as a percent chance. This means that the probability (a fractional number between 0 and 1) is multiplied by 100 and expressed as a percentage.

For the Sale 244 Action Area, annual, summer, and winter periods are shown in Section A-3.1.2. Contact, tabulated from a trajectory that began before the end of summer season, is considered a summer contact. BOEM also estimates the conditional probability of contact from spills that start in winter. Winter contacts are from spills that begin in winter. Therefore, if any contact to an ERA, LS, GLS, or BS is made by a trajectory that began by the end of winter, it is considered a winter contact. BOEM also estimates annual conditional probabilities of contact within 1, 3, 10, 30, and 110 days. Annual contact is for a trajectory that began in any month throughout the entire year.

A-3.3.1.2. Conditional Probabilities: Results

The chance of a large spill contacting a specific ERA, LS, GLS, or BS or any of the areas being assessed (assuming a spill has occurred) is called a conditional probability. It is conditioned on the assumption that a large spill has occurred. The conditional probability results for the oil-spill trajectory model are summarized generally below and are listed in Tables A.2-1 through A.2-60 for the Sale 244 Action Area. The Maps referenced in this discussion are as follows:

- Boundary Segments (BSs) are shown in Map A-1
- Environmental Resource Areas (ERAs) are shown in Maps A-2a through A-2h
- Land Segments (LSs) are shown in Maps A-3a through A-3d
- Grouped Land Segments (GLSs) are shown in Maps A-4a through 4b
- Hypothetical Launch Areas (LAs) and Pipelines (PLs) are shown in Map A-5

For specific analysis of conditional probabilities in regard to specific resources, please see Chapter 5 of this EIS. The following section provides generalized comparisons for an overall generalized view. Probabilities in the following discussions, unless otherwise noted, are conditional probabilities estimated by the OSRA model (expressed as percent chance) of a spill ≥1,000 bbl in size contacting ERAs and LSs within the days and seasons as specified below.

A-3.3.1.3. Comparisons between Spill Location and Season

The primary differences of contact between spill locations are geographic in the perspective of east to west and northern lower inlet versus southern lower inlet and Shelikof Strait. The land segments with the highest chance of contact from all launch areas are generally along the western shores of lower Cook Inlet in Kamishak Bay and upper Shelikof Strait. Contacts to the western shorelines are greater in magnitude and length of coastline contacted is longer for LAs located on the western side of Cook Inlet. LAs in southern Cook Inlet tend to produce patterns of contacts that show spills overall move more southward in the Inlet For a particular LA, contacts to the south are further away and higher in magnitude than contacts to the north. This reflects the predominate flow in the inlet and strait to the south. The PLs generally have balanced east and west contacts. Winter contacts are generally slightly higher in magnitude than summer contacts for the same LA or PL.

A-3.3.1.4. Generalities Through Time

3 Days: Generally, the highest chances of contacts within 3 days are directly adjacent to the LAs or PLs for ERAs, LSs and GLSs.

10 Days: Generally, a large portion of the trajectories contact shoreline within 10 days due to the enclosed nature of the shoreline of Cook Inlet and Shelikof Strait. In many cases, there was little difference between the 10-day and 30-day estimated chance of contact. This is because the study area is restricted within Cook Inlet and Shelikof Strait, and long travel times for oil-spill trajectories were not observed.

30 Days: The chance of contacts within 30 days generally increase only slightly if at all from 10 days. Some ERAs, primarily lower Shelikof Strait and the northeastern side of Kodiak, farther from the LAs have chances of contact ranging from 1-5%.

A-4. Oil-Spill Risk Analysis

A measure of oil-spill risk is determined by looking at the potential for one or more large spills occurring as a result of exploration, development, or production from the Scenario, and then of a large spill contacting a shoreline segment, resource, or resource area of concern (called an environmental resource area (ERA)). If spilled crude contacts any portion of a shoreline segment or ERA, it is called simply a contact. The oil spill risk analysis helps determine the relative risk of occurrence and contact of one or more large spills in and adjacent to the Sale 244 Action Area.

Combined probabilities are the chance of one or more large spills occurring and of those spills contacting over the life of the Scenario. They are estimated using the conditional probabilities, the large oil-spill rates, the resource estimates, and the assumed transportation scenarios. These are combined through matrix multiplication to estimate the mean number of one or more large spills from operations in and adjacent to the Sale 244 Action Area occurring and of any of these spills making a contact.

A-4.1. Chance of One or More Large Spills Occurring

The chance of one or more large spills occurring is derived from two components: (1) the large spill rate and (2) the resource-volume estimate. The spill rate is multiplied by the resource volume to estimate the mean number of spills. Oil spills are treated statistically as a Poisson process, meaning that they occur independently of one another. If BOEM constructed a histogram of the chance of exactly 0 spills occurring during some period, the chance of exactly 1 spill, or exactly 2 spills, and so on, the histogram would have a shape known as a Poisson distribution. An important and interesting feature of this distribution is that it is entirely described by a single parameter, the mean number of large spills. The entire histogram and estimate of the chance of one or more large spills occurring can be calculated from the mean number of large spills.

A-4.1.1. Large OCS Spill Rates

BOEM derives the large OCS oil-spill rates from Anderson, Mayes and LaBelle (2012). These rates are based on a trend analysis of historical large OCS spills from platforms/wells or pipelines from 1996-2010 as well as OCS production during that same time period as shown below:

Type	Mean
Platforms/Wells	0.25 spills per Bbbl produced
Pipelines	0.88 spills per Bbbl produced
Total	1.13 spills per Bbbl produced

This analysis shows that the major contributors to the large OCS spill rates are pipelines.

A-4.1.2. Resource-Volume Estimates

For Alternative 1, the Proposed Action, it is assumed that 0.215 Bbbl is produced and transported. The resource volume estimates and resource exploration and development scenarios are discussed in the EIS Chapter 2.4. The alternatives 3a, 3b, 3c, 4a, 4b, 5, and 6 deferrals were evaluated by the BOEM, Alaska OCS Region, Resource and Economic Analysis Section and determined to be essentially the same in terms of resource volumes as Alternative 1.

A-4.1.3. Transportation Assumptions

Section 3.1.5 discusses the transportation assumptions for the hypothetical launch areas and their associated hypothetical pipelines.

A-4.1.4. Results for the Chance of One or More Large Spills Occurring

BOEM's estimate of the likelihood of one or more large spills occurring assumes that there is a 100% chance that development(s) will occur and 0.215 Bbbl of crude oil and 571 Bcf of natural gas will be produced. BOEM evaluates what would happen if full development as described in the Scenario occurred, even though the chance of that happening is probably very small in a frontier area like the Lower Cook Inlet. If a development occurs, this oil-spill analysis more accurately represents the chance of one or more large spills occurring.

Additionally, the chance of one or more large spills occurring as a result of operations in and adjacent to the Sale 244 Action Area is estimated over the life of the development(s). For the Sale 244 Action Area, crude oil and natural gas production is assumed to occur over a production period of 33 years. In the estimates of one or more large spills occurring, the annual chances for large spills occurring from both pipeline and platforms/wells over the entire estimated life of the development(s) are added together to get the final result.

The large spill rates used in this section are all based on the mean number of large spills per Bbbl of hydrocarbon produced. Using the above mean spill rates for large spills, Table A.1-19 shows the estimated mean number of large oil spills for the Alternatives 1, 3a, 3b, 3c, 4a, 4b, 5, or 6. BOEM estimates 0.19 pipeline spills and 0.05 platform (and well) spills could occur, for a total (over the life of the Sale 244 Action Area) of 0.24 spills.

For purposes of analysis, BOEM assumes one large offshore or onshore spill occurs anywhere from Alternative 1, or its alternatives. This "what-if" analysis of oil spills addresses whether such spills could cause serious environmental impact. The large spill is assumed to occur during the development and production phase. This assumption is based on the fact that a very small fraction of spills are estimated during the relatively short exploration drilling phase, as compared to the total spill frequency for exploration, development and production activities.

Now, looking at the entire 33-year exploration and oil and natural gas production life of the Sale 244 Action Area, BOEM uses the above mean spill number to determine the Poisson distribution. Table

A.1-20 shows the chance of no large pipeline spills occurring is 83%, and the chance of one or more large pipeline spills occurring is 17%. The chance of no large platform (wells and platform) spills occurring is 95% and the chance of one or more large platform (wells and platform) spills is 5%. The mean spill number total is the sum of the mean number of platform, well, and pipeline spills over the entire 39-year exploration and production life. The chance of no large spills occurring is 78%, and the chance of one or more large spills occurring is 22% for the Scenario.

A-4.2. Chance of a Large Spill Contacting: Conditional Probabilities

The chance of a large spill from operations in or adjacent to the Sale 244 Action Area contacting boundary segments, environmental resources area, land segments or grouped land is taken from the oil-spill trajectory model results, called conditional probabilities. These are summarized in Section A-3.3.1 and are listed in Tables A.2-1 through A.2-60.

A-4.3. Results of the Oil-Spill Risk Analysis: Combined Probabilities

The combined probabilities represent the estimated overall (combined) chance that one or more large spills (≥1,000 bbl) will both occur and contact a specific resource area. Tables A.2-61 through A.2-64 illustrate the annual combined probabilities for the Sale 244 Action Area for Alternatives 1, 3a, 3b, 3c, 4a, 4b, 5, or 6.

A-5. Accidental Small Oil Spills

Small spills are spills that are <1,000 bbl. Tables A.1-1, A.1-21, and A.1-22 show the small spills BOEM analyzes for the effects of small spill(s) in Chapter 4. BOEM considers two oil types for small spills: crude and refined oil.

Small spills, although accidental, are relatively common. These are dealt with using routine spill prevention and response measures. Small spills would occur from both exploration and development activities. The majority of small spills could be contained on a vessel or platform, and refined fuel spills that reach the water would evaporate and disperse within hours to a few days. Further, those spills reaching the water may be contained by booms or absorbent pads. BOEM estimates small spills are likely to occur over the life of the exploration and development activities.

A-5.1. Exploration

Exploration includes both geological and geophysical activities (marine seismic, geotechnical and geological surveys) and exploration and delineation drilling activities. Small spills during exploration are likely to be refined oil products such as lube oil, hydraulic oil, gasoline, or diesel fuel.

A-5.1.1. Geological and Geophysical (G&G) Activities

Small fuel spills associated with the vessels used for G&G activities could occur, especially during offshore vessel-to-vessel fuel transfers. For purposes of the oil spill analyses for Alternatives 1, 3a, 3b, 3c, 4a, 4b, 5, or 6, no large or very large crude or diesel oil spills are estimated from G&G activities, although small spills are estimated to occur. This is based on a review of potential discharges and on the historical oil spill occurrence data for the Alaska OCS and adjacent State of Alaska waters.

For purposes of analysis, BOEM estimates an offshore vessel transfer spill ranges from 0 to <1-13 bbl (USDOI, BOEM, 2015). The <1 bbl is the estimated volume of diesel fuel resulting from an offshore vessel fuel transfer accident assuming the dry quick disconnect and positive pressure hoses function properly. Dry quick disconnect couplings are designed to snap closed should the valve become disconnected with the poppet open, thereby limiting liquid release. Positive pressure fuel hoses are designed to stop pumping if the pressure is lost in the hose due to a break.

In a potential scenario, where a transfer hose ruptures and the positive pressure hoses fail, BOEM assumed that it would take a maximum of 30 seconds for someone to discover the rupture and 30 seconds to stop the pump. The estimated volume spilled during the maximum 60 second interval is likely to be approximately 13 bbl. In this scenario, BOEM assumes that all spilled fuel reached the water and none remains on the deck of the vessel.

In this analysis, BOEM assumes that for 99% of fuel transfer failures, all dry quick disconnect and positive pressure hoses function properly. BOEM also assumes that every other G&G activity has an offshore transfer fuel spill (which is a very conservative estimate, based on the fact that no offshore fuel transfer spills have been reported from G&G surveys in the Alaska Region). Also, BOEM assumes that spills do not occur in the same space and time, and that up to one G&G activity has an equipment malfunction. Therefore, fuel spills from a maximum level of anticipated annual G&G activities could range from 0 to less than 1 bbl at a minimum annually and up to 13 bbl at a maximum of fuel spilled over the life of the G&G Surveys. Table A.1-21 shows the estimated number and volume of small spills during G&G activities.

A-5.1.2. Exploration and Delineation Drilling Activities

For purposes of the oil spill analyses for Alternatives 1, 3a, 3b, 3c, 4a, 4b, 5, or 6, no large crude or diesel oil spills are estimated from exploration and delineation drilling activities. This is based on a review of potential discharges, historical oil spill and modeling data, and the likelihood of oil spill occurrence. This estimate is based on:

- The low rate of OCS exploratory drilling well-control incidents spilling crude oil per well drilled
- The fact that, since 1971, one OCS crude oil spill (large/very large) has occurred during temporary abandonment (converting an exploration well to a development well) while more than 15,000 exploratory wells were also drilled
- The low number (10) of exploration wells being drilled as a result of this proposed action
- The fact that no crude oil would be produced from the exploration wells, and the wells would be permanently plugged and abandoned
- The history of exploration spills on the Alaska OCS, all of which have been small
- The fact that no large spills occurred while drilling 86 exploration wells to depth in the Alaska OCS 1975-2015

Pollution prevention and oil spill response regulations and methods, implemented by BOEM, BSEE, and the operators and since the Deepwater Horizon spill have reduced the risk of spills and diminished their potential severity (USDOI, BOEM, 2012a; Shell, 2011; 2012, 2015).

Historical OCS exploration spill data suggest that the most likely cause of an oil spill during exploration would be operational, such as a hose rupture, and the spill could be relatively small. For purposes of analysis, up to a 50-bbl diesel fuel-transfer spill was chosen as one spill volume in the small spill category and 5-bbl was selected as the typical volume. This was based on historical exploration spill sizes in the Alaska OCS, and OCS oil-spill data, which indicated that 99.7% of all OCS spills are <50 bbl (Anderson, Mayes, and LaBelle, 2012) and estimates of USCG Worst Case Discharge (WCD), average most probable discharge and maximum most probable discharge for exploration plans (Shell, 2011, 2012, 2015).

The WCD (for the purposes of the USCG) was calculated based on the definition contained in 33 CFR 154.1029(b) (2). Operators used the following values: (1) Maximum Time to Discover Release: 5 minutes; (2) Maximum Time to Shutdown Pumping: 0.5 minutes (30 seconds) (3) Maximum Transfer Rate: 320 gpm (based on representative fuel transfer pumps on the oil spill response vessel = 7.6 bbl/min; (4) Total Line Drainage Volume: 163 gal [assuming a 4-inch by 820-ft marine hose between the pump manifold on the fuel barge and the delivery flange on the inlet piping at the drillship] or 3.9 bbl. The total volume was 48 bbl and for this analysis was rounded to the nearest ten for a value of 50 bbl.

The maximum most probable discharge is 5.0 bbl of diesel fuel. It was calculated from the definition contained in 33 CFR 154.1020 (the lesser of 1,200 bbl or 10% of the volume of the WCD).

Small spills could occur during exploration and delineation drilling activities. In this analysis BOEM assumes that every drilling activity has an offshore transfer fuel spill. Over the life of the Scenario, up to one drilling activity has a WCD and the rest have up to a maximum most probable discharge for a total of up to 5 or 50 bbl annually. These spills do not occur in the same space and time. The volumes range from 5 up to 50 bbl of fuel spilled. The estimated number and volume of small spills during exploration activities presented is displayed in Table A.1-21.

The 50 bbl spill is estimated to last less than 3 days on the surface of the water, based on the SINTEF OWM calculations. In terms of timing, a small spill from the exploration activities could happen at any time from January-December. Conservatively, BOEM assumes that the vessel would not retain any of the diesel fuel, and depending on the time of year, a small spill could reach the vessel and then the environment. The environment could be open water or open water and ice. The analysis of a small spill examines the weathering of the estimated 50 bbl diesel fuel spill.

BOEM summarizes below the estimates for the fate and behavior of diesel fuel in the analysis of the effects of oil on environmental, economic and social resources in Chapter 5. BOEM outlines the scenario assumptions for an exploration drilling small spill to provide a consistent analysis of small oil spill impacts by resource:

- A small spill occurs from each exploration drilling activity
- The spill size is typically 5 bbl; over the life of the scenario one 50 bbl spill occurs
- The oil type is diesel fuel
- All the oil reaches the environment; the vessel or facility absorbs no oil
- There is no reduction in volume due to cleanup or containment. (Pollution prevention, containment and cleanup are analyzed separately as mitigation and as disturbance.)
- The spill could occur at any time of the exploration operations (January-December)
- The weathering for a 5 or 50 bbl spill is as shown in Table A.1-23, and the spill lasts less than 3 days on the water
- The spill starts within the Sale 244 Action Area

A-5.1.3. Modeling Simulations of Oil Weathering

To judge the effect of a small oil spill, BOEM makes estimates regarding how much oil evaporates, how much oil is dispersed, and how much oil remains after a certain time period. BOEM derives the weathering estimates of diesel fuel oil from the SINTEF Oil Weathering Model Version 4.0 (Reed et al., 2005) modeling results for up to 30 days. Table A.1-23 summarizes the results BOEM estimates for the fate and behavior of a range of small diesel fuel spills (1-50 bbl). Based on OWM modeling simulations, a small, 1-50-bbl diesel fuel oil spill will be localized and short term.

A-5.2. Development and Production

OCS petroleum oil spill frequencies are applied to estimate small spills for the Sale 244 Action Area. Following is the estimated number and volume of small crude and refined oil spills during development and production:

For purposes of analysis, this EIS assumes a median small crude or refined spill size of 1 gallon for spills <1 bbl, 3 bbl for spills of 1 bbl to <50 bbl and 126 bbl for spills of 50 bbl to <500 bbl. (Anderson, Mayes and LaBelle, 2012, Table 16). An estimated 450 small crude and refined oil spills could occur during the 33-year oil and natural gas-production period for Alternatives 1, 3a, 3b, 3c, 4a, 4b, 5, or 6; an average of about 13 spills per year or a little more than 1 per month over the life of the scenario (Table A.1-21 and 22).

A-5.2.1. Small Spill Assumptions Summary

The analysis of small oil spill effects for Alternatives 1, 3a, 3b, 4a, 4b, 5, or 6 is based on the following assumptions:

- Small spills occur during exploration and delineation activities,development and decommissioning activities.
- Spills from offshore refueling during geological and geophysical activities range from 0 up to <1 bbl annually with one individual spill of approximately 13 bbl over the life of geological and geophysical activities.
- Small spills during exploration and delineation drilling operations range from 0 up to 5 bbl annually with one individual spill of 50 bbl over the life of exploration and delineation drilling activities.
- All the oil reaches the environment.
- The oil types could be diesel during exploration and delineation activities and crude, or diesel during production.
- The small spill could occur during open water during exploration and delineation activities and at any time of the year during development and production.
- The spill weathering is shown in Table A.1-23.

A-6. Potential for Natural Gas Releases

This analysis evaluates the potential for a large gas release during natural gas development and production of 517 Bcf over 33 years, as well as the potential impacts of such releases on the environment. This analysis identifies potential releases from:

- LOWC escalating into a gas blowout at production platforms/wells
- Ruptured or leaking pipelines
- Onshore facilities

The following subsections discuss possible ways in which natural gas may be released into the environment, assign frequencies to notable events, and present hypothetical release scenarios for further environmental resource-specific analysis.

Loss of Well Control

It is possible, though unlikely, that a LOWC during natural gas production could cause a release of natural gas into the environment. A LOWC can result in a blowout, but blowouts do not always follow a LOWC incident. Also, the frequency of LOWCs can vary with the type of well drilled. The International Association of Oil and Gas Producers estimates the frequency of LOWC events at 3.6×10^{-4} gas blowouts per exploration well, and at 7.0×10^{-4} gas blowouts per development well drilled (IAOGP, 2010). The production well-control blowout incident rate for production of gas is an order of magnitude lower, estimated at 5.7×10^{-5} blowouts per well year (IAOGP, 2010). The estimated mean number of gas releases is less than one (0.04). The chance of no gas blowouts occurring is 96% and the chance of a gas release occurring is 4% over the life of the Proposed Action or its alternatives.

In year 8, infrastructure will have been installed, and sale of natural gas from the Sale Area is expected to begin. When this occurs, it is assumed that one well control incident of a single well on the facility could occur, releasing 8 million cubic feet of natural gas for one day. This is based on the average well production for one day from one well and the estimated rates of blowout duration for gas production wells.

Ruptured Pipeline

Although unlikely, there exists some potential for a gas pipeline to rupture. The estimated rate of offshore gas pipeline ruptures in the Gulf of Mexico is 2.4×10^{-5} per mile-year (USDOI, MMS, 2009). For a 115 mile offshore gas transmission pipeline system, over a 33 year production life, the estimated number of incidents is 0.09 offshore gas pipeline ruptures over the life of the gas sales. For onshore gas pipelines, the estimated spill rate for a generic DOT onshore gas transmission lines from 1994-2013 is 1.5×10^{-4} spill or release per pipeline mile per year (USDOT, 2013a, b). For a 50 mile onshore pipeline, over a 33 year production life, the estimated number of significant incidents using

DOT's estimated rate is 0.27 pipeline incidents over the life of the gas sales. Under DOT regulation, significant incidents are incidents that involve property damage of more than $50,000, injury, death, release of gas, or that are otherwise considered significant by the operator.

If a major release of dry natural gas would occur, this would cause a sudden decrease in gas pressure, which in turn would automatically initiate procedures to close the valves on both ends of the ruptured segment of pipeline. Closure of the valves would effectively isolate the rupture and limit the amount of natural gas released into the environment. Given the daily flow rate and the estimated total number of valves, it is estimated that approximately 20 million cubic feet could be released within one pipe section between two valves. Onshore any gas releases from an elevated pipeline would disperse into the atmosphere. There is some small potential for ignition.

Onshore Facility

Although unlikely, there remains some potential for a gas leak and explosion at the onshore facility, due to the enclosed space in the facility.

Gas Release Fate

Natural gas is primarily made of up methane CH_4 and ethane C_2H_6 which make up 85-90% of the volume of the mixture. Propane, butane, and heavier hydrocarbons can be extracted from the gas system and liquefied for transportation and storage. These natural gas products are commonly known as liquid petroleum gas or LPG. Pentanes through decane are the intermediate-weight hydrocarbons and are volatile liquids at atmospheric temperature and pressure. The common names for these natural gas products are pentanes-plus, condensate, natural gasoline, and natural gas liquids (NGLs). Produced gas is expected to be dry gas (no water or condensates).

In the event of a pipeline rupture, the leak detection system would close the pipeline isolation valves. Any release would be almost entirely vapor, rather than liquid. Winter temperatures could cause the butane and pentane components to initially remain in a liquid state. However, if any liquids formed, much of the volume would quickly evaporate due to the volatile nature of NGLs. The consequences of an accidental spill of NGLs as a result of a pipeline rupture could include fire and/or explosion of NGL vapors.

The primary component of natural gas is methane, a colorless, odorless, and tasteless gas. It is not toxic in the atmosphere, but is classified as a simple asphyxiate, possessing an inhalation hazard. As with all hydrocarbon gases, if inhaled in high enough concentration, oxygen deficiency could occur and result in suffocation. The specific gravity of methane is 0.55 (Air = 1.0). Being lighter than ambient air, it has the tendency to rise and dissipate into the atmosphere, rather than settle into low areas. For this reason, natural gas leaks are assumed to rise and disperse.

A-7. Very Large Oil Spills

Very large spills could potentially come from four sources associated with OCS exploration or development operations: (1) pipelines (2) facilities (3) tankers or (4) support vessels. BOEM reviewed those four sources and determined that loss of well-control (LOWC) incidents have the potential for the largest spill volumes, assuming all primary and secondary safeguards fail and the well does not bridge (collapse in on itself). At this time, pipelines are the preferred mode of petroleum transport (over tankers) in the Cook Inlet OCS and, therefore, BOEM did not consider the loss of a fully loaded tanker. The loss of the entire volume in an offshore pipeline would be less than a long duration well control incident with high flow rates. Sizes of spills from support vessels were considered based on foundering and the loss of entire fuel tanks, and determined to be lower in volume than a well control incident where all primary and secondary safeguards failed. For purposes of analysis, BOEM examined a well control incident which escalates into a long duration blowout requiring a relief well to terminate the flow. This EIS details the oil spill analysis results that are relevant to the very large oil spill (VLOS) analysis in Chapter 5.

A-7.1. VLOS Scenario

To facilitate analysis of the potential environmental impacts of a VLOS in the Cook Inlet, it is first necessary to develop a VLOS scenario. Scenarios are conceptual views of the future and represent possible sets of activities. They serve as planning tools that make possible an objective and organized analysis of hypothetical events. This VLOS scenario is not to be confused with what would be expected to occur as a result of any of the action alternatives.

The VLOS scenario is sometimes confused with worst-case discharge (WCD) analyses, which are used to evaluate an Exploration Plan (EP) or Development and Production Plan (DPP). Both calculations are alike to the extent that they are performed by BOEM using similar assumptions and identical analytical methods. However, these calculations differ in several important ways (Table A.1-24):

Very Large Oil Spill. Rather than analyzing a specific drilling proposal, the VLOS model selected a prospect within an area that potentially maximizes the variables driving high flow rates. Therefore, the VLOS scenario represents an extreme case in flow rate and discharge period that, in turn, represents the largest discharge expected from any site in the subject area.

Worst-Case Discharge. Site-specific WCDs at sites identified in a submitted plan in the subject area would typically result in much lower initial rates and aggregate discharges if discharge periods are held equal. The calculations also differ in their purpose. Whereas the VLOS scenario is a planning tool for NEPA environmental impacts analysis, a WCD is the calculation required by 30 CFR Part 250 to accompany an Exploration Plan or Development and Production Plan and provide a basis for an Oil-spill Response Plan.

The VLOS scenario is predicated on an unlikely event—a loss of well control during exploration or development that leads to a long duration blowout and a resulting VLOS. Information on OCS well control incidents was addressed in Section A-4.4.1. It is recognized that the frequency for a VLOS on the OCS from a well control incident is very low. Recent analyses have estimated the frequency ranges from $>10^{-4}$ – $<10^{-5}$ (USDOI, BOEM, 2012a, Table 4.3.3; Bercha Group, Inc., 2014a).

The low chance that the exploration well would successfully locate a large oil accumulation, coupled with the observed low incidence rates for accidental discharges in the course of actual drilling operations, predicts a very small, but not impossibly small, chance for the occurrence of a VLOS event. But this consideration of probability is not, nor should it be, integrated into the VLOS model. The VLOS discharge quantity is “conditioned” upon the assumption that all of the necessary chain of events required to create the VLOS actually occur (successful geology, operational failures, escaping confinement measures, reaching the marine environment, etc.). The VLOS discharge quantity is, therefore, not “risked” or reduced by the very low frequency for the occurrence of the event.

A-7.1.1. VLOS Scenario Parameters

A-7.1.1.1. Rate, Time and Composition of Hypothetical Spill

The VLOS scenario assumes a blowout leading to a very large oil spill. In developing this scenario, BOEM first generated a hypothetical oil discharge model that estimates the highest possible uncontrolled flow rate that could occur from any known prospect in the Sale Area, given real world constraints. The discharge model was constructed using a geologic model for a specific prospect in conjunction with a commercially-available computer program (AVALON/MERLIN) that forecasts the flow of fluids from the reservoir into the well, models the dynamics of multiphase (primarily oil and gas) flow up the wellbore, and assesses constraints on flow rate imposed by the open wellbore and shallower well casing. This model utilized information and selected variables that, individually and collectively, provided a maximized rate of flow. The most important variables for the discharge model included thickness, permeability, oil viscosity, gas content of oil, and reservoir pressure. Many other variables of lesser importance were also required.

Table A.1-25 summarizes the results of the discharge model for the hypothetical well. The oil discharge climbs rapidly to over 2,100 bbl/day during Day 1. After peaking in Day 1, Figure A-1 shows that the oil discharge (green boxes) declines through the days of flow as the reservoir is depressurized by approximately 228 psia by day 80 (Table A.1-25).

The decline in the flow rate flattens somewhat after Day 12, then declines gradually to 1,382 STB/day (65% of the Day 1 peak rate of 2,135 STB/day) by Day 80 when the near-wellbore reservoir pressure has fallen to 2,892 psia or 80% of the initial reservoir pressure (3,120 psia). The total oil discharge by the end of the flow period on Day 80 is 121,467 STB.

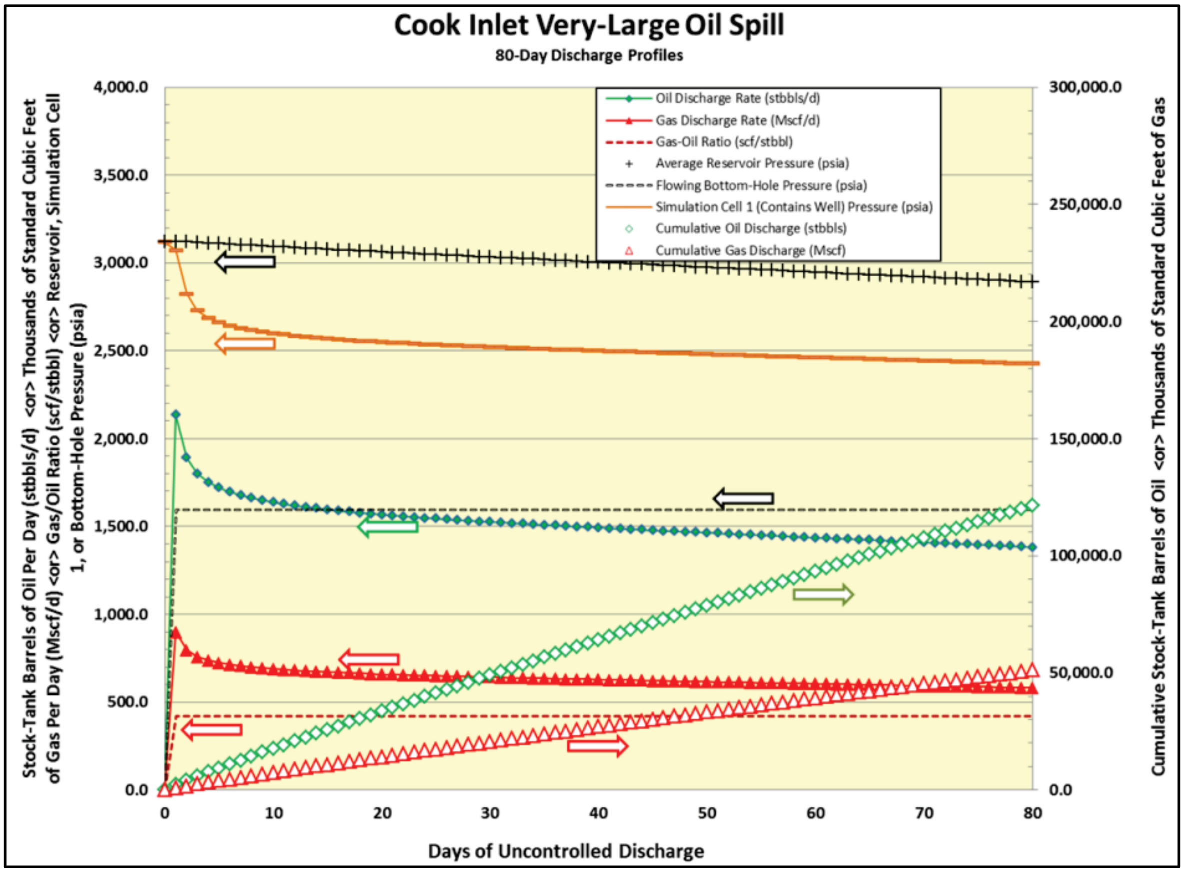


Figure A- 1. Changing 80 Day Discharge Rate after Well Blowout. *Decline in daily discharge rates and rising cumulative oil discharge for an 80-day period after a blowout at a hypothetical exploration well in the Cook Inlet Planning Area.*

The oil discharged from the hypothetical well is estimated to be 23° API crude oil like that recovered at the Pennzoil Starichokof State 1 well. This type of crude oil is believed to typify the Hemlock-Lower Kenai Group reservoirs in the southern part of the Cook Inlet geologic basin. The oil in the hypothetical reservoir is initially undersaturated (with gas) at a gas-oil ratio of 421 SCF/STB (quantities at standard conditions of 60°F (15.6°C) and 1 atm.) and this is reflected by the fact that the initial produced gas-oil ratio in the flow model (Day 1, see Table A.1-25) is also 421 SCF/STB. Water production over the flow period is minimal (as shown in Table A.1-25) because of the higher relative permeability to oil within the oil-saturated reservoir and the assumed absence of a brine-saturated reservoir in contact with the wellbore.

A-7.1.1.2. Cause of Spill

This scenario begins with an unlikely event: a loss of well control during drilling, workover or production that leads to a long duration blowout and a VLOS.

For the purpose of the analysis, an explosion and subsequent fire are assumed to occur. A blowout associated with a single well could result in a fire that would burn for 1 or 2 days. The exploration drilling rig may sink. If the blowout occurs in shallow water, the sinking rig may land in the immediate vicinity; if the blowout occurs in deeper water, the rig could land a great distance away. For example, the Deepwater Horizon drilling rig sank, landing 1,500 feet from the subsea wellhead.

Water depths in the majority of the Sale Area range from about 30 feet to approximately 210 feet; this range is considered shallow water.

For the purpose of modeling flow rates, the location of the blowout and leak was specified as occurring near the mudline (at the top of the blowout preventer). For the purpose of environmental effects analysis, it is acknowledged that a blowout could occur in other locations, such as at the sea surface, along the riser anywhere from the seafloor to the sea surface, or below the seafloor (outside the wellbore). The environmental effects analysis in Chapter 5 encompasses all these possibilities. As different blowout and leak locations may have bearing on spill response and intervention options.

A-7.1.1.3. Timing of the Initial Event

For purposes of analysis, the hypothetical VLOS is estimated to occur any time of the year January through December. Any drilling associated with the Proposed Action would be anticipated to occur within eight years of the lease sale at the conclusion of this NEPA process based on historic lease terms for Cook Inlet. The lease sale can also be canceled, in which case no drilling would occur as a result of Lease Sale 244.

A-7.1.1.4. Volume of Spill

Well blowouts generally involve two types of hydrocarbons, namely crude oil (or condensate) and natural gas. The volume ratio of these two fluids is a function of the characteristics of the fluids and the producing reservoir.

Table A.1-25 summarizes the results of the discharge model for the hypothetical VLOS. The oil discharge climbs rapidly to over 2,100 STB/d during day one. After peaking in Day 1, Figure A-1 shows that the oil discharge declines through the first 80 days of flow as the reservoir is depressurized by approximately 618 psi (Table A.1-25). As shown in Table A.1-25, the cumulative oil discharge over an 80-day spill is 121,467 STB. To simplify the analysis, BOEM estimates 120,000 bbl of oil are spilled in the VLOS scenario.

A-7.1.1.5. Duration of Spill

The duration of the offshore spill from a blowout depends on the time required for successful intervention. Intervention may take a variety of forms. There exists a variety of methods by which an operator or responder can stop the flow of oil. The availability of some of these techniques could vary under individual exploration plans. Under NTL 2015-N01, all exploration plans must specify as accurately as possible the time it would take to contract for a rig, move it on site, and drill a relief well (USDOI, BOEM, 2015). For purposes of analysis within this VLOS scenario, BOEM estimates the discharge would be stopped within 80 days of the initial event. This duration reflects the longest of three estimated time periods for completing a relief well as described in Table A.1-26 and rounded up to the nearest ten.

A-7.1.2. Spill Cause, Movement, and Response Parameters

The following discussion describes additional parameters of the VLOS scenario. These parameters are based on reasonably foreseeable factors related to oil spills, based on past VLOS events (i.e. the Exxon Valdez Oil Spill (EVOS), DWH event, and the Ixtoc oil spill), published scientific reports, consideration of Arctic-specific conditions, and application of best professional judgment. The result is a framework for identifying the most likely and most significant impacts of the hypothetical VLOS event. Key aspects of the scenario are listed below:

- A loss of well control during exploration drilling leads to a blowout and an ongoing, high volume release of crude oil and gas that continues for up to 40-80 days
- Oil remains on the surface of the water for up to a few weeks after flow has stopped
- The total volume of the oil is nearly 120,000 STB and the volume of the gas is 51 MSCF (million cubic feet)—within 80 days

- Roughly 17-20 percent of the VLOS evaporates. A small portion of the spill remains in the water column as small droplets. The remaining oil could be physically or chemically dispersed, sedimented, beached, weathered into tar balls, or biodegraded
- Information about where a very large spill could go and how long it takes to contact resources is estimated by an oil-spill trajectory model

A-7.1.2.1. Area of Spill

When oil reaches the sea surface, it spreads. The speed and extent of spreading depends on the type of oil and volume that is spilled. A spill of the size analyzed here would likely spread hundreds of square miles with some trajectories reaching lower Shelikof Strait. Also, the oil slick may break into several smaller slicks, depending on local wind patterns that drive the surface currents in the spill area. Estimates of where the oil spill would go were taken from the OSRA trajectory analysis (see Appendix A, Section A-7.5 and A.2-24, 25, 29, 30, 34, 35, 39, 40, 44, 45, 49, 50, 54, 55, 59 and 60).

A-7.1.2.2. Oil in the Environment: Properties and Persistence

The fate of oil in the environment depends on many factors, such as the source and composition of the oil, as well as its persistence (NRC, 2003). Persistence can be defined and measured in different ways (Davis et al., 2004), but the National Research Council (NRC) generally defines persistence as how long oil remains in the environment (NRC, 2003). Once oil enters the environment, it begins to change through physical, chemical, and biological weathering processes (NRC, 2003). These processes may interact and affect the properties and persistence of the oil through:

- Evaporation (volatilization)
- Emulsification (the formation of a mousse)
- Dissolution
- Oxidation
- Transport processes (NRC, 2003)

Horizontal transport takes place via spreading, advection, dispersion, and entrainment while vertical transport takes place via dispersion, entrainment, Langmuir circulation, sinking, overwashing, partitioning, and sedimentation (USDOI, MMS, 2007 FEIS, Appendix A, Figure A.1-1 Fate of Oils Spills in the Ocean During Arctic Summer, and Figure A-2. Fate of Oil Spills in the Ocean During Arctic Winter). The persistence of an oil slick is influenced by the effectiveness of oil-spill response efforts and affects the resources needed for oil recovery (Davis et al., 2004). The persistence of an oil slick may also affect the severity of environmental impacts as a result of the spilled oil.

Crude oils are not a single chemical, but instead are complex mixtures with varied compositions. Thus, the behavior of the oil and the risk the oil poses to natural resources depends on the composition of the specific oil encountered (Michel, 1992). Generally, oils can be divided into three groups of compounds: (1) light-weight, (2) medium-weight, and (3) heavy-weight components.

The oil discharged from the hypothetical Cook Inlet VLOS well is 23° API crude oil. This oil would be considered medium-weight as shown in Table A.1-27. On average, medium-weight crude oils are characterized as outlined in Table A.1-27.

Previous studies (Boehm and Fiest, 1982) supported the estimate that most released oil in shallow waters similar to the Cook Inlet would reach the surface of the water column. A small portion (1-3%) of the Ixtoc oil remained in the water column (dispersants were used), although limited scientific investigation occurred and analytical chemical methods 30 years ago may not have been as sensitive as today (Boehm and Fiest, 1982; Reible, 2010).

A-7.1.2.3. Release of Natural Gas

The quality and quantity of components in natural gas vary widely by the field, reservoir, or location from which the natural gas is produced. The oil in the VLOS reservoir is assumed to be initially undersaturated (with gas) at a gas-oil ratio of 421 SCF/STB (quantities at standard conditions of 60°F

(15.6°C) and 1.0 atm.) and this is reflected by the fact that the initial (Day 1) produced gas-oil ratio in the model (Table 4-55) is also 421 cf/bbl. As shown in Table A.1-25, the produced gas-oil ratio remains constant at 421 cf/bbl during the discharge period.

Gas discharge reaches a peak of 899 MSCF/d in Day 1 of the flow, falling to a minimum rate of 582 MSCF/day on Day 80. The cumulative gas discharge over the 80-day period (assumes completion of a relief well is required for the very large discharge case) is 51,138 MSCF. For purposes of analysis BOEM estimates 0.051 Bcf billion cubic feet. Natural gas is primarily made up of methane (CH_4) and ethane (C_2H_6) which make up 85-90% of the volume of the mixture.

A-7.1.2.4. Duration of Subsea and Shoreline Oiling

The duration of the shoreline oiling is measured from initial shoreline contact until the well is capped or killed and the remaining surface oil dissipates offshore. Depending on the spill's location in relation to winds, ice, and currents and the well's distance to shore, oil could reach the coast within 1 day to 110 days based on BOEM oil-spill trajectory analysis (Appendix A). While it is estimated that the majority of spilled surface oil would evaporate and naturally disperse offshore within 30 days of stopping the flow, some oil may remain in coastal areas until cleaned, as seen following the EVOS and DWH event (Michel et al., 2013). The generation of oil suspended particulate material or subsurface plumes from the well head would stop when the well was capped or killed. Subsurface plumes would dissipate over time due to mixing and advection (Boehm and Fiest, 1982).

A-7.1.2.5. Volume of Oil Reaching Shore

In the event of a VLOS, not all of the oil spilled would contact shore. The volume of oil recovered and chemically or naturally dispersed would vary. For example, the following are recovery and cleanup rates from previous high-volume, extended spills (Wolfe et al., 1994; Gundlach and Boehm, 1981; Gundlach et al., 1983; Lubchenco et al., 2010):

10-40 percent of oil recovered or reduced (including burned, chemically dispersed, and skimmed).

25-40 percent of oil naturally dispersed, evaporated, or dissolved.

20-65 percent of the oil remains offshore until biodegraded or until reaching shore.

In the case of the DWH event, "it is estimated that burning, skimming and direct recovery from the wellhead removed one quarter (25%) of the oil released from the wellhead. One quarter (25%) of the total oil naturally evaporated or dissolved, and just less than one quarter (24%) was dispersed (either naturally or as a result of operations) as microscopic droplets into Gulf waters. The residual amount–just over one quarter (26%)–is either on or just below the surface as light sheen and weathered tar balls, has washed ashore or been collected from the shore, or is buried in sand and sediments" (Federal Interagency Solutions Group, 2010). For planning purposes, USCG estimates that 5–30 percent of oil would reach shore in the event of an offshore spill (33 CFR Part 154, Appendix C, Table 2).

A-7.1.2.6. Length of Shoreline Contacted

While larger spill volumes increase the chance of oil reaching the shoreline, other factors that influence the length and location of shoreline contacted include the duration of the spill and the well's location in relation to winds, ice, currents, and the shoreline. The length of oiled shoreline increases over time as the spill continues. Dependent upon winds and currents throughout the VLOS event, already impacted areas could have oil refloated and oil other areas, increasing the oiled area.

A VLOS from a nearshore site would allow less time for oil to be weathered, dispersed, and/or recovered before reaching shore. This could result in a more concentrated and toxic oiling of the shoreline. A release site farther from shore could allow more time for oil to be weathered, dispersed, and recovered. This could result in a broader, patchier oiling of the shoreline.

A-7.1.2.7. Environmental Variables

The environmental conditions common to Cook Inlet/Shelikof Strait that might influence overall effectiveness of an oil spill response effort include:

- Weather (e.g., wind, visibility, precipitation, or temperature)
- Sea states, tides, or currents
- Ice or debris presence
- Natural hazards

A-7.1.2.7.1. Weather

The meteorological and topographical features of GOA cause the Cook Inlet and Shelikof Strait to be subject to marine extratropical cyclones, often relating to the passage of a low pressure system that extends south hundreds of miles. These storms move east along the Aleutian Islands from the western Pacific and are impeded by the inlet's mountainous terrain, which can cause dangerous wind conditions (NOAA, 2012). These topographical features block east-west airflow causing the formation of "channel winds" to the north and south (Schumacher, 2005).The consequences of the pressure and temperature disparity are channel winds that sometimes gust to 50 meters per second (about 97 knots, kts; 112 miles per hour, mph). The wind may flow "down Inlet" from the upper Cook Inlet while cross-channel east winds occur in the lower Cook Inlet causing convergent winds. Conversely, "up Inlet" winds combine with cross-channel winds to produce divergent wind conditions (Olsson and Liu, 2009). Mountain-gap winds create "williwaws" and waterspouts can create hazardous conditions for mariners and aviators (USDOI, MMS, 2003). A williwaw is a sudden and violent blast of wind descending from a mountainous coast to the sea. Olsson and Liu (as cited in Schumacher, 2005) note that the relative lack of direct wind observations in Cook Inlet makes quantification of such small-scale phenomena unfeasible, although they could impact boats and aircraft in the region at any given time.

Darkness, fog, falling snow, particularly heavy snowfall, and heavy rain can affect visibility. Five miles of visibility is required for dispersant operations by aircraft; booming and skimming vessels require between 0.125 nautical miles (nm) (200 m) and 0.5 nm (800 m) of visibility. Cook Inlet experiences 5.5 hours of sunlight in mid-winter, which increases to 19.5 hours by mid-summer. Based on Anchorage weather data from the U.S. Naval Observatory and reported in the CIPLC's 2012 ODPCP, low visibility of less than 1.0 nm (1.15 mi (6,000 feet) occurs only about four to five percent of the time, and is the lowest in the month of January.

Precipitation is common in Cook Inlet. Up to eight meters a year of liquid equivalent (wet) precipitation falls as a result of storms that occur once every four to five days, mostly in the cold season (Olsson and Liu, 2009). The average wet precipitation in Kenai is 20 inches (0.5 m) predominantly from late September through early January. Most wet precipitation falls as light rain and snow. In Homer, moderate rainfall is most likely in the late summer to early fall, and continues through early January; averaging 24 inches (0.61 m) in Homer (WRCC, 2015).

Colder temperatures affect response personnel and equipment. In Kenai, monthly temperatures average 7 to 63 degrees Fahrenheit (ºF), and can drop to -20ºF in December and January. In Homer, the monthly temperatures average 19 to 61ºF and are rarely below zero with an average at 5 to 10ºF in December and January (WRCC, 2015). Kenai's highest average monthly wind speed is 9 mph (7.9 kts) so that the wind chill could drop as low as -40ºF in the winter. Homer's highest average monthly wind speed is 28 mph (24 kts) so that the wind chill would be -15 ºF (WRCC, 2015).

A-7.1.2.7.2. Sea States, Tides and Currents

Tides may affect response efforts by producing varying sea states requiring different approaches to response. Tidal rips, which are strong, localized, and rather narrow currents of water, can also transport floating oil, and oil stranded on shorelines can be transported into nearshore waters and sediment during storms. Rip currents or "rip tides" are areas of rough water caused by opposing currents. The Cook Inlet can experience the largest tidal fluctuations in the world, which may exceed 20 feet (6 m). The tidal velocity of such fluctuations may be as fast as 9 mph (8 kts). There are three major oscillatory tidal currents, or rip currents, in the central portion of Cook Inlet (Oey et al., 2007). They are found east of Kalgin Island between Anchor Point and the Forelands – the East rip, the Mid-channel rip, and the West Rip (CIPLC, 2012 ODPCP, Appendix B, Figures 10-13).

A-7.1.2.7.3. Sea Ice

Sea ice can create unsafe working conditions or hamper the efficiency of oil spill response. While ice may be present in several forms, such as pack ice, shorefast ice, estuary and river ice, the largest portion of ice in Cook Inlet is freshwater ice that forms in the rivers and estuaries. The unique topography and weather systems experienced in the Cook Inlet, the Shelikof Strait, and the GOA make forecasting ice conditions difficult. The process is complicated by daily temperatures that often rise above freezing. Tidal action in the area creates piles of ice on the mud flats. Ice usually begins to form in Cook Inlet in October, expanding through November, and melts in the spring. While ice may reduce spill response options, the ice protects the shorelines and rivers from oil.

A-7.1.2.7.4. Natural Hazards

Several volcanoes lie on the west side of Cook Inlet, including Spurr, Redoubt, Iliamna, and Augustine. Volcanic eruptions may cause decreased visibility, excessive ash in the air (a hazard to personnel and aircraft), and inability to use equipment due to abrasive ash fall.

A-7.1.2.8. Recovery and Cleanup

The hypothetical VLOS scenario outlined thus far would trigger an extensive spill recovery and cleanup effort. It is anticipated that efforts to respond to a VLOS in the Cook Inlet would include the recovery and cleanup techniques and estimated levels of activities described below. It is noted that severe weather and/or the presence of ice could interfere with or temporarily preclude each of these methods. The effect of ice is analyzed in greater detail below in “Effect of Ice on Response Actions.” For a comprehensive list of Arctic oil-spill response research projects that BSEE has funded, the reader is referred to BSEE Arctic Oil-spill Response research (USDOI, BSEE, 2014b) which includes the subarctic areas.

In the event of a VLOS, two governmental organizations would assume prominent roles in coordinating response efforts: the Federal On-Scene Coordinator (FOSC), and the Alaska Regional Response Team (ARRT). The ARRT is an advisory board to the FOSC that provides Federal, state, and local governmental agencies with means to participate in response to pollution incidents. During a response the FOSC would consult with the ARRT on a routine basis for input regarding response operations and priorities. In addition to their advisory role during a response event, the ARRT is responsible for developing the Alaska Federal/State Preparedness Plan for Response to Oil and Hazardous Substance Discharges/Releases (Unified Plan), which details governmental incident response planning and responsibilities for the State of Alaska and 10 Subarea Contingency Plans, which provide region-specific response planning information for establishing operations in the event of a major response effort to an oil spill or hazardous material release. The Subarea Contingency Plans identify notification requirements, emergency response command structures, response procedures, community profiles, in-region response assets, logistics guidance, spill scenarios that could be encountered in the region and sensitive areas identification along with geographic response strategies, which provide suggested response actions to protect the resources at risk from a release of oil. For exploration activities in the Cook Inlet the Cook Inlet Subarea Contingency Plan is the applicable documents for addressing oil-spill response in the region.

Mechanical Recovery. Both mechanical and non-mechanical methods of oil-spill response can be utilized in the Cook Inlet to mitigate the impacts of an oil spill on the environment. The preferred means of spill response is mechanical recovery of the oil, which physically removes oil from the ocean. Mechanical recovery is accomplished through the use of devices such as containment booms and skimmers. A containment boom is deployed in the water and positioned within an oil slick to contain and concentrate oil into a pool thick enough to permit collection by a skimmer. The skimmer collects the oil and transfers it to a storage vessel (storage barges or oil tankers) where it will eventually be transferred to shore for appropriate recycling or disposal.

Dispersants. Although recent research in the use and effectiveness of chemical dispersants has shown varied results, use of dispersants may still be a response option for the Cook Inlet. Some research has shown that dispersants can be effective in cold and ice infested waters under certain conditions

(Belore et al, 2009). Recently completed field scale tests conducted by SINTEF (SINTEF, 2010) as part of the Oil in Ice Joint Industry Project (JIP) in the Barents Sea have demonstrated that results from lab scale and large wave tank tests hold true in actual ocean conditions. Oil released into the ocean during broken ice conditions was readily dispersed and addition of vessel propeller wash for increased wave energy results in increased oil dispersion in these conditions. It was also demonstrated that in these cold conditions weathering of the oil was significantly slowed providing a greater window of opportunity in which to successfully apply dispersants.

Dispersant application can be accomplished by means of injection at the source or through aerial or vessel based application. There are dispersant stockpiles located in Anchorage and the Lower 48 states. Dispersant use is limited to ocean application in waters generally deeper than 10 meters; this depth restriction is used to avoid or reduce potential toxicity concerns with respect to nearshore organisms.

The Unified Plan for Alaska does not have preapproved dispersant application zones for the Cook Inlet, so each request for dispersant application would be evaluated and approved or disapproved on a case-by-case basis by the FOSC in consultation with the EPA, DOI, and DOC. The decision regarding how and when dispersants would be applied would also reside with the FOSC in consultation with EPA, DOI, and DOC. Procedures governing the application of dispersants are provided in “The Alaska Federal and State Preparedness Plan for Response to Oil and Hazardous Substance Discharges and Releases” (Unified Plan) (ARRT, 2010). However, the FOSC is not limited to this procedure and may utilize other sources of information in determining what the most appropriate dispersant method would be given a specific situation.

In-situ Burning. In-situ burning is also a viable response method for the Cook Inlet and could be approved by the FOSC in consultation with the Unified Command and the ARRT. Any in-situ burning would be conducted in accordance with the Alaska Department of Environmental Conservation’s 2008 In-situ Burning Guidelines (ARRT, 2010). In-situ burning is a method that can be used in open ocean, broken ice, near shore and shoreline cleanup operations. In broken ice conditions, the ice acts as a natural containment boom limiting the spread of oil and concentrating it into thicker slicks, which aid in starting and maintaining combustion. In-situ burning has the potential to remove in excess of 90% of the volume of oil involved in the burn. In-situ burning experiments of oil in ice conducted as part of the Sintef JIP (SINTEF, 2010) has likewise demonstrated that cold temperatures serve to slow weathering of the oil, in turn expanding the window of opportunity for in-situ burning application over that experienced in more temperate regions.

Effect of Ice on Response Actions. For all response options, the presence of ice can both aid and hinder oil-spill response activities. Ice acts as a natural containment device preventing the rapid spread of oil across the ocean surface; it also serves to concentrate and thicken the oil allowing for more efficient skimming, dispersant application, and in-situ burning operations. Once shorefast ice is formed, it serves as a protective barrier limiting or preventing oil from contacting shorelines. Cold temperatures and ice will slow the weathering process by reducing volatilization of lighter volatile compounds of the oil, reducing impact of wind and waves, and extending the window of opportunity in which responders may utilize their response tools.

Conversely, ice can limit responders’ ability to detect and locate the oil, access the oil by vessel, prevent the flow of oil to skimmers, require thicker pools to permit in-situ burning and eventually encapsulate the oil within a growing ice sheet making access difficult or impossible. Once incorporated into the ice, further recovery operations would have to cease until the ice sheet becomes stable and safe enough to support equipment and personnel to excavate and/or trench through the ice to access the oil. The other response option is embedding tracking devices in the ice and monitoring its location until the ice sheet begins to melt and the oil surfaces through brine channels, at which time it could be collected or burned.

Levels of Recovery and Cleanup Activities. The levels of activities required to apply the techniques described above are dependent on the specific timing and location of a spill. As weather, ice, and logistical considerations allow, the number of vessels and responders would increase exponentially as a spill continues. The levels of activities described below are reasonable estimates provided as a basis for analysis. These estimates are based on Subarea Contingency Plans for the Cook Inlet and Kodiak subareas, past spill response and cleanup efforts including the EVOS and DWH events, and the best professional judgment of BOEM spill response experts.

- Between 5 and 10 staging areas would be established.
- About 15 to 20 vessels (i.e. vessels from Cook Inlet, Kodiak and Prince William Sound, and other vessels of opportunity) could be used in offshore areas. Some of these would be capable of oil skimming. The majority of open ocean vessels would be positioned relatively close to the source of the oil spill to capture oil in the thickest slicks, thus enabling the greatest rate of recovery.
- Thousands of responders (from industry, the Federal government, and private entities) could assist spill response and cleanup efforts as the spill progresses. Weather permitting, roughly 100 skimming, booming, and lightering vessels could be used in areas closer to shore. Based on the trajectory of the slick, shallow water vessels would be deployed to areas identified as priority protection sites.
- Booming would occur, dependent upon the location of the potentially impacted shoreline, environmental considerations, and agreed upon protection strategies involving the local potentially impacted communities. About 100 booming teams could monitor and operate in multiple areas.
- Use of dispersants and/or in-situ burning could occur if authorized by the Federal On-Scene Coordinator (FOSC). Use of dispersants would likely concentrate on the source of the flow or be conducted so as to protect sensitive resources. In-situ burning operations would likewise be conducted in the area of thickest concentration to ensure the highest efficiency for the effort. In-situ burning may also be utilized in nearshore and shoreline response where approved by FOSC.
- Dozens of planes and helicopters would fly over the spill area, including impacted coastal areas. Existing airport facilities along the Cook Inlet Shelikof Strait coast (including airports at Anchorage, Kenai, Homer, Seldovia, Port Graham, Kodiak, and any other suitable airstrips) would be used to support these aircraft. If aircraft are to apply dispersants, they could do so from altitudes of 50 to 100 feet.
- Workers could be housed offshore on vessels or in temporary camps at the 5–10 staging areas.

Depending on the timing and location of the spill, the above efforts could be affected by seasonal considerations. In the event that response efforts continue into the winter season, small vessel traffic would come to a halt once the forming ice begins to form on the shoreline and drift in sufficient concentration on the ocean surface. Larger skimming vessels could continue until conditions prevent oil from flowing into the skimmers. At this point, operations could shift to in-situ burning if sufficient thicknesses are encountered. The lack of daylight during winter months would increase the difficulties of response. Depending on the location and the ice concentration, the focus of the response would shift to placing tracking devices in the forming ice sheet to follow the oil as it is encapsulated into the ice sheet.

While it is estimated that the majority of spilled oil on the water surface would be dissipated within a few weeks of stopping the flow (Federal Interagency Solutions Group, 2010) during open water, oil has the potential to persist in the environment long after a spill event and has been detected in sediment 30 years after a spill (Etkin, McCay, and Michel, 2007). On coarse sand and gravel or cobble armored beaches, oil can sink deep into the sediments. In tidal flats and salt marshes, oil may seep into the muddy bottoms.

Effectiveness of intervention, response and cleanup efforts depends on the spatial location of the blowout, leak path of the oil and amount of ice in the area. For the purpose of analysis, effectiveness of response techniques is not factored into the spill volume posited by this scenario nor considered during OSRA modeling.

A-7.1.3. Behavior and Fate of a Very Large Crude Oil Spill

The Lease Sale 193 FEIS Appendix A.1, Section B, and this Appendix, Section A-2.1 summarize the behavior and fate of crude oil. This section summarizes and updates relevant information to the VLOS analysis.

A-7.1.3.1. Release from a Well Control Incident

A very large oil and gas release could rise to the ocean surface from shallow to moderate depths on the seafloor (e.g. 1979 Ixtoc I spill) or fall from the top of the rig or platform to the surface of the ocean. The force of the gas would facilitate the formation of small oil droplets (0.5 – 2.0 mm) and to disperse them in the ocean or atmosphere (Dickins and Buist, 1981; Belore, McHale and Chapple, 1998; S.L. Ross Environmental Research Ltd, D.F. Dickins and Associates Ltd., and Vaudrey and Associates Inc., 1998). A small portion (1-3%) of droplets could form a plume as identified from Ixtoc at shallow to moderate depths without the injection of dispersants (Boehm and Fiest, 1982). The more soluble compounds within the oil may dissolve, particularly from small droplets that are prevalent in the vertical plume, which is where the vigorous turbulence occurs (Adcroft et al., 2010). Figure A-2 diagrams a subsea blowout in shallow to moderate water depths (Westergaard, 1980).

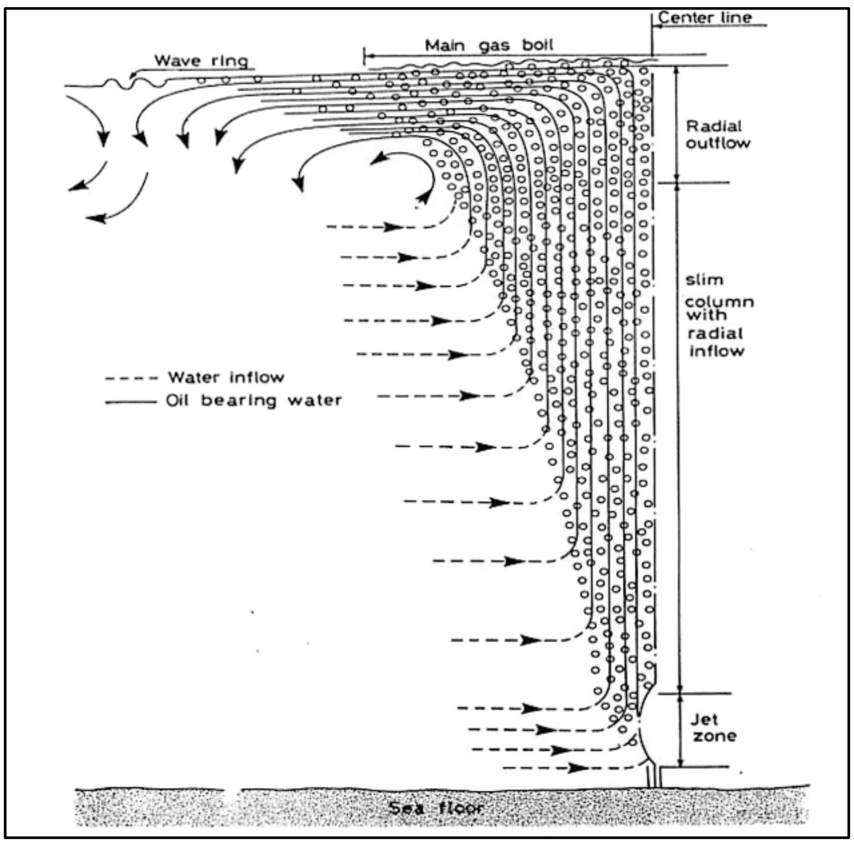


Figure A-2. Shallow (<50 meters) Underwater Blowout Plume *(Westergaard, 1980).*

A subsea release in shallow to moderate depths moves through three zones: (1) a jet zone causing turbulence and droplet formation, (2) a buoyancy zone where gas, oil, and water are carried to the surface and droplet size governs rise velocity, and (3) a surface interaction zone where the surface influence carries the oil with the prevailing currents or ice and the gas exits into the atmosphere, which causes a surface boil zone (Westergaard, 1980; PCCI, 1999; Reed et al., 2006). Volatile organic carbons would be measurable in the atmosphere downwind of the spill in a small area confined to a narrow plume (deGouw et al., 2011; Ryerson et al., 2011) during the summer open water and broken ice seasons.

For well control incidents at shallow to moderate depths, the gas is considered to be an ideal gas with a specific volume decreasing linearly with pressure. Dissolution of gas from rising bubbles may be minimal for incidents at shallow to moderate depth since the residence time of gas bubbles is expected to be short (Reed et al., 2006). Thus, very little of the gas would dissolve in the water column and nearly all of the gas would be released to the atmosphere.

A-7.1.3.2. Ice Present

The fate and behavior of oils in ice conditions is different from oil in temperate water; slower chemical and biological reactions occur when temperatures are lower. First year ice occurs in the northern and western areas of Cook Inlet. The ice would restrict the oil somewhat and reduce spreading (Gjosteen and Loset, 2004; Faksness et al., 2011). Weathering of oil in high-ice concentrations (70-90%) is significantly slower compared to weathering in open water (Brandvik et al., 2010). However, unless the oil is frozen into the ice, evaporation would continue to occur. Dispersion and emulsification rates are lower in broken ice than in open water. During winter freezeup, the oil would freeze into the grease ice and slush before ice sheeting occurs (NORCOR, 1975). Winds and storms could break up and disperse the ice and oil until the next freezing cycle occurs. These freezing cycles could be hours or days.

Faksness and Brandvik (2008a) studied the dissolved water-soluble crude oil components encapsulated in first-year sea ice. Their data show a concentration gradient from the surface of the ice to the bottom, indicating there is transport of the dissolved components up through brine channels. Field studies also showed that high air temperature leads to more porous ice, and the dissolved water-soluble components leak out of the ice rapidly; however, under cold air temperatures and less porous ice, the water-soluble components leak out of the ice more slowly and have potentially toxic concentrations (Faksness and Brandvik, 2008b).

Any oil remaining in the environment during deep winter could freeze into the forming and existing ice sheets (Dickins, 2011; Mar, Inc., et al., 2008). Then, in early spring, the unweathered oil would melt out of the ice at different rates. In first-year ice, most (85%) of the oil spilled at any one time would percolate up to the ice surface over about a 10-day period (Dickens, Buist and Pistruzak, 1981; Dickins et al., 2008; NORCOR, 1975; Nelson and Allen, 1981). Thus, in first-year ice, oil would be pooled on the ice surface for up to 10 days before being discharged from the ice surface to the water surface. The pools on the ice surface would concentrate the oil, but only to about 2 centimeters thick, allowing evaporation of 5% of the oil, the part of the oil composed of the lighter, more toxic components. By the time the oil is released from the melt pools on the ice surface, evaporation will have almost stopped, with only an additional 4% of the spilled oil evaporating during an additional 30 days on the water.

A-7.1.3.3. Open Water

Spilled oil on sea water would move with the currents, ice, and winds. In addition to sunlight breaking down the oil, sunlight also has the potential to cause photo-enhanced toxicity (Barron et al., 2008).

A-7.1.3.4. Persistence

Spilled oil in sediments weathers differently than spilled oil in the open ocean. Shoreline oiling and persistence depends on a number of factors (Etkin, McCay, and Michel, 2007). Certain factors allow for some spills to persist in the shoreline and adjacent intertidal areas for decades (Li and Boufadel, 2010; Owens, Taylor, and Humphrey, 2008; Peacock et al., 2005). Many coastlines of the study area have armored cobbled shores which can impede weathering, and high environmental sensitivity index (ESI) shoreline types such as marshes, peat, and fine-grained sediments to which oil clings. In these environments, oil tends to weather very slowly. The losses of hydrocarbons from both abiotic and biotic weathering in subsea subarctic sediments could be slow (Atlas, Horowitz, and Dushoshi, 1978; Payne, Clayton, and Kirstein, 2003). Table A.1-2 shows the percentage of ESI shoreline types of the adjacent coastlines. In general, the higher the ESI number the longer the persistence of oil. Besides oiling the shore, some components of spilled oil can deposit on the sea floor. Dispersion of oil droplets and suspension of sediments from turbulence at the discharge location could facilitate the formation of oiled sediments and oily particulate matter, which could be deposited on the seafloor in the vicinity of the discharge location (Lee and Page, 1997; Payne, Clayton and Kirstein, 2003; Sterling et al., 2004; Farwell et al., 2009).

Spilled oil can also enter tidal waters and sediments. Lee and Page (1997) reviewed several large spills and estimated 1–13% of the spilled oil entered subtidal zones with an order of magnitude less hydrocarbon concentration than found in intertidal sediments. Exceptions (for less hydrocarbon concentrations) were semi-enclosed areas with clay-silt surface sediments and high concentrations of suspended sediments (Page et al., 1989). Oil persistence in subtidal areas would be weeks to years, except for specific areas described above (Lee and Page, 1997). Biodegradation and weathering of intertidal areas in cold waters were on the order of months to decades (Atlas, Boehm, and Calder, 1981; Prince et al., 2003). A recent study of biodegradation in the Arctic showed that as temperature increased in the Arctic summer, biodegradation increased (Chang, Whyte, and Ghoshal, 2011).

A-7.1.3.5. Very Large Oil-Spill Weathering

The weathering for a very large oil spill is as follows:

- The crude oil properties will be similar to a medium crude oil of 25ºAPI
- The size of the crude oil spill ranges from about 2,100–1,400 bbl per day
- The wind, wave, and temperature conditions are as described
- The spill is a subsurface spill at approximately 40 m (meters)
- Broken ice spills occur into 50% ice cover
- The properties predicted by the model are those of the thick part of the slick
- The spill occurs as a long- duration spill estimated at a daily rate
- The fate and behavior are as modeled (See Table A.1-28)
- The oil spill persists for up to 30 days in open water and ice when the wind speed is under 6 m/s (meters/second)
- The wind speed remains 6 m/s or less

For purposes of analysis, we look at the mass balance of the VLOS; in other words, how much is evaporated, dispersed, and remaining. At the average wind speeds over the Sale 244 Action Area, dispersion is estimated to be moderate, ranging from 11-80% (Table A.1-28). Approximately 17-20% of the spill evaporates within 30 days.

However, at higher wind speeds (e.g., 10-15 m/s wind speed) and during summer, the slick would be dispersed and evaporated from the sea surface within a few days. Natural dispersion would take place if there was sufficient energy on the sea surface, such as breaking waves. The waves would break the oil slick into small droplets, typically with a diameter of 1–1000 µm (micrometers), which are mixed into the water masses (Reed et al., 2005). The largest droplets will resurface causing a thin monomolecular layer or sheen behind the main body of the oil spill. “Remaining” (in Table A.1-28) refers to the oil remaining after subtracting the above estimates from the total estimated release. Possible fates of the remaining oil include: remaining in the water column, settling to the sea floor, mixing with sediment, ingestion by microbes, or beaching on the shoreline with subsequent removal during shore cleanup activities or burial within the beach profile.

A-7.1.4. Very Large Oil Spill Conditional Probabilities

Assuming a hypothetical long-duration oil release occurs resulting in a VLOS, this section describes how the conditional probabilities for a large oil spill should be considered and applied for a VLOS, and where an offshore VLOS may go over longer time periods up to 110 days.

A large spill is modeled differently than a VLOS. A large spill would be represented by a single trajectory, while a VLOS of long duration would be represented by numerous trajectories, as described below.

In a large spill trajectory analysis, it is not estimated that any one trajectory brings oil to a particular location. Rather, the number of trajectories contacting an individual resource over the total number of trajectories launched is used to calculate the percent chance of a hypothetical large spill trajectory contacting that resource. For example, if 1,000 large oil spill trajectories are launched and 500 of the trajectories contact that location, there is a 50% chance of a large spill contacting that location.

A long duration VLOS would consist of a spill occurring continuously for up to 80 days and therefore this type of spill is more like a batch spill launched every day. In this case, there would be multiple trajectories over time with each trajectory launched regularly as the well continued to flow. Each trajectory would model how some fraction of the VLOS could spread to a specific resource or location. The multiple trajectories representing a VLOS would change how the conditional probabilities are interpreted. The conditional probabilities would represent how many trajectories come to that location, as described as percent trajectories (number of trajectories contacting a location/total number of trajectories launched). For example, if 1,000 trajectories are launched and 500 of the trajectories contact a specific location, then 50% of the trajectories would allow oil to be carried to that location. The terminology used hereafter is "percentage of trajectories contacting."

Therefore, the conditional probabilities are used to provide information about both the large and very large spill; however the interpretation of the data changes as discussed above. Appendix A, Tables A.2-24, 25, 29, 30, 34, 35, 39, 40, 44, 45, 49, 50, 54, 55, 59, and 60, which show summer and winter seasons within 30 and 110 days, are applicable to the VLOS conditional analysis.

A.1. Supporting Tables and Maps

Table A.1-1. Oil Spill Estimates: Phase, Activity and Source of Spill, Type of Oil, Number and Size of Spill, and Volume BOEM Assumes for Analysis in Cook Inlet Lease Sale 244 Action Area.

Phase	Type of Oil	Activity	Source of Spill	Number of Spill(s)[1]		Size of Spill(s) (in bbl)	Estimated Total Spill Volume
		Small Spills					
Exploration	**Diesel or Refined**	Geological and Geophysical Activities[2]	Offshore	0-6		<1 or one up to13 bbl	<18 bbl
		Exploration Plan Activities	Offshore and/or Onshore Operational Spills from All Sources	0-4		5 bbl or one up to 50 bbl	65 bbl
Development, Production and Decommissioning	**Crude, Condensate, Diesel or Refined Oil or Gas Release**	Development Plan Activities	Offshore and/or Onshore Operational Spills from all Sources	~450[1] Total			~300[1] bbl
				<1 bbl	432[1]	3 gallons	10 bbl
				1-<50 bbl	16	3 bbl	48 bbl
				50-<500 bbl	2	126 bbl	252 bbl
				500-<1,000 bbl	0	0 bbl	0 bbl
		Large Spills or Gas Releases					
		Development Plan Activities	Onshore Pipeline, or Offshore Pipeline, or Offshore Platform/Storage Tank/Well	Up to 1 from either		2,500 bbl, or 1,700 bbl, or 5,100 bbl	2,500 bbl, or 1,700 bbl, or 5,100 bbl
			Offshore Platform/Well	1 gas release		8 million ft^3	8 million ft^3

Note: [1] These numbers are for Alternatives 1, 3a, 3b, 4a, 4b, 5, or 6 and have been adjusted for rounding.
[2] Geophysical and Geotechnical Activities include Marine Seismic Surveys, Geohazard Surveys and Geotechnical Surveys.

Source: USDOI, BOEM, Alaska OCS Region (2015).

Table A.1-2. Land Segment (LS) ID and the Percent Type of Environmental Sensitivity Index Shoreline Closest to the Ocean for United States, Alaska Shoreline.

LS ID	Geographic Place Names	1A	2A	3A	4	5	6A	7	8A	9A	10A
1	Stepovak Bay, Kupreanof Peninsula, Ivanoff Bay	9	31	1	2	20	12	11	3	2	10
2	Jacob Island, Perryville	26	11	3	20	23	15	3	0	0	0
3	Mitrofania& Chiachi Island, Sosbee Bay	65	0	0	1	23	8	0	2	0	0
4	Mitrofania Bay, Stirni Point, Anchor Bay	24	10	0	21	6	18	4	4	0	13
5	Kuiukta Bay, Seal Cape	34	4	1	0	12	24	3	21	0	2
6	Warner Bay	11	5	0	0	12	24	4	35	4	5
7	Castle Bay, Chignik, Chignik Lagoon	1	17	0	0	16	13	22	6	15	10
8	Chignik Bay	4	32	1	0	22	21	9	1	9	0
9	Kujulik Bay, Unavikshak Island	8	29	1	0	24	6	28	1	3	0
10	Aniakchak Bay, Cape Kumlik, Kumlik Island	0	46	3	0	12	5	27	0	5	1
11	Amber Bay, Yantarni Bay	1	49	2	0	6	9	21	0	12	0
12	Nakalilok Bay, Ugaiushak Island	9	41	7	4	3	9	14	5	6	2
13	Cape Providence, Chiginagak Bay	15	19	0	0	17	23	14	4	8	0
14	Agripina Bay, Ashiiak Island, Cape Kilokak	15	14	1	0	21	11	6	1	28	4
15	Cape Kayakliut, Wide Bay	0	45	0	1	35	2	7	0	10	1
16	Capes Kanatak, Lgvak, and Unalishagvak, Portage Bay	12	40	0	1	19	4	5	1	18	0
17	Cape Aklek, Puale Bay	23	36	0	14	10	0	5	0	12	0
18	Alinchak Bay, Cape Kekurnoi, Bear Bay	5	28	0	1	14	0	17	0	34	1
19	Cape Kubugakli, Kashvik Bay, Katmai Bay	3	16	0	0	3	0	48	0	30	0
20	Amalik, Dakavak and Kinak Bays, Cape Iiktugitak, Takli Island	12	5	0	2	13	1	17	26	24	0
21	Kaflia Bay, Kukak Bay, Kuliak Bay, Missak Bay	10	9	0	0	25	1	3	11	37	3
22	Devils Cove, Hallo Bay	12	21	0	0	22	0	24	7	6	7
23	Cape Chiniak, Swikshak Bay	4	10	0	0	40	0	36	0	9	1
24	Fourpeaked Glacier	9	5	0	0	42	3	28	0	5	7
25	Cape Douglas, Sukoi Bay	0	46	1	1	28	0	10	4	10	1
26	Douglas River	0	23	0	0	15	0	52	5	0	6

LS ID	Geographic Place Names	1A	2A	3A	4	5	6A	7	8A	9A	10A
27	Akumwarvik Bay , McNeil Cove, Nordyke Island	0	26	0	0	1	0	3	8	47	15
28	Amakdedulia Cove, Bruin Bay, Chenik Head	0	29	0	0	18	2	13	15	24	0
29	Augustine Island	1	54	12	0	0	5	0	16	3	9
30	Rocky Cove, Tignagvik Point	0	31	0	4	22	4	9	10	1	20
31	liamna Bay, Iniskin Bay, Ursus Cove	2	28	0	0	21	2	0	8	39	0
32	Chinitna Point, Dry Bay	3	19	1	0	9	7	0	6	47	7
33	Chinitna Bay	4	10	0	2	17	14	23	0	25	5
34	Iliamna Point	1	0	0	4	12	1	28	0	12	42
35	Chisik Island, Tuxedni Bay	2	0	0	0	21	16	19	0	35	7
36	Redoubt Point	0	0	0	0	0	1	79	0	0	20
37	Drift River, Drift River Terminal	0	0	0	0	0	0	27	0	31	42
38	Kalgin Island	0	0	0	0	0	2	96	0	2	0
39	Seal River, Big River	0	0	0	0	0	0	0	0	54	46
40	Kustatan River,West Foreland	0	0	0	0	26	2	9	0	49	14
41	Chakachatna, McArthur & Middle River, Trading Bay	0	0	0	0	0	0	10	0	48	41
42	Beshta Bay	0	0	0	0	14	0	24	0	29	32
43	Tyonek, Chuitna River, Beluga	0	0	0	16	15	0	0	0	35	34
44	Beluga, Theodore, Lewis & Ivan Rivers	0	0	0	0	0	0	4	0	35	61
45	Susitna&Little Susitna Rivers, Big Island, Magot Point	0	0	0	3	0	0	11	0	26	60
46	Susitna Flats, Knik Arm	0	0	0	0	5	0	17	0	78	0
47	Fire Island	0	0	0	0	33	0	67	0	0	0
48	Anchorage, Turnagain Arm	0	0	0	0	15	0	85	0	0	0
49	Point Possession, Miller Creek	0	0	0	0	49	0	47	0	0	4
50	Moose Point, Otter Creek	0	46	0	0	0	0	26	0	0	28
51	Bishop Creek, Boulder Point, Swanson River	0	0	0	0	16	0	71	0	0	12
52	East Forelands, Kenai, Nikiski	0	0	0	61	34	0	6	0	0	0
53	Kalifornsky, Kasilof River, Kenai River	0	0	0	0	30	0	52	0	0	18
54	Clam Gulch, Kasilof	0	0	0	0	94	0	6	0	0	0
55	Deep Creek, Ninilchik, Ninilchik River	0	0	0	0	44	0	25	0	0	31
56	Cape Starichkof, Happy Valley	0	0	0	0	87	0	11	0	0	1
57	Anchor Point, Anchor River	0	0	0	0	45	0	55	0	0	0
58	Homer, Homer Spit	0	0	0	0	11	0	67	0	22	0
59	Fritz Creek, Halibut Cove	3	0	0	0	36	0	42	16	1	2
60	China Poot Bay, Gull Island	14	3	0	0	20	0	10	34	18	1
61	Barabara Point, Seldovia Bay	8	13	0	0	26	0	13	32	9	1
62	Nanwalek, Port Graham	7	32	0	0	31	1	8	8	10	3
63	Elizabeth Island, Port Chatham, Koyuktolik Bay	15	25	0	2	29	1	4	13	12	0
64	Chugach Bay, Rocky Bay, Windy Bay	24	18	0	0	17	0	0	22	19	0
65	West Arm Port Dick, Qikutulig Bay, Touglaalek Bay	17	13	0	0	11	2	0	47	10	1
66	Gore Point, Port Dick, Tonsina Bay	52	0	0	4	13	3	0	24	4	1
67	Nuka Passage, Nuka Bay, Nuka Island	30	0	0	1	8	2	5	49	4	1
68	Pye Islands, Surprise Bay	47	0	0	0	3	0	4	45	0	1
69	Black Bay, Thunder Bay, Two Arm Bay	26	0	0	0	24	1	3	44	0	2
70	Aialik Bay, Harris Bay	47	0	0	0	14	2	5	32	0	1
71	Aialik Cape, Aialik Bay, Resurrection Bay	52	0	0	0	25	1	0	22	0	0
72	Cape Resurrection, Day Harbor, Whidbey Bay	41	0	0	2	19	9	0	28	0	1
73	Johnstone Bay, Puget Bay	19	7	0	1	19	50	4	0	0	0
74	Elrington Island, Latouche Island	16	27	0	0	7	44	3	2	0	0
75	Montague Strait, Cape Clear	0	82	3	0	7	8	0	0	0	0
76	Monatgue Island (a)	6	42	5	0	7	35	4	0	0	0
77	Monatgue Island (b)	0	34	5	0	4	51	7	0	0	0
78	Monatgue Island (c)	0	27	0	0	2	60	8	0	0	2
79	Barren Islands, Ushagat Island	52	14	0	0	29	4	0	2	0	0
80	Amatuli Cove, East and West Amatuli Island	92	0	0	0	8	0	0	0	0	0
81	Shuyak Island	7	27	0	0	20	9	0	24	8	5
82	Bluefox Bay, Shuyak Island, Shuyak Strait	9	19	0	0	60	3	0	7	2	1
83	Foul Bay, Paramanof Bay	23	13	0	0	34	15	2	10	2	0
84	Malina Bay, Raspberry Island, Raspberry Strait	27	8	0	0	49	13	0	2	1	0
85	Kupreanof Strait, Viekoda Bay	22	21	0	0	39	19	0	0	0	0
86	Uganik Bay Uganik Strait, Cape Ugat	36	4	0	0	46	6	0	0	8	0

LS ID	Geographic Place Names	1A	2A	3A	4	5	6A	7	8A	9A	10A
87	Cape Kuliuk, Spiridon Bay, Uyak Bay	21	18	0	0	43	8	0	10	0	0
88	Karluk Lagoon, Northeast Harbor, Karluk	4	9	0	0	51	3	0	0	26	9
89	Halibut Bay, Middle Cape, Sturgeon Head	8	15	0	0	57	0	0	0	9	11
90	Ayakulik, Bumble Bay, Gurney Bay	26	14	0	0	50	1	0	0	8	1
91	Low Cape, Sukhoi Bay	0	3	0	0	43	0	0	32	23	0
92	Aiaktalik, Alitak Bay, Cape Alitak	7	19	0	0	26	1	0	15	27	4
93	Sitkinak Island	0	10	0	0	38	2	19	28	4	0
95	Tugidak Island	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
96	Chirikof Island	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
94	Semidi Islands	0	0	0	0	47	0	17	36	0	0
97	Sutwik Island	11	17	0	0	53	20	0	0	0	0
98	Aiaktalik Island, Japanese Bay, Kaguyak Bay, Russian Harbor	0	26	0	0	55	0	0	18	0	1
99	Kiavak Bay, Knoll Bay, Natalia Bay, Rolling Bay	14	31	2	0	24	4	0	20	5	0
100	McCord Bay, Newman Bay, Ocean Bay, Sitkalidak Island, Sitka	2	15	0	0	54	5	3	12	4	4
101	Boulder Bay, Outer Right Cape, Kiluida Bay	3	28	0	0	45	16	0	2	5	1
102	Gull Point, Pasagshak Bay, Ugak Bay	0	43	2	1	17	21	0	16	0	1
103	Barry Lagoon, Cape Chiniak, Cape Greville	3	40	0	0	0	0	0	57	0	0
104	Long Island, Chiniak Bay	9	32	0	2	0	2	0	42	9	3
105	Anton Larsen Bay, Narrow Strait, Kodiak, Spruce Island, Spruce Cape	1	26	0	0	8	11	0	50	3	0
106	Afognak Strait, Whale Island, Kizhuyak&Sharatin Bay	14	46	0	0	9	20	0	11	0	0
107	Kazakof Bay, Duck Bay	24	0	0	0	5	18	0	53	0	0
108	Izhut Bay, Pillar Cape	24	0	0	0	4	9	0	62	0	0
109	King Cove, Tonki Cape Peninsula	26	9	0	0	17	6	0	41	0	0
110	Marmot Cape, Marmot Island, Marmot Strait	23	32	0	0	13	32	0	0	0	0
111	Seal Bay, Tonki Bay	0	27	0	0	0	14	0	58	1	0
112	Andreon Bay, Big Fort Island, Big Waterfall Bay, Perenosa Bay	16	14	0	0	3	22	0	45	0	0

Source: USDOI, BOEM, Alaska OCS Region (2015) from USDOC NOAA, 1997, 2002, 2004.
Key: ND = no data

ID = identification (number). Number Description		
1A Exposed rocky cliffs	5 Mixed sand and gravel beaches	9A Sheltered tidal flats
2A Wavecut Bedrock Mud Clay Rocky Shoals	6A Gravel Beaches	10A Salt- and brackish-water marshes
3A Fine- to medium-grained sand beaches	7 Exposed tidal flats	
4 Coarse-grained sand beaches	8A Sheltered scarps in bedrock, mud, or clay	

Table A.1-3. Fate and Behavior of a Hypothetical 5,100-Barrel Diesel Oil Spill from a Platform in the Cook Inlet OCS.

	Summer Spill[1]				Winter Spill[2]				Winter Spill (Broken Ice)[2]			
Time After Spill in Days	1	3	10	30	1	3	10	30	1	3	10	30
Oil Remaining (%)	54	6	0	na	18	0	na	na	77	36	0	na
Oil Dispersed (%)	33	73	76	na	69	84	na	na	10	36	63	na
Oil Evaporated (%)	13	23	24	na	13	16	na	na	13	28	37	na

Source: USDOI, BOEM, Alaska OCS Region (2015).
Note: Calculated with the SINTEF oil-weathering model Version 4.0 of Reed et al. (2005) and assuming Marine Diesel.
[1] Summer (April 1-October 31), 12-knot wind speed, 9 degrees Celsius, 1-meter wave height. Average Marine Weather Area A (Brower et al., 1988)
[2] Winter Spill (November 1-March 31), 16-knot wind speed, 5 degrees Celsius, 1.8- meter wave heights and for Broken Ice 50% ice Average Marine Weather Area A (Brower et al., 1988)
na means not applicable.

Table A.1- 4. Fate and Behavior of a Hypothetical 5,100-Barrel Crude Oil Spill from a Platform in the Cook Inlet OCS.

	Summer Spill[1]				Winter Spill[2]				Winter Spill (Broken Ice)[2]			
Time After Spill in Days	1	3	10	30	1	3	10	30	1	3	10	30
Oil Remaining (%)	87	75	54	24	80	57	23	3	89	84	76	61
Oil Dispersed (%)	3	13	30	56	10	30	61	80	1	3	8	19
Oil Evaporated (%)	10	13	16	20	10	13	16	17	10	13	16	20
Discontinuous Area (km2)[3, 4]	14	59	279	1,159	14	58	278	1,153	14	58	278	1,153
Estimated Coastline Oiled (km)[5]	40				30				30			

Note: Notes following Table A.1-5 apply.

Table A.1- 5. Fate and Behavior of a Hypothetical 1,700-Barrel Crude Oil Spill from a Pipeline in the Cook Inlet OCS.

	Summer Spill[1]				Winter Spill[2]				Winter Spill (Broken Ice)[2]			
Time After Spill in Days	1	3	10	30	1	3	10	30	1	3	10	30
Oil Remaining (%)	86	75	54	24	77	56	23	3	89	86	79	67
Oil Dispersed (%)	4	12	30	56	12	31	61	80	1	2	6	14
Oil Evaporated (%)	10	13	16	20	11	13	16	17	10	12	15	19
Discontinuous Area (km^2)[3, 4]	8	34	159	662	8	33	82	658	8	33	82	658
Estimated Coastline Oiled (km) [5]	24				17				17			

Notes: Calculated with the SINTEF oil-weathering model Version 4.0 of Reed et al. (2005) and assuming a Medium Crude Oil of 20-25° API

[1] Summer (April 1-October 31), 12-knot wind speed, 9 degrees Celsius, 1-meter wave height. Average Marine Weather Area A (Brower et al., 1988)

[2] Winter Spill (November 1-March 31), 16-knot wind speed, 5 degrees Celsius, 1.8- meter wave heights and for Broken Ice 50% ice. Average Marine Weather Area A (Brower et al., 1988)

[3] This is the discontinuous area of oiled surface.

[4] Calculated from Equation 6 of Table 2 in Ford (1985) and is the discontinuous area of a continuing spill or the area swept by an instantaneous spill of a given volume. Note that ice dispersion occurs for about 30 days before meltout.

[5] Calculated from Equation 17 of Table 4 in Ford (1985) and is the result of stepwise multiple regressions for length of historical coastline affected.

Source: USDOI, BOEM, Alaska OCS Region (2015).

Table A.1- 6. Identification Number (ID) and Name of Environmental Resource Areas, Represented in the Oil-Spill Trajectory Model and Their Location on Environmental Resource Area Maps and Tables.

ID	NAME	GENERAL RESOURCE	MAP	Table A.1-
1	SUA: Tyonek Beluga	Subsistence	A-2a	11
2	SUA: Tyonek North	Subsistence	A-2a	11
3	SUA: Tyonek South	Subsistence	A-2a	11
4	SUA: Seldovia, Port Graham, Nanwalek	Subsistence	A-2a	11
5	SUA: Port Lions	Subsistence	A-2d	11
6	SUA: Ouzinke	Subsistence	A-2d	11
7	SUA: Larsen Bay	Subsistence	A-2d	11
8	SUA: Karluk	Subsistence	A-2d	11
9	SUA: Akhiok	Subsistence	A-2d	11
10	SUA: Old Harbor	Subsistence	A-2d	11
11	Augustine	Marine Mammals, Lower Trophic Level Organisms	A-2a	9, 13
12	South Cook HS 1a	Marine Mammals	A-2a	9
13	South Cook HS 1b	Marine Mammals	A-2a	9
14	South Cook HS 1c	Marine Mammals	A-2a	9
15	South Cook HS 1d	Marine Mammals	A-2a	9
16	Inner Kachemak Bay	Marine Mammals	A-2b	9
17	Clam Gulch HS	Marine Mammals	A-2a	9
18	Tuxedni HS	Marine Mammals	A-2a	9
19	Kalgin Island HS	Marine Mammals	A-2a	9
20	Redoubt Bay HS	Marine Mammals	A-2b	9
21	Trading Bay HS	Marine Mammals	A-2b	9
22	Susitna Flats HS	Marine Mammals	A-2a	9
23	Barren Is. Pinniped	Marine Mammals	A-2b	9
24	Shelikof MM 2	Marine Mammals, Whales	A-2d	9, 8
25	Shelikof MM 3	Marine Mammals, Whales	A-2d	9, 8
26	Shelikof MM 4	Marine Mammals, Whales	A-2d	9, 8
27	Shelikof MM 5	Marine Mammals, Whales	A-2d	9, 8
28	Shelikof MM 6	Marine Mammals	A-2d	9
29	Shelikof MM 7	Marine Mammals	A-2d	9
30	Shelikof MM 8	Marine Mammals	A-2d	9
31	Kodiak Pinniped 1	Marine Mammals	A-2e	9
32	Kodiak Pinniped 2	Marine Mammals	A-2e	9
33	Kodiak Pinniped 3	Marine Mammals	A-2e	9
34	Kodiak Pinniped 4	Marine Mammals	A-2e	9
35	Kodiak Pinniped 5	Marine Mammals	A-2e	9
36	Kodiak Pinniped 6	Marine Mammals	A-2e	9
37	Port Chatham Pinniped	Marine Mammals	A-2b	9
38	Port Dick Pinniped	Marine Mammals	A-2b	9
39	Two-Arm Bay Pinniped	Marine Mammals	A-2b	9
40	Nuka Bay Pinniped	Marine Mammals	A-2c	9
41	Resurrection/Chiswell	Marine Mammals, Whales	A-2c	9, 8
42	Cape Puget Pinniped	Marine Mammals	A-2c	9
43	AK Peninsula Pinniped 1	Marine Mammals	A-2h	9
44	AK Peninsula Pinniped 2	Marine Mammals	A-2h	9
45	Clam Gulch	Marine Mammals	A-2a	10
46	Outer Kachemak Bay	Marine Mammals	A-2b	10
47	SW Cook Inlet	Marine Mammals	A-2b	10
48	Kamishak Bay	Marine Mammals	A-2b	10
49	Katmai NP	Marine Mammals	A-2e	10
50	Becharof NWR	Marine Mammals	A-2e	10
51	Alaska Peninsula NWR- N	Marine Mammals	A-2f	10
52	Aniakchak NM&P	Marine Mammals	A-2h	10
53	Alaska Peninsula NWR South	Marine Mammals	A-2h	10
54	Sutwick Island	Marine Mammals	A-2h	10
55	Semidi Islands	Marine Mammals	A-2h	10
56	Chirikof Island	Marine Mammals	A-2h	10
57	Trinity Islands	Marine Mammals	A-2e	10
58	Kodiak NWR-east	Marine Mammals	A-2e	10

ID	NAME	GENERAL RESOURCE	MAP	Table A.1-
59	Kodiak NWR-south	Marine Mammals	A-2e	10
60	Kodiak NWR-west	Marine Mammals	A-2e	10
61	NE Kodiak	Marine Mammals	A-2e	10
62	Chiniak Bay	Marine Mammals	A-2e	10
63	Ugak Bay	Marine Mammals	A-2e	10
64	Afognak-west	Marine Mammals	A-2e	10
65	Afognak-north	Marine Mammals	A-2e	10
66	Afognak-east	Marine Mammals	A-2e	10
67	Shuyak	Marine Mammals	A-2e	10
68	Kenai Fjords-west	Marine Mammals	A-2b	10
69	Upper Cook Inlet- Beluga CH	Whales	A-2a	8
70	Forelands- Beluga CH	Whales	A-2a	8
71	Middle Cook Inlet-Beluga CH	Whales	A-2b	8
72	West Cook Inlet-Beluga CH	Whales	A-2b	8
73	NPRW Feeding Area	Whales	A-2f	8
74	NPRW CH	Whales	A-2d	8
75	Kachemak- Humpback Whale	Whales	A-2c	8
76	Shelikof- Humpback Whale	Whales	A-2f	8
77	N Kodiak- Humpback Whale	Whales	A-2c	8
78	E Kodiak- Humpback Whale	Whales	A-2f	8
79	S Kodiak- Humpback Whale	Whales	A-2f	8
80	Shelikof MM 1	Whales	A-2d	8
81	Shelikof MM 1a	Whales	A-2d	8
82	Shelikof MM 2a	Whales	A-2d	8
83	Shelikof MM 3a	Whales	A-2d	8
84	Shelikof MM 4a	Whales	A-2d	8
85	Shelikof MM 5a	Whales	A-2d	8
86	Shelikof MM 6a	Whales	A-2d	8
87	Shelikof MM 9	Whales	A-2d	8
88	Shelikof MM 10	Whales	A-2h	8
89	Shelikof MM 11	Whales	A-2h	8
90	Barren Islands- Fin Whale	Whales	A-2f	8
91	NE Kodiak- Fin Whale	Whales	A-2f	8
92	Kodiak- Gray Whale Feeding	Whales	A-2g	8
93	Upper E Kenai- Gray Whale	Whales	A-2c	8
94	Lower E Kenai- Gray Whale	Whales	A-2c	8
95	NE Kodiak- Gray Whale	Whales	A-2g	8
96	E Kodiak- Gray Whale	Whales	A-2g	8
97	SE Kodiak- Gray Whale	Whales	A-2f	8
98	Shelikof- Gray Whale	Whales	A-2g	8
99	N Shumagin- Gray Whale	Whales	A-2h	8
100	S Shumagin- Gray Whale	Whales	A-2h	8
101	Cook Inlet 1- Harbor Porpoise	Whales	A-2a	8
102	Cook Inlet 2- Harbor Porpoise	Whales	A-2a	8
103	Cook Inlet 3- Harbor Porpoise	Whales	A-2c	8
104	Cook Inlet 4- Harbor Porpoise	Whales	A-2c	8
105	Cook Inlet 5- Harbor Porpoise	Whales	A-2b	8
106	SE Kodiak- Harbor Porpoise	Whales	A-2e	8
107	S Kodiak- Harbor Porpoise	Whales	A-2g	8
108	Shelikof- Killer Whale	Whales	A-2e	8
109	E Kodiak- Killer Whale	Whales	A-2e	8
110	SE Kenai- Dall's Porpoise	Whales	A-2c	8
111	NW Afognak Is IBA	Birds	A-2c	7
112	Uganik and Viekoda Bay IBAs	Birds	A-2d	7
113	Marmot Bay/ Colonies IBAs	Birds	A-2c	7
114	Chiniak Bay IBA	Birds	A-2d	7
115	Ugak Bay: Birds	Birds	A-2d	7
116	Eastern Kodiak Is IBA	Birds	A-2d	7
117	Flat Is Colony IBA	Birds	A-2d	7
118	Sitkinak Strait STEI Habitat	Birds	A-2d	7

ID	NAME	GENERAL RESOURCE	MAP	Table A.1-
119	Gulf of Alaska Shelf IBA	Birds	A-2f	7
120	Chirikof Is Marine IBA	Birds	A-2f	7
121	Semidi Islands Colonies IBA	Birds	A-2h	7
122	Semidi Islands Marine IBA	Birds	A-2h	7
123	Spitz Is Colony IBA	Birds	A-2h	7
124	Seal Cape Marine IBA	Birds	A-2h	7
125	Chignik Bay Vicinity: Birds	Birds	A-2h	7
126	Ugaiushak Is Colonies IBA	Birds	A-2g	7
127	Wide Bay IBA	Birds	A-2g	7
128	Wide Bay STEI Habitat	Birds	A-2g	7
129	Cape Unalishagvak Vicinity: Birds	Birds	A-2g	7
130	South Alinchak Bay Colony	Birds	A-2g	7
131	Katmai Bay Colonies	Birds	A-2g	7
132	Amalik Bay Colonies IBA	Birds	A-2g	7
133	Ninagiak Is Colonies	Birds	A-2g	7
134	Kiukpalik Is Colony	Birds	A-2g	7
135	Shaw Is Colony	Birds	A-2g	7
136	Kamishak Bay IBA	Birds	A-2b	7
137	Kamishak Bay STEI Habitat	Birds	A-2b	7
138	Tuxedni Is Colony IBA	Birds	A-2c	7
139	Tuxedni Bay IBA	Birds	A-2c	7
140	Redoubt Bay IBA	Birds	A-2b	7
141	Trading Bay IBA	Birds	A-2b	7
142	Susitna Flats IBA	Birds	A-2b	7
143	Anchorage Coastal IBA	Birds	A-2b	7
144	Clam Gulch STEI Habitat.	Birds	A-2c	7
145	Outer Kachemak Bay/IBA	Birds, Marine Mammals	A-2a	7, 10
146	Lower Cook Inlet 153W59N IBA	Birds	A-2b	7
147	Barren Islands Marine IBA	Birds	A-2b	7
148	Barren Islands Colonies IBA	Birds	A-2a	7
149	SW Kenai Pen Marine IBA	Birds	A-2a	7
150	Kenai Fjords	Birds	A-2c	7
151	Gulf of AK Shelf 151W58N IBA	Birds	A-2c	7
152	Gulf of AK Shelf Edge 148W59N	Birds	A-2c	7
153	Polly Creek Beach	Lower Trophic Level Organisms	A-2a	13
154	Chinitna Bay	Lower Trophic Level Organisms	A-2a	13
155	Barren Islands	Lower Trophic Level Organisms	A-2a	13

Key: AK = Alaska, CH = Critical Habitat, E = East, HS = Harbor seal, IBA = Important Bird Area, Is = Island, MM = Marine Mammal, N= North, NE= Northeast, NM&P = National Monument and Park, NP= National Park, NPRW = North Pacific Right Whale, NW = Northwest, NWR = National Wildlife Refuge, Pen = Peninsula, S = South, STEI = Steller's Eider, SUA = Subsistence Use Area, SW = Southwest, W=West

Source: USDOI, BOEM, Alaska OCS Region (2015).

Table A.1-7. Environmental Resource Areas Used in the Analysis of Large or Very Large Oil Spill Effects on Birds in Chapter 5

ID	Name	Map	Vulnerable	Specific Resource	Reference
ERA ID					
111	NW Afognak Is IBA	A-2c	May-August	BLKI (Seabird Colony), BLOY	Audubon Alaska, 2015.
112	Uganik And Viekoda Bay IBAs	A-2d	May-August	BLKI (Seabird Colony), BLOY (Criteria B1), KIMU (Criteria A1), MAMU (Criteria A1)	Audubon Alaska, 2015.
113	Marmot Bay/Colonies IBAs	A-2c	January-December	Seabird Colonies: BLKI, TUPU, FTSP; Wintering Area: BLSC	Audubon Alaska, 2015.
114	Chiniak Bay IBA	A-2d	January-December	STEI Wintering Habitat Area. Wintering Habitat Also For EMGO, YBLO; Seabird Colonies: BLKI and Others	Audubon Alaska, 2015; Lance, 2014; Larned, Anderson, and Corcoran, 2010; Larned and Zweifelhofer, 2002.
115	Ugak Bay: Birds	A-2d	November-April	STEI Wintering Habitat Area	Lance, 2014; Larned, Anderson, and Corcoran, 2010; Larned and Zweifelhofer, 2002.
116	Eastern Kodiak Is IBA	A-2d	January-December	Open Water Habitat (WWSC). Seabird Colonies: BLKI, Others.	Audubon Alaska, 2015.
117	Flat Is Colony IBA	A-2d	May-August	TUPU (Seabird Colony).	Audubon Alaska, 2015.
118	Sitkinak Strait STEI Habitat	A-2d	November-April	STEI Wintering Area	Lance, 2014; Larned, Anderson, and Corcoran, 2010; Larned and Zweifelhofer, 2002.
119	Gulf Of Alaska Shelf IBA	A-2f	May-August	CAAU (Foraging)	Audubon Alaska, 2015.
120	Chirikof Is Marine IBA	A-2f	May-August	HOPU (Seabird Colony & Foraging)	Audubon Alaska, 2015.
121	Semidi Islands Colonies IBA	A-2h	May-August	Seabird Colonies: NOFU, HOPU, Numerous Species	Audubon Alaska, 2015.
122	Semidi Islands Marine IBA	A-2h	May-August	Seabird Foraging: HOPU.	Audubon Alaska, 2015.
123	Spitz Is Colony IBA	A-2h	May-August	Seabird Colonies: BLKI	Audubon Alaska, 2015.
124	Seal Cape Marine IBA	A-2h	May-August	Seabird Colonies: HOPU. Foraging: HOPU, GWGU	Audubon Alaska, 2015
125	Chignik Bay Vicinity: Birds	A-2h	January-December	STEI Wintering Area; Seabird Colonies: BLKI, TUPU, COMU. Wintering:	Audubon Alaska, 2015; Lance, 2014.
126	Ugaiushak Is Colonies IBA	A-2g	May-August	Seabird Colonies: HOPU, TUPU, RFCO, BLKI	Audubon Alaska, 2015.
127	Wide Bay IBA	A-2g	May-August	Seabird Colonies: RFCO. BLOY.	Audubon Alaska, 2015.
128	Wide Bay STEI Habitat	A-2g	November-April	STEI Wintering Area	Lance, 2014.
129	Cape Unalishagvak Vicinity: Birds	A-2g	May-August	Seabird Colonies: UNMU, BLKI.	USGS, 2014.
130	South Alinchak Bay Colony	A-2g	May-August	Seabird Colony: TUPU	USGS, 2014.
131	Katmai Bay Colonies	A-2g	May-August	Seabird Colonies: GWGU, PECO	USGS, 2014.
132	Amalik Bay Colonies IBA	A-2g	May-August	Seabird Colonies: RFCO, UNCO	Audubon Alaska, 2015.
133	Ninagiak Is Colonies	A-2g	May-August	Seabird Colonies: TUPU, HOPU, GWGU	USGS, 2014.
134	Kiukpalik Is Colony	A-2g	May-August	Seabird Colony: GWGU	USGS, 2014.
135	Shaw Is Colony	A-2g	May-August	Seabird Colony: GWGU	USGS, 2014.
136	Kamishak Bay IBA	A-2b	May-August	Seabird Colonies: GWGU, Others	Audubon Alaska, 2015.
137	Kamishak Bay STEI Habitat	A-2b	November-April	STEI Wintering Area	Lance, 2014; Larned, 2006; Rosenberg, 2007, pp. 3.
138	Tuxedni Is Colony IBA	A-2c	May-August	Seabird Colonies: BLKI, COMU, HOPU, GWGU, Others	Audubon Alaska, 2015.
139	Tuxedni Bay IBA	A-2c	July-April	Shorebird Migration Stopover: WESA. Waterfowl Migration Stopover: CAGO. Waterfowl Molting: SUSC, WWSC.	Audubon Alaska, 2015.
140	Redoubt Bay IBA	A-2b	January-December	Shorebird Migration Stopover. Waterfowl Migration Stopover And Breeding Area: Tule WF Geese And Others.	Audubon Alaska, 2015.
141	Trading Bay IBA	A-2b	January-December	Waterfowl Migration Stopover And Breeding Area: Wrangell Is SNGO And Others. Shorebird Wintering: ROSA	Audubon Alaska, 2015.
142	Susitna Flats IBA	A-2b	January-December	Waterfowl Migration Stopover And Breeding Area: Many Species. Shorebird Wintering: ROSA	Audubon Alaska, 2015.
143	Anchorage Coastal IBA	A-2b	March-October	Waterfowl Migration Area: SNGO And SACR.	Audubon Alaska, 2015.
144	Clam Gulch STEI Habitat.	A-2a	November-April	STEI Wintering Area	Lance, 2014; Rosenberg, 2007, Fig 1.
145	Outer Kachemak Bay/IBA	A-2a	January-December	Seabird And Seaduck Wintering; Waterfowl And Shorebird Migration Stopover; Seabird Foraging - MAMU	Audubon Alaska, 2015.
146	Lower Cook Inlet 153W59N IBA	A-2c	November-April	Foraging – GWGU	Audubon Alaska, 2015.
147	Barren Islands Marine IBA	A-2b	May-August	Foraging-TUPU	Audubon Alaska, 2015.

ID	Name	Map	Vulnerable	Specific Resource	Reference
148	Barren Islands Colonies IBA	A-2a	May-August	Seabird Colonies – TUPU, FTSP, BLKI, COMU, RHAU, GWGU, PECO, HOPU, Etc.	Audubon Alaska, 2015.
149	SW Kenai Pen Marine IBA	A-2a	May-August	Seabird Colonies – TUPU, Etc.	Audubon Alaska, 2015.
150	Kenai Fjords	A-2c	May-August	Seabird Colonies-BLKI, TUPU, RHAU, GWGU	Audubon Alaska, 2015.
151	Gulf of AK Shelf 151W58N IBA	A-2c	January-December	Foraging- GWGU	Audubon Alaska, 2015.
152	Gulf of AK Shelf Edge 148W59N	A-2c	January-December	Foraging-BFAL, GWGU	Audubon Alaska, 2015.
LS ID					
1	Ivanof Bay IBA	A-3a	January-December	Seabird Colonies: TUPU. Wintering: EMGO.	Audubon Alaska, 2015.
53	Kenai River Flats IBA	A-3c	March-October	Waterfowl Migration Area: SNGO, SACR, Others.	Audubon Alaska, 2015.
53	Kasilof River Flats IBA	A-3c	July-April	Shorebird Wintering: ROSA; Waterfowl Migration Stopover.	Audubon Alaska, 2015.
59	Fox River Flats IBA	A-3c	July-April	Shorebird and Waterfowl Migration Stopover; WESA; TRSW	Audubon Alaska, 2015.
87	Uyak Bay	A-3b	May-August	BLKI (Seabird Colony),	USGS, 2014.
GLS ID					
148	Prince William Sound IBA	A-4b	January-December	Seabird Colonies-BLKI, Etc. Molting-HADU, Etc.	Audubon Alaska, 2015.

Key: IBA= Important Bird Area; Black-footed Albatross (BFAL), Black-legged Kittiwake (BLKI), Black Oystercatcher (BLOY), Black Scoter (BLSC), Cassin's Auklet (CAAU), Common Murre (COMU), Emperor Goose (EMGO), Fork-tailed Storm-Petrel (FTSP), Glaucous-winged Gull (GWGU), Harlequin Duck (HADU), Horned Puffin (HOPU), Kittlitz's Murrelet (KIMU), Marbled Murrelet (MAMU), Northern Fulmar (NOFU), Pelagic Cormorant (PECO), Red-faced Cormorant (RFCO), Rhinoceros Auklet (RHAU), Rock Sandpiper (ROSA), Sandhill Crane (SACR), Snow Goose (SNGO): Surf Scoter (SUSC), Tufted Puffin (TUPU), STEI (Steller's Eider), Surf Scoter (SUSC), Western Sandpiper (WESA), White-winged Scoter (WWSC) (Pyle and DeSante, 2014).

Source: USDOI, BOEM, Alaska OCS Region (2015).

Table A.1-8. Environmental Resource Areas Used in the Analysis of Large or Very Large Oil Spill Effects on Marine Mammals (Whales) in Chapter 5.

ERA ID	Name	Map	Vulnerable	Specific Resource	Reference
16	Inner Kachemak Bay	A-2b	January-December	Beluga Whale, CH	Ashford, Ezer, and Jones, 2013; Ezer, Hobbs, and Oey, 2008; Ezer et al., 2013; 76 *FR* 20180, April 11, 2011; Hobbs et al., 2005; Laidre et al., 2000; Moore and DeMaster, 2000; Hobbs, Rugh, and DeMaster, 2000; Rugh, Mahoney, and Smith, 2004; Rugh, Shelden, and Mahoney, 2000; Shelden et al., 2012, 2013; Speckman and Piatt, 2000.
24	Shelikof MM 2	A-2d	January-December	Fin Whale	Brueggeman et al., 1987, 1988; Consiglieri et al., 1982; Hanson and Hubbard, 1999; Leatherwood, Bowles, and Reeves, 1983; Manly, 2007; NMML,1991, 1992, 1993, 1998, 2001, 2003a, 2003b, 2012; Rice and Wolman, 1981; Rugh et al., 2005a, 2005b; Shelden et al., 2013; Speckman, 2002; Waite, 2003; Waite et al., 1999; Witteveen and Wynne, 2012, 2013; Witteveen et al., 2014; Wynne, Foy, and Buck, 2011; Zerbini, Waite, and Wade, 2006.
25	Shelikof MM 3	A-2d	January-December	Fin Whale	Same as ERA 24.
26	Shelikof MM 4	A-2d	January-December	Fin Whale	Same as ERA 24.
27	Shelikof MM 5	A-2d	January-December	Fin Whale	Same as ERA 24.
28	Shelikof MM 6	A-2d	January-December	Fin Whale,	Same as ERA 24.
30	Shelikof MM 8	A-2d	January-December	Fin Whale	Same as ERA 24.
41	Resurrection- Killer Whale	A-2c	January-December	Killer Whale	Brueggeman et al., 1988; Consiglieri et al., 1982; Hansen and Hubbard, 1999; Leatherwood, Bowles, and Reeves, 1983; Matkin et al., 2012; NMML, 1998, 2001, 2003a, 2003b, 2012; Rice and Wolman, 1981; Rone, 2014; Rone et al., 2010; Rugh et al., 2005a, 2005b; Shelden et al., 2013; Speckman, 2002; Zerbini et al., 2007.
69	Upper Cook Inlet- Beluga CH	A-2a	January-December	Beluga Whale, CH	Same as ERA 16.
70	Forelands- Beluga CH	A-2a	January-December	Beluga Whale, CH	Same as ERA 16.
71	Middle Cook Inlet -Beluga CH	A-2b	January-December	Beluga Whale, CH	Same as ERA 16.
72	West Cook Inlet- Beluga CH	A-2b	January-December	Beluga Whale, CH	Same as ERA 16.
73	NPRW Feeding Area	A-2f	June-September	North Pacific Right Whale	Ferguson et al., 2015.
74	NPRW CH	A-2d	June-December	North Pacific Right Whale, CH	73 *FR* 19000, April 8, 2008

ERA ID	Name	Map	Vulnerable	Specific Resource	Reference
75	Kachemak- Humpback Whale	A-2c	May-December	Humpback Whale	Braham, 1984; Bruggeman et al., 1987, 1988; Consiglieri et al., 1982; Calambokidis et al., 2008; Dahlheim, 1994; Ferguson et al., 2015; Leatherwood, Bowles, and Reeves, 1983; Manly, 2007; NMML, 1991, 1993,1998, 2003a, 2003b, 2012; Rice and Wolman, 1981; Rugh et al., 2005a, 2005b; Shelden et al., 2013; Speckman, 2002; Waite, 2003; Waite et al., 1999; Witteveen and Wynne, 2012; Witteveen et al., 2007, 2008, 2011a, 2011b, 2014; Zerbini, Waite, and Wade, 2006.
76	Shelikof- Humpback Whale	A-2f	May-December	Humpback Whale	Braham, 1984; Bruggeman et al., 1987, 1988; Consiglieri et al., 1982; Calambokidis et al., 2008; Dahlheim, 1994; Ferguson et al., 2015; Leatherwood, Bowles, and Reeves, 1983; Manly, 2007; NMML, 1992, 1993, 1998, 2003a, 2003b, 2012; Rice and Wolman, 1981; Rugh et al., 2005a, 2005b; Shelden et al., 2013; Speckman, 2002; Waite, 2003; Waite et al., 1999; Witteveen and Wynne, 2012; Witteveen et al., 2007, 2008, 2011a, 2011b, 2014; Wright et al., 2015; Wynne, Foy, and Buck 2011; Zerbini, Waite, and Wade, 2006.
77	N Kodiak- Humpback Whale	A-2c	May-December	Humpback Whale	Same as ERA 76 excepting NMML, 2003a.
78	E Kodiak- Humpback Whale	A-2f	May-December	Humpback Whale	Same as ERA 76.
79	S Kodiak- Humpback Whale	A-2f	May-December	Humpback Whale	Same as ERA 76 excepting NMML, 2003a.
80	Shelikof MM 1	A-2d	January-December	Fin Whale	Brueggeman et al., 1987, 1988; Consiglieri et al., 1982; Hanson and Hubbard, 1999; Leatherwood, Bowles, and Reeves, 1983; Manly, 2007; NMML,1991, 1992, 1993, 1998, 2003a, 2003b, 2012; Rice and Wolman, 1981; Rugh et al., 2005a, 2005b; Shelden et al., 2013; Speckman, 2002; Waite, 2003; Waite et al., 1999; Witteveen and Wynne, 2012, 2013; Witteveen et al., 2014; Wynne, Foy, and Buck, 2011; Zerbini, Waite, and Wade, 2006
81	Shelikof MM 1a	A-2d	June-August	Dall’s Porpoise	Brueggeman et al., 1987, 1988; Consiglieri et al., 1982; Hansen and Hubbard, 1999; Leatherwood, Bowles, and Reeves, 1983; Manly, 2007; NMML, 1992, 1993, 1998, 2003a, 2003b, 2012; Rice and Wolman, 1981; Rugh et al., 2005a; Shelden et al., 2013; Speckman, 2002; Witteveen and Wynne, 2012, 2013.
82	Shelikof MM 2a	A-2d	June-August	Dall’s Porpoise	Same as ERA 81.
83	Shelikof MM 3a	A-2d	June-August	Dall’s Porpoise	Same as ERA 81.
84	Shelikof MM 4a	A-2d	June-August	Dall’s Porpoise	Same as ERA 81.
85	Shelikof MM 5a	A-2d	June-August	Dall’s Porpoise	Same as ERA 81.
86	Shelikof MM 6a	A-2d	June-August	Dall’s Porpoise	Same as ERA 81.
87	Shelikof MM 9	A-2d	June-August	Dall’s Porpoise	Same as ERA 81.
88	Shelikof MM 10	A-2h	June-August	Dall’s Porpoise	Same as ERA 81.
89	Shelikof MM 11	A-2h	January-December	Fin Whale	Same as ERA 80.
90	Barren Islands- Fin Whale	A-2f	January-December	Fin Whale	Same as ERA 80.
91	NE Kodiak- Fin Whale	A-2f	January-December	Fin Whale	Same as ERA 80.
92	Kodiak- Gray Whale Feeding	A-2g	June-August	Gray Whale	Braham, 1984; Brueggeman et al., 1987; Consiglieri et al., 1982; Cowen et al., 1987; Ferguson et al., 2015; Leatherwood, Bowles, and Reeves, 1983; Moore et al., 2007; NMML, 1992, 1993, 1998, 2003a, 2012; Rugh et al., 2005a, 2005b; Shelden et al., 2013; Witteveen and Wynne, 2012, 2013.
93	Upper E Kenai- Gray Whale	A-2c	April-December	Gray Whale	Braham, 1984; Brueggeman et al., 1987; Consiglieri et al., 1982; Cowen et al., 1987; Ferguson et al., 2015; Leatherwood, Bowles, and Reeves, 1983; Moore et al., 2007; NMML, 1992, 1998, 2003a, 2003b, 2009, 2012, 2013; Rone, 2014; Rone et al., 2010; Rugh et al., 2005a, 2005b; Shelden et al., 2013.
94	Lower E Kenai- Gray Whale	A-2c	April-December	Gray Whale	Same as ERA 93.
95	NE Kodiak- Gray Whale	A-2g	April-December	Gray Whale	Braham, 1984; Brueggeman et al., 1987; Consiglieri et al., 1982; Cowen et al., 1987; Ferguson et al., 2015; Leatherwood, Bowles, and Reeves, 1983; Moore et al., 2007; NMML, 1992, 1993,1998, 2003a, 2003b, 2012; Rugh et al., 2005a, 2005b; Shelden et al., 2013; Witteveen and Wynne, 2012, 2013; Wynne, Foy, and Buck, 2005.
96	E Kodiak- Gray Whale	A-2g	April-December	Gray Whale	Same as ERA 95.
97	SE Kodiak- Gray Whale	A-2f	April-December	Gray Whale	Same as ERA 95.
98	Shelikof- Gray Whale	A-2g	April-December	Gray Whale	Same as ERA 95.
99	N Shumagin- Gray Whale	A-2h	April-December	Gray Whale	Braham,; 1984; Brueggeman et al., 1987; Consiglieri et al., 1982; Cowen et al., 1987; Ferguson et al., 2015; Leatherwood, Bowles, and Reeves, 1983; Moore et al., 2007; NMML, 1992, 1993, 2001, 2003a, 2003b, 2012; Rugh, Shelden, and Schulman-Janiger, 2001, 2005a, 2005b; Shelden et al., 2013; Witteveen and Wynne, 2012, 2013.
100	S Shumagin- Gray Whale	A-2h	October-December	Gray Whale	Braham, 1984; Brueggeman et al., 1987; Consiglieri et al., 1982; Cowen et al., 1987; Ferguson et al., 2015; Leatherwood, Bowles, and Reeves, 1983; Moore et al., 2007; NMML, 1992, 1993,1998, 2001, 2003a; 2012; Rugh, Shelden, and Schulman-Janiger, 2001; Witteveen and Wynne, 2012, 2013;.

ERA ID	Name	Map	Vulnerable	Specific Resource	Reference
101	Cook Inlet 1- Harbor Porpoise	A-2a	June-September	Harbor Porpoise	Brueggeman et al., 1987; Consiglieri et al., 1982; Dahlheim et al., 2000. Hansen and Hubbard, 1999; Leatherwood, Bowles, and Reeves, 1983; Manly, 2006, 2007; NMML, 1991, 1998, 2012, 2013; Nemeth et al., 2007; Rone, 2014; Rugh et al., 2005a, 2005b; Shelden et al., 2013, 2014; Speckman, 2002; Speckman and Piatt, 2000.
102	Cook Inlet 2- Harbor Porpoise	A-2a	June-September	Harbor Porpoise	Same as ERA 101 plus NMML, 2001.
103	Cook Inlet 3- Harbor Porpoise	A-2c	June-September	Harbor Porpoise	Same as ERA 101.
104	Cook Inlet 4- Harbor Porpoise	A-2c	June-September	Harbor Porpoise	Same as ERA 101.
105	Cook Inlet 5- Harbor Porpoise	A-2b	June-September	Harbor Porpoise	Same as ERA 101.
106	SE Kodiak- Harbor Porpoise	A-2e	June-September	Harbor Porpoise	Brueggeman et al., 1987; Consiglieri et al., 1982; Dahlheim et al., 2000; Hansen and Hubbard, 1999; Manly, 2006, 2007; NMML, 1992, 1993, 1998, 2003a, 2012; Nemeth et al., 2007; Rugh et al., 2005a, 2005b; Shelden et al., 2013, 2014; Speckman, 2002; Speckman and Piatt, 2000; Witteveen and Wynne, 2012, 2013.
107	S Kodiak- Harbor Porpoise	A-2g	June-September	Harbor Porpoise	Same as ERA 106.
108	Shelikof- Killer Whale	A-2e	January-December	Killer Whale	Brueggeman et al., 1988; Consiglieri et al., 1982; Hansen and Hubbard, 1999; Leatherwood, Bowles, and Reeves, 1983; Matkin et al., 2012; NMML, 1992, 1993,1998, 2001, 2003a, 2003b, 2012; Rice and Wolman, 1981; Rugh et al., 2005a, 2005b; Shelden et al., 2013; Speckman, 2002; Witteveen and Wynne, 2012, 2013; Zerbini et al., 2007
109	E Kodiak- Killer Whale	A-2e	January-December	Killer Whale	Brueggeman et al., 1988; Consiglieri et al., 1982; Hansen and Hubbard, 1999; Leatherwood, Bowles, and Reeves, 1983; Matkin et al., 2012; NMML, 1992, 1993, 1998, 2003a, 2003b, 2009, 2012, 2013; Rice and Wolman, 1981; Rone, 2014; Rone et al., 2010; Rugh et al., 2005a, 2005b; Shelden et al., 2013; Speckman, 2002; Witteveen and Wynne, 2012, 2013; Zerbini et al., 2007.
110	SE Kenai- Dall's Porpoise	A-2c	June-August	Dall's Porpoise	Brueggeman et al., 1987, 1988; Consiglieri et al., 1982; Hansen and Hubbard, 1999; Leatherwood, Bowles, and Reeves, 1983; Manly, 2007; NMML, 1992, 1993, 1998, 2001, 2003a, 2003b, 2009, 2012, 2013; Rice and Wolman, 1981; Rone, 2014; Rone et al., 2010; Rugh et al., 2005a; Shelden et al., 2013; Speckman, 2002; Witteveen and Wynne, 2012, 2013.
BS ID					
2	Shumagin- Humpback Whale-	A-1	May-December	Humpback Whale	Brahem, 1984; Brueggeman et al., 1987, 1988; Consiglieri et al., 1982; Calambokidis et al., 2008; Dahlheim, 1994; Leatherwood, Bowles, and Reeves, 1983; Manly, 2007; NMML, 1992, 2001, 2003a, 2012; Rice and Wolman, 1981; Rugh et al., 2005a, 2005b; Shelden et al., 2013; Speckman, 2002; Waite, 2003; Waite et al., 1999; Witteveen and Wynne, 2013; Witteveen et al., 2007, 2008, 2011a, 2011b, 2014; Wynne, Foy, and Buck, 2011; Zerbini, Waite, and Wade, 2006.

Key: BS=Boundary Segment, CH=Critical Habitat; E = East; ERA = Environmental Resource Areas, MM=Marine Mammal; N = North; NE = Northeast; NPRW=North Pacific Right Whale; SE = Southeast.

Source: USDOI, BOEM, Alaska OCS Region (2015).

Table A.1- 9. Environmental Resource Areas Used in the Analysis of Large or Very Large Oil Spill Effects on Marine Mammals (Seals and Sea Lions) in Chapter 5.

ID	Name	Map	Vulnerable	Specific Resource	References
11	Augustine	A-2a	January-December	Harbor seals	Boveng et al., 2003; 2011; Boveng, London, and Verhoef, 2012; Lowry et al., 2001; Montgomery, Ver Hoef, and Boveng, 2007; NOAA, 2014b, O'Corry-Crowe, Martien, and Taylor, 2003; Pitcher and Calkins, 1979; Rugh et al., 2005; Ver Hoef and Boveng, 2007.
12	South Cook HS 1a	A-2a	January-December	Harbor seals	Boveng et al., 2003; 2011; Boveng, London, and Verhoef, 2012; Lowry et al., 2001; Montgomery, Ver Hoef, and Boveng, 2007; NOAA, 2014b, O'Corry-Crowe, Martien, and Taylor, 2003; Pitcher and Calkins, 1979; Rugh et al., 2005; Ver Hoef and Boveng, 2007.
13	South Cook HS 1b	A-2a	January-December	Harbor seals	Boveng et al., 2003; 2011; Boveng, London, and Verhoef, 2012; Lowry et al., 2001; Montgomery, Ver Hoef, and Boveng, 2007; NOAA, 2014b, O'Corry-Crowe, Martien, and Taylor, 2003; Pitcher and Calkins, 1979; Rugh et al., 2005; Ver Hoef and Boveng, 2007.
14	South Cook HS 1c	A-2a	January-December	Harbor seals	Boveng et al., 2003; 2011; Boveng, London, and Verhoef, 2012; Lowry et al., 2001; Montgomery, Ver Hoef, and Boveng, 2007; NOAA, 2014b, O'Corry-Crowe, Martien, and Taylor, 2003; Pitcher and Calkins, 1979; Rugh et al., 2005; Ver Hoef and Boveng, 2007.
15	South Cook HS 1d	A-2a	January-December	Harbor seals	Boveng et al., 2003; 2011; Boveng, London, and Verhoef, 2012; Lowry et al., 2001; Montgomery, Ver Hoef, and Boveng, 2007; NOAA, 2014b, O'Corry-Crowe, Martien, and Taylor, 2003; Pitcher and Calkins, 1979; Rugh et al., 2005; Ver Hoef and Boveng, 2007.

ID	Name	Map	Vulnerable	Specific Resource	References
16	Inner Kachemak Bay	A-2b	January-December	Harbor seals	ADEC, 1997; ADF&G, 1985a; 1988, 2014a; Boveng et al., 2003, 2011; Boveng, London, and Ver Hoef, 2012; Lowry et al., 2001; Montgomery, Ver Hoef, and Boveng. 2007; NOAA, 2014b; O'Corry-Crowe, Martien, and Taylor, 2003; Pitcher and Calkins, 1979; Rugh et al., 2005b.
17	Clam Gulch HS	A-2a	January-December	Harbor seals	ADEC, 1997; ADF&G, 1985a; 1988, 2014a; Boveng et al., 2003, 2011; Boveng, London, and Ver Hoef, 2012; Lowry et al., 2001; Montgomery, Ver Hoef and Boveng. 2007; NOAA, 2014b; O'Corry-Crowe, Martien, and Taylor, 2003; Pitcher and Calkins, 1979; Rugh et al., 2005.
18	Tuxedni HS	A-2a	March-December	Harbor seals	ADEC, 1997; ADF&G, 1985a; 1988, 2014a; Boveng et al., 2003, 2011; Boveng, London, and Ver Hoef, 2012; Lowry et al., 2001; Montgomery, Ver Hoef and Boveng. 2007; NOAA, 2014b; O'Corry-Crowe, Martien, and Taylor, 2003; Pitcher and Calkins, 1979; Rugh et al., 2005.
19	Kalgin Island HS	A-2a	March-December	Harbor seals	ADEC, 1997; ADF&G, 1985a; 1988, 2014a; Boveng et al., 2003, 2011; Boveng, London, and Ver Hoef, 2012; Lowry et al., 2001; Montgomery, Ver Hoef and Boveng. 2007; NOAA, 2014b; O'Corry-Crowe, Martien, and Taylor, 2003; Pitcher and Calkins, 1979; Rugh et al., 2005.
20	Redoubt Bay HS	A-2b	March-December	Harbor seals	ADEC, 1997; ADF&G, 1985a; 1988, 2014a; Boveng et al., 2003, 2011; Boveng, London, and Ver Hoef, 2012; Lowry et al., 2001; Montgomery, Ver Hoef and Boveng. 2007; NOAA, 2014b; O'Corry-Crowe, Martien, and Taylor, 2003; Pitcher and Calkins, 1979; Rugh et al., 2005.
21	Trading Bay HS	A-2b	March-December	Harbor seals	ADEC, 1997; ADF&G, 1985a; 1988, 2014a; Boveng et al., 2003, 2011; Boveng, London and Ver Hoef, 2012; Lowry et al., 2001; Montgomery, Ver Hoef and Boveng. 2007; NOAA, 2014b; O'Corry-Crowe, Martien, and Taylor, 2003; Pitcher and Calkins, 1979; Rugh et al., 2005.
22	Susitna Flats HS	A-2a	March-December	Harbor seals	ADEC, 1997; ADF&G, 1985a; 1988, 2014a; Boveng et al., 2003, 2011; Boveng, London and Ver Hoef, 2012; Lowry et al., 2001; Montgomery, Ver Hoef and Boveng. 2007; NOAA, 2014b; O'Corry-Crowe, Martien, and Taylor, 2003; Pitcher and Calkins, 1979; Rugh et al., 2005.
23	Barren Is. Pinniped	A-2b	January-December	Harbor seals, Steller sea lions	Boveng et al., 2003; 58 *FR* 45269, August 27, 1993; Lowry et al., 2001; NOAA, 2014b.
24	Shelikof MM 2	A-2d	January-December	Harbor seals, Steller sea lions	ADEC, 1997; ADF&G, 1985b; ADF&G, 1997; ADF&G, 2014; Boveng et al., 2003; 58 *FR* 45269, August 27, 1993; Lowry et al., 2001; NOAA, 2014b.
25	Shelikof MM 3	A-2d	January-December	Harbor seals, Steller sea lions	ADEC, 1997; ADF&G, 1985b; ADF&G, 1997; ADF&G, 2014; Boveng et al., 2003; 58 *FR* 45269, August 27, 1993; Lowry et al., 2001; NOAA, 2014b.
26	Shelikof MM 4	A-2d	January-December	Harbor seals, Steller sea lions	ADEC, 1997; ADF&G, 1985b; ADF&G, 1997; ADF&G, 2014; Boveng et al., 2003; 58 *FR* 45269, August 27, 1993; Lowry et al., 2001; NOAA, 2014b.
27	Shelikof MM 5	A-2d	January-December	Harbor seals, Steller sea lions	ADEC, 1997; ADF&G, 1985b; ADF&G, 1997; ADF&G, 2014; Boveng et al., 2003; 58 *FR* 45269, August 27, 1993; Lowry et al., 2001; NOAA, 2014b.
28	Shelikof MM 6	A-2d	January-December	Harbor seals, Steller sea lions	ADEC, 1997; ADF&G, 1985b; ADF&G, 1997; ADF&G, 2014; Boveng et al., 2003; 58 *FR* 45269, August 27, 1993; Lowry et al., 2001; NOAA, 2014b.
29	Shelikof MM 7	A-2d	January-December	Harbor seals, Steller sea lions	ADEC, 1997; ADF&G, 1985b; ADF&G, 1997; ADF&G, 2014; Boveng et al., 2003; 58 *FR* 45269, August 27, 1993; Lowry et al., 2001; NOAA, 2014b.
30	Shelikof MM 8	A-2d	January-December	Harbor seals, Steller sea lions	ADEC, 1997; ADF&G, 1985b; ADF&G, 1997; ADF&G, 2014; Boveng et al., 2003; 58 *FR* 45269, August 27, 1993; Lowry et al., 2001; NOAA, 2014b.
31	Kodiak Pinniped 1	A-2e	January-December	Harbor seals, Steller sea lions	ADEC, 1997; ADF&G, 1985b; ADF&G, 1997; ADF&G, 2014; Boveng et al., 2003; 58 *FR* 45269, August 27, 1993; Lowry et al., 2001; NOAA, 2014b.
32	Kodiak Pinniped 2	A-2e	January-December	Harbor seals, Steller sea lions	ADEC, 1997; ADF&G, 1985b; ADF&G, 1997; ADF&G, 2014; Boveng et al., 2003; 58 *FR* 45269, August 27, 1993; Lowry et al., 2001; NOAA, 2014b.
33	Kodiak Pinniped 3	A-2e	January-December	Harbor seals, Steller sea lions	ADEC, 1997; ADF&G, 1985b; ADF&G, 1997; ADF&G, 2014; Boveng et al., 2003; 58 *FR* 45269, August 27, 1993; Lowry et al., 2001; NOAA, 2014b.
34	Kodiak Pinniped 4	A-2e	January-December	Harbor seals, Steller sea lions	ADEC, 1997; ADF&G, 1985b; 1997; 2014a; Boveng et al., 2003; 58 *FR* 45269, August 27, 1993.
35	Kodiak Pinniped 5	A-2e	January-December	Harbor seals, Steller sea lions	ADEC, 1997; ADF&G, 1985b; 1997; 2014a; Boveng et al., 2003; 58 *FR* 45269, August 27, 1993; Lowry et al., 2001; NOAA, 2014b.
36	Kodiak Pinniped 6	A-2e	January-December	Harbor seals, Steller sea lions	ADEC, 1997; ADF&G, 1985b; 1997; 2014a; Boveng et al., 2003; 58 *FR* 45269, August 27, 1993; Lowry et al., 2001; NOAA, 2014b.
37	Port Chatham Pinniped	A-2b	January-December	Harbor seals, Steller sea lions	Boveng et al., 2003; 58 *FR* 45269, August 27, 1993; Lowry et al., 2001; NOAA, 2014b.
38	Port Dick Pinniped	A-2b	January-December	Harbor seals, Steller sea lions	Boveng et al., 2003; 58 *FR* 45269, August 27, 1993; Lowry et al., 2001; NOAA, 2014b.
39	Two-Arm Bay Pinniped	A-2b	January-December	Harbor seals, Steller sea lions	Boveng et al., 2003; 58 *FR* 45269, August 27, 1993; Lowry et al., 2001; NOAA, 2014b.
40	Nuka Bay Pinniped	A-2c	January-December	Harbor seals, Steller sea lions	Boveng et al., 2003; 58 *FR* 45269, August 27, 1993; Lowry et al., 2001; NOAA, 2014b.

ID	Name	Map	Vulnerable	Specific Resource	References
41	Chiswell Pinniped	A-2c	January-December	Harbor seals, Steller sea lions	Boveng et al., 2003; 58 *FR* 45269, August 27, 1993; Lowry et al., 2001; NOAA, 2014b.
42	Cape Puget Pinniped	A-2c	January-December	Harbor seals, Steller sea lions	Boveng et al., 2003; 58 *FR* 45269, August 27, 1993; Lowry et al., 2001; NOAA, 2014b.
43	AK Peninsula Pinniped 1	A-2h	January-December	Harbor seals, Steller sea lions	Boveng et al., 2003; 58 *FR* 45269, August 27, 1993; Lowry et al., 2001; NOAA, 2014.
44	AK Peninsula Pinniped 2	A-2h	January-December	Harbor seals, Steller sea lions	Boveng et al., 2003; 58 *FR* 45269, August 27, 1993; Lowry et al., 2001; NOAA, 2014.

Key: AK= Alaska; HS = Harbor Seal; Is. = Island, MM=Marine Mammal;
Source: USDOI, BOEM, Alaska OCS Region (2015).

Table A.1-10. Environmental Resource Areas Used in the Analysis of Large or Very Large Oil Spill Effects on Marine Mammals (Sea otters) in Chapter 5.

ID	Name	Map	Vulnerable	Specific Resource	Reference
ERA ID					
45	Clam Gulch	A-2a	January-December	Sea otters	Bodkin, Monson, and Esslinger, 2003; Doroff and Badajos, 2010; Gill, Doroff, and Burn, 2009; USFWS, 2014a.
16	Inner Kachemak Bay	A-2b	January-December	Sea otters	Doroff and Badajos, 2010; Gill, Doroff, and Burn, 2009.
46	Outer Kachemak Bay	A-2b	January-December	Sea otters	Bodkin, Monson, and Esslinger, 2003; Doroff and Badajos, 2010; Gill, Doroff, and Burn, 2009; USFWS, 2014a.
145	Outer Kachemak Bay/IBA	A-2a	January-December	Sea otters	Bodkin, Monson, and Esslinger, 2003; Doroff and Badajos, 2010; Gill, Doroff, and Burn, 2009; USFWS, 2014a.
47	SW Cook Inlet	A-2b	January-December	Sea otters	Bodkin, Monson, and Esslinger, 2003; 74 *FR* 51988, October 8, 2009; USFWS, 2013.
48	Kamishak Bay	A-2b	January-December	Sea otters	Bodkin, Monson, and Esslinger, 2003; 74 *FR* 51988, October 8, 2009; USFWS, 2013.
49	Katmai NP	A-2e	January-December	Sea otters	Coletti et al., 2014; 74 *FR* 51988, October 8, 2009; USFWS, 2013.
50	Becharof NWR	A-2e	January-December	Sea otters	Coletti et al., 2014; 74 *FR* 51988, October 8, 2009; USFWS, 2013, 2015c.
51	Alaska Peninsula NWR North	A-2f	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013.
52	Aniakchak NM&P	A-2h	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013.
53	Alaska Peninsula NWR South	A-2h	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013.
54	Sutwick Island	A-2h	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013.
55	Semidi Islands	A-2h	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013.
56	Chirikof Island	A-2h	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013.
57	Trinity Islands	A-2h	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013, 2014b.
58	Kodiak NWR-east	A-2e	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013, 2014b.
59	Kodiak NWR-south	A-2e	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013, 2014b.
60	Kodiak NWR-west	A-2e	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013, 2014b.
61	NE Kodiak	A-2e	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013, 2014b.
62	Chiniak Bay	A-2e	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013, 2014b.
63	Ugak Bay	A-2e	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013, 2014b.
64	Afognak-west	A-2e	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013, 2014b.
65	Afognak-north	A-2e	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013, 2014b.
66	Afognak-east	A-2e	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013, 2014b.
67	Shuyak	A-2e	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013, 2014b.
68	Kenai Fjords-west	A-2b	January-December	Sea otters	Bodkin, Monson, and Esslinger, 2003.
LS ID					
7	Chignik Bay	A-3a	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013.
15	Wide Bay	A.3a	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013.
35	Tuxedni Bay	A-3c	January-December	Sea otters	Bodkin, Monson, and Esslinger, 2003; 74 FR 51988, October 8, 2009; USFWS, 2013.
65	West arm Port Dick	A-3a	January-December	Sea otters	Bodkin, Monson, and Esslinger, 2003; Coletti, Bodkin, and Esslinger, 2011.
84	Raspberry Strait	A-3b	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013, 2014b.
87	Uyak Bay	A-3b	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013, 2014b.
86	Uginak Bay/Passage	A.3b	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013, 2014b.
92	Alitak Bay	A-3b	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013, 2014b.
GLS ID					

ID	Name	Map	Vulnerable	Specific Resource	Reference
119	Kuiukta Bay	A-4b	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013, 2014b.
124	Kukak Bay	A-4b	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013, 2014b.
141	Seldovia side Kachemak Bay	A-4b	January-December	Sea otters	Gill, Doroff, and Burn, 2009.
144	Kenai Fjords National Park	A-4b	January-December	Sea otters	Bodkin, Monson, and Esslinger, 2003; Coletti, Bodkin, and Esslinger, 2011.
146	Resurrection Bay	A-4b	January-December	Sea otters	Bodkin, Monson, and Esslinger, 2003; Coletti, Bodkin, and Esslinger, 2011.
149	Elrington-Bambridge-LaTouche Islands	A-4b	January-December	Sea otters	Bodkin et al., 2003.
150	E Montague Island	A.4b	January-December	Sea otters	Bodkin et al., 2003.
152	Barren Islands	A-4a	January-December	Sea otters	USFWS, 2013.
159	Kupreanof Strait	A-4a	January-December	Sea otters	74 *FR* 51988, October 8, 2009; USFWS, 2013, 2014b.

Key: E = East; IBA= Important Bird Area; NE= Northeast; NM&P= National Monument and Preserve; NP= National Park; NWR = National Wildlife Refuge.
Source: USDOI, BOEM, Alaska OCS Region (2015).

Table A.1-11. Environmental Resource Areas Used in the Analysis of Large or Very Large Oil Spill Effects on Subsistence Resources in Chapter 5.

ID	Name	Map	Vulnerable	Specific Resource	Reference
ERA ID					
1	SUA: Tyonek; Beluga	A-2a	March-October	Beluga	SRB&A and Huntington Consulting, 2011 (pp.37).
2	SUA: Tyonek North	A-2a	March-October	Salmon (5 Species) Tomcod, Herring, Eulachon, Harbor seal, Beluga, Clams, Cockle	Fall, Foster, and Stanek, 1984; Schroeder et al., 1987.
3	SUA: Tyonek South	A-2a	March-October	Salmon (5 Species) Tomcod, Herring, Eulachon, Harbor seal, Beluga, Clams, Cockle	Fall, Foster, and Stanek, 1984; Schroeder et al., 1987.
4	SUA: Seldovia, Port Graham, Nanwalek	A-2a	January-December	Salmon (5 Species), Halibut, Trout, Cod, Flounder, Rockfish, Sculpin, Herring, Clams, Crab, Bidarkies, Octopus, Waterfowl, Seals, Sea Lions, Eggs, Seaweed, Kelp	KPB, 1992 (Fig. B, pp. 4); Schroeder et al., 1987; Seldovia Village Tribe, 2013; Stanek, 1985.
5	SUA: Port Lions	A-2d	January-December	Salmon (5 Species), Halibut, Seals, Clams, Crab	Schroeder et al., 1987; Wolfe et al., 2012.
6	SUA: Ouzinke	A-2d	January-December	Salmon (4 Species), Halibut, Steelhead, Seals, Sea Lion, Clams, Crab	Schroeder et al., 1987; Wolfe et al., 2012.
7	SUA: Larsen Bay	A-2d	January-December	Salmon (5 Species), Halibut, Steelhead, Seals, Sea Lions, Clams, Crab	Schroeder et al., 1987; Wolfe et al., 2012.
8	SUA: Karluk	A-2d	January-December	Salmon (5 Species) ,Halibut, Seals, Sea Lions, Clams, Crab	Schroeder et al., 1987; Wolfe et al., 2012.
9	SUA: Akhiok	A-2d	January-December	Salmon (5 Species), Halibut, Steehead, Seals, Sea Lions, Clams, Crab	Schroeder et al., 1987; Wolfe et al., 2012.
10	SUA: Old Harbor	A-2d	January-December	Salmon (5 Species), Halibut, Steehead, Seals, Sea Lions, Clams, Crab	Schroeder et al., 1987; Wolfe et al., 2012.
GLS ID					
115	SUA: Chignik Lake, Ivanof Bay, Perryville	A-4a	January-December	Salmon, Halibut, Herring, Pacific Cod, Shellfish, Caribou, Deer, Moose, Brown Bear, Seals, Sea Lions, and Sea Otters.	Morris, 1987.
116	SUA: Chignik, Chignik Lagoon	A-4a	January-December	Salmon, Halibut, Herring, Pacific Cod, Shellfish, Caribou, Deer, Moose, Brown Bear, Seals, Sea Lions, and Sea Otters.	Morris, 1987.

Key: SUA= Subsistence Use Area
Source: USDOI, BOEM, Alaska OCS Region (2015).

Table A.1-12. Land Segments Used in the Analysis of Large or Very Large Oil Spill Effects on Anadromous Fish in Chapter 5.

LS ID	Name	Map	Vulnerable	Specific Resource	Reference
1	Unnamed stream(s)	A-3a	May-November	CHs,Pp,Ss,Ps,CHp,SHp,Sp,COs,Psr	Johnson and Coleman, 2014.
2	Unnamed stream(s), Kupreanof Creek, Ivanof River, Wolverine Creek, Smokey Hollow Creek, Osterback Creek, Big River, Bluff Point Creek	A-3a	May-November	CHp,Pp,CHs,Ps,COp,COs,Sp,CHsp	Johnson and Coleman, 2014.
3	Unnamed stream(s), Kametolook River, Candlefish Slough, Artemie's Creek, Ivanof River, Humpback Creek, Red Bluff Creek, Three Star River, Cross Creek Slough, Spring Creek	A-3a	May-November	CHp,Pp,COp,CHs,Ps,COr,Sp,COs, Psr	Johnson and Coleman, 2014.
4	Unnamed stream(s), Ivan River, Fishrack Creek, Red Bluff Creek	A-3a	May-November	CHp,COsr,Ps,Pp,SHp,CHs,COp,Sp	Johnson and Coleman, 2014.
5	Windy Creek, Foot Creek, Unnamed stream(s)	A-3a	May-November	CHs,Ps,Pp	Johnson and Coleman, 2014.
6	Unnamed stream(s), Spoon Creek, Portage Creek, Metrofania Creek, Castle Creek, Chignik River	A-3a	May-November	COsr,Psr,CHs,Ps,Pp,DVr,CHp	Johnson and Coleman, 2014.
7	Chignik River, Unnamed stream(s), Through Creek, Frank Creek, Alfred Creek, Metrofania Creek, Mallard Duck Creek, Marshinlak Creek, Packers Creek, Lake Bay Creek, Owen Creek	A-3a	May-November	CHp,COp,Ks,Ps,Ss,DVp,SHp,CHs,Pp ,Sp,DVsr,COs,Psr,DVr	Johnson and Coleman, 2014.

LS ID	Name	Map	Vulnerable	Specific Resource	Reference
8	McKinsey Creek, Thompson Creek, Neketa Creek, Unnamed stream(s), Dry Creek, Hook Creek, Bear Creek	A-3a	May-November	Ps,CHs,Pp,COs,COsr,COp	Johnson and Coleman, 2014.
9	Bear Creek, Packers Creek, Unnamed stream(s), Rudy Creek, Blue Violet Creek, Kumliun Creek, New Creek, Meshik L	A-3a	May-November	CHs,Ps,Pp,Ks,Ss,CHp,COr	Johnson and Coleman, 2014.
10	Unnamed stream(s), West Creek, North Fork Aniakchak River, Aniakchak River, New Creek, Black Creek, Wolverine Creek, Mystery Creek, Albert Johnson Creek	A-3a	May-November	Pp,CHp,Ps,CHs,Ss,COp,Sp	Johnson and Coleman, 2014.
11	Northeast Creek, Unnamed stream(s), Yantarni Creek, Misery Creek, Home Creek, Mountain Creek, West Creek, Main Creek	A-3a	May-November	CHs,COp,Ps,CHp,Pp,Ssr,Sp,Ss	Johnson and Coleman, 2014.
12	Unnamed stream(s), Camp Creek, Nakalilok Bay Creek	A-3a	May-November	CHp,COp,Pp,COpr,Kp,Ss,CHs,Ps,Sp	Johnson and Coleman, 2014.
13	Unnamed stream(s), Agripina River	A-3a	May-November	Ps,CHs,Pp,Ss,CHp,Sp,COp	Johnson and Coleman, 2014.
14	Glacier Creek, Unnamed stream(s), Kilokak Creek, Agripina River, Circ Creek, Alai Creek, Imuya Creek, Kialaguik Creek	A-3a	May-November	CHp,Pp,Ssr,CHs,Ps,Sp,COp,CHsr	Johnson and Coleman, 2014.
15	Big Creek, Unnamed stream(s), Tiny Creek, Pass Creek, Des Moines Creek, Black Creek, Short Creek, Beach Creek	A-3a	May-November	CHs,COp,Ps,Pp,Ss,CHsr,Psr	Johnson and Coleman, 2014.
16	Unnamed stream(s), Jute Creek, Salmon Creek, Bear Creek, Porcupine Creek, Rex Creek, South Fork Rex Creek, North Fork Rex Creek, Sulphur Creek, Little Kanatak Creek, Kanatak Creek, Otter Creek	A-3a	May-November	Ps,DVp,CHs,Ss,Pp,CHp,COp,Sp,COs	Johnson and Coleman, 2014.
17	Unnamed stream(s), Teresa Creek, Dry Creek, Trail Creek, Katie Creek, Becharof Creek, Oil Creek, Helen Creek, Portage Creek	A-3b	May-November	CHs,COp,Ps,DVp,DVs,CHsr,Ss,CHp, Pp	Johnson and Coleman, 2014.
18	North Creek, Moose Creek, Portage Creek, Helen Creek, Little Alinchak Creek, Big Alinchak Creek, Unnamed stream(s), West Creek	A-3b	May-November	CHs,COsr,Ps,DVp,CHp,Pp,Sp	Johnson and Coleman, 2014.
19	Big Kashvik Creek, Unnamed stream(s), Katmai River, Soluka Creek, Alagogshak Creek	A-3b	May-November	CHs,Ps,DVp,CHp,Pp	Johnson and Coleman, 2014.
20	Unnamed stream(s), Geographic Creek, Dakavak Creek	A-3b	May-November	Ps,Pp,CHsr,CHs,COsr	Johnson and Coleman, 2014.
21	Unnamed stream(s), Kinak Creek, Halferty Creek, Missak Creek, Low Pass Creek	A-3b	May-November	CHp,COp,Pp,Ss,COr,Ssr,CHs,Ps,CHs .Ps,COsr	Johnson and Coleman, 2014.
22	Serpent Creek, Hook Creek, Unnamed stream(s), Ninagiak River, Hallo Creek	A-3b	May-November	CHp,COsr,Pp,CHs,Ps,Psr	Johnson and Coleman, 2014.
23	Big River, Unnamed stream(s), Swikshak River, Chiniak Lagoon, Cape Chiniak Creek	A-3b	May-November	CHs,COsr,Ps,COp,Ss,DVp,CHp,Pp,C Or,Sr,COs,Sp,Psr,CHsr	Johnson and Coleman, 2014.
24	Unnamed stream(s), Swikshak River, Bluff Creek, Long Slough Creek	A-3b	May-November	Ps,DVp,Pp,CHs,Ss,COr,Sr,COp,CHp, Psr,Sp	Johnson and Coleman, 2014.
25	Douglas Creek, Unnamed stream(s), Clear Creek	A-3b	May-November	CHsr,Ps,CHs,COp,COsr	Johnson and Coleman, 2014.
26	Unnamed stream(s), Douglas River	A-3c	May-November	Ps,CHs,CHp,COp,Pp,Sp,COr,COs,Ss ,ACp	Johnson and Coleman, 2014.
27	Unnamed stream(s), McNeil River, Mikfik Creek, Little Kamishak River, Strike Creek, Kamishak River, Paint River	A-3c	May-November	Ss,ACp,CHs,Ps,COs,COr,Ks,Pp,COp, Kp,CHp,Sp	Johnson and Coleman, 2014.
28	Chenik Lake, Unnamed stream(s), Amakdedori Creek	A-3c	May-November	Ss,ACp,CHp,COp,Pp,SHp,Sp,COs,C Hs,Ps,COr	Johnson and Coleman, 2014.
30	Unnamed stream(s), Sunday Creek	A-3c	May-November	CHs,COs,Ps,ACp,Sp,CHp,Pp,Ss	Johnson and Coleman, 2014.
31	Unnamed stream(s), Y-Valley Creek	A-3c	May-November	Ss,Sp,Ps,Pp,ACp,CHs,CHp,COs,COr, COp,Kp,Kr	Johnson and Coleman, 2014.
32	Bowser Creek, Brown Creek, Chinitna River, Unnamed stream(s), Iniskin River, Right Arm Creek, Portage Creek, Fitz Creek, Trail Creek, Wrong Branch Trail Creek, Clearwater Creek, Roscoe Creek, Marsh Creek	A-3c	May-November	COp,CHs,Ps,CHp,Sp,ACp,Pp,COs	Johnson and Coleman, 2014.
33	West Glacier Creek, Fitz Creek, Silver Salmon Creek, East Glacier Creek	A-3c	May-November	CHp,Sp,COs,ACp,CHs,COp	Johnson and Coleman, 2014.
34	Silver Salmon Lakes, Johnson River, Unnamed stream(s), Shelter Creek	A-3c	May-November	CHp,COp,DVp,CHs,COs,Pp,Ps,Sp,C Or	Johnson and Coleman, 2014.
35	Crescent River, Unnamed stream(s), Hungryman Creek, Bear Creek	A-3c	May-November	CHp,COp,Kp,Pp,Sp,DVp,COr	Johnson and Coleman, 2014.
36	Wadell Lake, Bear Lake, Polly Creek, Harriet Creek, Unnamed stream(s), Redoubt Creek, Little Polly Creek, Redoubt Creek trib, Crescent River	A-3c	May-November	Ss,DVp,CHs,COs,CHp,COp,Ps,Sp,C Or,Kr,Kp,COsr,Pp	Johnson and Coleman, 2014.
37	Unnamed stream(s), Rust Slough, Cannery Creek, Drift River, Little Jack Slough	A-3c	May-November	Ss,Sp,COp,DVp,COpr,COr,Pp	Johnson and Coleman, 2014.
38	Packers Creek Lake, Unnamed stream(s), Packers Creek	A-3c	May-November	COp,Ss,DVp,COs,Sp	Johnson and Coleman, 2014.
39	Unnamed stream(s), Montana Bill Creek, Big River, Johnson Slough, Seal River, Bachatna Creek	A-3c	May-November	COs,COp,DVp,COr,Kp,Pp,Sp,Sr	Johnson and Coleman, 2014.

LS ID	Name	Map	Vulnerable	Specific Resource	Reference
40	Kustatan River, Unnamed stream(s)	A-3c	May-November	COp,Kp,Pp,Sp,DVp	Johnson and Coleman, 2014.
41	Nikolai Creek, Stedatna Creek, Middle River, Chakachatna River, Chuitkilnachna Creek, McArthur River, Unnamed stream(s)	A-3c	May-November	Ps,DVr,COr,COp,Sp,CHs,COpr,Kp,Pp,Spr,DVpr,CHp,Kr	Johnson and Coleman, 2014.
42	Tyonek Creek, Old Tyonek Creek, Unnamed stream(s), Nikolai Creek, Indian Creek, Chuitna River, Chuitna Braid	A-3c	May-November	Ps,COpr,Kp,OUp,COp,COr,CHr,Pr,Kpr,Pp,DVr,CHp,Sp,DVp,ALp,PCp	Johnson and Coleman, 2014.
43	Tukallah Lake, Threemile Creek, Unnamed stream(s), Chuitna River	A-3c	May-November	COsr,Kpr,Pp,Ss,CHp,Kr,COs,Ps,Sp,COr,CHr,Pr,CHs,COpr,Kp,Spr,ALp,DVp,PCp	Johnson and Coleman, 2014.
44	Ivan River, Beluga River, Pretty Creek, Theodore River, Lewis River, Unnamed stream(s)	A-3c	May-November	COp,Ks,Pp,Ksr,Kr,COpr,Kpr,Spr,COr,Ps,Sr,CHp	Johnson and Coleman, 2014.
45	Unnamed stream(s), Maguire Creek, Little Susitna River, Susitna River	A-3c	May-November	COp,Kr,COr,CHp,Kp,Pp,Sp,COs,ALp,DVp,HWp,OUs	Johnson and Coleman, 2014.
46	Fish Creek, Unnamed stream(s)	A-3c	May-November	COr,COp	Johnson and Coleman, 2014.
49	Seven Egg Creek, Miller Creek	A-3c	May-November	COs,COr	Johnson and Coleman, 2014.
50	Otter Creek, Seven Egg Creek, Unnamed stream(s)	A-3c	May-November	COs,DVp,COr	Johnson and Coleman, 2014.
51	Bishop Lake, Unnamed stream(s), Parsons Lake, Daniels Lake, Duck Lake, Bishop Creek, Stormy Lake Outlet Creek, Swanson River, Stormy Lake	A-3c	May-November	COs,Ss,DVp,COp,Sp,COsr,COr,Ps,Pp	Johnson and Coleman, 2014.
52	Unnamed stream(s)	A-3c	May-November	Kr,COr,Sr	Johnson and Coleman, 2014.
53	Unnamed stream(s), Kasilof River, Kenai River	A-3c	May-November	Sr,COr,Kr,COp,Ks,Ps,Sm,DVp,PCp,SHp,CHp,Sp,LPp,OUp,Wp	Johnson and Coleman, 2014.
54	Coal Creek, Crooked Creek, Unnamed stream(s), Kasilof River	A-3c	May-November	Ps,COs,DVp,Ks,Pp,Ss,PCp,SHp,COr,Kr	Johnson and Coleman, 2014.
55	Ninilchik River, Deep Creek, Unnamed stream(s), Clam Creek	A-3c	May-November	Ks,Pp,Kp,COs,DVp,SHp,Ps,COsr,Ksr,DVpr,COr,Kr,Kpr,DVr	Johnson and Coleman, 2014.
56	Stariski Creek, Chakok River, Unnamed stream(s), Clam Creek, Deep Creek	A-3c	May-November	Ps,COs,Ks,SHp,COr,DVp,Kp,Kr,COsr,DVr,COp	Johnson and Coleman, 2014.
57	Anchor River, Unnamed stream(s), Bridge Creek, Chakok River, Ruby Creek, Two Moose Creek, North Fork Anchor River, Twitter Creek, Telephone Creek	A-3c	May-November	Ps,CHp,COsr,Ksr,Pp,Sp,DVp,SHp,SHs,COr,Kr,DVr,SHr,COp,COs,Ks,DVpr	Johnson and Coleman, 2014.
58	Bridge Creek, Fritz Creek, Beluga Sough	A-3c	May-November	DVp,Ps,COr	Johnson and Coleman, 2014.
59	Humpy Creek, Beaver Creek, Unnamed stream(s)	A-3c	May-November	COr,CHs,COsr,Ksr,Ps,COp,DVpr	Johnson and Coleman, 2014.
60	Unnamed stream(s), Stonehocker Creek, Silver Creek, Estuary Creek, Wosnesenski River	A-3c	May-November	COp,COs,Pp,CHs,Ps,Ss,COr,Ssr,CHp,Sp	Johnson and Coleman, 2014.
61	Jakolof Creek, Unnamed stream(s), Barabara Creek, Seldovia River, Seldovia Slough	A-3c	May-November	COp,Sp,CHs,Ps,Pp,CHp,COs,Ss,DVs	Johnson and Coleman, 2014.
62	Unnamed stream(s), English Bay River	A-3c	May-November	COs,Pp,Ss,DVsr,CHs,Ps,CHp,DVp,COp,DVs,COr,Sp	Johnson and Coleman, 2014.
63	Unnamed stream(s), Perl Island Stream, English Bay River	A-3d	May-November	Pp,COp,Sp,COr,Ss,DVr,DVp,Ps,CHs,COs,CHp,Sr,DVsr	Johnson and Coleman, 2014.
64	Unnamed stream(s), Rocky River	A-3d	May-November	COp,Ss,CHs,COs,Ps,DVs,COr,DVsr,Sp,DVp,COsr,DVr	Johnson and Coleman, 2014.
65	Port Dick Creek, Unnamed stream(s), Island Creek, Slide Creek, Port Dick Creek	A-3d	May-November	CHs,COs,Ps,Sp,CHp,Pp	Johnson and Coleman, 2014.
66	Unnamed stream(s)	A-3d	May-November	CHs,Ps,CHp	Johnson and Coleman, 2014.
67	Unnamed stream(s), Ferrum Creek, Nuka Delta, Shelter Cove Creek	A-3d	May-November	Ps,CHs,COp,Pp,Sp	Johnson and Coleman, 2014.
68	Unnamed stream(s), Nuka River, Babcock Creek	A-3d	May-November	Ps,Pp,CHs,CHp,COp,SMp	Johnson and Coleman, 2014.
69	Delight Lake, Unnamed stream(s)	A-3d	May-November	COp,Kp,Ps,Ss,Pp,CHs,COs,Sp,Ks,COr	Johnson and Coleman, 2014.
70	Unnamed stream(s), Crescent Beach Pond, Boulder Creek	A-3d	May-November	Pp,Ps,CHs,COs,CHp,COp,Sp	Johnson and Coleman, 2014.
71	Unnamed stream(s)	A-3d	May-November	CHp,COp,Pp,Sp,Ss,Ps	Johnson and Coleman, 2014.
72	Unnamed stream(s), Likes Creek	A-3d	May-November	CHp,Pp,CHs,Ps	Johnson and Coleman, 2014.
73	Little Johnstone Lake, Unnamed stream(s), Puget Lake, Puget River	A-3d	May-November	CHsr,COsr,Pp,Ssr,DVsr,Ps,Ss	Johnson and Coleman, 2014.

LS ID	Name	Map	Vulnerable	Specific Resource	Reference
74	Unnamed stream(s)	A-3d	May-November	Pp,Ps	Johnson and Coleman, 2014.
75	Unnamed stream(s), San Juan Creek, Trap Creek	A-3d	May-November	Pp,COr,Ssr	Johnson and Coleman, 2014.
76	Unnamed stream(s), Nellie Martin River, Braided Creek, Patton Creek, Jeanie Creek, Slide Creek, Deception Creek, San Juan Creek, Stump Lake, Point Creek, Trap Creek, McLeod Creek, Clam Beach, Strike Creek, Patton River, Old Patton River Channel, Hanning Creek	A-3d	May-November	COr,Pp,COsr,Sr,CHp,Ps,CTp,DVp,Sp,COs,COpr,Psp,DVr,COp,Ssr,CHsp,CHs	Johnson and Coleman, 2014.
77	Unnamed stream(s), Montague Creek, Montague Island #4 (Clearcut), Beach River, Montague Island #5 (Glacial), Montague Island #2, Montague Island #3, Montague Island #6, Behymer Creek, Quadra Creek	A-3d	May-November	COr,Ps,Pp,DVp,CHp,CHs,COp	Johnson and Coleman, 2014.
78	Unnamed stream(s), Kelez Creek, Cabin Creek, Chalmers River, Wilby Creek, Wild Creek, Schuman Creek, Dry Creek, Stockdale Harbor, Stockdale Creek, Gilmour Creek, Carr Creek, McKernan Creek, Rosswog Creek, Pautzke Creek, Udall Creek, Shad Creek, Swamp Creek, Russell Creek	A-3d	May-November	Pp,CHp,COr,DVp,Ps,COs,CHsp,Psp,Sp,DVr,CHs	Johnson and Coleman, 2014.
81	Unnamed stream(s), Shangin Narrows, Carry Bear Creek, Danny's Slough	A-3b	May-November	Ps,COsr,Pp,Ssr,DVp,COs,Sr,COp,Psr	Johnson and Coleman, 2014.
82	Unnamed stream(s), Carry Inlet Lagoon, Big Bay Creek, SW Redfox Creek, Blue Fox Creek	A-3b	May-November	Ps,COr,DVp,COs,COsr,Pp,Sp,COp,Psr,Psr,Ssr,CHsr	Johnson and Coleman, 2014.
83	Unnamed stream(s), Long Lagoon, Devil Inlet Creek	A-3b	May-November	COs,Pp,Ss,DVp,SHp,Ps,CHp,COp,CHsr,Psr,COr,Pr	Johnson and Coleman, 2014.
84	Lower Malina Lake, Upper Malina Lake, Selief, Bear Creek, Unnamed stream(s), Malina Creek	A-3b	May-November	COp,Sp,DVp,SHp,COs,Ss,Ps,Pp,SHs	Johnson and Coleman, 2014.
85	Unnamed stream(s)	A-3b	May-November	Ps	Johnson and Coleman, 2014.
86	California Creek, Little River, Unnamed stream(s)	A-3b	May-November	CHs,COs,Ps,COp,Sp,SHp	Johnson and Coleman, 2014.
87	Unnamed stream(s)	A-3b	May-November	Ps,CHs,COs	Johnson and Coleman, 2014.
88	Sturgeon River, Unnamed stream(s), Karluk River	A-3b	May-November	CHpr,COp,Pp,DVp,SHp,CHs,Ps,COs,CHsr,CHr,COr,Kp,Sr,Ks,Ss,Ssr	Johnson and Coleman, 2014.
89	Unnamed stream(s), Grant Lagoon, Ayakulik River, Sturgeon River	A-3b	May-November	COr,Pr,DVp,Kp,Pp,COs,Ps,DVs,Ks,CHs,COsr,COp,SHp	Johnson and Coleman, 2014.
90	Unnamed stream(s), Ayakulik River, Red River	A-3b	May-November	CHsr,COsr,Psr,DVp,Ss,CHs,COs,Ps,CHp,COp,Kp,Pp,Sp,SHp	Johnson and Coleman, 2014.
91	Olga Creek, Big Sukhoi, Unnamed stream(s)	A-3b	May-November	CHsr,COp,Pp,Sp,DVp,SHp,CHs,COsr,CHp	Johnson and Coleman, 2014.
92	Unnamed stream(s), Little Sukhoi	A-3b	May-November	CHp,Pp,CHs,Ssr	Johnson and Coleman, 2014.
93	Mark Lake, Unnamed stream(s)	A-3b	May-November	Sp,Ps,CHs,COp,Pp,CHp,COr	Johnson and Coleman, 2014.
94	Unnamed stream(s)	A-3b	May-November	COr,COp,COs,CHp,Ps	Johnson and Coleman, 2014.
95	Unnamed stream(s)	A-3b	May-November	Pp	Johnson and Coleman, 2014.
98	Unnamed stream(s), Seven Rivers, Humpy River, East Portage Creek	A-3b	May-November	CHpr,Ppr,Sp,DVp,Pp,Ssr,CHr,Pr,Ps,CHp,COp,CHs,CHsr	Johnson and Coleman, 2014.
99	Unnamed stream(s), Japanese Bay, Rolling Bay, Avnulu Creek, Kaiugnak Point, NE Portage	A-3b	May-November	Pp,CHs,Ps,DVp,CHp,CHsr,COsr	Johnson and Coleman, 2014.
100	Unnamed stream(s), Lagoon Creek Headwaters, Natalia Cabin Creek, Rolling Bay, Ranch Creek, Fugitive Creek, Kuingcuk Creek, Sculpin Creek	A-3b	May-November	Pp,Ps,CHs,DVp,COs,Sp,Ss,COp,COpr,COr,Psr,CHsr,CHp	Johnson and Coleman, 2014.
101	Unnamed stream(s)	A-3b	May-November	CHs,Ps,COs,DVp,Pp,CHp,Ss	Johnson and Coleman, 2014.
102	Miam, Lake, Unnamed stream(s), Rose Tead, Lake, Zenter Stream, Delta Creek, Wild Creek, Saltery Creek	A-3b	May-November	CHs,COs,Pp,Ss,DVp,SHp,COp,Kp,Sp,Ps,COsr,Sr,COr,CHp,Ks,CHsr	Johnson and Coleman, 2014.
103	Chiniak Lake, Unnamed stream(s), Roslyn Creek, West Fork Twin Creek, Twin Creek, East Fork Twin Creek, Chiniak River, Chiniak Lagoon Creek, Sacramento River, Myrtle Creek, Kalsin Creek, Olds River, Kalsin Pond, Franks Creek, Little Navy Creek, Sequel Point Creek, Saturn Creek, Little Creek, Chiniak Springs, Big Creek	A-3b	May-November	COsr,COs,Ps,DVp,Psr,CHs,Pp,COr,COp,Pr,COpr,CHsr	Johnson and Coleman, 2014.
104	Unnamed stream(s), Orbin, Lake, Mayflower Lake, Panamaroff Creek, Devils Creek, Sargent Creek, Salonie Creek, Mayflower Creek, Russian Creek, Salt Creek, American River, Brechan's Channel, Cliff Point Creek	A-3b	May-November	CHs,COr,Ps,COsr,DVp,COs,CHp,Pp,COp,DVr,Pr,Ksr,Ssr,Sp,Ss,DVs	Johnson and Coleman, 2014.
105	Otmeloi Point Creek, Monashka Creek, Unnamed stream(s), Buskin Lake, Catherine, Lake, Island Lake, Dark Lake, Beaver Lake, Mission Lake, Potatopatch Lake, Seredni Point Creek, Virgina Creek, Pillar Creek, Red Cloud River, Buskin River, Devils Creek, Bear Creek, Hollie Creek, Elbow Creek, Battery Creek	A-3b	May-November	CHsr,COs,Ps,COp,CHp,Kp,Ss,DVp,COsr,Pp,Sp,CHs,DVr,COr,CHr,Pr,Sr,SHr,DVs,Ksr,Psr,Ssr,DVpr,SHsr,SHs	Johnson and Coleman, 2014.
106	Unnamed stream(s)	A-3b	May-November	COsr,Ps,COp,Pp	Johnson and Coleman, 2014.

LS ID	Name	Map	Vulnerable	Specific Resource	Reference
107	Afognak River, Unnamed stream(s), Crack Creek	A-3b	May-November	CHs,COp,Pp,Ss,DVp,SHp,Ps,Sp,COr,COs,COsr	Johnson and Coleman, 2014.
108	Unnamed stream(s), Little Kitoi Lake, Little Afognak Lake, Big Kitoi, Portage Creek, Lefthand Bay	A-3b	May-November	COsr,Ps,COr,COs,Ss,Sp,COp,Pp,DVp,SHp,CHp,COpr,Pr,CHsr,SHr	Johnson and Coleman, 2014.
109	Unnamed stream(s)	A-3b	May-November	CHp,COs,Ps,DVp,Pp,Ss,COr	Johnson and Coleman, 2014.
111	Pauls Lake, Laura Lake, Gretchen Lake, Portage Lake, Otter Lake, Unnamed stream(s), South Creek, Portage Creek	A-3b	May-November	CHp,COp,Pp,Ss,DVp,SHs,COsr,SHp,COr,DVr,Ps,COs,Sp,SHr,Psr,CHsr	Johnson and Coleman, 2014.
112	Pauls Lake, Unnamed stream(s), Big Bay Creek, East Shangin Bay, Little Waterfall Creek	A-3b	May-November	CHp,COp,Pp,Ss,DVp,SHs,COr,Ps,COs,COsr,Ssr,Psr	Johnson and Coleman, 2014.

Key:

AC	Arctic Char	CH	Chum Salmon	DV	Dolly Varden	LP	Lamprey, undifferentiated	SM	Smelts, undifferentiated	W	Whitefishes, undifferentiated	p	present
AL	Arctic Lamprey	CO	Coho Salmon	OU	Eulachon	PC	Pacific Lamprey	S	Sockeye Salmon	m	migration	r	rearing
K	Chinook Salmon	CT	Cutthroat Trout	HW	Humpback Whitefish	P	Pink Salmon	SH	Steelhead Trout	s	spawning		

Source: USDOI, BOEM, Alaska OCS Region (2015).

Table A.1-13. Environmental Resource Areas and Grouped Land Segments Used in the Analysis of Oil Spill Effects on Lower Trophic Level Organisms in Chapter 5.

ERA ID	Name	Map	Vulnerable	Specific Resource	Reference
11	Augustine	A-2a	January-December	Clams, Scallops, Seagrass	NPFMC, 2014 (pp. 29-35).
153	Polly Creek Beach	A-2a	January-December	Clams, Seagrass	Lees and Driskell, 2006 (Table 4, pp. 19-2,Table 5, pp. 23, Table 6, pp. 25-27).
154	Chinitna Bay	A-2a	January-December	Clams	Lees and Driskell, 2006 (Fig. 2, pp. 5, Table 6, pp 25-27).
155	Barren Islands	A-2a	January-December	Crabs	Bechtel and Gustafson, 2002 (pp. 2-5, 19-25).
GLS ID					
138	Clam Gulch Critical Habitat	A.1-4a	January-December	Clams	Kerkvliet and Booz, 2013 (Table 1, pp. 23, Table 2, p. 24).

Source: USDOI, BOEM, Alaska OCS Region (2015).

Table A.1-14. Grouped Land Segments Used in the Analysis of Oil Spill Effects on Terrestrial Mammals in Chapter 5.

GLS ID	Name	LSs	Map	Vulnerable	Specific Resource	Reference
117	Spring Bear Concentration-2	4-9	A-4a	March-May	Brown Bears	ADF&G, 1985b, 2014.
118	Bear Feeding Concentration -1	4-9	A-4b	June-August	Brown Bears	ADF&G, 1985b, 2014.
121	Spring Bear Concentration-3	10-14	A-4b	March-May	Brown Bears	ADF&G, 1985b, 2014.
125	Spring Bear Concentration-1	21-23	A-4a	March-May	Brown Bears	ADF&G, 1985b, 2014.
129	Redoubt Bay Brown Bears	37-40	A-4a	March -October	Brown Bear (Spring, Summer, Fall)	ADF&G, 1994
131	Trading Bay Moose	40-42	A-4a	Decmber-March	Moose (wintering)	ADF&G, 1985a, 1994.
132	Susitna Flats Black Bear	43-46	A-4a	April-June	Black Bear	ADEC, 1997, ADF&G, 1985a.
133	Susitna Flats Moose	43-46	A-4a	December-June	Moose (wintering and calving areas)	ADF&G, 1985a, 1988.
136	West Kenai Brown Bears	52-59	A-4a	June-October	Brown Bear (feeding areas)	ADF&G, 2015a.
140	West Kenai Black Bears	59-62	A-4a	June-October	Black Bear (feeding areas)	ADF&G, 2015a.
137	West Kenai Moose	53-55	A-4a	October-May	Moose (Rutting, wintering and calving)	ADF&G, 1985a, 2015a.
150	Montague Blacktail Deer	76-78	A-4b	December-March	Blacktail Deer (wintering area)	ADF&G, 1985a.
155	Afognak & Raspberry Winter Elk	81-85, 106-112	A-4a	December-March	Elk (Wintering)	ADF&G, 1985b, 2014.
157	Afognak Blacktail Deer	82-85, 107-109, 111-112	A-4b	December-March	Blacktail Deer (wintering area)	ADF&G, 1985b.
160	Kodiak Blacktail Deeer	89-95, 99-105	A-4a	December-March	Blacktail Deer (wintering area)	ADF&G, 1985b.

Source: USDOI, BOEM, Alaska OCS Region (2015).

Table A.1-15. Land Segments and Grouped Land Segments Used in the Analysis of Oil Spill Effects on Parks, Refuges and Special Areas in Chapter 5.

ID	Name	LSs	Map	Vulnerable	Specific Resource	Reference
LS ID						
35	Tuxedni State Game Refuge	35	A-3c	January-December	State Game Refuge	SOA, 2014a.
38	Kalgin Island Critical Habitat	38	A-3c	January-December	State Critical Habitat Area	SOA, 2014b; ADF&G, 2015b.
GLS ID						
113	Alaska Peninsula NWR	01-09, 11-15	A-4a	January-December	National Wildlife Refuge	USFWS, 2010, 2015a.
114	AMNWR SW Shelikof/GOA	1-17	A-4b	January-December	National Wildlife Refuge	USFWS, 2010, 2015b.
120	Aniakchak National Monument & Preserve	10-11	A-4b	January-December	National Monument and Preserve	NPS, 2015a.
122	Becharof NWR	16-18	A-4b	January-December	National Wildlife Refuge	USFWS, 2010, 2015c.
123	Katmai National Park	19-27	A-4a	January-December	National Park	NPS, 2015b.
126	McNeil River State Game Sanctuary & Refuge	27-28	A-4a	January-December	State Game Sanctuary and Refuge	ADF&G, 2015c.
127	AMNWR W Cook Inlet	27-29, 31-33, 35-36	A-4a	January-December	National Wildlife Refuge Tuxedni Bay and islands along Cook Inlet's western coast.	USFWS, 2010, 2015b.
128	Lake Clark National Park & Preserve	33-36	A-4a	January-December	National Park and Preserve	KPB, 2015, NPS, 2015c.
130	Redoubt Bay CHA & Trading Bay SGR	39-40	A-4a	January-December	State Critical Habitat Area and State Game Refuge	ADF&G, 1994, 2015d.
134	Susitna Flats State Game Refuge	43-46	A-4a	January-December	State Game Refuge	ADF&G, 1988, 2015e.
135	Kenai AK State Rec Mgmt Areas	51-57	A-4a	January-December	State Recreation Areas & State Special Management Areas: Anchor River SRA, Captain Cook SRA, Deep Creek SRA, Kasilof River SRA, Kenai River Special Management Area	ADNR, 2015a, 2015b, 2015c, 2015d, 2015e, KPB, 2015.
138	Clam Gulch Critical Habitat	54-56	A-4a	January-December	State Critical Habitat Area	ADF&G, 2015f.
139	Kachemak Bay State Park and Wilderness Park Kachemak Bay State Critical Habitat Area	59-60, 64-67	A-4b	January-December	State Park and Wilderness Park, State Critical Habitat Areas	ADF&G, 1993, 2015g, KPB, 2015, ADNR, 2015f.
142	AMNWR E Cook Inlet	60-62	A-4b	January-December	National Wildlife Refuge	USFWS, 2010, 2015b.
143	AMNWR W Outer Kenai/GOA	63-66	A-4b	January-December	National Wildlife Refuge	USFWS, 2010, 2015b.
144	Kenai Fjords National Park	66-71	A-4b	January-December	National Park	KPB, 2015., NPS, 2015d.
145	AMNWR E Outer Kenai/GOA	67-73	A-4b	January-December	National Wildlife Refuge	USFWS, 2010, 2015b.
147	Chugach National Forest	72-78	A-4b	January-December	National Forest	USFS, 2015.
153	Shuyak Island State Park	81-82, 112	A-4a	January-December	State Park	ADNR, 2015g.
154	AMNWR Afognak and Shuyak Islands	81-84, 106-112	A-4a	January-December	National Wildlife Refuge	USFWS, 2010, 2015b.
156	Kodiak National Wildlife Refuge	81-101, 110	A-4b	January-December	National Wildlife Refuge	USFWS, 2010, 2015d.
158	AMNWR W Kodiak/Shelikof	85-88, 90	A-4a	January-December	National Wildlife Refuge	USFWS, 2010, 2015b.
161	AMNWR S Kodiak/GOA and Tugidak Island Critical Habitat Area	93-97		January-December	National Wildlife Refuge, State Critical Habitat Areas	ADF&G, 1995., 2015g, USFWS, 2015b.
162	AMNWR E Kodiak/GOA	92, 98- 105		January-December	National Wildlife Refuge	USFWS, 2010, 2015c.
163	Woody Island and Buskin River State Recreation Sites	102, 105	A-4b	January-December	State Rec & Special Management Areas	ADNR, 2015h, 2015i.
164	Afognak Island State Park	109-111	A-4a	January-December	State Park	ADNR, 2015j.

Key: AMNWR = Alaska Maritime National Wildlife Refuge; CHA = Critical Habitat Area; E = East; GOA= Gulf of Alaska; NWR= National Wildlife Refuge, S = South; SGR = State Game Refuge; SW= Southwest; W = West.

Source: USDOI, BOEM, Alaska OCS Region (2015).

Table A.1-16. Land Segment ID and the Geographic Place Names within the Land Segment.

ID	Geographic Place Names	ID	Geographic Place Names
1	Stepovak & Ivanoff Bays, Kupreanof Pen.	**57**	Anchor Point, Anchor River
2	Jacob Island, Perryville	**58**	Homer, Homer Spit
3	Mitrofania & Chiachi Island, Sosbee Bay	**59**	Fritz Creek, Halibut Cove
4	Mitrofania & Anchor Bays, Stirni Point	**60**	China Poot Bay, Gull Island
5	Kuiukta Bay, Seal Cape	**61**	Barabara Point, Seldovia Bay
6	Warner Bay	**62**	Nanwalek, Port Graham
7	Castle Bay, Chignik, Chignik Lagoon	**63**	Elizabeth Island, Port Chatham, Koyuktolik Bay
8	Chignik Bay	**64**	Chugach Bay, Rocky Bay, Windy Bay
9	Kujulik Bay, Unavikshak Island	**65**	West Arm Port Dick, Qikutulig & Touglaalek Bays
10	Aniakchak Bay, Cape Kumlik, Kumlik Island	**66**	Gore Point, Port Dick, Tonsina Bay
11	Amber Bay, Yantarni Bay	**67**	Nuka Passage, Nuka Bay, Nuka Island
12	Nakalilok Bay, Ugaiushak Island	**68**	Pye Islands, Surprise Bay
13	Cape Providence, Chiginagak Bay	**69**	Black Bay, Thunder Bay, Two Arm Bay
14	Agripina Bay, Ashiiak Island, Cape Kilokak	**70**	Aialik Bay, Harris Bay
15	Cape Kayakliut, Wide Bay	**71**	Aialik Cape, Aialik Bay, Resurrection Bay
16	Capes Kanatak, Igvak, & Unalishagvak, Portage Bay	**72**	Cape Resurrection, Day Harbor, Whidbey Bay
17	Cape Aklek, Puale Bay	**73**	Johnstone Bay, Puget Bay
18	Alinchak Bay, Cape Kekurnoi, Bear Bay	**74**	Elrington Island, Latouche Island
19	Cape Kubugakli, Kashvik Bay, Katmai Bay	**75**	Montague Strait, Cape Clear
20	Amalik, Dakavak & Kinak Bays, Cape Iiktugitak, Takli Is.	**76**	Monatgue Island (a)
21	Kaflia, Kukak, Kuliak & Missak Bays	**77**	Monatgue Island (b)
22	Devils Cove, Hallo Bay	**78**	Monatgue Island (c)
23	Cape Chiniak, Swikshak Bay	**79**	Barren Islands, Ushagat Island
24	Fourpeaked Glacier	**80**	Amatuli Cove, East & West Amatuli Island
25	Cape Douglas, Sukoi Bay	**81**	Shuyak Island
26	Douglas River	**82**	Bluefox Bay, Shuyak Island, Shuyak Strait
27	Akumwarvik Bay , McNeil Cove, Nordyke Island	**83**	Foul Bay, Paramanof Bay
28	Amakdedulia Cove, Bruin Bay, Chenik Head	**84**	Malina Bay, Raspberry Island, Raspberry Strait
29	Augustine Island	**85**	Kupreanof Strait, Viekoda Bay
30	Rocky Cove, Tignagvik Point	**86**	Uganik Bay Uganik Strait, Cape Ugat
31	Iiamna Bay, Iniskin Bay, Ursus Cove	**87**	Cape Kuliuk, Spiridon Bay, Uyak Bay
32	Chinitna Point, Dry Bay	**88**	Karluk Lagoon, Northeast Harbor, Karluk
33	Chinitna Bay	**89**	Halibut Bay, Middle Cape, Sturgeon Head
34	Iliamna Point	**90**	Ayakulik, Bumble Bay, Gurney Bay
35	Chisik Island, Tuxedni Bay	**91**	Low Cape, Sukhoi Bay
36	Redoubt Point	**92**	Aiaktalik, Alitak Bay, Cape Alitak
37	Drift River, Drift River Terminal	**93**	Sitkinak Island
38	Kalgin Island	**94**	Tugidak Island
39	Seal River, Big River	**95**	Chirikof Island
40	Kustatan River,West Foreland	**96**	Semidi Islands
41	Chakachatna, McArthur & Middle River, Trading Bay	**97**	Sutwik Island
42	Beshta Bay	**98**	Aiaktalik Is., Japanese & Kaguyak Bays, Russian Harbor
43	Tyonek, Chuitna River, Beluga	**99**	Kiavak Bay, Knoll Bay, Natalia Bay, Rolling Bay
44	Beluga, Theodore, Lewis & Ivan Rivers	**100**	McCord, Newman, & Ocean Bays, Old Harbor
45	Susitna & Little Susitna Rivers, Big Is., Magot Point	**101**	Boulder Bay, Outer Right Cape, Kiluida Bay
46	Susitna Flats, Knik Arm	**102**	Gull Point, Pasagshak Bay, Ugak Bay
47	Fire Island	**103**	Barry Lagoon, Cape Chiniak, Cape Greville
48	Anchorage, Turnagain Arm	**104**	Long Island, Chiniak Bay
49	Point Possession, Miller Creek	**105**	Anton Larsen Bay, Narrow Strait, Kodiak, Spruce Is
50	Moose Point, Otter Creek	**106**	Afognak Strait, Whale Island, Kizhuyak & Sharatin Bays
51	Bishop Creek, Boulder Point, Swanson River	**107**	Kazakof Bay, Duck Bay
52	East Forelands, Kenai, Nikiski	**108**	Izhut Bay, Pillar Cape
53	Kalifornsky, Kasilof River, Kenai River	**109**	King Cove, Tonki Cape Peninsula
54	Clam Gulch, Kasilof	**110**	Marmot Cape, Marmot Island, Marmot Strait
55	Deep Creek, Ninilchik, Ninilchik River	**111**	Seal Bay, Tonki Bay
56	Cape Starichkof, Happy Valley	**112**	Andreon Bay, Big Fort Is. Big Waterfall & Perenosa Bay

Key: ID = identification (number).
Source: USDOI, BOEM, Alaska OCS Region (2015).

Table A.1-17. Grouped Land Segment ID, Geographic Names, Land Segments ID's which make up the Grouped Land Segment and Vulnerability.

GLS ID	Grouped Land Segment Name	Land Segment ID's	Vulnerable	MAP
113	Alaska Peninsula National Wildlife Refuge	01-09, 11-15	January-December	A-4a 3
114	AMNWR SW Shelikof/GOA	1-17	January-December	A-4b 5
115	SUA: Chignik Lake, Ivanof Bay, Perryville	02-11	January -December	A-4a 3
116	SUA: Chignik Chignik Lagoon	02-15	January–December	A-4a 3
117	Spring Bear Concentration-2	04-09	March-May	A-4a 4
118	Bear Feeding Concentration -1	04-09	June-August	A-4b 5
119	Kuiukta Bay	05-06	January-December	A-4b 5
120	Aniakchak National Monument and Preserve	10-11	January-December	A-4b 5
121	Spring Bear Concentration-3	10-14	March-May	A-4b 5
122	Becharof National Wildlife Refuge	16-18	January-December	A-4a 3
123	Katmai National Park	19-27	January-December	A-4a 2
124	Kukak Bay	21-22	January-December	A-4b 4
125	Spring Bear Concentration-1	21-23	March-May	A-4a 3
126	McNeil River State Game Sanctuary & Refuge	27-28	January-December	A-4a 2
127	AMNWR W Cook Inlet	27-29, 31-33, 35-36	January-December	A-4a 2
128	Lake Clark National Park and Preserve	33-36	January-December	A-4a 1
129	Redoubt Bay Brown Bears	37-40	April-October	A-4a 1
130	Redoubt Bay Critical Habitat Area	39-40	January-December	A-4a 1
131	Trading Bay Moose	40-42	December-March	A-4a 1
132	Susitna Flats Black Bear	43-46	April-June	A-4a 1
133	Susitna Flats Moose	43-46	December-June	A-4a 1
134	Susitna Flats State Game Refuge	43-46	January-December	A-4a 1
135	Kenai AK State Recreation Mgmt Areas	51-61	January-December	A-4a 1
136	West Kenai Brown Bears	52-59	June-October	A-4a 1
137	West Kenai Moose	53-55	October-May	A-4a 1
138	Clam Gulch Critical Habitat	54-56	January-December	A-4a 1
139	Kachemak Bay State Park & Wilderness Park	59-60, 64-67	January-December	A-4b 1
140	West Kenai Black Bears	59-62	Jun-October	A-4a 3
141	Seldovia side Kachemak Bay	59-62	January-December	A-4b 1
142	AMNWR E Cook Inlet	60-62	January-December	A-4b 3
143	AMNWR W Outer Kenai/GOA	63-66	January-December	A-4b 3
144	Kenai Fjords National Park	66-71	January-December	A-4b 3
145	AMNWR E Outer Kenai/GOA	67-73	January-December	A-4b 3
146	Resurrection Bay	71-72	January-December	A-4b 2
147	Chugach National Forest	72-78	January-December	A-4b 1
148	Prince William Sound IBA, AMNWR	74 -78	January-December	A-4b 2
149	Elrington-Bambridge-LaTouche Islands	74-75	January-December	A-4b 2
150	Montague Blacktail Deer	76-78	December-March	A-4b 1
151	Montague Island	76-78	January-December	A-4b 2
152	Barren Islands	79-80	January-December	A-4a 2
153	Shuyak Island State Park	81-82, 112	January-December	A-4a 2
154	AMNWR Afognak and Shuyak Islands	81-84, 106-112	January-December	A-4a 3
155	Afognak & Raspberry Winter Elk	81-85, 106-112	December-March	A-4a 2
156	Kodiak National Wildlife Refuge	81-101, 110	January-December	A-4b 4
157	Afognak Blacktail Deer	82-85, 107-109, 111-112	December-March	A-4b 4
158	AMNWR W Kodiak/Shelikof	85-88, 90	January-December	A-4a 2
159	Kupreanof Strait	85, 106	January-December	A-4a 3
160	Kodiak Blacktail Deer	89-95, 99-105	December-March	A-4a 3
161	AMNWR S Kodiak/GOA	93-97	January-December	A-4b 4
162	AMNWR E Kodiak/GOA	92, 98-105	January-December	A-4b 4
163	Woody Buskin River	102, 105	January-December	A-4b 4
164	Afognak Island State Park	109-111	January-December	A-4a 3

Key: AK=Alaska AMNWR= Alaska Maritime National Wildlife Refuge, E= East, GOA=Gulf of Alaska, IBA=Important Bird Area, S=South, SW=Southwest
Source: USDOI, BOEM, Alaska OCS Region (2015).

Table A.1-18. Cook Inlet Lease Sale 244 Action Area: Assumptions about How Launch Areas are Serviced by Pipelines for the Oil-Spill Trajectory Analysis.

Alternatives 1, 3a, 3b, 4a, 4b, 5, or 6	
Launch Area	**Serviced by Pipelines**
LA01	PL1
LA02	PL1
LA03	PL2, PL3
LA04	PL2, PL4
LA05	PL2, PL3
LA06	PL2, PL4

Source: USDOI, BOEM, Alaska OCS Region (2015).

Table A.1-19. Sale 244 Action Area: Estimated Mean Number of Large Platform, Pipeline and Total Spills for the Alternatives.

Alternative Number	Alternative Name	Mean Number of Platform/ Well Spills	Mean Number of Pipeline Spills	Mean Number of Spills Total
1, 3a, 3b, 4a, 4b, 5, or 6	Proposed Action and its Alternatives	0.05	0.19	0.24
2	No Action	0	0	0

Source: USDOI, BOEM, Alaska OCS Region (2015).

Table A.1-20. Sale 244 Action Area: Estimated Chance of One or More Large Platform, Pipeline and Total Spills Occurring for the Alternatives.

Alternative Number	Alternative Name	Percent Chance of One or More Platform/ Well Spills	Percent Chance of One or More Pipeline Spills	Percent Chance of One or More Spills Total
1, 3a, 3b, 4a, 4b, 5, or 6	Proposed Action and its Alternatives	5	17	22[1]
2	No Action	0	0	0

Note: [1.] Based on mean spill number of 0.243
Source: USDOI, BOEM, Alaska OCS Region (2015).

Table A.1-21. Small Refined and Crude Oil Spills: Range Assumed Showing Total Over the Life and Annual Number and Volume of Spills Over Exploration and Development and Production Activities.

Activity Phase	Estimated Total Number of Small Spills	Estimated Total Volume of Small Spills (bbl)	Estimated Annual Number of Small Spills	Estimated Annual Volume of Small Spills (bbl)
Refined Oil Spills				
Exploration G&G Activities	0-6	0-18	0-2	0-<2 or <14
Exploration & Delineation Drilling Activities	0-4	0-65	0-1	0-5 or 50
Small Crude and Refined Oil Spills				
Development and Production	450	300	13	91[1]

Note: [1] Average volume over 33 years.
Source: USDOI, BOEM, Alaska OCS Region (2015).

Table A.1-22. Small Refined and Crude Oil Spills: Development and Production Activities.

Activity Phase	Estimated Total Number of Small Spills	Estimated Total Volume of Small Spills (bbl)
Development and Production		
Total[1]	Approximately 450	Approximately 300
0- <1 bbl	434	10
0-<50 bbl	16	48
50 - <500	2	252
500-<1,000	0	0

Note: [1.] Total spill number or volumes are rounded to the nearest ten or hundred.
Source: USDOI, BOEM, Alaska OCS Region (2015).

Table A.1-23. Fate and Behavior of a Hypothetical 1, 5, 13, or 50-Barrel Diesel Fuel Oil Spill.

Scenario Element	Summer Spill[1]				Winter Spill[2]			
1 bbl								
Time After Spill in Hours	6	12	24	48	6	12	24	48
Oil Remaining (%)	26	2	0	na	0	na	na	na
Oil Dispersed (%)	55	75	77	na	85	na	na	na
Oil Evaporated (%)	19	22	23	na	15	na	na	na
5 bbl								
Time After Spill in Hours	6	12	24	48	6	12	24	48
Oil Remaining (%)	30	4	0	na	0	na	na	na
Oil Dispersed (%)	52	73	76	na	85	na	na	na
Oil Evaporated (%)	18	23	24	na	15	na	na	na
13 bbl								
Time After Spill in Hours	6	12	24	48	6	12	24	48
Oil Remaining (%)	26	2	0	na	0	na	na	na
Oil Dispersed (%)	55	75	76	na	85	na	na	na
Oil Evaporated (%)	19	23	24	na	15	na	na	na
50 bbl								
Time After Spill in Hours	6	12	24	48	6	12	24	48
Oil Remaining (%)	69	37	7	0	36	5	0	na
Oil Dispersed (%)	21	46	71	76	54	80	84	na
Oil Evaporated (%)	10	17	22	24	10	15	16	na

Notes: Calculated with the SINTEF oil-weathering model Version 4.0 of Reed et al. (2005) and assuming marine diesel, na means not applicable.
[1] Summer (April 1-October 31), 12-knot wind speed, 9 degrees Celsius, 1-meter wave height. Average Marine Weather Area A (Brower et al., 1988)
[2] Winter Spill (November 1-March 31), 16-knot wind speed, 5 degrees Celsius, 1.8- meter wave. Average Marine Weather Area A (Brower et al., 1988)

Table A.1-24 Comparison between VLOS and Worst-Case Discharge Analysis.

Characteristic	VLOS	WCD
Geographic Area of Focus	A broad area described by the Cook Inlet Program Area	A specific location described by an Exploration Plan (EP) or Development and Production Plan (DPP).
Reason for Analysis	The VLOS scenario is hypothetical and is provided as a general planning tool for the entire Program Area.	A WCD always accompanies an industry EP or DPP for a specific site, and provides the basis for an Oil-Spill Response Plan.
Regulatory Basis	A VLOS scenario serves to respond to CEQ regulations regarding a low probability, high impact event	The WCD calculation is required by 30 CFR Part 250.
Estimated Flow Rate	Maximizes estimated flow rate to represent the largest potential discharge estimated from any site in the entire Area ID.	Maximizes estimated flow rate to represent the largest potential discharge from one actual (known) drilling location. This will typically mean lower aggregate discharges than a VLOS.

Table A.1-25. AVALON/MERLIN Discharge Model Results for a Cook Inlet Well VLOS.

Day	Oil Discharge Rate (STB/d)	Gas Discharge Rate (MSCF/d)	Water Discharge Rate (STB/d)	Producing Gas-Oil Ratio (SCF/STB)	Cumulative Oil Discharge (STB)	Cumulative Gas Discharge (MSCF)	Average Reservoir Pressure (psia)	Flowing Bottom-Hole Pressure (psia) at Midpoint of Reservoir	Reservoir Pressure in Simulation Cell Containing Wellbore (psia)
0	0	0	0	0	0	0	3,120	0	3120
1	2,135	899	0	421	2,135	899	3,120	1,594	3,072
2	1,891	796	0	421	4,026	1,695	3,120	1,594	2,824
3	1,800	758	0	421	5,826	2,453	3,116	1,594	2,730
4	1,752	738	0	421	7,578	3,191	3,113	1,594	2,688
5	1,721	724	0	421	9,299	3,915	3,109	1,594	2,662
6	1,697	714	0	421	10,996	4,629	3,106	1,594	2,644
7	1,678	707	0	421	12,674	5,336	3,103	1,594	2,630
8	1,663	700	0	421	14,337	6,036	3,100	1,594	2,618
9	1,650	694	0	421	15,987	6,730	3,096	1,594	2,609
10	1,638	689	0	421	17,625	7,419	3,093	1,594	2,600
11	1,627	685	0	421	19,252	8,104	3,090	1,594	2,593
12	1,618	681	0	421	20,870	8,785	3,087	1,594	2,587
13	1,610	678	0	421	22,480	9,463	3,084	1,594	2,581
14	1,603	675	0	421	24,083	10,138	3,081	1,594	2,575
15	1,596	672	0	421	25,679	10,810	3,078	1,594	2,570
16	1,589	669	0	421	27,268	11,479	3,074	1,594	2,566
17	1,583	667	0	421	28,851	12,146	3,071	1,594	2,562
18	1,576	664	0	421	30,427	12,810	3,068	1,594	2,558

Day	Oil Discharge Rate (STB/d)	Gas Discharge Rate (MSCF/d)	Water Discharge Rate (STB/d)	Producing Gas-Oil Ratio (SCF/STB)	Cumulative Oil Discharge (STB)	Cumulative Gas Discharge (MSCF)	Average Reservoir Pressure (psia)	Flowing Bottom-Hole Pressure (psia) at Midpoint of Reservoir	Reservoir Pressure in Simulation Cell Containing Wellbore (psia)
19	1,571	661	0	421	31,998	13,471	3,065	1,594	2,554
20	1,566	659	0	421	33,564	14,130	3,062	1,594	2,551
21	1,561	657	0	421	35,125	14,787	3,059	1,594	2,547
22	1,557	655	0	421	36,682	15,442	3,056	1,594	2,544
23	1,552	654	0	421	38,234	16,096	3,053	1,594	2,541
24	1,548	652	0	421	39,782	16,748	3,050	1,594	2,538
25	1,544	650	0	421	41,326	17,398	3,047	1,594	2,535
26	1,540	648	0	421	42,866	18,046	3,044	1,594	2,533
27	1,536	647	0	421	44,402	18,693	3,041	1,594	2,530
28	1,533	645	0	421	45,935	19,338	3,038	1,594	2,527
29	1,529	644	0	421	47,464	19,982	3,035	1,594	2,525
30	1,525	642	0	421	48,989	20,624	3,032	1,594	2,522
31	1,522	641	0	421	50,511	21,265	3,029	1,594	2,520
32	1,519	639	0	421	52,030	21,904	3,026	1,594	2,518
33	1,515	638	0	421	53,545	22,542	3,024	1,594	2,516
34	1,512	637	0	421	55,057	23,179	3,021	1,594	2,513
35	1,509	635	0	421	56,566	23,814	3,018	1,594	2,511
36	1,506	634	0	421	58,072	24,448	3,015	1,594	2,509
37	1,502	632	0	421	59,574	25,080	3,012	1,594	2,507
38	1,499	631	0	421	61,073	25,711	3,009	1,594	2,505
39	1,496	630	0	421	62,569	26,341	3,006	1,594	2,503
40	1,493	629	0	421	64,062	26,970	3,003	1,594	2,501
41	1,490	627	0	421	65,552	27,597	3,000	1,594	2,499
42	1,487	626	0	421	67,039	28,223	2,997	1,594	2,497
43	1,484	625	0	421	68,523	28,848	2,994	1,594	2,495
44	1,481	624	0	421	70,004	29,472	2,992	1,594	2,493
45	1,478	622	0	421	71,482	30,094	2,989	1,594	2,491
46	1,475	621	0	421	72,957	30,715	2,986	1,594	2,489
47	1,472	620	0	421	74,429	31,335	2,983	1,594	2,487
48	1,470	619	0	421	75,899	31,954	2,980	1,594	2,485
49	1,467	617	0	421	77,366	32,571	2,977	1,594	2,483
50	1,464	616	0	421	78,830	33,187	2,974	1,594	2,481
51	1,461	615	0	421	80,291	33,802	2,972	1,594	2,479
52	1,458	614	0	421	81,749	34,416	2,969	1,594	2,477
53	1,455	613	0	421	83,204	35,029	2,966	1,594	2,476
54	1,453	612	0	421	84,657	35,641	2,963	1,594	2,474
55	1,450	610	0	421	86,107	36,251	2,960	1,594	2,472
56	1,447	609	0	421	87,554	36,860	2,958	1,594	2,470
57	1,444	608	0	421	88,998	37,468	2,955	1,594	2,468
58	1,441	607	0	421	90,439	38,075	2,952	1,594	2,466
59	1,439	606	0	421	91,878	38,681	2,949	1,594	2,465
60	1,436	605	0	421	93,314	39,286	2,946	1,594	2,463
61	1,433	603	0	421	94,747	39,889	2,944	1,594	2,461
62	1,430	602	0	421	96,177	40,491	2,941	1,594	2,459
63	1,428	601	0	421	97,605	41,092	2,938	1,594	2,457
64	1,425	600	0	421	99,030	41,692	2,935	1,594	2,456
65	1,422	599	0	421	100,452	42,291	2,932	1,594	2,454
66	1,420	598	0	421	101,872	42,889	2,930	1,594	2,452
67	1,417	597	0	421	103,289	43,486	2,927	1,594	2,450
68	1,414	595	0	421	104,703	44,081	2,924	1,594	2,449
69	1,412	594	0	421	106,115	44,675	2,921	1,594	2,447
70	1,409	593	0	421	107,524	45,268	2,919	1,594	2,445
71	1,406	592	0	421	108,930	45,860	2,916	1,594	2,443
72	1,404	591	0	421	110,334	46,451	2,913	1,594	2,441
73	1,401	590	0	421	111,735	47,041	2,911	1,594	2,440
74	1,398	589	0	421	113,133	47,630	2,908	1,594	2,438
75	1,396	588	0	421	114,529	48,218	2,905	1,594	2,436
76	1,393	586	0	421	115,922	48,804	2,902	1,594	2,435
77	1,390	585	0	421	117,312	49,389	2,900	1,594	2,433
78	1,388	584	0	421	118,700	49,973	2,897	1,594	2,431
79	1,385	583	0	421	120,085	50,556	2,894	1,594	2,429
80	1,382	582	0	421	121,467	51,138	2,892	1,594	2,428

Notes: STB/d, stock-tank (surface) barrels per day; MSCF/d, thousands of standard (surface conditions, or 60°F and 1 atmosphere (14.73 psia) cubic feet of gas; psia, pounds per square inch, absolute.Table refers to a very low probability hypothetical VLOS, occurring over a maximum (80-day) time period. The model estimates discharges during mobilization, drilling, and completion of a relief well.

Table A.1-26. Time Required to Drill Relief Well and Kill Discharge following VLOS at a Well.

1. Use of Original Drilling Platform and Equipment to Drill Relief Well	
Activity	**Time Estimate (days)**
Drilling of relief well	18
Killing of VLOS (original) well	5
Estimated Total Time Required	**23**
2. Use of Second Drilling Platform and Equipment to Drill Relief Well	
Activity	**Time Estimate (days)**
Transport of relief well rig to VLOS well site	25-56
Drilling of relief well	18
Killing of VLOS (original) well	5
EstimatedTotal Required Time	***48-79**

Notes: Estimated time periods required to drill a relief well and to kill the discharge at the Cook Inlet VLOS Well (provided by BSEE AKOCSR Field Operations).

Table A.1-27. Properties and Persistence for Medium Weight Crude Oil.

Medium-weight Crude Oil – Properties and Persistence	
Hydrocarbon compounds	Between 10 and 22 carbon atoms
API º	<31.1º
Evaporation rate	Evaporation rates of up to several days, although there will be some residue which does not evaporate at ambient temperatures
Solubility in water	Low water-soluble fraction (at most a few mg/L)
Acute toxicity	Moderate acute toxicity because they contain diaromatic hydrocarbons (naphthalenes) which are toxic in spite of their low solubilities
Chronic toxicity	Moderate
Bioaccumulation potential	Moderate potential for bioaccumulation and chronic toxicities associated with the diaromatic hydrocarbons
Compositional majority	Alkanes and cycloalkanes
Persistence	Moderate

Sources: Michel, 1992; Reed et al., 2005 (Sintef OWM); Brandvik, Resby, and Daling et al. (2010).

Table A.1-28. Fate and Behavior of a Hypothetical 1,400 to 2,100-Barrel Crude Oil Spill in the Cook Inlet.

	Summer Spill[1]				**Winter Spill[2]**				**Winter Spill (Broken Ice)[2]**			
Time After Spill (Days)	1	3	10	30	1	3	10	30	1	3	10	30
Oil Remaining (%)	84	74	52	24	75	55	22	3	88	84	75	61
Oil Dispersed (%)	11	13	31	56	14	32	62	80	1	3	8	19
Oil Evaporated (%)	5	13	17	20	11	13	16	17	11	13	17	20

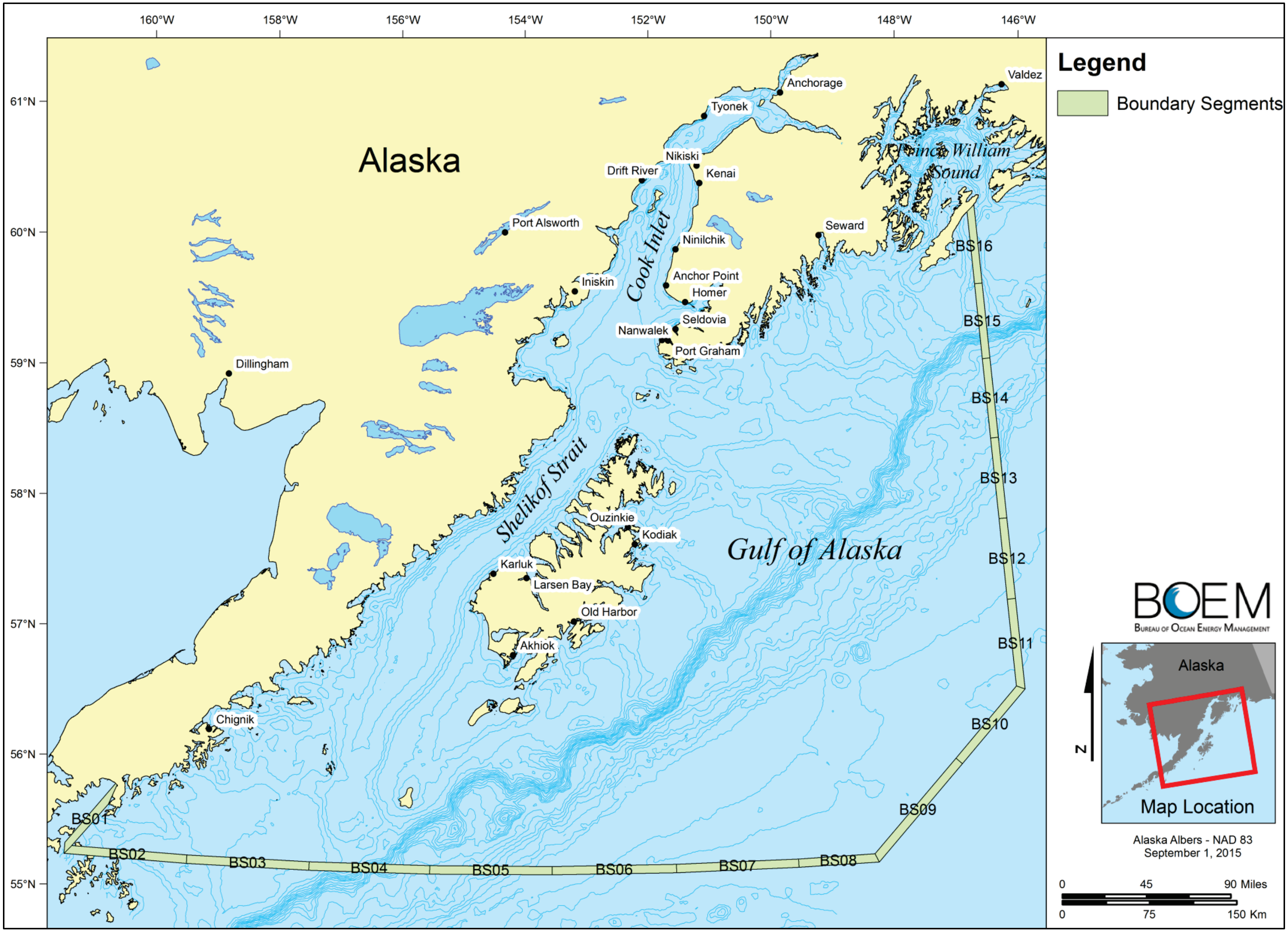
Notes: Calculated with the SINTEF oil-weathering model Version 4.0 of Reed et al. (2005) and assuming a Medium Crude Oil of 20-25º API

[1] Summer (April 1-October 31), 12-knot wind speed, 9 degrees Celsius, 1-meter wave height. Average Marine Weather Area A (Brower et al., 1988)

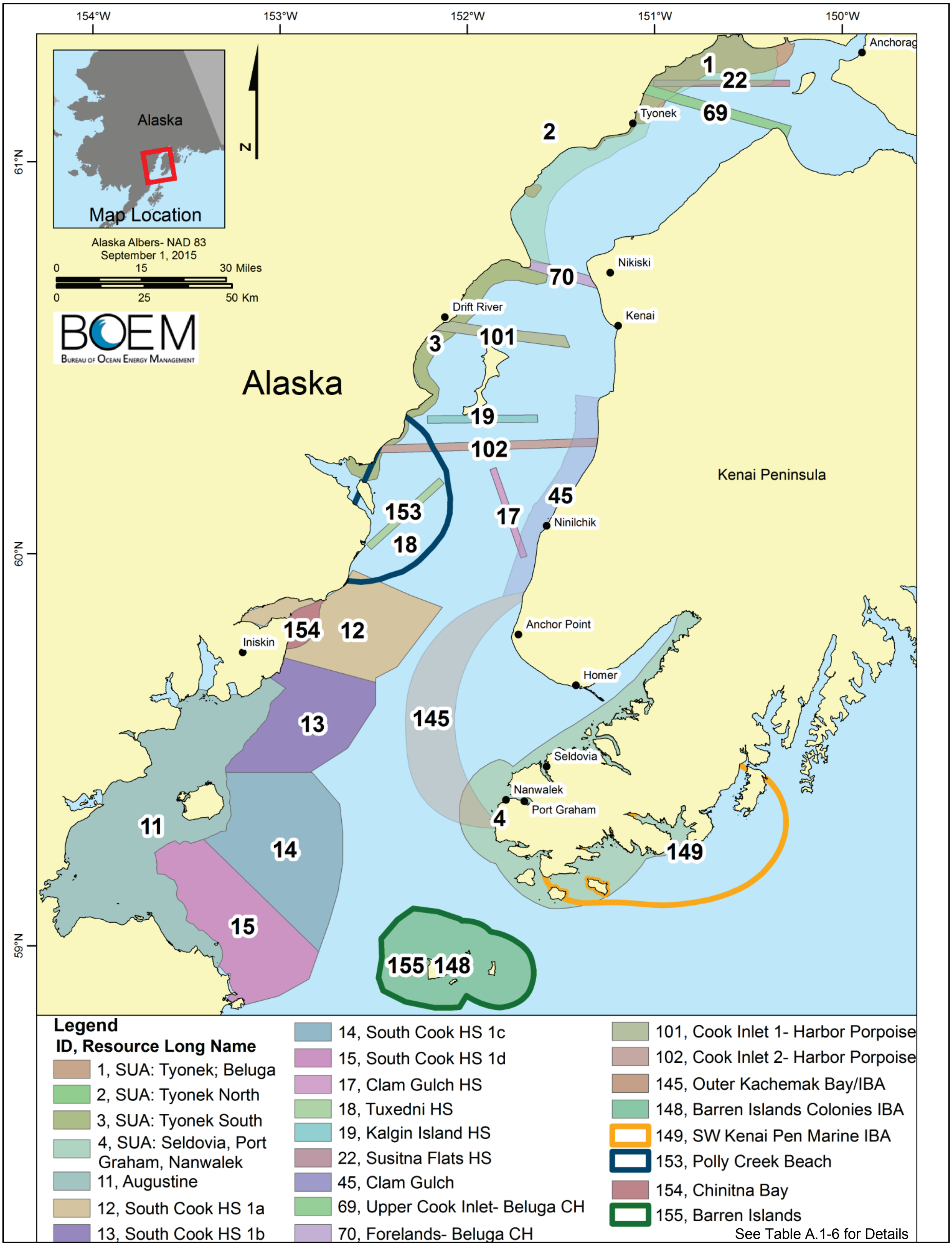
[2] Winter Spill (November 1-March 31), 16-knot wind speed, 5 degrees Celsius, 1.8- meter wave heights and for Broken Ice 50% ice. Average Marine Weather Area A (Brower et al., 1988)

Source: USDOI, BOEM, Alaska OCS Region (2015).

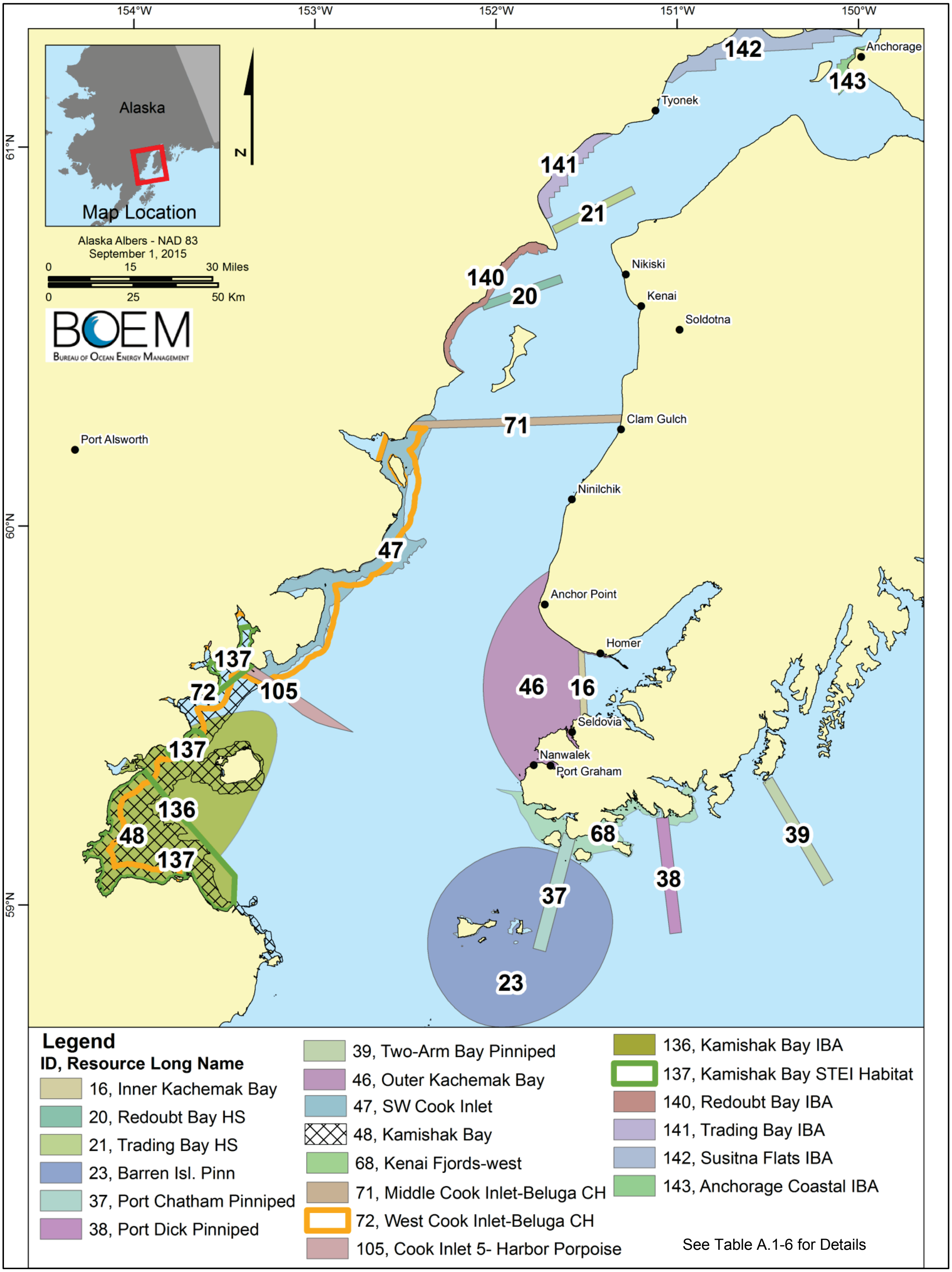
Appendix A Maps



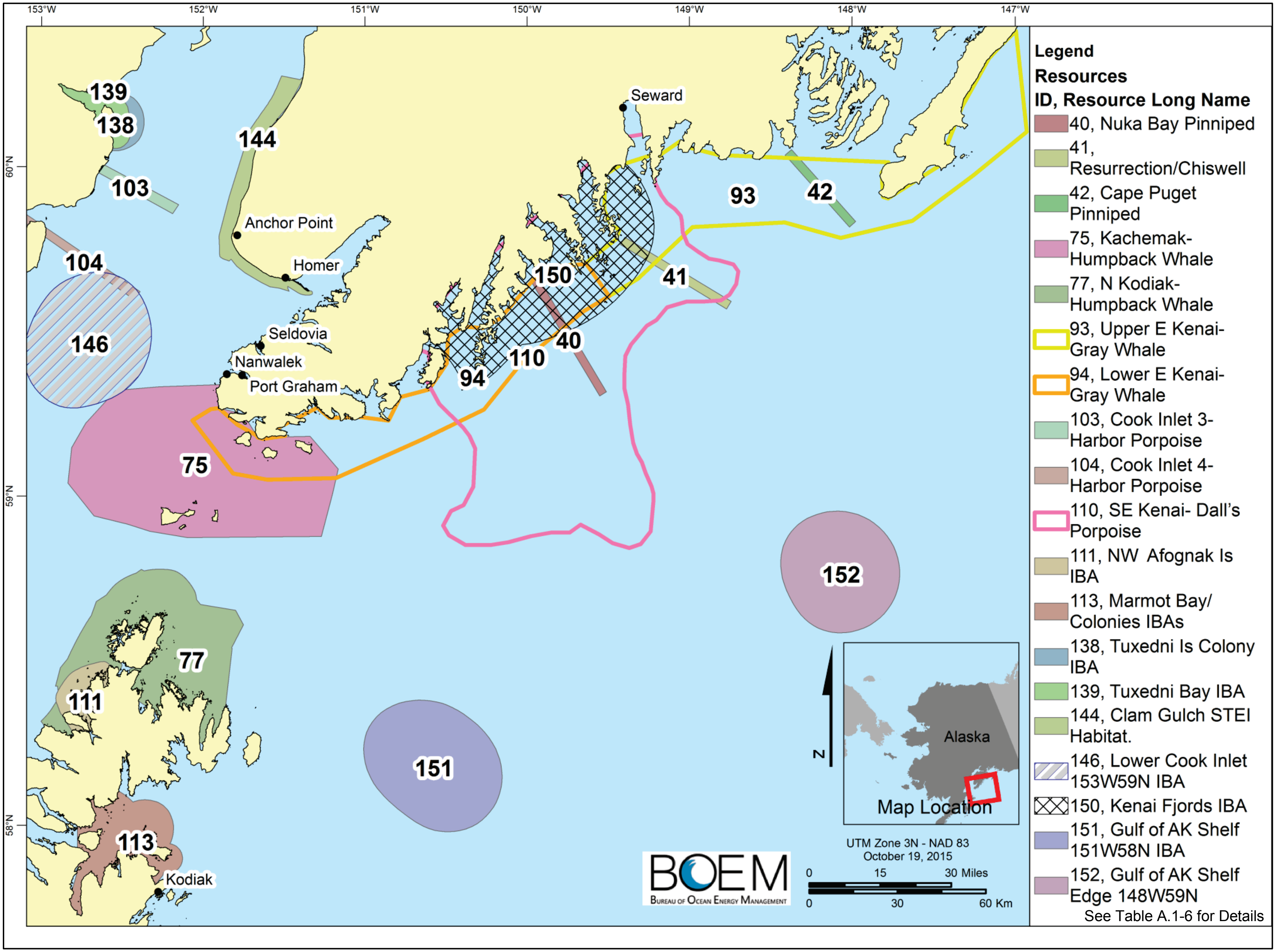
Map A-1. Study Area Used in the Oil-Spill Trajectory Analysis.



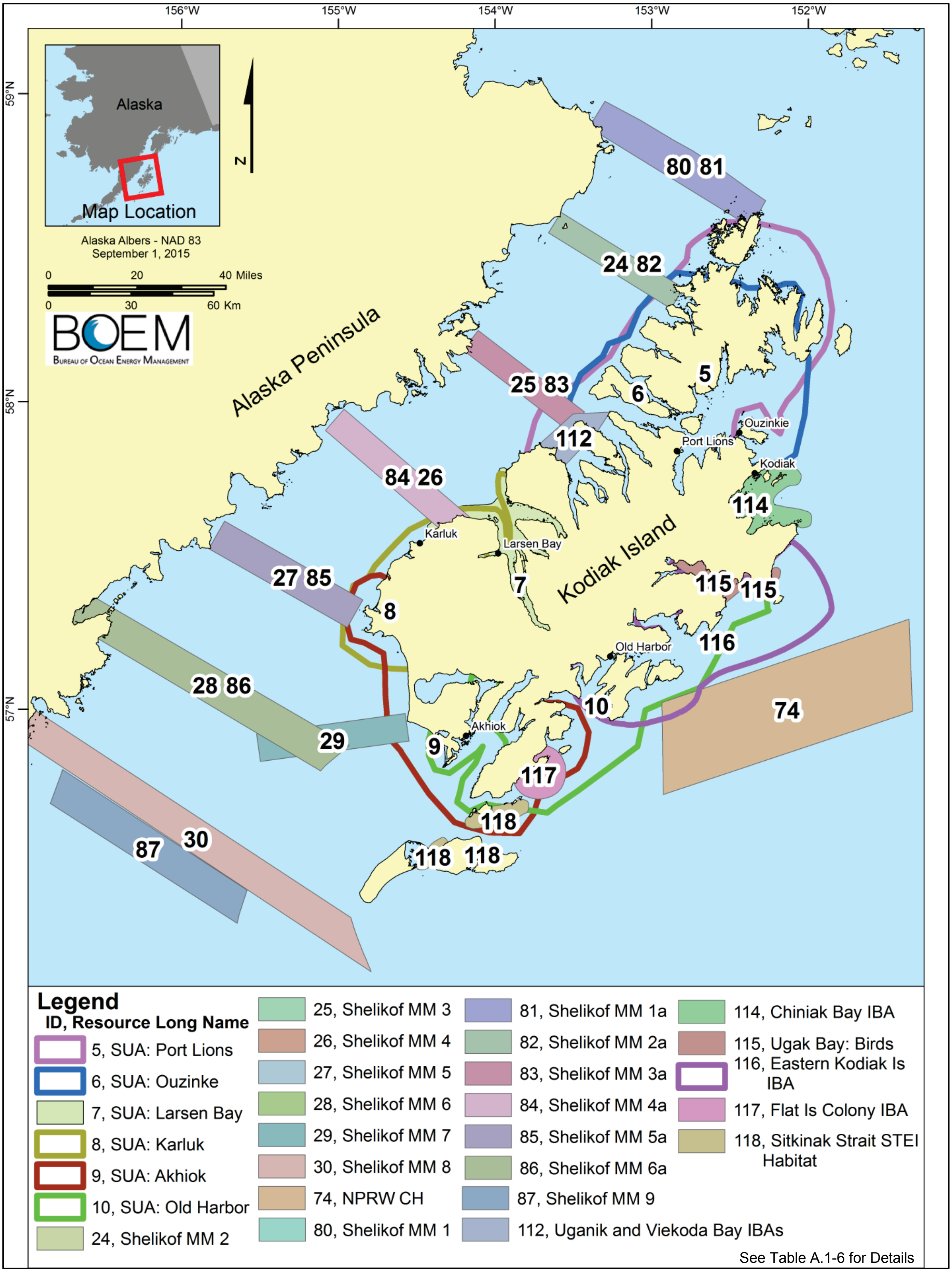
Map A-2a. Environmental Resource Areas Used in the Oil-Spill Trajectory Analysis.



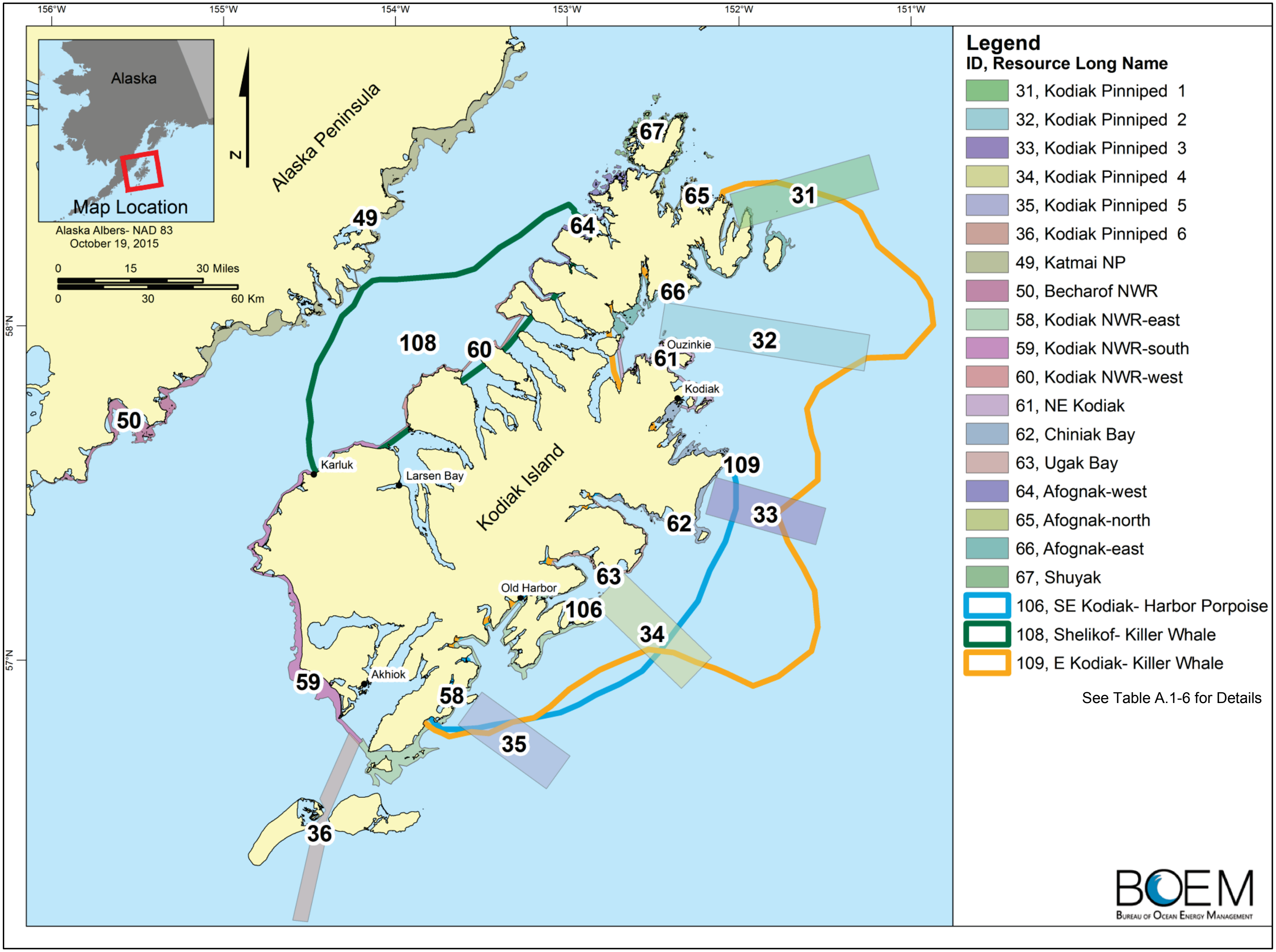
Map A-2b.Environmental Resource Areas Used in the Oil-Spill Trajectory Analysis.



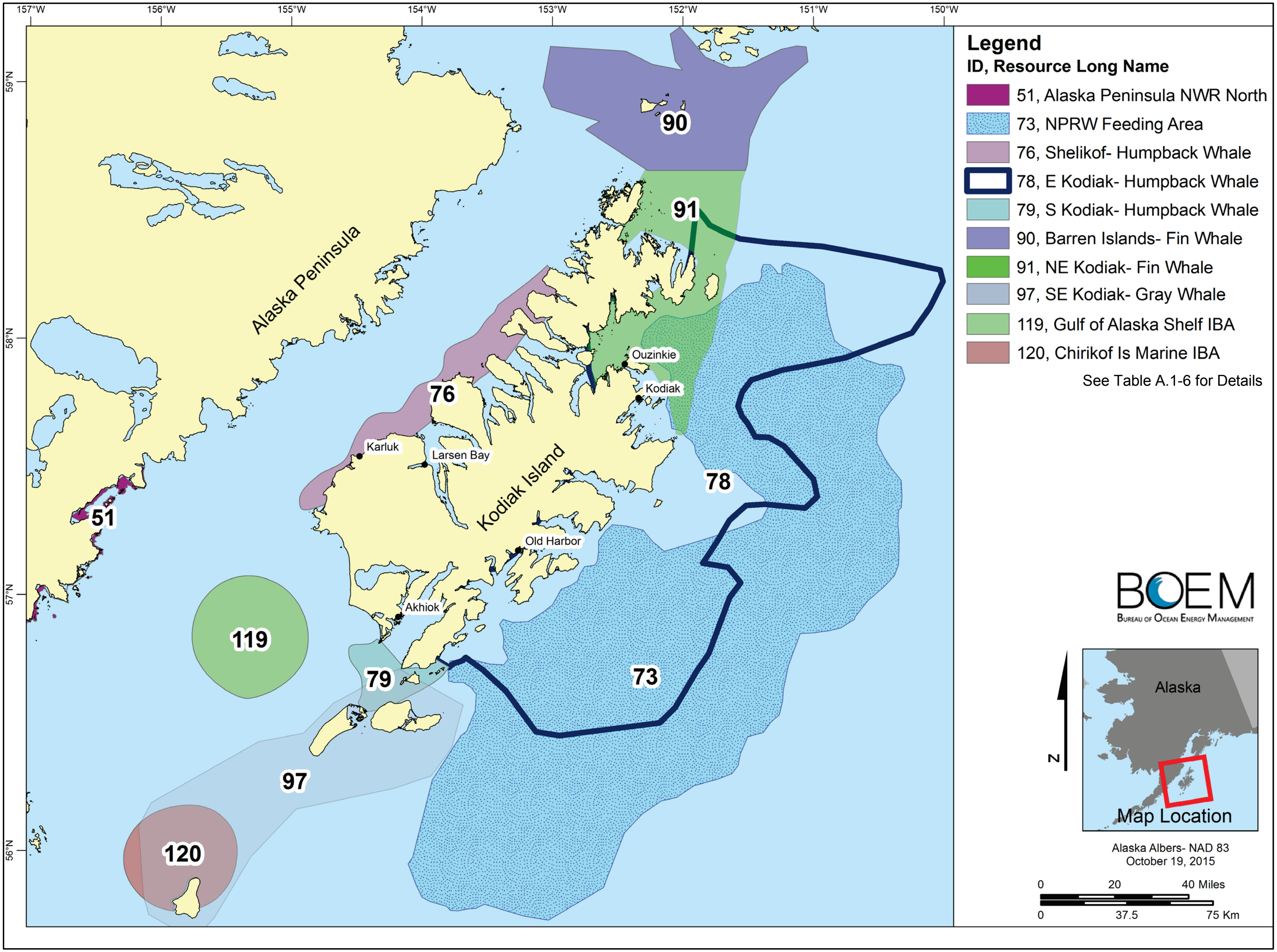
Map A-2c. Environmental Resource Areas Used in the Oil-Spill Trajectory Analysis.



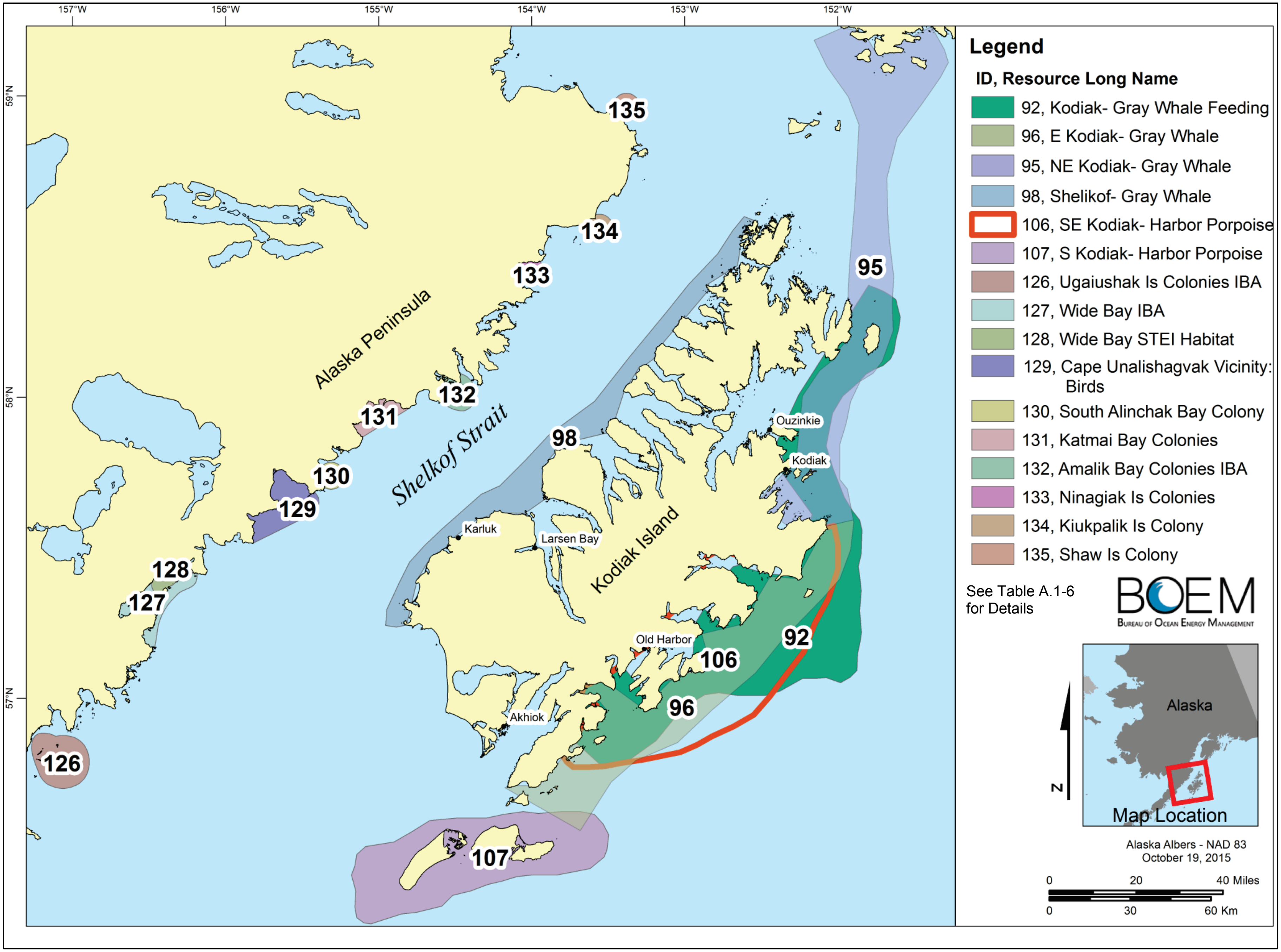
Map A-2d.Environmental Resource Areas Used in the Oil-Spill Trajectory Analysis.



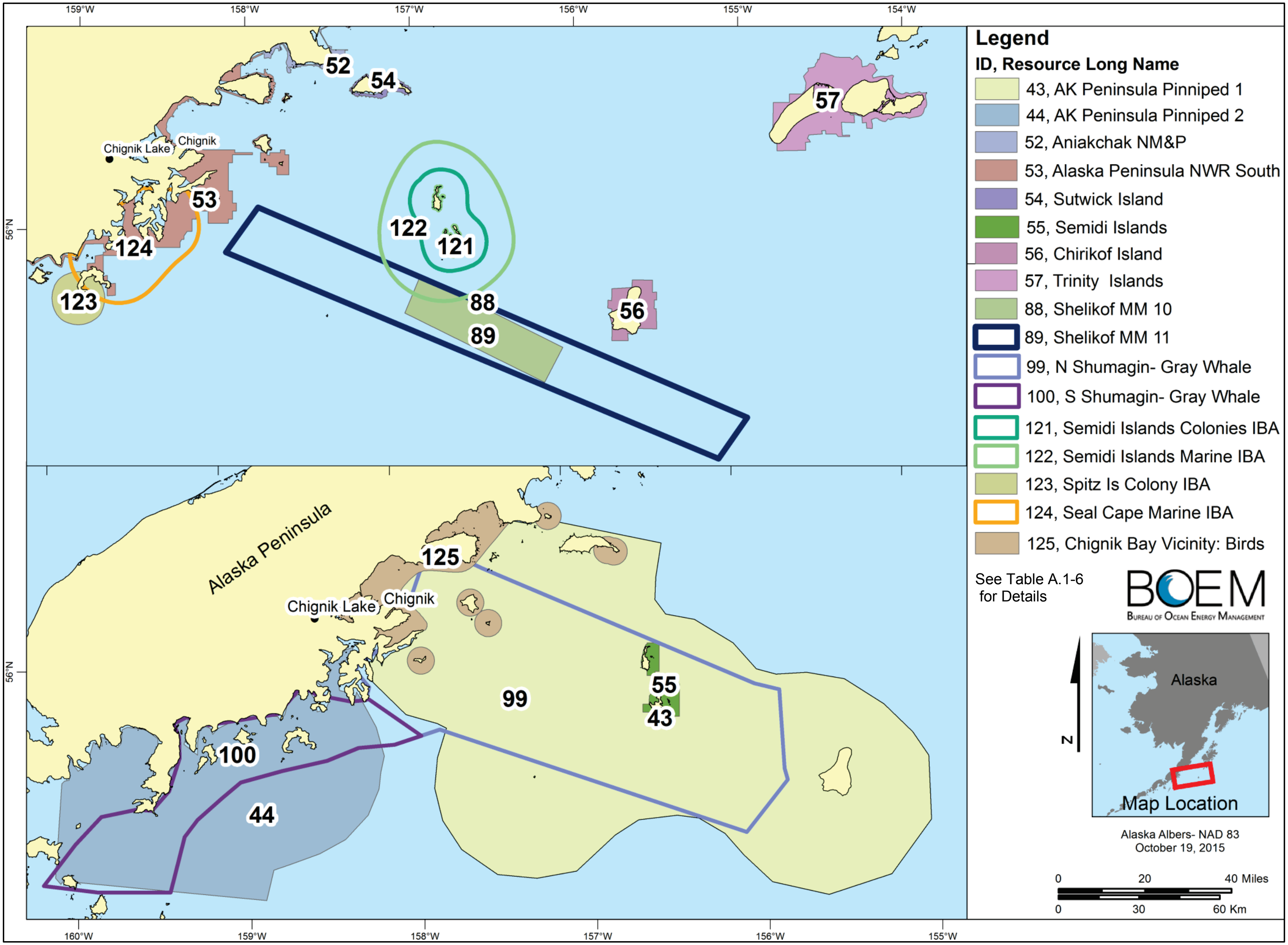
Map A-2e.Environmental Resource Areas Used in the Oil-Spill Trajectory Analysis.



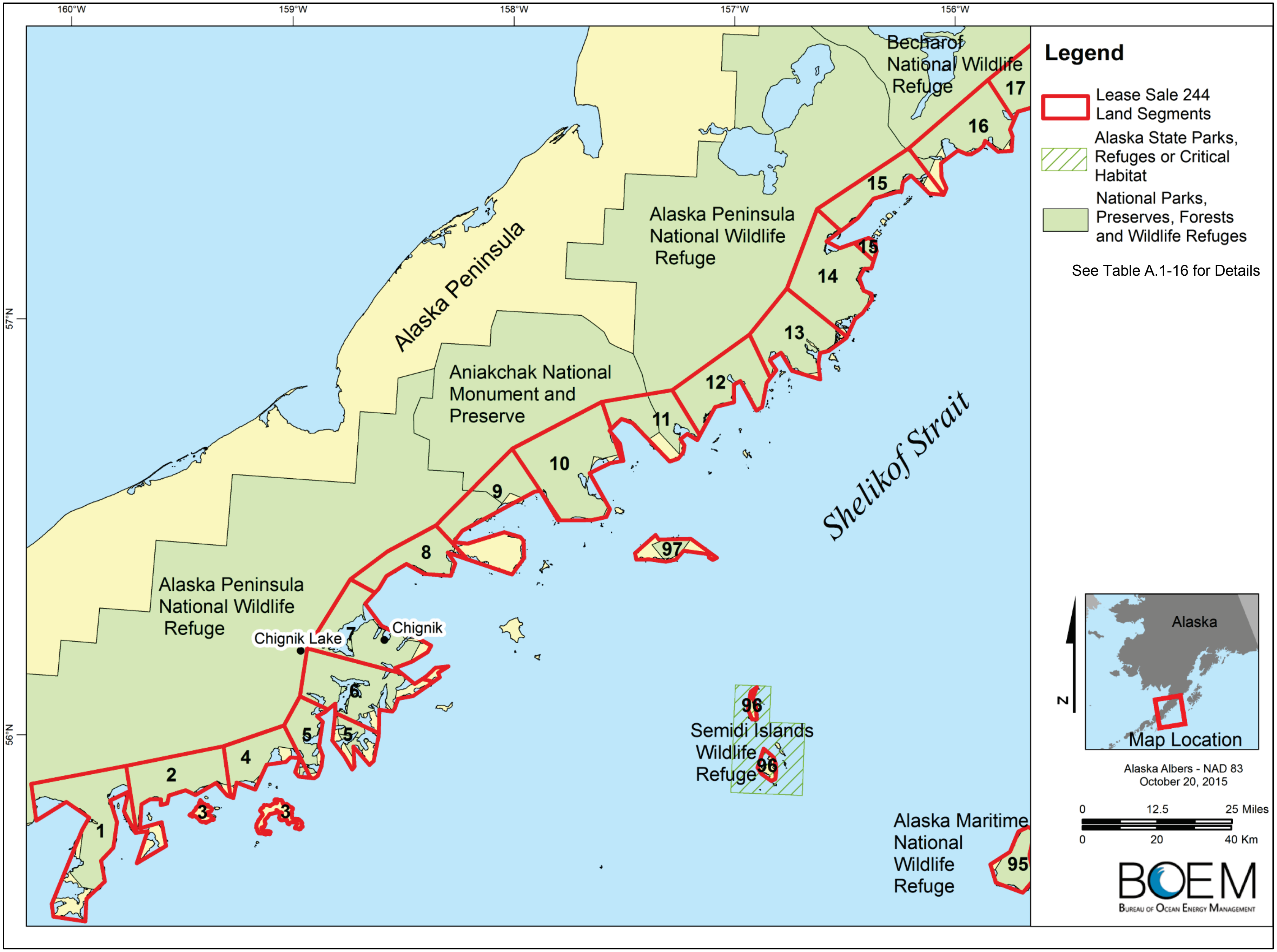
Map A-2f. Environmental Resource Areas Used in the Oil-Spill Trajectory Analysis.



Map A-2g. **Environmental Resource Areas Used in the Oil-Spill Trajectory Analysis.**



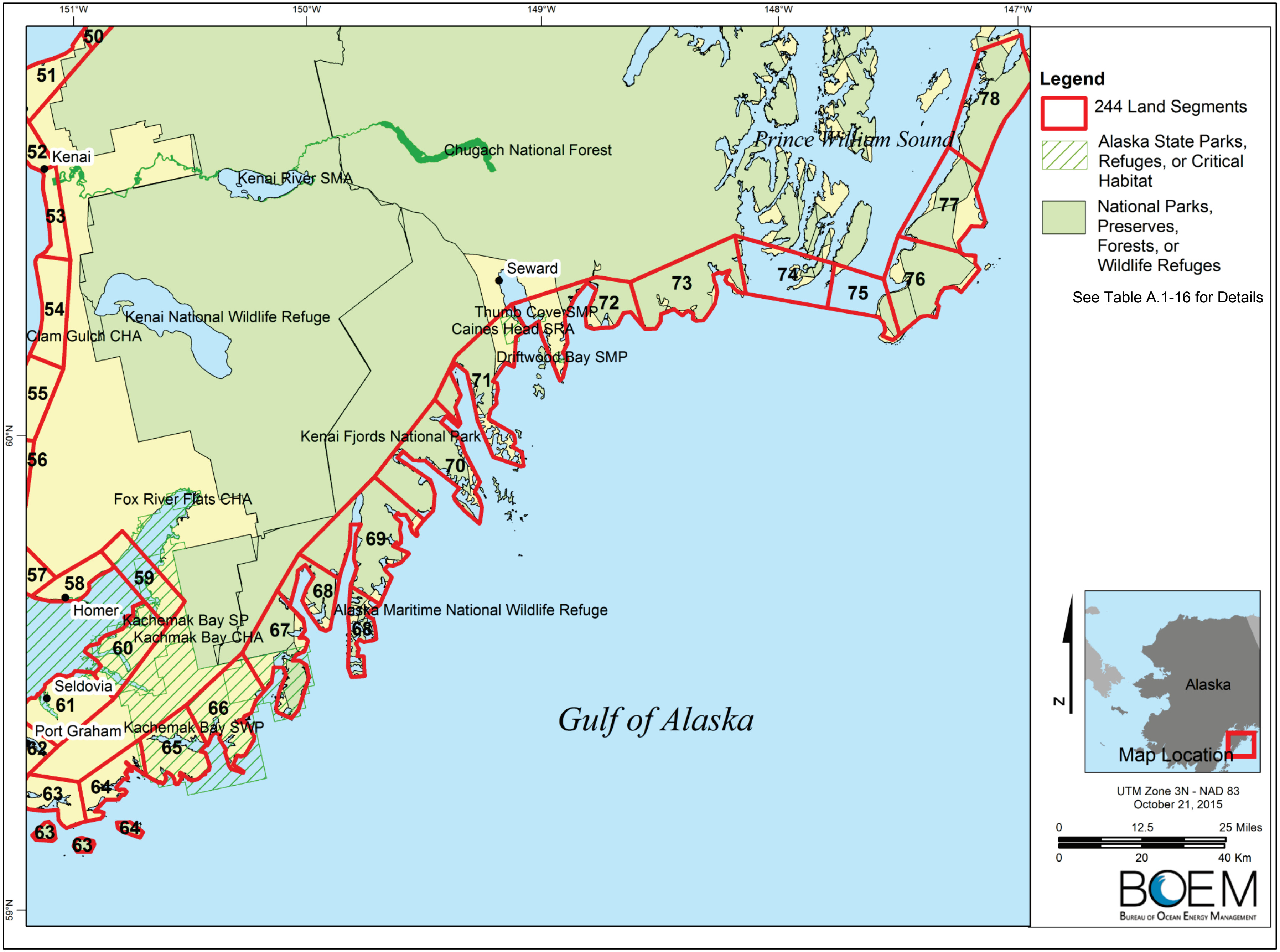
Map A-2h. **Environmental Resource Areas Used in the Oil-Spill Trajectory Analysis.**



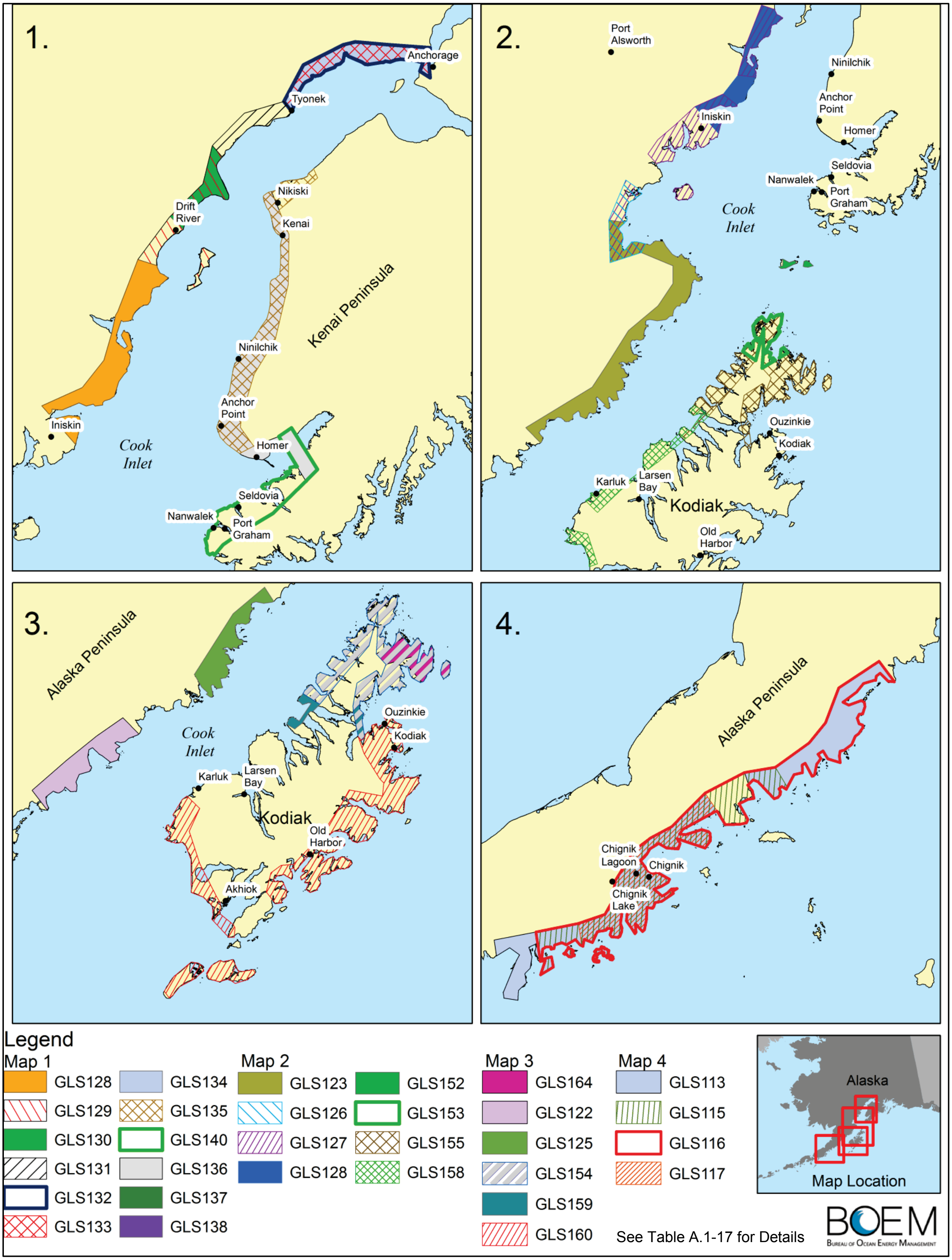
Map A-3a. Land Segments Used in the Oil-Spill Trajectory Analysis.

Map A-3b. Land Segments Used in the Oil-Spill Trajectory Analysis

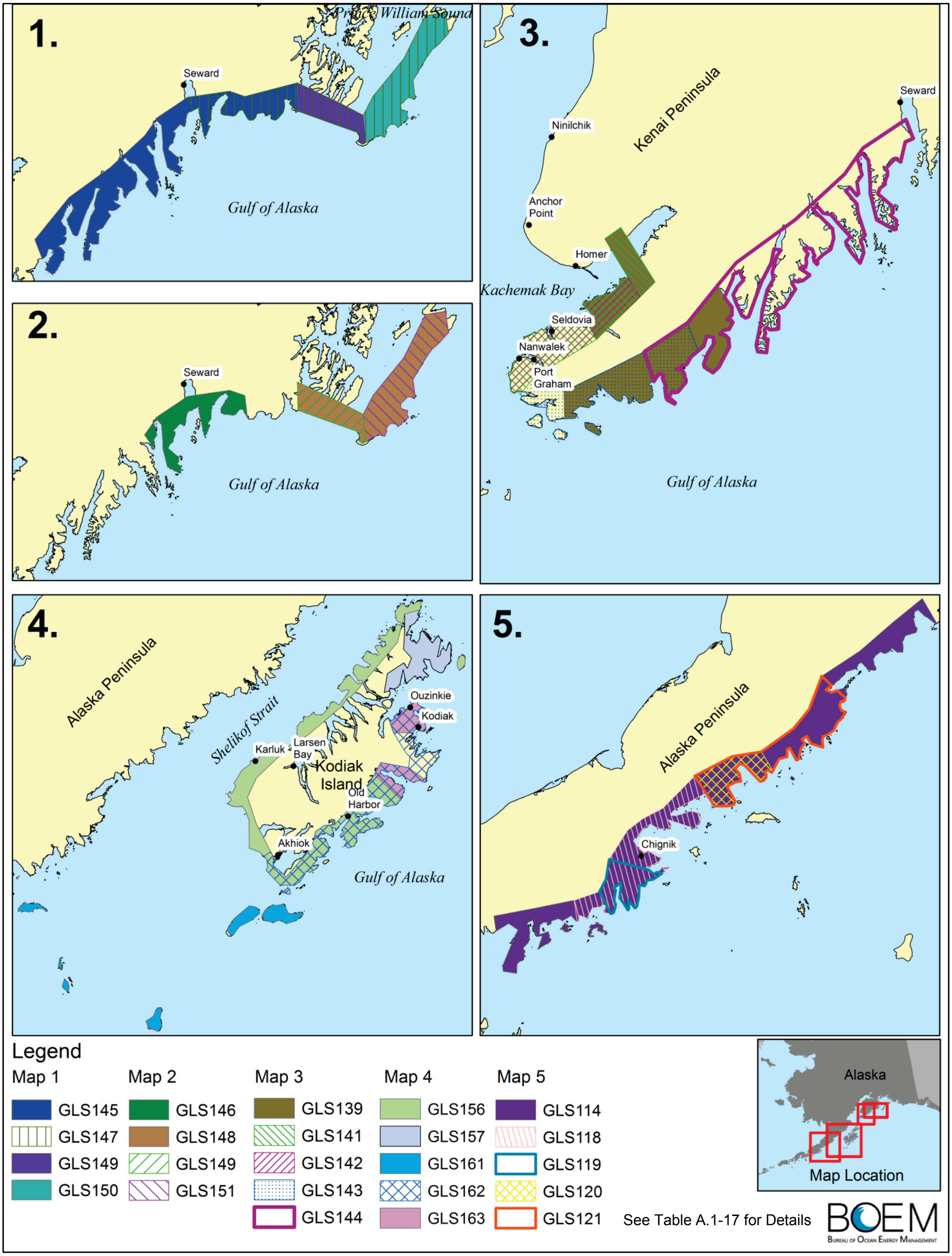
Map A-3c. Land Segments Used in the Oil-Spill Trajectory Analysis.



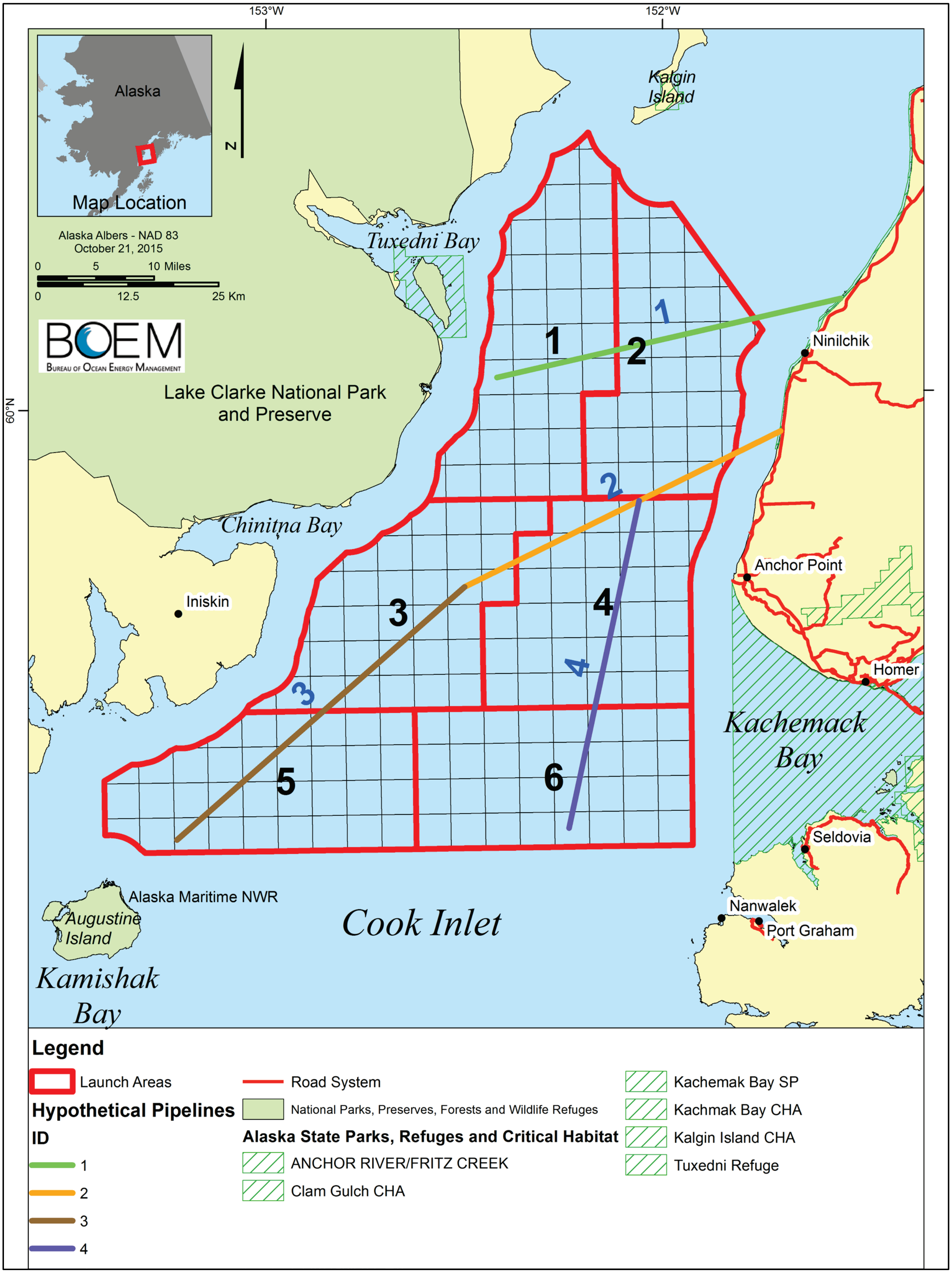
Map A-3d. Land Segments Used in the Oil-Spill Trajectory Analysis.



Map A-4a. Grouped Land Segments Used in the Oil-Spill Trajectory Analysis.



Map A-4b. Grouped Land Segments Used in the Oil-Spill Trajectory Analysis.



Map-A-5. Hypothetical Launch Areas and Pipelines Used in the Oil-Spill Trajectory Analysis.

A.2. OSRA Conditional and Combined Probability Tables

Tables A.2-1 through A.2-60 represent conditional probabilities (expressed as percent chance) that a large oil spill starting at a particular location (launch area (LA) or pipeline (PL) will contact a certain location (environmental resource area, land segment, boundary segment, or grouped land segment). The tables are further organized as annual or seasonal (winter, summer). Tables A.2-1 through A.2-20 represent annual conditional probabilities while Tables A.2-21 through A.2-60 represent seasonal conditional probabilities. Tables A.2-61 through A.2-64 represent combined probabilities (expressed as percent chance) of one or more large spills, and the estimated number of spills (mean), occurring and contacting a resource over the assumed life of the Sale 244 Action Area, Alternatives 1, 3a, 3b, 4a, 4b, 5, or 6. If the chance of contacting a given resource area is >99.5%, it is shown with a double asterisk (**). If the chance of a large spill contacting a resource area is <0.5%, it is shown with a dash (-). Resources with a <0.5% chance of contact from all LAs and PLs are not shown.

Tables A.2-1 through A.2-5 represent annual conditional probabilities (expressed as percent chance) that a large oil spill starting at a particular location will contact a certain environmental resource area (ERA) within:

Table A.2-1. 1 Days-(Annual-ERA).

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
0	Land	25	8	14	2	11	2	9	6	9	1
3	SUA: Tyonek South	13	2	-	-	-	-	1	-	-	-
4	SUA: Seldovia, Port Graham, Nanwalek	-	-	-	1	-	10	-	-	-	4
11	Augustine	1	-	20	1	48	1	-	1	32	-
12	South Cook HS 1a	50	27	83	48	3	11	44	39	42	28
13	South Cook HS 1b	13	2	79	16	85	22	7	8	95	9
14	South Cook HS 1c	-	-	10	-	47	4	-	-	35	1
15	South Cook HS 1d	-	-	-	-	4	-	-	-	3	-
16	Inner Kachemak Bay	-	-	-	1	-	-	-	-	-	-
17	Clam Gulch HS	-	44	-	4	-	-	29	32	-	2
18	Tuxedni HS	32	14	-	-	-	-	24	1	-	-
19	Kalgin Island HS	15	10	-	-	-	-	3	-	-	-
20	Redoubt Bay HS	6	1	-	-	-	-	-	-	-	-
45	Clam Gulch	-	10	-	4	-	-	16	35	-	2
46	Outer Kachemak Bay	-	5	1	37	-	37	1	22	-	28
47	SW Cook Inlet	49	11	28	2	6	-	28	3	10	1
48	Kamishak Bay	-	-	4	-	23	-	-	-	13	-
68	Kenai Fjords-west	-	-	-	-	-	1	-	-	-	1
70	Forelands- Beluga CH	1	-	-	-	-	-	-	-	-	-
71	Middle Cook Inlet-Beluga CH	28	26	-	-	-	-	17	4	-	-
72	West Cook Inlet-Beluga CH	31	7	27	1	15	-	16	2	14	-
75	Kachemak- Humpback Wha	-	-	-	-	2	6	-	-	1	3
90	Barren Islands- Fin Whale	-	-	-	-	1	1	-	-	1	-
94	Lower E Kenai- Gray Whale	-	-	-	-	-	1	-	-	-	-
95	NE Kodiak- Gray Whale	-	-	-	-	-	1	-	-	-	-
101	Cook Inlet 1- Harbor Porpoise	4	-	-	-	-	-	-	-	-	-
102	Cook Inlet 2- Harbor Porpoise	10	10	-	-	-	-	7	2	-	-
103	Cook Inlet 3- Harbor Porpoise	18	13	4	9	-	-	19	11	-	5
104	Cook Inlet 4- Harbor Porpoise	9	2	25	7	2	9	6	5	14	4
105	Cook Inlet 5- Harbor Porpoise	1	-	14	-	19	1	-	-	20	-
136	Kamishak Bay IBA	-	-	2	-	9	-	-	-	7	-
137	Kamishak Bay STEI Habitat	-	-	-	-	4	-	-	-	2	-
138	Tuxedni Is Colony IBA	12	3	-	-	-	-	7	-	-	-
139	Tuxedni Bay IBA	19	6	-	-	-	-	11	-	-	-
140	Redoubt Bay IBA	6	1	-	-	-	-	-	-	-	-
144	Clam Gulch STEI Habitat.	-	3	-	2	-	-	8	12	-	1
145	Outer Kachemak Bay/IBA	3	21	5	76	2	67	7	53	3	97

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
146	Lower Cook Inlet 153W59N IBA	2	-	27	13	33	32	1	4	37	16
153	Polly Creek Beach	87	40	6	5	-	-	65	11	-	3
154	Chinitna Bay	6	-	14	1	-	-	2	1	3	-

Table A.2-2. 3 Days-(Annual ERA).

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
0	Land	55	36	39	25	38	22	37	29	37	23
2	SUA: Tyonek North	1	-	-	-	-	-	-	-	-	-
3	SUA: Tyonek South	17	5	-	-	-	-	4	1	-	-
4	SUA: Seldovia, Port Graham, Nanwalek	1	1	3	9	2	21	1	3	2	14
11	Augustine	12	9	38	16	63	18	11	12	49	14
12	South Cook HS 1a	59	56	83	63	5	27	66	61	43	46
13	South Cook HS 1b	35	30	85	44	86	41	37	35	96	38
14	South Cook HS 1c	11	7	35	15	59	24	10	9	54	16
15	South Cook HS 1d	2	1	12	3	27	8	2	2	22	4
16	Inner Kachemak Bay	-	-	-	3	-	3	-	1	-	3
17	Clam Gulch HS	2	47	-	9	-	1	33	36	-	6
18	Tuxedni HS	35	24	-	2	-	-	31	8	-	2
19	Kalgin Island HS	16	14	-	-	-	-	6	3	-	-
20	Redoubt Bay HS	8	2	-	-	-	-	1	-	-	-
21	Trading Bay HS	1	-	-	-	-	-	-	-	-	-
23	Barren Isl. Pinn	-	-	2	1	3	5	-	-	3	3
24	Shelikof MM 2	-	-	-	-	3	-	-	-	2	-
37	Port Chatham Pinniped	-	-	-	-	-	1	-	-	-	1
45	Clam Gulch	1	15	-	8	-	2	19	39	-	6
46	Outer Kachemak Bay	4	11	5	44	2	46	6	28	4	37
47	SW Cook Inlet	61	37	38	19	10	9	50	24	17	15
48	Kamishak Bay	5	3	21	8	46	10	4	5	36	7
49	Katmai NP	-	-	-	-	1	-	-	-	1	-
68	Kenai Fjords-west	-	-	1	1	1	5	-	-	1	3
70	Forelands- Beluga CH	1	-	-	-	-	-	-	-	-	-
71	Middle Cook Inlet-Beluga CH	29	33	-	2	-	-	22	13	-	2
72	West Cook Inlet-Beluga CH	48	31	43	21	31	12	39	23	32	16
75	Kachemak- Humpback Whale	3	1	10	6	12	16	2	2	12	10
77	N Kodiak- Humpback Whale	-	-	-	-	1	-	-	-	1	-
80	Shelikof MM 1	1	-	5	1	13	3	-	1	11	2
81	Shelikof MM 1a	-	-	2	-	4	-	-	-	5	-
82	Shelikof MM 2a	-	-	-	-	1	-	-	-	1	-
90	Barren Islands- Fin Whale	2	1	9	4	17	13	1	2	14	8
94	Lower E Kenai- Gray Whale	-	-	1	1	1	4	-	-	1	2
95	NE Kodiak- Gray Whale	-	-	1	1	1	4	-	-	1	3
101	Cook Inlet 1- Harbor Porpoise	5	1	-	-	-	-	-	-	-	-
102	Cook Inlet 2- Harbor Porpoise	11	12	-	1	-	-	9	6	-	1
103	Cook Inlet 3- Harbor Porpoise	20	20	4	13	-	2	24	17	1	9
104	Cook Inlet 4- Harbor Porpoise	17	14	26	17	4	14	18	14	14	14
105	Cook Inlet 5- Harbor Porpoise	8	6	20	9	21	7	8	7	23	7
135	Shaw Is Colony	-	-	-	-	1	-	-	-	1	-
136	Kamishak Bay IBA	2	1	7	3	14	3	2	2	11	2
137	Kamishak Bay STEI Habitat	1	-	5	2	12	3	1	1	9	1
138	Tuxedni Is Colony IBA	12	6	-	-	-	-	9	2	-	-
139	Tuxedni Bay IBA	23	14	-	1	-	-	17	5	-	1
140	Redoubt Bay IBA	11	3	-	-	-	-	1	-	-	-
144	Clam Gulch STEI Habitat.	1	5	-	3	-	1	9	13	-	3
145	Outer Kachemak Bay/IBA	11	29	14	81	7	74	19	59	10	97
146	Lower Cook Inlet 153W59N IBA	10	11	31	26	34	38	11	17	38	28
147	Barren Islands Marine IBA	-	-	1	-	1	1	-	-	1	-
148	Barren Islands Colonies IBA	-	-	1	-	1	1	-	-	1	-

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
153	Polly Creek Beach	88	58	7	12	-	1	78	28	1	9
154	Chinitna Bay	14	9	18	8	1	3	12	9	5	6
155	Barren Islands	-	-	2	1	3	4	-	-	3	2

Table A.2-3. 10 Days-(Annual ERA).

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
0	Land	86	79	81	76	82	75	80	77	81	76
2	SUA: Tyonek North	1	-	-	-	-	-	-	-	-	-
3	SUA: Tyonek South	18	7	-	1	-	-	5	3	-	1
4	SUA: Seldovia, Port Graham, Nanwalek	5	6	9	17	6	29	7	9	7	21
5	SUA: Port Lions	4	4	8	6	11	8	4	5	10	6
6	SUA: Ouzinke	2	3	5	4	7	5	3	3	7	4
7	SUA: Larsen Bay	-	-	-	-	1	-	-	-	1	-
8	SUA: Karluk	-	-	1	-	1	1	-	-	1	1
11	Augustine	23	26	50	36	71	38	28	31	60	35
12	South Cook HS 1a	61	64	84	70	8	36	72	70	44	56
13	South Cook HS 1b	42	47	87	58	86	54	51	52	97	53
14	South Cook HS 1c	24	27	45	35	63	42	29	30	60	36
15	South Cook HS 1d	15	17	29	23	40	28	18	20	37	24
16	Inner Kachemak Bay	1	1	1	5	1	6	1	2	1	5
17	Clam Gulch HS	3	48	1	11	-	4	34	38	1	9
18	Tuxedni HS	36	27	1	5	-	1	34	12	-	4
19	Kalgin Island HS	17	15	-	2	-	-	8	5	-	1
20	Redoubt Bay HS	8	2	-	-	-	-	1	1	-	-
21	Trading Bay HS	1	-	-	-	-	-	-	-	-	-
23	Barren Isl. Pinn	5	5	9	8	10	12	6	6	10	9
24	Shelikof MM 2	6	7	13	10	17	13	7	8	16	11
25	Shelikof MM 3	2	2	5	4	7	5	3	3	7	4
26	Shelikof MM 4	1	1	2	1	3	2	1	1	3	2
27	Shelikof MM 5	-	-	1	-	1	1	-	-	1	-
28	Shelikof MM 6	-	-	-	-	1	-	-	-	1	-
31	Kodiak Pinniped 1	-	-	1	1	1	1	-	-	1	1
37	Port Chatham Pinniped	1	1	3	2	3	3	1	1	3	2
45	Clam Gulch	3	18	1	11	1	4	21	41	1	9
46	Outer Kachemak Bay	9	17	10	49	6	50	13	33	7	42
47	SW Cook Inlet	65	50	42	32	12	18	60	39	20	27
48	Kamishak Bay	17	20	37	28	58	31	21	24	50	28
49	Katmai NP	3	3	6	4	9	6	3	3	8	5
59	Kodiak NWR-south	-	-	-	-	1	-	-	-	1	-
60	Kodiak NWR-west	1	1	2	1	2	2	1	1	2	1
64	Afognak-west	2	2	4	3	6	4	2	2	5	3
67	Shuyak	2	2	4	3	5	4	2	2	5	3
68	Kenai Fjords-west	2	2	4	5	3	9	2	3	3	6
70	Forelands- Beluga CH	2	1	-	-	-	-	1	-	-	-
71	Middle Cook Inlet-Beluga CH	30	35	-	5	-	2	24	16	-	4
72	West Cook Inlet-Beluga CH	57	50	55	42	42	32	57	45	43	38
75	Kachemak- Humpback Whale	10	11	17	15	18	23	12	12	18	19
76	Shelikof- Humpback Whale	1	1	3	2	4	3	2	2	4	2
77	N Kodiak- Humpback Whale	3	3	7	5	9	6	4	4	9	5
78	E Kodiak- Humpback Whale	-	-	1	1	1	1	-	-	1	1
80	Shelikof MM 1	12	13	24	19	31	24	15	16	30	20
81	Shelikof MM 1a	4	3	7	4	9	4	4	4	9	3
82	Shelikof MM 2a	2	2	4	2	5	1	2	2	5	1
83	Shelikof MM 3a	1	-	2	1	2	-	1	1	2	-
84	Shelikof MM 4a	-	-	1	-	1	-	-	-	1	-
90	Barren Islands- Fin Whale	13	14	24	21	27	29	15	16	27	24
91	NE Kodiak- Fin Whale	1	1	2	1	3	2	1	1	3	2

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
94	Lower E Kenai- Gray Whale	2	2	4	4	3	7	2	3	4	5
95	NE Kodiak- Gray Whale	3	3	5	5	5	8	3	3	5	6
98	Shelikof- Gray Whale	3	3	7	5	10	6	4	4	9	5
101	Cook Inlet 1- Harbor Porpoise	5	1	-	-	-	-	-	-	-	-
102	Cook Inlet 2- Harbor Porpoise	11	13	-	3	-	1	9	7	-	2
103	Cook Inlet 3- Harbor Porpoise	21	23	5	16	1	6	26	21	1	13
104	Cook Inlet 4- Harbor Porpoise	19	21	27	23	5	19	23	21	15	20
105	Cook Inlet 5- Harbor Porpoise	12	13	23	16	22	14	14	14	25	14
108	Shelikof- Killer Whale	4	4	8	6	11	8	4	5	10	6
109	E Kodiak- Killer Whale	-	-	1	-	1	1	-	-	1	1
111	NW Afognak Is IBA	-	-	1	-	1	-	-	-	1	-
134	Kiukpalik Is Colony	-	-	1	-	1	-	-	-	1	-
135	Shaw Is Colony	1	1	2	1	3	1	1	1	3	1
136	Kamishak Bay IBA	5	6	11	8	16	8	6	7	14	8
137	Kamishak Bay STEI Habitat	4	5	10	8	17	10	5	7	14	8
138	Tuxedni Is Colony IBA	13	8	-	1	-	-	10	4	-	1
139	Tuxedni Bay IBA	24	16	1	3	-	1	19	7	-	3
140	Redoubt Bay IBA	11	4	-	-	-	-	2	1	-	-
144	Clam Gulch STEI Habitat.	1	6	1	5	-	2	10	14	-	4
145	Outer Kachemak Bay/IBA	16	36	19	82	11	76	26	63	14	97
146	Lower Cook Inlet 153W59N IBA	14	17	32	31	34	40	18	24	38	32
147	Barren Islands Marine IBA	2	2	4	2	4	3	2	2	4	2
148	Barren Islands Colonies IBA	2	2	3	2	4	2	2	1	4	2
151	Gulf of AK Shelf 151W58N IBA	-	-	-	-	-	1	-	-	-	-
153	Polly Creek Beach	88	64	8	19	1	5	82	36	1	15
154	Chinitna Bay	17	14	20	13	1	6	17	15	6	11
155	Barren Islands	5	4	8	7	9	11	5	5	9	8

Table A.2-4. 30 Days-(Annual ERA).

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
0	Land	97	96	96	95	95	95	97	96	96	95
2	SUA: Tyonek North	1	-	-	-	-	-	-	-	-	-
3	SUA: Tyonek South	18	8	-	1	-	-	5	3	-	1
4	SUA: Seldovia, Port Graham, Nanwalek	6	8	10	18	7	30	8	11	8	23
5	SUA: Port Lions	6	8	11	10	14	12	8	9	13	11
6	SUA: Ouzinke	4	5	7	7	9	8	5	6	9	7
7	SUA: Larsen Bay	1	1	1	1	1	1	1	1	1	1
8	SUA: Karluk	1	1	2	1	2	2	1	1	2	1
9	SUA: Akhiok	-	-	1	-	1	1	-	-	1	-
11	Augustine	25	29	52	39	72	41	31	34	62	38
12	South Cook HS 1a	61	65	84	71	8	37	72	71	44	56
13	South Cook HS 1b	42	48	87	60	86	56	52	54	97	55
14	South Cook HS 1c	25	29	46	38	64	44	31	32	60	39
15	South Cook HS 1d	17	20	31	27	41	32	22	23	39	27
16	Inner Kachemak Bay	1	1	1	5	1	6	1	2	1	5
17	Clam Gulch HS	4	48	1	12	1	4	34	38	1	9
18	Tuxedni HS	36	28	1	5	-	2	34	13	-	5
19	Kalgin Island HS	17	16	-	2	-	1	8	5	-	1
20	Redoubt Bay HS	8	2	-	-	-	-	1	1	-	-
21	Trading Bay HS	1	-	-	-	-	-	-	-	-	-
23	Barren Isl. Pinn	6	7	10	9	11	14	7	7	11	11
24	Shelikof MM 2	9	11	16	14	20	17	11	12	19	15
25	Shelikof MM 3	4	5	8	7	9	8	6	6	9	7
26	Shelikof MM 4	2	3	4	4	5	4	3	3	5	4
27	Shelikof MM 5	1	2	3	2	3	2	2	2	3	2
28	Shelikof MM 6	1	1	2	2	2	2	1	1	2	2
29	Shelikof MM 7	-	-	1	-	1	1	-	-	1	-

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
30	Shelikof MM 8	1	1	1	1	2	1	1	1	1	1
31	Kodiak Pinniped 1	1	1	2	1	2	2	1	1	2	2
37	Port Chatham Pinniped	2	2	3	3	3	4	2	2	3	3
43	AK Peninsula Pinniped 1	1	1	1	1	1	1	1	1	1	1
45	Clam Gulch	3	18	1	12	1	4	22	41	1	10
46	Outer Kachemak Bay	9	18	11	49	6	50	14	34	8	42
47	SW Cook Inlet	66	51	43	33	13	20	61	40	21	29
48	Kamishak Bay	19	24	39	32	60	35	25	27	52	32
49	Katmai NP	5	5	9	7	11	9	6	6	11	8
50	Becharof NWR	-	-	1	1	1	1	-	-	1	1
51	Alaska Peninsula NWR North	-	-	1	-	1	-	-	-	1	-
59	Kodiak NWR-south	1	1	1	1	2	2	1	1	2	1
60	Kodiak NWR-west	2	2	3	3	4	3	2	3	4	3
64	Afognak-west	3	4	5	5	7	6	4	4	7	5
66	Afognak-east	-	-	-	-	1	1	-	-	1	-
67	Shuyak	3	3	5	4	6	5	3	3	6	4
68	Kenai Fjords-west	3	3	4	5	4	9	3	4	4	7
70	Forelands- Beluga CH	2	1	-	-	-	-	1	-	-	-
71	Middle Cook Inlet-Beluga CH	30	35	1	6	-	2	24	16	-	5
72	West Cook Inlet-Beluga CH	59	53	57	45	43	35	60	48	45	42
73	NPRW Feeding Area	-	-	1	-	1	1	-	-	1	-
75	Kachemak- Humpback Whale	11	12	18	17	18	25	13	14	19	20
76	Shelikof- Humpback Whale	3	3	5	4	6	5	4	4	6	5
77	N Kodiak- Humpback Whale	5	5	8	7	10	8	6	6	10	7
78	E Kodiak- Humpback Whale	1	1	2	1	2	2	1	1	2	1
80	Shelikof MM 1	15	18	27	24	33	28	19	20	32	25
81	Shelikof MM 1a	4	5	8	5	10	5	5	5	10	5
82	Shelikof MM 2a	3	3	5	3	6	3	3	3	6	3
83	Shelikof MM 3a	1	2	3	2	3	2	2	1	3	2
84	Shelikof MM 4a	1	1	1	1	2	1	1	1	2	1
85	Shelikof MM 5a	1	1	1	1	1	1	1	1	1	1
86	Shelikof MM 6a	-	-	1	-	1	-	1	-	1	-
89	Shelikof MM 11	-	-	1	1	1	1	-	-	1	1
90	Barren Islands- Fin Whale	14	16	25	23	27	31	17	19	27	26
91	NE Kodiak- Fin Whale	2	2	3	3	3	3	2	2	3	3
94	Lower E Kenai- Gray Whale	3	3	4	5	4	7	3	3	4	6
95	NE Kodiak- Gray Whale	4	4	6	6	6	9	4	5	6	7
97	SE Kodiak- Gray Whale	-	-	1	1	1	1	-	-	1	1
98	Shelikof- Gray Whale	6	7	10	8	13	10	7	7	12	9
99	N Shumagin- Gray Whale	-	-	1	1	1	1	-	-	1	1
101	Cook Inlet 1- Harbor Porpoise	5	1	-	-	-	-	-	-	-	-
102	Cook Inlet 2- Harbor Porpoise	11	13	-	3	-	1	9	7	-	3
103	Cook Inlet 3- Harbor Porpoise	21	24	5	17	1	6	26	22	2	14
104	Cook Inlet 4- Harbor Porpoise	19	21	27	24	6	20	23	22	16	21
105	Cook Inlet 5- Harbor Porpoise	12	14	23	17	23	16	15	15	25	16
108	Shelikof- Killer Whale	6	7	11	10	13	12	8	8	13	10
109	E Kodiak- Killer Whale	1	1	2	1	2	2	1	1	2	1
111	NW Afognak Is IBA	1	1	1	1	1	1	1	1	1	1
134	Kiukpalik Is Colony	1	1	1	1	1	1	1	1	2	1
135	Shaw Is Colony	2	2	3	2	3	2	2	2	3	2
136	Kamishak Bay IBA	6	7	11	9	17	10	7	8	15	9
137	Kamishak Bay STEI Habitat	5	6	10	9	17	10	6	8	14	9
138	Tuxedni Is Colony IBA	13	8	-	2	-	1	10	4	-	2
139	Tuxedni Bay IBA	24	16	1	3	-	1	19	8	-	3
140	Redoubt Bay IBA	11	4	-	-	-	-	2	1	-	-
144	Clam Gulch STEI Habitat.	1	6	1	5	-	2	10	14	-	4
145	Outer Kachemak Bay/IBA	17	37	19	83	11	76	27	63	14	97
146	Lower Cook Inlet 153W59N IBA	14	18	32	31	34	40	18	24	38	32

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
147	Barren Islands Marine IBA	3	3	4	3	5	4	3	3	5	3
148	Barren Islands Colonies IBA	2	2	4	3	4	4	3	2	5	3
151	Gulf of AK Shelf 151W58N IBA	1	-	1	1	1	1	1	1	1	1
153	Polly Creek Beach	89	65	8	19	1	6	83	37	2	16
154	Chinitna Bay	17	15	20	14	1	7	18	15	6	12
155	Barren Islands	5	6	9	9	10	12	6	7	10	10

Table A.2-5. 110 Days-(Annual ERA).

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
0	Land	98	97	96	96	96	95	97	96	96	96
2	SUA: Tyonek North	1	-	-	-	-	-	-	-	-	-
3	SUA: Tyonek South	18	8	-	1	-	-	5	3	-	1
4	SUA: Seldovia, Port Graham, Nanwalek	6	8	10	18	7	30	8	11	8	23
5	SUA: Port Lions	6	8	11	10	14	12	8	9	13	11
6	SUA: Ouzinke	4	5	7	7	9	8	5	6	9	7
7	SUA: Larsen Bay	1	1	1	1	1	1	1	1	1	1
8	SUA: Karluk	1	1	2	2	2	2	1	1	2	2
9	SUA: Akhiok	-	-	1	-	1	1	-	-	1	1
11	Augustine	25	29	52	39	72	41	31	34	62	39
12	South Cook HS 1a	61	65	84	71	8	37	72	71	44	56
13	South Cook HS 1b	42	48	87	60	86	56	52	54	97	55
14	South Cook HS 1c	25	29	46	38	64	44	31	32	60	39
15	South Cook HS 1d	17	20	31	27	41	32	22	23	39	27
16	Inner Kachemak Bay	1	1	1	5	1	6	1	2	1	5
17	Clam Gulch HS	4	48	1	12	1	4	34	38	1	9
18	Tuxedni HS	36	28	1	5	-	2	34	13	-	5
19	Kalgin Island HS	17	16	-	2	-	1	8	5	-	1
20	Redoubt Bay HS	8	2	-	-	-	-	1	1	-	-
21	Trading Bay HS	1	-	-	-	-	-	-	-	-	-
23	Barren Isl. Pinn	6	7	10	9	11	14	7	7	11	11
24	Shelikof MM 2	9	11	16	14	20	17	11	12	19	15
25	Shelikof MM 3	4	5	8	7	9	8	6	6	9	7
26	Shelikof MM 4	2	3	4	4	5	4	3	3	5	4
27	Shelikof MM 5	1	2	3	2	3	2	2	2	3	2
28	Shelikof MM 6	1	1	2	2	2	2	1	1	2	2
29	Shelikof MM 7	-	-	1	-	1	1	-	-	1	-
30	Shelikof MM 8	1	1	1	1	2	1	1	1	2	1
31	Kodiak Pinniped 1	1	1	2	1	2	2	1	1	2	2
37	Port Chatham Pinniped	2	2	3	3	3	4	2	2	3	3
43	AK Peninsula Pinniped 1	1	1	1	1	1	1	1	1	1	1
45	Clam Gulch	3	18	1	12	1	4	22	41	1	10
46	Outer Kachemak Bay	9	18	11	49	6	50	14	34	8	42
47	SW Cook Inlet	66	51	43	33	13	20	61	40	21	29
48	Kamishak Bay	19	24	39	32	60	35	25	27	52	32
49	Katmai NP	5	5	9	7	11	9	6	7	11	8
50	Becharof NWR	-	-	1	1	1	1	-	-	1	1
51	Alaska Peninsula NWR North	-	-	1	-	1	1	-	-	1	-
59	Kodiak NWR-south	1	1	2	1	2	2	1	1	2	1
60	Kodiak NWR-west	2	2	3	3	4	3	2	3	4	3
64	Afognak-west	3	4	5	5	7	6	4	4	7	5
66	Afognak-east	-	-	1	-	1	1	-	-	1	-
67	Shuyak	3	3	5	4	6	5	3	3	6	4
68	Kenai Fjords-west	3	3	4	5	4	9	3	4	4	7
70	Forelands- Beluga CH	2	1	-	-	-	-	1	-	-	-
71	Middle Cook Inlet-Beluga CH	30	35	1	6	-	2	24	16	-	5
72	West Cook Inlet-Beluga CH	59	53	57	45	43	35	60	48	45	42
73	NPRW Feeding Area	-	-	1	-	1	1	-	-	1	-

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
75	Kachemak- Humpback Whale	11	12	18	17	18	25	13	14	19	20
76	Shelikof- Humpback Whale	3	3	5	4	6	5	4	4	6	5
77	N Kodiak- Humpback Whale	5	5	8	7	10	8	6	6	10	7
78	E Kodiak- Humpback Whale	1	1	2	1	2	2	1	1	2	1
80	Shelikof MM 1	15	18	27	24	33	28	19	20	32	25
81	Shelikof MM 1a	4	5	8	5	10	5	5	5	10	5
82	Shelikof MM 2a	3	3	5	3	6	3	3	3	6	3
83	Shelikof MM 3a	1	2	3	2	3	2	2	2	3	2
84	Shelikof MM 4a	1	1	1	1	2	1	1	1	2	1
85	Shelikof MM 5a	1	1	1	1	1	1	1	1	1	1
86	Shelikof MM 6a	-	-	1	-	1	-	1	-	1	-
89	Shelikof MM 11	-	-	1	1	1	1	-	1	1	1
90	Barren Islands- Fin Whale	14	17	25	23	28	31	17	19	27	26
91	NE Kodiak- Fin Whale	2	2	3	3	3	3	2	2	3	3
94	Lower E Kenai- Gray Whale	3	3	4	5	4	8	3	4	4	6
95	NE Kodiak- Gray Whale	4	4	6	6	6	9	4	5	6	7
97	SE Kodiak- Gray Whale	-	-	1	1	1	1	-	-	1	1
98	Shelikof- Gray Whale	6	7	10	9	13	10	7	8	12	9
99	N Shumagin- Gray Whale	-	-	1	1	1	1	1	1	1	1
101	Cook Inlet 1- Harbor Porpoise	5	1	-	-	-	-	-	-	-	-
102	Cook Inlet 2- Harbor Porpoise	11	13	-	3	-	1	9	7	-	3
103	Cook Inlet 3- Harbor Porpoise	21	24	5	17	1	7	26	22	2	14
104	Cook Inlet 4- Harbor Porpoise	19	21	27	24	6	20	23	22	16	21
105	Cook Inlet 5- Harbor Porpoise	12	14	23	17	23	16	15	15	25	16
108	Shelikof- Killer Whale	6	8	11	10	13	12	8	8	13	10
109	E Kodiak- Killer Whale	1	1	2	1	2	2	1	1	2	1
111	NW Afognak Is IBA	1	1	1	1	1	1	1	1	1	1
134	Kiukpalik Is Colony	1	1	1	1	2	1	1	1	2	1
135	Shaw Is Colony	2	2	3	2	3	2	2	2	3	2
136	Kamishak Bay IBA	6	7	11	9	17	10	7	8	15	9
137	Kamishak Bay STEI Habitat	5	6	10	9	17	10	6	8	14	9
138	Tuxedni Is Colony IBA	13	8	-	2	-	1	10	4	-	2
139	Tuxedni Bay IBA	24	16	1	3	-	1	19	8	-	3
140	Redoubt Bay IBA	11	4	-	-	-	-	2	1	-	-
144	Clam Gulch STEI Habitat.	1	6	1	5	-	2	10	14	-	4
145	Outer Kachemak Bay/IBA	17	37	19	83	11	76	27	63	14	97
146	Lower Cook Inlet 153W59N IBA	14	18	32	31	34	40	18	24	38	32
147	Barren Islands Marine IBA	3	3	4	3	5	4	3	3	5	3
148	Barren Islands Colonies IBA	2	2	4	3	5	4	3	2	5	3
151	Gulf of AK Shelf 151W58N IBA	1	1	1	1	1	1	1	1	1	1
153	Polly Creek Beach	89	65	8	19	1	6	83	37	2	16
154	Chinitna Bay	17	15	20	14	1	7	18	15	6	12
155	Barren Islands	6	6	9	9	10	12	7	7	10	10

Tables A.2-6 through A.2-10 represent annual conditional probabilities (expressed as percent chance) that a large oil spill starting at a particular location will contact a certain land segment (LS) within:

Table A.2-6. 1 Days-(Annual LS).

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
29	Augustine Island	-	-	-	-	4	-	-	-	3	-
30	Rocky Cove, Tignagvik Point	-	-	-	-	1	-	-	-	-	-
31	Iiamna Bay, Iniskin Bay, Ursus Cove	-	-	-	-	3	-	-	-	1	-
32	Chinitna Point, Dry Bay	-	-	4	-	3	-	-	-	3	-
33	Chinitna Bay	2	-	9	-	-	-	1	-	2	-
34	Iliamna Point	3	-	-	-	-	-	2	-	-	-
35	Chisik Island, Tuxedni Bay	9	2	-	-	-	-	4	-	-	-

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
36	Redoubt Point	8	1	-	-	-	-	1	-	-	-
37	Drift River, Drift River Terminal	1	-	-	-	-	-	-	-	-	-
38	Kalgin Islandd	1	2	-	-	-	-	-	-	-	-
55	Deep Creek, Ninilchik, Ninilchik River	-	-	-	-	-	-	1	-	-	-
56	Cape Starichkof, Happy Valley	-	1	-	1	-	-	-	5	-	-
61	Barabara Point, Seldovia Bay	-	-	-	-	-	1	-	-	-	-
62	Nanwalek, Port Graham	-	-	-	-	-	1	-	-	-	1

Table A.2-7. 3 Days-(Annual LS).

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
25	Spotted Glacier, Sukoi Bay	-	-	-	-	1	-	-	-	1	-
26	Douglas River	-	-	-	-	1	-	-	-	1	-
28	Amakdedulia Cove, Bruin Bay, Chenik Head	-	-	-	-	1	-	-	-	1	-
29	Augustine Island	1	-	5	1	11	2	1	1	9	1
30	Rocky Cove, Tignagvik Point	-	-	3	1	7	1	-	-	5	-
31	Iiamna Bay, Iniskin Bay, Ursus Cove	1	-	4	1	10	2	1	1	7	1
32	Chinitna Point, Dry Bay	3	2	10	3	6	3	2	3	7	3
33	Chinitna Bay	10	6	15	7	1	2	9	7	5	5
34	Iliamna Point	5	4	1	1	-	-	5	2	-	1
35	Chisik Island, Tuxedni Bay	14	9	-	1	-	-	10	3	-	1
36	Redoubt Point	14	5	-	-	-	-	3	1	-	-
37	Drift River, Drift River Terminal	3	1	-	-	-	-	-	-	-	-
38	Kalgin Islandd	2	3	-	-	-	-	-	-	-	-
40	Kustatan River,West Foreland	1	-	-	-	-	-	-	-	-	-
54	Clam Gulch, Kasilof	-	1	-	-	-	-	2	1	-	-
55	Deep Creek, Ninilchik, Ninilchik River	-	1	-	-	-	-	2	1	-	-
56	Cape Starichkof, Happy Valley	-	3	-	3	-	-	1	7	-	2
57	Anchor Point, Anchor River	-	-	-	1	-	1	-	1	-	1
60	China Poot Bay, Gull Island	-	-	-	-	-	1	-	-	-	-
61	Barabara Point, Seldovia Bay	-	-	-	2	-	3	-	1	-	2
62	Nanwalek, Port Graham	-	-	1	1	-	5	-	-	-	3
63	Elizabeth Island, Port Chatham, Koyuktolik Bay	-	-	-	-	-	1	-	-	-	-

Table A.2-8. 10 Days-(Annual LS).

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
21	Kaflia, Kukak, Kuliak & Missak Bays	-	-	1	-	1	1	-	-	1	1
22	Devils Cove, Hallo Bay	-	-	1	1	1	1	-	1	1	1
23	Cape Chiniak, Swikshak Bay	-	-	1	1	1	1	-	-	1	1
24	Fourpeaked Glacier	1	1	2	1	2	1	1	1	2	1
25	Spotted Glacier, Sukoi Bay	2	2	3	2	4	3	2	2	4	2
26	Douglas River	1	1	2	2	4	2	2	2	3	2
27	Akumwarvik Bay , McNeil Cove, Nordyke Island	-	-	1	-	1	1	-	-	1	-
28	Amakdedulia Cove, Bruin Bay, Chenik Head	1	1	3	2	5	3	1	2	4	2
29	Augustine Island	4	4	8	6	14	6	5	5	13	6
30	Rocky Cove, Tignagvik Point	3	3	6	4	10	5	3	4	8	4
31	Iiamna Bay, Iniskin Bay, Ursus Cove	3	3	7	5	12	6	4	4	9	5
32	Chinitna Point, Dry Bay	5	5	11	7	7	6	5	6	8	7
33	Chinitna Bay	13	12	17	12	1	6	14	13	6	10
34	Iliamna Point	6	5	1	2	-	1	7	4	-	2
35	Chisik Island, Tuxedni Bay	15	11	-	2	-	1	12	5	-	2
36	Redoubt Point	15	6	-	1	-	-	4	2	-	1
37	Drift River, Drift River Terminal	3	1	-	-	-	-	1	1	-	-
38	Kalgin Islandd	3	3	-	-	-	-	1	-	-	-
40	Kustatan River,West Foreland	1	-	-	-	-	-	-	-	-	-
54	Clam Gulch, Kasilof	-	2	-	1	-	-	3	2	-	1
55	Deep Creek, Ninilchik, Ninilchik River	-	2	-	1	-	-	2	2	-	1

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
56	Cape Starichkof, Happy Valley	1	4	-	4	-	1	2	8	-	3
57	Anchor Point, Anchor River	-	1	-	2	-	2	1	1	-	2
58	Homer, Homer Spit	-	-	-	1	-	1	-	-	-	1
60	China Poot Bay, Gull Island	-	-	-	1	-	1	-	-	-	1
61	Barabara Point, Seldovia Bay	1	1	1	4	1	5	1	2	1	4
62	Nanwalek, Port Graham	1	1	2	4	2	7	1	2	2	5
63	Elizabeth Island, Port Chatham, Koyuktolik Bay	-	-	1	1	1	2	-	1	1	1
79	Barren Islands, Ushagat Island	1	1	2	1	2	2	1	1	2	1
80	Amatuli Cove, East & West Amatuli Island	-	-	1	1	1	1	-	-	1	1
81	Shuyak Island	1	1	1	1	2	2	1	1	2	1
82	Bluefox Bay, Shuyak Island, Shuyak Strait	1	1	2	1	3	2	1	1	2	1
83	Foul Bay, Paramanof Bay	1	1	2	1	3	2	1	1	3	2
84	Malina Bay, Raspberry Island, Raspberry Strait	-	1	1	1	1	1	1	1	1	1
85	Kupreanof Strait, Viekoda Bay	-	-	-	-	1	1	-	-	1	-
86	Uganik Bay Uganik Strait, Cape Ugat	-	-	1	-	1	1	-	-	1	1

Table A.2-9. 30 Days-(Annual LS).

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
20	Amalik, Dakavak & Kinak Bays, Cape Iiktugitak, Takli Is.	-	-	-	-	1	-	-	-	-	-
21	Kaflia, Kukak, Kuliak & Missak Bays	1	1	1	1	1	1	1	1	1	1
22	Devils Cove, Hallo Bay	1	1	1	1	2	2	1	1	2	1
23	Cape Chiniak, Swikshak Bay	1	1	1	1	2	1	1	1	2	1
24	Fourpeaked Glacier	1	1	2	2	3	2	1	1	3	2
25	Spotted Glacier, Sukoi Bay	2	2	4	3	4	4	3	3	4	3
26	Douglas River	2	2	3	2	4	3	2	2	4	2
27	Akumwarvik Bay , McNeil Cove, Nordyke Island	-	-	1	1	1	1	1	1	1	1
28	Amakdedulia Cove, Bruin Bay, Chenik Head	2	2	4	3	6	4	2	2	5	3
29	Augustine Island	4	5	9	7	14	7	6	6	13	7
30	Rocky Cove, Tignagvik Point	3	4	7	5	10	6	4	4	9	5
31	Iiamna Bay, Iniskin Bay, Ursus Cove	3	4	8	6	12	6	5	5	10	6
32	Chinitna Point, Dry Bay	5	6	12	8	7	7	6	7	9	7
33	Chinitna Bay	13	12	17	13	1	6	15	13	6	11
34	Iliamna Point	6	5	1	2	-	1	7	4	-	2
35	Chisik Island, Tuxedni Bay	15	11	-	2	-	1	12	5	-	2
36	Redoubt Point	15	6	-	1	-	-	4	3	-	1
37	Drift River, Drift River Terminal	3	2	-	-	-	-	1	1	-	-
38	Kalgin Islandd	3	3	-	-	-	-	1	-	-	-
40	Kustatan River,West Foreland	1	-	-	-	-	-	-	-	-	-
54	Clam Gulch, Kasilof	-	3	-	1	-	-	3	2	-	1
55	Deep Creek, Ninilchik, Ninilchik River	-	2	-	1	-	-	2	2	-	1
56	Cape Starichkof, Happy Valley	1	4	1	4	-	2	2	8	-	3
57	Anchor Point, Anchor River	-	1	1	2	-	2	1	1	-	2
58	Homer, Homer Spit	-	-	-	1	-	2	-	-	-	1
60	China Poot Bay, Gull Island	-	-	-	1	-	1	-	-	-	1
61	Barabara Point, Seldovia Bay	1	1	1	4	1	5	1	2	1	4
62	Nanwalek, Port Graham	2	2	3	4	2	8	2	2	2	6
63	Elizabeth Island, Port Chatham, Koyuktolik Bay	1	1	1	1	1	2	1	1	1	2
79	Barren Islands, Ushagat Island	1	1	2	2	2	2	1	1	2	2
80	Amatuli Cove, East & West Amatuli Island	1	1	1	1	1	1	1	1	1	1
81	Shuyak Island	1	1	2	2	2	2	1	1	2	2
82	Bluefox Bay, Shuyak Island, Shuyak Strait	1	2	2	2	3	3	2	2	3	2
83	Foul Bay, Paramanof Bay	2	2	3	2	4	3	2	2	3	3
84	Malina Bay, Raspberry Island, Raspberry Strait	1	1	2	1	2	2	1	1	2	2
85	Kupreanof Strait, Viekoda Bay	1	1	1	1	1	1	1	1	1	1
86	Uganik Bay Uganik Strait, Cape Ugat	1	1	1	1	1	1	1	1	1	1
87	Cape Kuliuk, Spiridon Bay, Uyak Bay	-	-	1	1	1	1	-	-	1	1
88	Karluk Lagoon, Northeast Harbor, Karluk	-	-	1	-	1	1	-	-	1	1

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

Table A.2-10. 110 Days-(Annual LS).

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
20	Amalik, Dakavak & Kinak Bays, Cape Iiktugitak, Takli Is.	-	-	-	-	1	-	-	-	1	-
21	Kaflia, Kukak, Kuliak & Missak Bays	1	1	1	1	1	1	1	1	1	1
22	Devils Cove, Hallo Bay	1	1	1	1	2	2	1	1	2	1
23	Cape Chiniak, Swikshak Bay	1	1	1	1	2	1	1	1	2	1
24	Fourpeaked Glacier	1	1	2	2	3	2	1	1	3	2
25	Spotted Glacier, Sukoi Bay	2	2	4	3	5	4	3	3	4	3
26	Douglas River	2	2	3	2	4	3	2	2	4	2
27	Akumwarvik Bay , McNeil Cove, Nordyke Island	-	1	1	1	1	1	1	1	1	1
28	Amakdedulia Cove, Bruin Bay, Chenik Head	2	2	4	3	6	4	2	2	5	3
29	Augustine Island	4	5	9	7	14	7	6	6	13	7
30	Rocky Cove, Tignagvik Point	3	4	7	5	10	6	4	4	9	5
31	Iiamna Bay, Iniskin Bay, Ursus Cove	3	4	8	6	12	6	5	5	10	6
32	Chinitna Point, Dry Bay	5	6	12	8	7	7	6	7	9	7
33	Chinitna Bay	13	12	17	13	1	6	15	13	6	11
34	Iliamna Point	6	5	1	2	-	1	7	4	-	2
35	Chisik Island, Tuxedni Bay	15	11	-	2	-	1	12	5	-	2
36	Redoubt Point	15	6	-	1	-	-	4	3	-	1
37	Drift River, Drift River Terminal	3	2	-	-	-	-	1	1	-	-
38	Kalgin Islandd	3	3	-	-	-	-	1	-	-	-
40	Kustatan River,West Foreland	1	-	-	-	-	-	-	-	-	-
54	Clam Gulch, Kasilof	-	3	-	1	-	-	3	2	-	1
55	Deep Creek, Ninilchik, Ninilchik River	-	2	-	1	-	-	2	2	-	1
56	Cape Starichkof, Happy Valley	1	4	1	4	-	2	2	8	-	3
57	Anchor Point, Anchor River	-	1	1	2	-	2	1	1	-	2
58	Homer, Homer Spit	-	-	-	1	-	2	-	-	-	1
60	China Poot Bay, Gull Island	-	-	-	1	-	1	-	-	-	1
61	Barabara Point, Seldovia Bay	1	1	1	4	1	5	1	2	1	4
62	Nanwalek, Port Graham	2	2	3	4	2	8	2	3	2	6
63	Elizabeth Island, Port Chatham, Koyuktolik Bay	1	1	1	1	1	2	1	1	1	2
79	Barren Islands, Ushagat Island	1	1	2	2	2	2	1	1	2	2
80	Amatuli Cove, East & West Amatuli Island	1	1	1	1	1	1	1	1	1	1
81	Shuyak Island	1	1	2	2	2	2	1	1	2	2
82	Bluefox Bay, Shuyak Island, Shuyak Strait	1	2	2	2	3	3	2	2	3	2
83	Foul Bay, Paramanof Bay	2	2	3	2	4	3	2	2	3	3
84	Malina Bay, Raspberry Island, Raspberry Strait	1	1	2	1	2	2	1	1	2	2
85	Kupreanof Strait, Viekoda Bay	1	1	1	1	1	1	1	1	1	1
86	Uganik Bay Uganik Strait, Cape Ugat	1	1	1	1	1	1	1	1	1	1
87	Cape Kuliuk, Spiridon Bay, Uyak Bay	-	-	1	1	1	1	-	-	1	1
88	Karluk Lagoon, Northeast Harbor, Karluk	-	-	1	-	1	1	-	-	1	1

Tables A.2-11 through A.2-15 represent annual conditional probabilities (expressed as percent chance) that a large oil spill starting at a particular location will contact a group of land segments (GLS) within:

Table A.2-11. 1 Days-(Annual GLS).

ID	Grouped Land Segments Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
127	AMNWR W Cook Inlet	19	3	13	-	10	-	6	-	9	-
128	Lake Clark National Park and Preserve	22	3	9	-	-	-	8	-	2	-
129	Redoubt Bay Brown Bears	2	2	-	-	-	-	-	-	-	-
135	Kenai AK State Rec Mgmt Areas	-	2	-	1	-	1	2	6	-	1
136	West Kenai Brown Bears	-	1	-	1	-	-	1	3	-	-
137	West Kenai Moose	-	-	-	-	-	-	1	-	-	-
138	Clam Gulch Critical Habitat	-	2	-	1	-	-	2	5	-	-
140	West Kenai Black Bears	-	-	-	-	-	1	-	-	-	-
141	Seldovia side Kachemak Bay	-	-	-	-	-	2	-	-	-	1
142	AMNWR E Cook Inlet	-	-	-	-	-	2	-	-	-	1

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

Table A.2-12. 3 Days-(Annual GLS).

ID	Grouped Land Segments Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
123	Katmai National Park	-	-	1	-	2	-	-	-	2	-
126	McNeil River State Game Sanctuary and Refuge	-	-	-	-	1	-	-	-	1	-
127	AMNWR W Cook Inlet	42	22	34	14	28	9	25	15	29	11
128	Lake Clark National Park and Preserve	43	23	16	9	1	2	27	13	5	7
129	Redoubt Bay Brown Bears	4	2	-	-	-	-	-	-	-	-
130	Redoubt Bay Critical Habitat Area	1	-	-	-	-	-	-	-	-	-
135	Kenai AK State Rec Mgmt Areas	1	6	-	7	-	5	5	11	-	6
136	West Kenai Brown Bears	-	3	-	3	-	1	3	6	-	2
137	West Kenai Moose	-	2	-	-	-	-	2	1	-	-
138	Clam Gulch Critical Habitat	1	5	-	3	-	-	5	10	-	2
139	Kachemak Bay State Park and Wilderness Park	-	-	-	-	-	1	-	-	-	-
140	West Kenai Black Bears	-	-	-	2	-	4	-	-	-	3
141	Seldovia side Kachemak Bay	-	-	1	4	-	8	-	1	1	6
142	AMNWR E Cook Inlet	-	-	1	4	-	8	-	1	1	6
143	AMNWR W Outer Kenai/GOA	-	-	-	-	-	1	-	-	-	-
152	Barren Islands	-	-	-	-	-	1	-	-	-	-

Table A.2-13. 10 Days-(Annual GLS).

ID	Grouped Land Segments Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
123	Katmai National Park	5	5	11	8	15	10	6	6	14	8
124	Kukak Bay	1	1	2	1	2	2	1	1	2	1
125	Spring Bear Concentration-1	-	-	-	-	1	1	-	-	1	-
126	McNeil River State Game Sanctuary and Refuge	2	2	4	3	6	3	2	2	5	3
127	AMNWR W Cook Inlet	56	44	48	36	39	28	46	38	41	33
128	Lake Clark National Park and Preserve	49	34	18	17	1	7	37	24	6	14
129	Redoubt Bay Brown Bears	5	3	-	-	-	-	1	1	-	-
130	Redoubt Bay Critical Habitat Area	1	1	-	-	-	-	-	-	-	-
135	Kenai AK State Rec Mgmt Areas	3	10	3	14	1	12	10	16	2	13
136	West Kenai Brown Bears	1	5	1	6	1	4	4	9	1	5
137	West Kenai Moose	-	2	-	1	-	-	3	2	-	1
138	Clam Gulch Critical Habitat	1	8	1	6	-	2	7	13	-	5
139	Kachemak Bay State Park and Wilderness Park	-	-	-	1	-	1	-	-	-	1
140	West Kenai Black Bears	1	1	2	4	2	7	1	2	2	5
141	Seldovia side Kachemak Bay	2	3	4	9	2	13	3	4	3	10
142	AMNWR E Cook Inlet	2	3	4	8	2	13	3	4	3	10
143	AMNWR W Outer Kenai/GOA	1	-	1	1	1	2	1	1	1	1
152	Barren Islands	1	1	2	2	3	3	1	1	3	2
153	Shuyak Island State Park	2	1	3	2	5	4	2	2	4	3
154	AMNWR Afognak and Shuyak Islands	3	3	6	5	9	7	3	3	9	5
155	Afognak & Raspberry Winter Elk	1	1	2	2	3	4	1	2	3	3
156	Kodiak National Wildlife Refuge	4	4	8	6	11	8	4	4	10	7
157	Afognak Blacktail Deer	1	1	2	2	3	3	1	1	3	2
158	AMNWR W Kodiak/Shelikof	1	1	1	1	2	2	1	1	2	1
159	Kupreanof Strait	-	-	-	-	1	1	-	-	1	-

Table A.2-14. 30 Days-(Annual GLS).

ID	Grouped Land Segments Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
113	Alaska Peninsula National Wildlife Refuge	-	-	-	-	-	-	-	-	1	-
114	AMNWR SW Shelikof/GOA	-	1	1	1	1	1	1	1	1	1
116	SUA: Chignik Chignik Lagoon	-	-	1	-	1	-	-	-	1	-
122	Becharof National Wildlife Refuge	-	-	1	1	1	1	-	-	1	1
123	Katmai National Park	7	9	14	12	18	14	9	10	17	12
124	Kukak Bay	1	2	3	2	3	3	2	2	3	3
125	Spring Bear Concentration-1	-	-	1	1	1	1	-	-	1	1
126	McNeil River State Game Sanctuary and Refuge	2	3	4	4	7	5	2	3	6	4
127	AMNWR W Cook Inlet	58	48	50	40	41	32	49	42	43	37

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Grouped Land Segments Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
128	Lake Clark National Park and Preserve	49	35	18	18	2	8	38	25	7	15
129	Redoubt Bay Brown Bears	5	3	-	-	-	-	1	1	-	-
130	Redoubt Bay Critical Habitat Area	1	1	-	-	-	-	-	-	-	-
135	Kenai AK State Rec Mgmt Areas	4	11	3	15	2	12	10	17	2	14
136	West Kenai Brown Bears	1	6	1	6	1	4	5	9	1	6
137	West Kenai Moose	-	2	-	1	-	-	3	2	-	1
138	Clam Gulch Critical Habitat	2	8	1	6	-	2	8	13	1	5
139	Kachemak Bay State Park and Wilderness Park	-	-	1	1	-	2	1	1	1	1
140	West Kenai Black Bears	2	2	2	4	2	8	2	2	2	6
141	Seldovia side Kachemak Bay	3	3	4	9	3	14	4	5	3	11
142	AMNWR E Cook Inlet	3	3	4	9	3	14	4	5	3	11
143	AMNWR W Outer Kenai/GOA	1	1	2	1	1	2	1	1	2	2
152	Barren Islands	2	2	3	3	3	4	2	2	3	3
153	Shuyak Island State Park	3	3	4	4	6	5	3	3	5	4
154	AMNWR Afognak and Shuyak Islands	5	6	9	8	12	11	7	7	11	9
155	Afognak & Raspberry Winter Elk	2	2	3	4	4	5	2	3	4	4
156	Kodiak National Wildlife Refuge	7	9	13	12	16	15	9	10	15	13
157	Afognak Blacktail Deer	1	2	3	3	3	4	2	2	3	3
158	AMNWR W Kodiak/Shelikof	2	2	3	3	4	4	2	3	4	3
159	Kupreanof Strait	1	1	1	1	1	1	1	1	1	1
161	AMNWR E Kodiak/GOA	-	-	-	-	1	1	-	-	1	-
164	Afognak Island State Park	-	-	1	-	1	1	-	-	1	1

Table A.2-15. 110 Days-(Annual GLS).

ID	Grouped Land Segments Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
113	Alaska Peninsula National Wildlife Refuge	-	-	1	-	1	-	-	-	1	-
114	AMNWR SW Shelikof/GOA	1	1	1	1	1	1	1	1	1	1
116	SUA: Chignik Chignik Lagoon	-	-	1	-	1	-	-	-	1	-
122	Becharof National Wildlife Refuge	-	-	1	1	1	1	-	-	1	1
123	Katmai National Park	8	9	14	12	18	14	10	10	17	12
124	Kukak Bay	1	2	3	2	3	3	2	2	3	3
125	Spring Bear Concentration-1	-	-	1	1	1	1	-	-	1	1
126	McNeil River State Game Sanctuary and Refuge	2	3	4	4	7	5	2	3	6	4
127	AMNWR W Cook Inlet	58	48	50	40	41	32	49	42	43	37
128	Lake Clark National Park and Preserve	49	35	18	18	2	8	38	25	7	15
129	Redoubt Bay Brown Bears	5	3	-	-	-	-	1	1	-	-
130	Redoubt Bay Critical Habitat Area	1	1	-	-	-	-	-	-	-	-
135	Kenai AK State Rec Mgmt Areas	4	11	3	15	2	12	10	17	2	14
136	West Kenai Brown Bears	1	6	1	6	1	4	5	9	1	6
137	West Kenai Moose	-	2	-	1	-	-	3	2	-	1
138	Clam Gulch Critical Habitat	2	8	1	6	-	2	8	13	1	5
139	Kachemak Bay State Park and Wilderness Park	-	-	1	1	1	2	1	1	1	1
140	West Kenai Black Bears	2	2	2	4	2	8	2	2	2	6
141	Seldovia side Kachemak Bay	3	3	4	9	3	14	4	5	3	11
142	AMNWR E Cook Inlet	3	3	4	9	3	14	4	5	3	11
143	AMNWR W Outer Kenai/GOA	1	1	2	2	2	2	1	1	2	2
152	Barren Islands	2	2	3	3	3	4	2	2	3	3
153	Shuyak Island State Park	3	3	4	4	6	5	3	3	5	4
154	AMNWR Afognak and Shuyak Islands	5	6	9	9	12	11	7	7	11	9
155	Afognak & Raspberry Winter Elk	2	2	3	4	4	5	2	3	4	4
156	Kodiak National Wildlife Refuge	8	9	13	12	16	15	10	10	16	13
157	Afognak Blacktail Deer	1	2	3	3	3	4	2	2	3	3
158	AMNWR W Kodiak/Shelikof	2	2	3	3	4	4	2	3	4	3
159	Kupreanof Strait	1	1	1	1	1	1	1	1	1	1
161	AMNWR E Kodiak/GOA	-	-	1	1	1	1	-	-	1	1
164	Afognak Island State Park	-	-	1	1	1	1	-	-	1	1

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

Tables A.2-16 through A.2-20 represent annual conditional probabilities (expressed as percent chance) that a large oil spill starting at a particular location will contact a certain boundary segment (BS) within:

Table A.2-16. 1 Days-(Annual BS).

ID	Boundary Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4

Note: All rows have all values less than 0.5% and are not shown.

Table A.2-17. 3 Days-(Annual BS).

ID	Boundary Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4

Note: All rows have all values less than 0.5% and are not shown.

Table A.2-18. 10 Days-(Annual BS).

ID	Boundary Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4

Note: All rows have all values less than 0.5% and are not shown.

Table A.2-19. 30 Days-(Annual BS).

ID	Boundary Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4

Note: All rows have all values less than 0.5% and are not shown.

Table A.2-20. 110 Days-(Annual BS).

ID	Boundary Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
4	Gulf of Alaska	-	-	1	1	1	1	-	-	1	1

Tables A.2-21 through A.2-25 represent summer conditional probabilities (expressed as percent chance) that a large oil spill starting at a particular location will contact a certain environmental resource area within:

Table A.2-21. 1 Days-(Summer ERA).

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
0	Land	20	7	11	2	7	2	8	7	6	1
2	SUA: Tyonek North	1	-	-	-	-	-	-	-	-	-
3	SUA: Tyonek South	20	2	-	-	-	-	2	-	-	-
4	SUA: Seldovia, Port Graham, Nanwalek	-	-	-	1	-	10	-	-	-	4
11	Augustine	2	-	19	1	44	1	-	1	28	-
12	South Cook HS 1a	51	27	85	47	4	13	45	35	43	26
13	South Cook HS 1b	16	3	80	15	86	20	10	9	95	8
14	South Cook HS 1c	-	-	15	-	47	2	-	-	40	-
15	South Cook HS 1d	-	-	-	-	5	-	-	-	4	-
17	Clam Gulch HS	1	51	-	6	-	-	32	40	-	2
18	Tuxedni HS	40	16	-	-	-	-	30	1	-	-
19	Kalgin Island HS	21	14	-	-	-	-	4	-	-	-
20	Redoubt Bay HS	9	1	-	-	-	-	-	-	-	-
45	Clam Gulch	-	12	-	6	-	-	16	40	-	2
46	Outer Kachemak Bay	-	5	1	38	-	41	1	19	-	34
47	SW Cook Inlet	43	10	27	2	6	-	27	3	8	1
48	Kamishak Bay	-	-	4	-	19	-	-	-	11	-
68	Kenai Fjords-west	-	-	-	-	-	1	-	-	-	1
70	Forelands- Beluga CH	1	-	-	-	-	-	-	-	-	-
71	Middle Cook Inlet-Beluga CH	30	30	-	-	-	-	21	5	-	-
72	West Cook Inlet-Beluga CH	27	6	24	1	13	-	16	2	11	-
75	Kachemak- Humpback Whale	-	-	1	-	3	5	-	-	2	3
90	Barren Islands- Fin Whale	-	-	-	-	2	1	-	-	2	-
94	Lower E Kenai- Gray Whale	-	-	-	-	-	1	-	-	-	-
95	NE Kodiak- Gray Whale	-	-	-	-	-	1	-	-	-	-
101	Cook Inlet 1- Harbor Porpoise	8	1	-	-	-	-	-	-	-	-

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
102	Cook Inlet 2- Harbor Porpoise	20	20	-	-	-	-	14	4	-	-
103	Cook Inlet 3- Harbor Porpoise	36	25	7	18	-	-	38	22	1	10
104	Cook Inlet 4- Harbor Porpoise	18	3	50	15	4	17	12	9	28	8
105	Cook Inlet 5- Harbor Porpoise	2	-	27	1	38	2	-	1	40	-
136	Kamishak Bay IBA	-	-	4	-	18	-	-	-	13	-
137	Kamishak Bay STEI Habitat	-	-	-	-	1	-	-	-	-	-
138	Tuxedni Is Colony IBA	23	6	-	-	-	-	14	-	-	-
139	Tuxedni Bay IBA	12	3	-	-	-	-	9	-	-	-
140	Redoubt Bay IBA	7	1	-	-	-	-	-	-	-	-
144	Clam Gulch STEI Habitat.	-	1	-	1	-	-	3	4	-	-
145	Outer Kachemak Bay/IBA	4	20	5	77	2	67	8	48	2	97
146	Lower Cook Inlet 153W59N IBA	-	-	8	3	11	10	-	1	11	3
153	Polly Creek Beach	87	37	8	5	-	-	63	11	-	2
154	Chinitna Bay	6	-	13	1	-	-	3	1	2	-

Table A.2-22. 3 Days-(Summer ERA).

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
0	Land	50	31	32	23	31	20	33	28	29	21
2	SUA: Tyonek North	1	-	-	-	-	-	-	-	-	-
3	SUA: Tyonek South	27	8	-	-	-	-	6	2	-	-
4	SUA: Seldovia, Port Graham, Nanwalek	1	1	3	8	3	22	1	2	2	14
11	Augustine	12	8	35	15	57	15	11	11	43	13
12	South Cook HS 1a	60	54	85	64	7	32	65	57	44	47
13	South Cook HS 1b	38	30	86	43	87	40	39	33	96	36
14	South Cook HS 1c	14	8	38	13	59	17	13	9	57	11
15	South Cook HS 1d	3	1	13	3	26	4	2	2	23	2
16	Inner Kachemak Bay	-	-	-	3	-	5	-	-	-	3
17	Clam Gulch HS	3	55	-	13	-	2	35	45	-	9
18	Tuxedni HS	43	27	1	2	-	-	38	9	-	2
19	Kalgin Island HS	23	20	-	1	-	-	9	5	-	-
20	Redoubt Bay HS	12	2	-	-	-	-	1	-	-	-
21	Trading Bay HS	1	-	-	-	-	-	-	-	-	-
23	Barren Isl. Pinn	-	-	2	1	4	4	-	-	3	2
24	Shelikof MM 2	-	-	1	-	3	-	-	-	2	-
37	Port Chatham Pinniped	-	-	-	-	-	1	-	-	1	1
45	Clam Gulch	2	19	-	13	-	2	20	45	-	9
46	Outer Kachemak Bay	4	10	6	46	4	52	6	25	4	44
47	SW Cook Inlet	55	32	35	16	9	7	45	21	14	12
48	Kamishak Bay	5	3	19	7	39	8	4	5	31	6
49	Katmai NP	-	-	-	-	1	-	-	-	1	-
68	Kenai Fjords-west	-	-	1	1	1	5	-	-	1	3
70	Forelands- Beluga CH	2	-	-	-	-	-	-	-	-	-
71	Middle Cook Inlet-Beluga CH	32	39	-	3	-	-	27	18	-	2
72	West Cook Inlet-Beluga CH	42	26	39	17	28	9	36	19	27	13
75	Kachemak- Humpback Whale	4	1	13	4	16	14	3	2	16	8
77	N Kodiak- Humpback Whale	-	-	-	-	1	-	-	-	1	-
80	Shelikof MM 1	1	-	6	1	14	1	1	1	13	-
81	Shelikof MM 1a	1	-	5	-	9	-	-	-	9	-
82	Shelikof MM 2a	-	-	-	-	2	-	-	-	2	-
90	Barren Islands- Fin Whale	3	1	11	3	18	8	2	1	17	4
94	Lower E Kenai- Gray Whale	-	-	1	1	1	4	-	-	1	2
95	NE Kodiak- Gray Whale	-	-	1	1	2	4	-	-	1	2
98	Shelikof- Gray Whale	-	-	-	-	1	-	-	-	1	-
101	Cook Inlet 1- Harbor Porpoise	11	2	-	-	-	-	1	-	-	-
102	Cook Inlet 2- Harbor Porpoise	21	25	-	2	-	-	17	12	-	1
103	Cook Inlet 3- Harbor Porpoise	40	40	8	27	-	5	48	35	1	19
104	Cook Inlet 4- Harbor Porpoise	34	28	52	35	7	28	36	28	29	27

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
105	Cook Inlet 5- Harbor Porpoise	17	12	41	18	42	14	17	14	46	14
135	Shaw Is Colony	-	-	1	-	2	-	-	-	2	-
136	Kamishak Bay IBA	4	3	13	5	27	6	4	4	22	5
137	Kamishak Bay STEI Habitat	-	-	1	-	3	-	-	-	2	-
138	Tuxedni Is Colony IBA	25	12	-	1	-	-	18	4	-	1
139	Tuxedni Bay IBA	15	9	-	1	-	-	12	3	-	1
140	Redoubt Bay IBA	13	2	-	-	-	-	1	-	-	-
144	Clam Gulch STEI Habitat.	-	2	-	2	-	-	3	5	-	1
145	Outer Kachemak Bay/IBA	12	29	16	81	10	76	19	54	11	97
146	Lower Cook Inlet 153W59N IBA	2	2	9	6	11	11	2	3	12	7
147	Barren Islands Marine IBA	-	-	2	-	2	2	-	-	2	1
148	Barren Islands Colonies IBA	-	-	2	-	2	1	-	-	2	1
153	Polly Creek Beach	88	55	9	13	-	1	75	29	1	9
154	Chinitna Bay	14	8	16	7	-	2	12	7	4	5
155	Barren Islands	1	-	2	1	4	3	-	-	3	1

Table A.2-23. 10 Days-(Summer ERA).

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
0	Land	81	74	75	71	75	68	74	72	74	70
2	SUA: Tyonek North	2	-	-	-	-	-	-	-	-	-
3	SUA: Tyonek South	28	11	-	1	-	-	8	4	-	1
4	SUA: Seldovia, Port Graham, Nanwalek	6	6	11	16	10	32	8	8	10	22
5	SUA: Port Lions	3	3	6	3	10	3	3	3	9	3
6	SUA: Ouzinke	2	1	3	2	6	2	2	1	5	1
11	Augustine	23	25	48	34	67	35	27	29	55	33
12	South Cook HS 1a	62	66	86	75	11	47	73	70	46	62
13	South Cook HS 1b	46	49	88	60	87	58	54	53	97	56
14	South Cook HS 1c	26	27	49	33	64	36	30	28	63	31
15	South Cook HS 1d	15	15	29	19	40	21	17	16	38	18
16	Inner Kachemak Bay	1	1	2	5	1	9	1	1	1	6
17	Clam Gulch HS	5	56	2	17	1	6	37	47	1	14
18	Tuxedni HS	44	33	1	6	-	2	42	16	-	5
19	Kalgin Island HS	24	23	-	3	-	1	12	8	-	2
20	Redoubt Bay HS	13	3	-	-	-	-	2	1	-	-
21	Trading Bay HS	1	-	-	-	-	-	-	-	-	-
23	Barren Isl. Pinn	6	5	11	7	13	10	6	5	13	8
24	Shelikof MM 2	5	5	12	7	17	8	6	6	16	7
25	Shelikof MM 3	2	2	5	2	7	3	2	2	7	2
26	Shelikof MM 4	1	1	2	1	3	1	1	1	3	1
27	Shelikof MM 5	-	-	1	-	2	-	-	-	1	-
28	Shelikof MM 6	-	-	-	-	1	-	-	-	1	-
31	Kodiak Pinniped 1	-	-	1	-	1	1	-	-	1	1
37	Port Chatham Pinniped	2	1	3	2	4	3	2	1	4	2
45	Clam Gulch	4	23	2	18	1	7	23	48	1	14
46	Outer Kachemak Bay	10	18	14	52	10	58	14	31	11	50
47	SW Cook Inlet	60	47	39	31	11	17	56	37	17	26
48	Kamishak Bay	16	18	35	25	53	28	19	21	45	26
49	Katmai NP	3	3	7	4	9	4	3	3	9	3
50	Becharof NWR	-	-	-	-	1	-	-	-	-	-
60	Kodiak NWR-west	-	-	1	-	2	-	-	-	1	-
64	Afognak-west	1	1	3	1	4	1	1	1	4	1
67	Shuyak	2	1	4	2	5	2	2	1	5	2
68	Kenai Fjords-west	3	2	5	4	5	8	3	3	5	6
70	Forelands- Beluga CH	2	1	-	-	-	-	1	-	-	-
71	Middle Cook Inlet-Beluga CH	33	42	1	8	-	2	29	22	-	6
72	West Cook Inlet-Beluga CH	52	47	51	40	39	30	54	42	39	36
73	NPRW Feeding Area	-	-	-	-	1	-	-	-	-	-

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
75	Kachemak- Humpback Whale	13	13	23	16	25	24	15	13	26	19
76	Shelikof- Humpback Whale	1	1	3	1	4	1	1	1	4	1
77	N Kodiak- Humpback Whale	4	4	8	4	11	5	4	4	11	4
78	E Kodiak- Humpback Whale	1	-	1	-	1	1	-	-	1	1
80	Shelikof MM 1	12	11	24	15	32	17	13	12	31	14
81	Shelikof MM 1a	7	7	14	8	18	7	8	7	18	7
82	Shelikof MM 2a	3	3	7	3	9	3	4	3	9	3
83	Shelikof MM 3a	1	1	3	1	4	1	1	1	4	1
84	Shelikof MM 4a	-	-	1	-	2	-	-	-	2	-
85	Shelikof MM 5a	-	-	1	-	1	-	-	-	1	-
90	Barren Islands- Fin Whale	14	13	26	17	31	22	15	13	31	18
91	NE Kodiak- Fin Whale	1	1	3	1	3	2	1	1	3	1
94	Lower E Kenai- Gray Whale	3	3	5	4	5	8	3	3	6	5
95	NE Kodiak- Gray Whale	4	4	8	5	8	9	4	4	8	7
98	Shelikof- Gray Whale	3	3	7	3	10	4	3	3	10	3
101	Cook Inlet 1- Harbor Porpoise	11	2	-	-	-	-	1	-	-	-
102	Cook Inlet 2- Harbor Porpoise	22	26	-	6	-	2	18	14	-	5
103	Cook Inlet 3- Harbor Porpoise	42	47	10	33	2	12	52	43	3	26
104	Cook Inlet 4- Harbor Porpoise	39	42	53	46	10	38	46	42	30	41
105	Cook Inlet 5- Harbor Porpoise	24	26	45	31	45	28	29	28	49	29
108	Shelikof- Killer Whale	3	2	7	3	10	4	3	3	9	3
109	E Kodiak- Killer Whale	-	-	1	-	1	1	-	-	1	-
111	NW Afognak Is IBA	1	1	1	1	2	1	1	1	2	1
132	Amalik Bay Colonies IBA	-	-	-	-	1	-	-	-	-	-
133	Ninagiak Is Colonies	-	-	-	-	1	-	-	-	1	-
134	Kiukpalik Is Colony	1	1	2	1	2	1	1	1	2	1
135	Shaw Is Colony	2	2	4	3	6	3	2	2	6	2
136	Kamishak Bay IBA	10	12	21	16	33	17	12	14	29	16
137	Kamishak Bay STEI Habitat	1	1	2	1	5	2	1	1	4	2
138	Tuxedni Is Colony IBA	26	16	-	3	-	1	21	8	-	3
139	Tuxedni Bay IBA	16	11	-	2	-	1	14	6	-	2
140	Redoubt Bay IBA	14	3	-	-	-	-	2	1	-	-
144	Clam Gulch STEI Habitat.	1	3	-	3	-	1	4	6	-	2
145	Outer Kachemak Bay/IBA	19	38	23	83	16	79	29	60	18	97
146	Lower Cook Inlet 153W59N IBA	4	4	10	8	11	12	4	5	12	8
147	Barren Islands Marine IBA	4	3	7	4	8	6	4	3	9	4
148	Barren Islands Colonies IBA	4	3	7	4	8	5	4	3	8	4
153	Polly Creek Beach	89	65	10	22	1	6	81	41	1	17
154	Chinitna Bay	17	15	18	13	1	5	18	14	5	10
155	Barren Islands	6	5	10	6	11	9	6	5	12	7

Table A.2-24. 30 Days-(Summer ERA).

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
0	Land	96	96	94	94	94	94	96	95	94	94
2	SUA: Tyonek North	2	-	-	-	-	-	-	-	-	-
3	SUA: Tyonek South	28	11	-	2	-	1	8	5	-	1
4	SUA: Seldovia, Port Graham, Nanwalek	8	9	13	18	11	34	10	11	12	24
5	SUA: Port Lions	6	6	10	8	14	9	7	6	13	8
6	SUA: Ouzinke	4	4	6	5	8	6	4	4	8	5
7	SUA: Larsen Bay	-	-	1	-	1	1	-	-	1	-
8	SUA: Karluk	1	1	1	1	2	1	1	1	2	1
9	SUA: Akhiok	-	-	1	-	1	-	-	-	1	-
11	Augustine	26	30	51	39	69	40	31	34	58	38
12	South Cook HS 1a	62	67	86	76	13	48	73	71	47	63
13	South Cook HS 1b	46	51	88	63	87	60	56	55	97	58
14	South Cook HS 1c	27	30	50	36	65	39	32	31	64	35
15	South Cook HS 1d	18	19	32	23	42	26	21	20	40	23

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
16	Inner Kachemak Bay	1	2	2	6	1	9	2	2	2	7
17	Clam Gulch HS	5	57	2	18	1	7	37	48	2	14
18	Tuxedni HS	44	33	1	7	-	2	42	17	1	6
19	Kalgin Island HS	24	23	-	3	-	1	12	8	-	2
20	Redoubt Bay HS	13	3	-	-	-	-	2	1	-	-
21	Trading Bay HS	1	-	-	-	-	-	-	-	-	-
23	Barren Isl. Pinn	8	8	13	10	14	13	8	8	14	11
24	Shelikof MM 2	9	10	17	12	21	14	10	11	20	13
25	Shelikof MM 3	5	5	9	6	11	7	5	5	10	7
26	Shelikof MM 4	3	3	5	3	6	4	3	3	6	4
27	Shelikof MM 5	2	2	3	2	4	3	2	2	4	2
28	Shelikof MM 6	1	2	2	2	3	2	2	2	3	2
29	Shelikof MM 7	-	-	1	-	1	-	-	-	1	-
30	Shelikof MM 8	1	1	2	1	2	1	1	1	2	1
31	Kodiak Pinniped 1	1	1	2	2	3	2	1	1	2	2
32	Kodiak Pinniped 2	-	-	-	-	1	-	-	-	-	-
37	Port Chatham Pinniped	2	2	4	3	4	4	3	2	5	3
38	Port Dick Pinniped	-	-	1	1	1	1	-	-	1	-
43	AK Peninsula Pinniped 1	1	1	1	1	2	1	1	1	1	1
45	Clam Gulch	4	24	3	18	1	7	24	48	2	15
46	Outer Kachemak Bay	11	20	15	53	10	59	16	33	12	51
47	SW Cook Inlet	61	50	41	33	13	20	59	40	18	29
48	Kamishak Bay	19	23	38	31	55	33	24	26	48	31
49	Katmai NP	6	6	10	7	13	8	7	7	13	8
50	Becharof NWR	1	1	1	1	1	1	1	1	1	1
51	Alaska Peninsula NWR North	-	1	1	1	1	1	1	1	1	-
59	Kodiak NWR-south	1	1	1	1	1	1	1	1	1	1
60	Kodiak NWR-west	1	1	3	2	3	2	2	1	3	2
64	Afognak-west	2	3	4	3	6	4	3	3	5	3
65	Afognak-north	-	-	-	-	-	-	-	-	1	-
66	Afognak-east	-	-	1	-	1	1	-	-	1	1
67	Shuyak	3	3	5	4	7	5	3	3	7	4
68	Kenai Fjords-west	4	4	6	6	6	10	4	4	6	7
70	Forelands- Beluga CH	2	1	-	-	-	-	1	-	-	-
71	Middle Cook Inlet-Beluga CH	33	42	1	8	1	3	30	22	1	7
72	West Cook Inlet-Beluga CH	55	52	54	45	41	35	58	47	42	42
73	NPRW Feeding Area	1	1	1	1	2	1	1	1	1	1
75	Kachemak- Humpback Whale	15	16	25	19	26	27	17	16	27	22
76	Shelikof- Humpback Whale	3	3	6	4	7	5	4	3	7	4
77	N Kodiak- Humpback Whale	6	6	11	8	13	9	7	6	13	8
78	E Kodiak- Humpback Whale	1	1	3	2	3	2	1	1	3	2
80	Shelikof MM 1	15	17	28	21	35	23	18	18	35	21
81	Shelikof MM 1a	9	10	16	11	20	11	11	10	20	10
82	Shelikof MM 2a	5	6	9	6	11	6	6	6	11	6
83	Shelikof MM 3a	3	3	5	3	6	3	3	3	6	3
84	Shelikof MM 4a	2	2	3	2	3	2	2	2	3	2
85	Shelikof MM 5a	1	1	2	1	2	1	1	1	2	1
86	Shelikof MM 6a	1	1	1	1	1	1	1	1	1	1
87	Shelikof MM 9	1	-	1	-	1	-	1	-	1	-
89	Shelikof MM 11	-	-	1	-	1	-	-	-	1	-
90	Barren Islands- Fin Whale	16	16	28	20	32	26	18	17	32	22
91	NE Kodiak- Fin Whale	2	2	4	3	4	3	2	2	4	3
92	Kodiak- Gray Whale Feeding	-	-	1	-	1	-	-	-	1	-
94	Lower E Kenai- Gray Whale	4	4	7	6	7	9	4	5	7	7
95	NE Kodiak- Gray Whale	5	6	9	7	10	11	6	6	10	9
97	SE Kodiak- Gray Whale	-	-	1	-	1	-	-	-	1	-
98	Shelikof- Gray Whale	6	7	11	8	15	10	8	7	14	8
99	N Shumagin- Gray Whale	-	-	1	1	1	1	1	1	1	1

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
101	Cook Inlet 1- Harbor Porpoise	11	2	-	-	-	-	1	-	-	-
102	Cook Inlet 2- Harbor Porpoise	22	27	1	6	1	3	19	15	1	5
103	Cook Inlet 3- Harbor Porpoise	42	47	11	34	3	13	52	44	4	27
104	Cook Inlet 4- Harbor Porpoise	39	43	54	47	11	39	47	44	31	42
105	Cook Inlet 5- Harbor Porpoise	25	29	46	33	46	31	30	30	50	31
108	Shelikof- Killer Whale	6	6	11	8	14	9	7	7	13	8
109	E Kodiak- Killer Whale	1	1	2	1	2	2	1	1	2	1
111	NW Afognak Is IBA	1	1	2	1	2	1	1	1	2	1
112	Uganik and Viekoda Bay IBAs	-	-	1	-	1	1	-	-	1	-
119	Gulf of Alaska Shelf IBA	-	-	1	-	1	-	-	-	1	-
122	Semidi Islands Marine IBA	-	-	-	-	1	-	-	-	1	-
130	South Alinchak Bay Colony	-	-	1	1	1	1	1	-	1	1
132	Amalik Bay Colonies IBA	-	-	1	-	1	-	-	-	1	-
133	Ninagiak Is Colonies	-	-	1	1	1	-	1	-	1	-
134	Kiukpalik Is Colony	1	1	2	2	3	2	1	2	3	2
135	Shaw Is Colony	3	3	6	4	7	5	4	4	7	4
136	Kamishak Bay IBA	12	14	23	19	34	20	15	17	30	18
137	Kamishak Bay STEI Habitat	1	1	2	2	5	3	1	1	4	2
138	Tuxedni Is Colony IBA	26	16	1	4	-	1	21	8	-	3
139	Tuxedni Bay IBA	16	11	1	3	-	1	14	6	-	2
140	Redoubt Bay IBA	14	4	-	-	-	-	2	1	-	-
144	Clam Gulch STEI Habitat.	1	3	-	3	-	1	4	6	-	2
145	Outer Kachemak Bay/IBA	19	39	24	84	16	79	30	60	19	97
146	Lower Cook Inlet 153W59N IBA	4	4	10	8	11	12	4	5	12	8
147	Barren Islands Marine IBA	5	5	9	6	10	8	6	5	10	7
148	Barren Islands Colonies IBA	5	5	8	6	9	7	5	5	9	6
149	SW Kenai Pen Marine IBA	-	-	1	-	1	-	-	-	1	-
151	Gulf of AK Shelf 151W58N IBA	1	-	1	1	1	1	1	1	1	1
153	Polly Creek Beach	89	65	11	23	1	8	82	42	2	19
154	Chinitna Bay	18	16	19	14	1	6	19	16	5	12
155	Barren Islands	7	7	12	9	13	12	8	7	13	10

Table A.2-25. 110 Days-(Summer ERA).

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
0	Land	97	97	95	96	95	95	97	96	95	95
2	SUA: Tyonek North	2	-	-	-	-	-	-	-	-	-
3	SUA: Tyonek South	28	11	-	2	-	1	8	5	-	1
4	SUA: Seldovia, Port Graham, Nanwalek	8	9	13	18	11	34	10	11	12	24
5	SUA: Port Lions	6	6	10	8	14	9	7	7	13	8
6	SUA: Ouzinke	4	4	6	5	8	6	4	4	8	5
7	SUA: Larsen Bay	-	-	1	1	1	1	-	-	1	-
8	SUA: Karluk	1	1	1	1	2	1	1	1	2	1
9	SUA: Akhiok	-	-	1	-	1	-	-	-	1	-
11	Augustine	26	30	51	39	69	40	32	34	58	38
12	South Cook HS 1a	62	67	86	76	13	49	73	71	47	63
13	South Cook HS 1b	46	51	88	63	87	60	56	55	97	59
14	South Cook HS 1c	27	30	50	36	65	39	32	31	64	35
15	South Cook HS 1d	18	19	32	23	42	26	21	20	41	23
16	Inner Kachemak Bay	1	2	2	6	1	9	2	2	2	7
17	Clam Gulch HS	5	57	2	18	1	7	37	48	2	14
18	Tuxedni HS	44	33	1	7	-	2	42	17	1	6
19	Kalgin Island HS	24	23	-	3	-	1	12	8	-	2
20	Redoubt Bay HS	13	3	-	-	-	-	2	1	-	-
21	Trading Bay HS	1	-	-	-	-	-	-	-	-	-
23	Barren Isl. Pinn	8	8	13	10	14	13	8	8	14	11
24	Shelikof MM 2	9	10	17	12	21	14	11	11	20	13
25	Shelikof MM 3	5	5	9	6	11	7	6	5	11	7

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
26	Shelikof MM 4	3	3	5	4	6	4	3	3	6	4
27	Shelikof MM 5	2	2	3	2	4	3	2	2	4	2
28	Shelikof MM 6	1	2	3	2	3	2	2	2	3	2
29	Shelikof MM 7	-	-	1	-	1	-	-	-	1	-
30	Shelikof MM 8	1	1	2	1	2	2	1	1	2	1
31	Kodiak Pinniped 1	1	1	2	2	3	2	1	1	3	2
32	Kodiak Pinniped 2	-	-	1	-	1	-	-	-	1	-
37	Port Chatham Pinniped	2	2	4	3	4	5	3	2	5	3
38	Port Dick Pinniped	-	-	1	1	1	1	-	-	1	-
43	AK Peninsula Pinniped 1	1	1	2	1	2	1	1	1	2	1
45	Clam Gulch	4	24	3	18	1	7	24	48	2	15
46	Outer Kachemak Bay	11	20	15	53	10	59	16	33	12	51
47	SW Cook Inlet	61	50	41	33	13	20	59	40	18	29
48	Kamishak Bay	19	23	38	31	56	33	24	26	49	31
49	Katmai NP	6	6	10	7	13	8	7	7	13	8
50	Becharof NWR	1	1	1	1	1	1	1	1	1	1
51	Alaska Peninsula NWR North	1	1	1	1	1	1	1	1	1	1
59	Kodiak NWR-south	1	1	1	1	2	1	1	1	2	1
60	Kodiak NWR-west	1	1	3	2	3	2	2	1	3	2
64	Afognak-west	3	3	4	3	6	4	3	3	6	3
65	Afognak-north	-	-	-	-	-	-	-	-	1	-
66	Afognak-east	-	-	1	1	1	1	-	-	1	1
67	Shuyak	3	3	5	4	7	5	3	3	7	4
68	Kenai Fjords-west	4	4	6	6	6	10	4	4	6	7
70	Forelands- Beluga CH	2	1	-	-	-	-	1	-	-	-
71	Middle Cook Inlet-Beluga CH	33	42	1	8	1	3	30	22	1	7
72	West Cook Inlet-Beluga CH	55	52	54	45	42	35	58	47	42	42
73	NPRW Feeding Area	1	1	2	1	2	1	1	1	2	1
75	Kachemak- Humpback Whale	15	16	25	19	26	27	17	16	27	22
76	Shelikof- Humpback Whale	3	3	6	4	7	5	4	4	7	4
77	N Kodiak- Humpback Whale	6	6	11	8	13	9	7	7	13	8
78	E Kodiak- Humpback Whale	1	1	3	2	3	2	2	1	3	2
80	Shelikof MM 1	15	17	28	21	35	23	18	18	35	21
81	Shelikof MM 1a	9	10	16	11	20	11	11	10	20	10
82	Shelikof MM 2a	5	6	9	6	11	6	6	6	11	6
83	Shelikof MM 3a	3	3	5	3	6	3	3	3	6	3
84	Shelikof MM 4a	2	2	3	2	3	2	2	2	3	2
85	Shelikof MM 5a	1	1	2	1	2	1	1	1	2	1
86	Shelikof MM 6a	1	1	1	1	2	1	1	1	1	1
87	Shelikof MM 9	1	1	1	1	1	-	1	-	1	1
89	Shelikof MM 11	1	-	1	1	1	1	-	1	1	1
90	Barren Islands- Fin Whale	16	16	28	20	32	26	18	17	32	22
91	NE Kodiak- Fin Whale	2	2	4	3	4	3	2	2	4	3
92	Kodiak- Gray Whale Feeding	-	-	1	-	1	-	-	-	1	-
94	Lower E Kenai- Gray Whale	4	4	7	6	7	10	5	5	7	7
95	NE Kodiak- Gray Whale	5	6	9	7	10	11	6	6	10	9
97	SE Kodiak- Gray Whale	-	-	1	1	1	1	-	-	1	1
98	Shelikof- Gray Whale	6	7	11	8	15	10	8	7	14	8
99	N Shumagin- Gray Whale	1	1	1	1	1	1	1	1	1	1
101	Cook Inlet 1- Harbor Porpoise	11	2	-	-	-	-	1	-	-	-
102	Cook Inlet 2- Harbor Porpoise	22	27	1	6	1	3	19	15	1	5
103	Cook Inlet 3- Harbor Porpoise	42	47	11	34	3	13	52	44	4	27
104	Cook Inlet 4- Harbor Porpoise	39	43	54	47	11	40	47	44	31	42
105	Cook Inlet 5- Harbor Porpoise	25	29	46	33	46	31	30	30	50	31
108	Shelikof- Killer Whale	6	7	11	8	14	9	7	7	13	8
109	E Kodiak- Killer Whale	1	1	2	1	3	2	1	1	2	2
111	NW Afognak Is IBA	1	1	2	1	2	1	1	1	2	1
112	Uganik and Viekoda Bay IBAs	-	-	1	-	1	1	-	-	1	-

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
119	Gulf of Alaska Shelf IBA	-	-	1	-	1	-	-	-	1	-
122	Semidi Islands Marine IBA	-	-	1	-	1	-	-	-	1	-
130	South Alinchak Bay Colony	-	-	1	1	1	1	1	-	1	1
132	Amalik Bay Colonies IBA	-	1	1	-	1	-	-	-	1	-
133	Ninagiak Is Colonies	-	-	1	1	1	-	1	-	1	-
134	Kiukpalik Is Colony	1	1	2	2	3	2	2	2	3	2
135	Shaw Is Colony	3	3	6	4	7	5	4	4	7	4
136	Kamishak Bay IBA	12	14	23	19	34	20	15	17	30	19
137	Kamishak Bay STEI Habitat	1	1	2	2	5	3	1	1	4	2
138	Tuxedni Is Colony IBA	26	16	1	4	-	1	21	8	-	3
139	Tuxedni Bay IBA	16	11	1	3	-	1	14	6	-	2
140	Redoubt Bay IBA	14	4	-	-	-	-	2	1	-	-
144	Clam Gulch STEI Habitat.	1	3	-	3	-	1	4	6	-	2
145	Outer Kachemak Bay/IBA	19	39	24	84	16	79	30	60	19	97
146	Lower Cook Inlet 153W59N IBA	4	4	10	8	11	12	4	5	12	8
147	Barren Islands Marine IBA	5	5	9	6	10	8	6	5	10	7
148	Barren Islands Colonies IBA	5	5	8	6	9	7	5	5	9	6
149	SW Kenai Pen Marine IBA	-	-	1	-	1	1	-	-	1	-
151	Gulf of AK Shelf 151W58N IBA	1	1	1	1	1	1	1	1	1	1
153	Polly Creek Beach	89	65	11	23	1	8	82	42	2	19
154	Chinitna Bay	18	16	19	14	1	6	19	16	5	12
155	Barren Islands	7	7	12	9	13	12	8	7	13	10

Tables A.2-26 through A.2-30 represent summer conditional probabilities (expressed as percent chance) that a large oil spill starting at a particular location will contact a certain land segment within:

Table A.2-26. 1 Days-(Summer LS).

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
29	Augustine Island	-	-	-	-	2	-	-	-	2	-
30	Rocky Cove, Tignagvik Point	-	-	-	-	1	-	-	-	-	-
31	Iiamna Bay, Iniskin Bay, Ursus Cove	-	-	-	-	2	-	-	-	1	-
32	Chinitna Point, Dry Bay	-	-	3	-	2	-	-	-	2	-
33	Chinitna Bay	2	-	7	-	-	-	1	-	1	-
34	Iliamna Point	2	-	-	-	-	-	1	-	-	-
35	Chisik Island, Tuxedni Bay	5	1	-	-	-	-	4	-	-	-
36	Redoubt Point	8	1	-	-	-	-	1	-	-	-
37	Drift River, Drift River Terminal	1	-	-	-	-	-	-	-	-	-
38	Kalgin Islandd	2	3	-	-	-	-	-	-	-	-
54	Clam Gulch, Kasilof	-	-	-	-	-	-	1	-	-	-
55	Deep Creek, Ninilchik, Ninilchik River	-	-	-	-	-	-	1	1	-	-
56	Cape Starichkof, Happy Valley	-	1	-	1	-	-	-	6	-	-
62	Nanwalek, Port Graham	-	-	-	-	-	1	-	-	-	-

Table A.2-27. 3 Days-(Summer LS).

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
25	Spotted Glacier, Sukoi Bay	-	-	-	-	1	-	-	-	-	-
28	Amakdedulia Cove, Bruin Bay, Chenik Head	-	-	-	-	1	-	-	-	1	-
29	Augustine Island	1	-	3	1	8	1	1	1	7	1
30	Rocky Cove, Tignagvik Point	-	-	2	-	6	1	-	-	4	-
31	Iiamna Bay, Iniskin Bay, Ursus Cove	1	-	4	1	9	1	1	1	6	1
32	Chinitna Point, Dry Bay	3	2	9	3	4	2	2	2	6	2
33	Chinitna Bay	9	5	12	6	-	1	8	5	3	4
34	Iliamna Point	3	2	-	1	-	-	4	2	-	-
35	Chisik Island, Tuxedni Bay	10	6	-	-	-	-	8	2	-	-
36	Redoubt Point	15	4	-	-	-	-	3	1	-	-

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
37	Drift River, Drift River Terminal	3	1	-	-	-	-	-	-	-	-
38	Kalgin Islandd	4	3	-	-	-	-	-	-	-	-
40	Kustatan River,West Foreland	1	-	-	-	-	-	-	-	-	-
54	Clam Gulch, Kasilof	-	2	-	-	-	-	3	2	-	-
55	Deep Creek, Ninilchik, Ninilchik River	-	1	-	-	-	-	2	2	-	-
56	Cape Starichkof, Happy Valley	-	3	-	4	-	1	1	9	-	3
57	Anchor Point, Anchor River	-	-	-	2	-	1	-	1	-	1
58	Homer, Homer Spit	-	-	-	1	-	1	-	-	-	1
60	China Poot Bay, Gull Island	-	-	-	-	-	1	-	-	-	-
61	Barabara Point, Seldovia Bay	-	-	-	2	-	3	-	-	-	2
62	Nanwalek, Port Graham	-	-	-	1	-	5	-	-	-	3

Table A.2-28. 10 Days-(Summer LS).

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
21	Kaflia, Kukak, Kuliak & Missak Bays	-	-	1	-	1	-	-	-	1	-
22	Devils Cove, Hallo Bay	-	-	1	-	1	1	-	-	1	-
23	Cape Chiniak, Swikshak Bay	-	-	1	1	1	1	-	-	1	1
24	Fourpeaked Glacier	1	1	2	1	3	1	1	1	3	1
25	Spotted Glacier, Sukoi Bay	1	1	2	1	3	1	1	1	3	1
26	Douglas River	1	1	1	1	2	1	1	1	2	1
28	Amakdedulia Cove, Bruin Bay, Chenik Head	1	1	3	2	5	2	1	1	4	2
29	Augustine Island	3	4	7	5	11	6	4	5	11	5
30	Rocky Cove, Tignagvik Point	3	3	6	5	9	5	3	4	8	5
31	Iiamna Bay, Iniskin Bay, Ursus Cove	3	4	8	6	12	6	4	4	9	6
32	Chinitna Point, Dry Bay	5	6	11	7	6	6	6	6	7	6
33	Chinitna Bay	13	12	14	11	1	5	14	12	4	9
34	Iliamna Point	4	4	-	1	-	-	4	3	-	1
35	Chisik Island, Tuxedni Bay	11	9	-	2	-	-	10	5	-	1
36	Redoubt Point	17	6	-	1	-	-	4	2	-	-
37	Drift River, Drift River Terminal	3	1	-	-	-	-	-	-	-	-
38	Kalgin Islandd	4	4	-	-	-	-	1	-	-	-
40	Kustatan River,West Foreland	1	-	-	-	-	-	-	-	-	-
54	Clam Gulch, Kasilof	-	4	-	2	-	1	5	4	-	2
55	Deep Creek, Ninilchik, Ninilchik River	-	2	-	1	-	-	2	3	-	1
56	Cape Starichkof, Happy Valley	1	4	1	6	-	2	2	10	-	5
57	Anchor Point, Anchor River	-	1	1	3	-	4	1	1	-	3
58	Homer, Homer Spit	-	-	-	2	-	2	-	-	-	2
60	China Poot Bay, Gull Island	-	-	-	1	-	2	-	-	-	1
61	Barabara Point, Seldovia Bay	1	1	1	4	1	6	1	1	1	4
62	Nanwalek, Port Graham	1	2	3	3	3	8	2	2	3	6
63	Elizabeth Island, Port Chatham, Koyuktolik Bay	1	-	1	1	1	2	1	1	1	1
79	Barren Islands, Ushagat Island	1	1	2	1	2	1	1	1	2	1
80	Amatuli Cove, East & West Amatuli Island	-	-	1	-	1	1	-	-	1	1
81	Shuyak Island	1	-	1	1	2	1	1	1	2	1
82	Bluefox Bay, Shuyak Island, Shuyak Strait	1	1	2	1	3	1	1	1	2	1
83	Foul Bay, Paramanof Bay	1	1	1	1	2	1	1	1	2	1
84	Malina Bay, Raspberry Island, Raspberry Strait	-	-	1	-	1	-	-	-	1	-
85	Kupreanof Strait, Viekoda Bay	-	-	-	-	1	-	-	-	-	-

Table A.2-29. 30 Days-(Summer LS).

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
18	Alinchak Bay, Cape Kekurnoi, Bear Bay	-	-	-	-	1	-	-	-	-	-
19	Cape Kubugakli, Kashvik Bay, Katmai Bay	-	-	-	-	1	-	-	-	1	-
20	Amalik, Dakavak & Kinak Bays, Cape Iiktugitak, Takli Is.	-	-	-	-	1	-	-	-	1	-
21	Kaflia, Kukak, Kuliak & Missak Bays	1	1	1	1	2	1	1	1	2	1
22	Devils Cove, Hallo Bay	1	1	2	1	2	1	1	1	2	1

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
23	Cape Chiniak, Swikshak Bay	1	1	2	1	2	1	1	1	2	1
24	Fourpeaked Glacier	2	2	3	2	3	2	2	2	3	2
25	Spotted Glacier, Sukoi Bay	2	2	3	2	4	2	2	2	4	2
26	Douglas River	1	1	2	1	2	2	1	1	2	1
28	Amakdedulia Cove, Bruin Bay, Chenik Head	2	2	4	3	6	4	2	2	5	3
29	Augustine Island	4	5	8	6	12	7	5	6	11	6
30	Rocky Cove, Tignagvik Point	3	4	6	6	10	6	4	5	8	6
31	Iiamna Bay, Iniskin Bay, Ursus Cove	4	5	8	7	12	7	5	5	10	7
32	Chinitna Point, Dry Bay	6	6	11	8	6	6	7	7	7	7
33	Chinitna Bay	13	13	14	12	1	6	15	13	5	10
34	Iliamna Point	4	4	-	2	-	-	4	3	-	1
35	Chisik Island, Tuxedni Bay	11	9	-	2	-	1	10	5	-	2
36	Redoubt Point	17	6	-	1	-	-	4	2	-	1
37	Drift River, Drift River Terminal	3	1	-	-	-	-	-	-	-	-
38	Kalgin Islandd	4	4	-	-	-	-	1	-	-	-
40	Kustatan River,West Foreland	1	-	-	-	-	-	-	-	-	-
54	Clam Gulch, Kasilof	1	4	-	2	-	1	5	4	-	2
55	Deep Creek, Ninilchik, Ninilchik River	-	2	-	1	-	-	3	3	-	1
56	Cape Starichkof, Happy Valley	1	5	1	6	1	2	3	11	1	5
57	Anchor Point, Anchor River	1	1	1	3	1	4	1	2	1	3
58	Homer, Homer Spit	-	-	1	2	-	3	-	1	-	2
60	China Poot Bay, Gull Island	-	-	-	1	-	2	-	-	-	1
61	Barabara Point, Seldovia Bay	1	1	2	4	1	7	2	2	1	5
62	Nanwalek, Port Graham	2	2	3	4	3	8	3	3	3	6
63	Elizabeth Island, Port Chatham, Koyuktolik Bay	1	1	2	1	2	2	1	1	2	2
79	Barren Islands, Ushagat Island	2	1	2	2	3	2	2	1	3	2
80	Amatuli Cove, East & West Amatuli Island	1	1	1	1	1	1	1	1	1	1
81	Shuyak Island	1	1	2	1	2	2	1	1	3	1
82	Bluefox Bay, Shuyak Island, Shuyak Strait	1	2	2	2	3	2	2	2	3	2
83	Foul Bay, Paramanof Bay	1	2	2	2	3	2	1	2	3	2
84	Malina Bay, Raspberry Island, Raspberry Strait	1	1	1	1	2	1	1	1	2	1
85	Kupreanof Strait, Viekoda Bay	-	-	1	1	1	1	1	-	1	1
86	Uganik Bay Uganik Strait, Cape Ugat	-	-	1	1	1	1	-	-	1	1
87	Cape Kuliuk, Spiridon Bay, Uyak Bay	-	-	-	-	1	-	-	-	1	-

Table A.2-30. 110 Days-(Summer LS).

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
16	Capes Kanatak, Lgvak & Unalishagvak, Portage Bay	-	-	-	-	1	-	-	-	-	-
18	Alinchak Bay, Cape Kekurnoi, Bear Bay	-	-	-	-	1	-	-	-	-	-
19	Cape Kubugakli, Kashvik Bay, Katmai Bay	-	-	-	-	1	-	-	-	1	-
20	Amalik, Dakavak & Kinak Bays, Cape Iiktugitak, Takli Is.	-	-	-	-	1	-	-	-	1	-
21	Kaflia, Kukak, Kuliak & Missak Bays	1	1	1	1	2	1	1	1	2	1
22	Devils Cove, Hallo Bay	1	1	2	1	2	1	1	1	2	1
23	Cape Chiniak, Swikshak Bay	1	1	2	1	2	1	1	1	2	1
24	Fourpeaked Glacier	2	2	3	2	3	2	2	2	3	2
25	Spotted Glacier, Sukoi Bay	2	2	3	2	4	2	2	2	4	2
26	Douglas River	1	1	2	1	2	2	1	1	2	1
28	Amakdedulia Cove, Bruin Bay, Chenik Head	2	2	4	3	6	4	2	3	5	3
29	Augustine Island	4	5	8	6	12	7	5	6	11	6
30	Rocky Cove, Tignagvik Point	3	4	6	6	10	6	4	5	8	6
31	Iiamna Bay, Iniskin Bay, Ursus Cove	4	5	8	7	12	7	5	5	10	7
32	Chinitna Point, Dry Bay	6	6	11	8	6	6	7	7	7	7
33	Chinitna Bay	13	13	14	12	1	6	15	13	5	10
34	Iliamna Point	4	4	-	2	-	-	4	3	-	1
35	Chisik Island, Tuxedni Bay	11	9	-	2	-	1	10	5	-	2
36	Redoubt Point	17	6	-	1	-	-	4	2	-	1
37	Drift River, Drift River Terminal	3	1	-	-	-	-	-	-	-	-

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
38	Kalgin Islandd	4	4	-	-	-	-	1	-	-	-
40	Kustatan River,West Foreland	1	-	-	-	-	-	-	-	-	-
54	Clam Gulch, Kasilof	1	4	-	2	-	1	5	4	-	2
55	Deep Creek, Ninilchik, Ninilchik River	-	2	-	1	-	-	3	3	-	1
56	Cape Starichkof, Happy Valley	1	5	1	6	1	2	3	11	1	5
57	Anchor Point, Anchor River	1	1	1	3	1	4	1	2	1	3
58	Homer, Homer Spit	-	-	1	2	-	3	-	1	-	2
60	China Poot Bay, Gull Island	-	-	-	1	-	2	-	-	-	1
61	Barabara Point, Seldovia Bay	1	1	2	4	1	7	2	2	1	5
62	Nanwalek, Port Graham	2	3	3	4	3	8	3	3	3	6
63	Elizabeth Island, Port Chatham, Koyuktolik Bay	1	1	2	1	2	2	1	1	2	2
79	Barren Islands, Ushagat Island	2	1	2	2	3	2	2	1	3	2
80	Amatuli Cove, East & West Amatuli Island	1	1	1	1	1	1	1	1	1	1
81	Shuyak Island	1	1	2	1	2	2	1	1	3	1
82	Bluefox Bay, Shuyak Island, Shuyak Strait	1	2	2	2	3	2	2	2	3	2
83	Foul Bay, Paramanof Bay	1	2	2	2	3	2	1	2	3	2
84	Malina Bay, Raspberry Island, Raspberry Strait	1	1	1	1	2	1	1	1	2	1
85	Kupreanof Strait, Viekoda Bay	1	-	1	1	1	1	1	-	1	1
86	Uganik Bay Uganik Strait, Cape Ugat	-	-	1	1	1	1	-	-	1	1
87	Cape Kuliuk, Spiridon Bay, Uyak Bay	-	-	-	-	1	-	-	-	1	-
111	Seal Bay, Tonki Bay	-	-	-	-	-	-	-	-	1	-

Tables A.2-31 through A.2-35 represent summer conditional probabilities (expressed as percent chance) that a large oil spill starting at a particular location will contact a certain group of land segments within:

Table A.2-31. 1 Days-(Summer GLS).

ID	Grouped Land Segments Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
127	AMNWR W Cook Inlet	15	2	11	-	7	-	5	-	6	-
128	Lake Clark National Park and Preserve	17	2	7	-	-	-	7	-	1	-
129	Redoubt Bay Brown Bears	3	3	-	-	-	-	-	-	-	-
135	Kenai AK State Rec Mgmt Areas	-	2	-	2	-	1	2	7	-	1
136	West Kenai Brown Bears	-	1	-	1	-	-	1	5	-	-
138	Clam Gulch Critical Habitat	-	2	-	1	-	-	2	7	-	-
140	West Kenai Black Bears	-	-	-	-	-	1	-	-	-	-
141	Seldovia side Kachemak Bay	-	-	-	-	-	2	-	-	-	1
142	AMNWR E Cook Inlet	-	-	-	-	-	2	-	-	-	1

Table A.2-32. 3 Days-(Summer GLS).

ID	Grouped Land Segments Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
123	Katmai National Park	-	-	-	-	1	-	-	-	1	-
126	McNeil River State Game Sanctuary and Refuge	-	-	-	-	1	-	-	-	1	-
127	AMNWR W Cook Inlet	38	18	29	11	22	7	22	12	23	9
128	Lake Clark National Park and Preserve	37	18	13	7	-	1	22	10	3	5
129	Redoubt Bay Brown Bears	7	4	-	-	-	-	-	-	-	-
130	Redoubt Bay Critical Habitat Area	1	-	-	-	-	-	-	-	-	-
135	Kenai AK State Rec Mgmt Areas	1	7	1	9	-	7	7	13	-	8
136	West Kenai Brown Bears	-	5	-	5	-	2	5	10	-	4
137	West Kenai Moose	-	1	-	-	-	-	2	1	-	-
138	Clam Gulch Critical Habitat	1	6	-	5	-	1	6	12	-	3
139	Kachemak Bay State Park and Wilderness Park	-	-	-	-	-	1	-	-	-	-
140	West Kenai Black Bears	-	-	-	3	-	6	-	1	-	4
141	Seldovia side Kachemak Bay	-	-	1	3	1	9	-	1	-	6
142	AMNWR E Cook Inlet	-	-	1	3	1	9	-	1	-	6
152	Barren Islands	-	-	-	-	1	-	-	-	-	-

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

Table A.2-33. 10 Days-(Summer GLS).

ID	Grouped Land Segments Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
123	Katmai National Park	4	3	9	4	13	6	4	4	12	4
124	Kukak Bay	1	1	2	1	2	1	1	1	2	1
125	Spring Bear Concentration-1	-	-	-	-	1	1	-	-	1	-
126	McNeil River State Game Sanctuary and Refuge	1	1	3	2	5	3	1	1	4	2
127	AMNWR W Cook Inlet	53	41	43	33	35	25	43	35	36	30
128	Lake Clark National Park and Preserve	43	30	14	15	1	6	32	22	5	12
129	Redoubt Bay Brown Bears	8	5	-	-	-	-	1	1	-	-
130	Redoubt Bay Critical Habitat Area	1	-	-	-	-	-	-	-	-	-
135	Kenai AK State Rec Mgmt Areas	4	13	4	18	2	17	12	21	3	18
136	West Kenai Brown Bears	2	9	2	10	1	8	8	15	1	10
137	West Kenai Moose	-	2	-	1	-	-	2	2	-	1
138	Clam Gulch Critical Habitat	2	10	1	9	-	3	9	17	1	7
139	Kachemak Bay State Park and Wilderness Park	-	-	1	1	-	2	-	-	1	2
140	West Kenai Black Bears	2	2	3	6	3	12	2	3	3	8
141	Seldovia side Kachemak Bay	3	3	5	8	4	16	3	4	4	11
142	AMNWR E Cook Inlet	2	3	5	8	4	16	3	4	4	11
143	AMNWR W Outer Kenai/GOA	1	1	2	1	2	2	1	1	2	1
152	Barren Islands	1	1	3	1	3	2	1	1	3	2
153	Shuyak Island State Park	1	1	3	2	4	2	1	1	4	1
154	AMNWR Afognak and Shuyak Islands	2	2	5	3	8	3	2	2	7	2
156	Kodiak National Wildlife Refuge	3	2	6	3	9	3	3	2	8	3
158	AMNWR W Kodiak/Shelikof	-	-	1	-	1	-	-	-	1	-
159	Kupreanof Strait	-	-	-	-	1	-	-	-	-	-

Table A.2-34. 30 Days-(Summer GLS).

ID	Grouped Land Segments Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
113	Alaska Peninsula National Wildlife Refuge	-	-	1	1	1	-	1	1	1	-
114	AMNWR SW Shelikof/GOA	1	1	2	1	2	1	1	1	2	1
116	SUA: Chignik Chignik Lagoon	-	1	1	1	1	1	1	1	1	-
122	Becharof National Wildlife Refuge	-	1	1	1	1	1	1	1	1	1
123	Katmai National Park	7	8	13	9	16	11	8	8	16	9
124	Kukak Bay	1	2	3	2	4	3	2	2	4	2
125	Spring Bear Concentration-1	-	-	1	1	1	1	-	-	1	1
126	McNeil River State Game Sanctuary and Refuge	2	2	4	3	6	4	2	3	5	3
127	AMNWR W Cook Inlet	56	47	47	39	38	31	48	41	39	36
128	Lake Clark National Park and Preserve	44	32	15	16	2	7	34	23	5	14
129	Redoubt Bay Brown Bears	8	5	-	-	-	-	1	1	-	-
130	Redoubt Bay Critical Habitat Area	1	-	-	-	-	-	-	-	-	-
135	Kenai AK State Rec Mgmt Areas	5	15	5	20	3	19	14	22	4	20
136	West Kenai Brown Bears	2	10	2	12	2	9	9	16	2	11
137	West Kenai Moose	-	2	-	1	-	-	2	2	-	1
138	Clam Gulch Critical Habitat	2	11	1	9	1	4	10	18	1	8
139	Kachemak Bay State Park and Wilderness Park	1	1	1	2	1	2	1	1	1	2
140	West Kenai Black Bears	3	3	4	7	4	13	4	4	4	9
141	Seldovia side Kachemak Bay	3	4	6	9	5	17	5	5	5	13
142	AMNWR E Cook Inlet	3	4	5	9	5	17	5	5	5	12
143	AMNWR W Outer Kenai/GOA	1	1	2	2	2	3	2	2	2	2
152	Barren Islands	2	2	4	3	4	3	2	2	4	3
153	Shuyak Island State Park	2	3	4	3	6	4	3	3	6	3
154	AMNWR Afognak and Shuyak Islands	5	5	9	6	11	8	6	6	11	6
156	Kodiak National Wildlife Refuge	6	7	11	8	15	10	7	7	14	8
158	AMNWR W Kodiak/Shelikof	1	1	3	2	3	2	1	1	3	2
159	Kupreanof Strait	-	-	1	1	1	1	1	-	1	1
164	Afognak Island State Park	-	-	1	-	1	1	-	-	1	1

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

Table A.2-35. 110 Days-(Summer GLS).

ID	Grouped Land Segments Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
113	Alaska Peninsula National Wildlife Refuge	1	1	1	1	1	1	1	1	1	1
114	AMNWR SW Shelikof/GOA	1	1	2	1	2	1	1	1	2	1
116	SUA: Chignik Chignik Lagoon	1	1	1	1	1	1	1	1	1	1
122	Becharof National Wildlife Refuge	1	1	1	1	1	1	1	1	1	1
123	Katmai National Park	7	8	13	9	17	11	8	9	16	9
124	Kukak Bay	1	2	3	2	4	3	2	2	4	2
125	Spring Bear Concentration-1	-	-	1	1	1	1	-	-	1	1
126	McNeil River State Game Sanctuary and Refuge	2	2	4	3	6	4	2	3	5	3
127	AMNWR W Cook Inlet	56	47	47	39	38	31	49	41	39	36
128	Lake Clark National Park and Preserve	44	32	15	17	2	7	34	23	5	14
129	Redoubt Bay Brown Bears	8	5	-	-	-	-	1	1	-	-
130	Redoubt Bay Critical Habitat Area	1	-	-	-	-	-	-	-	-	-
135	Kenai AK State Rec Mgmt Areas	5	15	5	20	3	19	14	22	4	20
136	West Kenai Brown Bears	2	10	2	12	2	9	9	16	2	11
137	West Kenai Moose	-	2	-	1	-	-	2	2	-	1
138	Clam Gulch Critical Habitat	2	11	1	9	1	4	10	18	1	8
139	Kachemak Bay State Park and Wilderness Park	1	1	1	2	1	3	1	1	1	2
140	West Kenai Black Bears	3	4	4	7	4	13	4	4	4	9
141	Seldovia side Kachemak Bay	3	4	6	9	5	17	5	5	5	13
142	AMNWR E Cook Inlet	3	4	6	9	5	17	5	5	5	13
143	AMNWR W Outer Kenai/GOA	1	2	2	2	3	3	2	2	3	2
152	Barren Islands	2	2	4	3	4	3	2	2	4	3
153	Shuyak Island State Park	3	3	4	3	6	4	3	3	6	3
154	AMNWR Afognak and Shuyak Islands	5	5	9	6	12	8	6	6	11	7
156	Kodiak National Wildlife Refuge	7	7	12	9	15	10	8	7	15	9
158	AMNWR W Kodiak/Shelikof	1	1	3	2	3	2	2	1	3	2
159	Kupreanof Strait	1	-	1	1	1	1	1	-	1	1
161	AMNWR E Kodiak/GOA	-	-	1	1	1	1	1	-	1	-
164	Afognak Island State Park	-	-	1	1	1	1	-	-	1	1

Tables A.2-36 through A.2-40 represent summer conditional probabilities (expressed as percent chance) that a large oil spill starting at a particular location will contact a certain boundary segment within:

Table A.2-36. 1 Days-(Summer BS).

ID	Boundary Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4

Note: All rows have all values less than 0.5% and are not shown.

Table A.2-37. 3 Days-(Summer BS).

ID	Boundary Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4

Note: All rows have all values less than 0.5% and are not shown.

Table A.2-38. 10 Days-(Summer BS).

ID	Boundary Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4

Note: All rows have all values less than 0.5% and are not shown.

Table A.2-39. 30 Days-(Summer BS).

ID	Boundary Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
4	Gulf of Alaska	-	-	-	-	1	-	-	-	1	-

Table A.2-40. 110 Days-(Summer BS).

ID	Boundary Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
4	Gulf of Alaska	-	-	1	1	1	-	-	-	1	1

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

Tables A.2-41 through A.2-45 represent winter conditional probabilities (expressed as percent chance) that a large oil spill starting at a particular location will contact a certain environmental resource area within:

Table A.2-41. 1 Days-(Winter ERA).

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
0	Land	29	9	17	1	14	2	10	5	13	1
3	SUA: Tyonek South	6	1	-	-	-	-	-	-	-	-
4	SUA: Seldovia, Port Graham, Nanwalek	-	-	-	2	-	10	-	-	-	5
11	Augustine	1	-	21	-	52	1	-	-	36	-
12	South Cook HS 1a	50	28	81	48	2	9	42	43	41	30
13	South Cook HS 1b	10	1	78	17	84	24	4	8	95	11
14	South Cook HS 1c	-	-	6	-	46	6	-	-	31	1
15	South Cook HS 1d	-	-	-	-	3	-	-	-	2	-
16	Inner Kachemak Bay	-	-	-	1	-	-	-	-	-	-
17	Clam Gulch HS	-	37	-	2	-	-	27	25	-	1
18	Tuxedni HS	25	13	-	-	-	-	18	1	-	-
19	Kalgin Island HS	9	5	-	-	-	-	1	-	-	-
20	Redoubt Bay HS	3	-	-	-	-	-	-	-	-	-
45	Clam Gulch	-	8	-	2	-	-	16	31	-	1
46	Outer Kachemak Bay	-	6	1	36	-	34	1	25	-	21
47	SW Cook Inlet	54	13	30	2	7	-	30	3	13	1
48	Kamishak Bay	-	-	4	-	27	-	-	-	16	-
68	Kenai Fjords-west	-	-	-	-	-	1	-	-	-	1
71	Middle Cook Inlet-Beluga CH	26	22	-	-	-	-	13	3	-	-
72	West Cook Inlet-Beluga CH	36	8	30	1	17	1	16	2	18	-
75	Kachemak- Humpback Whale	-	-	-	-	1	7	-	-	-	4
90	Barren Islands- Fin Whale	-	-	-	-	-	1	-	-	-	-
94	Lower E Kenai- Gray Whale	-	-	-	-	-	1	-	-	-	-
95	NE Kodiak- Gray Whale	-	-	-	-	-	1	-	-	-	-
137	Kamishak Bay STEI Habitat	-	-	1	-	6	-	-	-	3	-
139	Tuxedni Bay IBA	26	8	-	-	-	-	13	-	-	-
140	Redoubt Bay IBA	5	1	-	-	-	-	-	-	-	-
144	Clam Gulch STEI Habitat.	-	4	-	3	-	-	13	19	-	1
145	Outer Kachemak Bay/IBA	3	22	5	76	1	66	7	59	3	97
146	Lower Cook Inlet 153W59N IBA	4	1	46	23	55	55	1	7	62	28
153	Polly Creek Beach	88	44	5	4	-	-	67	10	-	4
154	Chinitna Bay	5	-	15	1	-	-	2	1	4	-

Table A.2-42. 3 Days-(Winter ERA).

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
0	Land	61	40	46	28	46	24	41	31	45	25
3	SUA: Tyonek South	8	3	-	-	-	-	2	1	-	-
4	SUA: Seldovia, Port Graham, Nanwalek	1	1	3	11	2	20	1	3	2	14
11	Augustine	12	9	41	17	68	21	11	12	55	16
12	South Cook HS 1a	59	58	81	62	3	21	66	66	41	45
13	South Cook HS 1b	33	30	84	45	85	43	35	38	96	39
14	South Cook HS 1c	8	6	31	16	59	31	7	9	50	20
15	South Cook HS 1d	2	1	10	4	28	12	1	2	21	6
16	Inner Kachemak Bay	-	-	-	3	-	2	-	1	-	2
17	Clam Gulch HS	1	39	-	4	-	1	30	27	-	3
18	Tuxedni HS	27	21	-	2	-	-	24	7	-	2
19	Kalgin Island HS	9	7	-	-	-	-	3	1	-	-
20	Redoubt Bay HS	4	1	-	-	-	-	1	-	-	-
23	Barren Isl. Pinn	-	-	1	1	3	6	-	-	2	3
24	Shelikof MM 2	-	-	-	-	3	1	-	-	2	1
37	Port Chatham Pinniped	-	-	-	-	-	1	-	-	-	-
45	Clam Gulch	1	11	-	4	-	1	18	33	-	3

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
46	Outer Kachemak Bay	4	11	5	42	1	39	7	31	3	29
47	SW Cook Inlet	67	42	40	22	11	11	54	28	21	18
48	Kamishak Bay	5	3	24	9	52	13	4	6	40	9
49	Katmai NP	-	-	-	-	1	-	-	-	-	-
68	Kenai Fjords-west	-	-	1	2	1	6	-	-	1	4
70	Forelands- Beluga CH	1	-	-	-	-	-	-	-	-	-
71	Middle Cook Inlet-Beluga CH	27	26	-	2	-	-	17	8	-	1
72	West Cook Inlet-Beluga CH	54	35	48	24	35	15	43	27	38	19
75	Kachemak- Humpback Whale	2	1	7	7	8	18	1	3	7	12
77	N Kodiak- Humpback Whale	-	-	-	-	1	-	-	-	-	-
80	Shelikof MM 1	-	-	3	1	13	6	-	-	10	3
90	Barren Islands- Fin Whale	1	1	7	5	15	19	1	2	12	11
94	Lower E Kenai- Gray Whale	-	-	1	1	1	4	-	-	1	2
95	NE Kodiak- Gray Whale	-	-	1	1	1	4	-	-	1	3
137	Kamishak Bay STEI Habitat	1	1	9	3	22	5	1	2	16	3
139	Tuxedni Bay IBA	31	19	-	2	-	-	22	6	-	2
140	Redoubt Bay IBA	9	3	-	-	-	-	1	-	-	-
144	Clam Gulch STEI Habitat.	1	7	-	5	-	1	15	22	-	4
145	Outer Kachemak Bay/IBA	11	30	13	81	4	72	19	63	8	97
146	Lower Cook Inlet 153W59N IBA	19	20	53	47	56	64	21	31	64	49
153	Polly Creek Beach	88	61	5	12	-	2	81	28	1	10
154	Chinitna Bay	14	9	20	10	1	4	12	10	7	7
155	Barren Islands	-	-	1	1	2	5	-	-	2	3

Table A.2-43. 10 Days-(Winter ERA).

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
0	Land	90	84	88	81	89	82	85	81	89	81
3	SUA: Tyonek South	8	4	-	1	-	-	3	2	-	1
4	SUA: Seldovia, Port Graham, Nanwalek	5	6	6	18	3	25	6	10	4	21
5	SUA: Port Lions	5	5	10	8	13	13	6	7	12	10
6	SUA: Ouzinke	3	4	7	6	9	8	4	5	8	7
7	SUA: Larsen Bay	-	-	1	1	1	1	-	1	1	1
8	SUA: Karluk	-	-	1	1	1	1	-	1	1	1
11	Augustine	22	27	52	37	76	40	28	32	65	37
12	South Cook HS 1a	60	63	82	66	4	26	71	71	42	49
13	South Cook HS 1b	39	45	85	57	85	51	48	52	96	50
14	South Cook HS 1c	22	27	41	38	62	49	28	32	56	41
15	South Cook HS 1d	16	19	29	28	39	35	20	24	36	30
16	Inner Kachemak Bay	1	1	1	4	-	3	1	2	-	3
17	Clam Gulch HS	2	40	-	5	-	1	31	28	-	4
18	Tuxedni HS	28	22	1	4	-	1	26	9	-	3
19	Kalgin Island HS	10	8	-	1	-	-	4	2	-	1
20	Redoubt Bay HS	4	2	-	-	-	-	1	1	-	-
23	Barren Isl. Pinn	4	5	7	8	7	13	5	6	7	10
24	Shelikof MM 2	7	8	14	13	17	17	8	11	16	15
25	Shelikof MM 3	3	3	6	5	7	7	3	4	7	6
26	Shelikof MM 4	1	1	2	2	3	3	1	1	3	2
27	Shelikof MM 5	-	-	1	-	1	1	-	-	1	1
28	Shelikof MM 6	-	-	-	-	1	-	-	-	1	-
31	Kodiak Pinniped 1	-	-	1	1	1	1	-	-	1	1
37	Port Chatham Pinniped	1	1	2	2	1	3	1	1	2	2
45	Clam Gulch	2	12	-	5	-	1	19	34	-	4
46	Outer Kachemak Bay	7	16	7	45	2	42	11	35	4	33
47	SW Cook Inlet	70	52	44	33	13	20	63	40	24	29
48	Kamishak Bay	18	22	39	31	64	35	23	26	54	31
49	Katmai NP	3	3	6	5	8	7	3	4	7	6
59	Kodiak NWR-south	-	-	1	1	1	1	-	-	1	1

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
60	Kodiak NWR-west	1	1	2	2	3	3	2	2	3	3
64	Afognak-west	2	3	5	4	7	7	3	3	7	5
67	Shuyak	2	2	3	3	5	5	2	2	4	4
68	Kenai Fjords-west	2	2	3	5	1	9	2	3	2	7
70	Forelands- Beluga CH	1	1	-	-	-	-	1	-	-	-
71	Middle Cook Inlet-Beluga CH	28	28	-	3	-	1	18	9	-	2
72	West Cook Inlet-Beluga CH	63	53	58	44	44	34	60	47	48	40
75	Kachemak- Humpback Whale	7	9	11	15	10	22	9	12	10	18
76	Shelikof- Humpback Whale	2	2	3	3	5	4	2	2	4	3
77	N Kodiak- Humpback Whale	3	3	6	5	7	7	3	4	6	5
78	E Kodiak- Humpback Whale	-	-	1	1	1	1	-	-	1	1
80	Shelikof MM 1	13	16	24	24	30	31	16	19	29	27
90	Barren Islands- Fin Whale	11	15	21	25	23	35	15	19	22	29
91	NE Kodiak- Fin Whale	1	1	2	2	2	3	1	1	2	2
94	Lower E Kenai- Gray Whale	1	2	2	3	1	5	2	2	2	4
95	NE Kodiak- Gray Whale	2	2	3	4	2	7	2	3	3	5
98	Shelikof- Gray Whale	4	4	7	6	9	8	4	5	9	7
108	Shelikof- Killer Whale	5	5	9	9	11	11	6	7	11	9
109	E Kodiak- Killer Whale	-	-	1	1	1	1	-	-	1	1
137	Kamishak Bay STEI Habitat	8	10	18	15	29	17	10	12	24	15
139	Tuxedni Bay IBA	32	21	1	4	-	1	24	9	-	3
140	Redoubt Bay IBA	9	4	-	-	-	-	2	1	-	-
144	Clam Gulch STEI Habitat.	2	9	1	7	-	3	16	23	-	5
145	Outer Kachemak Bay/IBA	14	35	15	82	5	73	24	66	9	97
146	Lower Cook Inlet 153W59N IBA	24	31	54	54	57	67	31	42	64	56
151	Gulf of AK Shelf 151W58N IBA	-	-	-	-	1	1	-	-	-	-
153	Polly Creek Beach	88	64	6	15	-	4	83	32	1	13
154	Chinitna Bay	16	13	21	14	1	7	16	15	7	12
155	Barren Islands	3	4	7	8	7	13	5	5	7	10

Table A.2-44. 30 Days-(Winter ERA).

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
0	Land	98	97	97	96	96	96	97	96	97	96
3	SUA: Tyonek South	8	4	-	1	-	-	3	2	-	1
4	SUA: Seldovia, Port Graham, Nanwalek	5	7	7	18	3	25	6	11	5	21
5	SUA: Port Lions	7	9	12	12	14	16	9	11	13	14
6	SUA: Ouzinke	5	6	8	9	10	11	6	8	9	10
7	SUA: Larsen Bay	1	1	1	2	1	2	1	1	1	1
8	SUA: Karluk	1	1	2	2	2	2	1	2	2	2
9	SUA: Akhiok	-	-	-	-	1	1	-	-	1	1
11	Augustine	23	28	53	39	76	42	30	34	65	39
12	South Cook HS 1a	60	63	82	66	4	26	71	71	42	49
13	South Cook HS 1b	39	46	86	57	85	51	48	53	96	51
14	South Cook HS 1c	22	28	42	39	62	50	29	33	56	42
15	South Cook HS 1d	17	22	30	30	40	37	22	26	37	32
16	Inner Kachemak Bay	1	1	1	4	-	3	1	2	-	3
17	Clam Gulch HS	2	40	-	5	-	1	31	28	-	4
18	Tuxedni HS	28	22	1	4	-	1	26	9	-	3
19	Kalgin Island HS	10	8	-	1	-	-	4	2	-	1
20	Redoubt Bay HS	4	2	-	-	-	-	1	1	-	-
23	Barren Isl. Pinn	4	5	7	9	7	14	5	7	7	11
24	Shelikof MM 2	8	11	15	16	18	20	11	14	18	18
25	Shelikof MM 3	4	6	7	8	8	9	6	7	8	8
26	Shelikof MM 4	2	2	3	4	4	4	2	3	4	4
27	Shelikof MM 5	1	1	2	2	2	2	1	1	2	2
28	Shelikof MM 6	1	1	1	1	1	2	1	1	1	1
29	Shelikof MM 7	-	-	1	-	1	1	-	-	1	1

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
30	Shelikof MM 8	-	1	1	1	1	1	1	1	1	1
31	Kodiak Pinniped 1	1	1	1	1	1	2	1	1	1	1
37	Port Chatham Pinniped	1	1	2	2	2	4	1	2	2	3
43	AK Peninsula Pinniped 1	-	-	1	1	1	1	-	1	1	1
45	Clam Gulch	2	12	-	5	-	1	19	34	-	4
46	Outer Kachemak Bay	7	16	7	45	2	42	12	35	4	33
47	SW Cook Inlet	70	53	44	33	13	20	63	40	24	29
48	Kamishak Bay	20	24	40	33	64	36	25	29	55	33
49	Katmai NP	4	5	8	7	9	10	5	6	9	8
50	Becharof NWR	-	-	-	-	-	1	-	-	-	-
57	Trinity Islands	-	-	-	-	-	-	-	-	1	-
59	Kodiak NWR-south	1	1	2	2	2	2	1	2	2	2
60	Kodiak NWR-west	2	3	4	4	4	5	3	4	4	4
64	Afognak-west	3	5	6	6	8	8	4	6	8	7
65	Afognak-north	-	-	-	-	-	1	-	-	-	1
67	Shuyak	2	3	4	5	5	6	3	4	5	5
68	Kenai Fjords-west	2	2	3	5	2	9	2	4	2	7
70	Forelands- Beluga CH	1	1	-	-	-	-	1	-	-	-
71	Middle Cook Inlet-Beluga CH	28	28	-	3	-	1	18	9	-	2
72	West Cook Inlet-Beluga CH	64	55	59	46	45	35	61	49	48	41
75	Kachemak- Humpback Whale	7	9	11	15	10	23	9	12	10	19
76	Shelikof- Humpback Whale	3	4	4	5	5	5	4	4	5	5
77	N Kodiak- Humpback Whale	3	4	6	6	7	8	4	5	7	6
78	E Kodiak- Humpback Whale	1	1	1	1	1	1	1	1	1	1
80	Shelikof MM 1	14	19	26	27	31	34	19	22	30	30
89	Shelikof MM 11	-	-	1	1	1	1	-	-	1	1
90	Barren Islands- Fin Whale	12	17	22	26	23	36	17	21	22	31
91	NE Kodiak- Fin Whale	1	1	2	2	2	3	1	2	2	3
94	Lower E Kenai- Gray Whale	1	2	2	4	1	5	2	2	2	4
95	NE Kodiak- Gray Whale	2	2	3	5	2	7	2	3	3	6
97	SE Kodiak- Gray Whale	-	-	1	1	1	1	-	-	1	1
98	Shelikof- Gray Whale	5	7	8	9	10	10	7	8	10	9
99	N Shumagin- Gray Whale	-	-	-	-	-	1	-	-	-	-
108	Shelikof- Killer Whale	6	8	11	12	13	14	8	10	12	12
109	E Kodiak- Killer Whale	1	1	1	1	1	2	1	1	1	1
137	Kamishak Bay STEI Habitat	9	11	19	16	29	18	11	14	25	16
139	Tuxedni Bay IBA	32	21	1	4	-	1	24	9	-	4
140	Redoubt Bay IBA	9	4	-	-	-	-	2	2	-	-
144	Clam Gulch STEI Habitat.	2	9	1	7	-	3	16	23	1	5
145	Outer Kachemak Bay/IBA	14	35	15	82	5	73	24	66	9	97
146	Lower Cook Inlet 153W59N IBA	24	32	54	55	57	68	31	43	64	56
151	Gulf of AK Shelf 151W58N IBA	-	-	1	1	1	1	-	1	1	1
153	Polly Creek Beach	88	64	6	15	-	4	83	32	1	13
154	Chinitna Bay	16	14	21	14	1	7	16	15	7	12
155	Barren Islands	4	5	7	9	7	13	5	6	7	10

Table A.2-45. 110 Days-(Winter ERA).

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
0	Land	98	97	97	96	97	96	98	96	97	96
3	SUA: Tyonek South	8	4	-	1	-	-	3	2	-	1
4	SUA: Seldovia, Port Graham, Nanwalek	5	7	7	18	3	25	6	11	5	21
5	SUA: Port Lions	7	9	12	12	14	16	9	11	13	14
6	SUA: Ouzinke	5	6	8	9	10	11	6	8	9	10
7	SUA: Larsen Bay	1	1	1	2	1	2	1	1	1	1
8	SUA: Karluk	1	2	2	2	2	2	1	2	2	2
9	SUA: Akhiok	-	-	1	1	1	1	-	-	1	1
11	Augustine	23	28	53	39	76	42	30	34	65	39

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
12	South Cook HS 1a	60	63	82	66	4	26	71	71	42	49
13	South Cook HS 1b	39	46	86	57	85	51	48	53	96	51
14	South Cook HS 1c	22	28	42	39	62	50	29	33	56	42
15	South Cook HS 1d	17	22	30	30	40	37	22	26	37	32
16	Inner Kachemak Bay	1	1	1	4	-	3	1	2	-	3
17	Clam Gulch HS	2	40	-	5	-	1	31	28	-	4
18	Tuxedni HS	28	22	1	4	-	1	26	9	-	3
19	Kalgin Island HS	10	8	-	1	-	-	4	2	-	1
20	Redoubt Bay HS	4	2	-	-	-	-	1	1	-	-
23	Barren Isl. Pinn	4	5	7	9	7	14	5	7	7	11
24	Shelikof MM 2	8	12	15	16	19	20	11	14	18	18
25	Shelikof MM 3	4	6	7	8	8	9	6	7	8	8
26	Shelikof MM 4	2	2	3	4	4	4	2	3	4	4
27	Shelikof MM 5	1	1	2	2	2	2	1	1	2	2
28	Shelikof MM 6	1	1	1	2	1	2	1	1	1	2
29	Shelikof MM 7	-	-	1	-	1	1	-	-	1	1
30	Shelikof MM 8	-	1	1	1	1	1	1	1	1	1
31	Kodiak Pinniped 1	1	1	1	1	1	2	1	1	1	1
37	Port Chatham Pinniped	1	1	2	2	2	4	1	2	2	3
43	AK Peninsula Pinniped 1	-	1	1	1	1	1	1	1	1	1
45	Clam Gulch	2	12	-	5	-	1	19	34	-	4
46	Outer Kachemak Bay	7	16	7	45	2	42	12	35	4	33
47	SW Cook Inlet	70	53	44	33	13	20	63	40	24	29
48	Kamishak Bay	20	24	40	33	64	37	25	29	55	33
49	Katmai NP	4	5	8	7	9	10	5	6	9	8
50	Becharof NWR	-	-	-	-	-	1	-	-	-	-
57	Trinity Islands	-	-	-	-	1	1	-	-	1	1
59	Kodiak NWR-south	1	1	2	2	2	2	1	2	2	2
60	Kodiak NWR-west	2	3	4	4	4	5	3	4	4	4
64	Afognak-west	3	5	6	6	8	8	4	6	8	7
65	Afognak-north	-	-	-	-	-	1	-	-	-	1
67	Shuyak	2	3	4	5	5	6	3	4	5	5
68	Kenai Fjords-west	2	2	3	5	2	9	2	4	2	7
70	Forelands- Beluga CH	1	1	-	-	-	-	1	-	-	-
71	Middle Cook Inlet-Beluga CH	28	28	-	3	-	1	18	9	-	2
72	West Cook Inlet-Beluga CH	64	55	59	46	45	35	61	49	48	41
75	Kachemak- Humpback Whale	7	9	11	15	10	23	9	12	10	19
76	Shelikof- Humpback Whale	3	4	4	5	5	5	4	4	5	5
77	N Kodiak- Humpback Whale	3	4	6	6	7	8	4	5	7	6
78	E Kodiak- Humpback Whale	1	1	1	1	1	1	1	1	1	1
80	Shelikof MM 1	14	19	26	27	31	34	19	22	30	30
89	Shelikof MM 11	-	-	1	1	1	1	-	1	1	1
90	Barren Islands- Fin Whale	12	17	22	26	23	36	17	21	22	31
91	NE Kodiak- Fin Whale	1	1	2	2	2	3	1	2	2	3
94	Lower E Kenai- Gray Whale	1	2	2	4	1	5	2	2	2	4
95	NE Kodiak- Gray Whale	2	2	3	5	2	7	2	3	3	6
97	SE Kodiak- Gray Whale	-	-	1	1	1	1	-	-	1	1
98	Shelikof- Gray Whale	5	7	8	9	10	10	7	8	10	9
99	N Shumagin- Gray Whale	-	-	-	-	-	1	-	-	-	-
108	Shelikof- Killer Whale	6	8	11	12	13	14	8	10	12	13
109	E Kodiak- Killer Whale	1	1	1	1	1	2	1	1	1	1
137	Kamishak Bay STEI Habitat	9	11	19	16	29	18	11	14	25	16
139	Tuxedni Bay IBA	32	21	1	4	-	1	24	9	-	4
140	Redoubt Bay IBA	9	4	-	-	-	-	2	2	-	-
144	Clam Gulch STEI Habitat.	2	9	1	7	-	3	16	23	1	5
145	Outer Kachemak Bay/IBA	14	35	15	82	5	73	24	66	9	97
146	Lower Cook Inlet 153W59N IBA	24	32	54	55	57	68	31	43	64	56
151	Gulf of AK Shelf 151W58N IBA	-	-	1	1	1	1	1	1	1	1

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Environmental Resource Area Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
153	Polly Creek Beach	88	64	6	15	-	4	83	32	1	13
154	Chinitna Bay	16	14	21	14	1	7	16	15	7	12
155	Barren Islands	4	5	7	9	7	13	5	6	7	10

Tables A.2-46 through A.2-50 represent winter conditional probabilities (expressed as percent chance) that a large oil spill starting at a particular location will contact a certain land segment within:

Table A.2-46. 1 Days-(Winter LS).

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
29	Augustine Island	-	-	-	-	6	-	-	-	5	-
30	Rocky Cove, Tignagvik Point	-	-	-	-	2	-	-	-	-	-
31	Iiamna Bay, Iniskin Bay, Ursus Cove	-	-	-	-	3	-	-	-	1	-
32	Chinitna Point, Dry Bay	-	-	5	-	3	-	-	-	4	-
33	Chinitna Bay	2	-	10	-	-	-	1	-	3	-
34	Iliamna Point	4	1	1	-	-	-	3	-	-	-
35	Chisik Island, Tuxedni Bay	12	3	-	-	-	-	5	-	-	-
36	Redoubt Point	8	1	-	-	-	-	1	-	-	-
37	Drift River, Drift River Terminal	1	-	-	-	-	-	-	-	-	-
38	Kalgin Islandd	1	2	-	-	-	-	-	-	-	-
55	Deep Creek, Ninilchik, Ninilchik River	-	-	-	-	-	-	1	-	-	-
56	Cape Starichkof, Happy Valley	-	1	-	1	-	-	-	4	-	-
61	Barabara Point, Seldovia Bay	-	-	-	-	-	1	-	-	-	-
62	Nanwalek, Port Graham	-	-	-	-	-	1	-	-	-	1

Table A.2-47. 3 Days-(Winter LS).

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
25	Spotted Glacier, Sukoi Bay	-	-	-	-	1	1	-	-	1	-
26	Douglas River	-	-	-	-	2	-	-	-	1	-
28	Amakdedulia Cove, Bruin Bay, Chenik Head	-	-	-	-	2	-	-	-	1	-
29	Augustine Island	1	-	6	2	14	3	1	1	12	2
30	Rocky Cove, Tignagvik Point	1	-	4	1	8	1	-	1	6	1
31	Iiamna Bay, Iniskin Bay, Ursus Cove	1	-	5	1	10	2	1	1	8	1
32	Chinitna Point, Dry Bay	2	2	10	4	7	4	2	3	8	3
33	Chinitna Bay	11	7	18	8	1	3	9	8	6	6
34	Iliamna Point	7	5	1	2	-	-	7	3	-	1
35	Chisik Island, Tuxedni Bay	19	11	-	1	-	-	12	3	-	1
36	Redoubt Point	13	5	-	-	-	-	3	1	-	-
37	Drift River, Drift River Terminal	3	1	-	-	-	-	1	-	-	-
38	Kalgin Islandd	1	2	-	-	-	-	-	-	-	-
40	Kustatan River,West Foreland	1	-	-	-	-	-	-	-	-	-
54	Clam Gulch, Kasilof	-	1	-	-	-	-	1	-	-	-
55	Deep Creek, Ninilchik, Ninilchik River	-	1	-	-	-	-	1	1	-	-
56	Cape Starichkof, Happy Valley	-	3	-	2	-	-	1	6	-	1
57	Anchor Point, Anchor River	-	-	-	1	-	-	-	1	-	1
61	Barabara Point, Seldovia Bay	-	-	-	3	-	2	-	1	-	2
62	Nanwalek, Port Graham	-	-	1	2	-	5	-	-	-	3
63	Elizabeth Island, Port Chatham, Koyuktolik Bay	-	-	-	-	-	1	-	-	-	-
79	Barren Islands, Ushagat Island	-	-	-	-	-	1	-	-	-	-

Table A.2-48. 10 Days-(Winter LS).

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
21	Kaflia, Kukak, Kuliak & Missak Bays	-	-	1	-	1	1	-	-	1	1
22	Devils Cove, Hallo Bay	-	-	1	1	1	1	-	1	1	1
23	Cape Chiniak, Swikshak Bay	-	-	1	1	1	1	-	-	1	1
24	Fourpeaked Glacier	1	1	2	1	2	2	1	1	2	1

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
25	Spotted Glacier, Sukoi Bay	2	2	4	3	5	5	3	3	5	4
26	Douglas River	2	2	4	3	5	4	2	2	5	3
27	Akumwarvik Bay , McNeil Cove, Nordyke Island	1	1	1	1	1	1	1	1	1	1
28	Amakdedulia Cove, Bruin Bay, Chenik Head	1	1	3	3	5	3	1	2	4	3
29	Augustine Island	4	5	9	7	16	7	5	6	14	7
30	Rocky Cove, Tignagvik Point	3	3	6	4	11	5	3	4	9	4
31	Iiamna Bay, Iniskin Bay, Ursus Cove	3	3	7	5	12	5	3	4	10	5
32	Chinitna Point, Dry Bay	4	5	12	7	8	7	5	6	10	7
33	Chinitna Bay	13	12	20	13	2	7	14	14	7	11
34	Iliamna Point	8	6	1	3	-	1	9	4	1	2
35	Chisik Island, Tuxedni Bay	20	13	-	2	-	1	14	5	-	2
36	Redoubt Point	13	7	-	1	-	-	5	3	-	1
37	Drift River, Drift River Terminal	3	2	-	-	-	-	1	1	-	-
38	Kalgin Islandd	1	3	-	-	-	-	1	-	-	-
39	Seal River, Big River	1	-	-	-	-	-	-	-	-	-
40	Kustatan River,West Foreland	1	-	-	-	-	-	-	-	-	-
54	Clam Gulch, Kasilof	-	1	-	-	-	-	1	1	-	-
55	Deep Creek, Ninilchik, Ninilchik River	-	1	-	-	-	-	2	1	-	-
56	Cape Starichkof, Happy Valley	1	3	-	2	-	1	2	6	-	2
57	Anchor Point, Anchor River	-	1	-	1	-	-	-	1	-	1
58	Homer, Homer Spit	-	-	-	1	-	-	-	-	-	-
60	China Poot Bay, Gull Island	-	-	-	1	-	1	-	-	-	1
61	Barabara Point, Seldovia Bay	1	1	1	4	-	3	1	2	-	4
62	Nanwalek, Port Graham	1	1	2	4	1	7	1	2	1	5
63	Elizabeth Island, Port Chatham, Koyuktolik Bay	-	-	1	1	-	2	-	1	-	1
79	Barren Islands, Ushagat Island	1	1	1	1	1	2	1	1	1	2
80	Amatuli Cove, East & West Amatuli Island	-	-	1	1	1	1	-	-	1	1
81	Shuyak Island	1	1	1	2	2	2	1	1	2	2
82	Bluefox Bay, Shuyak Island, Shuyak Strait	1	1	2	2	3	3	1	1	3	2
83	Foul Bay, Paramanof Bay	1	1	3	2	4	3	1	1	3	3
84	Malina Bay, Raspberry Island, Raspberry Strait	1	1	1	1	2	2	1	1	2	2
85	Kupreanof Strait, Viekoda Bay	-	-	1	1	1	1	-	-	1	1
86	Uganik Bay Uganik Strait, Cape Ugat	-	-	1	1	1	1	1	1	1	1
87	Cape Kuliuk, Spiridon Bay, Uyak Bay	-	-	-	-	1	1	-	-	1	-

Table A.2-49. 30 Days-(Winter LS).

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
21	Kaflia, Kukak, Kuliak & Missak Bays	-	1	1	1	1	1	1	1	1	1
22	Devils Cove, Hallo Bay	1	1	1	1	2	2	1	1	2	2
23	Cape Chiniak, Swikshak Bay	-	1	1	1	1	1	1	1	1	1
24	Fourpeaked Glacier	1	1	2	2	2	2	1	1	2	2
25	Spotted Glacier, Sukoi Bay	2	3	4	4	5	5	3	3	5	4
26	Douglas River	2	3	4	3	5	4	3	3	5	4
27	Akumwarvik Bay , McNeil Cove, Nordyke Island	1	1	1	1	2	1	1	1	1	1
28	Amakdedulia Cove, Bruin Bay, Chenik Head	2	2	3	3	6	4	2	2	5	3
29	Augustine Island	5	6	9	7	17	8	6	6	15	7
30	Rocky Cove, Tignagvik Point	3	4	7	5	11	5	4	4	9	4
31	Iiamna Bay, Iniskin Bay, Ursus Cove	3	4	7	5	12	6	4	5	10	5
32	Chinitna Point, Dry Bay	4	5	12	8	8	7	5	7	10	7
33	Chinitna Bay	13	12	20	13	2	7	14	14	7	11
34	Iliamna Point	8	6	1	3	-	1	9	5	1	2
35	Chisik Island, Tuxedni Bay	20	13	-	3	-	1	14	5	-	2
36	Redoubt Point	13	7	-	1	-	-	5	3	-	1
37	Drift River, Drift River Terminal	3	2	-	-	-	-	1	1	-	-
38	Kalgin Islandd	1	3	-	-	-	-	1	-	-	-
39	Seal River, Big River	1	-	-	-	-	-	-	-	-	-
40	Kustatan River,West Foreland	1	-	-	-	-	-	-	-	-	-

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
54	Clam Gulch, Kasilof	-	1	-	-	-	-	1	1	-	-
55	Deep Creek, Ninilchik, Ninilchik River	-	1	-	-	-	-	2	1	-	-
56	Cape Starichkof, Happy Valley	1	3	-	2	-	1	2	6	-	2
57	Anchor Point, Anchor River	-	1	-	1	-	-	-	1	-	1
58	Homer, Homer Spit	-	-	-	1	-	-	-	-	-	-
60	China Poot Bay, Gull Island	-	-	-	1	-	1	-	-	-	1
61	Barabara Point, Seldovia Bay	1	1	1	4	-	4	1	2	-	4
62	Nanwalek, Port Graham	1	1	2	4	1	7	1	2	1	5
63	Elizabeth Island, Port Chatham, Koyuktolik Bay	-	-	1	1	1	2	-	1	1	2
79	Barren Islands, Ushagat Island	1	1	1	2	2	3	1	1	1	2
80	Amatuli Cove, East & West Amatuli Island	-	1	1	1	1	1	1	1	1	1
81	Shuyak Island	1	1	2	2	2	3	1	2	2	2
82	Bluefox Bay, Shuyak Island, Shuyak Strait	1	2	3	3	3	3	2	2	3	3
83	Foul Bay, Paramanof Bay	2	3	3	3	4	4	2	3	4	4
84	Malina Bay, Raspberry Island, Raspberry Strait	1	1	2	2	2	2	2	2	2	2
85	Kupreanof Strait, Viekoda Bay	1	1	1	1	1	1	1	1	1	1
86	Uganik Bay Uganik Strait, Cape Ugat	1	1	1	2	2	2	1	2	2	2
87	Cape Kuliuk, Spiridon Bay, Uyak Bay	-	1	1	1	1	1	-	1	1	1
88	Karluk Lagoon, Northeast Harbor, Karluk	-	1	1	1	1	1	1	1	1	1

Table A.2-50. 110 Days-(Winter LS).

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
21	Kaflia, Kukak, Kuliak & Missak Bays	-	1	1	1	1	1	1	1	1	1
22	Devils Cove, Hallo Bay	1	1	1	1	2	2	1	1	2	2
23	Cape Chiniak, Swikshak Bay	-	1	1	1	1	1	1	1	1	1
24	Fourpeaked Glacier	1	1	2	2	2	2	1	1	2	2
25	Spotted Glacier, Sukoi Bay	2	3	4	4	5	5	3	3	5	4
26	Douglas River	2	3	4	3	5	4	3	3	5	4
27	Akumwarvik Bay , McNeil Cove, Nordyke Island	1	1	1	1	2	1	1	1	1	1
28	Amakdedulia Cove, Bruin Bay, Chenik Head	2	2	3	3	6	4	2	2	5	3
29	Augustine Island	5	6	9	7	17	8	6	6	15	7
30	Rocky Cove, Tignagvik Point	3	4	7	5	11	5	4	4	9	4
31	Iiamna Bay, Iniskin Bay, Ursus Cove	3	4	7	5	12	6	4	5	10	5
32	Chinitna Point, Dry Bay	4	5	12	8	8	7	5	7	10	7
33	Chinitna Bay	13	12	20	13	2	7	14	14	7	11
34	Iliamna Point	8	6	1	3	-	1	9	5	1	2
35	Chisik Island, Tuxedni Bay	20	13	-	3	-	1	14	5	-	2
36	Redoubt Point	13	7	-	1	-	-	5	3	-	1
37	Drift River, Drift River Terminal	3	2	-	-	-	-	1	1	-	-
38	Kalgin Islandd	1	3	-	-	-	-	1	-	-	-
39	Seal River, Big River	1	-	-	-	-	-	-	-	-	-
40	Kustatan River,West Foreland	1	-	-	-	-	-	-	-	-	-
54	Clam Gulch, Kasilof	-	1	-	-	-	-	1	1	-	-
55	Deep Creek, Ninilchik, Ninilchik River	-	1	-	-	-	-	2	1	-	-
56	Cape Starichkof, Happy Valley	1	3	-	2	-	1	2	6	-	2
57	Anchor Point, Anchor River	-	1	-	1	-	-	-	1	-	1
58	Homer, Homer Spit	-	-	-	1	-	-	-	-	-	-
60	China Poot Bay, Gull Island	-	-	-	1	-	1	-	-	-	1
61	Barabara Point, Seldovia Bay	1	1	1	4	-	4	1	2	-	4
62	Nanwalek, Port Graham	1	1	2	4	1	7	1	2	1	5
63	Elizabeth Island, Port Chatham, Koyuktolik Bay	-	-	1	1	1	2	-	1	1	2
79	Barren Islands, Ushagat Island	1	1	1	2	2	3	1	1	1	2
80	Amatuli Cove, East & West Amatuli Island	-	1	1	1	1	1	1	1	1	1
81	Shuyak Island	1	1	2	2	2	3	1	2	2	2
82	Bluefox Bay, Shuyak Island, Shuyak Strait	1	2	3	3	3	3	2	2	3	3
83	Foul Bay, Paramanof Bay	2	3	3	3	4	4	2	3	4	4
84	Malina Bay, Raspberry Island, Raspberry Strait	1	1	2	2	2	2	2	2	2	2

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Land Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
85	Kupreanof Strait, Viekoda Bay	1	1	1	1	1	1	1	1	1	1
86	Uganik Bay Uganik Strait, Cape Ugat	1	1	1	2	2	2	1	2	2	2
87	Cape Kuliuk, Spiridon Bay, Uyak Bay	-	1	1	1	1	1	-	1	1	1
88	Karluk Lagoon, Northeast Harbor, Karluk	-	1	1	1	1	1	1	1	1	1

Tables A.2-51 through A.2-55 represent winter conditional probabilities (expressed as percent chance) that a large oil spill starting at a particular location will contact a certain group of land segments within:

Table A.2-51. 1 Days-(Winter GLS).

ID	Grouped Land Segments Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
127	AMNWR W Cook Inlet	23	4	16	-	13	-	6	-	12	-
128	Lake Clark National Park and Preserve	27	5	11	-	-	-	9	-	3	-
135	Kenai AK State Rec Mgmt Areas	-	2	-	1	-	1	2	4	-	1
136	West Kenai Brown Bears	-	-	-	-	-	-	-	1	-	-
137	West Kenai Moose	-	-	-	-	-	-	1	-	-	-
138	Clam Gulch Critical Habitat	-	1	-	1	-	-	2	4	-	-
141	Seldovia side Kachemak Bay	-	-	-	-	-	2	-	-	-	1
142	AMNWR E Cook Inlet	-	-	-	-	-	2	-	-	-	1

Table A.2-52. 3 Days-(Winter GLS).

ID	Grouped Land Segments Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
123	Katmai National Park	-	-	1	-	3	1	-	-	3	-
126	McNeil River State Game Sanctuary and Refuge	-	-	-	-	2	-	-	-	1	-
127	AMNWR W Cook Inlet	46	26	39	17	34	12	28	18	35	14
128	Lake Clark National Park and Preserve	49	28	19	11	1	3	32	16	7	9
129	Redoubt Bay Brown Bears	1	1	-	-	-	-	-	-	-	-
130	Redoubt Bay Critical Habitat Area	1	-	-	-	-	-	-	-	-	-
135	Kenai AK State Rec Mgmt Areas	1	5	-	6	-	4	4	9	-	5
136	West Kenai Brown Bears	-	1	-	1	-	-	1	2	-	1
137	West Kenai Moose	-	2	-	-	-	-	2	1	-	-
138	Clam Gulch Critical Habitat	-	4	-	2	-	-	4	7	-	1
140	West Kenai Black Bears	-	-	-	1	-	2	-	-	-	1
141	Seldovia side Kachemak Bay	-	-	1	5	-	8	-	1	1	6
142	AMNWR E Cook Inlet	-	-	1	5	-	8	-	1	1	6
143	AMNWR W Outer Kenai/GOA	-	-	-	-	-	1	-	-	-	-
152	Barren Islands	-	-	-	-	-	1	-	-	-	1

Table A.2-53. 10 Days-(Winter GLS).

ID	Grouped Land Segments Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
123	Katmai National Park	6	7	13	11	18	14	7	8	16	11
124	Kukak Bay	1	1	2	1	2	2	1	1	2	2
125	Spring Bear Concentration-1	-	-	-	-	1	-	-	-	1	-
126	McNeil River State Game Sanctuary and Refuge	2	2	4	3	7	4	2	3	5	4
127	AMNWR W Cook Inlet	59	47	52	39	44	31	48	41	47	36
128	Lake Clark National Park and Preserve	54	38	21	19	2	8	41	26	8	16
129	Redoubt Bay Brown Bears	1	1	-	-	-	-	-	-	-	-
130	Redoubt Bay Critical Habitat Area	1	1	-	-	-	-	-	-	-	-
131	Trading Bay Moose	1	-	-	-	-	-	-	-	-	-
135	Kenai AK State Rec Mgmt Areas	2	8	1	9	-	6	7	12	1	8
136	West Kenai Brown Bears	-	1	-	1	-	-	1	2	-	1
137	West Kenai Moose	-	2	-	1	-	-	3	2	-	-
138	Clam Gulch Critical Habitat	1	5	-	3	-	1	5	8	-	2
139	Kachemak Bay State Park and Wilderness Park	-	-	-	1	-	1	-	-	-	1
140	West Kenai Black Bears	-	-	1	2	-	3	-	1	-	2
141	Seldovia side Kachemak Bay	2	3	3	9	1	11	2	4	2	10

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Grouped Land Segments Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
142	AMNWR E Cook Inlet	2	3	3	9	1	11	2	4	2	10
143	AMNWR W Outer Kenai/GOA	-	-	1	1	-	2	-	1	1	1
152	Barren Islands	1	1	2	2	2	4	1	1	2	3
153	Shuyak Island State Park	2	2	4	3	5	5	2	2	4	4
154	AMNWR Afognak and Shuyak Islands	4	4	8	7	11	11	4	5	10	8
155	Afognak & Raspberry Winter Elk	2	2	5	5	7	7	3	3	6	6
156	Kodiak National Wildlife Refuge	5	5	10	9	14	13	5	6	13	11
157	Afognak Blacktail Deer	2	2	4	4	6	6	2	2	5	4
158	AMNWR W Kodiak/Shelikof	1	1	2	2	3	3	1	2	3	2
159	Kupreanof Strait	-	-	1	1	1	1	-	-	1	1

Table A.2-54. 30 Days-(Winter GLS).

ID	Grouped Land Segments Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
114	AMNWR SW Shelikof/GOA	-	-	-	-	-	1	-	-	-	1
122	Becharof National Wildlife Refuge	-	-	-	-	-	1	-	-	-	-
123	Katmai National Park	8	10	15	14	20	18	11	12	18	15
124	Kukak Bay	1	1	2	2	3	3	2	2	3	3
125	Spring Bear Concentration-1	-	-	1	-	1	1	-	-	1	-
126	McNeil River State Game Sanctuary and Refuge	2	3	4	4	7	5	3	3	6	4
127	AMNWR W Cook Inlet	60	49	53	41	45	33	50	43	48	38
128	Lake Clark National Park and Preserve	54	38	22	19	2	9	42	27	8	16
129	Redoubt Bay Brown Bears	1	1	-	-	-	-	-	-	-	-
130	Redoubt Bay Critical Habitat Area	1	1	-	-	-	-	-	-	-	-
131	Trading Bay Moose	1	-	-	-	-	-	-	-	-	-
135	Kenai AK State Rec Mgmt Areas	2	8	2	10	1	6	7	12	1	8
136	West Kenai Brown Bears	-	1	-	1	-	-	1	2	-	1
137	West Kenai Moose	-	2	-	1	-	-	3	2	-	1
138	Clam Gulch Critical Habitat	1	6	-	3	-	1	5	8	-	2
139	Kachemak Bay State Park and Wilderness Park	-	-	-	1	-	1	-	-	-	1
140	West Kenai Black Bears	-	-	1	2	-	3	-	1	-	2
141	Seldovia side Kachemak Bay	2	3	3	9	1	11	3	5	2	10
142	AMNWR E Cook Inlet	2	3	3	9	1	11	3	5	2	10
143	AMNWR W Outer Kenai/GOA	-	-	1	1	1	2	-	1	1	2
152	Barren Islands	1	2	2	3	2	4	2	2	2	3
153	Shuyak Island State Park	3	3	4	5	6	6	3	4	5	5
154	AMNWR Afognak and Shuyak Islands	6	7	10	11	12	14	8	9	12	12
155	Afognak & Raspberry Winter Elk	4	5	6	7	8	10	5	6	8	8
156	Kodiak National Wildlife Refuge	9	11	15	15	17	19	11	13	17	17
157	Afognak Blacktail Deer	3	4	5	6	6	8	4	5	6	6
158	AMNWR W Kodiak/Shelikof	2	3	4	5	4	5	3	4	4	5
159	Kupreanof Strait	1	1	1	1	1	1	1	1	1	1
160	Kodiak Blacktail Deer	-	-	-	-	1	-	-	-	1	-
161	AMNWR E Kodiak/GOA	-	-	1	-	1	1	-	-	1	1
164	Afognak Island State Park	-	-	-	1	-	1	-	-	-	1

Table A.2-55. 110 Days-(Winter GLS).

ID	Grouped Land Segments Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
114	AMNWR SW Shelikof/GOA	-	-	-	1	-	1	-	-	-	1
122	Becharof National Wildlife Refuge	-	-	-	-	-	1	-	-	-	-
123	Katmai National Park	8	10	15	14	20	18	11	12	18	15
124	Kukak Bay	1	1	2	2	3	3	2	2	3	3
125	Spring Bear Concentration-1	-	-	1	-	1	1	-	-	1	-
126	McNeil River State Game Sanctuary and Refuge	2	3	4	4	7	5	3	3	6	4
127	AMNWR W Cook Inlet	60	49	53	41	45	33	50	43	48	38
128	Lake Clark National Park and Preserve	54	38	22	19	2	9	42	27	8	16
129	Redoubt Bay Brown Bears	1	1	-	-	-	-	-	-	-	-

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ID	Grouped Land Segments Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
130	Redoubt Bay Critical Habitat Area	1	1	-	-	-	-	-	-	-	-
131	Trading Bay Moose	1	-	-	-	-	-	-	-	-	-
135	Kenai AK State Rec Mgmt Areas	2	8	2	10	1	6	7	12	1	8
136	West Kenai Brown Bears	-	1	-	1	-	-	1	2	-	1
137	West Kenai Moose	-	2	-	1	-	-	3	2	-	1
138	Clam Gulch Critical Habitat	1	6	-	3	-	1	5	8	-	2
139	Kachemak Bay State Park and Wilderness Park	-	-	-	1	-	1	-	-	-	1
140	West Kenai Black Bears	-	-	1	2	-	3	-	1	-	2
141	Seldovia side Kachemak Bay	2	3	3	9	1	11	3	5	2	10
142	AMNWR E Cook Inlet	2	3	3	9	1	11	3	5	2	10
143	AMNWR W Outer Kenai/GOA	-	-	1	1	1	2	-	1	1	2
152	Barren Islands	1	2	2	3	2	4	2	2	2	3
153	Shuyak Island State Park	3	3	4	5	6	6	3	4	5	5
154	AMNWR Afognak and Shuyak Islands	6	7	10	11	12	14	8	9	12	12
155	Afognak & Raspberry Winter Elk	4	5	6	7	8	10	5	6	8	8
156	Kodiak National Wildlife Refuge	9	11	15	16	17	20	11	14	17	17
157	Afognak Blacktail Deer	3	4	5	6	6	8	4	5	6	6
158	AMNWR W Kodiak/Shelikof	2	3	4	5	4	5	3	4	4	5
159	Kupreanof Strait	1	1	1	1	1	1	1	1	1	1
160	Kodiak Blacktail Deer	-	-	-	-	1	-	-	-	1	-
161	AMNWR E Kodiak/GOA	-	-	1	1	1	1	-	-	1	1
164	Afognak Island State Park	-	-	-	1	-	1	-	-	-	1

Tables A.2-56 through A.2-60 represent winter conditional probabilities (expressed as percent chance) that a large oil spill starting at a particular location will contact a certain boundary segment within:

Table A.2-56. 1 Days-(Winter BS).

ID	Boundary Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4

Note: All rows have all values less than 0.5% and are not shown.

Table A.2-57. 3 Days-(Winter BS).

ID	Boundary Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4

Note: All rows have all values less than 0.5% and are not shown.

Table A.2-58. 10 Days-(Winter BS).

ID	Boundary Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4

Note: All rows have all values less than 0.5% and are not shown.

Table A.2-59. 30 Days-(Winter BS).

ID	Boundary Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4

Note: All rows have all values less than 0.5% and are not shown.

Table A.2-60. 110 Days-(Winter BS).

ID	Boundary Segment Name	LA 1	LA 2	LA 3	LA 4	LA 5	LA 6	PL 1	PL 2	PL 3	PL 4
4	Gulf of Alaska	-	-	1	-	-	1	-	-	-	-

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

Tables A.2-61 through A.2-64 represent combined probabilities (expressed as percent chance), over the assumed life of the Sale 244 Action Area, Alternatives 1, 3a, 3b, 4a, 4b, 5, or 6, of one or more spills ≥1,000 bbl, and the estimated number of spills (mean), occurring and contacting a certain:

Table A.2-61. Environmental Resource Area.

ERA ID	Environmental Resource Area Name	1 day		3 days		10 days		30 days	
		%	mean	%	mean	%	mean	%	mean
0	Land	2	0.02	9	0.09	18	0.19	21	0.23
3	SUA:Tyonek South	1	0.01	1	0.01	2	0.02	2	0.02
4	SUA: Seldovia, Port Graham, Nanwalek	-	0.00	1	0.01	2	0.02	3	0.03
5	SUA: Port Lions	-	0.00	-	0.00	1	0.01	2	0.02
6	SUA: Ouzinke	-	0.00	-	0.00	1	0.01	1	0.01
11	Augustine	1	0.01	4	0.04	7	0.08	8	0.08
12	South Cook HS 1a	9	0.09	13	0.14	14	0.16	14	0.16
13	South Cook HS 1b	4	0.04	9	0.10	12	0.13	12	0.13
14	South Cook HS 1c	1	0.01	3	0.03	7	0.08	8	0.08
15	South Cook HS 1d	-	0.00	1	0.01	5	0.05	5	0.06
16	Inner Kachemak Bay	-	0.00	-	0.00	-	0.00	1	0.01
17	Clam Gulch HS	5	0.05	6	0.06	6	0.06	6	0.06
18	Tuxedni HS	3	0.03	4	0.04	5	0.05	5	0.05
19	Kalgin Island HS	2	0.02	2	0.02	3	0.03	3	0.03
20	Redoubt Bay HS	-	0.00	1	0.01	1	0.01	1	0.01
23	Barren Isl. Pinniped	-	0.00	-	0.00	1	0.02	2	0.02
24	Shelikof MM 2	-	0.00	-	0.00	2	0.02	3	0.03
25	Shelikof MM 3	-	0.00	-	0.00	1	0.01	1	0.01
26	Shelikof MM 4	-	0.00	-	0.00	-	0.00	1	0.01
37	Port Chatham Pinniped	-	0.00	-	0.00	-	0.00	1	0.01
45	Clam Gulch	1	0.01	2	0.02	3	0.03	3	0.03
46	Outer Kachemak Bay	3	0.03	4	0.04	5	0.06	6	0.06
47	SW Cook Inlet	4	0.04	8	0.09	11	0.11	11	0.11
48	Kamishak Bay	-	0.00	2	0.02	6	0.06	6	0.07
49	Katmai NP	-	0.00	-	0.00	1	0.01	2	0.02
60	Kodiak NWR-west	-	0.00	-	0.00	-	0.00	1	0.01
64	Afognak-west	-	0.00	-	0.00	1	0.01	1	0.01
67	Shuyak	-	0.00	-	0.00	1	0.01	1	0.01
68	Kenai Fjords-west	-	0.00	-	0.00	1	0.01	1	0.01
71	Middle Cook Inlet-Beluga CH	4	0.04	5	0.05	5	0.06	5	0.06
72	West Cook Inlet-Beluga CH	3	0.03	7	0.08	11	0.12	12	0.13
75	Kachemak- Humpback Whale	-	0.00	1	0.01	3	0.03	3	0.03
76	Shelikof- Humpback Whale	-	0.00	-	0.00	-	0.00	1	0.01
77	N Kodiak- Humpback Whale	-	0.00	-	0.00	1	0.01	1	0.01
80	Shelikof MM 1	-	0.00	-	0.00	4	0.04	5	0.05
81	Shelikof MM 1a	-	0.00	-	0.00	1	0.01	1	0.01
82	Shelikof MM 2a	-	0.00	0	0.00	-	0.00	1	0.01
90	Barren Islands- Fin Whale	-	0.00	1	0.01	4	0.04	4	0.05
94	Lower E Kenai- Gray Whale	-	0.00	-	0.00	1	0.01	1	0.01
95	NE Kodiak- Gray Whale	-	0.00	-	0.00	1	0.01	1	0.01
98	Shelikof- Gray Whale	-	0.00	-	0.00	1	0.01	2	0.02
102	Cook Inlet 2- Harbor Porpoise	2	0.02	2	0.02	2	0.02	2	0.02
103	Cook Inlet 3- Harbor Porpoise	3	0.03	4	0.04	4	0.05	5	0.05
104	Cook Inlet 4- Harbor Porpoise	1	0.01	4	0.04	5	0.05	5	0.05
105	Cook Inlet 5- Harbor Porpoise	-	0.00	2	0.02	3	0.04	4	0.04
108	Shelikof- Killer Whale	-	0.00	-	0.00	1	0.01	2	0.02
136	Kamishak Bay IBA	-	0.00	1	0.01	2	0.02	2	0.02
137	Kamishak Bay STEI Habitat	-	0.00	-	0.00	2	0.02	2	0.02
138	Tuxedni Is Colony IBA	1	0.01	1	0.01	2	0.02	2	0.02

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

ERA ID	Environmental Resource Area Name	1 day		3 days		10 days		30 days	
		%	mean	%	mean	%	mean	%	mean
139	Tuxedni Bay IBA	1	0.01	3	0.03	3	0.03	3	0.03
140	Redoubt Bay IBA	-	0.00	1	0.01	1	0.01	1	0.01
144	Clam Gulch STEI Habitat.	-	0.00	1	0.01	1	0.01	1	0.01
145	Outer Kachemak Bay/IBA	7	0.07	9	0.09	10	0.10	10	0.10
146	Lower Cook Inlet 153W59N IBA	2	0.02	4	0.04	5	0.05	5	0.05
147	Barren Islands Marine IBA	-	0.00	-	0.00	1	0.01	1	0.01
148	Barren Islands Colonies IBA	-	0.00	-	0.00	-	0.00	1	0.01
153	Polly Creek Beach	8	0.09	11	0.11	12	0.12	12	0.12
154	Chinitna Bay	1	0.01	2	0.02	3	0.03	4	0.04
155	Barren Islands	-0	0.00	-	0.00	1	0.01	2	0.02

Table A.2-62. Land Segment.

LS ID	Land Segment Name	1 days		3 days		10 days		30 days	
		%	mean	%	mean	%	mean	%	mean
25	Spotted Glacier, Sukoi Bay	-	0.00	-	0.00	-	0.00	1	0.01
26	Douglas River	-	0.00	-	0.00	-	0.00	1	0.01
28	Amakdedulia Cove, Bruin Bay, Chenik Head	-	0.00	-	0.00	-	0.00	1	0.01
29	Augustine Island	-	0.00	-	0.00	1	0.01	1	0.01
30	Rocky Cove, Tignagvik Point	-	0.00	-	0.00	1	0.01	1	0.01
31	liamna Bay, Iniskin Bay, Ursus Cove	-	0.00	-	0.00	1	0.01	1	0.01
32	Chinitna Point, Dry Bay	-	0.00	1	0.01	1	0.01	2	0.02
33	Chinitna Bay	-	0.00	2	0.02	3	0.03	3	0.03
34	Iliamna Point	-	0.00	1	0.01	1	0.01	1	0.01
35	Chisik Island, Tuxedni Bay	1	0.01	2	0.02	2	0.02	2	0.02
36	Redoubt Point	-	0.00	1	0.01	1	0.01	1	0.01
56	Cape Starichkof, Happy Valley	-	0.00	-	0.00	1	0.01	1	0.01
62	Nanwalek, Port Graham	-	0.00	-	0.00	1	0.01	1	0.01
83	Foul Bay, Paramanof Bay	0	0.00	-	0.00	-	0.00	1	0.01

Table A.2-63. Grouped Land Segment.

GLS ID	Grouped Land Segment Name	1 days		3 days		10 days		30 days	
		%	mean	%	mean	%	mean	%	mean
123	Katmai National Park	-	0.00	-	0.00	2	0.02	2	0.02
126	McNeil River State Game Sanctuary and Refuge	-	0.00	-	0.00	1	0.01	1	0.01
127	AMNWR W Cook Inlet	1	0.01	6	0.06	10	0.11	11	0.11
128	Lake Clark National Park and Preserve	1	0.02	5	0.05	7	0.07	7	0.07
129	Redoubt Bay Brown Bears	-	0.00	-	0.00	1	0.01	1	0.01
135	Kenai AK State Rec Mgmt Areas	-	0.00	1	0.01	2	0.02	2	0.02
136	West Kenai Brown Bears	-	0.00	1	0.01	1	0.01	1	0.01
138	Clam Gulch Critical Habitat	-	0.00	1	0.01	1	0.01	1	0.01
140	West Kenai Black Bears	-	0.00	-	0.00	1	0.01	1	0.01
141	Seldovia side Kachemak Bay	-	0.00	-	0.00	1	0.01	1	0.01
142	AMNWR E Cook Inlet	-	0.00	-	0.00	1	0.01	1	0.01
152	Barren Islands	-	0.00	-	0.00	-	0.00	1	0.01
153	Shuyak Island State Park	-	0.00	-	0.00	-	0.00	1	0.01
154	AMNWR Afognak and Shuyak Islands	-	0.00	-	0.00	1	0.01	2	0.02
155	Afognak & Raspberry Winter Elk	-	0.00	-	0.00	-	0.00	1	0.01
156	Kodiak National Wildlife Refuge	-	0.00	-	0.00	1	0.01	2	0.02
157	Afognak Blacktail Deer	-	0.00	-	0.00	-	0.00	1	0.01
158	AMNWR W Kodiak/Shelikof	-	0.00	-	0.00	-	0.00	1	0.01

Table A.2-64. Boundary Segment.

BS ID	Boundary Segment Name	1 days		3 days		10 days		30 days	
		%	mean	%	mean	%	mean	%	mean

Note: All rows have all values less than 0.5% and are not shown.

Note: For all tables in Section A.2, OSRA Conditional and Combined Probability Tables: ** = Greater than 99.5 percent; - = less than 0.5 percent; LA = Launch Area, PL = Pipeline. Rows with all values less than 0.5 percent are not shown.

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APPENDIX B

Very Large Oil Spill (VLOS) Estimate for an Exploration Well in the (Federal) Cook Inlet Planning Area, Alaska

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Appendix B. Very Large Oil Spill (VLOS) Estimate for an Exploration Well in the (Federal) Cook Inlet Planning Area, Alaska

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Appendix B. Very Large Oil Spill (VLOS) Estimate for an Exploration Well in the (Federal) Cook Inlet Planning Area, Alaska

B-1. Blowout Event and Oil Spill Modeled for Cook Inlet (Federal Waters)

The hypothetical Cook Inlet very-large-oil-spill (VLOS) well as modeled by BOEM initiates at a "worst-case" rate of 2,135 stock-tank barrels of oil per day (stbbls/d) on day one of the event. The oil discharge rate declines to 1,525 stbbls/d with a cumulative discharge of 48,898 stbbls by day 30. The maximum estimated time required to complete a relief well at the VLOS site is 80 days (BOEM, 2012). By day 80 of the discharge event the daily oil discharge has declined to 1,382 stbbls/d with a cumulative oil discharge of 121,467 stbbls.

B-2. Siting of Hypothetical Incident ("Blowout") Cook Inlet VLOS Well

A candidate well site in Federal waters on the flank of a known oil pool (Cosmopolitan field) was adopted as the site for a hypothetical uncontrolled discharge of oil directly into the Cook Inlet marine environment from an exploration well. Although this discharge event is entirely hypothetical and very unlikely to occur in the course of drilling a well at this location, the modeled discharge provides a realistic basis for evaluating the environmental impacts of an oil discharge.

As a known oil pool with several well penetrations but little production beyond extensive flow-testing (47,902 stbbls[1]), the Cosmopolitan field is the most credible candidate proxy for a model for an uncontrolled discharge into the Federal waters of southern Cook Inlet. Oil flow rates from various wells at Cosmopolitan field have ranged from 110 to 1,000 stbbls/d.[2] No wells to date have tested the Cosmopolitan oil pool on the west flank where it may extend into Federal waters (Federal waters lie >3.5 st. mi.[3] from shore). BlueCrest Energy has proposed to develop the Cosmopolitan oil resources with 33 extended-reach wells from an onshore pad ~3.3 st. mi. east of the field midpoint, with initial field production of 5,000 stbbls/d and rising to 17,000 stbbls/d within 5 years (Lidji, 2015b). In 2005, Pioneer (Natural Resources Alaska) forecast a recoverable resource potential of 30 to 100 million barrels (MMstbbls) of oil for the Cosmopolitan field (Lidji, 2014).

B-3. Results of Exploratory Drilling in Federal OCS Waters of Cook Inlet, 1977-1985

In the southern part of Cook Inlet, the Tertiary-age rocks that host the commercial fields in northern Cook Inlet and at Cosmopolitan field are very thin or absent except in the northern part of the Cook Inlet (Federal) planning area. The locations of oil and gas fields, the Cook Inlet (Federal) planning area, and the southern extent of Tertiary-age rocks in the Cook Inlet geologic basin are shown in Figure B-1. The wells drilled in the Federal waters of southern Cook Inlet mostly targeted prospects involving Cretaceous through Jurassic ages, as enumerated in the stratigraphic column of Figure B-2.

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[1] *Flow tests of the Cosmopolitan field Starichkof pay zone in the discovery well in 1967 produced 20°API oil at an aggregate rate of 110 stbbls/d (well data for Starichkof State No. 1 well). A total of 14,851 stbbls was produced at rates up to 1,000 stbbls/d in a deviated well by ConocoPhillips in 2003 (Bailey, 2014). In 2007 Pioneer produced 33,000 stbbls of oil at rates of approximately 300 stbbls/d from a horizontal sidetrack that undulated through the pay zone (Bailey, 2014). All of this produced oil was trucked to the Tesoro refinery at Nikiski and the new BlueCrest plan for field development also calls for trucking the oil to Nikiski (Lidji, 2015a).*

[2] *stbbls/d: stock-tank or surface barrels (gas-free at 60°F and 1 atmosphere or 14.73 psia).*

[3] *st. mi.: statute miles; 1 nautical mile (n. mi.) = 1.15078 st. mi.*

None of the 14 wells[4] drilled elsewhere on the Federal waters of Cook Inlet from 1977 to 1985 encountered significant quantities of oil or gas (BOEM, 2006, page 2 and fig. 4). The general observation obtained by the exploration drilling was that the Jurassic-Cretaceous-age target reservoirs offer scant porosity owing to extensive chemical cements that plugged pores prior to invasion by oil. For this reason, the rocks generally offer little storage space for petroleum, and even in the case of oil-bearing rocks, lack the ability to flow oil to a wellbore at any significant rate. Two exploration wells encountered oil in Upper Cretaceous sandstones (age: 66-99 million years ago) and in flow tests recovered oil at estimated rates of several barrels per day to 68 barrels per day.[5]

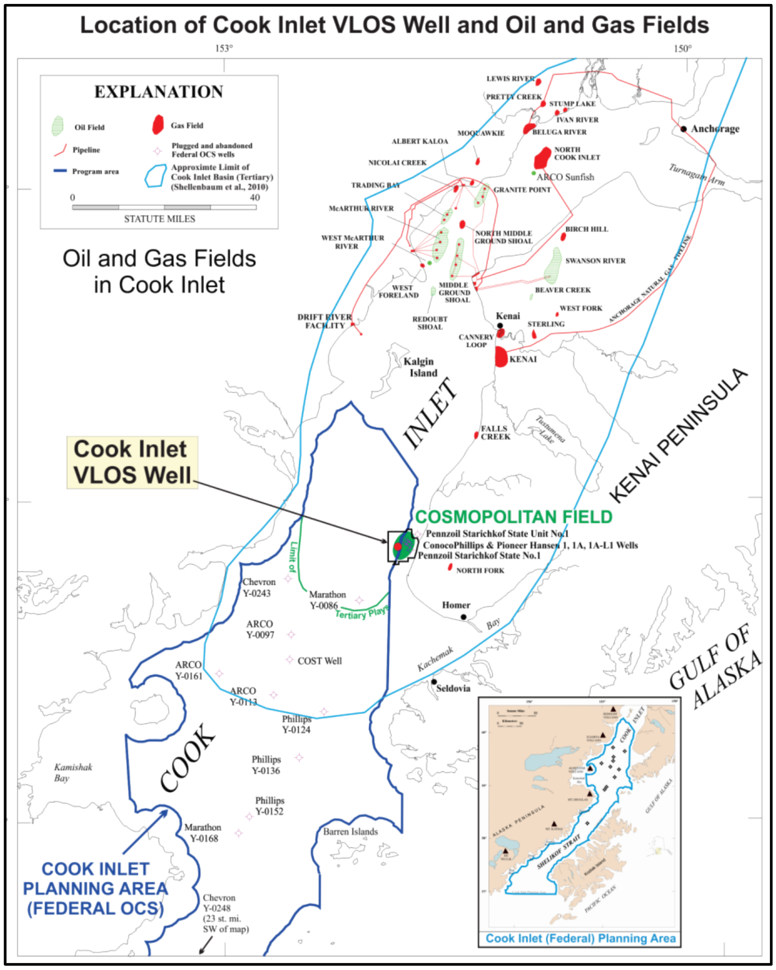

Figure B-1. Location of Cook Inlet VLOS well at Cosmopolitan field. *Figure includes commercial oil and gas fields in northern Cook Inlet geological basin, outline of northern part of Cook Inlet*

[4] *Thirteen wells were drilled on leases over identified oil/gas prospects. Of the 13 explorations wells, 3 wells were sidetracks or re-drills, for a total of 10 actual prospects tested. The first well, drilled in 1977, was a "continental offshore stratigraphic test" or "COST" well drilled by an industry consortium to obtain geological data.*

[5] *The Y-0097 "Raven" well recovered 28.5°API oil at perhaps several barrels per day (oil flowing into lower part of test tubing that was then sampled by a wireline device) from Upper Cretaceous sandstones at the top of the Kaguyak Formation. The Y-0086 "Guppy" well recovered 30.1°API oil at an estimated rate of 68 barrels per day (15 barrels of black oil recovered in 5.3 hours of flow) from Upper Cretaceous sandstones at the base of the Kaguyak Formation, shown in the stratigraphic column in Figure B-2.*

(Federal) planning area, and ten exploration wells plus a stratigraphic data well ("COST" well) drilled in the period from 1977-1985.

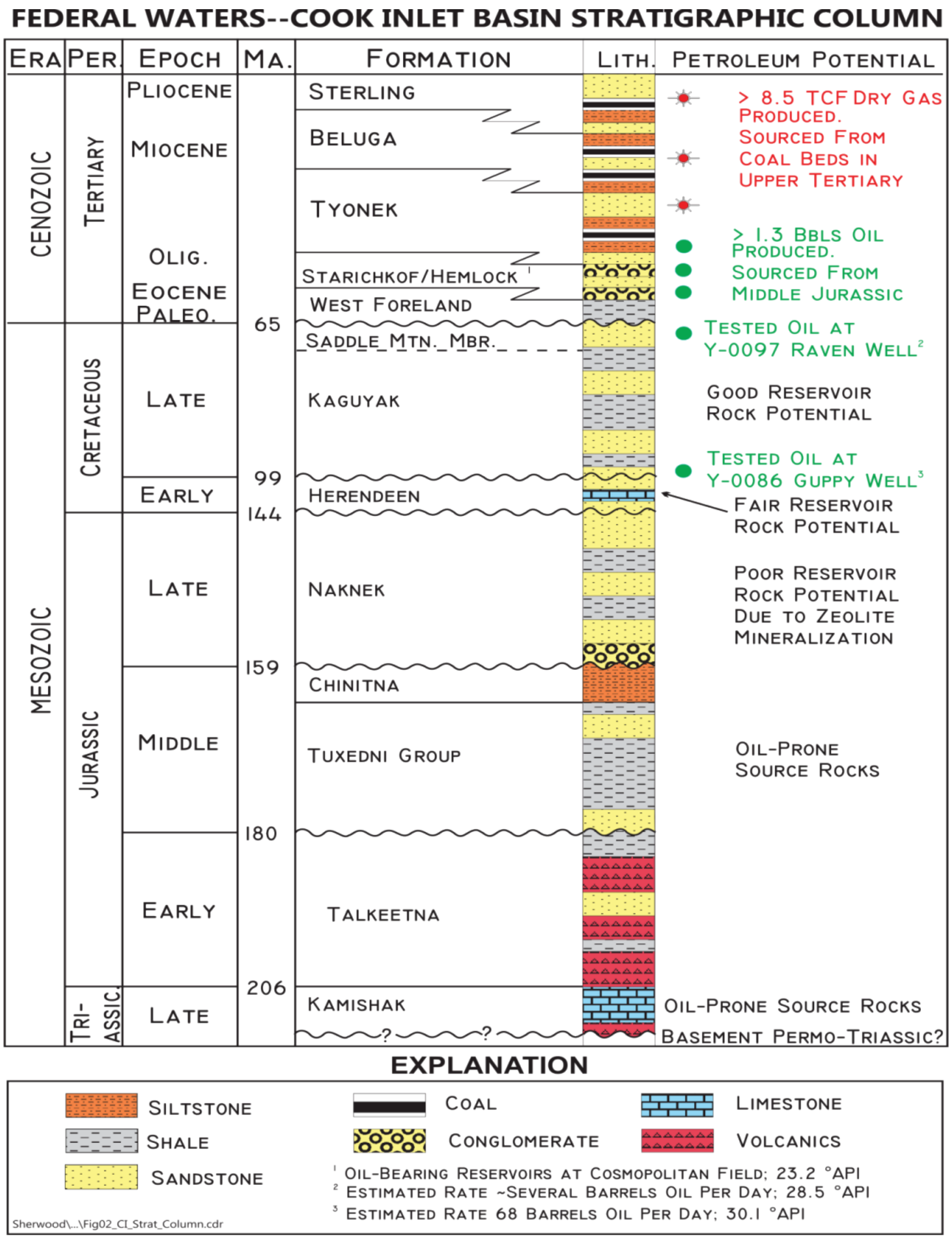

Figure B-2. Stratigraphic column for Cook Inlet geologic basin. *Adapted from BOEM, 2006, Figure 5, p.15.*

The Cook Inlet VLOS well was located to maximize key geological characteristics that drive high flow rates—principally a thick reservoir in this case—and then modeled for potential discharge volumes in a blowout event. Only an oil column is forecast to be penetrated by the VLOS well and no gas- or water-saturated reservoirs participate in the flow and act to limit the oil discharge. The improbability of a discharge event of the modeled magnitude is not considered in the analysis.

The hypothetical oil discharge is assumed to originate from an exploration well on the west flank of the Cosmopolitan field that straddles Federal and State waters in the Cook Inlet, as shown in Figure B-1. Seismic mapping indicates that most of the Cosmopolitan oil pool is located beneath State of

Alaska waters. Seismic mapping also shows that at least part of the oil pool—specifically the "Starichkof" conglomerate and sandstones in the upper part of the oil pool—may extend west into Federal OCS waters. At the 1967 Pennzoil Starichkof State 1 discovery well, oil was tested from sandstones and conglomerates in the interval 6,754-6,928 ft bkb. The oil-bearing sandstones are informally termed the "Starichkof sands" and are illustrated in the log profile shown in Figure B-3. A deeper reservoir unit—the Hemlock conglomerate—is water-bearing at the discovery well but is elsewhere oil bearing. Oil-bearing Hemlock sandstones may extend west into Federal OCS waters as well.

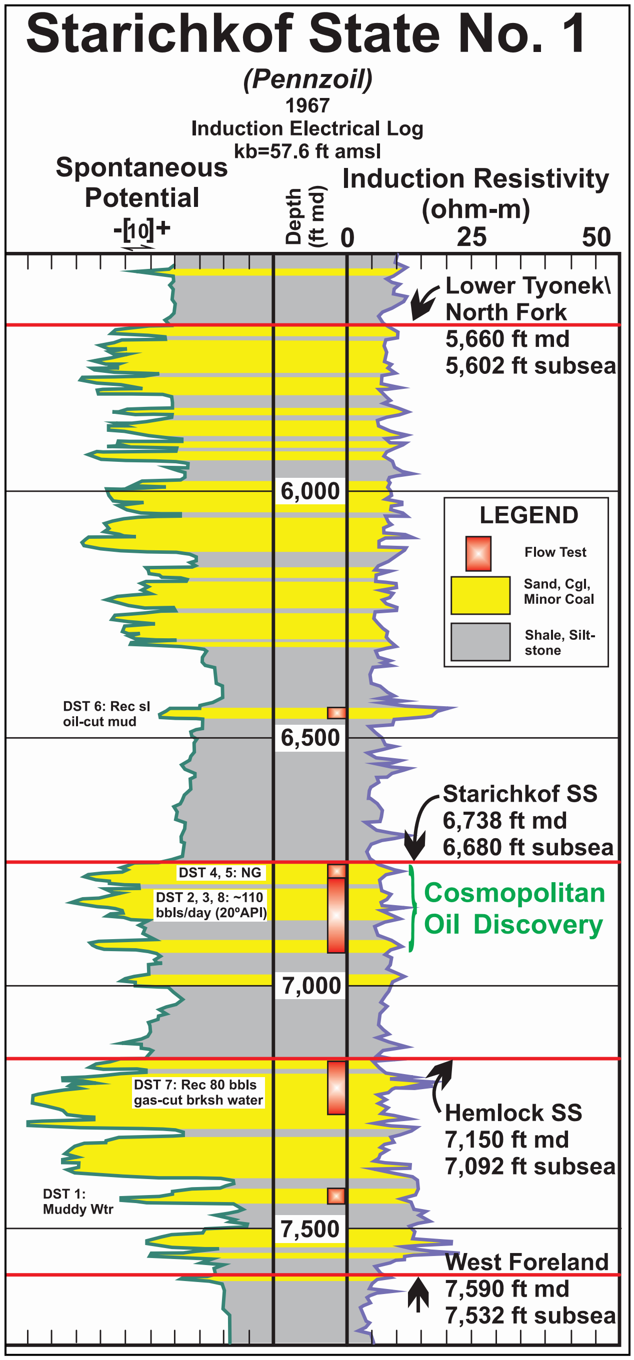

Figure B-3. Spontaneous-Potential/Resistivity Log of Discovery Well
(Cosmopolitan Oil Field). Includes Key Stratigraphic Datum and Results of Flow Tests.

Seismic mapping at Cosmopolitan field is frustrated by distortions of key reflections in the Starichkof-Hemlock-West Foreland interval over the crest of the Cosmopolitan oil field. Thus, the true extent(s) of the oil pool(s) at the Cosmopolitan field remain uncertain. For purposes of modeling the potential oil discharge from a Cook Inlet VLOS well, it is assumed that oil-charged reservoirs extend west into Federal OCS waters. The oil column exposed to the wellbore of the VLOS well is assumed to involve the entirety of the Starichkof sandstone reservoir and about one-quarter of the Hemlock conglomerate reservoir.

B-4. The Gemini Solutions *AVALON/MERLIN* Computer Model for Worst-Case Discharge

The computer model used to forecast the flow of fluids out of the Cook Inlet VLOS well is a state-of-the-art proprietary commercial program by Gemini Solutions, Inc. of Richmond, Texas (Gemini, 2015). The program is constructed as a desktop finite-difference simulator that divides the active flow system into many small cells and then iterates through time-increments of flow with re-assessments that successively modify the state[6] of each cell in the flow system. Cells may be defined in radial or Cartesian coordinates and both types of models are typically tested and compared. Finite-difference models use approximations to relevant differential equations to calculate changes (e.g., pressures, fluid saturations, etc. in the case of fluid flow) within each cell. The incremental approach minimizes approximation errors by confining individual calculations to small, individual cells and makes it possible to quantify behavior across complex systems with internal discontinuities (e.g., flow from reservoir to open wellbore to casing to production manifold to pipeline, etc.). The model is robust, offering the capability to model fluid behavior through fundamental compositional data or through measured physical properties that can be used to forecast (through empirical correlations among fluid and rock properties) other properties.

The *Gemini Solutions Inc* model consists of two components, "*AVALON*" and "*MERLIN*", that respectively simulate: 1) flow up a system of tubular passages (or "tubular system"); and 2) inflow (into the bottom of a well) from a pressurized porous reservoir. Each of these two capacities varies in a regular manner with the wellbore pressure at the reservoir during flow. The correlative capacities of these two components of the flow system determine the natural discharge rate that can be achieved through the exit point at the top of the well. The maximum discharge capacity of the two-component system is determined at the intersection of the "inflow" capacity of the formation to yield oil to the wellbore and the "outflow" or take-away capacity of the tubular system that comprises the well plumbing. Figure B-4 illustrates the graphic solution for the natural flow capacity obtained at the intersection of the inflow and outflow performance relations for a particular reservoir and wellbore tubular system. Figure B-4 also illustrates the effect of different wellbore or casing sizes on natural flow rate (generally, larger pipe allows a higher flow rate).

In theory, the maximum possible discharge rate can be limited by either the aggregate outflow capacity of the tubular system or by the reservoir inflow capacity at the base of the well. In the design of development wells and take-away pipelines, these two components of the flow system, the tubular system and the reservoir, are balanced to achieve the most efficient long-term recovery of hydrocarbons from the reservoir. For a high-yield reservoir early in the production life of the well, the discharge rate is usually limited by the choke effect of wellbore tubular systems that are insufficient to accommodate the maximum potential inflow from the reservoir.

The capacity for flow up the open (uncased) wellbore and the casing is governed by the tubular system properties (diameter, length, roughness, and frictional resistance), the driving formation pressure, and the density characteristics and thermal effects of the multiphase oil-gas-water mix

[6] *Properties such as pressure, oil viscosity, gas-oil ratio, oil saturation, relative permeability to oil, etc.*

(ranging from gassy liquid(s) to wet gas) moving upward through the wellbore. Flowing pressure in the wellbore at the reservoir face is likewise a function of the aggregate density of the multiphase wellbore fluids, frictional and gravitational resistance to flow, ambient pressure (wellhead exterior), and reservoir pressure.

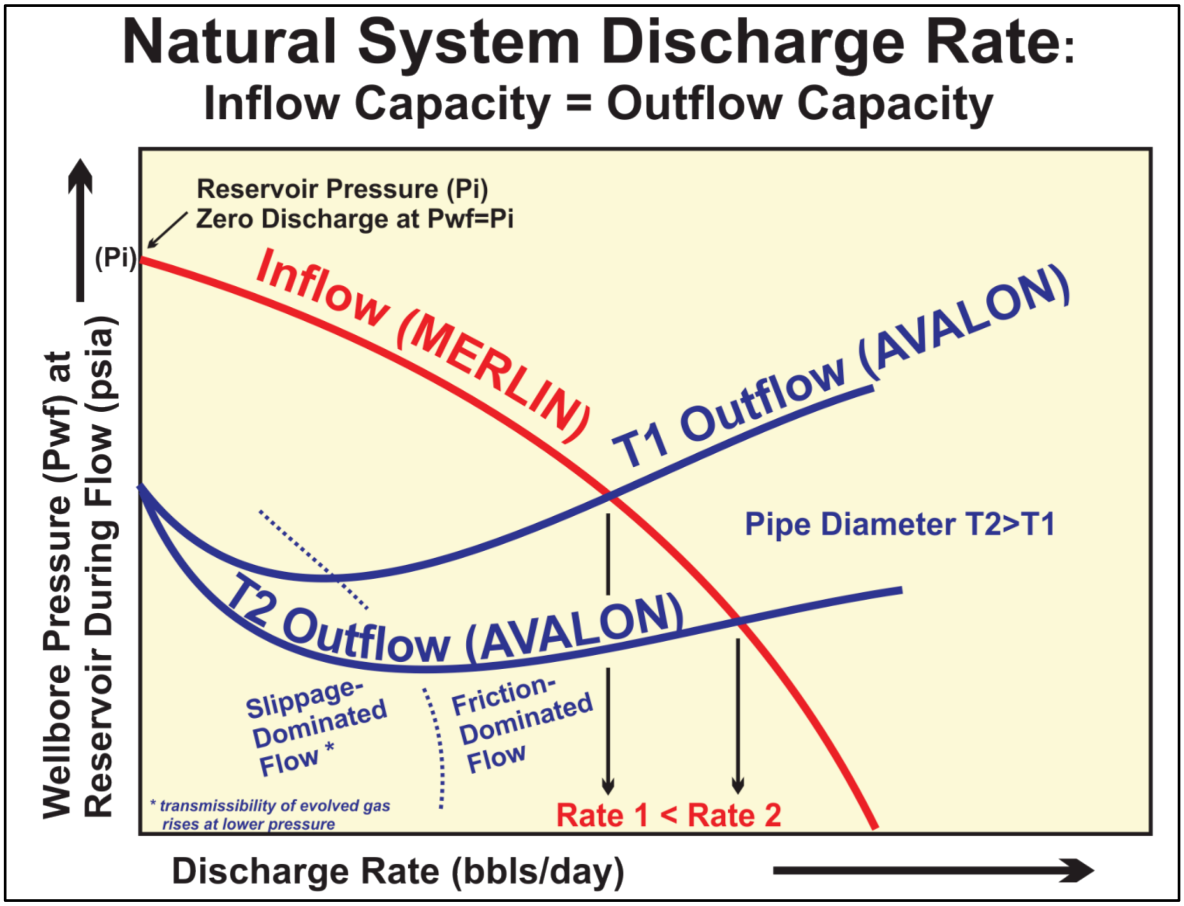

Figure B-4. Inflow and outflow performances for volumetric discharge rates as a function of wellbore pressure. *Intersections of inflow and outflow curves determine the natural discharge rate of a given reservoir-wellbore system. Large and small (diameter) wellbores are represented; in general, larger wellbores permit higher discharge rates.*

The inflow from the reservoir formation is chiefly governed by flowing bottom-hole pressure, pore system size and connectivity, formation pressure, drive mechanism, fluid compositions, fluid properties at reservoir conditions of pressure and temperature, and the length of the wellbore segment passing through the reservoir formation. The geological model for inflow is discussed further below in order to illustrate how key geological variables control discharge rate.

B-5. Darcy Radial Flow Equation and Sources of Basic Data for Cook Inlet VLOS Model

The most important variables for the reservoir inflow component of the discharge model include the aggregate thickness of flow units (h), initial (reservoir pore) pressure (Pi), flowing bottom-hole pressure (Pwf), permeability-to-oil (k_o) of the reservoir formation, and oil viscosity (μ_o). Inflow rates are particularly sensitive to permeability, which at extremes can vary across 7 orders of magnitude (0.01-10,000 mD) or greater, although more typically in the range between 10-1,000 mD. Oil viscosity and oil formation volume factor can vary by several factors. Possible quantitative ranges for variables are listed in the key below the Darcy radial-flow equation (presented below) to convey a sense of variance among the key variables and relative sensitivities to discharge rate.

At any particular instance, the flow of fluids out of a reservoir and into a well, or "inflow", is grossly governed by the Darcy radial flow equation, as summarized in its simplest form for an oil reservoir below. The purpose of including the equation here is to illustrate the roles of the key variables in determining oil flow rate, denoted in the convention of petroleum engineers as "q_o". Note that in the basic Darcy equation the discharge-limiting constraint imposed by the wellbore tubular system is represented only by the assumed wellbore bottom-hole flowing pressure (Pwf). In practice, the latter is supplied by the *AVALON* analysis of the system of tubulars from the reservoir to the surface. As can be seen in the Darcy radial flow equation, a high value for Pwf acts to oppose inflow; when Pwf=Pi, the inflow rate (q_o) falls to zero, as shown in Figure B-4.

Darcy radial flow *(steady-state) equation from Ahmed (2010, p. 435, equation 6-144)*

$$q_o = \frac{0.00708 * k_o * h * (Pi - Pwf)}{\mu_o * B_{oi} * ((\ln r_e / r_w) + S)}$$

where
q_o= oil discharge rate, stock-tank barrels/day (stbbls/d);
k_o=permeability to oil, millidarcys (mD), range 0.01- >10,000 mD;
h= thickness, ft, typically 10-200 ft;
Pi = initial reservoir pore pressure, psi, typically 1,500-20,000 psia;
Pwf = bottom-hole flowing pressure, psi, typically 300-8,000 psia;
μ_o = oil viscosity, centipoise (cP), typically 0.1 to 30.0 cP;
B_{oi} = oil formation volume factor, reservoir bbls per stock-tank bbl, typically 1.0-3.0;
r_e = drainage radius, ft, typically 1,000-30,000 ft;
r_w = radius of well, ft, typically 0.35 to 0.73 ft;
S = skin factor, dimensionless, typically 0-500.

Many other variables of lesser importance that do not appear in the Darcy radial flow equation are required for the *AVALON/MERLIN* reservoir inflow simulator. Table B-1 summarizes some of the key reservoir and fluid properties and model parameters that formed the input data to the reservoir inflow model. Table B-1 also lists the wellbore flowing pressure (Pwf) obtained from the *AVALON* modeling of outflow capacity.

Table B-1. Summary of Selected Model Data for BOEM WCD Model for Lower Cook Inlet VLOS Well.

Selected Model VLOS Well Data (two columns)			
Initial Reservoir Pressure (**p_i**, psia)	3,120	Exponent for Gas Relative Permeability Curve (**n_G**, a curve shape factor)	3.5
Flowing Bottom-Hole Pressure (**p_{wf}**, psia) - Modeled by *AVALON/MERLIN*	1,594	Oil Gravity (°API)	23.2
Reservoir Temperature, **T**, °F (°R)	138 (598)	Initial Oil Formation Volume Factor (**Boi** or FVF, reservoir volume/surface or stock-tank volume)	1.165
Reservoir Porosity (**ϕ**, fraction of rock volume)	0.17	Initial Gas-Oil Ratio (**Rsi** or GOR, standard cubic feet gas per surface or stock-tank bbl oil)	421
Reservoir Horizontal Permeability (**k_H**, mD)	20	Oil Bubble Point Pressure (**Pb**, psia)	2,257
Reservoir Vertical Permeability (**k_V**, mD)	2	Dead (Gas-Free) Oil Viscosity at Standard (Surface) Conditions (**μ_{OD}**, cp)	7.90
True Stratigraphic Thickness (**TST**, or Darcy "h", ft)	201	Oil Viscosity at Initial Reservoir Pressure (**μ_{Oi}**, cP)	2.83
True Vertical Thickness Flow Units (**TVT** or simulation-model "h", ft)	210	Oil Viscosity at Bubble-Point Pressure (**μ_{OB}**, cP)	2.66
Formation Dip (degrees departure from horizontal, °)	~17°	Skin Factor (**S**)	0
Drainage Radius (**r_e**, ft)	1,490	Reservoir Oil Density (**ρ_{OI}**, g/cm^3)	0.8158

Selected Model VLOS Well Data (two columns)			
Well Radius at Reservoir (**r_W**, ft)	0.396	Static Pressure Gradient of Reservoir Oil (psi/ft)	0.3533
Initial Oil Saturation (**Soi**, fraction of porosity)	0.63	Specific Gas Gravity (**SGG**, Air=1.0)	0.66
Connate, Initial, or Irreducible Water Saturation (**Swi**, fraction of porosity)	0.37	Formation or Rock Compressibility (**Cf**, microsips or v/v/psi*10^{-6})	3.72
Residual Oil to Gas (**Sorg**, fraction of porosity)	0.30	Oil Compressibility (**Co**, microsips or v/v/psi*10^{-6})	7.01
Residual Oil to Water (**Sorw**, fraction of porosity)	0.40	Brine Compressibility (**Cw**, microsips or v/v/psi*10^{-6})	3.05
Critical Gas Saturation (**Sgc**, fraction of porosity)	0.10	Total Compressibility (**Ct**, microsips or v/v/psi*10^{-6})	9.266
Endpoint for Oil Relative Permeability Curve (**kro**, fraction of "k_H")	0.90	Brine Salinity (ppm NaCl)	16,000
Endpoint for Water Relative Permeability Curve (**krw**, fraction of "k_H")	0.15	Brine Viscosity (**μ_W**, cP)	0.523
Endpoint for Gas Relative Permeability Curve (**krg**, fraction of "k_H")	1.00	Water Volume Factor (**B_W**, reservoir volume/standard volume)	1.012
Exponent for Oil-Water Relative Permeability Curve (**n_{OW}**, a curve shape factor)	3.5	Assumed Casing Roughness (inches)	0.0018
Exponent for Oil-Gas Relative Permeability Curve (**n_{OG}**, a curve shape factor)	3.5	Assumed Open-Hole Roughness (inches)	0.1
Exponent for Water Relative Permeability Curve (**n_W**, a curve shape factor)	3.5	Ambient Wellhead Temperature (°F)	30

Notes: psi, pounds per square inch; °R, °Rankine (=°F+460); Boi, oil volume factor (aka FVF or formation volume factor); rb/stb, reservoir barrels per stock-tank barrel of oil (at 1 atmosphere and 60°F); Rsi, gas saturation (aka GOR or gas-oil ratio); scf/stb, standard cubic feet of gas per stock-tank barrel of oil (at 1 atmosphere and 60°F); cP, centipoise.

In the Cook Inlet VLOS well discharge model, no “skin” factors related to the near-wellbore alteration of the reservoir that might limit flow rate or arrest the discharge were incorporated into the model. The “skin factor (S)” shown in the Darcy radial flow equation above usually quantifies the plugging of reservoir pores (by drilling fluid solids) that often accompanies the drilling of a well; for the Cook Inlet VLOS model “S” is set to zero (no effect on discharge rate). Furthermore, the VLOS model assumes that no “bridging” or collapse of the open segment of the wellbore is present to restrict or terminate flow. And, no near-wellbore reservoir boundaries (such as faults) are invoked to limit the potential drainage area. The drainage area for the well is bounded at a radius of 1,490 ft (160 acres).

Reservoir pressure and temperature are forecast from data collected in the Pennzoil Starichkof State 1 well located ~2.0 statute miles east of the Cook Inlet VLOS well location. Estimates for reservoir porosity and permeability are based on core and log data from offsetting wells and are consistent with properties published for Cook Inlet fields with Hemlock-Lower Kenai Group reservoirs, as shown in Table B-2.

Table B-2. Cook Inlet Oil Fields, Hemlock-Kenai Group, Reservoir Properties *

Oil Field (Pool)	Porosity (%)	Permeability (mD)	Connate Water (Swi)	Oil Viscosity at Initial Reservoir Conditions (cp)	Oil Gravity (°API)	Specific Gas Gravity (Air=1.0)
Granite Point (Hemlock Undefined Oil)	11	5	0.45	NR	34	0.68
McArthur River (Middle Kenai Oil) **	14	10	0.39	NR	41-44	0.8
McArthur River (Hemlock Oil)	10.5	53	0.35	1.19	33.1	NR
McArthur River (Middle Kenai G Oil)	18.1	65	0.35	1.09	34	NR
McArthur River (Undefined Oil)	4.9	6.3	0.34	1.13	33	NR
Middle Ground Shoal ("A")	16	15	0.4	NR	39	NR
Middle Ground Shoal ("B", "C", and "D")	16	15	0.4	NR	36-38	NR

Oil Field (Pool)	Porosity (%)	Permeability (mD)	Connate Water (Swi)	Oil Viscosity at Initial Reservoir Conditions (cp)	Oil Gravity (°API)	Specific Gas Gravity (Air=1.0)
Middle Ground Shoal ("E", "F", and "G")	11	10	0.30-0.40	0.85	36-38	NR
Redoubt Shoal (Undefined Oil)	11.5	6	0.38	2	26.5	NR
Swanson River (Hemlock Oil)	21	55	0.4	NR	30	NR
Trading Bay (G NE Hemlock NE)	12	12	0.36	1.036	35.8-36.2	NR
Trading Bay (Hemlock Oil)	15	10	NR	1.78	28	NR
Trading Bay (Middle Kenai "B" Oil)	NR	NR	NR	8.1	20	NR
Trading Bay (Middle Kenai "C" Oil)	NR	NR	NR	4.1	25	NR
Trading Bay (Middle Kenai "D" Oil)	20	250	NR	1.24	26	NR
Trading Bay (Middle Kenai "E" Oil)	20	130	NR	7.1	30.7	NR
Trading Bay (Undefined Oil)	NR	NR	NR	NR	23	NR
West McArthur River (Oil)	12	30	0.32	3.4	28.4	0.93
Averages	***14.2***	***44.82***	***0.37***	***2.75***	***31.29***	***0.80***

Notes: * as reported by the Alaska Oil and Gas Conservation Commission at web page for 2004 and 2005 pool statistics at http://doa.alaska.gov/ogc/annual/annindex.html (accessed 24 apr'15)
** "Middle Kenai Group" refers to lower Tyonek Formation and Upper Hemlock Formation in some fields

The gross thickness of the oil-bearing sandstones at the Cook Inlet VLOS well is extrapolated from the Starichkof and Hemlock sandstones penetrated at the Pennzoil Starichkof State 1 well. Because of the poor continuity of individual sandstones, a composite approach was taken to estimating a model for net pay at the VLOS well, using net/gross ratios established for the Starichkof and Hemlock sequences. Those results are summarized below:

Pennzoil Starichkof State 1 Well

Starichkof Sandstone Unit, 6,744-7,150 ft md bkb; gross=406 ft; net sandstone= 153 ft; overall net/gross= 0.38.

Hemlock Conglomerate Unit, 7,150-7,590 ft md bkb; gross= 440 ft; net sandstone= 280 ft; overall net/gross= 0.64.

The net/gross ratios are coupled with seismic isopach mapping and corrections for formation dip to obtain an estimated true-stratigraphic thickness of 201 ft for the “pay” or aggregated flow units (“h”) for the VLOS model. Table B-3 summarizes pay thickness (aggregate oil-bearing reservoirs) data for Cook Inlet fields and pools. A basin-wide map of the pay thickness data shown in Figure B-5 places the pay thickness assumed at the Cook Inlet VLOS well (210 ft) in context.

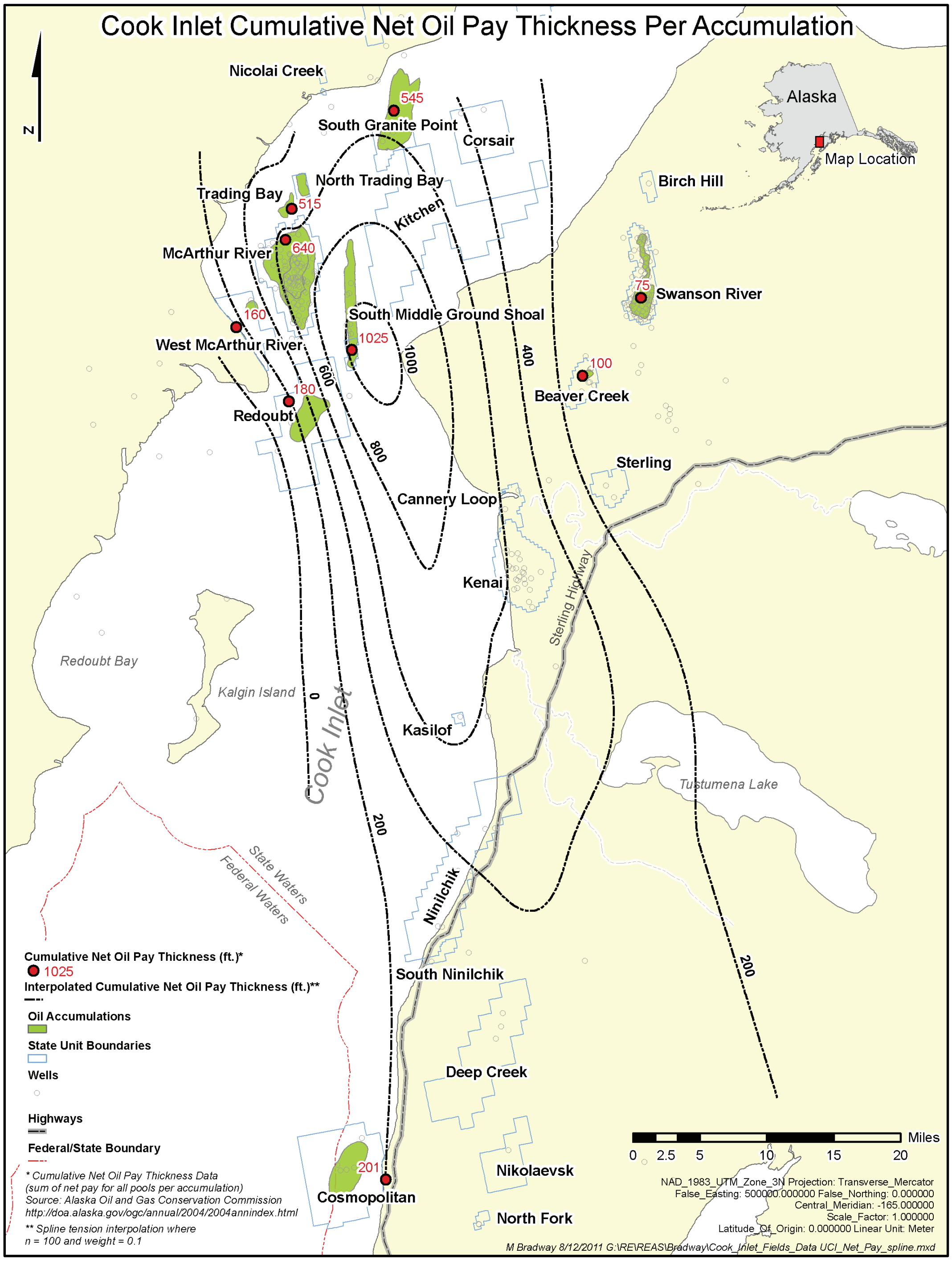

Figure B-5. Regional Map for Thicknesses of "Pay" (Oil-Bearing Sandstones). *Data for oil fields in northern Cook Inlet basin and the thickness adopted for modeling an uncontrolled oil discharge at Cosmopolitan field.*

Table B-3. Cook Inlet Oil Fields, Hemlock Kenai Group, Pay Thicknesses *

Oil Field (Pool)	Gross Pay Thickness (ft)	Net Pay Thickness (ft)	Net Pay Thickness (ft) and Midpoint of Ranged Net Pay Thickness (ft)
Granite Point (Hemlock Undefined Oil)	380	120	120
McArthur River (Middle Kenai Oil) **	250-600	250-600	425
McArthur River (Hemlock Oil)	NR	290	290
McArthur River (Middle Kenai G Oil)	NR	100	100
McArthur River (Undefined Oil)	NR	150	150
Middle Ground Shoal ("A")	NR	190	190
Middle Ground Shoal ("B", "C", and "D")	NR	335	335
Middle Ground Shoal ("E", "F", and "G")	NR	500	500
Redoubt Shoal (Undefined Oil)	675	180-450	315
Swanson River (Hemlock Oil)	NR	70-220	145
Trading Bay (G NE Hemlock NE)	400	215	215
Trading Bay (Hemlock Oil)	NR	300	300
Trading Bay (Middle Kenai "B" Oil)	NR	NR	NR
Trading Bay (Middle Kenai "C" Oil)	NR	NR	NR
Trading Bay (Middle Kenai "D" Oil)	NR	NR	NR
Trading Bay (Middle Kenai "E" Oil)	NR	NR	NR
Trading Bay (Undefined Oil)	NR	NR	NR
West McArthur River (Oil)	290	160	160
	Average Net Pay (13 Pools)=		***250***

Notes: * as reported by the Alaska Oil and Gas Conservation Commission at web page for 2004 and 2005 pool statistics at http://doa.alaska.gov/ogc/annual/annindex.html (accessed 24 apr'15)
** "Middle Kenai Group" refers to lower Tyonek Formation and Upper Hemlock Formation in some fields

Table B-2 reports initial water saturation values (Swi) for several Hemlock-Kenai Group reservoirs in Cook Inlet oil fields. The average of the reported Swi values is 0.37 and this value was adopted for the model for the Cook Inlet VLOS well.

The oil discharged from the Cook Inlet VLOS well is assumed to be 23.2° API crude oil on the basis of PVT studies of oil produced during tests at the Hansen 1 and Hansen 1A wells (AOGCC, 2005; AOGCC, 2010;). The Starichkof State 1 well recovered 20° API oil in an emulsion with water and sediment from the upper part of the Starichkof sandstones. The oil was separated by centrifuge at Core lab and determined to be 24° API (Core Laboratory, 1967). A regional map of oil gravity for Cook Inlet oil fields in reservoirs correlative to the Cosmopolitan reservoir(s) is presented for regional context in Figure B-6.

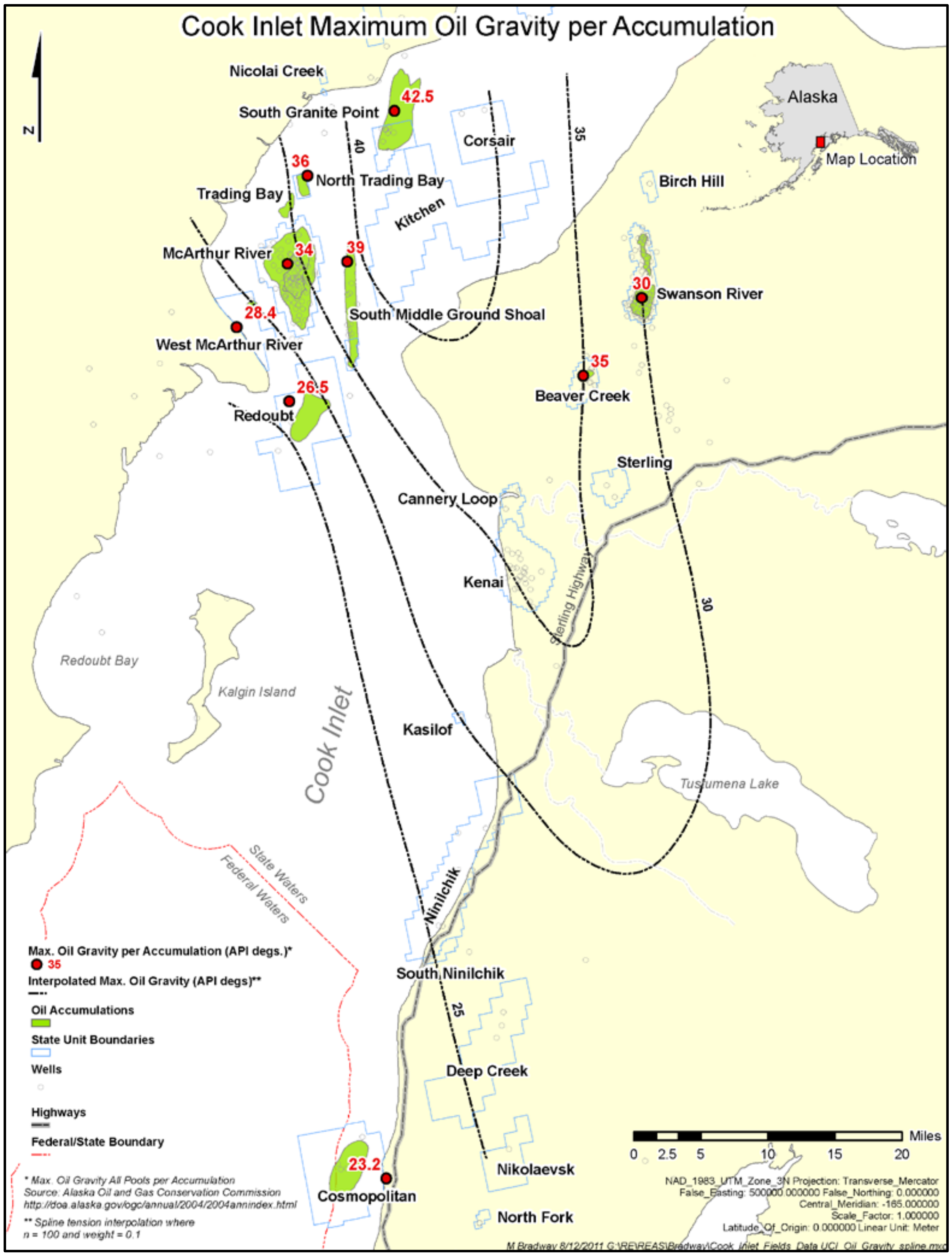

Figure B-6. Distribution of Oil Gravity in Tertiary-Age Reservoirs (*Commercial Oil Fields in Northern Cook Inlet and the Cosmopolitan Field). Overall, oil gravity declines in the southern and western parts of the Cook Inlet geologic basin.*

Like most Cook Inlet oils, the Cosmopolitan oil appears to be under-saturated[7], apparently a function of low gas yields from the Middle Jurassic Tuxedni Group oil source beds as a function of modest

[7] *"Under-saturated" refers to a condition in which the oil contains less natural gas in solution than the maximum possible at the in situ reservoir pressure and temperature conditions. As reservoir pressure declines with extraction of under-saturated oil, a "bubble point" is reached and gas leaves solution to form a free gas phase (bubbles) in the reservoir. In oil fields with a gas cap, the oil is generally found to be "saturated" with respect to the maximum possible content of dissolved natural gas.*

thermal exposure[8]. A gas-oil ratio (GOR) of *421 standard cubic ft/stock-tank-bbl oil (scf/stbbl) was adopted for the WCD model for the Cook Inlet VLOS well.* This value is based on PVT studies of oil produced during long-term tests at the Hansen 1A sidetrack well (AOGCC, 2010). Reported GOR values of the 4 oil samples range from 389 to 426 scf/stb. Sample SSB 11879-QA, obtained from the upper Hemlock sequence at 18,976 ft md bkb, has an OBM-corrected GOR of 421 scf/stb and was selected as the model oil for the VLOS model because the laboratory PVT test pressure and temperature is exactly the same as the pressure and temperature estimated at the midpoint of the oil-bearing reservoir sequence (combined Starichkof and Hemlock sequences) at the VLOS well. GOR values from other data sets range widely. Three tests of Hemlock conglomerates and one test of the Starichkof sandstones were conducted in the Hansen 1 well (AOGCC, 2005). Two Hemlock oil tests reported GOR values of 115 and 197 scf/stbbl. The Starichkof (identified as "Tyonek") oil test reported a GOR of 200 scf/stbbl.

Assuming the VLOS model reservoir temperature, pressure, specific gas gravity, and oil gravity (138°F, 3,046 psi, 0.66 (air=1), and 23.2° API, respectively), the GOR at saturation is estimated to be 474 scf/stbbl. The under-saturation of the oil leads to higher oil viscosity in the reservoir and thus a moderating role in limiting discharge rates.

A bubble-point pressure is estimated at 2,257 psia based upon PVT studies of oil produced during long-term tests at the Hansen 1A sidetrack well. Reported bubble-point pressures for 4 samples from these tests ranged from 2,257 to 2,484 psia. The sample with an estimated bubble-point pressure of 2,257 psia was selected as the model oil for the VLOS model because the laboratory PVT test pressure and temperature is exactly the same as the VLOS model pressure and temperature at the midpoint of the oil-bearing reservoir sequence (combined Starichkof and Hemlock sequences) at the VLOS well.

The oil viscosity at reservoir temperature and pressure is estimated to be 2.825 centipoise (cP) based upon PVT studies of oil produced during long-term tests at the Hansen 1A well (AOGCC, 2010). Reported viscosity values for 2 of 4 samples from these tests ranged from 2.825 to 3.603 cP. The value of 2.825 cP was selected as the model oil viscosity because the laboratory PVT test pressure and temperature is exactly the same as the pressure and temperature at the midpoint of the oil-bearing reservoir sequence (combined Starichkof and Hemlock sequences). The same PVT study produced an estimate of bubble-point viscosity of 2.66 cP. Other oil viscosity studies generally show values much higher than 2.825 cP. Oil samples recovered (and centrifuged from an oil-water emulsion) from the Pennzoil Starichkof State 1 well were subjected to a series of viscosity measurements at 130°F and varying pressures after recombination with methane at a ratio of 75 scf/stbbl. At 130°F, approaching the reservoir temperature of 138°F, the reported viscosity of this under-saturated oil is 17.7 cP. As acknowledged in the Darcy radial-flow equation above, high viscosity exerts a powerful effect upon discharge rate. Adoption of an oil viscosity of 17.7 cP achieves a reduction of flow rate to 16% (2.825*100/17.7) of the rate obtained with an oil viscosity of 2.825 cP). Viscosity data for commercial oil fields in northern Cook Inlet are listed in Table B-3. For context, a regional map of oil viscosity data for reservoirs correlative to the Starichkof and Hemlock sandstones is shown in Figure B-7.

[8] *With exposure to high temperatures, source rocks generally first generate and expel oil which contains very little gas. With sufficient increase in temperature, oil expulsion is generally followed by gas expulsion or cracking of the oil to gas and increasing solution gas-oil ratios for the oil.*

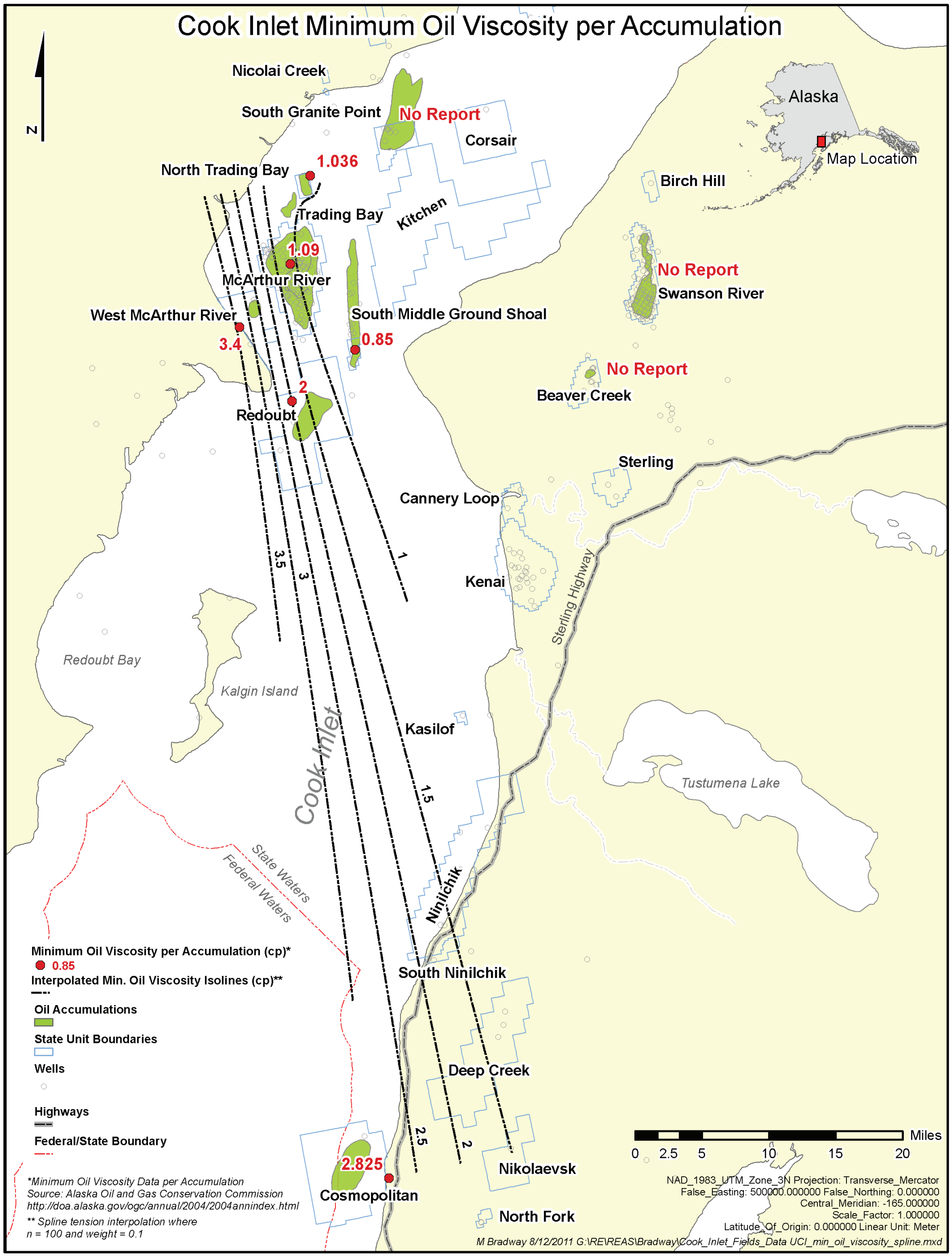

Figure B-7. Distribution of oil viscosity in Tertiary-age reservoirs in commercial oil fields (northern Cook Inlet and the Cosmopolitan field). *Overall, oil viscosity rises as oil gravity declines in the southern and western parts of the Cook Inlet geologic basin.*

B-6. BOEM Mechanical and Reservoir Design Models for the Cook Inlet VLOS Well

The casing plan for the Cook Inlet VLOS well is modeled on the casing programs used at the vertical Pennzoil Starichkof State 1 and Starichkof State-Unit 1 wells drilled in State waters by Pennzoil in 1967. Casing strings 20-inches, 13-3/8-inches, and 9-5/8-inches in outer diameter are assumed to be nested and reach to the wellhead at the base of the blowout preventer under the drill floor. The inner-most casing string, the 9-5/8-inch (outer-diameter) string with an interior diameter of 8.535 inches (radius, 0.356 ft), extends from the top of the oil-bearing Starichkof sandstone sequence (exact depth proprietary) to the base of the blowout preventer and forms the main part of the flow path during the discharge. For modeling purposes, the 9-5/8-inch string is assumed to extend through the blowout preventer to the Kelly bushing. Interior roughness of the 9-5/8-inch casing string is defaulted to 0.0018 inches for purposes of estimating frictional effects.

The lower part of the discharge flow path is the open wellbore through the oil-bearing reservoir sandstones. The drilled diameter of the open-hole is 8-1/2 inches but the hole is assumed to be enlarged to 9-1/2-inches (radius, 0.396 ft) consistent with the caliper on the sonic log in the Pennzoil Starichkof State Unit 1 well in the section just above the target formations, which shows a section drilled with an 8-3/4-inch bit typically enlarged to 9.5 to 10 inches. The open-hole diameter ranges over 1.6 inches from extremes of 8.9 to 10.5 inches in the interval from 6,000-6,900 ft bkb in the Pennzoil Starichkof State-Unit well. Interior roughness of the 9-1/2-inch open hole in the VLOS well is defaulted to 0.10 inches for purposes of estimating frictional effects.

The reservoir model for the *MERLIN* simulation of the Cook Inlet VLOS well was constructed for an assumed 25,000 acre reservoir field assuming a vertical-well-spacing of ~200 acres for development. To simulate this field a 21 cell by 21 cell (total 441 cells) Cartesian grid system of varying dimensions was designed with the producing well located at the center of this grid. This grid system utilizes smaller cells centered around the location of the VLOS well and surrounded by progressively larger cells in outlying grids, as shown in Figure B-8.

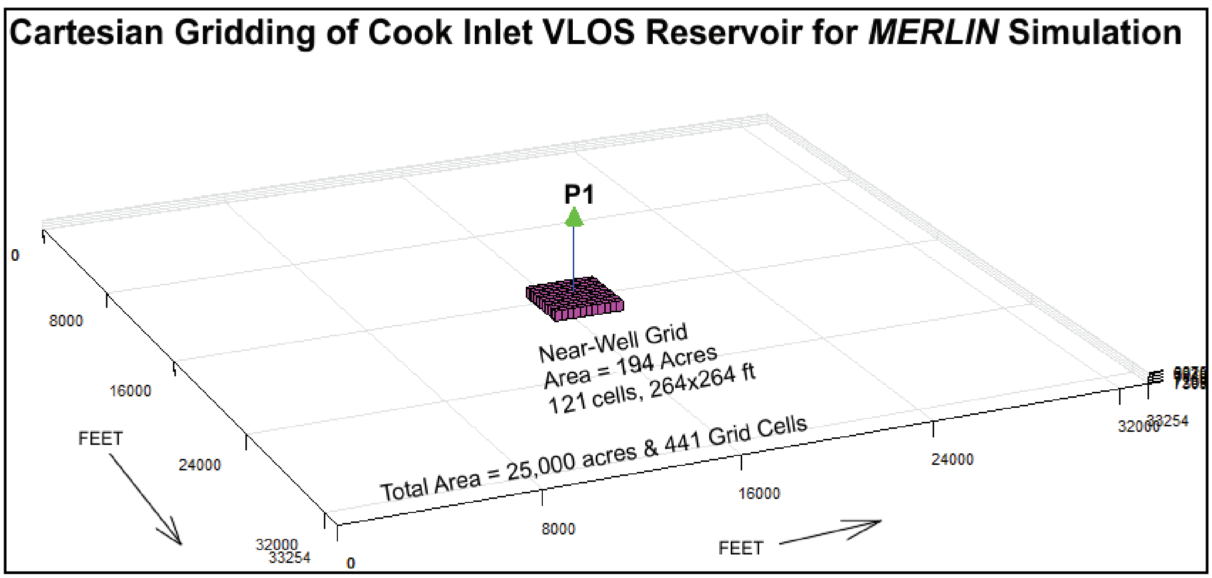

Figure B-8. Perspective of elements of Cartesian grid for worst-case discharge simulation at the Cook Inlet VLOS well. *Well is located at the Cosmopolitan oil field near Anchor Point, Alaska. "P1" is the VLOS well at the center of the detailed near-well 194-acre grid consisting of 121 cells, each 264 ft on a side. The gridded volume is ~200 ft thick. Cell dimensions progressively increase to a maximum of 7,830x7,830 ft per cell at distance from the "P1" well (intermediate cells outside of 264x264-ft cell grid around P1 not shown).*

The near-well grid was designed around cells 264 ft on a side based upon a well spacing of 194 acres (8,433,216 ft^2 divided into a 11x11-cell grid consisting of 121 cells). Outside the near-well grid, cell dimensions are then increased in an approximately geometric progression until the 25,000 reservoir area is met. The grid sizing utilized in the model is based upon the following Cartesian cell dimensions: 264'x264', 489'x489', 980'x980', 1960'x1960', 3916'x3916', and 7830'x7830'. The

Cook Inlet VLOS well was also independently modeled with a radial configuration consisting of a system of concentric bands centered on the well and increasing in radial thickness at distance from the well. The radial simulation model yielded results similar to the Cartesian model, with a slightly lower day 1 oil discharge rate than the Cartesian model (2,032 stbbls/d versus 2,135 stbbls/d for the Cartesian model).

B-7. Worst-Case-Discharge Modeling Results

A comprehensive discharge schedule for the Cook Inlet VLOS well over a 100-day period is reported in Tables B-4 and B-5. Figure B-9 provides a chart that illustrates the discharge patterns over time for selected elements of tables B-4 and B-5.

Following initiation of the blowout, the oil discharge from the Cook Inlet VLOS well aggregates to 2,135 stbbls over the course of day 1 (first 24 hours). This includes filling the volume of an empty wellbore with produced oil and gas (Pwf=0 psia at time=0). After peaking in day 1, Figure B-9 shows that the oil discharge rate in the *BOEM* model declines abruptly (overall, -4.8% per day[9]) through the first 4 days of flow, then moderately (overall, 0.7% per day) from day 4 to day 15, and thereafter declining very slowly (overall, 0.2% per day) out to 100 days. The overall annualized oil discharge decline rate over 100 days is approximately 82%/year.

Gas in proportion to oil (reservoir GOR=421 scf/stbbl) is also discharged. Because reservoir pressure does not fall below the bubble point (2,257 psia) during the flow period, the producing GOR remains constant at 421 scf/stbbl (tbls. B-4, B-5). Water discharge is negligible and is rounded to zero in tables B-4 and B-5. After the wellbore is filled, the flowing bottom-hole pressure remains constant at 1,594 psia throughout the 100 days of flow.

Some key timelines and cumulative oil discharge estimates follow (also listed in tbls. B-4 and B-5):

- The day 1 aggregate discharge or “worst-case” rate is 2,135 stbbls/d.
- At the end of day 30, the cumulative oil discharge reported for the Cook Inlet VLOS well model is 48,989 bbls. The oil discharge rate by day 30 has fallen to 1,525 stbbls/day.
- The minimum time required to arrest the blowout[10] is estimated to be 50 days (BOEM, 2012). At the end of day 50, the cumulative oil discharge reported by the VLOS model is 78,830 stbbls. The oil discharge rate at day 50 is 1,464 stbbls/day.
- The maximum time required to arrest the blowout[9] is estimated to be 80 days (BOEM, 2012). At the end of day 80, the cumulative oil discharge reported by the VLOS model is 121,467 stbbls. The oil discharge rate at day 80 is 1,382 stbbls/day.

Also shown in Tables B-4 and B-5 are the substantial cumulative gas discharges from the Cook Inlet VLOS well. At the end of day 30, the cumulative gas discharge is $20{,}624*10^3$ standard[11] cubic feet (by convention reported as 20,624 Mscf). At the end of day 50, the cumulative gas discharge is 33,187 Mscf. At the end of day 80, the cumulative gas discharge reported for the Cook Inlet VLOS model is 51,138 Mscf.

[9] *Calculated as: Decline (fraction per day) = [(final rate/initial rate)^(1/number of days)] - 1*

[10] *Includes the time required to mobilize the relief well rig, to drill the relief well, and to intersect the blowout wellbore and to stop the uncontrolled flow.*

[11] *“Standard” refers to volume measurement at defined standard conditions--60°F and 1 atmosphere (14.73 psia).*

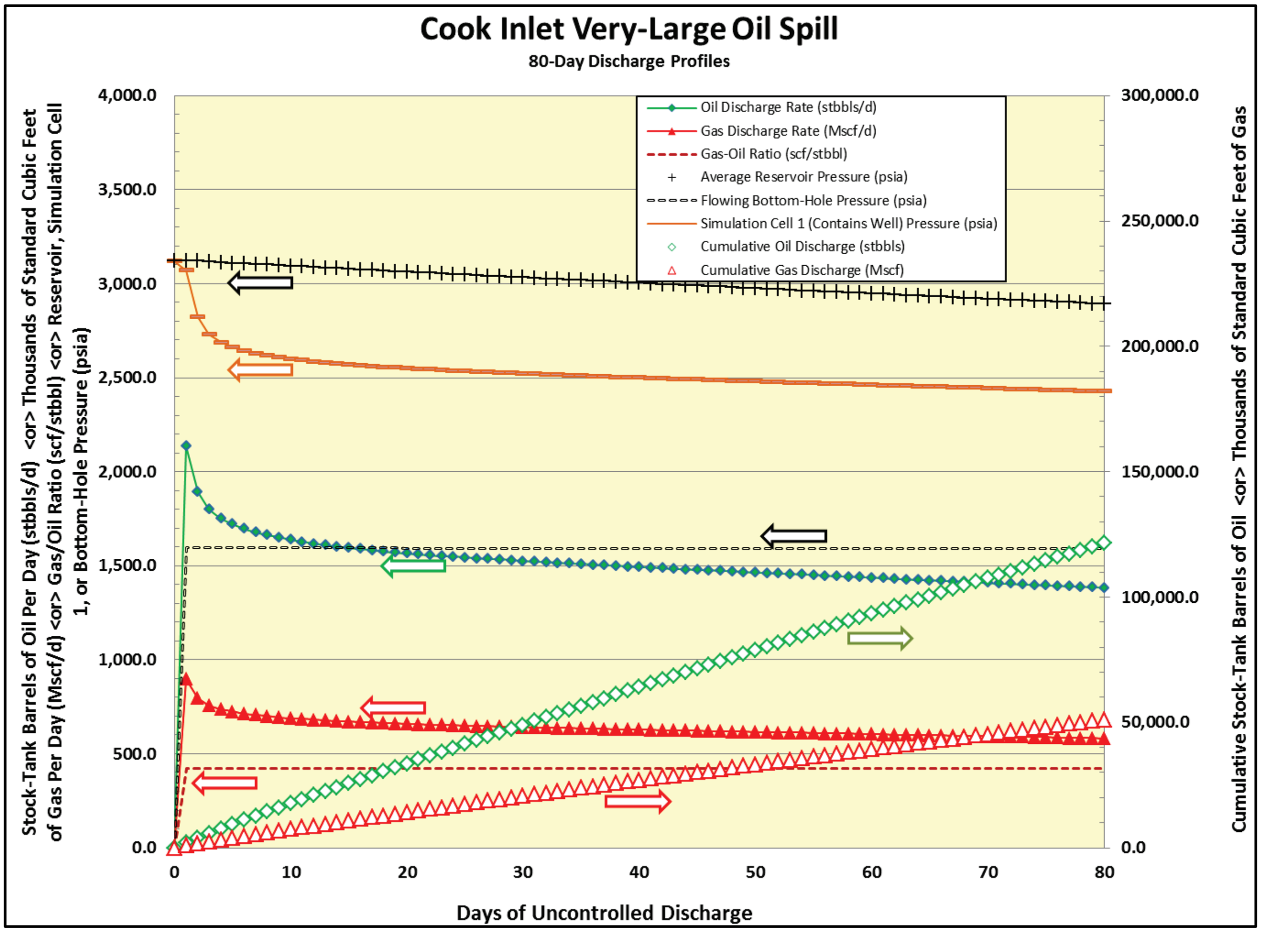

Figure B-9. Time-progression of oil (green symbols) and gas (red symbols) discharges over 100 days from the hypothetical Cook Inlet VLOS well *(Cosmopolitan oil field in southern Cook Inlet basin, Alaska). Oil and gas discharge rates are scaled at left; cumulative discharges are scaled at right. Flowing bottom-hole (within the wellbore at the reservoir depth) pressure is constant at 1,594 psia and producing gas-oil ratio is constant at 421 scf/stbbl. Declines in average reservoir pressure and cell 1 (cell containing the VLOS well) are also displayed.*

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B-9. Uncontrolled Discharge Table

Table B-4. VLOS - Uncontrolled Discharge from a Single Exploration Well - Days 1-80.

Discharge Day	Oil Discharge Rate (STB/d)	Gas Discharge Rate (MSCF/d)	Water Discharge Rate (STB/d)	Producing Gas-Oil Ratio (SCF/STB)	Cumulative Oil Discharge (STB)	Cumulative Gas Discharge (MSCF)	Average Reservoir Pressure (psia)	Flowing Bottom-Hole Pressure (psia) at Midpoint of Reservoir	Reservoir Pressure in Simulation Cell Containing Wellbore (psia)
0	0	0	0	0	0	0	3,120	0	3,120
1	2,135	899	0	421	2,135	899	3,120	1,594	3,072
2	1,891	796	0	421	4,026	1,695	3,120	1,594	2,824
3	1,800	758	0	421	5,826	2,453	3,116	1,594	2,730
4	1,752	738	0	421	7,578	3,191	3,113	1,594	2,688
5	1,721	724	0	421	9,299	3,915	3,109	1,594	2,662
6	1,697	714	0	421	10,996	4,629	3,106	1,594	2,644
7	1,678	707	0	421	12,674	5,336	3,103	1,594	2,630
8	1,663	700	0	421	14,337	6,036	3,100	1,594	2,618
9	1,650	694	0	421	15,987	6,730	3,096	1,594	2,609
10	1,638	689	0	421	17,625	7,419	3,093	1,594	2,600
11	1,627	685	0	421	19,252	8,104	3,090	1,594	2,593
12	1,618	681	0	421	20,870	8,785	3,087	1,594	2,587
13	1,610	678	0	421	22,480	9,463	3,084	1,594	2,581
14	1,603	675	0	421	24,083	10,138	3,081	1,594	2,575
15	1,596	672	0	421	25,679	10,810	3,078	1,594	2,570
16	1,589	669	0	421	27,268	11,479	3,074	1,594	2,566
17	1,583	667	0	421	28,851	12,146	3,071	1,594	2,562
18	1,576	664	0	421	30,427	12,810	3,068	1,594	2,558
19	1,571	661	0	421	31,998	13,471	3,065	1,594	2,554
20	1,566	659	0	421	33,564	14,130	3,062	1,594	2,551
21	1,561	657	0	421	35,125	14,787	3,059	1,594	2,547
22	1,557	655	0	421	36,682	15,442	3,056	1,594	2,544
23	1,552	654	0	421	38,234	16,096	3,053	1,594	2,541
24	1,548	652	0	421	39,782	16,748	3,050	1,594	2,538
25	1,544	650	0	421	41,326	17,398	3,047	1,594	2,535
26	1,540	648	0	421	42,866	18,046	3,044	1,594	2,533
27	1,536	647	0	421	44,402	18,693	3,041	1,594	2,530
28	1,533	645	0	421	45,935	19,338	3,038	1,594	2,527
29	1,529	644	0	421	47,464	19,982	3,035	1,594	2,525
30	1,525	642	0	421	48,989	20,624	3,032	1,594	2,522
31	1,522	641	0	421	50,511	21,265	3,029	1,594	2,520
32	1,519	639	0	421	52,030	21,904	3,026	1,594	2,518
33	1,515	638	0	421	53,545	22,542	3,024	1,594	2,516
34	1,512	637	0	421	55,057	23,179	3,021	1,594	2,513
35	1,509	635	0	421	56,566	23,814	3,018	1,594	2,511
36	1,506	634	0	421	58,072	24,448	3,015	1,594	2,509
37	1,502	632	0	421	59,574	25,080	3,012	1,594	2,507
38	1,499	631	0	421	61,073	25,711	3,009	1,594	2,505
39	1,496	630	0	421	62,569	26,341	3,006	1,594	2,503
40	1,493	629	0	421	64,062	26,970	3,003	1,594	2,501
41	1,490	627	0	421	65,552	27,597	3,000	1,594	2,499
42	1,487	626	0	421	67,039	28,223	2,997	1,594	2,497
43	1,484	625	0	421	68,523	28,848	2,994	1,594	2,495
44	1,481	624	0	421	70,004	29,472	2,992	1,594	2,493
45	1,478	622	0	421	71,482	30,094	2,989	1,594	2,491
46	1,475	621	0	421	72,957	30,715	2,986	1,594	2,489

Discharge Day	Oil Discharge Rate (STB/d)	Gas Discharge Rate (MSCF/d)	Water Discharge Rate (STB/d)	Producing Gas-Oil Ratio (SCF/STB)	Cumulative Oil Discharge (STB)	Cumulative Gas Discharge (MSCF)	Average Reservoir Pressure (psia)	Flowing Bottom-Hole Pressure (psia) at Midpoint of Reservoir	Reservoir Pressure in Simulation Cell Containing Wellbore (psia)
47	1,472	620	0	421	74,429	31,335	2,983	1,594	2,487
48	1,470	619	0	421	75,899	31,954	2,980	1,594	2,485
49	1,467	617	0	421	77,366	32,571	2,977	1,594	2,483
50	1,464	616	0	421	78,830	33,187	2,974	1,594	2,481
51	1,461	615	0	421	80,291	33,802	2,972	1,594	2,479
52	1,458	614	0	421	81,749	34,416	2,969	1,594	2,477
53	1,455	613	0	421	83,204	35,029	2,966	1,594	2,476
54	1,453	612	0	421	84,657	35,641	2,963	1,594	2,474
55	1,450	610	0	421	86,107	36,251	2,960	1,594	2,472
56	1,447	609	0	421	87,554	36,860	2,958	1,594	2,470
57	1,444	608	0	421	88,998	37,468	2,955	1,594	2,468
58	1,441	607	0	421	90,439	38,075	2,952	1,594	2,466
59	1,439	606	0	421	91,878	38,681	2,949	1,594	2,465
60	1,436	605	0	421	93,314	39,286	2,946	1,594	2,463
61	1,433	603	0	421	94,747	39,889	2,944	1,594	2,461
62	1,430	602	0	421	96,177	40,491	2,941	1,594	2,459
63	1,428	601	0	421	97,605	41,092	2,938	1,594	2,457
64	1,425	600	0	421	99,030	41,692	2,935	1,594	2,456
65	1,422	599	0	421	100,452	42,291	2,932	1,594	2,454
66	1,420	598	0	421	101,872	42,889	2,930	1,594	2,452
67	1,417	597	0	421	103,289	43,486	2,927	1,594	2,450
68	1,414	595	0	421	104,703	44,081	2,924	1,594	2,449
69	1,412	594	0	421	106,115	44,675	2,921	1,594	2,447
70	1,409	593	0	421	107,524	45,268	2,919	1,594	2,445
71	1,406	592	0	421	108,930	45,860	2,916	1,594	2,443
72	1,404	591	0	421	110,334	46,451	2,913	1,594	2,441
73	1,401	590	0	421	111,735	47,041	2,911	1,594	2,440
74	1,398	589	0	421	113,133	47,630	2,908	1,594	2,438
75	1,396	588	0	421	114,529	48,218	2,905	1,594	2,436
76	1,393	586	0	421	115,922	48,804	2,902	1,594	2,435
77	1,390	585	0	421	117,312	49,389	2,900	1,594	2,433
78	1,388	584	0	421	118,700	49,973	2,897	1,594	2,431
79	1,385	583	0	421	120,085	50,556	2,894	1,594	2,429
80	1,382	582	0	421	121,467	51,138	2,892	1,594	2,428

Notes: Cartesian grid model 25,000 acre reservoir field with ~200 acre development pattern/spacing, field summary table from Merlin-Avalon simulation.

Relief well mobilized to blowout site, drills relief well, and gains control of blowout well by day 50 (estimate of minimum time required) or day 80 (estimate of maximum time required).

STB/d, stock-tank (surface) barrels per day; MSCF/d, thousands of standard (surface conditions, or 60°F and 1 atmosphere (14.73 psia) cubic feet of gas; psia, pounds per square inch, absolute.

APPENDIX C

Air Quality Modeling For Lease Sale 244

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Appendix C. Air Quality Modeling

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Air Quality Modeling

C-1. Introduction

Outer Continental Shelf (OCS) oil and gas exploration and development activities result in emissions of nitrogen oxides (NO_X), sulfur dioxide (SO_2), carbon monoxide (CO), particulate matter (PM), lead (Pb), and can contribute to the formation of ozone (O_3). The U.S. Environmental Protection Agency (EPA) sets National Ambient Air Quality Standards (NAAQS) for these pollutants to provide for the protection of public health and the environment. The Clean Air Act, as amended (42 U.S.C. §§ 7470 to 7479) also establishes a program for the Prevention of Significant Deterioration (PSD) designed to set limits to the amount of air quality degradation from new and modified emission sources in special geographical areas that historically maintain good air quality, referred to as Class I areas (national parks and wilderness areas) and Class II areas (national preserves, recreation areas, and national monuments). The PSD program sets maximum allowable increases in pollutant concentrations, relative to the baseline levels, for concentrations of NO_2, SO_2, and PM. These limits are most restrictive in areas designated as Class I areas and are the responsibility of the state Federal Land Manager (FLM).

The assessment of potential air quality impacts under the National Environmental Policy Act (NEPA) requires the analysis and evaluation of projected air emissions when applied to computer-simulated dispersion modeling. Dispersion modeling results due to the proposed action and each of its alternatives are compared to the NAAQS to determine compliance to the relevant sections of the Clean Air Act (as amended). Air quality simulation modeling can also illustrate potential impacts to visibility, one of the Air Quality Related Values (AQRVs) which the FLM is responsible for protecting.

Air quality modeling was performed using Offshore and Coastal Dispersion (OCD5) model (https://www3.epa.gov/ttn/scram/dispersion_prefrec.htm#ocd) to assess potential air quality impacts from OCS oil and gas development associated with Proposed Lease Sale 244 and the air quality modeling study area (Figure C-1) in Cook Inlet in the Alaska Region on the Tuxedni National Wilderness Area (NWA). Emission scenarios were developed based on projected exploration and production activities. The modeling emphasized possible impacts on the Tuxedni NWA, a PSD Class I area under the Clean Air Act located on Chisik Island west and inshore of the proposed Lease Area. The modeling showed that the highest concentrations of NO_2, SO_2, and PM_{10} would occur in close proximity to and oil and gas facility in the proposed Lease Area, i.e., an exploration rig or production platform. The modeled concentrations decrease rapidly with distance. Projected concentrations within Tuxedni NWA were well within the PSD Class I maximum allowable increases. If the projected concentrations from a proposed facility exceed the Class I Significance Levels, a comprehensive PSD increment consumption analysis would need to be conducted by the permit applicant. Within the Tuxedni NWA, the modeled annual average NO_2, maximum 24-hour and 3-hour SO_2, and the maximum 24-hour and annual PM_{10} values exceed the Class I significance levels for the exploration scenario. The production scenario also results in exceedances of significance levels for annual average NO_2 concentrations and the Max 24-hr PM_{10} within Tuxedni NWA. Visibility screening using VISCREEN (https://www3.epa.gov/scram001/dispersion_screening.htm#viscreen) indicated that a plume from an exploration or production facility near Tuxedni NWA could be visible under the most restrictive meteorological conditions (up to about 50 km from the Tuxedni NWA). The plume would most likely not be visible under average meteorological conditions, but more rigorous analyses would be needed to more precisely evaluate any effects.

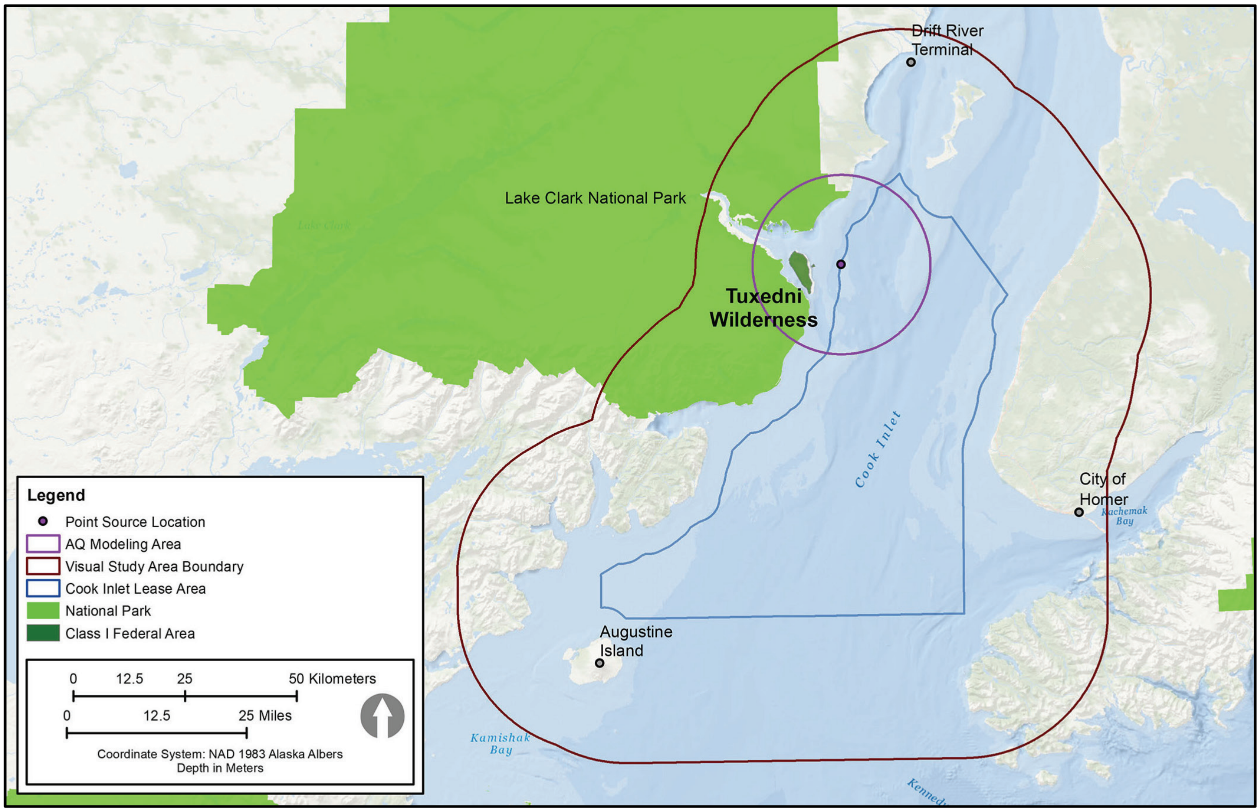

Figure C-1. Air Quality Modeling Study Area.

C-2. Existing Air Quality

Information on air emissions in the area may be obtained from an EPA database (http://dec.alaska.gov/Applications/Air/airtoolsweb/PointSourceEmissionInventory). Industrial emissions on the Kenai Peninsula primarily arise from gas processing, oil refining, power generation, and petrochemical production. Other emissions result from motor vehicles (highway and off-highway activities). Vessel traffic in Cook Inlet is also a significant source of emissions. In Anchorage, the largest emissions are attributed to motor vehicles. Off-highway vehicular sources also contribute a significant fraction of the total emissions. Industrial sources consist mainly of power generation and refuse burning facilities.

The air quality monitoring stations nearest the project area are limited to the Anchorage urban center. Measurements have shown that pollutant levels are well within the NAAQS. The Anchorage municipality was in nonattainment for CO (1971 standard) as recently as 2003 and for PM_{10} (1987 standard) as recently as 2012, but has since been redesignated an attainment area and operates under a maintenance program. No other NAAQS violations have occurred since 2012. Ambient levels of pollutants in the remainder of the project area are presumed by EPA to be well within the NAAQS.

C-3. Climate

The climate of the Cook Inlet is characterized by cold winters and cool summers. Temperatures are moderated by the marine influences from the inlet and the Gulf of Alaska waters to the south. At Homer, Alaska the average maximum and minimum temperatures in January are around -1°C and -10°C, respectively. In July, the average maximum temperature is around 15°C, while the minimum is around 9°C. Precipitation is distributed fairly evenly throughout the year, but tends to be highest in the fall and lowest in the spring. Winds are strongly channeled by the surrounding high topography and tend to blow along the length of the Cook Inlet, except in areas where there are gaps in the mountain ranges.

C-4. Lease Sale 244 Development Scenario

It was assumed that for these proposed lease sales approximately 215 million barrels of oil and up to 571 billion cubic feet of gas would be discovered and produced from a single development project (Section 2.4.1). Exploration would peak between the years 2018 and 2021 with the drilling of seven to ten exploration/delineation wells. This would be followed by the installation of two to three production platforms in the years 2023 to 2026, and 55 to 66 production wells between 2023 and 2029. Oil and gas production would peak in the years 2025 through 2027 with a maximum daily production of 68,000 barrels of oil and 181 million cubic feet of gas.

C-5. Development of Emission Scenario

Exploration and delineation wells could be carried from a semisubmersible or a jack-up rig, or similar type of bottom-founded unit. For this analysis it was assumed that drilling would take place from a bottom founded drilling unit. The equipment inventory, power requirements, and duration were based on information from a permit application for the Shell Beaufort Sea Alaska Exploratory Drilling Program. The primary emission sources were the main diesel engines, emergency generator, deck cranes, incinerators, and support vessels.

Emissions for a production platform were calculated based on the most recent emissions inventory of Cook Inlet Energy's Osprey Platform. It was assumed that the primary emissions sources on the platform would be the drilling engines, emergency generators, deck cranes, heaters and boilers, test flare, and support vessels.

C-6. Meteorological Data

The OCD5 model requires offshore meteorological data, onshore surface data, and onshore radiosonde data. There are no meteorological buoys in Cook Inlet; however, there are two C-MAN (Coastal-Marine Automated Network) stations. The Drift River Terminal (DRFA2) station is located just to the north of the proposed lease sale area, while the Augustine Island (AUGA2) site is near the west-central boundary of the lease area. A National Weather Service (NWS) surface observation station is located at Homer. Wind roses were constructed to compare the wind climatology from the three stations. At DRFA2 the winds are primarily from the north and north-northwest, with a secondary maximum from the south. It is very evident that the winds are channeled strongly by the surrounding topography. At AUGA2 the most frequent wind directions are from the northeast, west and west-northwest. The westerly winds are the result of a gap in the topography to the west of the island. At the Homer site, the most frequent wind directions are from the northeast and north-northeast. There also is a secondary maximum for winds from the west-southwest. The winds are again strongly influenced by the topography as they are mainly aligned along the length of the Kachemak Bay. The frequency distribution of wind direction in the Cook Inlet therefore varies by location. For the area around Tuxedni Island, winds will tend to be similar to those observed at DRFA2 with prevailing northerly directions. This would result in a low frequency of occurrence of direct transport of pollutants to Tuxedni NWA, and hence the overall impacts. However, the winds at Homer were selected to use in the modeling as a longer term record is available for this site. The calculated pollutant concentrations would be less conservative because a larger percentage of northeasterly winds occur in that dataset.

Since no sea surface temperature observations are taken at the two C-MAN stations, certain values for long-term averages of air-sea temperature differences were assumed. The Cook Inlet does not freeze over entirely in winter. Therefore, with air temperatures generally below freezing, one would expect the sea surface temperature to be higher than the air temperature. In the summer, the sea surface temperatures will lag behind the air temperatures, so one would expect the air temperature generally to be warmer than the sea surface temperature. For the modeling input for OCD, the air-sea temperature difference was varied by season with a lowest value of -3.0°C for December and January and a highest value of 2.0°C for July and August.

The data from the Homer NWS site were used to derive the onshore stability classification, while the upper air soundings from the Anchorage radiosonde station were used to estimate the over land mixing height values. Five years of meteorological data were used, consisting of the years 2001 through 2005. For over water, a default value of 500 m was used for the mixing height.

C-7. OCD Model Input

For the exploration phase, OCD modeling runs were made for an exploration drilling unit. For the development and production phase, modeling was performed for a production facility. Estimated emissions from support vessels were included for both facilities. In order to evaluate a worst-case impact on the Tuxedni NWA, in each case the source was placed 6 km to the northeast of Tuxedni. In the model runs, the emission sources having similar stack parameter characteristics were grouped. For grouped sources, a single set of stack parameters was generated by a weighted average of the individual emission sources. Overwater receptors were generated using a polar grid with concentric circles ranging from 0.5 to 3.0 km from the source. A total of 31 onshore receptors were generated. Of these, 16 receptor points were placed within the Tuxedni NWA, and the remaining ones were located just inland within the Lake Park National Park and Reserve. Receptor elevations were estimated by examining USGS topographic maps. Separate model runs were performed for each of the PSD parameters, including the annual average NO_2; annual, 24-hour, and 3-hour average SO_2; and annual and 24-hr PM_{10} concentrations.

C-8. OCD Modeling Results

Table C-1 lists the modeling results for the exploratory drilling operations. The concentrations over water are far higher than any of the values onshore. The highest predicted concentrations were found within 0.5 km of the source (the highest average concentrations are those listed in the “Overwater” column of Table C-1). At the 3-km distance from the source, the concentrations were lower by about a factor of 10, while the highest onshore concentrations were lower by about a factor of 100.

Table C-1. OCD Modeling Results for Cook Inlet Exploration (μg/m^3).

Year	Overwater					Tuxedni NWA					Other Onshore				
	2001	2002	2003	2004	2005	2001	2002	2003	2004	2005	2001	2002	2003	2004	2005
Annual Avg. NO2	5.095	5.977	6.271	6.663	6.957	2.254	2.254	2.352	2.352	2.450	0.098	0.098	0.196	0.098	0.098
Annual Avg. SO2	0.084	0.098	0.103	0.110	0.115	0.037	0.037	0.039	0.039	0.040	0.002	0.002	0.003	0.002	0.002
Max 24-hr SO_2	1.480	1.443	1.467	1.009	1.614	0.363	0.258	0.253	0.276	0.226	0.066	0.052	0.068	0.065	0.058
Max 3-hr SO_2	5.583	5.605	5.599	5.065	5.599	1.125	0.997	0.788	0.650	0.728	0.352	0.268	0.313	0.341	0.462
Annual Avg. PM10	0.603	0.707	0.742	0.788	0.823	0.267	0.267	0.278	0.278	0.290	0.012	0.012	0.023	0.012	0.012
Max 24-hr PM_{10}	10.628	10.361	10.535	7.244	11.590	2.608	1.854	1.820	1.982	1.623	0.475	0.371	0.487	0.464	0.417

Note: NO_2 = nitrogen dioxide; NWA = National Wilderness Area; OCD = Offshore and Coastal Dispersion; PM_{10} = particulate matter; SO_2 = sulfur dioxide.

Table C-2 lists the values of the NAAQS, PSD Class II and Class I maximum allowable increments, and the PSD Class I significance levels. The highest onshore pollutant concentrations are within the PSD Class II and Class I maximum allowable increments. Within the Tuxedni NWA the annual average NO_2, maximum 24-hour and 3-hour SO_2, and the maximum 24-hour and annual PM_{10} values exceed the Class I significance levels. If the projected concentrations from a proposed facility exceed the significance levels, a comprehensive PSD increment consumption analysis would need to be conducted by the permit applicant.

Table C-2. PSD Maximum Allowable Increases and Class I Significance Levels (µg/m^3).

Pollutant & Averaging Period	NAAQS	Class II	Class I	Class I Significance Level
Annual Avg. NO_2	100	25	2.5	0.1
Annual Avg. SO_2	80	29	2	0.1
Max 24-hr SO_2	365	91	5	0.2
Max 3-hr SO_2	1300	512	25	1.0
Annual Avg. PM_{10}	50	17	4	0.2
Max 24-hr PM_{10}	150	30	8	0.3

Note: NAAQS = National Ambient Air Quality Standards; NO_2 = nitrogen dioxide; NWA = National Wilderness Area; PM_{10} = particulate matter; PSD = Prevention of Significant Deterioration; SO_2 = sulfur dioxide.

Table C-3 shows the modeling results for a production facility. The concentrations are significantly lower than the values for the exploration activity, mainly due to the reduced vessel activity. The highest onshore pollutant concentrations are well within the PSD Class II and Class I maximum allowable increments. The annual average NO_2 concentrations and the Max 24-hr PM_{10} within Tuxedni NWA exceed the Class I significance levels, but the SO_2 and annual PM_{10} concentrations are below the Class I significance levels for all averaging times.

Table C-3. OCD Modeling Results for Cook Inlet Production Facility (µg/m^3).

Year	Overwater					Tuxedni NWA					Other Onshore				
	2001	2002	2003	2004	2005	2001	2002	2003	2004	2005	2001	2002	2003	2004	2005
Annual Avg. NO_2	2.167	2.543	2.668	2.834	2.959	0.959	0.959	1.000	1.000	1.042	0.042	0.042	0.083	0.042	0.042
Annual Avg. SO_2	0.002	0.002	0.003	0.003	0.003	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.0001	0.000	0.000
Max 24-hr SO_2	0.036	0.035	0.036	0.025	0.039	0.009	0.006	0.006	0.007	0.006	0.002	0.001	0.002	0.002	0.001
Max 3-hr SO_2	0.136	0.137	0.137	0.124	0.137	0.027	0.024	0.019	0.016	0.018	0.009	0.007	0.008	0.008	0.011
Annual Avg. PM_{10}	0.186	0.218	0.229	0.243	0.254	0.082	0.082	0.086	0.086	0.090	0.004	0.004	0.007	0.004	0.004
Max 24-hr PM_{10}	3.283	3.201	3.255	2.238	3.580	0.806	0.573	0.562	0.612	0.501	0.147	0.115	0.150	0.143	0.129

Note: NAAQS = National Ambient Air Quality Standards; NO_2 = nitrogen dioxide; NWA = National Wilderness Area; OCD = Offshore and Coastal Dispersion; PM_{10} = particulate matter; SO_2 = sulfur dioxide.

Air quality impacts at other possible locations near the shoreline would be similar to those projected here. Impacts to locations further inland from shore would be lower. The projected pollutant concentrations in the Tuxedni NWA would be lower than in most other areas in the Cook Inlet because the prevailing winds would, in most cases, transport emissions away from the islands.

C-9. Cumulative Impacts

In addition to the oil and gas activities described above, there are other past, present and future actions that could generate emissions on or near the OCS. Those activities that could generate emissions within the region during the next 40-50 years include: ongoing oil and gas exploration, development, and production (onshore and in State of Alaska waters), future oil & gas exploration, development and production activities and infrastructure (onshore and in state waters), construction activities related to renewable energy and mining projects, marine transportation, harbors, ports and terminal operations, the Knik Arm Crossing Project (vicinity of Cook Inlet), submarine cable projects, dredging and marine disposal, military activities and fishing activities.

There are very few emission sources within about 50 km of the Tuxedni NWA. The nearest significant emission sources consist of a group of industrial facilities around Kenai about 90 km to the northeast of Tuxedni. The SCREEN3 screening model was run to estimate the most conservative case impacts from those facilities to the Tuxedni NWA. The model considered the maximum effects of the plume impinging on the terrain. For NOx, the combined maximum 24-hour average concentration from the facilities was 5.7 $\mu g/m^3$. The screening model does not yield annual average concentrations. However, annual average concentrations were estimated by applying the ratio of annual to maximum 24-hour average concentrations that was based on the OCD modeling runs for the proposed OCS activities. This ratio was found to be around 8.0. The use of this ratio yielded an annual average $N0_2$ concentration of 0.7 $\mu g/m^3$. This is comparable to the annual average $N0_2$ concentration of 0.27 $\mu g/m^3$ that was projected for the Cook Inlet OCS activities. If one combines the two values, the total concentration would be just below 1.0 $\mu g/m^3$, which is within the PSD Class I maximum allowable increment of 2.5 $\mu g/m^3$.

The maximum 24-hour PM_{10} concentration from the Kenai facilities using SCREEN3 was 0.2 $\mu g/m^3$. This is also comparable to the maximum 24-hour value of 0.5 $\mu g/m^3$ for the Cook Inlet lease sale modeling. If one combines the two concentrations, the total value is 0.7 $\mu g/m^3$, which is well within the maximum PSD Class I increment of 8 $\mu g/m^3$. The projected annual average PM_{10} concentration is 0.02 $\mu g/m^3$. The annual average PM_{10} concentration from the proposed lease sale activities was also 0.02 $\mu g/m^3$. The combined value is well within the PSD Class I allowable increment of 4 $\mu g/m^3$.

Cumulative impacts may result from any additional OCS activities in the Cook Inlet as well as contributions from oil and gas development in State waters. The additional impacts would depend on the locations of these activities with respect to those associated with the proposed lease sales. If several more OCS facilities were to be located in close proximity to the one modeled, the combined concentrations would still be within the PSD Class I limits. In reality, facilities would most likely be spread in different locations, and the combined effects would not be significantly higher than the ones associated with a single facility.

C-10. Visibility

A number of visibility screening runs were performed using the VISCREEN modeling system (VISCREEN, 2013) to evaluate potential effects of OCS activities on visibility from the Tuxedni NWA. VISCREEN calculates the potential impact of a plume of specified emissions for specific transport and dispersion conditions. For a certain distance between a source and an observer and a given set of meteorological conditions, the model calculates plume perceptibility and color contrast for a range of different viewing angles. These parameters are calculated for both a sky and a terrain background. The model does not assess impacts on regional haze; it only evaluates the visibility effects from a single plume. The model runs assumed a 100 km visible range, with a value of 0.04 ppm for background ozone. Table C-4 summarizes the five model runs. For the exploration activity, the screening criteria for plume perceptibility and color contrast were exceeded by a large margin for a 12-km distance between the source and the observer. When the distance is increased to 30 km, the screening thresholds were still exceeded, but by much smaller margins. For a 50-km distance, none of the screening criteria were exceeded.

For a production facility, the screening criteria were exceeded for the 12-km distance between the source and the observer, while none of the criteria are exceeded for a 30-km distance. The modeling was performed using the most conservative meteorological conditions, which are light winds and a stable atmosphere (Class F). For more typical meteorological conditions, the screening criteria were not exceeded. The model results indicate that under certain meteorological conditions, emission sources within about 50 km from the Tuxedni NWA may result in a visible plume for an observer there, but that more rigorous analyses would be needed to more precisely evaluate any effects.

Table C-4. Summary of VISCREEN Modeling Results.

Scenario and Meteorology	Distance, km	Plume Perceptibility			Color Contrast		
		Critical Value	Sky	Terrain	Critical Value	Sky	Terrain
Exploration, 1 m/sec, Stability Class F	12	2.0	15.8	20.3	0.05	-0.091	0.199
Exploration, 2 m/sec, Stability Class F	30	2.0	4.8	4.1	0.05	-0.035	0.052
Exploration, 3 m/sec, Stability Class F	50	2.0	1.4	1.2	0.05	-0.009	0.016
Production 1 m/sec, Stability Class F	12	2.0	7.7	11.3	0.05	-0.047	0.104
Production, 2 m/sec, Stability Class F	30	2.0	1.8	2.0	0.05	-0.010	0.026

Notes: EPA. 2000. Offshore and Coastal Dispersion Model, Version 5 (OCD5), 2000. Available at http://www3.epa.gov/scram001/dispersion_prefrec.htm.
EPA. 2013. SCREEN3 Gaussian Plume Model, 2013. Available at http://www3.epa.gov/scram001/dispersion_screening.htm.
EPA. 2013. VISCREEN Plume Visual Impact Prediction Model, 2013. Available at http://www3.epa.gov/scram001/dispersion_screening.htm.

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APPENDIX D

Applicable Laws, Regulatory Responsibilities, and Executive Orders

Appendix D. Applicable Laws, Regulatory Responsibilities, and Executive Orders

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LIST OF ACRONYMS

ACHP .... Advisory Council on Historic Preservation
BA .... Biological Assessment
BO .... Biological Opinion
BOEM .... Bureau of Ocean Energy Management
BSEE .... Bureau of Safety and Environmental Enforcement
CAAA .... Clean Air Act Amended
CEC .... Commission on Environmental Cooperation
CEQ .... Council on Environmental Quality
CFR .... Code of Federal Regulations
CWA .... Clean Water Act
EEZ .... Exclusive Economic Zone
EFH .... Essential Fish Habitat
EIS .... Environmental Impact Statement
EPAct .... Energy Policy Act
EPCA .... Energy Policy and Conservation Act
ESA .... Endangered Species Act
FOGRMA .... Federal Oil and Gas Royalty Management Act
FWCA .... Fish and Wildlife Coordination Act
G&G .... Geological and Geophysical
IHA .... Incidental Harassment Authorizations
ITA .... Incidental Take Authorization
ITS .... Incidental Take Statement
LOA .... Letters of Authorization
MARPOL .... International Convention of the Prevention of Pollution from Ships
MBTA .... Migratory Bird Treaty Act
MMPA .... Marine Mammal Protection Act
MOU .... Memorandum of Understanding
MPA .... Marine Protected Areas
MPRSA .... Marine Protection, Research, and Sanctuaries Act
NAAQS .... National Ambient Air Quality Standards
NEPA .... National Environmental Policy Act
NHPA .... National Historic Preservation Act
NMFS .... National Marine Fisheries Service
NMSA .... National Marine Sanctuaries Act
NOAA .... National Oceanic and Atmospheric Administration
NPDES .... National Pollutant Discharge Elimination System
NWP .... Nationwide Permit
OCS .... Outer Continental Shelf
OCSLA .... Outer Continental Shelf Lands Act
OPA 90 .... Oil Pollution Act of 1990
PSD .... Prevention of Significant Deterioration
PTSA .... Port and Tanker Safety Act
RCRA .... Resource Conservation and Recovery Act
RHA .... Rivers and Harbors Act
Secretary .... Secretary of the Interior
TEIA .... Transboundary Environmental Impact Assessment
U.S. .... United States
U.S.C. .... United States Code
USACE .... U.S. Army Corps of Engineers

USCG..U.S. Coast Guard
USEPA..U.S. Environmental Protection Agency
USFWS.......................................U.S. Fish and Wildlife Service
Vtss ....Vessel Traffic Service/Separation Schemes

APPENDIX D. APPLICABLE LAWS, REGULATORY RESPONSIBILITIES, AND EXECUTIVE ORDERS

This appendix provides a brief summary of only those portions of Federal public laws enacted by Congress and other applicable Federal regulatory responsibilities and executive orders (EO) as they relate directly or indirectly to Bureau of Ocean Energy Management (BOEM) management of mineral leasing, exploration and development, and production activities on leases located in the submerged lands of the Outer Continental Shelf (OCS).

This appendix also references certain key responsibilities and jurisdictions of other Federal agencies and departments involved in the regulation of oil and gas operations on the OCS.

This appendix is not intended to be a comprehensive list or explanation. References, explanations, or summaries are given only to summarize the law and are not meant as legal interpretations. The entire text of the laws should be consulted for updates and additional requirements and information.

D-1. FEDERAL LAWS AND REGULATORY RESPONSIBILITIES

D-1.1. OUTER CONTINENTAL SHELF LANDS ACT

The Outer Continental Shelf Lands Act (OCSLA) of 1953 (43 United States Code (U.S.C.) 1331 *et seq*.), as amended, established Federal jurisdiction over submerged lands on the OCS seaward of state boundaries (which were defined in the Submerged Lands Act of 1953) and directs the implementation of an OCS oil and gas exploration and development program. The basic goals of the Act are to:

1. Establish policies and procedures for managing the oil and natural gas resources of the OCS that are intended to result in expedited exploration and development of the OCS in order to achieve national economic and energy policy goals, assure national security, reduce dependence on foreign sources, and maintain a favorable balance of payments in world trade;
2. Preserve, protect, and develop oil and natural gas resources of the OCS in a manner that is consistent with the need (a) to make such resources available to meet the Nation's energy needs as rapidly as possible; (b) to balance orderly resource development with protection of the human, marine, and coastal environments; (c) to ensure the public a fair and equitable return on the resources of the OCS; and (d) to preserve and maintain free enterprise competition;
3. Encourage development of new and improved technology for energy resource production, which will eliminate or minimize risk of damage to the human, marine, and coastal environments; and
4. Ensure that affected States and Local Governments have timely access to information regarding OCS activities and opportunities to review, comment, and participate in policy and planning decisions.

The Secretary of the Interior (Secretary) is responsible under OCSLA for the administration of mineral exploration and development of the OCS. Within the U.S. Department of the Interior (USDOI), BOEM, and the Bureau of Safety and Environmental Enforcement (BSEE) are charged with managing and regulating the development of OCS oil and gas resources in accordance with the provisions of OCSLA. Relevant BOEM and BSEE regulatory provisions include the following:

- 30 CFR 250 — Oil and Gas and Sulphur Operations in the Outer Continental Shelf
    - Contains the regulations of the BSEE Offshore program that govern oil, gas, and sulphur exploration, development and production operations on the OCS.
    - Establishes procedures under which operators must submit requests, applications, notices, and supplemental information to BSEE for approval.

- 30 CFR 254 — Oil-Spill Response Requirements (discussed further below at Section D.1.14 Oil Pollution Act).
- 30 CFR 550 — Oil and Gas and Sulphur Operations in the Outer Continental Shelf
  - Contains the regulations of the BOEM Offshore program that govern oil, gas, and sulphur exploration, development and production operations on the OCS.
  - Establishes procedures under which operators must submit proposed plans, requests, applications, notices, and supplemental information to BOEM. Establishes BOEM's review process and further defines the criteria for BOEM approval of proposed activities.
- 30 CFR 551 — Geological and Geophysical (G&G) Explorations
  - Allows G&G activities in the OCS related to oil, gas, and sulphur on unleased lands or on lands under lease to a third party.
  - Ensures that operators carry out G&G activities in a safe and environmentally sound manner so as to prevent harm or damage to, or waste of, any natural resources (including any mineral deposit in areas leased or not leased), any life (including fish and other aquatic life), property, or the marine, coastal, or human environment.
  - Informs operators and third parties of their legal and contractual obligations, and of the U.S. Government's rights to access G&G data and information collected under permit, as well as proprietary terms of such data.
- 30 CFR 556 — Leasing
  - Establishes the procedures under which the Secretary of the Interior (Secretary) will exercise the authority to administer a leasing program for oil, gas, and sulphur.

OSCLA also extends the authority of the Secretary of the Army, through the U.S. Army Corps of Engineers (USACE), to the OCS to prevent obstruction to navigation in United States (U.S.) navigable waters. OSCLA grants authority to the U.S. Coast Guard (USCG) to promulgate and enforce regulations covering lighting and warning devices, safety equipment, and other safety-related matters pertaining to life and property on fixed OCS platforms and drilling vessels.

D-1.2. NATIONAL ENVIRONMENTAL POLICY ACT

The National Environmental Policy Act (NEPA), signed into law on January 1, 1970 established national environmental policies and requires a detailed EIS to be prepared for major Federal actions that may have a significant impact on the environment. The EIS shall fully discuss significant environmental impacts and inform decision makers and the public of reasonable alternatives, and it must address any adverse environmental effects that cannot be avoided or mitigated, alternatives to the proposed action, the relationship between short-term uses and long-term productivity of the environment, and any irreversible and irretrievable commitments of resources involved in the proposed action.

In 1979, the Council on Environmental Quality (CEQ) established uniform guidelines for implementing the procedural provisions of NEPA. These regulations (40 CFR 1500-1508) provide for the use of the NEPA process to identify and assess reasonable alternatives to a proposed action that avoid or mitigate adverse effects of a given action upon the quality of the human environment. The USDOI also maintains regulations concerning the implementation of NEPA; these can be found in 43 CFR 46 (*Federal Register*, 2008).

D-1.3. ENDANGERED SPECIES ACT

The Endangered Species Act (ESA), enacted in 1973 (16 U.S.C. 1531), provides a program for the conservation of threatened and endangered plants and animals and the ecosystems on which they depend. The ESA was designed to protect and recover critically imperiled species as a "consequence of economic growth and development untempered by adequate concern and conservation" and is administered by the most marine species, while USFWS has responsibility over freshwater fishes and terrestrial species. The ESA prohibits the unauthorized "take" of listed species, with "take" defined as harassing, harming, pursuing, hunting, shooting, wounding, killing, trapping, capturing, collecting, or attempting to do these things to that species.

Section 7(a)(1) of the ESA directs agencies to utilize their authorities to carry out programs for the conservation of threatened and endangered species. Federal agencies must consult with NMFS and USFWS, under Section 7(a)(2), on activities that may affect a listed species. These interagency, or Section 7, consultations are designed to assist Federal agencies in fulfilling their duty to ensure Federal actions do not jeopardize the continued existence of a species or destroy or adversely modify critical habitat. There are two types of Section 7 consultation: informal and formal.

Informal consultation occurs where a Federal agency determines that its action may affect, but is not likely to adversely affect listed species. Informal consultation is concluded when NMFS or USFWS concurs with the action agency's determination. During this process, NMFS and USFWS may also identify additional measures to minimize adverse impacts to listed species and/or their designated critical habitat.

Formal consultation is triggered when a Federal agency determines that its action is likely to adversely affect listed species or designated critical habitat. To initiate formal consultation, a Federal agency would submit a consultation package, usually referred to as a Biological Assessment (BA), to USFWS and/or NMFS for proposed actions that may affect listed species or critical habitat. After NMFS and USFWS review the BA, they provide a determination regarding the nature of any effects on each listed species likely to be adversely affected (i.e., subject to take or adverse effect on critical habitat). Formal consultation is concluded when the USFWS and/or NMFS issue a Biological Opinion (BO) containing the necessary and sufficient terms and conditions under which the action can proceed. Where appropriate, NMFS and USFWS may also issue an Incidental Take Statement (ITS) authorizing Federal agencies to take limited numbers of listed species.

BOEM will consult with USFWS and NMFS to ensure the Federal activities proposed in the Cook Inlet Planning Area do not jeopardize the continued existence of threatened or endangered species and/or result in adverse modification or destruction of their critical habitat.

D-1.4. MARINE MAMMAL PROTECTION ACT

The Marine Mammal Protection Act (MMPA) as amended (16 U.S.C. § 1361 *et seq*.) was enacted on October 21, 1972 based on the following findings: marine mammals are resources of great international significance; certain species or stocks are, or may be, in danger of extinction or depletion as a result of man's activities; such species or stocks should not be permitted to diminish beyond the point at which they cease to be a significant functioning element in the ecosystem of which they are a part, and; the primary objective of their management should be to maintain the health and stability of the marine ecosystem. To serve this broader goal, the MMPA (16 U.S.C. 1371, 50 CFR subpart 1) established a moratorium on the take of marine mammals. The term "take," as defined in the MMPA, means to harass, hunt, capture, or kill any marine mammal or to attempt such activity. The MMPA defines harassment as any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment) or 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).

There are certain exceptions to the general take prohibition whereby USFWS and NMFS may authorize take. One of these is the issuance of Incidental Take Authorizations (ITAs). Such authorization can be obtained through a Letter of Authorization (LOA) or an Incidental Take Authorization (IHA).

Letters of Authorization (LOAs) are predicated on the promulgation of regulations outlining:

- Permissible methods and the specified geographical region of taking;
- The means of effecting the least practicable adverse impact on the species or stock and its habitat and on the availability of the species or stock for "subsistence" uses; and,
- Requirements for monitoring and reporting, including requirements for the independent peer-review of proposed monitoring plans where the proposed activity may affect the availability of a species or stock for taking for subsistence uses.

Meanwhile, IHAs may be granted for specific requests to incidentally take small numbers of marine mammals by harassment within a specified timeframe. In order to authorize incidental take of marine mammals under through either an LOA or IHA, USFWS or NMFS (whichever has jurisdiction over the marine mammals at issue) must first find that the taking would be of small numbers, have no more than a negligible impact on those marine mammal species or stocks, and not have an unmitigable adverse impact on the availability of the species or stock for subsistence uses.

To ensure that activities on the OCS adhere to MMPA regulations, BOEM actively seeks information concerning impacts of OCS activities on local species of marine mammals and coordinates with USFWS and NMFS.

D-1.5. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT

The Magnuson-Stevens Fishery Conservation and Management Act of 1976 (16 U.S.C. § 1801 *et seq*.) established and delineated an area from the states' seaward boundary to approximately 200 nautical miles from shore as a fisheries conservation zone for the U.S. and its possessions. The Act created eight regional Fishery Management Councils and mandated a continuing planning program for marine fisheries management by the Fishery Management Councils. The Act, as amended, requires that a Fishery Management Plan (50 CFR 600), based on the best available scientific and economic data, be prepared for each commercial species (or related group of species) of fish in need of conservation and management within each respective region.

The Magnuson-Stevens Fishery Conservation and Management Act was reauthorized by Congress through passage of the Sustainable Fisheries Act of 1996. This reauthorization implements a number of reforms and changes. One change required NMFS to designate and conserve Essential Fish Habitat (EFH) for those species managed under an existing Fishery Management Plan. By designating EFHs, Congress hoped to minimize, to the extent practicable, any adverse effects on habitat caused by fishing or non-fishing activities and to identify other actions to encourage the conservation and enhancement of such habitat. The phrase "essential fish habitat," as defined in the Sustainable Fisheries Act of 1996, encompasses "those waters and substrate necessary to fishes for spawning, breeding, feeding, or growth to maturity." As a result of this change, Federal agencies must consult with NMFS on those activities that may have direct (for example, physical disruption) or indirect (for example, loss of prey species) effects on EFH.

Of the Fishery Management Plans for Alaskan fisheries, the plans for the Gulf of Alaska groundfish and statewide salmon and scallop management plans designate EFH within the Alaska OCS Cook Inlet Planning Area. The Fishery Management Plans are amended and updated as new information from studies and public input is received and assessed. BOEM will consult with NMFS concerning potential effects to EFH and has prepared an EFH assessment for use in that process.

D-1.6. MIGRATORY BIRD TREATY ACT

The Migratory Bird Treaty Act (MBTA) of 1918 (16 U.S.C. 703–712) is the primary legislation in the U.S. established to conserve migratory birds. It implements the U.S.'s commitment to four bilateral treaties, or conventions, for the protection of a shared migratory bird resource. The MBTA prohibits the taking, killing, or possessing of migratory birds unless permitted by regulation.

D-1.7. CLEAN AIR ACT

The Clean Air Act (CAA) of 1970 (42 U.S.C. § 7401 *et seq*.), is the comprehensive federal law that regulates air emissions from stationary and mobile sources. The CAA authorizes the U.S. Environmental Protection Agency (USEPA) to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. At present, USEPA has set NAAQS for six principal (or "criteria") pollutants: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particle pollution ($PM_{2.5}$ and PM_{10}), and sulfur dioxide (SO_2). Facilities (e.g. oil and gas drilling rigs and production platforms) that emit a certain amount of criteria pollutants must obtain and abide by the terms of CAA permits. Pursuant to Section 112 of the CAA, the USEPA has also developed technology-based emissions standards for hazardous air pollutants.

Section 309 requires the USEPA to review and comment on the environmental impact of certain proposed actions of other Federal agencies in accordance with NEPA. The comments must be in writing and made available to the public at the conclusion of a review. If the USEPA determines that the proposed action is unsatisfactory from the standpoint of public health or welfare or environmental quality, they must publish that determination and the matter must be referred to the CEQ.

D-1.8. CLEAN WATER ACT

The Clean Water Act (CWA) (33 U.S.C. §1251 *et seq*. (1972)) established the basic structure for regulating discharges of pollutants into the waters of the U.S. and regulating quality standards for surface waters. Under the CWA, it is unlawful for any person to discharge any pollutant from a point source into navigable waters without a National Pollutant Discharge Elimination System (NPDES) permit. USEPA may not issue a permit for a discharge into ocean waters unless the discharge complies with the guidelines established under Section 403(c) of the CWA. These guidelines are intended to prevent degradation of the marine environment and require an assessment of the effect of the proposed discharges on sensitive biological communities and aesthetic, recreational, and economic values. Before a permit may be granted, the assessment must demonstrate that the proposed discharge(s) will not cause unreasonable degradation to the marine environment based on the ten factors specified at 40 CFR § 125.122.

Section 311 of the CWA (33 U.S.C. § 1321), as amended, prohibits the discharge of oil or hazardous substances into the navigable waters of the U.S. that may affect natural resources, except under limited circumstances, and establishes civil penalty liability and enforcement procedures to be administered by the USCG.

In conjunction with the issuance of a NPDES permit, the USEPA is responsible for publishing an Ocean Discharge Criteria Evaluation that evaluates the impacts of waste discharges proposed for oil and gas projects. The purpose of the Ocean Discharge Criteria Evaluation is to demonstrate whether or not a particular discharge will cause unreasonable degradation to the marine environment.

Section 404 of the CWA (33 U.S.C. § 1344) authorizes issuance of permits, under certain criteria, for discharge of dredged or fill material into navigable waters at specified disposal sites. The Secretary of the Army, acting through the USACE, has the authority to administer Section 404.

The USACEs Nationwide Permit (NWP) Program, also called a general permit was developed to streamline the evaluation and approval process for certain types of activities that have only minimal impacts to the aquatic environment. These permits may also grant authorization under various provisions of the Rivers and Harbors Act (see D.1.15, below). Any applicant that intends to use a NWP should ensure that their proposed activity meets the terms, conditions, and any regional conditions of the NWP, and any additional Section 401 water quality requirements. Most G&G survey activities qualify for one of two NWPs. NWP 5 covers the placement of Scientific Measurement Devices such as staff gauges, tide gauges, water recording devices, water quality testing and improvement devices, and similar structures, applicable to certain G&G activities such as the temporary installation of meteorological buoys or other data collection devices. NWP 6 addresses survey activities such as core sampling, seismic exploratory operations, plugging of seismic shot holes and other exploratory-type bore holes, exploratory trenching, soil surveys, sampling, and historic resources surveys. Most G&G survey activities would require a NWP 6. Drilling and discharge of excavated material from test wells for oil and gas exploration are not authorized by NWP 6 and would require a Section 404/Section 10 Permit, also called a standard permit.

D-1.9. ENERGY POLICY AND CONSERVATION ACT

The Energy Policy and Conservation Act (EPCA) (P.L.94-163, 42 U.S.C. § 6201), enacted December 22, 1975, responded to the 1973 oil crisis by creating a comprehensive approach to Federal energy policy. The primary goals of the EPCA are to increase energy production and supply, reduce energy demand, provide energy efficiency, and give the executive branch additional powers to respond to disruptions in energy supply. Bidders submitting bids on OCS leases are subject to the provisions of 18 U.S.C. 1860. BOEM regulations implementing certain provisions of the EPCA are at 30 CFR Part 556.

D-1.10. INTERNATIONAL CONVENTION OF THE PREVENTION OF POLLUTION FROM SHIPS AND MARINE PLASTICS POLLUTION RESEARCH AND CONTROL ACT

The 1978 International Convention of the Prevention of Pollution from Ships (MARPOL) contains five annexes on ocean dumping. Annex V is of particular importance to the maritime community (for example, shippers, oil- platform personnel, fishers, and recreational boaters) because it prohibits the disposal of plastics at sea and regulates the disposal of other types of garbage at sea. The USCG is the enforcement agency for MARPOL Annex V within the U.S. Exclusive Economic Zone (EEZ) (within 200 miles of the U.S. shoreline).

The Marine Plastic Pollution Research and Control Act of 1988 (33 U.S.C. § 1901 *et seq*.) is the Federal law implementing MARPOL Annex V in all U.S. waters. Under the Marine Plastic Pollution Research and Control Act, it is illegal to throw plastic trash off any vessel within the U.S. EEZ, and to throw any other garbage overboard while navigating in inland waters or within 3 miles offshore. Fixed and floating platforms, drilling rigs, manned productions platforms, and support vessels operating under a Federal oil and gas lease are required to develop waste management plans and to post placards reflecting discharge limitations and restrictions.

D-1.11. MARINE PROTECTION, RESEARCH, AND SANCTUARIES ACT

The Marine Protection, Research, and Sanctuaries Act (MPRSA) (33 U.S.C. § 1401 *et seq*.), enacted in 1972 and also referred to as the Ocean Dumping Act, generally prohibits (1) transportation of material from the U.S. for the purpose of ocean dumping; (2) transportation of material from anywhere for the purpose of ocean dumping by U.S. agencies or U.S.-flagged vessels; and (3) dumping of material transported from outside the U.S. into the U.S. territorial sea. A permit is required to deviate from these prohibitions. Permits for dumping dredged material into ocean waters are issued by the USACE.

Under MPRSA, the standard for permit issuance is whether the dumping will "unreasonably degrade or endanger" human health, welfare, or the marine environment. USEPA is charged with developing ocean dumping criteria to be used in evaluating permit applications. The MPRSA contains provisions that address marine sanctuaries which are administered by the National Oceanic and Atmospheric

Administration (NOAA). A reauthorization of Title III in 1992 resulted in the renaming of this section to the National Marine Sanctuaries Act (NMSA).

D-1.12. NATIONAL FISHING ENHANCEMENT ACT

The National Fishing Enhancement Act of 1984 (33 U.S.C. § 2101 *et seq*.), also known as the Artificial Reef Act, established broad artificial reef development standards and a national policy to encourage the development of artificial reefs that will enhance fishery resources and commercial and recreational fishing. The National Plan identifies oil and gas structures as acceptable material of opportunity for artificial reef development. BOEM adopted a rigs-to-reefs policy in 1985 in response to this Act and to broaden interest in the use of petroleum platforms as artificial reefs.

D-1.13. NATIONAL HISTORIC PRESERVATION ACT

The National Historic Preservation Act (NHPA) of 1966, as amended, established a program for the preservation of historic properties. Section 106 of the NHPA (36 CFR 800), "Protection of Historic Properties," as amended through 2004, requires that Federal agencies having direct or indirect jurisdiction over a proposed Federal, Federally assisted, or Federally licensed undertaking, prior to approval of the expenditure of funds or the issuance of a license, to take into account the effect of the undertaking on any district, site, building, structure, or object included in or eligible for inclusion in the National Register of Historic Places. The Advisory Council on Historic Preservation (ACHP), which administers Section 106, has issued regulations (36 CFR 800) defining how Federal agencies are to meet the statutory responsibilities. The head of a Federal agency shall afford the ACHP a reasonable opportunity to review and comment on the undertaking.

An undertaking has an effect on a historic property when it has the potential to alter the characteristics of the property that led to its inclusion in the National Register of Historic Places. The effects can include physical disturbance, noise, or visual effects. If an adverse effect on historic properties is found, BOEM would notify the ACHP, consult with the State Historic Preservation Office, and encourage the applicant to avoid, minimize, or mitigate the adverse effects. Ground-disturbing activities associated with construction, as well as visual effects of OCS energy infrastructure are subject to Section 106 review.

Historic properties (i.e., archaeological resources) on the OCS include historic shipwrecks, sunken aircraft, lighthouses, and prehistoric archaeological sites that have become inundated as a result of the 120-m (394-ft) rise in global sea level since the height of the last Ice Age (ca. 19,000 years ago).

Before approving any OCS exploration or development activities within an archaeologically sensitive area, BOEM requires the lessee to conduct a marine remote-sensing survey and to prepare an archaeological report (30 CFR 550.194).

Archaeological surveys are required both onshore and offshore in areas where there is the potential for archaeological resources to exist, so that potential impacts to archaeological resources from physical disturbance could be mitigated. If the marine remote-sensing survey indicates any evidence of a potential historic property, the lessee must either:

- Move the site of the proposed lease operations a sufficient distance to avoid the potential historic property, or
- Conduct further investigations to determine the nature and significance of the potential historic property. If further investigation determines that there is a significant historic property within the area of proposed OCS operations, NHPA consultation procedures will be followed.

D-1.14. OIL POLLUTION ACT

The Oil Pollution Act of 1990 (OPA 90), as amended (33 U.S.C. § 2701 *et seq*.), establishes a single uniform Federal system of liability and compensation for damages caused by oil spills in U.S. navigable waters. The OPA 90 requires removal of spilled oil and establishes a national system of planning for and responding to oil-spill incidents. The OPA 90 includes provisions to:

- Improve oil-spill prevention, preparedness, and response capability;
- Establish limitations on liability for damages resulting from oil pollution;
- Provide funding for natural resource damage assessment;
- Implement a fund for the payment of compensation for such damages; and
- Establish an oil pollution research and development program.

The USCG is responsible for enforcing vessel compliance with OPA 90. The USCG regulations on the oil-spill liability of vessels and operators are found under 33 CFR §§ 132, 135, and 136.

Section 1016 of OPA 90 (33 U.S.C. § 2716), as amended by the Coast Guard Authorization Act of 1996, supersedes the offshore oil-spill financial-responsibility provision of Title III of the OCSLA Amendments of 1978, previously administered by the USCG. Under OPA 90 and EO 12777 - Implementation of Section 311 of the Federal Water Pollution Control Act of October 18, 1972, as Amended, and the Oil Pollution Act of 1990 (October 18, 1991), the Secretary is given authority over covered offshore facilities and associated pipelines (except deepwater ports) for all Federal and State waters. The Secretary delegated this authority to BOEM or BSEE. The resulting tasks for BOEM include the following: reviewing exploration and development plans, reviewing spill financial liability limits, and certifying spill financial responsibility.

BOEM regulations are at 30 CFR § 553 that implement Title I of the OPA 90 establish the requirements for demonstrating oil-spill financial responsibility for covered offshore facilities requiring responsible parties to demonstrate they can pay for cleanup and damages caused by facility oil spills. These regulations govern financial responsibility requirements for: oil spills, covered offshore facilities and related requirements, certain crude oil wells, production platforms, and pipelines located in the OCS and certain State waters.

BSEE oil spill response regulations at 30 CFR 254 require that an owner or operator of an oil handling, storage, or transportation facility located seaward of the coast line must submit a spill-response plan to BSEE for approval. The spill-response plan must demonstrate the ability to respond quickly and effectively to any oil emission (other than natural seepage), intentional or unintentional, including but not limited to, spilling, leaking, pumping, pouring, emitting, emptying, or dumping that is discharged from the facility.

D-1.15. RIVERS AND HARBORS ACT

The Rivers and Harbors Act (RHA) (33 U.S.C. 401, 403, 407), enacted in 1899, was the first Federal water pollution act in the U.S. It focuses on protecting navigation, protecting waters from pollution, and acted as a precursor to the CWA of 1972.

Various sections of this Act establish permit requirements to prevent unauthorized obstruction or alteration of any navigable water of the U.S. The USACE, through the Secretary of the Army, has permitting authority for any structure work conducted in or affecting U.S. navigable waters and for construction of artificial islands, fixed structures, and other installations on the OCS. This authority arises from a provision in the OCSLA (43 U.S.C. § 1333(e)) that extends the Secretary of the Army's authority to prevent obstruction to navigation in U.S. navigable waters from structures located on the OCS that are used for exploring, developing, producing, or transporting natural resources.

Section 10 (33 U.S.C. 403) prohibits the unauthorized obstruction or alteration of any navigable water of the U.S., that is, construction of various structures that hinder navigable capacity of any waters, without the approval of Congress. While the initial purpose of the Act was to prevent obstructions to navigation, a 1959 Supreme Court decision interpreted obstruction to navigation to include water pollution. In addition, Section 10 authorizes the USACE, through the Secretary of the Army, to issue permits for all offshore construction in U.S. navigable waters, including pipelines, exploratory drilling vessels, fixed and mobile platforms, piers, wharves, bulkheads, or other works. Permits also must be issued for onshore facilities that involve dredging, filling, and excavating in U.S. navigable waters. Section 10 is applicable for structures, installations, and other devices on the OCS seabed. Section 10 is not applicable to most actions undertaken for exploration on the OCS, the exception being drilling and discharge of excavated material from test wells, as they fall under NWP-6. A NWP-5 for "Scientific Measurement Devices" and NWP-6 for "Survey Activities" are both appropriate for Section 10 actions.

D-1.16. RESOURCE CONSERVATION AND RECOVERY ACT

The Resource Conservation and Recovery Act (RCRA) of 1976 (42 U.S.C. § 6901 *et seq.*), and as amended through 1996, provides a framework for the safe disposal and management of hazardous and solid wastes. Most oil-field wastes have been exempted from coverage under the RCRA hazardous-waste regulations. Any hazardous wastes that are not exempt must be disposed of at a hazardous-waste facility.

D-1.17. PORTS AND WATERWAYS SAFETY ACT

The Ports and Waterways Safety Act (PWSA) (33 U.S.C. § 1221 *et seq.*) enacted in 1972, authorizes the USCG to establish vessel traffic service/separation schemes (VTSS) for ports, harbors, and other waters subject to congested vessel traffic. The VTSS apply to commercial ships, other than fishing vessels, weighing 300 gross tons (270 gross metric tons) or more. The USCG is authorized to designate safety fairways, fairway anchorages, and traffic separation schemes to provide unobstructed approaches through oil fields for vessels using ports. The USCG regulations provide listings of these designated areas along with special conditions related to oil and gas production. In general, no fixed structures such as platforms are allowed in fairways. Temporary underwater obstacles such as anchors and attendant cables or chains attached to floating or semisubmersible drilling rigs may be placed in a fairway under certain conditions. Fixed structures may be placed in anchorages, but the number of structures is limited. The USCG regulations on port access routes are found under 33 CFR § 164.

The PWSA generally applies in any port or place under the jurisdiction of the U.S., or in any area covered by an international agreement. Title 33 CFR 2.05-30 defines waters subject to the jurisdiction of the U.S. as navigable waters, other waters on lands owned by the U.S., and waters within U.S. territories and possession of the U.S. The PWSA was amended by the Port and Tanker Safety Act (PTSA) of 1978 (Public Law 95-474). Under the PTSA, Congress found that increased supervision of vessel and port operations was necessary to reduce the possibility of vessel or cargo loss, or damage to life, property or the marine environment and ensure that the handling of dangerous articles and substances on the structures in, on, or immediately adjacent to the navigable waters of the U.S. is conducted in accordance with established standards and requirements.

The PTSA provided broader regulatory authority over regulated and non-regulated areas such as improvements in the supervision and control of all types of vessels operating in U.S. navigable waters, and in the safety of foreign or domestic tank vessels that transport or transfer oil or hazardous cargoes in ports or places subject to U.S. jurisdiction. The PTSA also reflects certain tank vessel standards and requirements accepted internationally, specifically those developed by the International Conference on Tanker Safety and Pollution Prevention.

D-1.18. FEDERAL OIL AND GAS ROYALTY MANAGEMENT ACT

The Federal Oil and Gas Royalty Management Act (FOGRMA) of 1982 (30 U.S.C. § 701 *et seq.*), was enacted to ensure that all oil and gas originating on public land and on the OCS are properly accounted for under the direction of the Secretary. This Act defines the responsibilities and obligations of lessees, operators, and other persons involved in the transportation of oil and gas from Federal, Indian, and OCS lands. The Secretary has the responsibility to maintain a royalty management system and enforce the prompt collection and disbursement of oil and gas revenues owed to the U.S., Indian lessors, and the states.

The Secretary oversees a comprehensive inspection and collection system with fiscal and production accounting and auditing systems to accurately determine oil and gas royalties, interest, fines, penalties, fees, deposits, and other payments owed and to collect and account for the payments in a timely manner.

The FOGRMA requires a lessee, operator, or other person directly involved in the developing, producing, transporting, purchasing, or selling of oil and gas to establish and maintain records, make reports, and provide information as required by the Secretary.

Regulations at 30 CFR 1201 through 1243 were published by BOEM to implement the provisions of the FOGRMA. Regulations at 30 CFR 1218 through 1256 address royalties, net profit shares, Fisherman's Contingency Fund, and rental payments on Federal OCS leases.

D-1.19. BALD EAGLE PROTECTION ACT

The Bald Eagle Protection Act (16 U.S.C. § 668-668d) prohibits the taking or possession of and commerce in bald and golden eagles, with limited exceptions. This Act imposes criminal and civil penalties on anyone (including associations, partnerships and corporations) in the U.S. or within its jurisdiction who, unless excepted, takes, possesses, sells, purchases, barters, offers to sell or purchase or barter, transports, exports or imports at any time or in any manner a bald or golden eagle, alive or dead; or any part, nest or egg or these eagles; or violates any permit or regulations issued under the Act. The Secretary may permit the taking of golden eagle nests which interfere with resource development or recovery operations. Bald eagles may not be taken for any purpose unless the Secretary issues a permit prior to taking. Authorized USDOI employees who witness a violation of this Act may arrest the violator without a warrant and take the person to an officer or court.

D-2. EXECUTIVE ORDERS

- D-2.1. Executive Order 13212 – Actions to Expedite Energy-Related Projects
- D-2.2. Executive Order 12898 – Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations
- D-2.3. Executive Order 13175 – Consultation and Coordination with Indian Tribal Governments
- D-2.4. Executive Order 13007 – Indian Sacred Sites
- D-2.5. Executive Order 13158 – Marine Protected Areas
- D-2.6 Executive Order 13186 – Responsibilities of Federal Agencies To Protect Migratory Birds
- D-2.6. Executive Order 13547 – Stewardship of the Ocean, Our Coasts, and the Great Lakes
- D-2.7. Executive Order 13112 – Invasive Species
- D-2.8. Executive Order 11990 – Protection of Wetlands
- D-2.10. Executive Order 11988 – Floodplain Management

D-2.1. EXECUTIVE ORDER 13212 – ACTIONS TO EXPEDITE ENERGY-RELATED PROJECTS

The EO 13212, issued by President George W. Bush on May 18, 2001, states that "… in order to take additional steps to expedite the increased supply and availability of energy to our Nation …," (*Federal Register,* 2001) it is necessary to improve the Federal Government's internal management of actions associated with energy-related projects. In general, the EO directs executive departments and agencies to take appropriate actions to expedite projects that will increase the production, transmission, or conservation of energy. Departments and agencies must expedite their review of permits or take other actions as necessary to accelerate the completion of such projects while maintaining safety, public health, and environmental protections. Agencies must take such actions to the extent permitted by law, the regulations, and where appropriate.

D-2.2. EXECUTIVE ORDER 12898 – FEDERAL ACTIONS TO ADDRESS ENVIRONMENTAL JUSTICE IN MINORITY POPULATIONS AND LOW- INCOME POPULATIONS

Signed on February 11, 1994, by President William J. Clinton, EO 12898 required that each Federal agency, to the greatest extent practicable and permitted by law, make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. The EO required that within one year each Federal agency develop an environmental justice strategy that identified and addressed disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations. The CEQ has oversight of the Federal Government's compliance with EO 12898. The CEQ guidance for implementation of EO 12898 in the context of NEPA (CEQ, 1997) identifies a minority population as an affected area where more than 50 percent of the population belongs to a minority group or where the percentage presence of minority groups is meaningfully greater than in the general population (*Federal Register*, 1994a).

Agencies are required to incorporate into their NEPA documents analysis of the environmental effects of their proposed action on minorities and low-income populations and communities. The environmental justice issues encompass a broad range of impacts covered by NEPA, and concerns may arise from impacts on the natural or physical environment or from interrelated social, cultural, and economic effects.

Environmental justice concerns are considered anywhere where OCS projects and associated NEPA documentation take place; however, issues concerning Alaska OCS-related impacts primarily have focused on the subsistence hunting, fishing, and gathering activities that occur in coastal areas.

D-2.3. EXECUTIVE ORDER 13175 – CONSULTATION AND COORDINATION WITH INDIAN TRIBAL GOVERNMENTS

Signed on November 6, 2000, by President William J. Clinton, EO 13175 established regular and meaningful consultation and collaboration with tribal officials in the development of Federal policies that have tribal implications, to strengthen the U.S. Government-to-government relationships with Indian Tribes, and to reduce the imposition of unfunded mandates upon Indian Tribes. EO 13175 reaffirmed the Federal Government's commitment to a Government-to-government relationship with Indian Tribes, and directed Federal agencies to establish procedures to consult and collaborate with Tribal Governments when new agency regulations would have tribal implications. This EO is a directive to all Federal agencies, but it only has persuasive authority for independent regulatory agencies (i.e., the Federal Communications Commission, Securities and Exchange Commission, etc.), and is not meant to create a right, substantial or procedural, that is enforceable by law.

D-2.4. EXECUTIVE ORDER 13007 – INDIAN SACRED SITES

Signed on May 24, 1996, by President William J. Clinton, EO 13007 directs Federal land-managing agencies to accommodate access to, and ceremonial use of, Indian sacred sites by Indian religious practitioners and to avoid adversely affecting the physical integrity of such sacred sites. It is BOEM's policy to consider the potential effects of all aspects of plans, projects, programs, and activities on Indian sacred sites, and to consult with Tribal Governments before taking actions that may affect Indian sacred sites located on Federal lands (*Federal Register*, 1994b).

D-2.5. EXECUTIVE ORDER 13158 – MARINE PROTECTED AREAS

Signed on May 26, 2000, by President William J. Clinton, EO 13158 strengthened and expanded the nation's system of marine protected areas (MPAs) (*Federal Register*, 2000). Specifically, the EO was to, consistent with domestic and international law: (a) strengthen the management, protection, and conservation of existing marine protected areas and establish new or expanded MPAs; (b) develop a scientifically based, comprehensive national system of MPAs representing diverse U.S. marine ecosystems, and the nation's natural and cultural resources; and (c) avoid causing harm to MPAs through Federally conducted, approved, or funded activities. More than 1,700 such Federal and state/territory sites exist today.

This EO directs Federal agencies to work closely with State, Local, and non-governmental partners to create a comprehensive system of MPAs "representing diverse U.S. marine ecosystems, and the nation's natural and cultural resources." Ultimately, the MPA system will include new sites, as well as enhancements to the conservation of existing sites. The MPA Center, established under EO 13158, was created to support and link MPA programs, providing the best available science and tools, as well as a means to work together to address common management challenges. In cooperation with the USDOI and working closely with other organizations, the MPA Center coordinates the effort to implement the EO and:

- Develops the framework for a national system of MPAs;
- Coordinates the development of information, tools, and strategies;
- Provides guidance that will encourage efforts to enhance and expand the protection of existing MPAs and to establish or recommend new ones;
- Coordinates the MPA website;
- Partners with Federal and non-Federal organizations to conduct research, analysis, and exploration;
- Helps maintain the National MPA List; and
- Supports the MPA Advisory Committee.

D-2.6. EXECUTIVE ORDER 13186, RESPONSIBILITIES OF FEDERAL AGENCIES TO PROTECT MIGRATORY BIRDS

EO 13186, Responsibilities of Federal Agencies To Protect Migratory Birds, directed that each Federal agency taking actions that have, or are likely to have, a measurable negative effect on migratory bird populations is directed to develop and implement, within two years, a MOU with USFWS that shall promote the conservation of migratory bird populations (*Federal Register*, 2001). On June 4, 2009, USDOI entered into an MOU with USFWS to comply with EO 13186 (USDOI, 2009). The overall purpose of the MOU is to strengthen collaboration between BOEM and BSEE and USFWS. Included in the MOU is the direction to expand coverage in environmental reviews mandated by NEPA of the effects of agency actions on migratory birds, with emphasis on species of concern in furtherance of conservation of migratory bird populations.

D-2.7. EXECUTIVE ORDER 13547 – STEWARDSHIP OF THE OCEAN, OUR COASTS, AND THE GREAT LAKES

Signed on July 19, 2010, by President Obama, EO 13547 established a National Ocean Policy and the National Ocean Council (*Federal Register*, 2010). The EO establishes a national policy to ensure the protection, maintenance, and restoration of the health of ocean, coastal, and Great Lakes ecosystems and resources, enhance the sustainability of ocean and coastal economies, preserve our maritime heritage, support sustainable uses and access, provide for adaptive management to enhance our understanding of and capacity to respond to climate change and ocean acidification, and coordinate with U.S. national security and foreign policy interests. Where BOEM actions affect the ocean, the EO requires BOEM to take such action as necessary to implement this policy, the stewardship principles, and national priority objectives adopted by the EO, and guidance from the National Ocean Council.

The National Ocean Policy, created by EO 13547, established the National Ocean Council, which consists of 27 Federal agencies, offices, and departments (including BOEM) that work together to share information and streamline decision-making (National Ocean Council, 2013). EO 13547 adopted the Final Recommendations of the Interagency Ocean Policy Task Force which provided:

- A framework for the Nation's first ever National Policy for the Stewardship of the Ocean, Coasts and Great Lakes;
- A governance structure to provide sustained high-level and coordinated attention to ocean, coastal, and Great Lakes issues;
- An implementation strategy that identifies nine priority objectives; and
- A framework for effective Marine Planing employing a comprehensive and integrated Ecosystem-Based Management approach (USDOI, BOEM, 2015).

D-2.8. EXECUTIVE ORDER 13112 – INVASIVE SPECIES

Signed on February 3, 1999, by President William J. Clinton, EO 13112 was intended to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause (*Federal Register*, 1999). EO 13112 defines an "invasive species" as a species that is not native (or alien) to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health. This EO requires all Federal agencies to:

- Identify any actions affecting the status of invasive species
- Prevent invasive-species introduction
- Detect and respond to and control populations of invasive species in a cost-effective and environmentally sound manner
- Monitor invasive-species populations accurately and reliably
- Provide for restoration of native species and habitat conditions in invaded ecosystems
- Conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species
- Promote public education on invasive species and the means to address them
- Refrain from authorizing, funding, or carrying out actions that are likely to cause or promote invasive species introduction or spread, unless the Federal agency has determined that the benefits of such actions clearly outweigh the potential harm caused by invasive species and that all feasible and prudent measures to minimize risk of harm will be taken

D-2.9. EXECUTIVE ORDER 11990 – PROTECTION OF WETLANDS

Signed on May 24, 1977, by President Jimmy Carter, EO 11990 directs Federal agencies to avoid construction or management practices that would adversely affect wetlands unless that agency finds that (1) there is no practicable alternative, and (2) the proposed action includes all practicable measures to minimize harm to the wetlands. It directs all Federal agencies to minimize the destruction, loss, or degradation of wetlands; and preserve and enhance the natural beneficial values of wetlands in the conduct of the agency's responsibilities (EO 11990, 1977).

D-2.10. EXECUTIVE ORDER 11988 – FLOODPLAIN MANAGEMENT

Signed on May 24, 1977, by President Jimmy Carter, EO 11988 directs Federal agencies to avoid construction or management practices that would adversely affect floodplains unless that agency finds (1) there is no practical alternative and (2) the proposed action has been designed or modified to minimize harm to or within the floodplain. The EO directs all Federal agencies to reduce the risk of flood loss; minimize the impact of floods on human safety, health, and welfare; and to restore and preserve the natural and beneficial values served by floodplains in carrying out the agency's responsibilities (EO 11988, 1977).

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APPENDIX E

Estimate of Employment, Population, and Fiscal Impacts

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Estimate of Employment, Population and Fiscal Impacts

OCS Sale 244: Upper Cook Inlet

July 2015

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EXECUTIVE SUMMARY

This report is input to the socioeconomic impact analysis for the OCS Sale 244 EIS, Upper Cook Inlet, scheduled for 2016. The exploration and development scenario underlying the analysis was provided by BOEM in their “Lease Sale 244, Cook Inlet EIS Exploration and Development Scenario” (“BOEM scenario”).

This report contains the estimated direct employment estimates for the Kenai Peninsula Borough (KPB) applied to each segment (exploration, development, and production). The direct employment estimates generate direct earnings estimates. Indirect and induced employment and earnings multipliers are applied to the direct employment and earnings to yield total employment and earnings. The employment estimates generate population estimates. Finally, the fiscal impact to the KPB, State of Alaska, and federal government are estimated.

During the exploration phase employment is from seismic surveys (including geohazard and geotechnical work) and exploration and delineation drilling. During the development phase there is employment from platform installation, development drilling, and pipeline construction. During the production phase there is platform and shore-based employment to produce oil and gas.

This report utilizes the best available public information. Some of this is through literature searches and interviews with knowledgeable parties. Some of the data is based on current and planned activities associated with offshore development in Furie Alaska’s Kitchen Lights Unit, and BlueCrest Energy’s Cosmopolitan Unit, the first offshore developments in Cook Inlet since 2000, as analogs to what actually OCS development would look like. The former is currently under development for planned production to commence this year. The latter is in feasibility planning.

1. SEISMIC, GEOHAZARD, AND GEOTECHNICAL SURVEYS

Per the BOEM scenario these scenarios would occur in late summer / early fall, and could continue until freeze-up before December 1. There would be one seismic survey in years 1 and 2, one geohazard survey in year 1 and two in years 2 and 3, and one technical survey in year 1 and two in years 2 and 3.

It is assumed a 3-D seismic survey contains 120 people on 7-8 boats that operate 24 hours per day. This includes two complete crews, with one-third of the crew rotating every 30 days. Geohazard and geotechnical surveys consist of 1-2 boats with 20 people that operate 24 hours per day. This also includes two complete crews, with one-third of the crew rotating every 30 days.[1]

Table 1 shows the estimates for the surveying employment.

TABLE 1: DIRECT EMPLOYMENT ESTIMATES – SEISMIC/GEOHAZARDS/GEOTECHNICAL

Year	Seismic					Geohazards					GeoTechnical					Total
	Number of Surveys	Crew Size	Rotation	Seasonality	Subtotal	Number of Surveys	Crew Size	Rotation	Seasonality	Subtotal	Number of Surveys	Crew Size	Rotation	Seasonality	Subtotal	
1	1	115	1.33	0.25	38	1	20	1.33	0.25	7	1	20	1.33	0.25	7	**52**
2	1	115	1.33	0.25	38	2	20	1.33	0.25	13	2	20	1.33	0.25	13	**65**
3	0	115	1.33	0.25	0	2	20	1.33	0.25	13	2	20	1.33	0.25	13	**27**

2. EXPLORATION / DELINEATION DRILLING

Per the BOEM scenario exploratory / delineation drilling would occur in years 2 (3 wells), 3 (3 wells), 4 (2 wells), and 5 (2 wells), for a total of 10 wells. Each well would take 30-60 days to drill, and a rig could drill three wells in a season.

Even though the recent offshore exploratory drilling from jack-up rigs utilized outside crews, it is assumed that due to the longevity of the program local crews would be used. An estimated 100 jobs is required for rig operation during exploration.[2]

Table 2 displays the estimated direct employment for exploratory / delineation drilling.

TABLE 2: DIRECT EMPLOYMENT ESTIMATES – EXPLORATION/DELINEATION DRILLING

Year	Number of Wells	Crew Size	Seasonality	Total
1	0	100	0.167	0
2	3	100	0.167	50
3	3	100	0.167	50
4	2	100	0.167	33
5	2	100	0.167	33

[1] Conversations with SAExploration and Apache Corporation, June 23, 2015.
[2] AIDEA, Project Development and Asset Management Project Summary Matrix Active Projects, February 2015.

3. DEVELOPMENT: PLATFORM INSTALLATION

The Kitchen Lights platform currently under construction in Cook Inlet is a monopod platform consisting of modular components built elsewhere and shipped up. Because the installation is so specialized, and because there is only one platform involved, specialized crews from the Gulf of Mexico are being employed. Crews reside on support vessels, and most vendor supplies are from outside. There is little interaction with the community.

Per the BOEM scenario there would be three platforms. It is assumed the platform installation would proceed no differently than under the Kitchen Lights experience. Therefore, the direct employment impact to the KPB.

4. DEVELOPMENT: DRILLING

Per the BOEM scenario production and service wells would be drilled in years 7 (3 wells), 8 (9 wells), 9 (12 wells), 10 (15 wells), 11 (15 wells), 12 (6 wells), and 13 (6 wells), for a total of 66 wells. A maximum of 6 wells could be drilled from any platform in a year.

It is estimated there would be 28 jobs associated with each well.3

Table 3 shows the estimated direct employment from development drilling.

TABLE 3: DIRECT EMPLOYMENT ESTIMATES – DEVELOPMENT DRILLING

Year	Number of Wells	Crew Size	Seasonality	Total
7	3	28	0.167	14
8	9	28	0.167	42
9	12	28	0.167	56
10	15	28	0.167	70
11	15	28	0.167	70
12	6	28	0.167	28
13	6	28	0.167	28

5. DEVELOPMENT: PIPELINES CONSTRUCTION

Per the BOEM scenario there would be 50 miles each of onshore oil and gas pipelines, 85 miles of offshore oil pipelines, and 115 miles of offshore gas pipelines. Pipeline diameter would be 12 inches.

[3] Petroleum News Alaska, "Furie inching closer to kitchen lights startup," 11/16/14.

The onshore pipe would be installed in year 6. There would be 60 miles of offshore oil pipe installed in year 6 and 25 miles in year 9. There would be 60 miles of offshore gas pipeline installed in year 6, 30 miles in year 7, and 25 miles in year 9.

Per the BOEM scenario the offshore pipe would be installed with subsea trenching jets similar to proposed Trans-Foreland pipeline, which will run between east and west Cook Inlet.

The Trans-Foreland pipeline is an 8-inch diameter pipe, which will run 29 miles. It is anticipated a crew of 130 will install the pipe in 6 months (0.16 miles per day), followed by 12 permanent operations jobs.[4]

Accordingly, at 29 miles per crew per year (working in the ice-free season), there would be 4 offshore crews working in year 6, 1 crew in year 7, and 2 crews in year 9.

For the onshore pipe it is estimated an onshore crew of 20 could install the pipe in one year.[5] This would be 0.3 miles per day, similar to the Kenai Kachemak Pipeline construction experience in 2002.[6] There would be an estimated 6 jobs associated with ongoing operation.

Table 4 displays the estimated direct employment for pipeline construction.

TABLE 4: DIRECT EMPLOYMENT ESTIMATES – PIPELINE CONSTRUCTION

	ONSHORE				OFFSHORE				TOTAL
Year	Crews	Size of Crew	Seasonality	Subtotal	Crews	Size of Crew	Seasonality	Subtotal	
6	1	20	1.0	20	4	130	0.5	260	280
7	0	20	1.0	0	1	130	0.5	65	65
8	0	20	1.0	0	0	130	0.5	0	0
9	0	20	1.0	0	2	130	0.5	130	130

[4] Petroleum News Alaska, "Cook Inlet Energy works west side," 11/17/13.
[5] The INGAA Foundation, Inc., "Building Interstate Natural Gas Transmission Pipelines: A Primer," January 2013, p.25.
[6] Petroleum News Alaska, "Gas delivery to Enstar driving Kenai Kachemak Pipeline schedule," 1/20/02.

6. ON-SHORE FACILITIES

Per the BOEM scenario, there will be sufficient onshore capacity for shore bases and oil and gas processing. Accordingly no such facilities will be required.

7. PRODUCTION

Per the BOEM scenario oil production (and small amounts of associated gas) would occur from two platforms beginning in year 7 and 10, respectively, and continue through year 33. Gas production would occur from one platform in years 8-33. It is estimated there would 15 permanent jobs for each platform for operation and maintenance, and administration and support.[7]

As discussed above, there would also be 12 offshore long-term positions and 6 onshore positions associated with the pipelines.

Table 5 depicts the estimated direct employment for the production phase.

[7] Memo from Ted Leonard, Executive Director, Alaska Industrial & Development Export Authority to Board Members regarding Resolution No. G15—01 Authorizing Cost Reimbursement between AIDEA, Furie Operating Alaska, LLC and Cornucopia Oil & Gas Co., LLC, January 14, 2015.

TABLE 5: DIRECT EMPLOYMENT ESTIMATES – PRODUCTION						
Year	**Oil Platform 1**	**Oil Platform 2**	**Gas Platform**	**Onshore Pipe**	**Offshore Pipe**	**TOTAL**
7	15	0	0	6	12	33
8	15	0	15	6	12	48
9	15	0	15	6	12	48
10	15	15	15	6	12	63
11	15	15	15	6	12	63
12	15	15	15	6	12	63
13	15	15	15	6	12	63
14	15	15	15	6	12	63
15	15	15	15	6	12	63
16	15	15	15	6	12	63
17	15	15	15	6	12	63
18	15	15	15	6	12	63
19	15	15	15	6	12	63
20	15	15	15	6	12	63
21	15	15	15	6	12	63
22	15	15	15	6	12	63
23	15	15	15	6	12	63
24	15	15	15	6	12	63
25	15	15	15	6	12	63
26	15	15	15	6	12	63
27	15	15	15	6	12	63
28	15	15	15	6	12	63
29	15	15	15	6	12	63
30	15	15	15	6	12	63
31	15	15	15	6	12	63
32	15	15	15	6	12	63
33	15	15	15	6	12	63

8. DIRECT EMPLOYMENT SUMMARY

Table 6 is a summary of the all the direct employment. It is categorized by the distinct occupational multiplier groupings described below. These include extraction (production), drilling (exploration / delineation and development drilling), and support activities (seismic, geohazard, and geotechnical surveys, and pipeline construction and operation and maintenance).

The figures are adjusted for non-resident employment. It is estimated that 18% of non-Alaska residents accounted for the KPB oil and gas industry workforce in 2011.[8] These are workers who commute from out of state in to and out of the Borough.

[8] McDowell Group, "Cook Inlet Oil and Gas Industry Labor Force Assessment," May 2013, p.2.

TABLE 6: DIRECT EMPLOYMENT ESTIMATES – SUMMARY OF DIRECT EMPLOYMENT ADJUSTED FOR NON-RESIDENT LABOR

Year	Extraction 1/	Drilling 2/	Support 3/	TOTAL
1	0	0	42	42
2	0	41	53	94
3	0	41	22	63
4	0	27	0	27
5	0	27	0	27
6	0	0	230	230
7	12	11	68	92
8	25	34	15	74
9	25	46	121	192
10	37	57	15	109
11	37	57	15	109
12	37	23	15	75
13	37	23	15	75
14	37	0	15	52
15	37	0	15	52
16	37	0	15	52
17	37	0	15	52
18	37	0	15	52
19	37	0	15	52
20	37	0	15	52
21	37	0	15	52
22	37	0	15	52
23	37	0	15	52
24	37	0	15	52
25	37	0	15	52
26	37	0	15	52
27	37	0	15	52
28	37	0	15	52
29	37	0	15	52
30	37	0	15	52
31	37	0	15	52
32	37	0	15	52
33	37	0	15	52

1 Includes production
2 Includes exploration/delineation and development drilling
3 Includes seismic, geohazard, and geotechnical surveys and pipeline construction and o&m
4 Adjusted for 18% non-resident workforce

The remainder is new jobs in the Borough. As discussed in the population section below, it is not anticipated there would be commuting between Anchorage and the Mat-Su Borough to the KPB to any material extent.

The economic impact from the 18% non-Alaska residents would be widely distributed geographically. The following tables focus on impacts to the KPB.

9. EARNINGS

An estimate of the increase in direct earnings can be derived by using local wage data. The average annual wage for oil and gas industry employment in the Kenai Peninsula Borough in 2011 was $98,445.[9] In 2015 dollars this would be $109,000. This value was applied to all direct employment in the multiplier analysis.

Table 7 depicts the estimated additional direct earnings in 2015 dollars.

10.INDIRECT AND INDUCED EMPLOYMENT (MULTIPLIER ANALYSIS)

The direct impacts, depicted above, are the first round of inputs purchased by the final-demand industry; the value of inputs purchased in the on-site spending by the final-demand industry. Once the additional direct employment and earnings are estimated, the total economic impact on the region is estimated. This includes the cumulative effects on total industry employment and earnings that result from the additional direct employment. This is executed through multipliers, which depict the ratios of total changes in regional economies to an initial change.

The indirect impact relates to the subsequent rounds of inputs purchased by supporting supply industries with intermediate goods to the on-site direct spending.

The induced impact is the value of goods and services purchased by all workers whose earnings are affected by the final-demand change; the retail and wholesale jobs created when the direct and indirect employment spend their money on other products in the economy.

For this analysis the U.S. Department of Commerce, Bureau of Economic Analysis (BEA), Regional Input-Output Modeling System (RIMS II) multipliers were utilized. Regional input-output multipliers are based on a set of detailed set of industry accounts that measures the goods and services produced by each industry and the use of these goods and services by final users.[10]

[9] McDowell Group, *op. cit*., p.20.
[10] User Guide can be found at https://www.bea.gov/regional/pdf/rims/rimsii_user_guide.pdf

TABLE 7: DIRECT EARNINGS ESTIMATES				
Year	Extraction	Drilling	Support	TOTAL
1	$0	$0	$5	$5
2	$0	$4	$6	$10
3	$0	$4	$2	$7
4	$0	$3	$0	$3
5	$0	$3	$0	$3
6	$0	$0	$25	$25
7	$1	$1	$7	$10
8	$3	$4	$2	$8
9	$3	$5	$13	$21
10	$4	$6	$2	$12
11	$4	$6	$2	$12
12	$4	$3	$2	$8
13	$4	$3	$2	$8
14	$4	$0	$2	$6
15	$4	$0	$2	$6
16	$4	$0	$2	$6
17	$4	$0	$2	$6
18	$4	$0	$2	$6
19	$4	$0	$2	$6
20	$4	$0	$2	$6
21	$4	$0	$2	$6
22	$4	$0	$2	$6
23	$4	$0	$2	$6
24	$4	$0	$2	$6
25	$4	$0	$2	$6
26	$4	$0	$2	$6
27	$4	$0	$2	$6
28	$4	$0	$2	$6
29	$4	$0	$2	$6
30	$4	$0	$2	$6
31	$4	$0	$2	$6
32	$4	$0	$2	$6
33	$4	$0	$2	$6

The multipliers are derived from two sources. A national input-output table, an accounting framework that shows the distribution of the inputs purchased and outputs sold, and regional data, which are used to adjust the national input-output table to reflect the region's industrial structure and trading patterns. In this case the region is the Kenai Peninsula Borough, a region for which BEA has estimated multipliers.

The two specific multipliers utilized in this analysis are the direct-effect multipliers for employment and earnings. The former is the ratio of the total change in jobs per change in job in the final-demand industry. The latter is the ratio of the total change in household earnings per dollar change in household earnings in the final-demand industry.

Type I multipliers measure the direct and indirect employment and earnings. Type II multipliers measure the direct, indirect, and induced employment and earnings, yielding the total impact.

The direct-effect multipliers are applied to the estimated direct increases in employment and earnings to conduct the analysis. BEA provides these two multipliers for three job classes associated with oil and gas. These are oil and gas extraction, drilling oil and gas wells, and support activity for oil and gas operations. Specific tasks were allocated into the three categories as described in Table 6 above.

The multipliers are depicted in Table 8.

The employment multipliers represent the total change in number of jobs in all industries for each additional job in the industry corresponding to the entry. The earnings multipliers represent the total dollar change in earnings of households employed by all industries for each additional dollar of earnings paid directly to households employed by the industry corresponding to the entry.

It can be noted that the multipliers between the job categories do not vary much.

Using these multipliers, total employment in the region (direct, indirect, and induced) is expected to increase by the product of the multiplier and the direct employment. Total earnings in the region are expected to increase by the product of the multiplier and the direct earnings.

TABLE 8: DIRECT EFFECT RIMS II MULTIPLIERS		
Employment (Jobs)		**Earnings (Dollars)**
TYPE I (INDIRECT)		
Oil & gas extraction	1.3877	1.3101
Drilling oil & gas wells	1.2186	1.1653
Support activity for oil & gas operations	1.3045	1.1777
TYPE II (INDIRECT & INDUCED)		
Oil & gas extraction	1.9151	1.5705
Drilling oil & gas wells	1.6788	1.3969
Support activity for oil & gas operations	1.8583	1.4118
Source: BEA		

Table 9A, using the Type I multipliers, depicts the increased direct and indirect employment. Table 9B, using the Type II multipliers, depicts the increased direct, indirect, and induced (and hence total) employment. Table 9C breaks out employment between direct, indirect, induced, and total.

Table 10A, using the Type I multipliers, depicts the increased direct and indirect earnings. Table 10B, using the Type II multipliers, depicts the increased direct, indirect, and induced (and hence total) earnings. Table 10C breaks out earnings between direct, indirect, induced, and total.

11.POPULATION IMPACT

Previous tables show the estimates for the increases in jobs from Cook Inlet OCS activity. As described, they were adjusted for non-Alaska residents; i.e., workers who commute in and out of the Borough from out of the state. The remainder will reside in the Borough, given that the jobs are there. Population impacts will depend on the extent to which current residents do not assume the new jobs.

Current residents make take these jobs to the extent there is unemployment in the Borough, and to the extent they either have the necessary skills for those jobs, or can be trained for them.

Current unemployment in the Kenai Peninsula Borough is 7.4%[11] Total employment in 2014 was 20,782.[12] This implies 1,538 are unemployed. Total Borough population in 2010 per the census was 55,400.

There are several entities in the area that offer some level of training for oil and gas occupations. Nevertheless, experience is generally a more important qualification than entry-level training.

Also note that while there are 1,113 oil and gas jobs within the Borough, there are 1,773 residents that work oil and gas occupations on the North Slope, where wages are generally higher than Cook Inlet.[13] To

[11] Alaska Department of Labor, "Alaska Economic Trends," July 2015, p.14.
[12] Alaska Department of Labor, "Census of Employment and Wages," 2014.
[13] Alaska Department of Labor, "Alaska Economic Trends," June 2013, p.7.

the extent a KPB resident who works on the North Slope gets a new job in the KPB, it is still a new KPB job. This would create a North Slope vacancy that presumably would not be filled by another KPB resident.

There are over 7,000 Anchorage and Mat-Su residents employed on the North Slope. It follows that the propensity for then to move to the KPB would be low. It is not anticipated that there would be any appreciable commuting between Anchorage/Mat-Su and the KPB. (To the extent they might relocate to take new jobs, the state population would remain unchanged.)

There is some question as to the extent workers might relocate during the exploration and development phases. However, this phase lasts 13 years in the BOEM scenario, in principle the non-resident employment adjustments implicitly address relocation, and the jobs numbers themselves are relatively low, especially with the assumed platform installation being performed by non-residents. (The only possible exception might be the short period of extensive pipeline construction in years 6 and 9.)

There is little data to precisely ascertain the exact dynamics that will determine the population outcome. To the extent there is full employment in the Borough all new employment would result in new population. This, of course, is not the case. Accordingly, to account qualitatively and directionally for new jobs that would be held by current residents, it has been assumed that 10 percent of the jobs will be taken by unemployed residents. This would be a peak of 43 jobs during development and 10 jobs during the production phase.

The average number of people per household for the KPB was 2.5 from 2009-2013.[14] The increased population from the Sale 244 development is estimated as the product of the increased total employment as adjusted for current residents taking new jobs, and the average number of people per household. Table 11 depicts the estimated increase in population.

[14] United States Census Bureau, "American Community Survey," 2013.

TABLE 9A: DIRECT & INDIRECT EMPLOYMENT ESTIMATES				
Year	**Extraction**	**Drilling**	**Support**	**TOTAL**
1	0	0	55	55
2	0	50	69	119
3	0	50	28	78
4	0	33	0	33
5	0	33	0	33
6	0	0	300	300
7	17	14	89	120
8	34	42	20	96
9	34	56	158	248
10	51	70	20	141
11	51	70	20	141
12	51	28	20	99
13	51	28	20	99
14	51	0	20	71
15	51	0	20	71
16	51	0	20	71
17	51	0	20	71
18	51	0	20	71
19	51	0	20	71
20	51	0	20	71
21	51	0	20	71
22	51	0	20	71
23	51	0	20	71
24	51	0	20	71
25	51	0	20	71
26	51	0	20	71
27	51	0	20	71
28	51	0	20	71
29	51	0	20	71
30	51	0	20	71
31	51	0	20	71
32	51	0	20	71
33	51	0	20	71

TABLE 9B: TOTAL EMPLOYMENT ESTIMATES – INCLUDED DIRECT, INDIRECT & INDUCED				
Year	**Extraction**	**Drilling**	**Support**	**TOTAL**
1	0	0	79	79
2	0	69	99	168
3	0	69	41	109
4	0	46	0	46
5	0	46	0	46
6	0	0	427	427
7	24	19	126	169
8	47	58	28	133
9	47	77	225	349
10	71	96	28	195
11	71	96	28	195
12	71	39	28	137
13	71	39	28	137
14	71	0	28	99
15	71	0	28	99
16	71	0	28	99
17	71	0	28	99
18	71	0	28	99
19	71	0	28	99
20	71	0	28	99
21	71	0	28	99
22	71	0	28	99
23	71	0	28	99
24	71	0	28	99
25	71	0	28	99
26	71	0	28	99
27	71	0	28	99
28	71	0	28	99
29	71	0	28	99
30	71	0	28	99
31	71	0	28	99
32	71	0	28	99
33	71	0	28	99

TABLE 9C: DIRECT, INDIRECT, & INDUCED EMPLOYMENT ESTIMATES

Year	Direct	Indirect	Induced	TOTAL
1	42	13	23	79
2	94	25	48	168
3	63	16	31	109
4	27	6	13	46
5	27	6	13	46
6	230	70	127	427
7	92	28	49	169
8	74	22	37	133
9	192	57	101	349
10	109	31	54	195
11	109	31	54	195
12	75	24	38	137
13	75	24	38	137
14	52	19	28	99
15	52	19	28	99
16	52	19	28	99
17	52	19	28	99
18	52	19	28	99
19	52	19	28	99
20	52	19	28	99
21	52	19	28	99
22	52	19	28	99
23	52	19	28	99
24	52	19	28	99
25	52	19	28	99
26	52	19	28	99
27	52	19	28	99
28	52	19	28	99
29	52	19	28	99
30	52	19	28	99
31	52	19	28	99
32	52	19	28	99
33	52	19	28	99

TABLE 10A: DIRECT & INDIRECT EARNINGS ESTIMATES (millions of 2015 dollars)				
Year	**Extraction**	**Drilling**	**Support**	**TOTAL**
1	$0	$0	$5	$5
2	$0	$5	$7	$12
3	$0	$5	$3	$8
4	$0	$3	$0	$3
5	$0	$3	$0	$3
6	$0	$0	$30	$30
7	$2	$1	$9	$12
8	$4	$4	$2	$10
9	$4	$6	$16	$25
10	$5	$7	$2	$14
11	$5	$7	$2	$14
12	$5	$3	$2	$10
13	$5	$3	$2	$10
14	$5	$0	$2	$7
15	$5	$0	$2	$7
16	$5	$0	$2	$7
17	$5	$0	$2	$7
18	$5	$0	$2	$7
19	$5	$0	$2	$7
20	$5	$0	$2	$7
21	$5	$0	$2	$7
22	$5	$0	$2	$7
23	$5	$0	$2	$7
24	$5	$0	$2	$7
25	$5	$0	$2	$7
26	$5	$0	$2	$7
27	$5	$0	$2	$7
28	$5	$0	$2	$7
29	$5	$0	$2	$7
30	$5	$0	$2	$7
31	$5	$0	$2	$7
32	$5	$0	$2	$7
33	$5	$0	$2	$7

TABLE 10B: TOTAL EARNINGS ESTIMATES – INCLUDES DIRECT, INDIRECT & INDUCED				
(millions of 2015 dollars)				
Year	Extraction	Drilling	Support	TOTAL
1	$0	$0	$7	$7
2	$0	$6	$8	$14
3	$0	$6	$3	$10
4	$0	$4	$0	$4
5	$0	$4	$0	$4
6	$0	$0	$35	$35
7	$2	$2	$10	$14
8	$4	$5	$2	$12
9	$4	$7	$19	$30
10	$6	$9	$2	$17
11	$6	$9	$2	$17
12	$6	$3	$2	$12
13	$6	$3	$2	$12
14	$6	$0	$2	$9
15	$6	$0	$2	$9
16	$6	$0	$2	$9
17	$6	$0	$2	$9
18	$6	$0	$2	$9
19	$6	$0	$2	$9
20	$6	$0	$2	$9
21	$6	$0	$2	$9
22	$6	$0	$2	$9
23	$6	$0	$2	$9
24	$6	$0	$2	$9
25	$6	$0	$2	$9
26	$6	$0	$2	$9
27	$6	$0	$2	$9
28	$6	$0	$2	$9
29	$6	$0	$2	$9
30	$6	$0	$2	$9
31	$6	$0	$2	$9
32	$6	$0	$2	$9
33	$6	$0	$2	$9

TABLE 10C: DIRECT, INDIRECT & INDUCED EARNINGS ESTIMATES				
(millions of 2015 dollars)				
Year	Direct	Indirect	Induced	TOTAL
1	$5	$1	$1	$7
2	$10	$2	$2	$14
3	$7	$1	$2	$10
4	$3	$0	$1	$4
5	$3	$0	$1	$4
6	$25	$4	$6	$35
7	$10	$2	$2	$14
8	$8	$2	$2	$12
9	$21	$4	$5	$30
10	$12	$3	$3	$17
11	$12	$3	$3	$17
12	$8	$2	$2	$12
13	$8	$2	$2	$12
14	$6	$2	$1	$9
15	$6	$2	$1	$9
16	$6	$2	$1	$9
17	$6	$2	$1	$9
18	$6	$2	$1	$9
19	$6	$2	$1	$9
20	$6	$2	$1	$9
21	$6	$2	$1	$9
22	$6	$2	$1	$9
23	$6	$2	$1	$9
24	$6	$2	$1	$9
25	$6	$2	$1	$9
26	$6	$2	$1	$9
27	$6	$2	$1	$9
28	$6	$2	$1	$9
29	$6	$2	$1	$9
30	$6	$2	$1	$9
31	$6	$2	$1	$9
32	$6	$2	$1	$9
33	$6	$2	$1	$9

12.FISCAL IMPACT

12.1. Property Tax: Kenai Peninsula Borough and State of Alaska

Since development would occur in federal waters, the state (and KPB) would receive neither bonus bids, royalties, nor production or state corporate income taxes. The borough would receive property taxes for assets on borough land. As cited above, per the BOEM scenario, there would be no new onshore facilities.

The borough would receive property tax from the 100 miles of onshore pipelines. The Kenai Kachemak Pipeline, also 12-inch diameter, constructed in 2002, cost $45 million, or $75,000 per inch mile.[15] With inflation it is estimated these pipelines would cost $100,000 per inch mile. This lines up closely with many other recent estimates.[16]

One hundred miles of 12-inch diameter pipeline at $100,000 per inch mile would cost $120 million. At the borough's 4.5 mill rate this would amount to $540,000 in property tax starting in year 6, subject to inflation and depreciation.

The difference between the state rate of 20 mills and the Borough rate of 4.5 mills goes to the State of Alaska. This would be $1.86 million in year 6.

Table 12 shows the property tax by year. Over the life of the project the Borough would receive $8 million, and the State $27 million, in 2015 dollars.

12.2. Revenues to Federal Government; Royalties and Corporate Income Tax

12.2.1. Royalties

Table 13 displays the estimated federal royalties from the lease sale. Oil and natural gas volumes were given as part of the BOEM scenarios. Total oil is 214 million barrels, and total gas is 567 billion cubic feet.

The oil price forecast was from the Department of Energy, Energy Information Administration "Annual Energy Outlook" (April 14, 2015). These are in 2015 dollars for Brent crude oil.[17]

[15] Petroleum News Alaska, "Marathon joins Kenai Kachemak Pipeline Project consortium," 9/23/01.
[16] For example, see Oil & Gas Journal, "Billions Needed to Meet Long-Term Natural Gas Infrastructure Supply, Demands," April 2009.
[17] The forecast contains 3% real annual long-term growth and is higher than many other projections.

TABLE 11: TOTAL POPULATION IMPACT	
Year	
1	177
2	377
3	246
4	103
5	103
6	962
7	381
8	299
9	785
10	439
11	439
12	308
13	308
14	222
15	222
16	222
17	222
18	222
19	222
20	222
21	222
22	222
23	222
24	222
25	222
26	222
27	222
28	222
29	222
30	222
31	222
32	222
33	222

TABLE 12: ESTIMATED PROPERTY TAX					
(millions of 2015 dollars)					
Year	**Expenditure**	**Assessed Value**	**Total Prop Tax**	**To Kenai Pen Bor**	**To State of Alaska**
6	$120	$120	$2.40	$0.54	$1.86
7		$116	$2.31	$0.52	$1.79
8		$111	$2.23	$0.50	$1.73
9		$107	$2.14	$0.48	$1.66
10		$103	$2.06	$0.46	$1.59
11		$99	$1.97	$0.44	$1.53
12		$94	$1.89	$0.42	$1.46
13		$90	$1.80	$0.40	$1.39
14		$86	$1.71	$0.39	$1.33
15		$81	$1.63	$0.37	$1.26
16		$77	$1.54	$0.35	$1.20
17		$73	$1.46	$0.33	$1.13
18		$69	$1.37	$0.31	$1.06
19		$64	$1.28	$0.29	$1.00
20		$60	$1.20	$0.27	$0.93
21		$56	$1.11	$0.25	$0.86
22		$51	$1.03	$0.23	$0.80
23		$47	$0.94	$0.21	$0.73
24		$43	$0.86	$0.19	$0.66
25		$38	$0.77	$0.17	$0.60
26		$34	$0.68	$0.15	$0.53
27		$30	$0.60	$0.13	$0.46
28		$26	$0.51	$0.12	$0.40
29		$21	$0.43	$0.10	$0.33
30		$17	$0.34	$0.08	$0.26
31		$13	$0.25	$0.06	$0.20
32		$8	$0.17	$0.04	$0.13
33		$4	$0.08	$0.02	$0.06
Total			**$34.77**	**$7.82**	**$26.94**

The assumed gas price was the current Enstar price of $6.77 per mcf.

The royalty is the gross value at the lease boundary, which is the market price less pipeline tariffs. The estimated pipeline tariffs are $0.56/bbl for oil and $0.27/mcf for gas.[18]

The royalty rate was assumed to be 12.5%, the same as the last Cook Inlet Sale # 191.

Total royalties are $3.6 billion in 2015 dollars.

12.2.2. Federal Income Tax

Federal corporate income taxes are gross revenues minus expenses, subject to the tax rate, which is 35%.

Table 14 shows the estimated gross revenues for oil and gas, a total of $28.8 billion.

Table 15 shows the estimated costs. Due to uncertainties as to precisely how development would occur and the operating environment, coupled with the uniqueness of the operating environment, there is considerable variability surrounds these cost estimates.

The estimated cost of the seismic and other survey programs would be $50 million, based on Apache's proposed 5-year program on the Kenai Peninsula.[19]

Exploration wells are estimated to cost $25 million each based on the Kitchen Lights experience, for a total of $250 million.[20]

Platform costs are estimated at $350 million each based on Kitchen Lights and adjusted for additional slots and water depth, for a total of $1.05 billion.[21]

Development wells are estimated at $10 million each, based on a rig rate of $175,000 per day, for a total of $660 million.[22]

Operating costs (opex) are estimated at $10 per barrel for oil and $1/mcf for gas.[23]

The estimated total costs, including royalties and property tax, before income tax, are $8.4 billion in 2015 dollars.

Table 16 shows the tax calculation.

Seismic and other survey costs are amortized over 7 years.

Exploration drilling costs are considered intangible, and as such are 70% expensed, with the remaining 30% amortized over 5 years.

Platform costs are depreciated over 7 years.

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[18] The cost of the pipelines underlying the tariffs were the $120 million discussed above for the onshore pipe and $530 mm for the offshore based on $221,000 per inch mile (Petroleum News Alaska, "Plans unfolding for building new trans-Cook Inlet pipeline," June 24, 2012.

[19] Petroleum News Alaska, "Apache eyeing long game in Cook Inlet exploration," June 7, 2015.

[20] Petroleum News Alaska, "Furie nearing the finish line at Kitchen Lights unit," July 20, 2014.

[21] Petroleum News Alaska, "$50M loan would improve Kitchen Lights economics: due diligence approved," January 25, 2015.

[22] Petroleum News Alaska, "BlueCrest plotting course at Cosmopolitan unit," June 7, 2015.

[23] Van Meurs Corporation, World Rating of Oil and Gas Terms: Volume 6A, 2013, p. 56.

Development wells are assumed to be 80% intangible. 70% of the intangible portion is expensed with the remaining 30% amortized over 5 years. The 20% that is not intangible is depreciated over 5 years.

Operating costs are expensed.

Total estimated income taxes are $7.2 billion.

Finally, note that bonus bids to the federal government have not been estimated insofar as they involve assessments of geological risk. Thus the federal revenue estimates are understated by the after-tax amount of the bid.[24] However, in terms of materiality, at these prices and costs it would probably take a rather favorable geological assessment approaching a 50% probability of success to justify a $1 billion bid.

TABLE 13: FEDERAL ROYALTY ESTIMATES

(millions of 2015 dollars)

Year	Oil Vol (mmbbl)	Gas Vol (bcf)	Oil Price ($/bbl)	Gas Price ($/mcf)	Oil Royalty ($mm)	Gas Royalty ($mm)	Total Royalty ($mm)
7	1	0	$93	$6.77	$12	$0	$12
8	5	8	$95	$6.77	$59	$7	$66
9	9	30	$98	$6.77	$110	$24	$134
10	14	48	$101	$6.77	$176	$39	$215
11	20	66	$104	$6.77	$259	$54	$313
12	22	65	$107	$6.77	$293	$53	$346
13	25	61	$110	$6.77	$343	$50	$393
14	22	53	$114	$6.77	$311	$43	$354
15	18	44	$117	$6.77	$262	$36	$298
16	15	36	$121	$6.77	$225	$29	$255
17	12	29	$124	$6.77	$186	$24	$209
18	10	24	$128	$6.77	$159	$20	$179
19	8	20	$132	$6.77	$131	$16	$147
20	7	16	$135	$6.77	$118	$13	$131
21	5	13	$139	$6.77	$87	$11	$97
22	4	11	$143	$6.77	$71	$9	$80
23	4	9	$148	$6.77	$74	$7	$81
24	3	7	$152	$6.77	$57	$6	$63
25	2	6	$156	$6.77	$39	$5	$44
26	2	5	$161	$6.77	$40	$4	$44
27	2	4	$165	$6.77	$41	$3	$44
28	1	3	$170	$6.77	$21	$2	$24
29	1	3	$175	$6.77	$22	$2	$24
30	1	2	$180	$6.77	$22	$2	$24
31	1	2	$185	$6.77	$23	$2	$25
32	0	1	$190	$6.77	$0	$1	$1
33	0	1	$195	$6.77	$0	$1	$1
TOTAL	**214**	**567**			**$3,142**	**$461**	**$3,603**

[24] The bids are deductible. This would be 65% (1 – 35%) of the bid amount.

TABLE 14: GROSS OIL & GAS REVENUE ESTIMATES (millions of 2015 dollars)									
Year	**Oil Vol (mmbbl)**	**Gas Vol (bcf)**	**Oil Price ($/bbl)**	**Gas Price ($/mcf)**	**Oil Tariff ($/bbl)**	**Gas Tariff ($/mcf)**	**Oil Gross Val ($mm)**	**Gas Gross Val ($mm)**	**Tot Gross Val ($mm)**
1									
2									
3									
4									
5									
6									
7	1	0	$93	$6.77	$0.56	$0.27	$92	$0	$92
8	5	8	$95	$6.77	$0.56	$0.27	$474	$52	$526
9	9	30	$98	$6.77	$0.56	$0.27	$878	$195	$1,073
10	14	48	$101	$6.77	$0.56	$0.27	$1,407	$312	$1,719
11	20	66	$104	$6.77	$0.56	$0.27	$2,071	$429	$2,500
12	22	65	$107	$6.77	$0.56	$0.27	$2,347	$423	$2,769
13	25	61	$110	$6.77	$0.56	$0.27	$2,747	$397	$3,144
14	22	53	$114	$6.77	$0.56	$0.27	$2,491	$345	$2,835
15	18	44	$117	$6.77	$0.56	$0.27	$2,099	$286	$2,385
16	15	36	$121	$6.77	$0.56	$0.27	$1,802	$234	$2,036
17	12	29	$124	$6.77	$0.56	$0.27	$1,485	$189	$1,673
18	10	24	$128	$6.77	$0.56	$0.27	$1,273	$156	$1,429
19	8	20	$132	$6.77	$0.56	$0.27	$1,048	$130	$1,178
20	7	16	$135	$6.77	$0.56	$0.27	$944	$104	$1,048
21	5	13	$139	$6.77	$0.56	$0.27	$694	$85	$778
22	4	11	$143	$6.77	$0.56	$0.27	$571	$72	$643
23	4	9	$148	$6.77	$0.56	$0.27	$590	$59	$648
24	3	7	$152	$6.77	$0.56	$0.27	$455	$46	$500
25	2	6	$156	$6.77	$0.56	$0.27	$312	$39	$351
26	2	5	$161	$6.77	$0.56	$0.27	$321	$33	$353
27	2	4	$165	$6.77	$0.56	$0.27	$330	$26	$356
28	1	3	$170	$6.77	$0.56	$0.27	$169	$20	$189
29	1	3	$175	$6.77	$0.56	$0.27	$174	$20	$194
30	1	2	$180	$6.77	$0.56	$0.27	$179	$13	$192
31	1	2	$185	$6.77	$0.56	$0.27	$184	$13	$197
32	0	1	$190	$6.77	$0.56	$0.27	$0	$7	$7
33	0	1	$195	$6.77	$0.56	$0.27	$0	$7	$7
TOTAL	**214**	**567**					**$25,138**	**$3,686**	**$28,823**

TABLE 15: ESTIMATED COSTS									
(millions of 2015 dollars)									
Year	Seismic	Explr Wells	Platforms	Dev Wells	Oil Opex	Gas Opex	Royalties	Property Tax	TOTAL
1	$20	$75							$95
2	$20	$75							$95
3	$10	$50							$60
4		$50							$50
5									$0
6				$30				$2	$32
7			$350	$90	$10	$0	$12	$2	$464
8			$350	$120	$50	$8	$66	$2	$596
9				$150	$90	$30	$134	$2	$406
10			$350	$150	$140	$48	$215	$2	$905
11				$60	$200	$66	$313	$2	$640
12				$60	$220	$65	$346	$2	$693
13					$250	$61	$393	$2	$706
14					$220	$53	$354	$2	$629
15					$180	$44	$298	$2	$524
16					$150	$36	$255	$2	$442
17					$120	$29	$209	$1	$360
18					$100	$24	$179	$1	$304
19					$80	$20	$147	$1	$249
20					$70	$16	$131	$1	$218
21					$50	$13	$97	$1	$161
22					$40	$11	$80	$1	$132
23					$40	$9	$81	$1	$131
24					$30	$7	$63	$1	$100
25					$20	$6	$44	$1	$71
26					$20	$5	$44	$1	$70
27					$20	$4	$44	$1	$69
28					$10	$3	$24	$1	$37
29					$10	$3	$24	$0	$38
30					$10	$2	$24	$0	$36
31					$10	$2	$25	$0	$37
32					$0	$1	$1	$0	$2
33					$0	$1	$1	$0	$2
TOTAL	**$50**	**$250**	**$1,050**	**$660**	**$2,140**	**$567**	**$3,603**	**$35**	**$8,355**

TABLE 16: FEDERAL CORPORATE INCOME TAX ESTIMATE (millions of 2015 dollars]											
Year	Gross Revenue	Seismic Surveys	Exploration Wells	Platforms	Development Wells	Operating Costs	Royalties	Property Tax	Total Costs	Pre-Tax Income	Corp Inc Tax
1	$0	$3	$57	$0	$0	$0	$0	$0	$60	-$60	-$21
2	$0	$6	$62	$0	$0	$0	$0	$0	$67	-$67	-$24
3	$0	$7	$47	$0	$0	$0	$0	$0	$54	-$54	-$19
4	$0	$7	$50	$0	$0	$0	$0	$0	$57	-$57	-$20
5	$0	$7	$15	$0	$0	$0	$0	$0	$22	-$22	-$8
6	$0	$7	$11	$0	$19	$0	$0	$2	$39	-$39	-$14
7	$92	$7	$6	$50	$62	$10	$12	$2	$149	-$57	-$20
8	$526	$4	$3	$136	$90	$58	$66	$2	$359	$167	$58
9	$1,073	$1	$0	$147	$121	$120	$134	$2	$525	$548	$192
10	$1,719	$0	$0	$155	$133	$188	$215	$2	$693	$1,026	$359
11	$2,500	$0	$0	$161	$84	$266	$313	$2	$825	$1,675	$586
12	$2,769	$0	$0	$124	$79	$285	$346	$2	$836	$1,934	$677
13	$3,144	$0	$0	$106	$35	$311	$393	$2	$847	$2,297	$804
14	$2,835	$0	$0	$78	$22	$273	$354	$2	$729	$2,106	$737
15	$2,385	$0	$0	$47	$10	$224	$298	$2	$581	$1,804	$632
16	$2,036	$0	$0	$31	$5	$186	$255	$2	$478	$1,558	$545
17	$1,673	$0	$0	$16	$1	$149	$209	$1	$376	$1,298	$454
18	$1,429	$0	$0	$0	$0	$124	$179	$1	$304	$1,125	$394
19	$1,178	$0	$0	$0	$0	$100	$147	$1	$249	$930	$325
20	$1,048	$0	$0	$0	$0	$86	$131	$1	$218	$830	$291
21	$778	$0	$0	$0	$0	$63	$97	$1	$161	$617	$216
22	$643	$0	$0	$0	$0	$51	$80	$1	$132	$511	$179
23	$648	$0	$0	$0	$0	$49	$81	$1	$131	$517	$181
24	$500	$0	$0	$0	$0	$37	$63	$1	$100	$400	$140
25	$351	$0	$0	$0	$0	$26	$44	$1	$71	$280	$98
26	$353	$0	$0	$0	$0	$25	$44	$1	$70	$283	$99
27	$356	$0	$0	$0	$0	$24	$44	$1	$69	$287	$100
28	$189	$0	$0	$0	$0	$13	$24	$1	$37	$152	$53
29	$194	$0	$0	$0	$0	$13	$24	$0	$38	$156	$55
30	$192	$0	$0	$0	$0	$12	$24	$0	$36	$156	$55
31	$197	$0	$0	$0	$0	$12	$25	$0	$37	$160	$56
32	$7	$0	$0	$0	$0	$1	$1	$0	$2	$5	$2
33	$7	$0	$0	$0	$0	$1	$1	$0	$2	$5	$2
TOTAL	**$28,823**	**$50**	**$250**	**$1,050**	**$660**	**$2,707**	**$3,603**	**$35**	**$8,355**	**$20,468**	**$7,164**

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The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island communities.

The Bureau of Ocean Energy Management Mission

The Bureau of Ocean Energy Management (BOEM) promotes energy independence, environmental protection, and economic development through responsible, science-based management of offshore conventional and renewable energy.