

4 ENVIRONMENTAL CONSEQUENCES

4.1 ENVIRONMENTAL CONSEQUENCES ASSOCIATED WITH OCS OIL AND GAS ACTIVITIES

This programmatic environmental impact statement (PEIS) evaluates 8 alternatives, including no action (see Chapter 2). All of the action alternatives identify Outer Continental Shelf (OCS) Planning Areas in the Gulf of Mexico (GOM), Cook Inlet, and the Arctic where lease sales may occur under the 2012-2017 OCS Oil and Gas Leasing Program (the Program). Chapter 3 of this PEIS describes the nature and condition of natural and socioeconomic resources that have a potential to be affected by oil and gas (O&G) activities within those OCS Planning Areas under the Program. In general, O&G development follows a four-phase process, beginning with (1) exploration to locate viable deposits, (2) development of the production well and support infrastructure, (3) operation (oil or gas production), and (4) decommissioning of the well once it is no longer productive or profitable.

Since lease- and project-specific details are not known at this time, the analyses in this PEIS take a programmatic approach and evaluate resources on a larger, more regional scale rather than at a lease-block scale (the scale at which project-specific impacts could occur). The evaluation of environmental consequences presented in this PEIS focuses on those resources most likely to be affected during future O&G development under each of the alternatives considered in this PEIS. Some information is currently unavailable, particularly with regard to affected environment baseline changes; however, this information is not essential in order to make a reasoned choice among alternatives at this programmatic stage (see Section 1.3.1.1: Incomplete and Unavailable Information). Exploration and development scenarios have been prepared that identify potential levels of O&G development that may occur as a result of lease sales in the GOM, the Cook Inlet, and the Chukchi and Beaufort Sea Planning Areas under the Program. These scenarios are presented for each alternative later in this chapter and are used for the programmatic impact analyses of this PEIS. More detailed, location-specific impact analyses would be conducted in subsequent lease sale-specific National Environmental Policy Act (NEPA) analyses.

The programmatic evaluation of environmental or socioeconomic impacts presented in this PEIS provides useful information for considering the effects of O&G development on the resources of the OCS (and associated coastal environments) under each alternative. The programmatic analyses identify the types of activities that typically occur during exploration, development, production, and decommissioning; the resources that could be affected by those activities; and the nature and relative magnitude of effects those resources could incur.

4.1.1 Routine Operations and Common Impact-Producing Factors

Impacts from OCS O&G development originate from the specific activities that occur following OCS leasing, and both activities and impacts will vary by the phase of O&G development. Each phase will have a set of impact-producing factors (some unique to a

1 particular phase) that represent O&G development activities that produce physical or
2 environmental conditions that may affect one or more natural, cultural, or socioeconomic
3 resources, and these may vary within each phase depending on the specific activity. For
4 example, an impact-producing factor associated with exploration is noise, which will differ in its
5 nature, magnitude, and duration depending on how it is generated. Noise generated by seismic
6 survey equipment will differ in magnitude, frequency, and duration from noise generated during
7 exploration well drilling or by ship traffic. The resources that could be affected by noise and the
8 nature and magnitude of potential effects will also vary, depending on the source and
9 characteristics of the noise (duration, frequency, magnitude) that is generated.

10
11 The nature, magnitude, and duration of each impact-producing factor (and any
12 subsequent environmental effects) will also vary among the four phases of O&G development.
13 For example, noise generated by seismic survey equipment will be relatively short term in
14 duration but very high in magnitude, and will cease once the survey portion of the exploration
15 phase is completed. Similarly, noise from the explosive removal of a platform during the
16 decommissioning phase would be of very short-term duration (effectively a one-time event). In
17 contrast, noise from ship and helicopter traffic that supports production platforms could be
18 generated for 20 years or more, depending on the production lifespan of the platform.
19 Table 4.1.1-1 presents the major categories of impact-producing factors associated with O&G
20 development on the OCS. It is important to note that many impact-producing factors can be
21 associated with multiple O&G development phases, and can be subject to mitigation measures to
22 help reduce impacts.

23
24 The following discussions summarize the general types of activities that may be expected
25 during each of the four O&G development phases and identify likely impact-producing factors
26 for each phase. These impact-producing factors, the resources that each may affect, and the
27 nature, magnitude, and duration of possible effects are discussed in more detail in the resource-
28 specific impact sections presented later in this chapter.

31 **4.1.1.1 Exploration**

32
33 During exploration, typical activities include the conduct of geophysical seismic surveys
34 and possibly the development of exploration wells. During seismic surveys, one or more air
35 guns (or other sound sources) are towed behind a ship at depths of 5–10 m (16–33 ft) and
36 produce acoustic energy pulses that are directed towards the seafloor. The acoustic signals then
37 reflect off subsurface sedimentary boundaries and are recorded by hydrophones, which are
38 typically also towed behind the survey ship. Following analysis of the acoustic data, one or more
39 exploratory wells may be drilled to confirm the presence and determine the viability of the
40 potential hydrocarbon reservoirs identified by the survey. Development of an exploration well
41 typically involves the use of a mobile offshore drilling unit (MODU) (such as a jackup rig, a
42 semisubmersible rig, or drillship) and the placement of infrastructure (such as a drilling template
43 and a blowout preventer) on the seafloor to aid in the drilling. Both the seismic surveys and
44 exploration well development involve the use of ships, whether to tow air guns and hydrophones
45 or to bring drilling equipment and other support materials to the well location.

1 **TABLE 4.1.1-1 Impact-Producing Factors Associated with OCS O&G Development Phases**

Impact-Producing Factor	O&G Development Phase				
	Exploration		Development	Operation	Decommissioning
	Seismic Survey	Exploration Well			
<i>Noise</i>	X	X	X	X	X
Seismic noise	X				
Ship noise	X	X	X	X	X
Aircraft noise	X	X	X	X	X
Drilling noise		X	X		
Trenching noise			X		
Production noise				X	
Onshore construction			X		
Platform removal					X
<i>Traffic</i>	X	X	X	X	X
Aircraft traffic		X	X	X	X
Ship traffic	X	X	X	X	X
<i>Drilling Mud/Debris</i>		X	X		
<i>Bottom/Land Disturbance</i>		X	X		
Drilling		X	X		
Pipeline trenching			X		
Onshore construction			X		
<i>Air Emissions</i>		X	X	X	X
Offshore		X	X	X	X
Onshore			X	X	X
<i>Explosives</i>					X
Platform removal					X
<i>Lighting</i>		X	X	X	
Offshore facilities		X	X	X	
Onshore facilities			X	X	
<i>Visible Infrastructure</i>		X	X	X	
Offshore		X	X	X	
Onshore			X	X	
<i>Space Use Conflicts</i>	X	X	X	X	
Offshore facilities	X	X	X	X	
Onshore facilities			X	X	
<i>Accidental Spills</i>		X	X	X	

2

1 Impact-producing factors associated with exploration include noise, ship traffic, drilling
2 mud and debris, seafloor disturbance, air emissions, lighting, visible infrastructure, and space use
3 conflicts (Table 4.1.1-1). Noise will be generated by operating air gun arrays, vessel traffic,
4 drilling, and support aircraft traffic. Resources of primary concern from noise impacts are
5 marine mammals, sea turtles, and fish.
6

7 Ship traffic during the seismic surveys or in support of exploration well development has
8 the potential for collisions with marine mammals and sea turtles, while the presence of ship and
9 support aircraft traffic could affect normal behaviors of nearby biota (especially marine
10 mammals). The disposal of drilling mud and debris during exploration well development will
11 also affect local water quality and possibly biota.
12

13 Exploration well development will involve seafloor disturbance, primarily through the
14 placement of drilling support infrastructure. This disturbance may affect overlying water quality
15 as well as benthic biota and archeological resources (if present). Air emissions from the MODUs
16 may affect local air quality, while MODU lighting may affect birds. Depending on location,
17 MODUs may also present a visual impact. The conduct of seismic surveys and exploration well
18 development could conflict with other uses of the marine environment at that location.
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21 **4.1.1.2 Development**

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23 Once exploration has confirmed the presence of a commercially viable reservoir, the next
24 phase of O&G development is the construction of the production platform and drilling of
25 production wells. Production wells are drilled using MODUs, and the type of production
26 platform installed will depend on the water depth of the site and, to a lesser extent, on the
27 expected facility lifecycle, the type and quantity of hydrocarbon product (e.g., oil or gas)
28 expected, and the number of wells to be drilled. The number of wells per production platform
29 depends on the type of production facility, the size of the hydrocarbon reservoir, and the
30 drilling/production strategy for the drilling program. Production platforms may be fixed,
31 floating, or subsea (only in deep water). Fixed platforms rigidly attached to the seafloor are
32 typical in water depths up to 400 m (1,312 ft), while floating or subsea platforms are typically in
33 waters deeper than 400 m (1,312 ft). Floating platforms are attached to the seafloor using line-
34 mooring systems and anchors. Development will also include installation of seafloor pipelines
35 for conveying product to existing pipeline infrastructure or to new onshore production facilities.
36 In shallower waters (<60 m [<200 ft]), pipelines are typically buried to a depth of at least 0.91 m
37 (3 ft) below the mudline. Pipelines may also be buried (trenched) in deeper waters, depending
38 on conditions along the subsea pipeline corridor.
39

40 Impact-producing factors of development include noise, ship and helicopter traffic,
41 drilling mud and debris, seafloor and land disturbance, air emissions, lighting, and visible
42 infrastructure. During the development phase, noise will be generated during drilling, by ship
43 and helicopter traffic, pipeline trenching, and onshore construction. Resources that could be
44 affected by development-related noise include marine mammals, sea turtles, marine and coastal
45 birds, and fish. Marine mammals and sea turtles could be affected by collisions with ship traffic

1 supporting platform construction and drilling, while the presence of ship and helicopter traffic
2 could disturb normal behaviors of marine mammals and birds.

3
4 The disposal of drilling muds and fluids may affect local water quality and aquatic biota.
5 Some amount of seafloor disturbance will occur as a result of drilling, platform mooring, and
6 pipeline trenching, which would result in some loss of habitat and biota as well as reductions in
7 overlying water quality. Seafloor disturbance could also affect archeological resources if present
8 in the project area. Air emissions from platforms where drilling is occurring as well as at
9 onshore construction sites could affect local air quality. The lighting of offshore platforms could
10 affect birds, while lighting at onshore facilities could affect sea turtles. Visual impacts may be
11 incurred for some developments, depending on the location and nature (size) of the offshore
12 platform or onsite facilities. Development of production wells and platforms as well as of new
13 pipelines and onshore processing facilities could result in some space use conflicts in the project
14 area.

15 16 17 **4.1.1.3 Operation**

18
19 Following completion of the production wells and platform, the facilities are operated to
20 extract the hydrocarbon resource and transport it to onshore processing facilities. During the
21 operation phase, activities center on maintenance of the production wells (workover operations)
22 and platforms. Impact-producing factors associated with normal operations include noise, ship
23 and helicopter traffic, air emissions, lighting, and visible infrastructure (Table 4.1.1-1).

24
25 During normal operations, noise will be generated by maintenance activities and by ship
26 and helicopter traffic and may affect marine mammals and fish. Collisions with support ships
27 could affect marine mammals and sea turtles, while ship and helicopter traffic could disturb
28 normal behaviors of nearby biota. As noted for the development phase, lighting of onshore
29 facilities could affect sea turtles, while lighting of offshore platforms could affect birds. Any
30 visual impacts identified for the development phase could continue for the duration of the
31 operation phase. Similarly, some of the space use conflicts incurred during the development
32 phase would continue through production.

33 34 35 **4.1.1.4 Decommissioning**

36
37 Following lease termination or relinquishment, all platforms and seafloor obstructions are
38 required to be removed. All bottom-founded infrastructure is severed at least 5 m (15 ft) below
39 the mudline. Production infrastructure could be removed using explosive or nonexplosive
40 methods. Impact-producing factors associated with decommissioning include noise, ship and
41 helicopter traffic, air emissions, and explosives.

42
43 Noise would be generated during either explosive or nonexplosive structure removal, as
44 well as by ship and helicopter traffic supporting removal activities, and could affect marine
45 mammals, sea turtles, and fish. Ship traffic could result in collisions with marine mammals and
46 sea turtles, while ship and helicopter traffic could disturb behaviors of biota in the vicinity of the

1 platform undergoing decommissioning. Air emissions could affect local air quality. Pressure
2 from explosive detonations could injure marine mammals, sea turtles, and fish. Some additional
3 space use conflicts could arise with explosive platform removal.
4

6 **4.1.2 Accidental Events and Spills**

7
8 A variety of accidental events or spills may occur during OCS O&G development
9 (Table 4.1.2-1). During normal operations, ship and platform activities generate a variety of
10 solid waste materials, such as plastic containers, nylon rope and fasteners, and plastic bags. The
11 accidental release of such solid waste materials could affect marine mammals, sea turtles, and
12 birds. While sanitary and domestic wastes produced in ships and platforms are routinely
13 processed through onsite waste treatment facilities, the accidental discharge of such releases
14 could affect local water quality and biota.
15

16 Ships supporting platform activities may accidentally collide with MODUs or platforms,
17 releasing diesel fuel, which could affect water quality and biota. Loss of well control results in
18 the uncontrolled release of a reservoir fluid that may result in the release of gas, condensate or
19 crude oil, drilling fluids, sand, or water. Historically, most losses of well control have occurred
20 during development drilling operations, but loss of well control can happen during exploratory
21 drilling, production, well completions, or workover operations (MMS 2008a). Releases
22 associated with loss of well control may affect water quality, biota, and space use.
23

24 Oil spills are unplanned accidental events. Depending on the phase of O&G development
25 and the location, magnitude, and duration of a spill, natural resources that may be affected
26 include marine mammals, marine and coastal birds, sea turtles, fish, benthic and pelagic
27 invertebrates, water quality, marine and coastal habitats, and areas of special concern (such as
28 marine parks and protected areas). In addition, spills may also affect a variety of socioeconomic
29 conditions such as local employment, commercial and recreational fisheries, tourism,
30 sociocultural systems, and subsistence. Spill scenarios for the GOM, Cook Inlet, and Arctic
31 planning areas have been developed for use in this PEIS and are presented in detail in
32 Section 4.4.2. This draft PEIS also considers the potential effects of a catastrophic discharge
33 event (i.e., a low probability, very large volume accidental oil spill).
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36 **4.1.3 Assessment Approach**

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38 The environmental consequences discussed in subsequent sections of Chapter 4 address
39 the potential impacts that could be incurred under any of the seven action alternatives
40 (Alternatives 1–7). Because Alternative 1, the Proposed Action, encompasses the six OCS
41 Planning Areas considered for inclusion in the Program, OCS oil and gas activities that could
42 occur following leasing under Alternative 1 may be expected to have the potential to cause
43 impacts over the greatest geographic area. Any such potential impacts could also occur under
44 the other action alternatives (Alternatives 2–7), as each represents a subset of the planning areas
45 included in the proposed action. Thus, the analyses presented in Chapter 4, while focused on the
46 proposed action, are fully applicable to each of the other action alternatives.

1 **TABLE 4.1.2-1 Accidental Events and Spills That May Be Associated with OCS O&G**
2 **Development Phases**

Accidental Event or Spill	O&G Development Phase				
	Exploration		Development	Operation	Decommissioning
	Seismic Survey	Exploration Well			
Solid waste release	X	X	X	X	X
Sanitary waste release	X	X	X	X	X
Vessel collisions	X	X	X	X	X
Loss of well control		X	X	X	
Oil spills		X	X	X	X

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It is not possible to identify specific impacts from future OCS O&G development activities without development-specific location and design details. There are, however, general impacts that are typical of offshore O&G development, regardless of where development occurs. For example, the placement of a seafloor pipeline crossing shallow waters to a landfall will require trenching, which will disturb the seafloor and affect the overlying water quality, regardless of whether that pipeline is located in Cook Inlet or in the Western GOM Planning Area. The potential effects of pipeline placement will, however, differ between shallow and deep waters and by the nature of the seafloor communities present along the actual pipeline route.

As previously discussed, lease- and project-specific details are not known at this time. Thus, the analyses in this PEIS take a programmatic approach and evaluate resources on a larger, more regional scale rather than at a lease-block scale (the scale at which project-specific impacts could occur). Thus, the evaluation of environmental consequences presented in this PEIS has focused on those resources most likely to be affected during future O&G development on the OCS under the alternatives presented in Chapter 2.

For each resource, the impact-producing factors identified in Tables 4.1.1-1 and 4.1.2-1 were further examined and refined to identify aspects of those factors specific to the resource under evaluation. The analyses also identified, as applicable, important components of each resource to further refine the relationship between the impacting factors and the resource. For example, for sea turtles, the impact analyses identified four life stages (eggs, hatchlings, juveniles, and adults), four habitat types (nesting, foraging, overwintering, and nursery), and three important behaviors (courtship/nesting, foraging, migration) that could be affected by OCS O&G development activities. The impact analyses then focused on the impact-producing factors that could affect any of these life stages, habitats, or behaviors. Table 4.1.3-1 illustrates the refinement and linkage of impacting factors and important resource components.

1 **TABLE 4.1.3-1 Relationships among Development Phase Impacting Factors and Habitats, Life**
2 **Stage, and Behavior of Sea Turtles**

Development Phase and Impacting Factor	Sea Turtle Resource Component									
	Habitat Disturbance or Loss				Life Stage Affected				Behavior Affected	
	Nesting	Foraging	Overwintering	Nursery	Eggs	Hatchlings	Juveniles	Adults	Foraging	Courtship/ Nesting Migration
Vessel noise						X	X	X	X	
Aircraft noise										
Drilling noise							X	X		
Trenching noise							X	X	X	
Onshore construction noise								X		X
Offshore air emissions										
Onshore air emissions										
Aircraft traffic										
Vessel traffic						X	X	X		
Hazardous materials						X	X	X		
Solid wastes						X	X	X		
Drilling mud/debris						X	X	X		
Bottom disturbance from drilling										
Bottom disturbance from pipeline trenching		X	X	X			X	X	X	X
Offshore lighting										
Onshore construction	X				X	X		X		X
Onshore lighting	X					X		X		X
Aircraft noise										
Offshore air emissions										
Onshore air emissions										
Vessel traffic						X	X	X		
Aircraft traffic										
Hazardous materials						X	X	X		
Solid wastes						X	X	X		
Explosive platform removal						X	X	X		
Offshore lighting										

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4.1.4 Definition of Impact Levels

The conclusions for most resource analyses use a four-level classification scheme to characterize the impacts that could result with OCS O&G development under the alternatives presented in this PEIS.

4.1.4.1 Impact Levels for Biological and Physical Resources

The following impact levels for biological and physical resources are used for the analysis of water quality, air quality, marine and terrestrial mammals, marine and coastal birds, fish resources, sea turtles, coastal and seafloor habitats, and areas of special concern (such as essential fish habitats [EFHs], marine sanctuaries, parks, refuges, and reserves). For biota, these levels are based on population-level impacts rather than impacts on individuals.

- Negligible: No measurable impacts.
- Minor:
 - Most impacts on the affected resource could be avoided with proper mitigation.
 - If impacts occur, the affected resource will recover completely without mitigation once the impacting stressor is eliminated.
- Moderate:
 - Impacts on the affected resource are unavoidable.
 - The viability of the affected resource is not threatened although some impacts may be irreversible, or
 - The affected resource would recover completely if proper mitigation is applied during the life of the project or proper remedial action is taken once the impacting stressor is eliminated.
- Major:
 - Impacts on the affected resource are unavoidable.
 - The viability of the affected resource may be threatened, and
 - The affected resource would not fully recover even if proper mitigation is applied during the life of the project or remedial action is implemented once the impacting stressor is eliminated.

4.1.4.2 Impact Levels for Societal Issues

The following impact levels are used for the analysis of demography, employment, and regional income; land use and infrastructure; commercial and recreational fisheries; tourism and recreation; sociocultural systems; environmental justice; and archeological and historic resources.

- Negligible: No measureable impacts.
- Minor:
 - Adverse impacts on the affected activity, community, resource could be avoided with proper mitigation.
 - Impacts would not disrupt the normal or routine functions of the affected activity or community.

- 1 – Once the impacting stressor is eliminated, the affected activity or
2 community will, without any mitigation, return to a condition with no
3 measurable effects.
4
5 • Moderate:
6 – Impacts to the affected activity, community, or resource are unavoidable.
7 – Proper mitigation would reduce impacts substantially during the life of the
8 project.
9 – A portion of the affected resource would be damaged or destroyed.
10 – The affected activity or community would have to adjust somewhat to
11 account for disruptions due to impacts of the project, OR
12 – Once the impacting stressor is eliminated, the affected activity or
13 community will return to a condition with no measurable effects if proper
14 remedial action is taken.
15
16 • Major:
17 – Impacts on the affected activity, community, or resource are unavoidable.
18 – Proper mitigation would reduce impacts somewhat during the life of the
19 project.
20 – All of the affected resource would be permanently damaged or destroyed.
21 – The affected activity or community would experience unavoidable
22 disruptions to a degree beyond what is normally acceptable, and
23 – Once the impacting agent is eliminated, the affected activity or community
24 may retain measurable effects for a significant period of time or
25 indefinitely, even if remedial action is taken.
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28 **4.2 RELATIONSHIP OF THE PHYSICAL ENVIRONMENT TO OIL AND GAS** 29 **OPERATIONS**

30 31 32 **4.2.1 Physiography, Bathymetry, and Geologic Hazards**

33 34 35 **4.2.1.1 Gulf of Mexico**

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38 **4.2.1.1.1 Physiography and Bathymetry.** The GOM is a small ocean basin measuring
39 900 km (660 mi) from north to south and 1,600 km (990 mi) from east to west with a mean water
40 depth of about 1,615 m (5,300 ft) (Bryant et al. 1991; GulfBase 2011). The basin is almost
41 completely surrounded by continental landmasses. Its shoreline runs 5,700 km (3,500 mi) from
42 Cape Sable, Florida, to the tip of Mexico's Yucatan Peninsula, with another 380 km (240 mi) of
43 shoreline on the northwest tip of Cuba (GulfBase 2011).
44

45 The continental shelf extends from the coastline to a water depth of about 200 m (660 ft).
46 Width of the shelf varies, ranging from 10 km (6 mi) near the Mississippi Delta to about 280 km

1 (175 mi) off the southern tip of Florida and the Yucatan Peninsula. Its topographic relief is
2 relatively low. Extending from the edge of the shelf to the abyssal plain is the continental slope,
3 a steep area with high topographic relief and diverse geomorphic features (canyons, troughs, and
4 salt structures). The base of the slope occurs at a median depth of about 2,800 m (9,190 ft). The
5 Sigsbee Deep, located within the Sigsbee Abyssal Plain in the southwestern part of the basin, is
6 the deepest region of the GOM with a maximum depth ranging from 3,750 m (12,300 ft) to
7 4,330 m (14,200 ft). The GOM basin contains a volume of 2,434,000 km³ (6.43 × 10¹⁷ gal) of
8 water (Shideler 1985; GulfBase 2011).
9

10 Antoine (1972) has divided the GOM into physiographic provinces, the components of
11 which correspond to the ecological regions delineated by the Commission for Environmental
12 Cooperation (CEC) (Wilkinson et al. 2009). The physiographic regions presented below are
13 organized from north to south. They are based on the CEC's nomenclature (Level II seafloor
14 geomorphological regions¹) and incorporate the physiographic descriptions of Antoine (1972),
15 Bryant et al. (1991), Shideler (1985), Wilhelm and Ewing (1972), and GulfBase (2011).
16

17 **Northern Gulf of Mexico Shelf and Slope.** On its west side, the northern GOM shelf
18 and slope extends from the Rio Grande (Texas) to Alabama and from 320 km (200 mi) inland of
19 today's shoreline to the Sigsbee Escarpment. It encompasses the Texas-Louisiana Shelf and
20 Slope and the Mississippi-Alabama Shelf (Figure 4.2.1-1). The major geologic feature in this
21 province is the Mississippi Fan, which extends from the Mississippi River Delta to the central
22 abyssal plain. The upper part of the fan (to a water depth of about 2,500 m or 8,200 ft) has a
23 complex and rugged topography attributed to salt diapirism,² slumping, and current scour; the
24 lower part of the fan by contrast is smooth, with a gently sloping surface that merges with the
25 abyssal plain to the southeast and southwest. The Mississippi Canyon cuts the eastern side of the
26 Texas-Louisiana Shelf to the southwest of the Mississippi River Delta. The submarine canyon is
27 thought to have formed from large-scale slumping along the shelf edge. The area is
28 characterized by thick sediments and widespread salt deposits.
29

30 To the east, the northern GOM shelf and slope extends from just east of the Mississippi
31 River Delta near Biloxi, Mississippi, to the eastern side of Apalachee Bay (west Florida) and
32 encompasses the West Florida Shelf and Terrace (Figure 4.2.1-1). The shelf in this region is
33 characterized by soft terrigenous (land-derived) sediments. Sediments are thick west of DeSoto
34 Canyon; Mississippi River-derived sediments cover the western edge of the carbonate platform
35 of the West Florida Shelf. The Florida Escarpment, with slopes as high as 45° in places,

1 The CEC's Level II seafloor geomorphological regions are determined by large-scale physiography (e.g., continental shelf, slope, and abyssal plain) and extend offshore to a depth of 370 km (200 mi). The designation of Level II regions is helpful to understanding marine ecosystems because it illustrates the importance of depth as a major determinant of benthic marine communities and shows how physiographic features can influence current flows and upwelling (Wilkinson et al. 2009). Other sections (e.g., Section 3.2 on Marine and Coastal Ecoregions) provide finer scale Level III region descriptions that take into account local variables such as water mass, regional landforms, and biological community types on the continental shelf.

2 Salt diapirism refers to a process by which natural salt (mainly halite but also including anhydrite and gypsum) in the subsurface deforms and flows in response to loading pressures from overlying sediments. Because of its low density, salt tends to flow upward from its source bed, forming intrusive bodies known as diapirs. Salt diapirs are common features of sedimentary basins like the Gulf of Mexico (Nelson 1991).

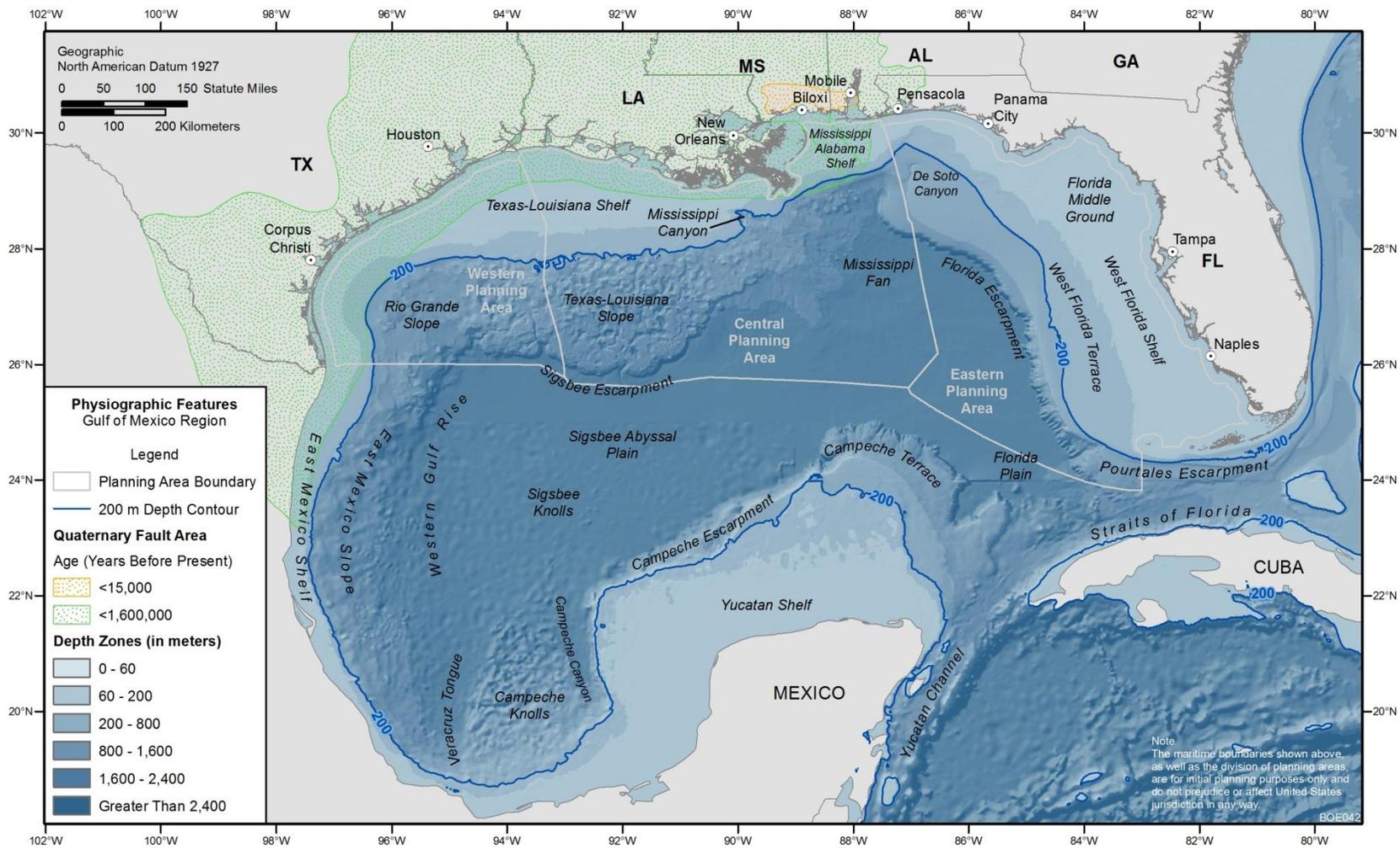


FIGURE 4.2.1-1 Physiographic Regions of the GOM (based on Bryant et al. 1991)

1 separates the West Florida Shelf from the deeper GOM basin and also forms the southeastern
2 side of DeSoto Canyon.

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4 **South Florida/Bahamian Shelf and Slope.** This region is the submerged portion of the
5 Florida Peninsula. The region extends along the West Florida coast from Apalachee Bay
6 southward to the Straits of Florida and includes the Florida Keys and Dry Tortugas. Sediments
7 become progressively more carbonate (ocean-derived) from north to south with thick
8 accumulations in the Florida Basin. The basin may have been enclosed by a barrier reef system
9 at one time. The Jordon Knoll, located within the Straits of Florida, is composed of remnants of
10 the ancient reef system.

11
12 **Gulf of Mexico Basin.** The GOM Basin consists of the continental rise, the Sigsbee
13 Abyssal Plain, and the Mississippi Cone. The continental rise is situated between the Sigsbee
14 Escarpment and the Sigsbee Abyssal Plain (Figure 4.2.1-1). It is a large wedge of sediments
15 originating from the unstable continental slope (deposited by gravity flows). The Sigsbee
16 Abyssal Plain is the deep, flat portion of the GOM bottom just northwest of the Campeche
17 Escarpment. It is 450 km (280 mi) long and 290 km (180 mi) wide and covers an area of more
18 than 103,600 km² (40,000 mi²). The plain is underlain by very thick sediments (up to 9 km, or
19 5.6 mi); the only major topographical features in this region are the small salt diapirs that form
20 the Sigsbee Knolls. The Mississippi Cone lies between the Mississippi Canyon to the west and
21 DeSoto Canyon to the east. It is the portion of the Mississippi River Delta that has accumulated
22 at the base of the continental slope.

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25 **4.2.1.1.2 Geologic Hazards.** Several types of geologic hazards are known to occur in
26 the marine environment of the GOM region, most of which present a risk to offshore oil and gas
27 activities because they contribute directly or indirectly to seafloor instability. As a result,
28 seafloor instability is likely the principal engineering constraint to the emplacement of bottom-
29 founded structures, including pipelines, drilling rigs, and production platforms.

30
31 Geologic hazards within the GOM are common on the northern continental slope
32 (Figure 4.2.1-1) because of its high sedimentation and subsidence rates and the compensating
33 movement of underlying salt. Geologic hazards are frequently concentrated in the areas along
34 the edges of intraslope basins³ where topography is high and complex. These intervening
35 regions are created by shallow diapiric salt bodies and are steeply sloped and highly faulted.
36 They are also areas of natural fluid and gas migration to the seafloor surface
37 (Roberts et al. 2005). The potential geologic hazards in the GOM region are described below.

38
39 **Irregular Topography.** The regional topography of the continental slope is irregular,
40 consisting predominantly of domes, ridges, and basins. On a more local scale, topographic
41 features include slope failures, mounds, depressions, and scarps⁴ (Roberts 2001). Such features

³ Intraslope basins are flat, featureless areas on the continental slope of the northwestern GOM where sediment depositional processes predominate.

⁴ Scarps (or escarpments) are steep bluff-like features formed by the downward displacement of sediments or rocks along a vertical fault plane.

1 produce a wide range of potential hazards to drill rigs, bottom-laid and buried pipelines, and
2 production platforms. The most topographically rugged province in the region is the Texas-
3 Louisiana Slope, a 120,000- km² (46,300-mi²) area of banks, knolls, basins, and domes where
4 local slope gradients can exceed 20°. Topographic variability in this area is attributed to the
5 movement of salt in the subsurface and the natural venting and seepage of petroleum and other
6 fluids at the seafloor surface (Roberts et al. 2005; Bryant and Lui 2000; Kennicutt and
7 Brooks 1990; Roberts et al. 1998).

8
9 Substrate types range from lithified (rock-like) hard bottoms⁵ (bioherms, hardgrounds,
10 carbonate banks, and outcrops) to extremely soft, fluid mud bottoms. Hard-bottom substrates are
11 associated with topographic highs (most often created by salt diapirs) and present hazards to
12 activities such as drilling, locating production platforms, and laying pipelines. The coral reefs of
13 the Flower Garden Banks in the northwestern GOM are an example (Roberts et al. 2005; Roberts
14 and Aharon 1994; Schmahl et al. 2011; see also Sections 3.7.2.1.2 and 3.9.1.2.1).

15
16 **Bedforms and Bedform Migration.** Bedforms are depositional features on the seabed
17 that form by the movement of sediment caused by bottom currents. An extensive field of
18 bedforms, ranging in size from small ripples and mudwaves to large furrows, is present at the
19 base of the continental slope (along the Sigsbee Escarpment) in the GOM (Bean 2005; Bryant
20 and Liu 2000). Large bedforms and their migration create potential navigation hazards and may
21 undermine submarine pipelines. Numerous studies of these features relate their morphology and
22 migration to water depth, availability of sediment, grain size, and current velocity (Whitmeyer
23 and FitzGerald 2008).

24
25 Deep tow surveys conducted by Texas A&M University have found that the 30-m (98-ft)
26 wide and 10-m (32-ft) deep furrows to the south of the Sigsbee Escarpment parallel the regional
27 contours and extend for tens to hundreds of kilometers. These features indicate the long-term
28 presence of high-velocity bottom currents along the base of the escarpment (Bryant and
29 Liu 2000). Bean (2005) estimates current velocities in this region to be as high as 95 cm/s
30 (37 in./s), significant enough to affect structures on the seafloor or in the water column. The
31 bedforms have steep upstream-facing sides (where deposition takes place), suggesting they
32 migrate in an upcurrent direction (Bean 2005).

33
34 **Bottom Scour.** Vigorous tidal circulation and storm waves have an important effect on
35 the transport of sediments on the surface of the continental shelf. Episodic sediment movement
36 caused by waves and ocean currents can undermine foundational structures and move
37 unanchored bottom-laid pipelines (as reported by Thompson et al. 2005 and Coyne and
38 Dollar 2005). Teague et al. (2006) estimate that in 2004 Hurricane Ivan displaced as much as
39 100 million m³ (3.5 billion ft³) of sediment from a 35 by 15 km (22 by 9 mi) region in the
40 storm's path, causing up to 36 cm (14 in.) of scour at moorings in areas over which the
41 maximum wind stress occurred. Bottom scour occurs as a result of sediment resuspension by

⁵ Hard bottoms formed on diapiric high areas beyond the shelf edge during periods of lowered sea level in the late Pleistocene. During this time, the areas provided a substrate for the colonization of sedentary marine organisms. As sea level rose, the remains of the colonized organisms in these areas became fossilized, forming bioherms (e.g., fossilized coral reefs) and shallow banks (Robert et al. 2005).

1 waves and current-driven transport of entrained sediments. Sediments entrained in bottom
2 currents increase water density and mass, giving the strength to cause further scouring. In
3 addition, wind-generated surface waves apply cyclic pressure to bottom sediments causing
4 seabed motion (liquefaction).

5
6 **Fluid and Gas Expulsion.** There are a wide range of natural fluid and gas⁶ expulsion
7 processes in seafloor sediments across the northern GOM continental slope. The geologic
8 features related to these processes are variable and depend largely on the rate and duration of
9 delivery as well as the composition of the fluid and gas expelled (Hardage 2011; Roberts 2001a).
10 These include mud volcanoes, flows, and vents, resulting from rapid-flux or mud-prone
11 processes; gas hydrate mounds and chemosynthetic communities, resulting from moderate-flux
12 processes; and hard bottoms (carbonate mounds, hardgrounds, and nodular masses), resulting
13 from slow-flux or mineral-prone processes (Roberts 2001a, 2002). Below water depths of about
14 500 m (1,640 ft), moderate-flux processes dominate, promoting gas hydrate formation at or near
15 the seafloor and creating conditions optimal for sustaining dense and diverse chemosynthetic
16 communities. Rapid- and slow-flux processes may also occur on a more local scale at these
17 depths (Roberts 2002). Pockmarks — circular to oval depressions resulting from the removal of
18 sediment near areas of rapid (and possibly explosive) gas expulsion — have been mapped along
19 the northern continental shelf and slope. Some of these features are over 300 m (1,000 ft) in
20 diameter (BOEMRE 2011n).

21
22 The main geologic hazard stemming from the processes of fluid and gas expulsion (seeps
23 and eruptions) is seabed slope failure (submarine slumps and slides), especially on the
24 continental slope and within active river deltas and submarine canyons. Fluid and gas releases
25 lower sediment shear strengths and as a result can destabilize seabed structures such as cables,
26 pipelines, and platforms.

27
28 Studies using high-resolution seismic and side-scan sonar have shown that the linear
29 spatial distribution of seafloor features caused by fluid and gas expulsion can usually be
30 correlated with faults intersecting the modern seafloor. Faults are important conduits for the
31 upward natural migration of fluids and gases through the sedimentary column to the seafloor
32 (Roberts 2001b). Neurater and Bryant (1990) report that it is the churning action of upwelling
33 fluids and gases that causes a “slurry” of unconsolidated mud to form and migrate to the surface
34 of the seafloor.

35
36 Along the Texas-Louisiana Shelf, shallow gas accumulations are most common in old
37 channel systems. Shallow gas accumulations are also found in areas affected by salt uplift where
38 numerous faults form pathways to near-surface sediments, creating small gas pockets that
39 become sealed in thin clay layers (Foote and Martin 1981).

40

⁶ Gases (predominantly methane) migrating from the seabed originate from both deep sources (termed thermogenic gases because they are heat-generated) and more shallow sources (termed biogenic or microbial gases because they are derived from the activity of microorganisms). Regardless of origin, high-pressure methane is highly mobile, flammable, and buoyant and poses a great hazard to drilling operations when encountered (Judd and Hovland 2007).

1 **Natural Gas Hydrates.** Gas hydrates are naturally occurring solids composed of
2 hydrogen-bonded water lattices (also known as clathrates) that trap methane and other low-
3 weight gas molecules (e.g., carbon dioxide, propane, and ethane). They form in deepwater ocean
4 sediments within a surface-parallel layer referred to as the hydrate stability zone under
5 conditions of high pressure and low temperature. In the GOM, gas hydrate deposits are found in
6 localized deepwater areas at or near the seafloor (intersecting the seafloor at a water depth of
7 about 500 m, or 1,640 ft). They occur as a disseminated accumulation in the pore spaces of
8 sedimentary units across vertical sections ranging in thickness from a few centimeters to several
9 hundred meters. In more massive form, they occur in faults, fractures, and nodules and range in
10 thickness from a few centimeters to several hundred meters. The size and shape of the hydrate
11 stability zone are influenced by the presence of numerous salt features (Boatman and
12 Peterson 2000; Roberts 2001b; MMS 2006a; Frye 2008).

13
14 Because they are pressure- and temperature-sensitive, gas hydrates (if present) can easily
15 dissociate and rapidly release large amounts of gas during a drilling operation. Hydrate
16 dissociation may trigger seafloor slumps and catastrophic landslides, which pose significant
17 hazards for offshore oil and gas operations, including the loss of support for drilling and
18 production platforms and pipelines, collapse of wellbore casings, and seafloor subsidence around
19 wellbores where gas has leaked to the surface. As drilling operations in the GOM move into
20 deeper waters, gas hydrate outcrops are likely to be encountered more frequently (Boatman and
21 Peterson 2000; Roberts 2001b; MMS 2006a).

22
23 In addition to their natural occurrence in sediments, gas hydrates may also form on
24 drilling equipment and in pipelines in deep water, trapping methane and other gas molecules and
25 posing hazards such as drilling difficulties, blockages and pressure buildup in valves and
26 pipelines, and an increased risk of well control loss (Boatman and Peterson 2000).

27
28 **Shallow Water Flow.** Shallow water flow is a deepwater drilling hazard that occurs
29 when overpressured, unconsolidated sands are encountered at shallow depths, 460 to 2,100 m
30 (1,500 to 7,000 ft) below the seabed (Huffman and Castagna 2001). When encountered, these
31 sands are prone to uncontrolled flow, potentially damaging the well and causing well casing
32 failure — which could result in the loss of the well.⁷ In extreme cases, overpressured sands have
33 been known to erupt, creating seafloor craters (due to collapse), mounds, and cracks. Shallow
34 water flow sands are difficult to detect seismically because there is little contrast in acoustic
35 impedance at sand/shale interfaces at shallow depths (Lu et al. 2005; Ostermeier et al. 2002);
36 however, some investigators are having success using high-resolution multi-component seismic
37 data to delineate anomalies to identify zones that might produce shallow water flow
38 (e.g., Hoffman and Castagna 2001).

39
40 **Slope Failure.** Submarine slope failures result from processes that reduce the shear
41 strength of sediment on submarine slopes and/or increase the main driving force (gravity) that
42 promotes the downslope movement of sediments. Hance (2003) summarizes the published
43 literature on submarine slope failure and identifies 14 triggering mechanisms, a subset of which

⁷ Shallow water flow is estimated to have occurred in about 70% of all deepwater wells (Hoffman and Castagna 2001).

1 is relevant to the GOM shelf and slope: (1) sedimentation processes that involve rapid
2 deposition, especially in offshore delta areas and at the base of submarine canyons; (2) increased
3 fluid pressures resulting from the disassociation of gas hydrates and the release and accumulation
4 of free gas; (3) ocean storm waves and subsurface current (internal) waves; (4) tidal events,
5 especially along coastlines; (5) human activities such as construction and dredging, usually along
6 coastlines; (6) salt diapirism, which oversteepens soils on the flanks of diapirs; (7) mud-related
7 volcanic activity; and (8) sediment creep, a process involving the slow movement of large
8 masses of sediment.

9
10 Mudflows occur within well-defined gullies along the submerged portion of the
11 Mississippi Delta, creating unstable conditions vulnerable to failure. Areas between the
12 mudflow gullies have lower sedimentation rates and are considered to be generally stable.
13 Active deposition takes place downslope of the gullies. Damage to pipelines and production
14 facilities due to mudflow overruns has been documented in this region (Hitchcock et al. 2010).
15 Other forms of sediment instability along the delta front include collapse depressions, submarine
16 landslides, and shelf-edge slumps (Coleman et al. 1991; Coleman and Prior 1988).

17
18 Nodine et al. (2006) also reported pipeline damage by mudslides within (and confined to)
19 the mudflow lobes along the delta front during Hurricane Ivan in 2004.

20
21 **Faulting.** Faulting occurs on a range of scales within the GOM continental shelf and
22 slope, from major growth faults⁸ that cut across thousands of meters of sedimentary section to
23 much smaller faults related primarily to salt movement in the shallow subsurface. Vertical
24 offsets along faults create steep scarps on the seafloor, leading to various forms of subaqueous
25 mass movement (falls, slides or slumps, flows, and turbidity flow) that contributes to the
26 seafloor's irregular topography. Faults also provide pathways for the upward migration and
27 expulsion of fluids and gas at the seafloor surface (Roberts 2001b; Coleman and Prior 1988).

28
29 Active faults could pose a hazard to oil and gas activities in areas of rapid deposition and
30 subsidence (such as the Mississippi Delta), especially in areas where formation fluids such as
31 water and oil are withdrawn. In the GOM, fault activity is thought to be most prevalent on steep
32 slopes at the shelf edge where sediment accumulation creates loading stress that is periodically
33 relieved by sudden faulting and associated with active salt diapirs on the upper slope (Foote and
34 Martin 1981).

35 36 37 **4.2.1.2 Alaska – Cook Inlet**

38
39 The Cook Inlet Planning Area encompasses the lower half of Cook Inlet (referred to as
40 lower Cook Inlet) and Shelikof Strait. The following descriptions of physiography, bathymetry,

⁸ Growth faults are normal (extensional) faults that form at the same time massive volumes of sediments are accumulating within an area of high deposition, such as the Mississippi Delta. The fault plane is typically well-defined and is linear or concave and fairly steep. Growth faults exhibit greater offset with increasing depth and extend more than 150 m (500 ft) below the sea floor. They are most common on the outer shelf and upper slope where sediment accumulation and subsidence are greatest (Foote and Martin 1981; MMS 2006; Teague et al. 2006).

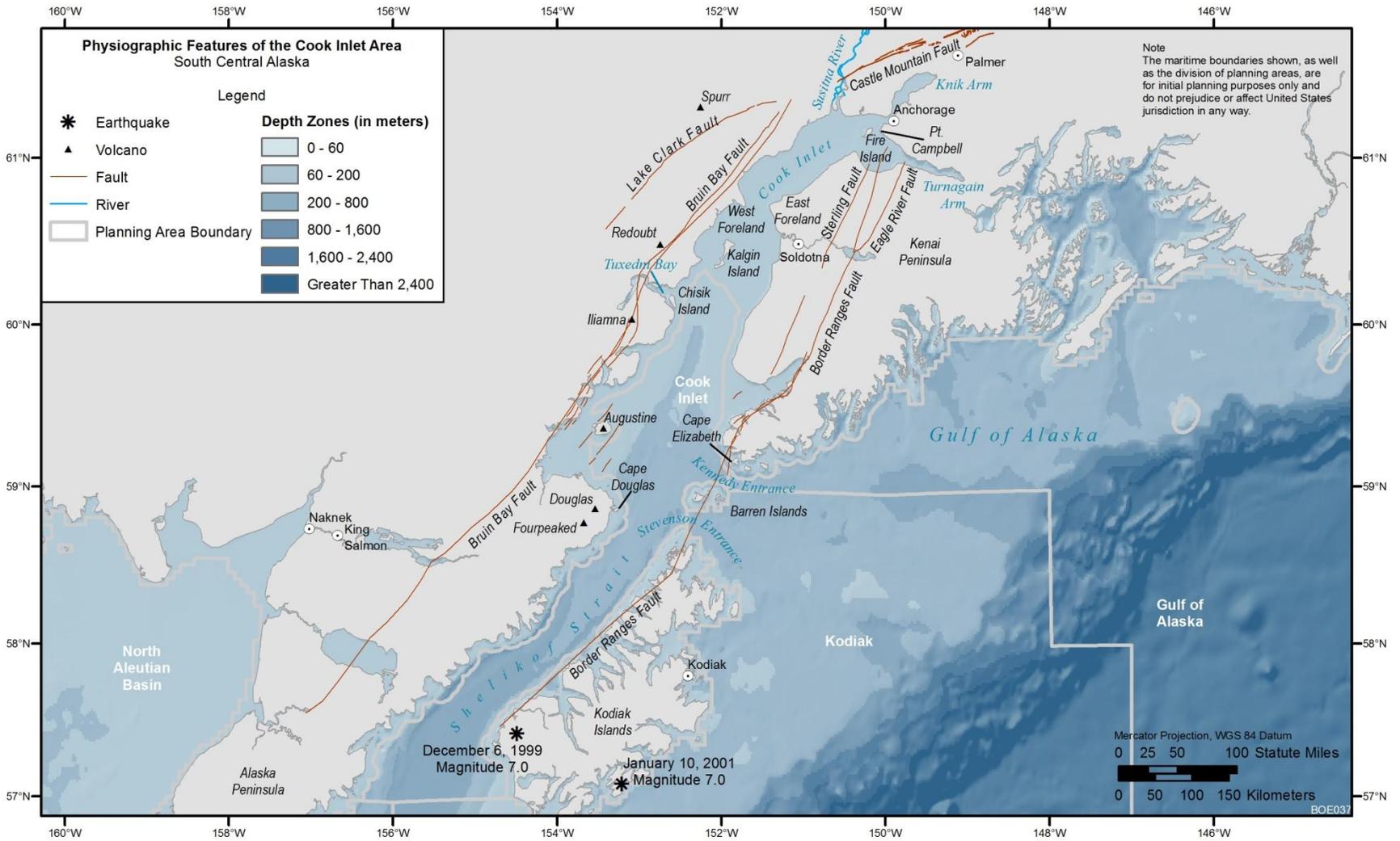
1 and geologic hazards address physiographic features and geologic processes throughout Cook
2 Inlet (including the upper inlet) for completeness.

3
4
5 **4.2.1.2.1 Physiography and Bathymetry.** Cook Inlet is a northeast-trending, 350-km
6 (220-mi) long tidal estuary on the south-central coast of Alaska. It is situated between the
7 Kenai Peninsula and Alaska Peninsula and extends from Anchorage to the Gulf of Alaska
8 (Figure 4.2.1-2). The inlet is composed of three distinct physiographic regions: the head, the
9 upper inlet, and the lower inlet. The head region lies at the northernmost end of Cook Inlet and
10 consists of two long and narrow bays: Knik and Turnagain Arms, both of which have extensive
11 tidal marsh flats during low tide. Knik Arm begins at the confluence of the Knik and Matanuska
12 Rivers, about 50 km (31 mi) inland; it ranges in width from about 2 to 10 km (1.2 to 6.2 mi).
13 The Port of Anchorage is located on the southeast shore of Knik Arm, at the mouth of Ship
14 Creek. Turnagain Arm extends about 75 km (47 mi) inland to the railroad depot at Portage; it
15 ranges in width from about 2 to 26 km (1.2 to 16 mi). Fire Island is located at the midpoint
16 between Knik and Turnagain Arms, just off the coast of Anchorage (Mulherin et al. 2001).

17
18 Upper Cook Inlet is about 95 km (59 mi) long and extends from Point Campbell to the
19 East and West Forelands (Figures 4.2.1-2 and 4.2.1-3). It ranges in width from 20 to 30 km
20 (12 to 19 mi) and narrows to 16 km (10 mi) between the Foreland peninsulas. Several shallow
21 shoals occur in this region, including Middle Ground Shoal, just north of the Forelands and north
22 of the inlet's midline; Beluga Shoal, due south of the mouth of Susitna River, at the inlet's
23 midline; and Fire Island Shoal, due west of Fire Island. Water depths in upper Cook Inlet are
24 generally less than 37 m (120 ft), with the greatest depths at Trading Bay, the largest bay in the
25 upper inlet, just east of the mouth of McArthur River (Mulherin et al. 2001; ADNR 2009a).

26
27 Lower Cook Inlet is about 200 km (120 mi) long and lies between the Foreland
28 peninsulas and the inlet's mouth, which opens to the Gulf of Alaska between Cape Douglas on
29 the Alaska Peninsula and Cape Elizabeth on the Kenai Peninsula (Figures 4.2.1-2 and 4.2.1-4).
30 There are several islands within the lower inlet, including Augustine Island, in Kamishak Bay;
31 Chisik Island, at the mouth of Tuxedini Bay; and Kalgin Island, about 30 km (19 mi) south of the
32 Forelands. The Barren Islands and Chugach Islands are located at the inlet's mouth. The
33 bathymetry is characterized as having sloping sides forming a central depression (Cook Trough)
34 that gradually deepens to the south and widens as it approaches the Cook Plateau near the mouth
35 of the inlet. The depression bifurcates to the north into two channels, divided by a narrow shoal
36 (Kalgin Platform) extending southward from Kalgin Island. The Cook Plateau lies between the
37 lower end of the Cook Trough and the top of Cook Ramp, a gently sloping ramp delineating the
38 sandy sediments to the north and muddy sands to the south. The Cook Plateau and parts of the
39 Cook Ramp are covered by bedforms of various sizes. The ramp slopes from a water depth of
40 about 70 m (230 ft) to about 120 to 130 m (390 to 430 ft) as it approaches the north end of the
41 Shelikof Trough (Mulherin et al. 2001; ADNR 2009a; Bouma 1981; Bouma et al. 1978a).

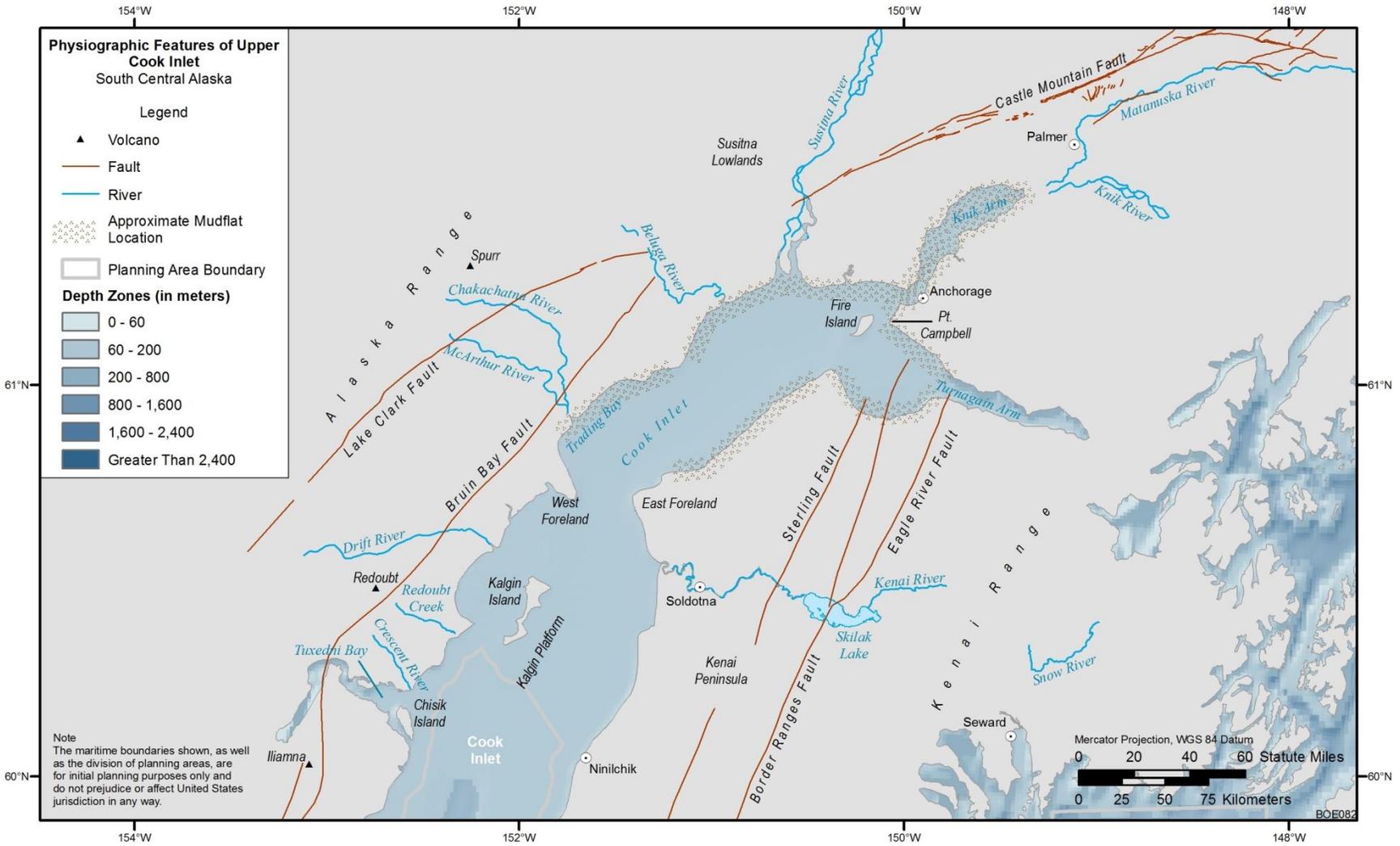
42
43 The Chinitna Platform covers most of the western part of lower Cook Inlet
44 (Figure 4.2.1-2). Its surface is smooth with numerous small topographic highs and lows. Most
45 of the bottom is hard and covered by coarse-grained sediment and shells (although embayments



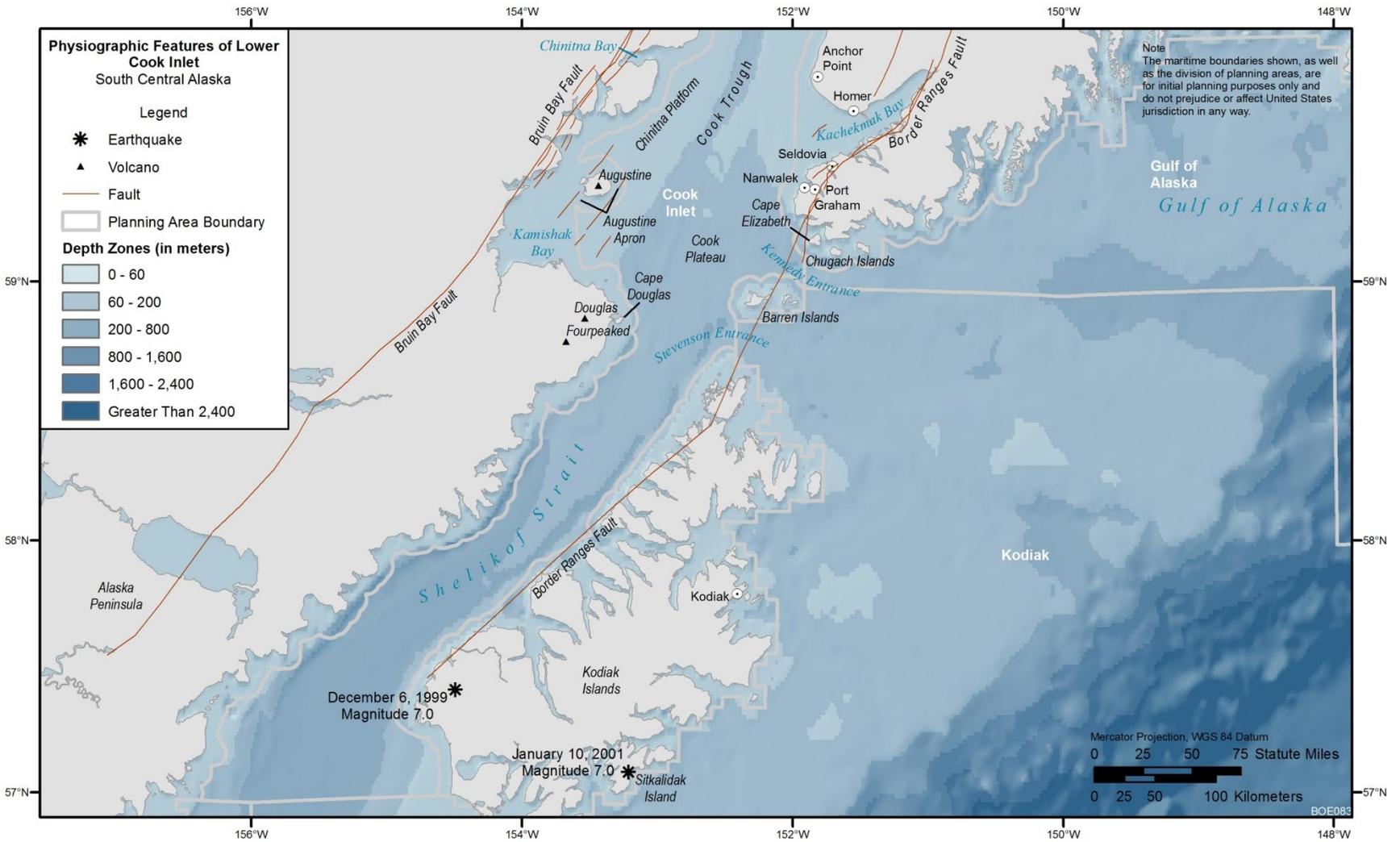
1

2 **FIGURE 4.2.1-2 Physiographic Features of Cook Inlet (Earthquake data from USGS 2011a; map data for faults from Labay and**
3 **Haussler 2001; Troutman and Stanley 2003; and Clough 2011.)**

4



1
2 **FIGURE 4.2.1-3 Upper Cook Inlet (Map data for faults from Labay and Haeussler 2001; Troutman and Stanley 2003; and**
3 **Clough 2011; mudflat data from Mulherin et al. 2001.)**
4



1

2 **FIGURE 4.2.1-4 Lower Cook Inlet (Earthquake data from USGS 2011a; map data for faults from Labay and Haeussler 2001;**
3 **Troutman and Stanley 2003; and Clough 2011.)**

4

1 may have muddy bottoms). Augustine Island is located on the platform, and a shallow area,
2 known as the Augustine Apron, encircles the island (Bouma 1981).

3
4 There are three entrances to the lower inlet from the Gulf of Alaska; these are the
5 Kennedy and Stevenson Entrances on either side of the Barren Islands off the northeastern end of
6 the Kodiak Islands and the opening of Shelikof Strait on the inlets' southwestern end.

7
8 Shelikof Strait lies between the Kodiak Island group and the Alaska Peninsula and also
9 has a northeast orientation (Figure 4.2.1-2). The strait is about 200 km (120 mi) long, with an
10 average width of about 45 km (27 mi). The seafloor in this region consists of a flat, central
11 platform (coinciding with the Shelikof Trough) that slopes gently to the southwest. The platform
12 is flanked by narrow marginal channels that run alongside the Kodiak Islands and the Alaska
13 Peninsula. Relief on the platform and within the marginal channels can be as high as 100 m
14 (330 ft) locally. Water depths in Shelikof Strait increase gradually in a southwestward direction,
15 ranging from about 80 m (260 ft) at the mouth of Cook Inlet to more than 300 m (980 ft) off the
16 west end of the Kodiak Islands (Hampton et al. 1978; Bouma 1981; Hampton et al. 1981). Deep
17 subsurface faults (offsetting rocks of Tertiary age or older) occur along the margins of Shelikof
18 Strait and run parallel to the shorelines of Kodiak Island and the Alaska Peninsula. Shallow
19 faults are more recently active and occur throughout the strait — along its margins, as growth
20 faults, and in association with structural highs (horsts or remnant volcanic necks) — and trend
21 predominantly to the northeast (Hoose and Whitney 1980).

22
23
24 **4.2.1.2.2 Geologic Hazards.** Several types of geologic hazards are known to occur in
25 the marine environment of Cook Inlet and Shelikof Strait and may present a risk to offshore oil
26 and gas activities because they are dangerous to navigation or potentially damaging to marine
27 structures. The potential geologic hazards in Cook Inlet and Shelikof Strait, except for sea ice,
28 which is addressed in Section 4.2.2.1.1, are described below.

29
30 **Seafloor Instability.** The generally shallow nature and large tidal range of Cook Inlet
31 (9 m [30 ft]) produce rapid currents. The Coriolis effect is also pronounced at this latitude, and
32 during peak flow, all these factors combine to create strong cross-currents and considerable
33 turbulence (strong currents and turbulence are also generated as tides flow through the
34 constricted Forelands area). High current velocities and turbulence keep fine sediments (silt and
35 clay) in suspension, so they are transported far from their source in the head region — the
36 Susitna and Knik Rivers — and then back again with the incoming tide. As a result, bottom
37 sediments throughout most of the inlet are predominantly coarse-grained (cobbles, pebbles, and
38 sand) with only minor amounts of silt and clay. Grain size distribution in the inlet, which
39 reflects the type and energy of transportation during the tidal cycle, is as follows: (1) sand, in the
40 head region to the east of the Susitna River; (2) sandy-gravel and gravel, in the upper inlet and
41 the upper part of the lower inlet (to Chinitna Bay); and (3) gravelly sand with minor silt and clay,
42 in the lower inlet as far as the Barren Islands (Sharma and Burrell 1970).

43
44 MMS (1995a) concluded that the bottom sediments in Cook Inlet provide a stable
45 substrate with no unusual geotechnical issues. This conclusion was based on the nature of
46 bottom sediments in Cook Inlet (mainly coarse-grained), the low rate of sediment accumulation,

1 and the low relief of the seafloor. Previous studies found no areas of soft, unconsolidated
2 sediments or evidence of failed or unstable slopes.⁹

3
4 **Bedforms and Bedform Migration.** Bedforms are depositional features on the seabed
5 that form by the movement of sediment by strong bottom currents. Bedforms are common in
6 Cook Inlet and occur as sand waves, dunes, sand ribbons, sand ridges, and megaripples with
7 wavelengths ranging from 50 to 800 m (160 to 2,600 ft) and heights from 2.0 to 14 m (6.6 to
8 46 ft). The type of bedform occurring at a given location depends on factors such as sediment
9 size and availability, water depth, and current velocity (Hampton 1982a). Bedform migration
10 and the strong bottom currents that cause it are known to be hazardous to offshore operations in
11 upper Cook Inlet because they undermine or bury bottom-founded structures such as anchors and
12 pipelines (Bouma et al. 1978b; Bouma and Hampton 1986; Whitney et al. 1979; Bartsch-
13 Winkler 1982). Several pipeline failures in Cook Inlet have been attributed to sediment
14 movement that results from current-sediment interaction (ADNR 2009a).

15
16 The largest bedform fields in lower Cook Inlet occur in its central and southern parts
17 (especially on Cook Plateau and Cook Ramp) where bottom current velocities may be as high as
18 50 cm/s (20 in./s) (Whitney and Thurston 1977; Bouma et al. 1978b; Bouma 1981). Studies
19 conducted in the lower inlet indicate sand grains move mainly during storm events and in
20 response to ebb and flood cycles, especially during spring tide (Bouma and Hampton 1986).

21
22 **Shallow Gas.** Shallow gas is a hazard to drilling operations when encountered because it
23 increases the potential for loss of well control. Shallow gas-charged sediments¹⁰ have been
24 documented in Cook Inlet, and loss of well control incidents have occurred at the Steelhead
25 platform (well M-26; 1987–1988) and Grayling platform (well G-10RD; 1985) in upper Cook
26 Inlet north of the West Foreland. The incident at the Grayling platform stopped on its own as a
27 result of well bore collapse that naturally sealed off the escaping fluids and gases. At the
28 Steelhead platform, however, some injuries to workers and damage to the platform occurred as a
29 result of escaping gases that caught fire (ADNR 2009a).

30
31 Whitney and Thurston (1981) delineated shallow gas-charged sediment areas at depths of
32 less than 50 m (160 ft) below the seafloor in lower Cook Inlet based on high-resolution seismic
33 profiles. The areas occur to the west of the Barren Islands between bathymetric contours 150 km
34 and 180 km (93 mi and 110 mi) and to the southeast of Augustine Island between bathymetric

⁹ Studies of sediments in the head region (at the northernmost end of Cook Inlet), however, do indicate soft sediments (e.g., in Knik Arm) that have unstable banks and bottoms and a high liquefaction potential. Surface bedforms are common features in these sediments (Bartsch-Winkler 1982).

¹⁰ Natural gas (predominantly methane) in Cook Inlet sediments likely originates from the decay of trapped organic matter in recent sediments and seepage from deeper sources, as reported by Molnia et al. (1979) for the Gulf of Alaska. Gas from deeper sources in the Cook Inlet basin has two types of occurrences: (1) the shallow reserves of biogenic gas in the Sterling, Beluga, and upper Tyonek Formations of the nonmarine Kenai Group of Tertiary age, at depths less than 2,300 m (7,500 ft); and (2) the oil-associated (thermogenic) gas in the lower Tyonek Formation, the Hemlock Conglomerate, and the West Foreland Formation at the base of the Tertiary section, having migrated from underlying marine source rocks of Jurassic age (Claypool et al. 1980). Regardless of origin, high-pressure methane is highly mobile, flammable, and buoyant and poses a great hazard to drilling operations when encountered (Judd and Hovland 2007).

1 contours 20 km and 100 km (12 mi and 62 mi) (Whitney and Thurston 1981). Although areas of
2 gas-charged sediments can be identified in high-resolution marine seismic data, the
3 concentrations of gas in sediments are highly variable over small lateral and vertical distances
4 (Hampton 1982b).

5
6 Hoose and Whitney (1980) mapped possible gas-charged sediments in the shallow
7 subsurface at the northeast end of Shelikof Strait (also based on high-resolution marine seismic
8 data).

9
10 **Seismicity.** Seismicity in the Cook Inlet region is related to movement along the Alaska-
11 Aleutian megathrust fault as the northwestward-moving Pacific plate subducts into the mantle
12 beneath the North American plate (Figure 4.2.1-5). Shallow crustal earthquakes are generated as
13 a result of deformation of the overriding North American plate; deeper earthquakes occur along
14 the interface of the plates (Benioff Zone) that extends from the trench to depths of 40 to 60 km
15 (25 to 37 mi), deepening to the northwest. Within the subducting Pacific plate, earthquakes can
16 be as deep as 300 km (186 mi) (Rhea et al. 2010).

17
18 Major fault systems occur along the margins of the Cook Inlet basin. They include the
19 Castle Mountain, Lake Clark, and Bruin Bay Faults, located to the north and northwest; and the
20 Border Ranges Fault, on the Kenai Peninsula to the southeast (Figure 4.2.1-2). The faults have a
21 northeast strike and are among the largest strike-slip fault systems in Alaska. Of these, only the
22 Castle Mountain Fault has been active in recent times (with several earthquakes with an inferred
23 M_w of 7.1 occurring in the past 4,100 years along the southern slopes of the Talkeetna
24 Mountains) (Labay and Haeussler 2001; Haeussler et al. 2000). There is no evidence of recent or
25 Quaternary movement along the Lake Clark or Bruin faults. Haessler and Saltus (2004)
26 identified a 26-km (16-mi) right-lateral offset on the Lake Clark Fault that likely occurred in the
27 past 34 to 39 million years (Late Eocene), based on aeromagnetic data. The most recent activity
28 on the Border Ranges fault system likely occurred less than 24 million years ago (Neogene);
29 some investigators suggest activity may have been as recent as several thousand years ago
30 (Stevens and Craw 2004).

31
32 The highest magnitude earthquakes in Alaska are associated with the Alaska-Aleutian
33 megathrust zone and are common in the Aleutian Islands, the Alaska Peninsula, and the Gulf of
34 Alaska. Since 1900, six earthquakes over magnitude 8.4 have occurred in these regions (some of
35 which predate oil and gas activities in Cook Inlet) (Rhea et al. 2010).

36
37 Since 1973, more than 1,200 earthquakes have been recorded in the Cook Inlet region
38 (USGS 2011a). Of these, 10 had magnitudes greater than 6.0. The two largest earthquakes
39 occurred in 1999 and 2001 and were located on Kodiak and Sitkalidak Islands (Figure 4.2.1-2).
40 Each earthquake registered a moment magnitude (M_w)¹¹ of 7.0 (Figure 4.2.1-2).

¹¹ Moment magnitude (M_w) is used for earthquakes with magnitudes greater than 3.5 and is based on the moment of the earthquake, equal to the rigidity of the earth times the average amount of slip on the fault times the amount of fault area that slipped. Moment magnitude is the preferred magnitude for all earthquakes listed in USGS databases. It replaces the more general usage of “M,” which is used to describe historical earthquakes in the literature. An “M” denotes a magnitude consistent with the Richter scale (USGS 2010).

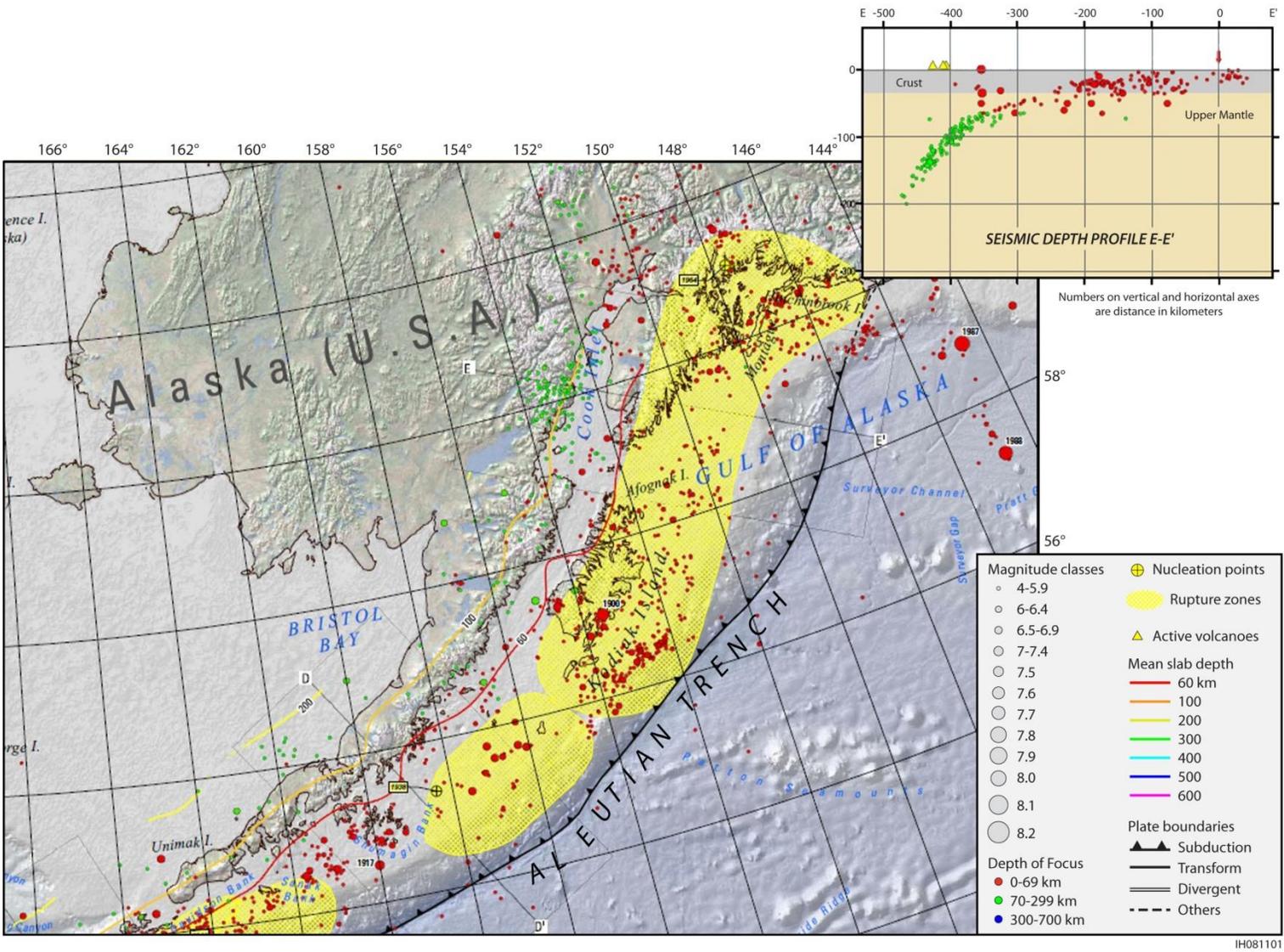


FIGURE 4.2.1-5 The Alaska-Aleutian Megathrust Fault and Subduction Zone (Aleutian Trench) with Seismicity Depth Profile across Cook Inlet (Rhea et al. 2010)

1
2
3
4-25

1 Earthquakes greater than M 6.0 pose a risk to the Cook Inlet region by triggering floods
2 and landslides. Earthquakes greater than M 7.0 may trigger a tsunami and cause emergency
3 events such as fires, explosions, and hazardous material spills and a disruption of vital services
4 (water, sewer, power, gas, and transportation).
5

6 Cook Inlet lies within an area where the peak horizontal accelerations of 0.30 and 0.40 g
7 have a 10% probability of exceedance in 50 years (USGS 1999). Shaking associated with this
8 level of acceleration is generally perceived as very strong to severe, and the potential for damage
9 to structures is moderate to heavy (Wald et al. 2005). Given the high intensity of ground shaking
10 and the high incidence of historic seismicity in the Cook Inlet region (i.e., 1,200 earthquakes in
11 the past 40 years with 10 exceeding M 6.0) the potential for liquefaction in inlet sediments is also
12 likely to be high, but only in areas like the head region and upper inlet where sediments are
13 composed of glacial silt and fine sands, as demonstrated by the widespread liquefaction
14 documented in Turnagain Arm during the Great Alaska Earthquake of 1964. Areas like the OCS
15 where bottom sediments are more coarse-grained are not likely to be affected (Greb and
16 Archer 2007).
17

18 **Volcanic Activity.** There are four monitored volcanoes located in the Cook Inlet region
19 (from north to south): Spurr, Redoubt, Iliamna, and Augustine (Figure 4.2.1-2; Table 4.2.1-1).
20 These volcanoes are part of the Aleutian Island Arc, a chain of volcanoes extending from
21 south central Alaska to the far western tip of the Aleutian Islands. Three of these volcanoes
22 (Spurr, Redoubt, and Iliamna) are located to the west of Cook Inlet. Augustine is an island
23 volcano in lower Cook Inlet; it is the most active volcano in the region. All but Iliamna
24 have erupted several times in the past 150 to 200 years and may erupt again in the future
25 (Waythomas et al. 1997; Waythomas and Waitt 1998). Because of their composition, volcanoes
26 in the Cook Inlet region are prone to explosive eruptions. Hazards in the immediate vicinity of
27 the eruption include volcanic ash fallout and ballistics, lahars (mudflows) and floods, pyroclastic
28 flows and surges, debris avalanches, directed blasts, and volcanic gases. Lease areas in Cook
29 Inlet would be out of the range of most of these eruption hazards except during very large
30 eruptions (on the scale of the 1980 Mount St. Helens eruption), which tend to be rare events
31 (Combellick et al. 1995; ADN 2009a). Ash fall associated with the 2009 eruption of Redoubt
32 forced the temporary closure of the Anchorage Airport (ADN 2009); however, there were no
33 reports that it affected oil and gas operations or damaged infrastructure within or around Cook
34 Inlet.
35

36 Drainages with headwaters near the three onshore Cook Inlet volcanoes are susceptible to
37 lahars (mudflows) and floods during volcanic eruptions due to the permanent snow and ice
38 stored in snowfields and glaciers on the upper flanks of the volcanoes that can generate flooding
39 upon melting. For example, the Redoubt eruption that occurred in 1989–1990 caused significant
40 melting of the Drift Glacier, generating lahars that inundated the Drift River valley and
41 threatened the Drift River Oil Terminal. Oil storage tanks were damaged (although the tanks did
42 not rupture) and loading operations at the terminal (and associated pipeline and platform
43 services) were interrupted for several months, but resumed once a protective dike was installed
44 around the tank farm and support facilities. The interruption in operations at the terminal caused
45 a significant financial impact to the area (Waythomas et al. 1997; ADN 2009a; KPB 2011).
46 Drainages vulnerable to volcanically induced floods are the Chakachatna River drainage (from

1 **TABLE 4.2.1-1 Monitored Volcanoes near Cook Inlet^a**

Volcano	Description/Location	Historical Eruptions	Potential Hazards
Mount Spurr	Ice- and snow-covered stratovolcano on the west side of Cook Inlet, about 120 km (75 mi) west of Anchorage. Peak; elevation is 3,374 m (11,070 ft).	1953 and 1992 (Crater Peak flank vent about 3.5 km [2 mi] south of summit).	Ash clouds, ash fall and bombs, pyroclastic flows and surges, and mudflows (lahars) that could inundate drainages on all sides of the volcano, but primarily on south and east flanks. Eruptions at the Crater Peak vent were brief and explosive, producing columns of ash.
Redoubt	Stratovolcano on the west side of Cook Inlet, about 170 km (106 mi) southwest of Anchorage. Peak elevation is 3,108 m (10,197 ft).	1902, 1966–1968, 1989–1990, and 2009.	Ash clouds, ash fall and bombs, pyroclastic flows and surges, debris avalanches, directed blasts, volcanic gases, tsunamis, and mudflows (lahars) and floods that could inundate drainages on all sides of the volcano, primarily on the north flank. The 1989–1990 eruption produced a lahar that traveled down the Drift River and partially flooded the Drift River Oil Terminal facility. Significant ash plume. Ash fall from the 2009 eruption forced the airport in Anchorage to close temporarily (ADN 2009); there were no reports of damage to oil and gas operations in Cook Inlet. Tephra from future eruptions could travel several hundred kilometers from the volcano (carried by prevailing winds to the northeast).
Iliamna	Ice- and snow-covered stratovolcano on the west side of lower Cook Inlet, about 225 km (140 mi) southwest of Anchorage and 113 km (70 mi) southwest of Homer. Peak elevation is 3,053 m (10,016 ft).	No historical activity.	Ash clouds, ash fall and bombs, pyroclastic flows and surges, debris avalanches, and mudflows (lahars) and floods that could inundate drainages on all sides of the volcano.
Augustine	Island stratovolcano in lower Cook Inlet, about 290 km (180 mi) southwest of Anchorage and 120 km (75 mi) southwest of Homer. Peak elevation is 1,260 m (4,134 ft).	Most active volcano in region with significant eruptions in 1812, 1883, 1908, 1935, 1963–1964, 1976, 1986, and 2006.	Ash clouds, ash fall and volcanic bombs, pyroclastic flows and surges, debris avalanches, directed blasts, mudflows (lahars) and floods, volcanic gases, tsunamis, and lava flows. A large avalanche on the volcano's north flank during the 1883 eruption flowed into Cook Inlet and may have initiated a tsunami at Nanwalek, about 90 km (56 mi) to the east.

^a Volcanoes listed are monitored by the Alaska Volcano Observatory in Anchorage. Other volcanoes in the region west of Cook Inlet include Hayes and Double Glacier. The Hayes volcano is a stratovolcano remnant, almost completely ice-covered; no fumeroles have been observed. Most recent eruptions were more than 3,000 years ago. The Double Glacier volcano is a dome remnant surrounded by the Double Glacier; it is considered to be inactive. There are also numerous unmonitored volcanoes (e.g., Mt. Douglas and Fourpeaked Mountain) on the Alaska Peninsula to the west of the Kodiak Islands.

Sources: USGS 2011b; Waythomas and Waitt 1998; Waythomas et al. 1997; Till et al. 1990.

1 Trading Bay to the McArthur River), the Drift River drainage (from Montana Bill Creek to Little
2 Jack Slough), Redoubt Creek, and the Crescent River. The Drift and Chakachatna Rivers are the
3 most likely to host such floods. Volcanogenic mudflows and floods could affect roads and
4 onshore and offshore infrastructure such as pipelines (Combellick et al. 1995; ADNR 2009a).

5
6 Other (more distal) volcanic-related hazards include volcanic ash clouds and tsunamis.
7 Volcanic ash is ejected high into the atmosphere and stratosphere by explosive eruptions and
8 drifts downwind, eventually falling to the ground. Hazards related to ashfalls include damage to
9 mechanical and electronic equipment (e.g., engines, computers, and transformers) and, in more
10 rare events, building collapse. Volcanic ashfalls in Cook Inlet are typically less than a few
11 millimeters in thickness and occur with an average frequency of a few every 10 to 20 years
12 (Combellick et al. 1995; ADNR 2009a).

13
14 An eruption from Augustine volcano in 1883 caused a debris avalanche that entered
15 Cook Inlet and initiated a tsunami that caused four 4.6 to 9.1 m (15 to 30 ft) waves to hit
16 Nanwalek about 90 km (56 mi) to the east (Waythomas and Waitt 1998; KBP 2011). Waves of
17 4.6 m (15 ft) also reportedly struck Port Graham. Boats were swept into the harbor and several
18 residences were flooded, but damage was minor because the tide was low at the time
19 (KBP 2011). While the risk of coastal damage from locally generated tsunamis is potentially
20 high, the probability of occurrence is low. The configuration of Cook Inlet and its narrow
21 entrances reduce the likelihood that a tsunami generated outside the inlet would create a
22 significant hazard (Bouma and Hampton 1986).

23
24 **Flooding.** The U.S. Geological Survey (USGS) reports that floods in the Cook Inlet
25 drainage basin result from intense, warm rains originating in the Pacific Ocean. They are also
26 caused by the release of water from glacier-dammed lakes or ice jams (and by tsunamis and
27 seiches, discussed in the next section). Nearly all major floods occur between July and early
28 October, but they can also occur during snowmelt season (May to June) if the snowpack is above
29 average (Brabets et al. 1999).

30
31 Since streamflow monitoring began in the late 1940s, at least four major floods have
32 occurred in the drainage basin, covering large areas of the basin and causing considerable
33 property damage (Brabets et al. 1999):

- 34
35 • *May 1971.* Snow cover was greater than average along the Alaska Range, and
36 below-normal air temperatures delayed snowmelt until July, creating
37 conditions conducive to flooding. Inundated areas included northeast and
38 west Anchorage and parts of the Susitna and Matanuska River basins.
- 39
40 • *October 1986.* A large Pacific storm system moved onshore over south
41 central Alaska, causing record-setting rainfall that caused flooding in the
42 lower Susitna River Valley, with recurrence intervals greater than 100 years.
- 43
44 • *August 1989.* Record rainfall caused several streams in the Anchorage area to
45 exceed prior record peak discharges. The Knik River also recorded a peak
46 discharge at a 100-year recurrence.

- 1 • *September 1995*. Remnants of a tropical storm caused flooding along the
2 Skwentna River, the Knik River and tributaries, the Kenai River, and along
3 Glacier Creeks (Girdwood). Several rivers discharging to Knik Arm had peak
4 flows estimated to have been greater than the 100-year flood.
5

6 Other floods in the Cook Inlet drainage basin have occurred from glacier-dam outbursts
7 that result when glacial movement opens a pathway for water trapped behind a glacier to be
8 released. Rivers on the west side of the upper inlet are subject to outburst floods of great
9 magnitude as a result of sudden drainage of large, glacier-dammed lakes; among these are the
10 Beluga, Chakachatna, Middle, McArthur, Big, and Drift Rivers. One of the largest outburst
11 floods occurred in 1969 (and again in 2007) when water released from glacier-dammed Skilak
12 Lake lifted ice on the frozen river and severely scoured the river banks as a surge of water and
13 large chunks of ice travelled downstream. Outburst floods also occur on the Kenai River (east of
14 Cook Inlet) where a glacier-dammed lake at the headwaters of the Snow River fails every two to
15 2–5 years. Historically, the Knik River near Palmer (at the northernmost end of Cook Inlet) has
16 flooded when glacier-dammed Lake George fails. Such floods occur more frequently in the fall
17 and can be especially severe if the lakes or the Kenai River are already high or frozen
18 (Brabets et al. 1999; Combellick et al. 1995; ADNR 2009a; KPB 2011).
19

20 Ice jam flooding occurs during the spring breakup process when strong ice or
21 constrictions in a river (bends or obstructions like islands or gravel bars) create jam points that
22 cause moving ice along the breakup front to stop (NOAA 2011a). It also occurs when low-
23 density ice masses (frazil ice) become trapped and pile up under surface ice. The ice stoppage
24 causes water levels to rise and flood the adjacent land. Ice jams are more often associated with
25 single-channel rivers in interior and northern Alaska than in rivers of the Cook Inlet drainage
26 basin, but a flood from an ice jam downstream of Skilak Lake in the Kenai River watershed (east
27 of Cook Inlet) occurred in 1969 after an outburst from Skilak Glacier at the head of Skilak Lake,
28 creating a record high river stage (74.25 m [22.63 ft]) and causing severe damage in Soldotna.
29 Ice jams are unpredictable and have the potential to be worse than 100- or 500-year events,
30 causing heavy damage to bridges, piers, levees, jetties, and other structures along the riverbank
31 (Brabets et al. 1999; NOAA 2011a; ADNR 2009a; KPB 2011).
32

33 Hazards from flooding result from inundation, riverbank instability and erosion, high
34 bedload transport, deposition at the river mouth, and channel modification and mainly affect
35 onshore facilities (e.g., terminal facilities and pipelines) (ADNR 2009a). Assessing flood
36 potential and community vulnerability is difficult because significant natural and man-made
37 changes occur within floodplains over short time intervals. The KPB has begun Federal
38 Emergency Management Agency (FEMA) flood insurance rate mapping updates, which are
39 scheduled to be completed in late 2010. A vulnerability assessment to identify the population,
40 property, and environment that may be exposed to flooding is also planned for Seward
41 (KPB 2011).
42

43 ***Tsunamis and Seiches.*** A tsunami is a series of long ocean waves generated by the
44 displacement of a large volume of water caused by earthquakes, volcanic eruptions, submarine
45 landslides, or onshore landslides that rapidly release large volumes of debris into the water.
46 Most tsunami waves affecting south central Alaska are generated along subduction zones

1 bordering the Pacific Ocean where motion along a dip-slip fault and the elastic rebound of
2 subducting crust, produced by an earthquake of magnitude greater than 6.5 on the Richter scale,
3 causes vertical displacement of the seafloor. The great seismicity associated with the subduction
4 zone of the Aleutian-Alaskan megathrust fault system makes the southern coastal region of
5 Alaska, especially the Gulf of Alaska and the Aleutian Islands, highly susceptible to tsunamis
6 (Costello 1985).

7
8 Tsunamis are typically not hazardous to vessels and floating structures on the open ocean
9 because of their small wave heights (less than a few feet). However, they are potentially very
10 damaging to coastal regions and nearshore facilities because wave heights can increase
11 significantly as tsunamis approach shallow water. High, breaking waves that reach the shoreline
12 at high tide cause much more damage than waves that are low and nonbreaking or that occur at
13 low tide (Combellick and Long 1983; MMS 1992).

14
15 Because of the shallow, elongated configuration of Cook Inlet and its narrow entrances,
16 the hazard from distant tsunamis is low. The hazard from local tsunamis is also low because
17 there are no active surface faults in the inlet, no adjacent steep slopes to serve as sources of
18 massive slides into the inlet, and no evidence of thick, unstable seafloor deposits that could fail
19 and create massive underwater slides. Local landslide-generated tsunamis, however, can be
20 quite large and potentially damaging, as demonstrated by the series of 4.6 to 9.1 m (15 to 30 ft)
21 waves that reportedly hit Nanwalek and Port Graham on the east side of lower Cook Inlet as a
22 result of a debris avalanche caused by the eruption of Augustine volcano in 1883 (Waythomas
23 and Waitt 1998; KBP 2011). Future eruptions of Augustine could potentially generate a tsunami
24 in lower Cook Inlet if significant volumes of volcanic debris were to enter the sea rapidly
25 (although this remains a topic of debate). Modeling studies indicate that a moderate wave is
26 possible (with lead times of about 27 to 125 min), but the likelihood of a tsunami is considered to
27 be low. None of the last five eruptions of Augustine volcano, including the latest one in 2006,
28 resulted in a tsunami; nevertheless, the West Coast and Alaska Tsunami Warning Center and the
29 Alaska Volcano Observatory continue to refine their public outreach strategy to deal with a
30 volcanogenic tsunami because local consequences of such an event could be high
31 (Neal et al. 2011; Waythomas and Waitt 1998; ADNR 2009a).

32
33 Seiches are periodic oscillations of standing waves in partially or completely enclosed
34 water-filled basins like lakes, bays, or rivers triggered by changes in wind stress or atmospheric
35 pressure and, less commonly, by landslides and earthquakes (McCulloch 1966). In Alaska, they
36 may also be generated by the collapse of deltas into deep glacial lakes (KPB 2011). An example
37 is the Lituya Bay earthquake of 1958 (M_w 8.2), which caused a landslide at the head of Lituya
38 Bay (on the Gulf of Alaska) and generated a seiche with a wave run-up of about 530 m (1,750 ft)
39 (MMS 1992; Bouma and Hampton 1986).

40
41 During the Great Alaska Earthquake of 1964 (M_w 9.2), tsunamis were generated by uplift
42 of the seafloor and seiches were generated by landslides in semiconfined bays and inlets
43 (USGS 2011b; MMS 1992). Because the Kenai Peninsula is susceptible to earthquakes with
44 magnitudes greater than M 6.0, the Kenai Peninsula borough mitigation plan rates the coastal
45 communities and facilities in lower Cook Inlet (south of the Forelands) as highly vulnerable to
46 tsunamis — vulnerable communities include Port Graham, Nanwalek, Seldovia, Homer, Anchor

1 Point, and Niniilchik. The tsunami risk for upper Cook Inlet, however, is considered low because
2 of its relatively shallow depth and its distance from the lower end of the inlet (KPB 2011).
3
4

5 **4.2.1.3 Alaska – Arctic**

6
7

8 **4.2.1.3.1 Physiography and Bathymetry.** The Arctic region is located along the arctic
9 coastline of Alaska. It is composed of the Beaufort Sea, Chukchi Sea, and Hope Basin Planning
10 Areas (Figure 4.2.1-6). The Beaufort Sea stretches from the Alaska-Yukon border westward to
11 Point Barrow. Here, the continental shelf has very low relief (on average 1 m/km;
12 Craig et al. 1985) and extends 60 to 120 km (37 to 75 mi) from shore to water depths of 60 to
13 70 m (200 to 230 ft). Large-scale physiographic features are rare on the shelf, although barrier
14 islands (rising several meters above sea level) and shoals (rising 5 to 10 m [16 to 33 ft] above the
15 seabed) occur in a chain on the inner shelf along the 20-m (66-ft) depth contour, parallel to the
16 shoreline. These features are migrating to the west at rates of about 20 to 30 m (66 to 98 ft) each
17 year (MMS 2008c). Beyond the shelf is the Alaska rise and slope, an area where gravity-driven
18 slope failures greatly influence the seafloor morphology (Grantz et al. 1994).
19

20 The Chukchi Sea is a broad embayment of the Arctic Ocean. It lies to the west of the
21 Beaufort Sea, between Point Barrow to the east and Cape Prince of Wales to the west
22 (Figure 4.2.1-6). The continental shelf in this region has low relief and a gentle slope to the
23 north. Water depths range from about 30 to 60 m (98 to 200 ft) on the shelf and drop sharply to
24 greater than 3,000 m (9,800 ft) into the Arctic basin to the north and east. There are several
25 shoals on the shelf. Two prominent shoals, Herald Shoal to the west and Hanna Shoal to the east
26 (at depths less than 20 m [66 ft] below sea level), are separated by a broad area that is about 35 to
27 40 m (110 to 130 ft) deep with a central channel. Isolated shoals also occur in the nearshore
28 region (along the north and west coasts) in water depths of 20 to 30 m (66 to 98 ft). Hope Basin,
29 a broad and shallow valley with water depths of about 50 m (160 ft), is located to the southwest
30 of Point Hope (MMS 2008c). The outer edge of the shelf is dissected by gullies and large
31 erosional features (Phillips et al. 1988).
32

33 The Beaufort and Chukchi shelves are separated by the Barrow Sea Valley, a 200-km
34 (120-mi) long, flat-bottomed basin incised by fluvial erosion during the Pleistocene epoch and
35 interglacial marine currents (Figure 4.2.1-6). The valley ranges in depths from about 100 to
36 250 m (330 to 820 ft) (Craig et al. 1985; Phillips et al. 1988).
37
38

39 **4.2.1.3.2 Geologic Hazards.** Several types of geologic hazards are known to occur in
40 the marine environment of the Beaufort and Chukchi Seas and may present a risk to offshore oil
41 and gas activities because they are dangerous to navigation or potentially damaging to marine
42 structures. The potential geologic hazards in the Arctic region, except for sea ice and permafrost,
43 which are addressed in Section 4.2.2.1.2 and 4.2.2.2, are described below.
44

45 **Offshore and Coastal Currents.** Marine currents along the central Beaufort shelf are
46 primarily wind-driven and are strongly regulated by the presence or absence of ice. Sediment is

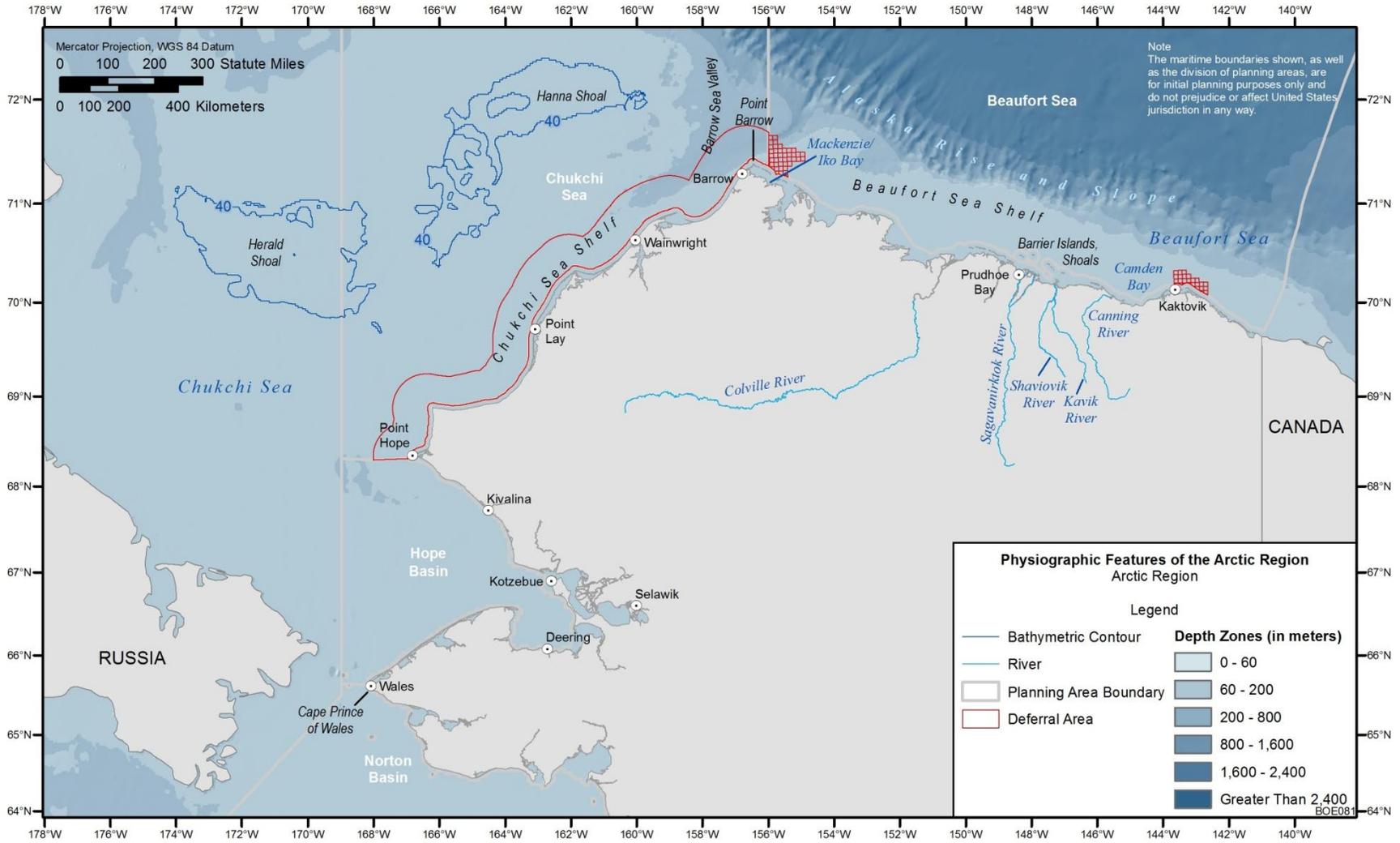


FIGURE 4.2.1-6 Physiographic Features of the Arctic Region

1 transported by these currents along the barrier islands and the coastal promontories, although,
2 because of the short open water season, the annual rate of longshore sediment transport is
3 relatively low. The currents along the inner shelf generally flow to the west in response to the
4 prevailing northeast wind, with current reversals occurring close to shore during storms. Farther
5 from the shoreline, on the open shelf, the currents average between 7 and 10 cm/s (2.8 to
6 3.9 in./s). During storms, east-flowing currents have been measured with velocities of up to
7 95 cm/s (37 in./s), although typical storm current velocities are an order of magnitude lower.
8 Under the ice in the winter, the currents are usually less than 2 cm/s (0.79 in./s), although some
9 currents have been measured at up to 25 cm/s (9.8 in./s) in areas around grounded ice blocks
10 (Hopkins and Hartz 1978; ADNR 2009a).

11
12 Geostrophic currents occur on the outer shelf, flowing parallel to the shelf-slope break.
13 These currents have been measured at velocities of up to 50 cm/s (20 in./s) and can travel in both
14 easterly and westerly directions. Since the tidal range on the central Beaufort shelf is small,
15 approximately 15 to 30 cm (5.9 to 12 in.), the tidal currents exert only minor influences on the
16 sedimentary regime. When the water flow on the shelf is restricted by bottomfast ice, these
17 currents can act as important scouring agents (Craig et al. 1985; ADNR 2009a).

18
19 Offshore structures must be designed to withstand strong marine currents, loading from
20 ice forces, and severe storms in the Beaufort Sea. Production platforms will typically be bottom-
21 founded (gravity base) to withstand conditions that change with the seasons. Drill ships for
22 exploration are not bottom-founded; therefore, they can only operate in low ice cover conditions.
23 Artificial or natural gravel islands must be fortified and built to withstand coastal currents as well
24 as the forces of moving sea ice for the lifespan of the producing field. To this end, they may
25 require periodic maintenance in response to heavy storms (ADNR 2009a).

26
27 **Flooding.** Floods due to seasonal snowmelt and ice jams occur annually along most of
28 the rivers in the Arctic region and many of the adjacent low terraces. Spring ice breakup on
29 rivers often occurs over the first few days of a three-week period of flooding in late May through
30 early June. Up to 80% of the flow occurs during this period. The impact of flooding is in large
31 part related to the magnitude and timing of seasonal ice breakup. The formation of ice jams is
32 especially associated with catastrophic flooding. Some of the most damaging floods are
33 associated with an above-average snowpack that is melted by rainstorms and sudden warming
34 (ADNR 2009a).

35
36 Significant bank erosion may occur during flooding, depending on the amount of water
37 and its level with respect to the river bank and the nature of the sediment (or ice) load. Ice
38 carried along by rivers can produce significant erosion, especially if breakup occurs during a low
39 river stage. Spring floodwaters inundate large areas of the deltas, and on reaching the coast
40 spread over stable ground and floating ice up to 30 km (19 mi) from shore. When floodwater
41 reaches openings in the ice often associated with tidal cracks, thermal cracks, and seal breathing
42 holes, it rushes through with enough force to scour the bottom to depths of several meters
43 (a process known as strudel scouring) (ADNR 2009a).

44
45 Along the Beaufort shelf, strudel scour craters have formed up to 6 m (20 ft) deep and
46 20 m (66 ft) across. In a study for the Northstar Pipeline, strudel scours were found in water

1 depths of 2.2 to 5.4 m (7.2 to 18 ft), with the greatest scour occurring at depths of 3 to 4 m
2 (9.8 to 13 ft). Sheltered coastal areas and bays adjacent to major rivers (such as the Colville,
3 Sagavanirktok, and Canning) are particularly susceptible to strudel scouring. In these areas,
4 deltas can be totally reworked by strudel scouring in several thousand years, although the scours
5 can be filled in very rapidly (ADNR 2009a).
6

7 In addition to seasonal flooding, many rivers along the coast are subject to seasonal icing
8 before spring thaw. This is due to overflow of the stream or groundwater under pressure, often
9 where frozen or impermeable bed sections force the winter flow to the surface to freeze in a
10 series of thin overflows, or where spring-fed tributaries overflow wide braided rivers. In areas of
11 repeated overflow, residual ice sheets often become thick enough to extend beyond the
12 floodplain margin. These large overflows and residual ice sheets have been documented on the
13 Sagavanirktok, Shaviovik, Kavik, and Canning Rivers (ADNR 2009a).
14

15 Seasonal flooding of lowlands and river channels is extensive along major rivers of the
16 Arctic region. Thus, measures must be taken before facility construction and field development
17 to prevent impacts on structures and environmental damage (ADNR 2009a).
18

19 **Barrier Island and Bedform Migration.** Barrier islands along the Beaufort shelf
20 consist of dynamic constructional islands and remnants of the Arctic coastal plain (ACP). As the
21 barrier islands along the Beaufort shelf are migrating westward and landward due to erosion and
22 redeposition by waves and currents, they are generally becoming narrower and breaking up into
23 smaller segments (Hopins and Hartz 1978). During the open water season, longshore drift, storm
24 surges, and ice push contribute to the erosion, migration, and breakup of these islands, which
25 may permanently affect their size and influence on coastal processes.
26

27 Along the Chukchi shelf, asymmetrical bedform features, including small sand waves,
28 larger shore-parallel shoals, and the grouped features of the Blossom Shoals, occur in water
29 depths ranging from less than 15 m (50 ft) to approximately 60 m (200 ft) and extend to
30 distances of up to 160 km (100 mi) offshore. The migration of sand waves and other bedforms
31 can cause problems to offshore facilities by undermining or burying fixed structures, anchors,
32 moorings for submersibles, and pipelines, which can rupture (Bouma and Hampton 1986).
33

34 **Overpressured Sediments.** Along the Beaufort and Chukchi shelves, extremely high
35 pore pressures are likely to be found in deep basins (Kaktovik, Camden, and Nuwuk) where
36 Cenozoic strata are very thick. For example, in the Point Thomson area, pore pressure gradients
37 as high as 0.8 psi/ft (far exceeding the normal gradient of 0.433 psi/ft) have been measured in
38 sediments at burial depths of 4,000 m (13,100 ft) (Craig et al. 1985; ADNR 2009a).
39

40 Encountering overpressured sediments during drilling can result in a loss of well control
41 or uncontrolled flow (if formation pressures exceed the weight of drilling mud in the well bore).
42 Identifying locations of overpressured sediments by seismic data analysis and adjusting the
43 drilling mud mixture accordingly reduce this risk (ADNR 2009a).
44

45 **Shallow Gas Deposits and Natural Gas Hydrates.** Shallow gas deposits have been
46 mapped using high-resolution seismic data in isolated areas within the continental shelf and

1 slope regions of the Beaufort and Chukchi Seas. A recent investigation by the Joint Russian-
2 American Long-Term Census of the Arctic Project team identified a pockmark field on the
3 Chukchi Plateau. The pockmarks are typically related to the explosive release of gas (or gas-
4 saturated water or oil)¹² (Astakhov et al. 2010). On the middle and inner shelf, gas is
5 concentrated in buried Pleistocene delta and channel systems, along active faults overlying
6 natural gas sources and in pockets within and beneath permafrost very near to shore. On the
7 outer shelf and slope, shallow gas is likely to occur in association with a large body of gas
8 hydrate and at the head of the landslide terrain on the outermost region of the shelf and upper
9 slope. The origins of shallow gas may be biogenic or thermogenic; in either case, its presence
10 poses a hazard to bottom-founded structures because it can reduce the shear strength of
11 sediments. Loss of well control may also occur when drilling operations encounter
12 overpressured gas below the seabed (Grantz et al. 1982a, b; ADNR 1999).

13
14 Natural gas hydrates are unique compounds consisting of ice-like substances composed
15 of gas trapped within water molecules. They are common in offshore regions under low-
16 temperature, high-pressure conditions as well as at shallower depths associated with permafrost.
17 In the Beaufort and Chukchi Seas, gas hydrates have been found at shallow depths under
18 permafrost along the inner shelf and onshore at Prudhoe Bay and at the Mount Elbert well in
19 Milne Point where downhole coring and logging operations were recently completed
20 (ADNR 2009a).

21
22 One of the main problems associated with gas hydrates is dissociation, which causes
23 unstable conditions by increasing fluid pressure and reducing sediment shear strength. Natural
24 mechanisms leading to gas hydrate dissociation include sea level decrease and sediment
25 temperature increase. Man-made mechanisms include heat transfer during petroleum production
26 that leads to melting of hydrates. During drilling, rapid decomposition of gas hydrates can cause
27 a rapid increase in pressure in the wellbore, gasification of the drilling mud, and the possible loss
28 of well control. If the release of the hydrate gas is too rapid, a loss of well control can occur, and
29 the escaping gas could ignite. In addition, the flow of hot hydrocarbons past a hydrate layer
30 could result in hydrate decomposition around the wellbore and loss of strength of the affected
31 sediments (ADNR 2009a).

32
33 Dissociation of gas hydrates is a potential cause of submarine slope failures. Acoustic
34 records indicate a stretch of slumps in the Beaufort Sea along the shelf-edge break. The slumps
35 extend for at least 500 km (310 mi) in an area of known gas hydrates and should be considered
36 during exploration and development activities (ADNR 2009a).

37
38 Because gas hydrates and shallow gas deposits pose risks similar to overpressured
39 sediments, the same mechanisms for well control should be employed to reduce the danger of
40 loss of life or damage to the environment (ADNR 2009a).

41
42 **Sediment Sliding, Slumping, and Subsidence.** Locally high rates of deposition of
43 unconsolidated sediments on the increased gradient of the continental shelf edge may form

¹² On the Chukchi Plateau, pockmarks may indicate areas of rapid gas release; however, their size and morphology are also consistent with thermokarst depressions developed along the Arctic shoreline (Astakhov et al. 2010).

1 unstable slopes that lead to intensive soil movements such as slumping, gravitational creep,
2 turbidity or debris flows, and mudslides. A chaotic sediment slide terrane exists along the length
3 of the Beaufort shelf and upper slope, seaward to the 50- to 60-m (160- to 200-ft) isobath. The
4 distinct landslide types in this area include large bedding-plane slides and block glides.
5 Sediment slumping, possibly associated with permafrost melting, has been observed north of the
6 Mackenzie Delta in Canadian waters and may also disrupt buried pipelines and damage drilling
7 structures (Grantz et al. 1982b).
8

9 Sediment slumping may also occur in association with active faulting. Regionally high
10 rates of deposition on the continental shelf may cause isostatic adjustments and deep-seated
11 gravity faulting (active faulting). Active gravity faults related to large rotational slump blocks
12 occur on the outer Beaufort shelf and upper slope due to increased gradients along the shelf-
13 slope break (Grantz and Dinter 1980).
14

15 **Seismicity.** Ground shaking during a major earthquake can cause consolidation problems
16 in artificial gravel islands used as drilling platforms and affect bottom-founded structures.
17 Earthquakes can also cause vertical and/or horizontal displacement along faults, uplift or
18 subsidence, surface tilt, ground failure, and inundation (due to tsunamis) — all of which may
19 affect the integrity of development infrastructure.
20

21 Several types of shallow faults occur on the Beaufort shelf, including high-angle,
22 basement-involved normal faults (Barrow Arch in Harrison Bay); listric growth faults; and
23 down-to-the-north gravity faults along the shelf-slope break. There has been no seismicity
24 associated with the high-angle faults in Harrison Bay in recent times and there is little evidence
25 of Quaternary movement, but these faults may act as conduits for gas migration
26 (Grantz et al. 1982a, b; Craig et al. 1985).
27

28 The Camden Bay area, located at the northern end of a north-northeast trending band of
29 seismicity extending northward from east-central Alaska, is seismically active, and near-surface
30 faults show marked evidence of Quaternary movement. Since monitoring began in 1978,
31 numerous earthquakes have occurred in the area along the axis of the northeast-southwest
32 trending Camden anticline, ranging in magnitude from 1 to 6 (Craig et al. 1985;
33 Grantz et al. 1982a, b).
34

35 There is no historical record of seismicity on the Chukchi shelf; however, sediment-
36 covered fault scarps in the northern Chukchi Sea suggest Quaternary movement along faults in
37 this region (Thurston and Theiss 1987; Grantz et al. 1982a).
38

39 The region along Alaska's northern coast lies within an area where the peak horizontal
40 acceleration with a 10% probability of exceedance in 50 years is between 0.03 and 0.07 g
41 (Wesson et al. 2007). Shaking associated with this level of acceleration is generally perceived as
42 weak, and the potential for damage to structures is negligible (Wald et al. 2005).
43
44

1 **4.2.2 Sea Ice and Permafrost**
2
3

4 **4.2.2.1 Sea Ice**
5
6

7 **4.2.2.1.1 Cook Inlet.** Ice cover in Cook Inlet is seasonal, forming in the fall (October to
8 November; although the lower inlet is usually still ice-free in December) and disappearing
9 completely in the spring. However, the dates of onset and clearance can vary considerably from
10 year to year. The U.S. Army Corps of Engineers' (USACE) report *Marine Ice Atlas for Cook*
11 *Inlet, Alaska* (Mulherin et al. 2001) provides a description of the factors that favor and
12 discourage ice growth. It notes that offshore platforms built in Cook Inlet follow ice design
13 criteria specified by the American Petroleum Institute. Since 1984, the National Weather
14 Service (NWS) has provided analysis and forecasts for the extent, concentration, and stage of
15 development of ice to aid commercial navigation, as well as fishing and tourist activities in the
16 inlet (NWS ice chart archives are maintained by the Alaska State Climate Center in Anchorage);
17 the National Ice Center also prepares semiweekly analyses throughout the ice season.
18

19 There are four types of ice that form in Cook Inlet: pack ice, shorefast ice, stamukhi, and
20 estuarine and river ice. Pack ice is freely floating sea ice that forms directly from the freezing of
21 seawater. In the shallow and turbulent waters of Cook Inlet, a major component of pack ice is
22 "frazil" ice, which occurs as low-density masses of slushy, unconsolidated ice on the water
23 surface. Floating ice poses the greatest hazard to navigation and marine structures. Between
24 1964 and 1986, at least eight incidents involving sea ice in Cook Inlet were recorded by the
25 U.S. Coast Guard (USCG), most resulting in damaged pilings and docks in the Port of
26 Anchorage area. In 1988, a small crude oil spill resulted when a tanker was punctured by ice.
27 Several similar ice-related incidents have been recorded since then (Mulherin et al. 2001).
28

29 Shorefast ice is unmoving ice that remains firmly attached to the shoreline or other
30 stationary structures once it forms. It forms directly by the freezing of seawater and from the
31 piling and refreezing of ice or the flooding of snow on top of the ice. One form of shorefast ice,
32 "beach ice," forms during flood tide as water freezes with mud and bonds to the sea bottom.
33 When the air temperature is colder than seawater, this ice becomes progressively thicker with
34 each successive high tide, accumulating as much as 2.5 cm (1 in.) of ice per tidal flood. The ice
35 usually breaks free before it reaches about 0.5 m (1.6 ft) in thickness. Once freed, it becomes
36 floating (pack) ice and drifts into deeper water (Mulherin et al. 2001).
37

38 Stamukhi are a form of sea ice that have broken and piled upward (hummocked) due to
39 winds, tides, or thermal expansion. Under the right conditions (e.g., repeated wetting and
40 accretion of seawater), they form the massive ice blocks (ice cakes) common to Cook Inlet.
41 Stamukhi as thick as 12 m (40 ft) have been reported. Their large size makes them very
42 hazardous to shipping vessels (Mulherin et al. 2001).
43

44 Much of the ice in Cook Inlet derives from freshwater sources — estuaries and rivers —
45 especially in the head region and upper inlet. Estuarine ice is similar to sea ice but is
46 significantly stronger. It is commonly entrained in pack ice and presents the same hazards to

1 navigation and marine (shoreline) structures. River ice is discharged into the inlet during spring
2 breakup; ice pieces can be as thick as 2 m (6.7 ft) (Mulherin et al. 2001).
3
4

5 **4.2.2.1.2 Arctic Region.** The Beaufort shelf is ice-covered between mid-October and
6 mid-June, with a typical ice-free period during August and September. Sea ice begins forming in
7 late September to early October and becomes continuous nearshore by mid-October. This ice
8 remains through the winter and starts to break up in July, but the nearshore region is not ice-free
9 until early August. In recent years, breakup has occurred earlier by as many as 21 and 6 days
10 along the Beaufort and Chukchi coasts, respectively. Ice-free coastlines now occur over a month
11 earlier along the Beaufort coast (ADNR 2009a; MMS 2008c).
12

13 During the winter months, ice occurs within three main nearshore and offshore zones:
14 the landfast zone, the shear zone (also called the active or stamukhi zone), and the pack ice zone.
15 Landfast ice forms along the shore and develops seaward in the early fall, extending 25 to 50 km
16 (16 to 31 mi) from shore by late winter. This ice is up to 2 m (6.6 ft) thick and is considered
17 stable because it is relatively stationary (moving less than a few meters after it forms). Small
18 movements of the ice are related to storm fronts, which cause narrow leads and rubble fields in
19 this zone (Reimnitz and Barnes 1974; MMS 2008c; ADNR 2009a).
20

21 The shear zone (stamukhi zone) is a transitional zone between landfast ice and the highly
22 mobile pack ice, occurring approximately 20 to 60 km (12 to 37 mi) from the coast in water
23 depths of about 20 to 100 m (60 to 330 ft). Fragments of seasonal ice and multiyear ice ridges
24 are common in this zone. Ice ridges range in thickness from 10 to 12 m (33 to 39 ft) with an
25 average thickness of 6 m (20 ft). It is here where ice is constantly being reworked and shifted
26 and ice gouging (discussed below) occurs most intensely (ADNR 2009a; MMS 2008c).
27

28 Seaward of the stamukhi zone is the pack ice zone, which marks the shoreward edge of
29 the permanent polar ice cap. It consists of multiyear ice, ice ridges, and ice island fragments that
30 migrate westward in response to the clockwise circumpolar gyre (Reimnitz and Barnes 1974;
31 ADNR 2009a). The drift rate of ice in this zone can be as high as 20 km/day (12 mi/day)
32 (MMS 2008c).
33

34 The Chukchi shelf is largely covered by ice between mid-November and mid-June;
35 August and September are typically ice-free. Ice thicknesses in the region are generally less than
36 1.2 to 1.4 m (3.9 to 4.6 ft) during the annual cycle. Multiyear ice is common in the Chukchi Sea;
37 extensive ridging (with a ridge frequency of 3 to 5 per kilometer and sail heights of 1.5 to 3.7 m
38 [4.9 to 12 ft]) is also common (MMS 2008c).
39

40 Sea ice poses a potential hazard to coastal and offshore structures; for example, concrete
41 island drilling structures could be pushed off location, ice could override a fixed structure, or a
42 marine pipeline could be damaged where it comes ashore. Facilities exposed to the potential
43 risks of each sea ice zone must be designed and fortified to accommodate ice forces
44 (ADNR 2009a).
45

1 **Ice Scouring (Ice Gouging and Strudel Scour).** The continental shelf below the
2 Beaufort and Chukchi Seas is vulnerable to ice gouging and strudel scour, both of which must be
3 taken into consideration when siting and designing subsea pipelines. Ice gouging results when
4 ice ridges or icebergs with deep keels, moving under the influence of forces such as wind and
5 ocean currents, run aground and penetrate the seabed, leaving linear to curvilinear deep furrows.
6 Strudel scour occurs in relatively shallow water in the spring during river breakup when
7 overflow waters spreading over bottomfast ice sheets and draining with high velocity through
8 holes in the ice sheet (e.g., tidal cracks, thermal cracks, and seal breathing holes) erode the
9 underlying sediments, leaving behind circular or linear areas of scour in the seabed. The
10 magnitude and frequency of strudel scour events are affected by the timing and location of
11 overflowing river discharge (and the effects of ice jams), and the types of surface features
12 present (e.g., drainage cracks and fissures). Pipelines should be trenched to depths below the
13 predicted scour depth and should be designed to withstand the forces associated with the gouging
14 process, which can cause significant soil displacement (MMS 2008c; ADNR 2009a).

15
16 Although ice gouges are found across the entire Beaufort shelf, they are concentrated in
17 the stamuhki zone, between the 10- and 30-m (33- and 98-ft) depth contours, with the most
18 intense gouging on the up-drift side of shoals and islands bordering the stamuhki zone. In this
19 region, crossing frequencies of 1 to 6 gouges/km/yr and a maximum gouge depth of 3.9 m (13 ft)
20 have been reported. Ice gouges have a general east-west orientation, reflecting the prevailing
21 wind and surface current directions; however, on the inner shelf where shoals and other bottom
22 features deflect the ice, orientations are more variable. Off Prudhoe Bay, the inner boundary of
23 high-intensity ice gouging is controlled by the location of the island chains, about 15 to 20 km
24 (9.3 to 12 mi) offshore. In Harrison Bay, where there are no barrier islands, ice gouges are
25 concentrated in areas of abundant ice ridge formation (MMS 2008c; Craig et al. 2005).

26
27 Ice gouging is less frequent inshore of the stamuhki zone (with reported crossing
28 frequencies ranging from 1 to 2 gouges/km/yr) (MMS 2008c). It is also less severe in this region
29 because gouges are rapidly buried by sand waves or sediment sheets (loose, coarser grained
30 sediments in the nearshore region degrade more rapidly than the more cohesive, fine-grained
31 sediments offshore). The incidence of ice gouging also decreases with increasing water depth
32 offshore of the stamuhki zone since the number of ice keels large enough to reach the bottom
33 decreases. Along the outer shelf edge, strong geostrophic currents smooth the older ice gouges
34 by eroding or filling them in (ADNR 2009a).

35
36 Little survey data on ice gouging features are available for the Chukchi Sea, and
37 repetitive mapping that would allow observed gouges to be dated and gouge rates to be estimated
38 has not been done. However, gouge geometry (depth and width) and density have been recorded
39 over broad areas in the Chukchi Sea, to a maximum water depth of 60 m (200 ft). The most
40 significant ice gouging occurs on the main part of the continental shelf at water depths of 30 to
41 60 m (98 to 200 ft) where surficial sediments consist of thin deposits of sand and gravel
42 overlying stiff consolidated clay or dense sandy gravel. In this region, a maximum gouge depth
43 of 4.5 m (15 ft) was observed within a water depth of 35 to 40 m (110 to 130 ft). Gouges may be
44 many kilometers long and tens of meters wide, and their dominant orientation is northeast-
45 southwest (MMS 2008c; Phillips et al. 1978).

1 The areas adjacent to the Herald and Hanna shoals have only limited ice gouging
2 (no gouge depths were recorded). Nearshore areas where water is shallow (less than 30 m
3 [98 ft]) have an average gouge depth of 0.8 m (2.6 ft) and also have a low ice gouging density
4 (MMS 2008c; Toimil 1978). Nearshore sediments are reworked by waves and currents to the
5 extent that ice gouge morphology is readily obliterated by erosion and/or burial (Barnes and
6 Reimnitz 1979). In general, ice gouging is more prevalent in the northern part of Chukchi Sea
7 because the extent and duration of ice cover is greater. In the southern part of the Sea, the longer
8 open water season allows for more reworking of the seabed by wave and current action, which
9 likely masks evidence of past gouging (MMS 2008c).

10
11 **Ice Movement (Ice Ride-up, Ice Override, and Icebergs).** Continuous, large-scale ice
12 movements in the Beaufort Sea are caused by major current systems (e.g., the Beaufort Gyre),
13 tidal currents, or geostrophic winds. Local, short-term movements result mainly from wind,
14 wave, and current action, particularly during storms. During a single ice season, ice movements
15 create zones of landfast and pack ice. Zone boundaries fluctuate with seasonal ice growth and
16 movement. Ice movements at a given site may have a predominant direction due to geography
17 and environmental conditions (ADNR 2009a).

18
19 On islands and coastal regions throughout the Beaufort Sea, both ice ride-up (or ice push)
20 and ice override events erode and transport significant amounts of sediment. Ice ride-up occurs
21 where strong wind or currents force ice blocks onshore, pushing the sediment from the coast into
22 the ridges farther inland. These processes are particularly important to consider for the outer
23 barrier islands, where ice ride-up ridges may be as high as 2.5 m (8.2 ft) and extend 100 m
24 (330 ft) inland, and man-made structures are along the coast. They also have the potential to
25 alter shorelines and nearshore bathymetry, increasing the risk of damage to man-made structures
26 by erosion. Several accounts of damage to structures due to ice ride-up events have been
27 documented along the Beaufort coast. For example, in January 1984, ice overtopped the
28 Kadluck, an 8-m (26-ft) high caisson-retained drilling island located in Mackenzie Bay
29 (MMS 2003e; ADNR 2009a).

30
31 Ice override occurs both offshore and onshore wherever ice overrides rafted ice or ice
32 ride-ups along the coastline. Ice override onshore will add an additional dead load to a buried
33 pipeline in the transition area from offshore to onshore beginning where the ice contacts the sea
34 floor. This dead load, along with the force being exerted by the ice and the strength of soil, must
35 be considered in pipeline design (ADNR 2009a).

36
37 Icebergs in the Beaufort Sea are rare but may be present as a result of calving off Nansen
38 Island. Natural ice islands have also been observed on occasion. Ice islands are produced by the
39 breakup of portions of the Ellesmere Ice Shelf and occur as tabular icebergs of the Arctic Ocean.
40 They are usually 40 to 50 m (130 to 160 ft) thick with lateral dimensions that range from tens of
41 meters to tens of kilometers. The annual risk of an iceberg or ice island impacting an offshore
42 production facility is estimated to be 1 in 1,000 years; however, there is no threat to exploration
43 or development activities in more shallow, nearshore regions (MMS 2008c; ADNR 2009a).

4.2.2.2 Subsea and Coastal Permafrost (Arctic Region)

Bonded permafrost formed on the Beaufort shelf during the Pleistocene lowstands of sea level to several hundred meters below the exposed shelf (Wang et al. 1982; Hunter and Hobson 1974). During the subsequent highstands of sea level, melting of the permafrost occurred, in part due to geothermal heating and saline advection of seawater into the sediments (MMS 1985; MMS 2003e). Currently, permafrost is known to be present onshore and is inferred to be present offshore in the Beaufort Sea Planning Area (MMS 1985). Subsea permafrost is inferred but has not been identified beneath the Chukchi Sea shelf (MMS 1987). Depths to the top of subsea permafrost in the Beaufort shelf are highly variable, and the thickness of the permafrost is unknown (MMS 1985). There is a transition from bonded permafrost on land that is unstable when thawed to generally thaw-stable materials offshore.

Thaw subsidence (also known as thermokarst subsidence) and frost heave associated with permafrost in the Arctic region can create potential hazards to onshore oil and gas operations. The geologic record during the last Arctic glacial-to-interglacial transition indicates that global warming played a key role in disrupting the thermal balance of permafrost and initiating regional thaw subsidence. And some of the thermokarst activity (e.g., melting of ice wedges) over the last 100 to 150 years can also be attributed to global warming (Murton 2008). Oil and gas related activities may also contribute to this process. These include drilling through permafrost layers; building and maintaining crude oil pipelines; placement and operation of bottom-founded structures; and construction of artificial islands, causeways, and berms. Subsea permafrost that contains trapped gas may melt during the drilling of wells or the subsequent production activities in areas surrounding the borehole, causing subsidence and rupture of the well casings and potentially leading to loss of well control.

4.2.3 Physical Oceanography

4.2.3.1 Gulf of Mexico

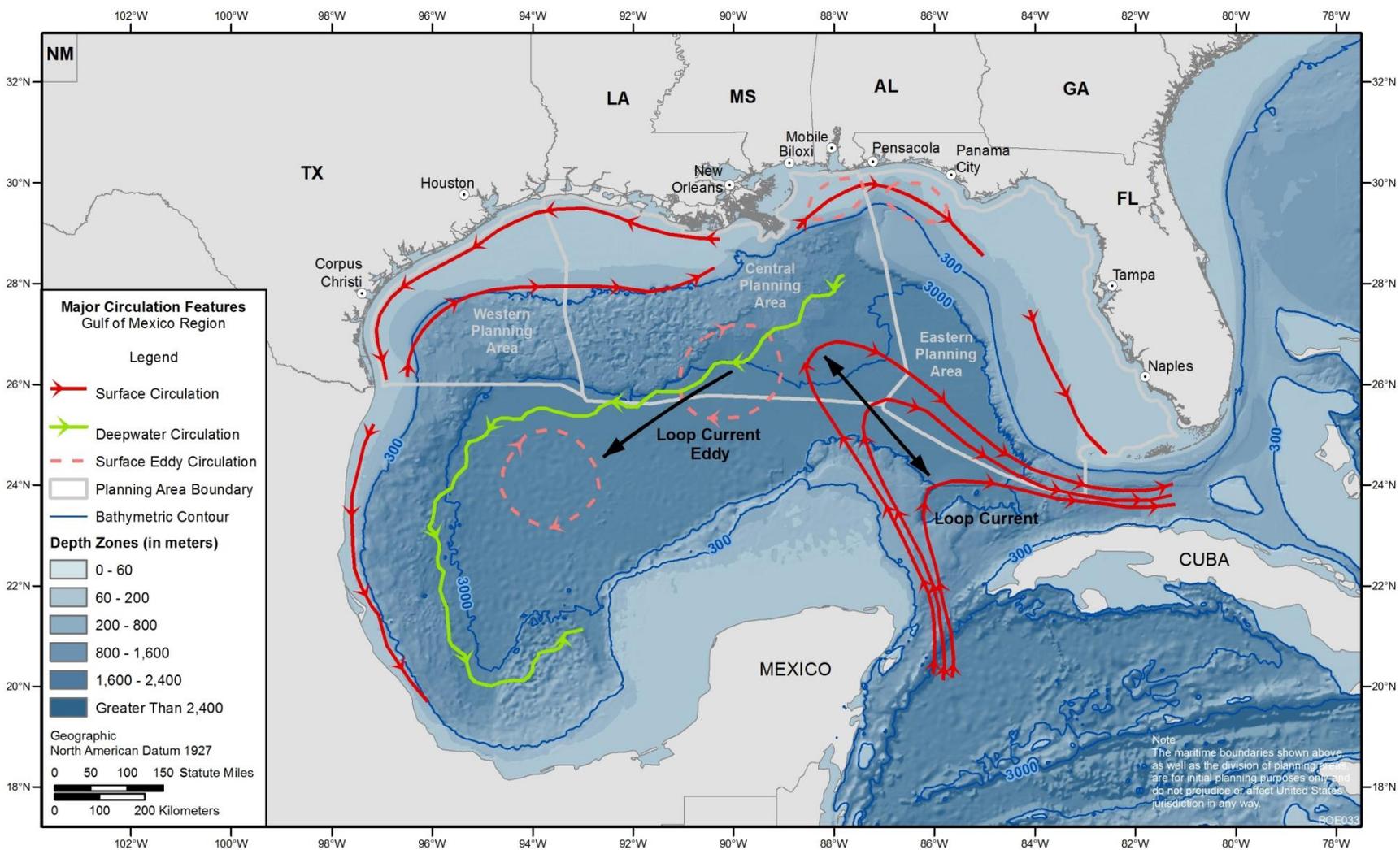
The physical conditions of ocean waters have the potential to disrupt activities relating to oil and gas production that occur on the continental shelf and slope, as well as in deepwater regions of the GOM. Coherent water motions and breaking waves can fatigue and damage oil and gas platforms and facilities, limit the timing of supply boats and drilling operations, and suspend all operations during extreme conditions such as hurricanes or tropical storms (MMS 2005a; Kaiser and Pulsipher 2007). As waves approach deck heights of platforms and supply ships, they can put equipment and personnel at risk (MMS 2005b). Storm events can also produce large forces near the ocean bottom that can scour sediments and affect pipelines and platform structures (Det Norske Veritas 2007; Cruz and Krausmann 2008; Wijesekera et al. 2010). Additionally, water currents and waves affect the horizontal and vertical transport of spilled oil, as well as contribute to the physical conditions that control natural weathering processes such as evaporation, emulsification, and oxidation (NOAA 2002; NRC 2003b).

1 The GOM is a partially enclosed sea covering an area of approximately 1.5 million km²
2 (579,153 mi²) and is connected to the Caribbean Sea and the Atlantic Ocean. The bathymetry of
3 the GOM can be generalized as having a wide continental shelf along its northern and southern
4 edges, prominent escarpments, and a relatively flat ocean floor (Bouma and Roberts 1990; see
5 Figure 4.2.1-1. Circulation patterns in the GOM are the result of complex interactions among the
6 bathymetry of the basin and forcing mechanisms that include winds, atmospheric conditions,
7 water density (related to temperature and salinity), and the Loop Current (described below)
8 (e.g., Oey et al. 2004; Sturges and Kenyos 2008). The GOM can be characterized as a two-
9 layered system with respect to circulation patterns having a surface layer of up to 1,000 m
10 (3,281 ft) in depth and a deep layer reaching down to the ocean floor at depths of approximately
11 4,000 m (13, 123 ft) (Lugo-Fernandez and Green 2011).

12
13 A generalized depiction of major circulation patterns and bathymetry of the GOM is
14 shown in Figure 4.2.3-1. The Loop Current and its associated meso-scale eddies are the
15 dominant circulation features (Oey et al. 2005). Effects associated with Earth's rotation set up a
16 western boundary current that is a part of an anticyclonic (clockwise) circulation pattern found
17 in the western half of the GOM (Sturges and Blaha 1975; Sturges 1993). Over the continental
18 shelf of Texas and Louisiana, wind-driven downcoast currents are common, with an opposite
19 current along the continental slope (Cochrane and Kelly 1986; Nowlin et al. 1998; Zavala-
20 Hidalgo et al. 2003). Currents along the continental shelf off Mississippi-Alabama show a
21 pattern of complex cyclonic and anticyclonic eddy pairs with strong inter-annual variability, and
22 they are also influenced by the positioning of the Loop Current (Brooks and Giammona 1991;
23 Jochens et al. 2002). Deepwater circulation follows a counterclockwise pattern and consists
24 primarily of low-frequency waves that receive energy from the Loop Current and its eddies
25 (Hamilton 1990, 2007).

26
27 Understanding the circulation patterns and physical oceanographic conditions is vital for
28 improving oil and gas production and exploration activities with respect to preserving the
29 environment (Ji 2004; Lugo-Fernandez and Green 2011). In the GOM, the energetic water
30 currents and waves that have the greatest potential to affect oil and gas activities can be
31 characterized as those associated with episodic weather events (e.g., hurricanes and tropical
32 storms), large-scale circulation patterns including the Loop Current and its associated meso-scale
33 eddies, vertically coherent deepwater currents, and high-speed jets (DiMarco et al. 2004).

34
35
36 **4.2.3.1.1 Hurricanes and Tropical Storms.** Tropical conditions normally prevail over
37 the GOM from June until October, and in a typical year, 11 tropical storms will form in the
38 region with approximately 6 reaching hurricane status (Blake et al. 2007). Hurricanes and
39 tropical storms can increase surface current speeds to between 1 and 2 m/s (3.2 and 6.8 ft/s) in
40 continental shelf regions (Nowlin et al. 1998; Teague et al. 2007), as well as produce current
41 speeds of more than 0.5 m/s (1.6 ft/s) in deeper waters on the continental slope (Brooks 1983;
42 Teague et al. 2007). Recorded wave heights during recent hurricanes have shown an increasing
43 pattern, with maximum wave heights exceeding 30 m (98 ft), which are greater than the current
44 100-year storm criteria for platform deck heights (MMS 2005b; Jeong and Panchang 2008).
45 Storm surges can impact infrastructure along coasts and have been reported to range between
46 2 and 8 m (7 and 26 ft) for hurricanes reaching the northern coast of the GOM (NOAA 2011b).



1
 2 **FIGURE 4.2.3-1 Generalized Circulation Patterns in the GOM**

1 Extensive observations of hurricane-induced currents and waves were not available until
2 recent years, starting with Hurricane Ivan in 2004, which passed over an extensive array of
3 instrumented moorings of the U.S. Naval Research Laboratory's Slope to Shelf Energetics and
4 Exchange Dynamics (SEED) program (Stone et al. 2005; Teague et al. 2006a). As Hurricane
5 Ivan approached the northern GOM in the fall of 2004, wind stresses produced downwelling
6 conditions on the continental shelf with advective onshore surface currents and offshore currents
7 in the lower portion of the water column (Mitchell et al. 2005; Teague et al. 2007). Current
8 speeds on the continental shelf were often greater than 1.1 m/s (3.6 ft/s) with many flow
9 reversals during the passage of the hurricane, and strong waves prevailed for up to 10 days in the
10 wake of the hurricane's passage (Teague et al. 2007; Wijesekera et al. 2010). Sediment scour on
11 the continental shelf was observed to be more than 100 million m³ (81071 ac-ft) over a region of
12 525 km² (203 mi²) (Teague et al. 2006b). Maximum wave heights associated with Hurricane
13 Ivan reached 28 m (92 ft) with significant wave heights (average wave height of the upper-third-
14 largest waves) reach 16 m (52 ft) (Jeong and Panchang 2008).

15
16 Hurricanes Ivan, Katrina, and Rita (2004 and 2005) were some of the most powerful
17 hurricanes to enter the GOM (Stone et al. 2005) and were very damaging to oil and gas facilities
18 and production operations (Cruz and Krausmann 2008). The strong winds, rapid currents, high
19 waves, and sediment scour associated with Hurricane Ivan damaged offshore platforms,
20 production wells, and pipeline systems resulting in a disruption of 10% of the GOM's production
21 over a four-month period (MMS 2005c). Hurricanes Katrina and Rita resulted in more than
22 150 platforms (approximately 4% of the total number of platforms in the GOM) being damaged
23 or destroyed primarily by effects associated with wave inundation (Cruz and Krausmann 2008).
24 In response to these recent and severe hurricane events, industry and regulators are reexamining
25 offshore oil and gas structural designs to improve their resistance to hurricanes, especially with
26 respect to deck heights to resist wave inundation, as well as mooring anchors and pipeline
27 designs to prevent damage by sediment scouring and mudslides (Abraham 2005; MMS 2005b).

28
29
30 **4.2.3.1.2 Loop Current and Loop Current Eddies.** The dominant circulation pattern
31 in the GOM is the Loop Current, which can be generalized as a horseshoe-shaped circulation
32 pattern that enters through the Yucatan Channel and exits through the Florida Straits
33 (Figure 4.2.3-1). The Loop Current covers approximately 10% of the GOM's area
34 (Hamilton et al. 2000; Lugo-Fernandez and Green 2011), has surface current speeds up to
35 1.8 m/s (5.9 ft/s) (Oey et al. 2005), and is present down to an 800-m (2,625-ft) depth
36 (Nowlin et al. 2000; Lugo-Fernandez 2007). The incoming water of the Loop Current through
37 the Yucatan Channel is typically warmer and saltier than the GOM waters, which in combination
38 with its highly inertial circulation pattern generates energetic conditions that drive circulation
39 patterns throughout the entire GOM (Lugo-Fernandez 2007; Jochens and DiMarco 2008;
40 Lugo-Fernandez and Green 2011).

41
42 The Loop Current is not a stagnant circulation, as it alters its orientation angle and
43 periodically extends northwesterly into the GOM with filaments being observed to intrude
44 onto the continental slope near the Mississippi River Delta (Muller-Karger et al. 2001;
45 Oey et al. 2005). As the Loop Current extends north to approximately 27°N, an instability
46 causes the formation of an anticyclonic eddy (Loop Current Eddy) to separate off from the Loop

1 Current (Hamilton et al. 2000; Vukovich 2007). The physical mechanisms that trigger these
2 Loop Current Eddy separations and their frequency of occurrence are not fully understood
3 (Chang and Oey 2010; Sturges et al. 2010), but the period between Loop Current Eddy
4 separations ranges from 0.5 to 18.5 months (e.g., Vukovich 2007). A linear relationship that
5 exists between the period between Loop Current Eddy separations and the retreat latitude of the
6 Loop Current following separation results from a balance in vorticity between water entering and
7 water exiting the GOM that is displaced by the intrusion of the Loop Current moving toward the
8 northern slope region (Lugo-Fernandez and Leben 2010). Loop Current Eddies typically have a
9 diameter of 300 to 400 km (186 to 248 mi), current speeds between 1.5 to 2 m/s (4.9 to 6.6 ft/s),
10 and speeds up to 0.1 m/s (0.3 ft/s) at a 500-m (1,640-ft) depth (Brooks 1984; Cooper et al. 1990).
11 Loop Current Eddies migrate to the west and southwest under forces induced by the Earth's
12 curvature and rotation with translation speeds ranging from 2 to 5 km/day (1.2 to 3.1 mi/day)
13 (Brooks 1984; Oey et al. 2005).

14

15 Loop Current Eddies typically affect deepwater regions (depths greater than 400 m
16 [1,312 ft]) of the GOM and have the potential to disrupt exploration, drilling, and production
17 activities (Crout 2009). Currents associated with Loop Current Eddies have the ability to cause
18 vortex-induced vibrations that can damage platforms and drilling equipment (Kaiser and
19 Pulsipher 2007). It has been estimated that a sustained current of 2 m/s (6.6 ft/s) can use up the
20 fatigue life of certain mooring system components in 1 week (DiMarco et al. 2004).

21

22

23 **4.2.3.1.3 Deepwater Currents and Subsurface Jets.** Oil and gas exploration and
24 production activities are expanding more and more to deepwater regions of the GOM, which is
25 what motivates the current research emphasis in deepwater currents (McKone et al. 2007; Lugo-
26 Fernandez and Green 2011). Energetic waves and high-speed jets can affect the transport of
27 pollutants such as drilling fluids and oil, as well as physical structures relating to oil and gas
28 operations (DiMarco et al. 2004). For example, the Deep Water Horizon oil spill of 2010
29 demonstrated the need to understand how deepwater currents affect underwater oil spill plumes
30 (e.g., Adcroft et al. 2010).

31

32 Deepwater currents (depths greater than 1,000 m [3,281 ft]) along the northern GOM are
33 typically characterized as meandering waves (referred to as topographic Rossby waves [TRWs])
34 that are vertically coherent with some degree of bottom intensification, have periods greater than
35 10 days, are largely decoupled from surface circulations, and have a propagation velocity on the
36 order of 9 km/day (5.6 mi/day) (Hamilton 1990, 2009; Sturges et al. 2004). The energy source
37 of these deepwater currents is not fully realized, but recent studies suggest that the Loop Current
38 generates deepwater eddies near the Campeche Terrace that excite wave propagation westward
39 along the continental slope of the northern GOM (Oey 2008). Additionally, high-energy
40 waves (with periods of less than 10 days) have been observed locally along the Sigsbee
41 Escarpment with maximum speeds of 0.9 m/s (3 ft/s) at depths below 1,500 m (4,921 ft)
42 (Donohue et al. 2008). The analysis by Hamilton (2009) suggests that highly energetic TRWs
43 along the Sigsbee Escarpment generate a mean deepwater flow to the west along the steep
44 escarpment, which acts as the main deepwater transport pathway from the western to the eastern
45 GOM, and that in the western GOM, TRWs are less energetic but interact in a similar fashion
46 with the continental slope to form a generalized mean deepwater flow to the south along the

1 base of the continental slope off Mexico (the generalized deepwater flow path is shown in
2 Figure 4.2.3-1).

3
4 Subsurface jets are characterized as currents with no surface expression, having durations
5 on the order of hours to days, speeds in excess 0.4 m/s (1.3 ft/s), and observed currents up to
6 2 m/s (6.6 ft/s) (DiMarco et al. 2004). Subsurface jets occur at shallow depths (150–600 m
7 [492–1,968 ft]) and in deep waters, and they are typically produced by the downward
8 propagation of inertia in the wake of a storm passage or the interactions of eddy circulations and
9 the topography of the continental slope (DiMarco et al. 2004; Fan et al. 2007). Deepwater jets
10 are difficult to measure because of their limited spatial and temporal extents, but observations
11 from moored instruments in the northwestern GOM show deepwater jets having maximum
12 currents speeds between 0.5 and 0.8 m/s (1.5 and 2.6 ft/s) with durations on the order of 1 to
13 8 days (Hamilton and Badan 2009).

14 15 16 **4.2.3.2 Alaska Region** 17

18 Sea ice, ocean currents, tides, waves, and storm surges affect offshore oil and gas
19 operations on the Alaska continental shelf and facilities located near the coastline. Typical
20 currents and waves do not threaten the physical integrity of production equipment; however, cold
21 air temperatures and the spray from waves can freeze on structures, causing structural damage as
22 well as affecting the buoyancy of supply and drilling vessels to the extent of capsizing ships
23 (Jones and Andreas 2009). Tides are considered minor along the coastal regions of the Arctic
24 Ocean (NRC 2003a; Weingartner 2003), but tidal ranges in Cook Inlet are considered among the
25 largest in the world (Archer and Hubbard 2003). Impacts of storm surges vary by season from
26 coastal flooding during summer and fall events to ice gouging and damage associated with ice
27 ride-up (wind-driven surge of ice onto shore) during winter and spring storm events
28 (Lynch et al. 2008). While all these oceanographic factors influence oil and gas operations, the
29 primary design consideration for platforms, vessels, pipelines, and other structures is the
30 presence of sea ice and its interactions with currents, tides, and the bathymetry of the Alaska
31 continental shelf (Weeks and Weller 1984; NRC 2003a).

32
33 The climate of the Arctic region is complex because of its multiple interactions with
34 oceanic and terrestrial systems, and effects associated with global climate change have resulted
35 in significant changes to the Arctic's atmospheric and oceanographic conditions over the past
36 couple of decades (e.g., Morison et al. 2000; Arctic Council and IASC 2005). Air temperatures
37 in the regions north of 60°N have warmed at a faster rate than that of the overall northern
38 hemisphere over the past century (Arctic Council and IASC 2005). During the 1990s, several
39 studies revealed a warming trend in the layer of Arctic Ocean water with origins from the
40 Atlantic Ocean (Carmack et al. 1995; Grotefendt et al. 1998; Gunn and Muench 2001), as well as
41 an overall increase in Arctic Ocean sea surface temperatures and lower surface-layer salinities
42 along regions of the Beaufort Sea and the Chukchi Sea (Morison et al. 2000; Comiso 2003;
43 Comiso et al. 2003).

44
45 The warming of air and water temperatures in Arctic regions generates variability in key
46 factors and processes controlling oceanographic conditions, which include precipitation and

1 snow patterns, freshwater and sediment inputs to oceans, thermohaline circulation patterns
2 (controlled by temperature and salinity gradients), and the aerial coverage and composition of
3 sea ice (Morison et al. 2000; Arctic Council and IASC 2005; Bonsal and Kochtubajda 2009).
4 Changes in oceanic conditions have also corresponded with sea level rise in the Arctic Ocean
5 (Proshutinsky et al. 2001). Predicting oceanic responses to climate change is difficult because of
6 complex interactions (often nonlinear) among factors such as water and air temperatures, sea ice,
7 sea level rise, and thermohaline circulation patterns (e.g., Wang et al. 2003).

8
9 Alaskan coastal waters are largely covered by sea ice with some open-water areas for
10 three-quarters of the year, from October until June, with the minimum sea ice extent occurring
11 in September as sea ice begins to form and the maximum extent in March (Weeks and
12 Weller 1984). Sea ice properties vary according to its age and the physical conditions under
13 which it forms, melts, refreezes, and reforms (Gow and Tucker 1991). A general classification
14 of sea ice includes ice formed along shores known as landfast ice and ice formed at sea called
15 drift ice, which can conglomerate to form pack ice or ice floes (Mulherin et al. 2001). Landfast
16 ice gradually advances seaward in the fall, rapidly retreats in the spring, and can break up and
17 reform several times in between. Ice floes move according to wind and currents and can collide
18 and pile on top of one another to form pressure ridges, as well as converge to form well-defined
19 ice-free openings, or polynyas (Mahoney et al. 2007). Another important distinction in sea ice is
20 the difference between newly formed first-year sea ice and multiyear sea ice, which by definition
21 is summer minimum sea ice extent (Lemke et al. 2007).

22
23 The spatial and temporal variability in sea ice extent and thickness are controlled by local
24 climate and oceanic factors, with many studies indicating a decreasing trend in Arctic sea ice
25 over recent decades (e.g., Johannesen et al. 1995; Parkinson 2000; Comiso 2002). Sea ice
26 extent, as observed mainly by remote sensing methods, has decreased at a rate of approximately
27 3% per decade starting in the 1970s (Johannesen et al. 1995; Parkinson et al. 1999). However,
28 multiyear sea ice has decreased at a rate of nearly 9 to 12% per decade since the 1980s
29 (Comiso 2002; Perovich et al. 2010). Since 2000, the extent of summer sea ice was at record
30 lows in 2002 (Serreze et al. 2003), 2004 (Stroeve et al. 2005), 2007 (Perovich et al. 2008), and
31 2010 (Richter-Menge and Jeffries 2010). Sea ice thickness has also decreased during recent
32 decades, with average sea ice draft (the depth of ice below sea level) values decreasing by as
33 much as 1.3 m (4 ft) (Rothrock et al. 1999) and sea ice volumes decreasing at a rate of 4% per
34 decade since 1948 (Rothrock and Zhang 2005). These recent trends in declining sea ice are a
35 result of anthropogenic influences and natural climate variability, and recent climate simulations
36 suggest that natural climate variability has the potential to cause a stabilization to a slight
37 recovery of sea ice trends over short times scales on the order of a decade or less in the
38 beginning part of the twenty-first century (Kay et al. 2011).

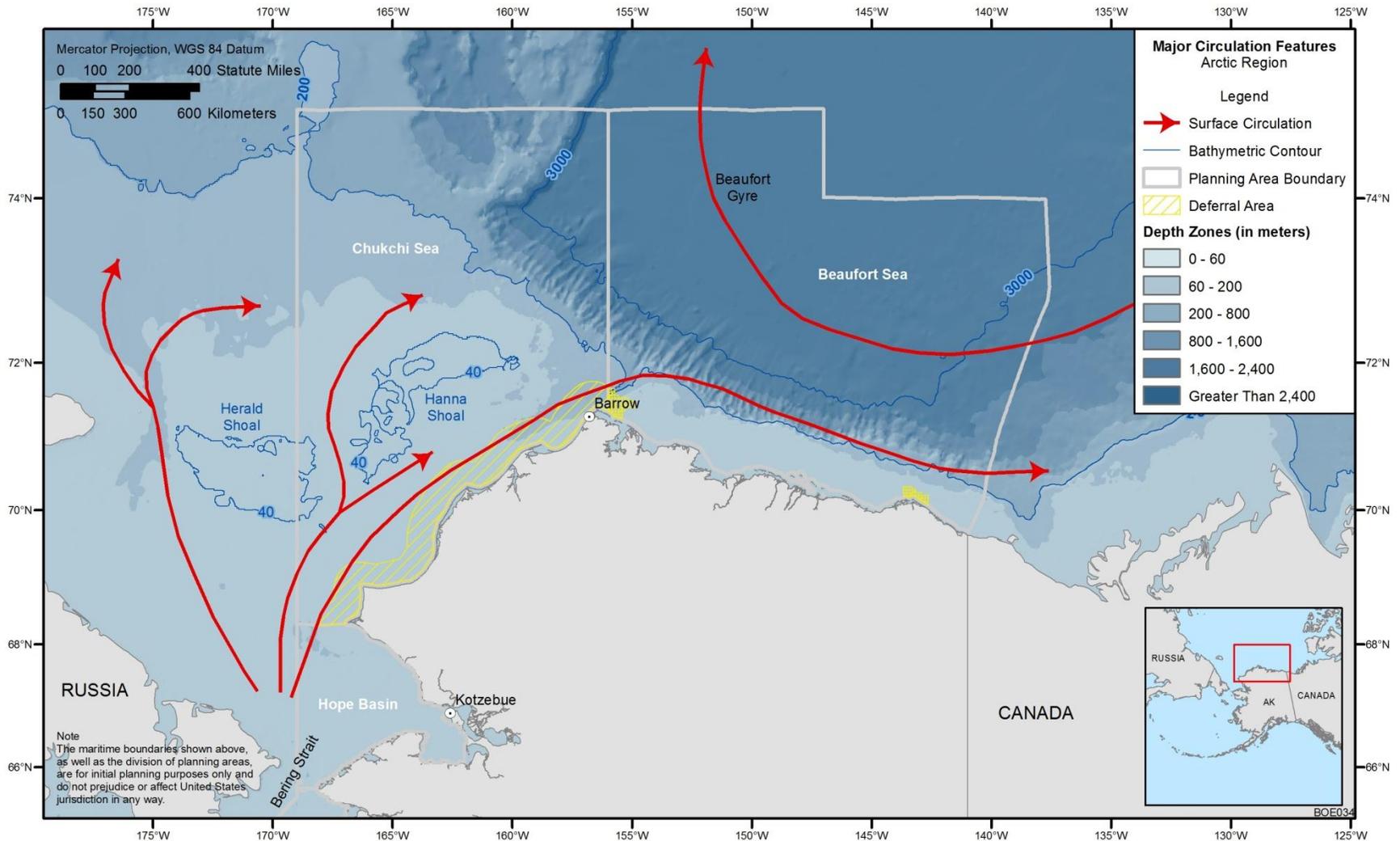
39
40 The interactions of sea ice with currents and waves have the potential to create hazardous
41 conditions and damage physical structures through ice gouging, ice ride-up, and scouring, and to
42 block vessel traffic (Weeks and Weller 1984). Landfast ice is typically not a concern as it exerts
43 nominal internal stresses to structures, but ice floes formed during breakup conditions near shore
44 or out in open pack ice areas have velocities on the order of 1 m/s (3 ft/s) (Stringer and
45 Sackinger 1976). Ice gouging is caused by grounded ice keels within ice floes moving in
46 response to wind and currents that typically occur in regions parallel to shorelines (Shapiro and

1 Barnes 1991). Ice gouging is of particular concern for pipelines, as seabed gouging depths can
2 often exceed 3 m (10 ft), affecting coastal regions with up to 50 m (164 ft) of water depth
3 (Weeks and Weller 1984). Ice ride-up occurs as repeated ice floes converge on shore, pile on top
4 of each other, and pile shoreward under continued momentum. Ice ride-up events frequently
5 occur during the spring and fall and can affect structures that are on the order of 50 m (164 ft)
6 inland (Kovacs and Sodhi 1980). In spring, river floodwaters can inundate coastal areas covered
7 by sea ice and potentially break through the ice, generating jet flows and scour craters in the
8 sediments below (process referred to as strudel scour), which can damage pipelines and support
9 structures. Strudel scour craters can be more than 4 m (13 ft) deep and 15 m (49 ft) across and
10 can last up to 2–3 years before being refilled (Reimnitz and Kempema 1982). Strudel scour
11 occurs most commonly near river deltas extending outward to water depths of 6 m (20 ft)
12 (Hearon et al. 2009).
13

14 Sea ice also affects oil spill cleanup and weathering processes, as well as acting as a
15 transport mechanism for spilled oil (Stringer 1980). Oil transport and reaction processes are
16 significantly altered for waters that contain more than 30% aerial coverage of sea ice in
17 comparison to open ocean waters (NRC 2003b). The presence of ice and lower water
18 temperatures typically result in lower rates of oil weathering processes such as evaporation,
19 emulsification, and oxidation (Thomas 1983); lower rates of dispersion because of the increased
20 viscosity of oil at lower temperatures (Payne et al. 1991) and the presence of sea ice also has the
21 potential to confine oil spills (Weeks and Weller 1984). Conversely, enhanced transport of oil
22 by sea ice conditions can occur along open water channels or polynyas or by oil incorporation
23 into moving ice floes (Payne et al. 1987). Empirical relationships describing the fate and
24 transport of spilled oil-sea ice interactions are presented in Buist et al. (2008). Ultimately, the
25 fate of oil in the presence of sea ice largely depends on the season (summer ice free, winter ice
26 cover, and fall ice formation), as well as the age and morphology of the sea ice, because these
27 factors determine the ability of the oil to reach reactive areas for oil weathering processes to
28 occur as well as the weathering reaction rates (Payne et al. 1991; NRC 2003b).
29
30

31 **4.2.3.2.1 Arctic Ocean: Beaufort Sea and Chukchi Sea.** The Beaufort Sea and
32 Chukchi Sea are semi-enclosed seas connected to the Arctic Ocean located along the northern
33 coast of Alaska. The Chukchi Sea is a shallow, continental shelf sea with depths typically
34 less than 50 m (164 ft) that receives Pacific Ocean water through the Bering Strait
35 (Woodgate et al. 2005). The Beaufort Sea consists of a narrow (approximately 100 km [62 mi]
36 wide) continental shelf before a shelfbreak that occurs near the 200-m (656-ft) water depth
37 contour followed by a portion of the Canadian Basin of the Arctic Ocean (Weingartner 2003).
38 The continental shelf region of the Beaufort and Chukchi Seas contains small shoals and barrier
39 islands that affect shelf circulation patterns and are typically associated with the location of ice
40 ridges (NRC 2003a).
41

42 The general circulation patterns in the Beaufort and Chukchi Seas are shown in
43 Figure 4.2.3-2. Circulation in the Canadian Basin of the Arctic Ocean is dominated by the
44 Beaufort Gyre, which is typically a clockwise (anticyclonic) circulation forced by prevailing
45 atmospheric high pressure over the Arctic, but can reverse to a counterclockwise (cyclonic)
46 circulation during summer months or prolonged periods of atmospheric low pressure



1

2

FIGURE 4.2.3-2 Generalized Circulation Patterns in the Chukchi Sea and Beaufort Sea

1 (Proshutinsky et al. 2003; Asplin et al. 2009). The sea level slope between the Pacific Ocean and
2 the Arctic Ocean drives water through the Bering Strait into the Chukchi Sea, which separates
3 into three principal branches of northward flow among Herald Shoal, Hanna Shoal, and the
4 Alaskan coast (Weingartner et al. 2005; Woodgate et al. 2005; Weingartner et al. 2010).
5 Currently, it is not fully understood how Pacific Ocean waters moving across the Chukchi Sea
6 interact with circulation patterns off the shelfbreak of the Beaufort Sea, but evidence suggests
7 the presence of narrow currents near the Beaufort shelfbreak with prevailing eastward flow
8 and seasonal variability in surface and subsurface intensified currents (Pickart 2004;
9 Spall et al. 2008; Nikolopoulos et al. 2009; Okkonen et al. 2009; Pickart et al. 2010;
10 Weingartner et al. 2010). During the summer open-water season, current speeds along
11 continental shelf areas often exceed 0.2 m/s (0.7 ft/s) with maximum speeds as high as 1 m/s
12 (3 ft/s) in certain regions of constricted flow such as the Bering Strait and Barrow Canyon;
13 during ice-covered seasons, current speeds are generally less than 0.1 m/s (0.3 ft/s)
14 (Weingartner et al. 1998, 2009; Weingartner and Okkonen 2001).

15
16 The coasts of the Beaufort Sea and Chukchi Sea consist of river deltas, barrier islands,
17 exposed bluffs, and large inlets; inland is characterized by low-relief lands underlain by
18 permafrost (Jorgenson and Brown 2005). The combination of wind-driven waves, river erosion,
19 and sea ice scour with highly erodible coastal lands creates the potential for high erosion rates
20 along the Beaufort Sea and Chukchi Sea coasts (Kowalik 1984; Mars and Houseknecht 2007).
21 From 1950 to 1980, the coastal erosion rates averaged 0.6 m/yr (2 ft/yr), and over the period
22 from 1980 to 2000 this rate has increased to 1.2 m/yr (3.9 ft/yr) (Ping et al. 2011).

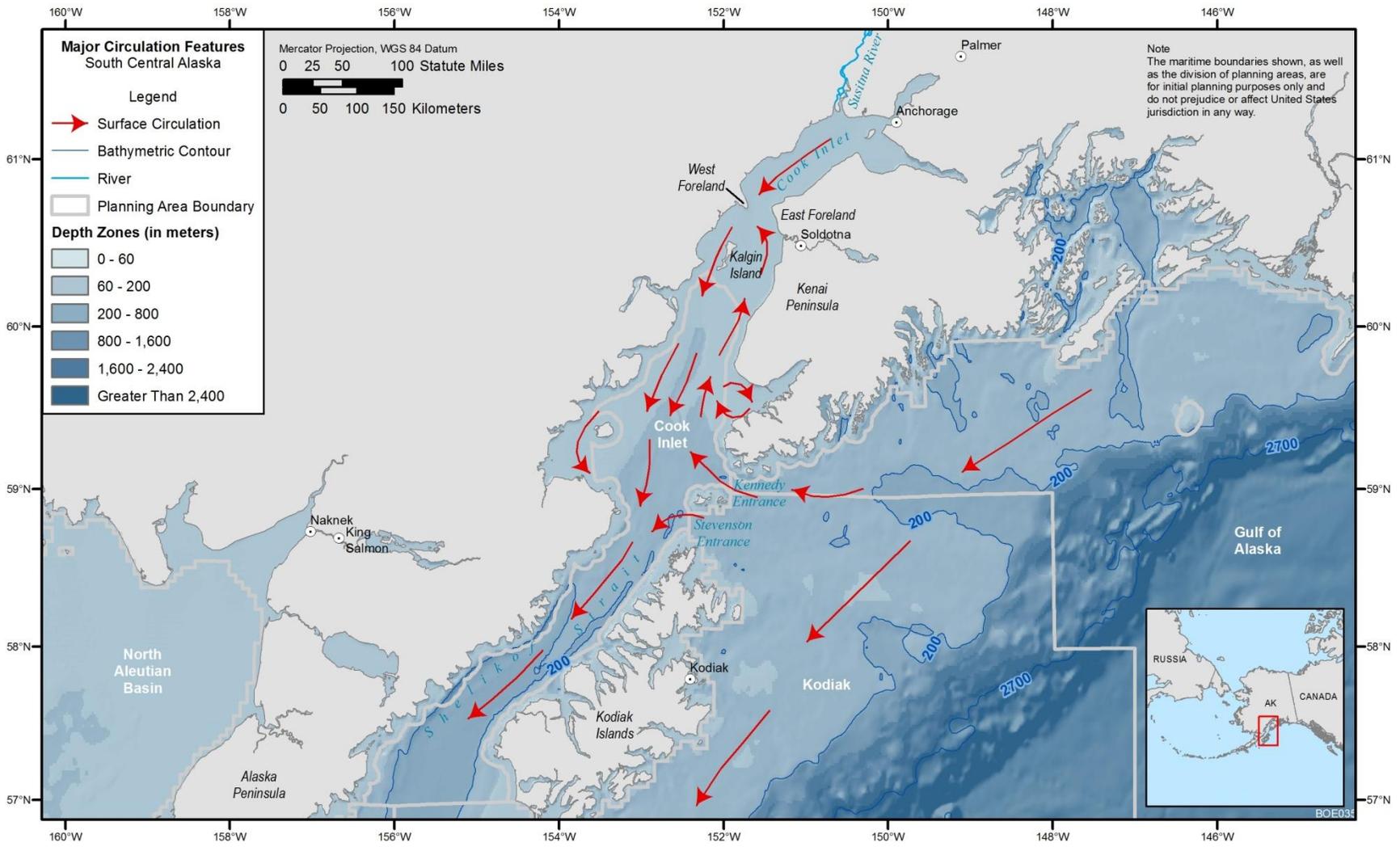
23
24 Present and future offshore oil and gas operations in the Beaufort and Chukchi Seas need
25 to take into account climate change impacts on circulation and sea ice patterns. The complex
26 circulation patterns on the Arctic continental shelf are affected by water temperature and density
27 gradients and freshwater inputs of varying temperature from rivers as well as increased sea ice
28 and glacier melting over recent years (Yamamoto-Kawai et al. 2009). Furthermore, reductions in
29 sea ice have been more apparent in nearshore areas associated with landfast ice (typically
30 extending out between 5 and 50 km [3 and 31 mi] from shore) in comparison to offshore regions
31 (Mahoney et al. 2007; Fissel et al. 2009). A recent study has also shown that remote-sensing of
32 sea ice extent may not always distinguish between first-year and multiyear sea ice, which is an
33 important distinction in sea ice quality for supporting exploration activities, biotic habitats, and
34 waterway access (Barber et al. 2009). The summer open ice season that determines when ships
35 can enter the coastal regions along the north Alaskan coast has trended toward an earlier opening
36 date in the spring and a later closing date in the fall (Fissel et al. 2009; Markus et al. 2009).
37 While decreased sea ice has the potential to support more shipping activity in the Arctic, it is
38 likely that hazardous ice floes will persist (Stewart et al. 2007), and decreases in landfast ice
39 could result in increased impacts on coastlines through wave damage and ice ride-up (Arctic
40 Council and IASC 2005).

41
42
43 **4.2.3.2.2 Cook Inlet and Shelikof Strait.** Cook Inlet and Shelikof Strait are located on
44 the continental shelf of the Gulf of Alaska, which is a semi-enclosed basin of the Pacific Ocean
45 surrounded by the steep terrain of the Alaskan coast. The continental shelf region is
46 characterized as having a complex bathymetry of channels, island chains, and embayments.

1 Cook Inlet is a large embayment with a length of 330 km (205 mi) along a northeast to southwest
2 axis that is approximately 37 km (23 mi) wide in the northeast near Anchorage and 83 km
3 (52 mi) wide at its mouth (Gatto 1975). The upper and lower portions of Cook Inlet are formed
4 by the coastline constriction that occurs near the West Forelands to the north of Kalgin Island.
5 The Shelikof Strait, located southwest of Cook Inlet between the Alaskan coast and the Kodiak
6 Islands, forms a fairly uniform channel that is approximately 270 km (168 mi) in length and
7 45 km (28 mi) wide (Muench and Schumacher 1980). Figure 4.2.3-3 shows the location of Cook
8 Inlet and Shelikof Strait along with major circulation patterns.
9

10 The circulation along the continental shelf of the Gulf of Alaska is dominated by the
11 Alaskan Coastal Current, which is driven by winds and freshwater runoff of the numerous rivers
12 and glaciers along the Alaskan coast (Stabeno et al. 2004). Alaskan Coastal Current waters enter
13 Cook Inlet through the Kennedy and Stevenson Entrances and flow northward along the eastern
14 side of the inlet as the result of Coriolis forces (induced by the rotation of the Earth) and then
15 cross over to the western side of the inlet because of the shoreline geometry near the Forelands
16 (Rappeport 1982). Observed circulation patterns suggest a net outflow of surface flows out of
17 the inlet, which implies that there is a net inflow of deepwater flows into the inlet (Potter and
18 Weingartner 2010). Cook Inlet is estuarine in character because of the mixing of marine waters
19 from the Alaskan Coastal Current and freshwater inflows from several rivers, resulting in
20 complex density-driven circulation patterns (Rappeport 1982; Mulherin et al. 2001). The
21 Matanuska River, Knik River, and Susitna River combined contribute more than 70% of the
22 freshwater inputs to Cook Inlet in the northern basin, as well as act as a significant source of
23 suspended sediments that can reach concentrations greater than 1,700 mg/L (Gatto 1975).
24 Riverine inputs of freshwater and sediments to the northern portion of Cook Inlet vary
25 seasonally, and their resulting influences on temperatures and salinity generate seasonal
26 variability in circulation patterns in Cook Inlet (Okkonen et al. 2009).
27

28 The circulation patterns in Cook Inlet are significantly influenced by the strong
29 semidiurnal tide pattern with corresponding tidal amplitudes that range between 4.2 and 5 m
30 (14 and 16.4 ft) in the lower portion and up to 9.0 m (29.5 ft) in the upper portion of Cook Inlet
31 near Anchorage (Rappeport 1982; Archer and Hubbard 2003). Tidal currents travel at speeds
32 ranging between 1 and 4 m/s (3 and 13 ft/s) (Whitney 2000; Oey et al. 2007). Average water
33 depths in Cook Inlet vary from 18.3 m (60 ft) in the upper portion to 36.6 m (120 ft) near its
34 mouth, with several deep channels along its longitudinal axis that contain sand dunes with
35 heights on the order of 2 m (7 ft) (Haley et al. 2000). The interaction of density-driven
36 circulation and tidal currents results in rip currents that form persistently along the deep channels
37 (Haley et al. 2000; Whitney 2000), which can often be observed by turbidity color changes, as
38 well as the accumulation of surface debris and foam along rip current edges (Rappeport 1982).
39 The ebbing flow out of Cook Inlet combines with Alaskan Coastal Current waters and enters the
40 Shelikof Strait, where water depths are on the order of 200 m (656 ft) and average current speeds
41 range between 0.2 m/s (0.7 ft/s) in the winter and 0.1 m/s (0.3 ft/s) in the summer (Muench and
42 Schumacher 1980). The southwest flow out of the Shelikof Strait merges with the Alaskan
43 Stream (the western boundary current of the Gulf of Alaska) approximately 200 km (124 mi)
44 southwest of Kodiak Island (Stabeno et al. 2004; Rovegno et al. 2009).
45



1

2 **FIGURE 4.2.3-3 Generalized Circulation Patterns in Cook Inlet and the Shelikof Strait**

1 Significant wave heights (average wave height of the upper-third-largest waves) are
2 typically 0.6 m (2 ft) in the lower portion of Cook Inlet and the Shelikof Strait, but maximum
3 wave heights of 5.5 m (18 ft) have been recorded during storm events (Rappeport 1982).
4 Tsunamis can occur in response to volcanic activity of Mount St. Augustine on Augustine Island
5 in the southwestern portion of lower Cook Inlet. Modeling results of the 1883 tsunami suggested
6 wave heights of amplitude 1.2 to 1.8 m (3.9 to 5.9 ft) (Kienle et al. 1986). However, more recent
7 modeling results suggest that the timing of a tsunami with the tidal phase can result in a fivefold
8 amplification of wave heights near the shores of Anchor Point (Kowalik and Proshutinsky 2010).
9

10 Ice floes moving with tidal currents are the largest threat to navigation and marine
11 structures in Cook Inlet. According to Mulherin et al. (2001), three types of sea ice form in
12 Cook Inlet: pack ice, landfast ice, and stamukhi ice (forms by stacking of low-tide formed ice
13 sheets on the sediment surface). The sea ice forms in the upper portion of Cook Inlet in the fall,
14 while the lower portion is typically ice free until December. Stamukhi ice stacks can reach 7.5 to
15 12.2 m (24.6 to 40 ft) in thickness and typically become ice floes that move away from the shore
16 because of buoyancy forces. During the fall-winter ice-covered season, the ice pack can cover
17 between 10 and 80% of Cook Inlet, which becomes completely ice free each spring (Muench and
18 Schumacher 1980; Mulherin et al. 2001).
19
20

21 **4.3 ASSESSMENT OF ISSUES OF PROGRAMMATIC CONCERN**

22
23

24 **4.3.1 Multiple Use Issues and Marine Spatial Planning**

25

26 The activities that may occur and the facilities that may be installed on the OCS as a
27 result of the Program are described in Section 4.4.1, which presents a scenario for the projected
28 amounts of oil and gas exploration and development activities and the number of facilities and
29 pipelines that are estimated to take place or be installed during the program, if Alternative 1, the
30 Proposed Action, is implemented. Comparisons with other alternatives are provided later in the
31 document, but the analyses presented in Sections 4.3 and 4.4 would apply, as appropriate, across
32 all the alternatives. Much of the rest of this chapter is concerned with assessing potential
33 impacts from these activities and facilities on the environmental resources that are analyzed in
34 the PEIS. In some areas, these oil and gas facilities and activities also create a potential for space
35 use conflicts with other activities and facility sitings not related to oil and gas development. This
36 section discusses the other major activities and facilities on the OCS that could occur and coexist
37 with oil and gas construction and activities during the program and, as a result, create potential
38 space use conflicts. These conflicts could include situations in which the presence of oil and gas
39 infrastructure and associated support, exploration, and production activities preclude, or are
40 precluded by, other uses of the OCS; or situations in which oil and gas facilities and activities in
41 combination with other types of activities and infrastructure could threaten the ecological
42 sustainability of the area. Typically, the Bureau of Ocean Energy Management (BOEM) has
43 managed OCS space and multiple use issues through coordination with other State and Federal
44 agencies that manage and regulate activities on or near the OCS, and has developed regulations,
45 lease stipulations, and other mechanisms to restrict oil and gas activities to avoid conflict with
46 other activities taking place in the same area. In recent years, Coastal and Marine Spatial

1 Planning (CMSP) has emerged as a new paradigm and planning strategy for coordinating all
2 marine and coastal activities and facility constructions within the context of a national zoning
3 plan.
4

6 **4.3.1.1 Multiple Use Issues**

7
8

9 **4.3.1.1.1 Department of Defense Use Areas.** Military Use Areas, established off all
10 U.S. coastlines, are required by the U.S. Air Force (USAF), Navy, Marine Corps, and Special
11 Operations Forces for conducting various testing and training missions. Military activities can
12 be quite varied, but they normally consist of air-to-air, air-to-surface, and surface-to-surface
13 naval fleet training; submarine and antisubmarine training; and Air Force exercises. Offshore
14 military areas (including military dumping areas) are present in some OCS planning areas.
15 Section 3.9.1.2.3 of this draft PEIS discusses offshore military use areas in the OCS planning
16 areas being considered for the proposed action.
17

18 Aircraft operated by all U.S. Department of Defense (USDOD) units train within a
19 number of special use airspace (SUA) locations that overlie the military operating areas, as
20 designated by the Federal Aviation Administration (U.S. Fleet Forces 2010). SUAs are the most
21 relevant to the oil and gas leasing program because they are largely located offshore, extending
22 from 5.6 km (3 NM or 3.5 mi) outward from the coast over international waters and in
23 international airspace.
24

25 There are 21 U.S. military bases along the coasts of the planning areas being considered
26 for oil and gas leasing in the proposed action: 18 bases along the GOM coast and 3 in the
27 vicinity of the Cook Inlet Planning Area. In addition, there are four active USAF radar sites
28 located on the coast bordering the Beaufort and Chukchi Sea Planning Areas. They are all Long-
29 Range Radar Sites, and each site has restricted areas within certain facilities. Access to each is
30 only for personnel on official business and with approval of the commander of the USAF's
31 611th Air Support Group. While there are a number of military use restriction areas (danger
32 zones or restricted areas) in the GOM (see Figure 3.9.1-2), there are no such restrictions in the
33 waters of the Cook Inlet Planning Area or the Beaufort and Chukchi Sea Planning Areas
34 (National Marine Protected Areas Center 2008). In the Cook Inlet Planning Area, the closest
35 danger zone is Blying Sound, which is managed by the U.S. Navy and located to the east of
36 Cook Inlet near Prince William Sound. The Blying Sound Danger Zone is rarely activated, and
37 there are no use restrictions for most of the year.
38

39 Danger zones are defined as water areas used for a variety of hazardous operations
40 (Marine Protected Areas Center 2008; U.S. Fleet Forces 2010). Danger zones may be closed to
41 the public on a full-time or intermittent basis. Restricted areas are water areas defined as such
42 for the purpose of prohibiting or limiting public access. Restricted areas generally provide
43 security for Federal Government property and/or protect the public from the risks of damage or
44 injury that could arise from the Federal Government's use of that area.
45

1 There are more than 40 military warning areas in the northern GOM area, designated by
2 the USAF for the conduct of various testing and training missions, and by the U.S. Navy for
3 various naval training and testing operations. Most of these areas overlie waters that are less
4 than 800 m (2,600 ft) in depth (Figure 3.9.1-2).

5
6 Although offshore oil and gas activities have the potential to affect military activities, the
7 USDOD and U.S. Department of the Interior (USDOJ) have cooperated on these issues for many
8 years and have developed mitigation measures that minimize the potential for conflicts. For
9 example, stipulations are applied to oil and gas leases in critical military use areas. Whenever
10 possible, close coordination between oil and gas operators and the military authorities for
11 specific operational areas is encouraged and, in some cases, is required under these lease
12 stipulations. In some instances where the military requires unimpeded access to specific areas on
13 the OCS, specific lease blocks have been deleted from one or more proposed lease sales.

14
15 The USDOJ will continue to coordinate with the USDOD regarding future lease
16 offerings, new areas of industry interest, and current or proposed areas of military operations. As
17 part of this coordination, applicable stipulations would continue to be routinely evaluated and
18 modified, as necessary, to minimize or eliminate conflicts. An example of this process was the
19 inclusion of three previously deferred blocks (Mustang Island Blocks 793, 799 and 816) in the
20 Western GOM Planning Area in OCS Lease Sales 192 and 196, subject to a recently revised
21 Lease Stipulation of Operations in the Naval Mine Warfare Area.

22
23 Offshore oil and gas development under the proposed action within the Alaska Region
24 would not interfere with standard or routine military practices. Additional vessel traffic resulting
25 from industry development and exploration would simply increase existing traffic and not affect
26 military activities. The BOEM works in cooperation with the USCG regarding industry
27 exploration and development in waters off the coast of Alaska.

28
29
30 **4.3.1.1.2 Liquefied Natural Gas Facilities.** Natural gas is liquefied to concentrate a
31 much greater volume of product in a given space to facilitate storage and/or transportation. Use
32 of liquefied natural gas (LNG) reduces the volume it occupies by a factor of more than 600,
33 making the transportation of gas in tankers economical. Environmental effects specific to LNG
34 transportation and facilities are associated with explosions and fires and with the cryogenic and
35 cooling effects of either an accidental release of LNG or the release of cooled water during the
36 vaporization process. In the GOM, most, if not all, LNG facilities are expected to use an open-
37 loop vaporization process that uses a throughput of approximately 130 to 250 million gallons per
38 day of seawater to raise the temperature of the LNG from -260°F to 40°F . This process
39 produces a discharge of seawater that has been cooled by as much as 20°F . These discharges are
40 expected to occur in water depths ranging from 18 to 55 m (60 to 280 ft). This large volume of
41 cool, dense water could create an impact on the surrounding environment, rendering the area
42 uninhabitable by local species of invertebrates and fish, especially in the GOM. The magnitude
43 of this impact is still unknown since there is only one facility (the Gulf Gateway facility)
44 currently operating. The potential cumulative effect of multiple facilities also needs
45 consideration. In addition to the thermal discharge, biocides are added to prevent fouling of the
46 flow through the system.

1 These facilities operate by offloading vaporized LNG from tankers into the existing
2 offshore natural gas pipeline system. Although BOEM does not permit or regulate these
3 facilities, their increased presence and use on the OCS will create space use issues and will add
4 to the existing mix of potential offshore cumulative impacts. Currently, only one LNG facility
5 has been constructed and is operating on the GOM OCS. The Gulf Gateway Energy Bridge,
6 which was brought into service in March 2005, is located in 85.3 m (280 ft) of water in West
7 Cameron, South Addition Block 603, approximately 116 mi (187 km) offshore of the Texas–
8 Louisiana border. The Gulf Gateway Energy Bridge is capable of delivering natural gas at a
9 base load rate of 500 Bcf per day.

10
11 Other LNG facilities on the OCS are currently in some stage of the permitting process.
12 The Bienville Offshore Energy Terminal is a planned LNG facility located 63 mi (101 km) south
13 of Mobile Point, Alabama. The initial application for the facility was withdrawn on October 9,
14 2008, and a revised application, submitted on June 30, 2009, featured a redesigned terminal
15 using “closed-loop” ambient air technology for LNG vaporization. The application was
16 approved in 2010. In Louisiana, the Main Pass Energy Hub is a converted sulfur and brine
17 mining facility. This LNG facility is expected to begin operations sometime in 2011 or 2012.

18
19
20 **4.3.1.1.3 Alternate Energy Development.** In April 2009, the President and the
21 Secretary of the Interior announced the final regulations for the OCS Renewable Energy
22 Program, which was authorized by the Energy Policy Act of 2005. The final regulations
23 (74 CFR Part 81: 19638–19871) govern management of the BOEM Renewable Energy Program
24 by establishing a program to grant leases, easements, and right-of-ways (ROWs) for renewable
25 energy development activities on the OCS. Renewable energy from the OCS may come from
26 technologies and projects that harness offshore wind energy, ocean wave (hydrokinetic) energy,
27 or ocean current (hydrokinetic) energy.

28
29 Multiple Federal agencies have responsibilities for the regulation and oversight of
30 renewable energy development on the OCS. The BOEM issues leases and grants for both OCS
31 wind and hydrokinetic projects and permits the construction and operation of wind facilities.
32 The Federal Energy Regulatory Commission will permit the construction and operation of
33 hydrokinetic facilities on BOEM-issued wave and current energy leases. The BOEM also has
34 the authority to issue ROWs for offshore transmission lines that would link OCS renewable
35 energy projects in order to facilitate efficient interconnection of the OCS projects to the onshore
36 electric grid.

37
38 As required by the Energy Policy Act, the BOEM will issue leases on a competitive basis
39 unless it determines that no competitive interest exists. After a lease is acquired, the developer
40 must submit and receive approval of appropriate plans (for wind energy projects) or license
41 applications (for hydrokinetic projects). At the end of the lease term, the developer must
42 decommission the facilities in compliance with BOEM regulations.

43
44 There are currently no commercial hydrokinetic or wind energy projects on the OCS in
45 the planning areas under consideration for the Program. The BOEM, in coordination with
46 relevant states, has identified Wind Energy Areas (WEAs) offshore of the mid-Atlantic coast.

1 Although OCS oil and gas leasing and development activities could interfere with future OCS
2 wind energy renewable energy projects (and vice-versa), the BOEM offshore oil and gas and
3 offshore renewable energy programs will be coordinated to ensure that leasing and development
4 activities under both programs are carried out with as little conflict between the two programs as
5 possible. The identification of any future WEAs in areas with high or expected levels of oil and
6 gas development (such as the GOM) will also be closely coordinated between the two programs.
7 No such WEAs, however, have been identified in any of the BOEM OCS planning areas being
8 considered for oil and gas leasing under the proposed action, nor are any wind or kinetic energy
9 developments anticipated there during the program.

12 **4.3.1.2 Coastal and Marine Spatial Planning**

14 On July 19, 2010, the President signed Executive Order (EO) 13547, *Stewardship of the*
15 *Ocean, Our Coasts, and the Great Lakes*, establishing a national policy for the stewardship of
16 these resources. This national policy identifies Coastal and Marine Planning (CSMP) as one
17 of the nine objectives. Furthermore, it outlines a framework for effective CMSP to address
18 conservation, economic activity, user conflict, and sustainable use of the ocean, coasts, and
19 Great Lakes.

21 Despite the existence of numerous articles on CMSP (e.g., see papers in *Marine Policy*,
22 Vol. 32, 2008) and the incorporation of marine spatial planning (MSP) principles by various
23 nations into their resource management practices (e.g., EO 13547; the National Oceanic and
24 Atmospheric Administration (NOAA) CSMP Program, [http://www.cmsp.noaa.gov/program/](http://www.cmsp.noaa.gov/program/index.html)
25 [index.html](http://www.cmsp.noaa.gov/program/index.html)), a standard, universally accepted definition of MSP currently does not exist. Most
26 existing definitions are phrased in broad terms and objectives, such as the United Nations
27 Educational, Scientific and Cultural Organization (UNESCO) definition, “[MSP] ... is a public
28 process of analyzing and allocating the spatial and temporal distribution of human activities in
29 marine areas to achieve ecological, economic, and social objectives that have been specified
30 through a political process” (UNESCO-IOC 2010).

32 Although NEPA is not usually seen as a spatial planning exercise, the PEIS for the
33 Program and subsequent NEPA evaluations effectively are, at least in part, just that. The draft
34 PEIS identifies broad areas of the OCS where oil and gas leasing may occur and identifies in a
35 spatial and temporal context the potential for impacts on natural and social resources and systems
36 that could occur with subsequent oil and gas leasing in those areas. The subsequent lease sale
37 and post-lease NEPA analyses identify the specific areas and time frames where and when
38 mitigating measures need to be applied to address potentially unacceptable impacts on natural
39 resources and socioeconomic resources and systems. One outcome of this NEPA process,
40 therefore, is the identification of areas on the OCS where BOEM regulates and manages oil and
41 gas operations to meet economic and social objectives in a manner compatible with
42 environmental sustainability objectives.

44 Table 4.3.1-1 describes ways in which the objectives and methods of CMSP are
45 compatible with or differ from those of the Five-Year Programmatic EIS. While there are

1 **TABLE 4.3.1-1 Comparison of the Objectives and Methods of CMSP with Those of the 2012-2017**
 2 **OCS Oil and Gas Leasing Program PEIS^a**

Coastal and Marine Spatial Planning	Programmatic EIS
Envisioned as a tool to make ecosystem-based management of marine resources possible.	Uses a broad scale appropriate for an ecoregional approach for evaluating potential impacts.
Large Marine Ecosystems (LMEs) used to define spatial boundaries.	Large Marine Ecosystems (LMEs) used to define spatial boundaries.
Based on hierarchal scale-based approach addressing different issues and at different scales at each level of analysis, and in which each level provides context for the next lower level.	The NEPA concept of tiering is based on a hierarchal scale-based approach in which the programmatic EIS provides the general context for the more detailed analyses in the lease sale EIS.
Used to develop areas identifying ecologically sensitive regions as well as areas suitable for specific human uses.	Used as the first step in a planning process to develop areas where oil and gas operations will be regulated to be consistent, in combination with other uses of the area, with current environmental sustainability objectives.
Used to plan for existing and proposed offshore uses, while reconciling economic, social, and environmental demands on an area.	Programmatic cumulative analysis evaluates all differing economic, social, and environmental demands on an area to inform the decision on program timing, size, and locations.
Based on multiple sector planning approach.	Focused on the effects of a single sector on other sectors.

^a Highlighted text shows areas of particular similarity.

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fundamental similarities and overlaps between the objectives and approaches of CMSP and the 2012-2017 PEIS, a major distinction between the two planning approaches is that the PEIS perspective focuses on the single use of the OCS for hydrocarbon exploration, extraction, and transportation, whereas the CMSP focuses on reconciling all economic, social, and ecosystem uses of an area in developing a CMS plan.

The National Ocean Policy framework document divides U.S. waters (mean high water mark to 200 NM) into nine regions based on Large Marine Ecosystem (LME) boundaries. CMS plans will be created and implemented at the regional level though stakeholder input. It is anticipated that the plans will serve as an overlay for decisions made under existing regulatory mandates. In effect, regional CMS plans once approved by the National Ocean Council (NOC) will assist the BOEM programmatic EIS process in making informed decisions.

4.3.2 Health Impact Assessment

4.3.2.1 National Environmental Policy Act

The National Environmental Policy Act and its related Federal guidelines (40 CFR 1508.8; 1978) have explicit language that requires the evaluation of both direct and indirect effects of the oil and gas industry on human health as well as the effects on low-income and minority populations (CEQ 1997). NEPA regulations instruct agencies to evaluate “the degree to which the proposed action affects public health or safety” (Berner 2011). Although these mandates exist, limited health information is currently included in Federal EISs. With the addition of the discussion of health issues in the planning stages, the impacts on human health can be considered beforehand, public and decision-maker awareness can be promoted, and prevention or mitigation can be built into the operations (Bhatia 2007; Niven and McLeod 2009). This would, in essence, change the process from reactionary to precautionary, thus attempting to remove or control health issues at the source (Niven and McLeod 2009).

4.3.2.2 Potential Impacts on the Human Environment

Offshore oil and gas activities have the potential to cause both adverse and beneficial impacts on human health. The exploration and development phases of oil and gas activities are beneficial because they require a large and diverse labor force to build the platforms, exploratory rigs, and various ships, boats, and barges necessary for working offshore (Luton and Cluck 2003). Increases in the labor force can promote the economy and development of infrastructure in these communities (Berner 2011).

Effects on the human environment can be both positive and negative, specifically with respect to psychological effects. The announcement of a leasing decision can affect humans in a positive way because it can boost the economy and bring much needed infrastructure development, while possible negative effects could be related to additional stress and anxiety over oil spills and impacts on the natural resources that communities use for a subsistence lifestyle (NRC 2003). Negative impacts on the human environment vary based on whether they are the result of routine events or the result of the threat/event of an accidental oil spill.

4.3.2.3 Potential Impacts of Routine Events Oil and Gas Activities

The North Slope Borough, Alaska, and the Alaska regional office of BOEM, through a Memorandum of Understanding, have evaluated the effects of the oil and gas industry on humans in the region. Appendix J of the *Beaufort and Chukchi Sea Planning Areas Oil and Gas Lease Sales 209, 212, 217, and 221 Draft Environmental Impact Statement* (OCS EIS/EA MMS 2008-0055) presents a full evaluation of these effects and is hereby incorporated by reference in this PEIS (http://www.alaska.boemre.gov/ref/EIS%20EA/ArcticMultiSale_209/_DEIS.htm).

1 Public concerns regarding pollution of locally harvested fish and game, loss of traditional
2 food sources and hunting grounds, and rapid social changes are examples of negative impacts on
3 humans in Alaska. The harvesting of wildlife resources in the North Slope of Alaska contributes
4 widely to the cultural, nutritional, and economic way of life of the residents living there (NRC
5 2003). These impacts could affect both physical and mental health of Native tribal communities.
6 Changes in the traditional way of life can lead to deteriorating physical well-being and mental
7 health as well as increased domestic violence and substance abuse. North Slope tribal
8 communities are concerned about the impacts of noise associated with routine operations on
9 bowhead whale migration routes, as they depend on these whales for subsistence (NRC 2003). If
10 the whales migrate farther offshore, there are increased safety risks for the whalers themselves
11 who must travel in more dangerous seas to hunt. Increased stress and anxiety from oil and gas
12 development may contribute to the mental health issues of Alaskans (NRC 2003).

13
14 The increased development has increased the smog and haze near some villages, which
15 could be the cause for increased instances of asthma. Air quality is a major concern for the
16 residents who live there (NRC 2003). The impacts of the proposed action on air quality and
17 related health concerns are discussed in Section 4.4.4. Increased rates of diabetes are likely
18 the result of residents consuming higher concentrations of nonsubsistence foods such as
19 shortening, lard, butter, and bacon, and consuming less fish and marine mammal products
20 (Ebbesson et al. 1999 referenced in NRC 2003).

21
22 However, the increased revenue from the oil and gas industry can promote the economy
23 and improve infrastructure of these more remote locations, resulting in beneficial impacts
24 (Berner 2011). Alaska Natives have recognized that they have benefited by receiving monies to
25 spend on public works and facilities, as well as better health care and counseling centers
26 (NRC 2003).

27
28 As discussed in Section 4.4.14, Environmental Justice, much of the Alaska Native
29 population resides in the coastal areas of Alaska. Any new onshore and offshore infrastructure
30 occurring between 2012 and 2017 could be located near these populations or near areas where
31 subsistence hunting occurs. Any adverse environmental impacts on fish and mammal
32 subsistence resources from installation of infrastructure and routine operations of these facilities
33 could have disproportionately higher health or environmental impacts on Alaska Native
34 populations. Mitigation measures, cooperative agreements between Native and industry groups,
35 and government-to-government consultations are designed to limit the effects from routine
36 events.

37 38 39 **4.3.2.4 Potential Impacts of Accidental Spills**

40
41
42 **4.3.2.4.1 Gulf of Mexico.** The impacts on human health as a result of oil spills can be
43 broken down into several categories. Goldstein et al. (2011) list the categories as “those related
44 to worker safety; toxicological effects in workers, visitors, and community members; mental
45 health effects from social and economic disruption; and ecosystem effects that have
46 consequences for human health.” Initial concerns focus on the short-term toxicological effects to

1 humans such as nausea, dizziness, eye irritation, headaches, and respiratory and dermal irritation,
2 but more research is necessary to understand long-term effects (Goldstein et al. 2011). Impacts
3 on air quality include the emission of pollutants from the oil and the fire emissions that are
4 hazardous and possibly fatal to humans, as well as the dispersant mist resulting from the
5 application of the chemical dispersants on the oil (BOEMRE 2011). The impacts of the
6 proposed action on air quality are fully discussed in Section 4.4.4.

7
8 After an accidental release of oil into the environment, the more volatile, water-soluble,
9 and degradable compounds will be weathered and degraded, leaving behind the heavier, less
10 degradable elements. These heavier elements, when combined with sand on beaches, form tar
11 balls, which can be encountered by beachgoers for some time. Humans walking along the beach
12 can absorb these heavier elements through the soles of their feet and subsequently into their
13 bloodstream (OSAT-2 2011). Beachgoers may also inhale petroleum hydrocarbons present as
14 vapors or attached to airborne particles (OSAT-2 2011). Other immediate effects of particular
15 concern are heat stroke and exhaustion and the inappropriate use of personal protective
16 equipment by cleanup crews, especially in the GOM. In the case of the Deepwater Horizon
17 event, elevated rates of post-traumatic stress disorder, depression, alcohol abuse, and conflicts
18 between domestic partners were observed (Goldstein et al. 2011). A large part of the GOM
19 region's economy is based on the oil and gas industry and the harvesting of seafood.
20 Restrictions placed on these industries due to an oil spill can increase the anxiety levels of
21 humans and may contribute mental health issues (Goldstein et al. 2011).

22
23 Oil spills have the potential to impact certain groups of people more than others based on
24 their current state of health. For example, GOM coast populations include communities that are
25 still recovering from Hurricane Katrina, and "among the 50 States, Louisiana ranks 44th to 49th
26 (depending on the metric used, with 1st being the best) in the overall health of residents, rates of
27 infant death, death from cancer, premature death, death from cardiovascular causes, high-school
28 graduation, children living in poverty, health insurance coverage, and violent crime"
29 (United Health Foundation 2009 as referenced in Goldstein et al. 2011). As discussed in
30 Section 4.4.14, there are areas in the GOM of environmental justice concern. It is possible these
31 low-income and minority populations could be affected to a greater extent than the general
32 population because of their dietary reliance on wild coastal resources, their reliance on these
33 resources for other subsistence purposes such as sharing and bartering, their limited flexibility in
34 substituting wild resources with those purchased, and their likelihood of participating in cleanup
35 efforts and other mitigating activities.

36
37
38 **4.3.2.4.2 Arctic and Cook Inlet.** The Native tribes of the North Slope have serious
39 concerns about what would happen if there was an accidental oil spill in the Arctic region. An
40 oil spill could have physical, psychological, social, economic, spiritual, and cultural impacts on
41 the Native Alaskans. Major areas of concern are with impacts on subsistence resources, air
42 quality, and oil spill cleanup. These concerns are related to how and if it would be cleaned up
43 and how the International Whaling Commission would react if the spill greatly impacted the
44 bowhead whale population (NRC 2003). The impacts of the proposed action on air quality are
45 discussed in Section 4.4.4. The North Slope Borough, Alaska, and the Alaska regional office of
46 BOEM have, through a Memorandum of Understanding, evaluated the effects of the oil and gas

1 industry on humans in the region. Appendix J of the *Beaufort and Chukchi Sea Planning Areas*
2 *Oil and Gas Lease Sales 209, 212, 217, and 221 Draft Environmental Impact Statement*
3 (MMS 2008) presents a full evaluation of these effects.
4

5 Oil spills can affect human health in Alaska through the same ways as discussed for the
6 GOM; additionally, major concerns involving the impacts on human health due to oil spills relate
7 to the subsistence lifestyle of Native Alaskans. Humans can be affected through contact with the
8 contaminants, such as through inhalation, skin contact, or intake of contaminated foods; through
9 reduced availability of subsistence resources; through interference with subsistence harvest
10 patterns; and stress due to fears of long-term implications of the spill (MMS 2007d as referenced
11 in MMS 2008).
12

13 As discussed in Section 4.4.14, there are areas in the Alaska region that are of
14 environmental justice concern. Much of the Alaska Native population resides in the coastal
15 areas of Alaska, and subsistence activities of Native communities could be affected by accidental
16 oil spills, with the potential health effects of oil spill contamination of subsistence foods being
17 the main concern. Mitigation measures, cooperative agreements between Native and industry
18 groups, and government-to-government consultations are designed to limit the effects from oil
19 spills.
20

21 22 **4.3.2.5 Conclusion** 23

24 Health effects are discussed throughout this PEIS, as appropriate. The State of Alaska is
25 currently developing an approach to integrate health analysis into the EIS by way of a Health
26 Impact Assessment (HIA) (Berner 2011). An HIA is a scientific method used to assess the
27 potential effects of a policy on the health of a population and the distribution of those effects,
28 and it brings together stakeholders to find a solution (Quigley 2006, CEQ 1981, referenced in
29 Berner 2011). The overall purpose of HIAs is “to inform and influence decision making on
30 proposals and plans, so health protection and promotion are effectively integrated into them”
31 (Quigley et al. 2006). This programmatic-level EIS acknowledges that there will be impacts
32 on human health, both positive and negative, from the proposed action, but it is a broad-level
33 document discussing the impacts over entire planning areas. It would be more appropriate to
34 discuss impacts to site-specific populations at the lease sale level when a better understanding
35 of who will be affected is clear.
36
37

38 **4.3.3 Invasive Species** 39

40 EO 13112, *Invasive Species*, defines invasive species as species that are non-native
41 (or alien) to the ecosystem under consideration and whose introduction causes or is likely to
42 cause economic or environmental harm or harm to human health. Invasive species can be plants,
43 animals, or pathogens. Nationwide, invasive species are associated with environmental damages
44 and losses totaling over \$138 billion annually (Pimentel et al. 2000). More than 50,000 invasive
45 species have been documented to date in the United States, and roughly 42% of threatened and
46 endangered species in this country are considered at risk primarily because of invasive species

1 (Pimentel et al. 2005). Effects of invasive species can be devastating on both habitat and native
2 species and may (1) include a decrease in biological diversity of native ecosystems, (2) decrease
3 the quality of important habitats for native fish and invertebrate species, (3) reduce habitats
4 needed by threatened and endangered species, (4) increase direct and indirect competition with
5 aquatic plants and animals, and (5) pose human health risks
6 (<http://www.invasivespeciesinfo.gov/whatis.shtml>).
7

8 Oil and gas activities may play a part in the introduction of invasive species or may
9 provide substrate and habitat encouraging the establishment of invasive species. Drillships and
10 semisubmersibles are used and relocated throughout the world's oceans. Over time, fouling,
11 encrusting, and boring organisms will attach to these devices. Unintentional introductions may
12 occur when these drilling rigs are relocated to a new region such as the GOM. These same
13 drillships and semisubmersibles may transport and release ballast water containing invasive
14 plankton, larval invertebrates, or even fish, which may then become established due to the
15 availability of acceptable habitat, plentiful food supply, and lack of predators.
16

17 Since 1998, there have been at least 16 documented cases of rigs being brought into the
18 GOM from other parts of the world. Some rigs operating in the GOM were constructed or
19 recently modified in Singapore, Taiwan, and Scotland. Newly built rigs undergoing their last
20 year of construction stand in waters of surrounding shipyards. A year is sufficient time for
21 fouling and encrusting organisms to colonize rig surfaces. One large semisubmersible was kept
22 in Mobile Bay, Alabama, for 1 yr. Prior to being placed in Mobile Bay, it had spent 6 months
23 drilling off the coast of Trinidad.
24

25 Oil and gas drilling rigs, platforms, and pipelines provide substrate and habitat for sessile
26 organisms. Invasive mussels, barnacles, and corals are known to use rigs and platforms as
27 attachment sites. Many marine organisms require hard surfaces to use as attachment sites for all
28 or part of their natural history. Jellyfish have a polyp stage that requires hard substrate. Polyps
29 settling on rigs in one location and then transported to another region can asexually reproduce.
30 One polyp can produce up to 300 new jellyfish. Currently, there are thousands of oil and
31 gas platforms in the GOM, each of which can provide a hectare or more of hard substrate that
32 can support algae, mollusks, and other sessile invertebrates (Atchison et al. 2008). No-activity-
33 zone natural reefs provide 104.5 km² (40.3 mi²) of hard substrate, which could be used for
34 settlement sites.
35

36 Above-water platform structures may also encourage the colonization of new habitat by
37 invasive species. Many migratory bird species use the platform structures as stopover spots
38 while crossing the GOM (Russell 2005). Ongoing research funded by the BOEMRE is studying
39 the interactions between migrating birds and oil and gas structures off the Louisiana coast.
40

41 A number of invasive species have been recorded from the OCS planning areas
42 considered for oil and gas leasing in the proposed action. In the GOM, invasive species reported
43 since the mid-1900s include the brown mussel (*Perna perna*), the Australian spotted jellyfish
44 (*Phyllorhiza punctata*), the pink jellyfish (*Drymonema dalmatina*), two species of hydroids
45 (*Cordylophora caspia* and *Garveia franciscana*), a sea anemone (*Diadumene lineata*),
46 a polychaete worm (*Hydroides elegans* and *Ficopomatus enigmaticus*), the Atlantic copepod

1 (*Centropages typicus*), four barnacle species (*Balanus amphitrite*, *B. reticulatus*, *B. trigonus*, and
2 *Tetraclita stalactifera stalactifera*), and four species of isopod (*Sphaeroma walkeri*, *S. terebrans*,
3 *Limnoria* spp., and *Ligia exotica*). Some of these species are native to other parts of the world
4 (e.g., the brown mussel is native to Africa and South America), while other species are native to
5 North American marine habitats but not to the GOM (e.g., the Atlantic copepod *Centropages*
6 *typicus*). Suggested avenues of initial introduction of these various species include discharge of
7 ballast water, dumping of ballast rock, or attachment to vessel surfaces.

8
9 Although invasive species are a worldwide problem, Alaska has far fewer invasive
10 species compared to the rest of the nation (Piorkowski 2003a). Relatively few aquatic invasive
11 species have been introduced and become established in Alaska compared to other States. This
12 is, in part, due to Alaska's plant and animal transportation laws, geographic isolation, northern
13 climate, small human population, and relatively few concentrated disturbed habitat areas
14 (Fay 2002). However, a non-native amphipod and a colonial tunicate have been found in
15 Alaskan waters. Potential introduction pathways include the movement of large ships and ballast
16 water from the United States west coast and Asia, and the relocation of previously used docks
17 and pier timbers (ADFG 2011). While invasive species impacts, to date, are low, potential
18 threats must be monitored because a significant portion of Alaska's economy, including sport
19 and commercial fishing, depends upon the pristine and natural quality of its aquatic ecosystems.
20 Climate change may also affect the ability of marine invasives to become established (Invasive
21 Species Advisory Committee 2010). For example, changes in water temperature or precipitation
22 regimes (and associated runoff into coastal waters) may make areas more favorable for an
23 invasive species to become established or spread.

24
25 Exploratory drilling of Federal leases offshore of Alaska requires bringing rigs and/or
26 vessels to Alaska. Such rigs or vessels may come from the GOM, the West Coast, or foreign
27 waters and be contaminated with species alien to Alaska. Such species may be attached to the
28 hull structure (e.g., sponges and barnacles), hitch a ride on the vessel (e.g., rats, insects,
29 crustaceans, and mollusks), or be transported via ballast water (e.g., crustaceans and mollusks).
30 Once brought to Alaska, alien species contaminating a rig or vessel may subsequently disperse
31 into Alaska's ecosystems.

32
33 Although introduction of invasive species to Alaskan waters could occur through the
34 import and placement of offshore oil/gas structures, the threat has not been considered
35 significant. The Alaska Aquatic Nuisance Species Management Plan (Fay 2002) considers
36 activities other than oil/gas structures major pathways for the introduction of aquatic alien
37 species, including aquaculture; aquarium trade; biological control; boats, ships, and aircraft;
38 channels, canals, and locks; live bait; nursery industry; scientific research institutions, schools,
39 and public aquariums; recreational fisheries enhancement; restaurants; and seafood retail and
40 processing.

41
42 Vessels, including those used by the oil/gas industry, do pose more potential for
43 introducing invasive species than oil/gas structures. For example, Hines and Ruiz (2000)
44 reported finding 13 species of crustaceans and 1 species of fish arriving at Port Valdez in the
45 ballast water of oil tankers voyaging from San Francisco Bay or Long Beach, California. The
46 issue of invasive species and ballast water is managed by the USCG under the National Invasive

1 Species Act of 1996. The USCG has promulgated regulations (33 CFR Part 151) to make
2 compliance with ballast water guidelines mandatory. Therefore, oil- or gas-related vessels are
3 required to abide by these requirements in order to reduce the potential for introduction of
4 invasive species.

7 **4.3.4 Risk of a Low-probability, Catastrophic Discharge Event**

10 **4.3.4.1 Introduction**

11
12 The risk of potentially severe consequences of oil spills, especially the risk and
13 consequence of low-probability, large volume spills, is an issue of programmatic concern.
14 Although unexpected and accidental, large spills may result from OCS exploration or
15 development operations involving facilities, tankers, pipelines, and/or support vessels. Incidents
16 with the greatest potential for catastrophic consequences are losses of well control with
17 uncontrolled releases of large volumes of oil, where primary and secondary barriers fail, the well
18 does not bridge (bridging occurs when the wellbore collapses and seals the flow path), and the
19 flow is of long duration (Holand 1997). The term “catastrophic discharge event” is used in this
20 section to describe an event that results in a very large discharge into the environment that may
21 cause long-term and widespread effects on marine and coastal environments.

22
23 In general, historical data show that loss of well control events resulting in oil spills are
24 infrequent and that those resulting in large accidental oil spills are even rarer events (Anderson
25 and Labelle 2000; Anderson in preparation; Bercha Group 2006, 2008; Izon et al., 2007). The
26 Norwegian SINTEF Offshore Blowout Database, which tracks worldwide offshore oil and gas
27 blowouts, where risk-comparable drilling operations are analyzed, supports the same conclusion
28 (IAOGP 2010). New drilling regulations and recent advances in containment technology may
29 further reduce the frequency and size of oil spills from OCS operations. However, as the 2010
30 DWH event illustrated, there is a small risk for very large spills to occur and result in
31 unacceptable impacts, some of which have the potential to be catastrophic.

32
33 A fundamental challenge is to accurately describe this very small risk, especially since
34 there have been relatively few large oil spills that can serve as benchmarks (Scarlett et al. 2011).
35 Prior to the DWH event, the three largest spills on the OCS were 80,000, 65,000 and 53,000, and
36 all occurred before 1971. From 1971 to 2010 there were 253 well control incidents, 53 of which
37 spilled oil. Excluding the DWH event, less than 2,000 bbl were spilled from these 53 well
38 control incidents. During this same period, more than 41,500 wells were drilled on the OCS and
39 almost 16 Bbbl of oil produced. The National Commission on the BP Deepwater Horizon Oil
40 Spill and Offshore Drilling has recently argued for a more rigorous and transparent oil spill risk
41 and planning process to support government and industry decision making (2011). At the
42 present time, there is not an ideal, standardized approach to characterizing the risk of spill
43 occurrence and consequence across all relevant space and time scales, consistent with inherent
44 uncertainties associated with different regional factors and different exploration or production
45 operations (Pritchard and Lacy 2011).

1 Historically, BOEM has characterized oil spill risk using the Oil Spill Risk Analysis
2 (OSRA) model to identify the risk of oil released from numerous locations on the OCS
3 contacting environmental resources. BOEM performs OSRA modeling in support of individual
4 lease sales and certain exploration/development plans. BOEM also considers risk during the
5 review of an operator's Exploration Plan, Development and Production Plan (or Development
6 Operations Coordination Document), and/or Application for Permit to Drill (APD). The same
7 OSRA runs often form the basis for spill risk and resource contact analysis in industry-submitted
8 plans. The APD describes the drilling procedures and technology that are planned to be used to
9 drill a specific well under the specific geologic, geophysical, and environmental conditions that
10 exist at the site. BOEM evaluates the APD to determine whether the operator's drilling plan is
11 appropriate for the drilling risk of the site.

12
13 Industry often prepares sophisticated, well-specific risk assessments for exploration or
14 development wells. The hazards-based or well-specific approach can use event-tree, fault-tree,
15 and "safety case" analytical methods (Cooke et al. 2011; DNV 2010). Well-specific quantitative
16 risk analysis (QRA) is frequently performed by operators (e.g., Mechanical Risk Integrity,
17 BlowFAM, BowTieXP), where risk is quantified and compared to acceptance criteria and
18 thresholds. Such quantitative risk analysis considers formation/well characteristics, technology
19 and procedures, and human error/management (which is frequently a root cause of many well
20 control incidents). The recently promulgated Safety and Environmental Management System
21 (SEMS) rule, building on API Recommended Practices (RPs) 14C, 14J, and 75, now requires all
22 OCS operators to identify, address, and manage safety and environmental hazards during design,
23 construction, start-up, operation, and maintenance activities.

24
25 To support the planning decision involved in establishing a 5-yr schedule of lease sales,
26 detailed analyses of highly variable, region-specific and/or well-specific risk is neither feasible
27 nor appropriate. At this decision juncture, the critical realization is that the risk of a spill with
28 catastrophic consequences albeit small, is not zero. Different OCS regions and operations may
29 have different risk profiles (Scarlett et al. 2011). This section assesses the importance of
30 different catastrophic discharge event risk factors in different program areas. This discussion is
31 presented to bring into focus critical risk factors, acting individually or in combination, that may
32 occur in program areas so that additional consideration is given to these issues during the
33 Program. In addition, recent regulatory changes implemented since the DWH event that BOEM
34 believes contributes to risk reduction are summarized.

35 36 37 **4.3.4.2 Risk Factors Influencing Occurrence, Size, Containment, Response, and** 38 **Fate/Consequence of a Catastrophic Discharge**

39
40 Risk is the combination of the probability of an event and the magnitude of the
41 consequences of that event. While BOEM primarily analyzes spills in context of routine small
42 spills and accidental large spills, this programmatic discussion on risk focuses on low-
43 probability, very large volume, long-duration OCS spills with the potential for catastrophic
44 effects (40 CFR 1502.22). Such a catastrophic discharge event may result in "large-scale
45 damage involving destruction of species, ecosystems, infrastructure, or property with long-term
46 effects, and/or major loss of human life" (Eccleston 2010). Such a spill is defined by the

1 National Oil and Hazardous Substances Pollution Contingency Plan as a “spill of national
2 significance” or “a spill which due to its severity, size, location, actual or potential impact on the
3 public health and welfare or the environment, or the necessary response effort, is so complex that
4 it requires extraordinary coordination of federal, state, local, and responsible party resources to
5 contain and cleanup the discharge” (40 CF. Part 300, Appendix E). For a spill to be considered a
6 catastrophic discharge event, its potential discharge volume must be such that catastrophic
7 effects could occur. As previously discussed, long duration uncontrolled flows from a well
8 control incident provide the greatest volumes of potential flow and are the spill sources
9 considered in this section. A scenario of maximum spill volume and duration is presented in
10 Table 4.3.4-1, describing catastrophic discharge characteristics in different program areas. The
11 discharge rate, volume, extent, and duration varies with geologic formation, well design, and
12 engineering characteristics, spill response capabilities, and time to containment. The potential
13 volume of oil that could enter the environment fundamentally depends on the success of
14 intervention, containment, response efforts at the incident site, or the length of time needed to
15 stop the flow from the well by drilling a relief well. The effect of discharged oil not recovered is
16 influenced by various weathering processes and response measures, such as use of dispersants
17 and burning. The potential adverse effects also vary with time of year and location of release
18 relative to winds, currents, land, and sensitive resources, specifics of the well (i.e., flow rates,
19 hydrocarbon characteristics, and infrastructure damage), and response capability (i.e., speed and
20 effectiveness). A catastrophic discharge event does not inherently equate to a spill with
21 catastrophic effect. Instead, impacts depend critically on the spill size, oil type, environmental
22 conditions, resources present and exposed, toxicity and other impact mechanisms, and
23 population/ecosystem resilience and recovery following direct exposure.
24

25 Industrial Economics, Inc., and Environmental Research Consulting, under contract to
26 BOEM, identified a suite of factors that may contribute to loss of well control and affect the size
27 and duration of catastrophic discharge event, differences in efficacy of containment and
28 response, and differences in fate. They include the following:
29

- 30 • Geologic formation and hazards;
- 31
- 32 • Water depth and hazards;
- 33
- 34 • Geographic location (including water depth);
- 35
- 36 • Well design and integrity;
- 37
- 38 • Loss of well control prevention and intervention;
- 39
- 40 • Scale and expansion;
- 41
- 42 • Human error;
- 43
- 44 • Containment capability;
- 45
- 46 • Response capability;

1 **TABLE 4.3.4-1 Risk Factors That Affect a Catastrophic Discharge Event**

Risk Factors	Factors That Affect Occurrence	Factors That Contribute to Catastrophic Consequences
Geology	Drilling location, drill depth; mature vs. frontier areas Reservoir pressure and volume Seabed complexity Shelf hazards	Larger reservoir volume Higher reservoir pressures Uncertainty associated with drilling in frontier areas
Water Depth	Increased water depth increases complexity of operation	Shallow water depth increases probability of contact with humans, sensitive species and sensitive environments
Well Design and Integrity	Drill string length Cementing and casing design Well integrity New technologies (e.g., associated with expansion) Prevention systems (e.g., BOPs, Backup control systems, ROVs) Human error Scale of operations and expansion	Exploratory drilling and improper well construction Prevention system failure Source of blowout: wells and platforms (as opposed to pipelines) Human error, often involving lack of understanding of new technologies
Loss of well control prevention and intervention	Improperly maintained equipment	Mechanical failure Equipment failure
Scale and expansion	Complexity of operations both physical and operational Human error Coordination and management	Human error Coordination and management
Human error	Lack of training and preparedness Extreme working environments	Lack of training Failure to take precautionary measures
Containment Capability	N/A	Subsea vs. surface containment
Response Capability	N/A	Distance from shore (duration) Response capability in remote areas Capping at the well vs. drilling relief well vs. chemical and mechanical response
Geography	Region-specific meteorology: temperature, extreme weather, prevalence of ice	Distance to shore: proximity to coastline increases probability of catastrophe Hurricanes associated with high-volume spills

TABLE 4.3.4-1 (Cont.)

Risk Factors	Factors That Affect Occurrence	Factors That Contribute to Catastrophic Consequences
Oil types, weathering and fate	Temperature of oil: higher oil temperatures and lower water temperatures (e.g., Arctic) increase likelihood of breakage Tidal patterns Currents and hurricanes	Oil weathering and evaporation Mechanical recovery, dispersal, or burning Transport/ice Oil persistence Ambient temperatures affect rate of oil flow from blowout location

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- Oil types and weathering/fate; and
- Specific regional geographic considerations, including oceanography and meteorology.

Many of these factors apply to drilling, abandonment, containment, response, and effects of the event and contribute to the overall catastrophic discharge risk associated with an OCS area, or even a particular well. The interplay of these factors is relevant to evaluating the risk of a catastrophic discharge event and ensuing consequences (Table 1). As the BP report concluded on the DWH event, a complex series of connected mechanical failures, human judgments, engineering design mistakes, and operational, implementation, and team interactions often contribute to incidents (BP 2010). Many of the risk factors are interrelated, and some factors both increase and decrease cumulative risk depending upon whether one is evaluating the risk of occurrence or the consequence of that occurrence. Moreover, some risk factors may contribute to more or less risk depending on the specific situation.

4.3.4.2.1 Loss of Well Control Occurrence.

Geologic Conditions. Depending on the region, the geology of the OCS varies greatly in character and oil and gas exploration potential. Risk assessments of mature areas (areas where prior drilling operations have occurred) benefit from previous geological exploration and well development. Alternatively, frontier areas, such as the Arctic, are relatively underexplored and do not have long registries of geological data or previous attempts at well drilling. This adds additional risk to frontier operations. Though improvements in seismic technology allow three-dimensional modeling of sub-seafloor geology, frontier areas inherently are characterized by greater risk (USGS 2011; National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling 2011). Geologic data in deepwater and ultra-deepwater frontiers in the GOM is growing, as is the industry’s understanding of the geological variability and risks, especially as operators continue to develop leases tied to these oil-rich areas.

Because of variations in shallow and deep geologic framework, exploration and drilling often encounter numerous challenges including shallow hazards, such as seafloor instability,

1 shallow water flow, permafrost, and gas hydrate, shallow gas and sour gas zones, as well as
2 relatively deeper hazards, such as salt, and tar zones (Close et al. 2008; Nuka and Pearson 2010;
3 Shaughnessy et al. 2007). In deepwater reservoirs in the GOM, narrow margins in pore pressure
4 and fracture gradient, over-pressurized and low pressure zones, and reservoir
5 compartmentalization (including low flow assurance) can represent key engineering challenges
6 (Cunha et al. 2009; IHS/GPT 2011). Such geological differences across the different regions
7 represent key concerns for the potential influence geology exerts on wellbore integrity, a key
8 element in drilling and developing wells.
9

10 Most of the larger reservoirs being targeted on the shallow GOM shelf produce natural
11 gas. There are comparatively fewer plays capable of very large oil discharges as compared to
12 deep water. In shallow water, the relatively lower formation pressure typically results in a higher
13 margin of safety, although encountering shallow gas represents a substantial hazard. The
14 pressure margin allows operators to change the weight of the drilling mud by several pounds per
15 gallon to balance formation pressures. In additional, a large number of shallow-water wells
16 actually require positive external stimulation to produce and facilitate flow of the product from
17 the drilling site.
18

19 In general, geologic pressure (pore pressure) and temperature increase with depth.
20 Offshore oil reservoirs can be highly pressurized and compressed under thousands of feet of
21 unconsolidated sediment, salt bodies, and sedimentary rock. The true vertical depth of some
22 reservoirs may exceed 9,144 m (30,000 ft). Deep wells are known to have pressure ratings
23 exceeding 20,000 pounds per square inch (psi) (USDOJ 2010; Midé 2010). As pressure and
24 pressure gradients increase, drilling operations become more challenging and necessitate careful
25 balancing of pressures to prevent either the collapse of the well (from excessive pore pressures)
26 or fracturing of the rock and loss of circulation (from excessive drilling pressure). Deeper
27 reservoirs also tend to feature larger volumes of oil. In the event of a well blowout, wells tapped
28 into larger reservoirs can potentially release more oil into the environment and at greater
29 discharge rates since flow rates depend in part on temperature and pressure. Uncontrolled flow
30 rate, or “open flow potential,” can be over 100,000 bbl per day.
31

32 **Water Depth: Rig and Well Complexity.** Water depth alone is not a strong predictor
33 of well control incidents, but it is related to the complexity of technology and operations
34 (Jablonowski 2007; Malloy, 2008; Cohen and Krupnick 2011). Exploration wells are most often
35 drilled in open water where no platform exists. Jackups, submersibles, semisubmersibles, and
36 drillships, collectively referred to as mobile offshore drilling units (MODUs), are commonplace
37 in exploration drilling, whereas modular rigs installed on platforms are more commonly used in
38 production wells. Drilling of a production well often involves interaction with a production
39 platform and the existing wells on the platform. Water depth not only drives the drilling
40 technology, but also influences well design and construction practices, as well as safety measures
41 used to mitigate risk of well control incidents. As oil prices remain relatively high, exploration
42 and production firms venture into deeper waters where larger reservoirs of oil are known to exist.
43 While contingent on a number of factors, deepwater and ultra-deepwater oil operations may have
44 higher safety incidence rates owing to rig complexity, although there have been and continue to
45 be a greater number of loss of well control events in shallow water (Shultz 1999;
46 Jablonowski 2007; Izon et al. 2007; Cohen and Krupnick 2011).

1 Although definitions of exact depth ranges vary, shallow water depths are generally
2 defined as less than 200 m (656 ft). Shallow water exploration and development rigs involve
3 comparatively simple well construction, allow direct access to well control prevention
4 mechanisms, are less susceptible to deepwater currents (although waves and strong coastal
5 currents are in play), and do not face complications with pressure and temperature variations
6 found with deepwater and ultra-deepwater wells. In addition, shallow water depths allow surface
7 blowout preventer (BOP) placement where preventative maintenance and service can be done
8 directly by rig operators. At the same time, GOM infrastructure in shallow water tends to be
9 older and may be more prone to mechanical failure. Depending on water depth, OCS
10 exploration wells in the Arctic may be drilled from an artificial island; large, usually bottom-
11 anchored drilling structures; or a drill ship.

12
13 The greater complexity of wells and specialized equipment used on deepwater and ultra-
14 deepwater rigs may present more opportunity for mechanical breakdown and accidents
15 (Jablonowski 2007). Well complexity increases the number of routine operations and incidence
16 of unusual operations, such as stuck pipe and complex casing and cementing programs
17 (Jablonowski 2007). Complexity also increases the number of individual tasks that need to be
18 performed on a well, complicating procedures and communication.

19
20 Deepwater depths are roughly defined as seabed depths that exceed 200 m (656 ft) but
21 are less than 1,500 m (4,921 ft). Because of the extreme depths of deepwater drilling, these
22 operators can no longer utilize traditional fixed platforms directly on the seabed, and different
23 technologies and procedures are required. Deepwater drilling rigs are multi-point moored to the
24 sea floor or, more recently, dynamically positioned. More complex operations such as mooring,
25 station keeping, riser management, and deepwater well control may complicate operations and
26 increase the number of procedures prone to errors and equipment prone to failure. The newest
27 platforms incorporate advanced technology, about which few data on long-term success or
28 incidents have been gathered (USDOJ 2011b). The technologically advanced BP Thunder Horse
29 platform, for instance, intended to be BP's largest producer in the GOM, flooded because of the
30 backward installation of a valve. Deepwater wells require subsea BOP placement at depths
31 unreachable for human service; ROVs become necessary. Maintenance, repair, and assurance of
32 proper functioning of such mechanisms are more difficult at greater depths.

33
34 Ultra-deepwater is a relatively new class of wells defined as exceeding wellhead depths
35 of 1,500 m (4,921 ft). Similar to deepwater platforms, ultra-deepwater rigs are floating semi-
36 submersibles and dynamic positioned drill ships. Ultra-deepwater wells require intricate and
37 complex platforms, structures, and equipment to operate. High hydrostatic pressures and low
38 ambient temperatures in such deep waters necessitate heavier and more specialized equipment.
39 The extended depth demands larger platforms and operating rigs to handle the added drilling
40 materials, as well as storage capacity.

41
42 **Well Design and Integrity.** Well construction is a process with numerous stages
43 preceding well abandonment or production. Construction of an offshore well involves different
44 types of setting agents, pipe, casing, cements, wellhead technology, rigs and platforms, drilling
45 muds (synthetic or water based), and cleaning/preparation agents. These differ by environment,

1 with deepwater wells requiring distinctly different construction and technologies to withstand
2 conditions at extreme hydrostatic pressures and lower temperatures.

3
4 Since the process of sub-seabed drilling cannot be directly observed, drilling operators in
5 an offshore environment are reliant on secondary indicators to ensure proper construction of the
6 well. Geophysical imaging, pressure readings, and reclaimed fluid testing are some of the
7 secondary indicators used in drilling at depth. Though these tests lend accuracy in mapping
8 pressure zones, impediments such as pockets of gas, shallow water flows, faults, salt deposits, or
9 rubble zones are not always forecast.

10
11 The primary function of a well system is to reliably contain, control, and transport
12 hydrocarbons to the surface. In general, risks are determined by well bore parameters and an
13 operator's familiarity with the well bore. Drilling engineers must constantly monitor pore
14 pressures, fracture gradients, fluid circulation, and abnormal pressure zones to avoid loss of well
15 control. When drilling into frontier or new reservoirs, limited knowledge of wellbore parameters
16 can increase risk of accidents. The number of barriers are often scaled with the likely
17 consequence of failure; multiple barriers are often used to achieve adequate reliability and avoid
18 leaks. Complex hole sizing, drilling string, wellhead technology, and mud programs, as well as
19 casing and cementing designs are required to reach target depths in deep water and ultra-deep
20 water. Mud, casing, and cementing programs must be designed, refined, and implemented as
21 well bore parameters and formation characteristics are being monitored.

22
23 Drilling mud/completion fluid pressure is the primary well control barrier for drilling and
24 well intervention operations (PCCI 1999). When this fluid hydrostatic pressure drops below that
25 of the formation, a kick occurs, which means that formation fluid enters the wellbore. Casing
26 and cementing programs, diverters, BOPs, and wellheads can provide backup (secondary or
27 redundant) barriers to prevent a blowout when a kick occurs. Casing and cement, as well as
28 drilling or completion fluids, are used to ensure the fluids in a formation do not enter the
29 wellbore during drilling and completion operations. For production operations, a packer/tubing
30 string and tree may provide the primary well control barrier. The production casing and
31 wellhead system provide a backup barrier in case of a packer or tubing string leak.

32
33 In 2008, BOEMRE published guidelines on the various steps towards managed pressure
34 drilling, a process that avoids the continuous flow of formation fluids, to facilitate better
35 planning of drilling operations (Eschenbach and Harper 2011). Further drilling safety
36 procedures and practice guidelines have been submitted by BOEMRE in recent years due to the
37 2010 DWH incident, including the new Drilling Safety Rule and SEMS rule. Under these and
38 other rules, drilling practices must properly address and manage known and possible risks with
39 adequate mitigation and safety technology (USDOJ 2010; USGS 2011).

40
41 Well integrity issues arise with the cement used in construction. Fluids used to clean and
42 prepare the well for cement are either water-, synthetic-, or oil-based, which can contaminate
43 cement. At sub-seabed depths of 5,486 m (18,000 ft) or more, heavy cleaning fluids run the risk
44 of not filling their intended purpose and contaminating subsequent cementing jobs. Cementing
45 problems were associated with 18 of 39 blowouts between 1972 and 1999 in the GOM
46 (Izon et al. 2007). However, the majority of these cement-related blowouts were of short

1 duration, primarily released natural gas, and involved shallow strings in a well-surface casing.
2 Mechanical indicators such as negative pressure testing and pressure and heat gauges to test
3 cement integrity have also come under scrutiny for lack of accuracy; the pressure gauges used
4 for negative pressure testing for Macondo were accurate to ± 400 psi, a rather imprecise measure
5 (OPG 2011). It is presumed both cementing issues and mechanical failure may have been a
6 factor in the Macondo well blowout (National Commission on the BP Deepwater Horizon Oil
7 Spill and Offshore Drilling 2011; JITF 2011).

8
9 When considering the risk of loss of well control, it is important to distinguish among the
10 different types of wells, including exploration, development, and production wells. Exploration
11 wells are drilled in open water from a mobile offshore drilling unit, whereas production and
12 development wells are often drilled under an existing platform. In general, exploration may
13 involve greater uncertainty due to the availability of geologic data, nature of drilling technology,
14 and unique barrier factors, such as BOP placement (Eschenbach and Harper 2011). From 1971
15 to 2010, there have been over a total of 41,781 wells drilled in the OCS. Of these, 26,245 were
16 development wells, 15,491 were exploration wells, and 43 were core tests or relief wells. The
17 overall OCS well control incident rate for drilling was 1 loss of well control incident per 292
18 wells drilled (1 per 201 for exploration wells, and 1 per 410 for development wells). These well
19 control incident rates include all well control incident rates related to drilling operations whether
20 or not a spill occurred. Despite the increased risk of drilling wells on undeveloped frontiers,
21 procedures followed in drilling exploratory wells may be more conservative (i.e., safer) to
22 account for this increased level of uncertainty (Eschenbach and Harper 2011).

23
24 In the GOM from 1980 through 2004, there was a relatively higher number of well
25 releases during development drilling and well workover operations as compared to exploration
26 drilling. This contrasts with worldwide trends where more well releases tend to occur during
27 exploratory drilling (Holand 2006). Holand (2006) attributes this to the fact that more
28 development wells are actually drilled. Hurricanes or ship collisions caused approximately 50%
29 of the production blowouts (Holand 2006). Simultaneous operations of drilling and production
30 also increase the risk of incidents when drilling production wells. Another root cause of
31 sustained blowouts during completion and workover is the positive potential for pressurized
32 hydrocarbons and limited bridging tendency with flow through perforations or gravel pack
33 (Flak 1997).

34
35 In general, the riskier wells include wildcat wells (first well into formation), offset wells
36 (wells drilled near another well that encountered drilling trouble zones or past well control
37 problems), and extended or ultra-deep drilling (SPE Advisory Summit 2011). Deepwater and
38 ultra-deepwater wells require complex infrastructure, planning, and execution to construct;
39 therefore, facilities and volume of production tend to get larger with distance from shore and
40 water depth (Shultz 1999). The complex nature of the formations, combined with the drilling
41 depths in high-pressure/high-temperature conditions required to reach the target zones, presents a
42 challenge to drilling engineers (Close et al. 2008). This challenge is highlighted in the greater
43 number of casing strings required to drill to target depth, which in turn creates the challenge in
44 achieving good cement isolation in a tight tolerance annuli (Close et al. 2008; Chatar et al. 2010).
45 Despite such challenges, over 2,300 deepwater development wellbores and approximately
46 2,600 deepwater exploration wellbores have been drilled. Of these, the Macondo well is the only

1 exploration well to involve a blowout and large oil spill. No spills have occurred for deepwater
2 development wells.

3
4 **Loss Well of Control Prevention and Intervention.** A blowout occurs when there is
5 failure to control a kick and regain pressure control, and can be defined as an uncontrolled flow
6 of formation fluids. Oskarsen (2004) classifies offshore operations blowouts in three groups:

- 7
8 • Surface blowouts characterized by fluid flow from a permeable formation to
9 the rig floor;
- 10
11 • Subsurface blowouts characterized by fluid flow at the well at the mudline,
12 where the exit conditions are controlled by the seawater; and
- 13
14 • Underground blowouts characterized by fluid flow from one formation zone
15 to another, typically by using the wellbore as a flow path.

16
17 Potential scenarios for each blowout type are described in Oskarsen (2004). Blowout
18 rates by different phases of exploration and production operations and relative water depths are
19 available in Holand (2006). Although high hydrostatic pressures at depth will aid in choking any
20 flow from potential blowout points (PCCI 1999), two independent barriers are typically used for
21 well control. The primary barrier is usually the hydrostatic pressure exerted by the well
22 mud/synthetic fluid column (either static or dynamic). The secondary barriers typically include
23 the pressure control equipment such as the BOP, the diverter system, the wellhead (innermost
24 casing hanger seal), and the choke/kill line valves. These barriers are routinely used during
25 drilling, completion and workover operations. If the well is flowing (i.e., producing oil and/or
26 gas), the primary barrier is that closest to the reservoir (PCCI 1999).

27
28 Individual BOP systems are used during drilling operations to prevent unrestrained
29 release of crude oil from reservoirs. BOPs are composed of all systems required to operate them,
30 including flexible joint, annular preventer, ram preventer, connector, choke and kill lines, choke
31 manifold and auxiliary equipment (USDOJ 1996). The specific type of BOP may influence the
32 loss of well control and well releases. For example, fault tree analysis in the DNV Beaufort Sea
33 Study showed that there is substantial risk reduction with BOPs having two sets of blind shear
34 rams spaced at least 1.2 m (4 ft) apart. The study concluded that the reliability of a two blind
35 shear system is 99.32%, compared to 99% for a single blind shear ram (Midé, 2010). Despite the
36 seemingly low percentage, an increase of 0.32% in BOP reliability raises the estimated number
37 of wells that can be drilled before an uncontrolled blowout to 6,213 from 4,225 (Midé 2010).

38
39 In shallow-water wells, BOPs are placed above the sea on the rig, allowing for periodic
40 repair and maintenance. The operations of surface BOPs are not subject to all of the
41 complicating factors associated with subsea BOPs, and they are more accessible for repair and
42 intervention. However, surface BOPs that are placed on floating facilities (as opposed to jack-up
43 rigs) present other significant risks. The high-pressure riser and casing from the seafloor to the
44 rig can be exposed to dynamic stresses. A failure of a high-pressure riser due to these stresses
45 can lead to uncontrolled flow below the surface BOP system located on the floating facility.
46 Well operations from a floating platform with a surface BOP stack and a high-pressure riser

1 (through the water column) are higher risk operations than drilling from a jack-up rig or a fixed
2 platform. The single high-pressure riser (or in some cases, a dual riser system) used by floating
3 platforms is subject to environmental forces such as current induced vibration that make it more
4 susceptible to stress fatigue. Jack-up rigs and fixed production platforms have more casing
5 strings tied back to the surface of the rig or platform, which provide additional external support
6 for the pressured casing. In addition, because these tied-back casing strings are used in
7 shallower water operations with a shorter water column, they are less exposed to current-induced
8 stress.

9
10 Deepwater and ultra-deepwater wells have subsea BOPs that are affixed directly to the
11 well on the seafloor. Deepwater and ultra-deepwater seafloor depths exceed depths at which
12 human operators can work, thus requiring submersibles and emergency backup control systems.
13 These systems can demonstrate failures. For example, the main control system of BOPs has a
14 failure rate of approximately 50% at depths of 800–1,200 m (2,625–3,937 ft), and approximately
15 7% at depths of 1,200–2,100 m (3,937–6,890 ft) (Midé 2010). Midé (2010) suggested that this is
16 because less variability exists in relatively calmer waters at deepest depths (e.g., currents and
17 marine life do not affect machinery as much in deep water). Important technology includes the
18 acoustic backup system, which communicates with the BOP system in the event of electrical and
19 hydraulic connection loss with the wellhead. DNV (2010) reported a 25% reliability of current
20 acoustic backup systems. ROV activation of the BOP using the secondary control system has a
21 75% success rate.

22
23 Overall, more research and development is necessary to increase the success rates of
24 control systems in order to reduce the risk of deepwater drilling operations. Evidence for the
25 containment response to the DWH incident, as well as a review of industrial and governmental
26 containment response, suggests that mitigation technology has not kept pace with extraction
27 technology that enabled industry to drill in increasingly deeper waters (IPIECA 2008;
28 Cohen et al. 2010). However, industry and regulatory enhancements are under development to
29 address control systems (USDOJ 2010; DNV 2010).

30
31 **Scale and Expansion.** Scale and expansion of OCS operations increases the complexity
32 of drilling and production operations. Factors associated with scale include the number of wells,
33 new types of production facilities, new methods of transporting oil, higher levels of production,
34 the addition of simultaneous operations during production, and higher rates of pumping.
35 Expansions in scale of oil production require more well and platform construction, along with
36 higher production volumes. New technologies necessitated by an increased scale of operations
37 may be associated with higher levels of risk, especially when technologies are not fully
38 developed. The number of incidents reported increases with more complex operations, in
39 particular with deepwater operations which, by their very nature, often entail greater scale,
40 expansion, and complexity (Cohen and Krupnick 2011). Large-scale oil production involves the
41 use of subsea well complexes and large central processing and storage facilities, about which
42 little data on long-term success and incidents have been gathered. The OCS operations in the
43 GOM are moving farther offshore and incorporate more complex drilling and production
44 operations. For example, the Shell Perdido Project is simultaneously connected to 22 different
45 wellhead sites (Shell 2011b). A production facility of this scale, in addition to being in ultra-
46 deep water, typifies the trend in scale and expansion (Shell 2011a).

1
2 More complex facilities and operations require equally complex management structures.
3 Operations of greater scale entail a complex set of relations between different operators,
4 contractors, and management groups. While the probability of release on more complex
5 facilities has not been actively studied, it is noted that the Macondo well suffered from
6 insufficient correction of known concerns prior to blowout because of management and
7 communication issues between operators and contractors (National Academy of Sciences 2010;
8 JITF 2011).

9
10 **Human Error.** Human error, or combinations of human and mechanical failure, are the
11 root cause of many OCS accidents and spills (Jablonowski 2007; Muehlenbachs et al. 2010).
12 Low-probability, high-impact failures such as the Macondo well blowout indicated more
13 stringent requirements were necessary (Winter 2010; DOI 2010). In the case of the Macondo
14 well, operators misread pressure readings, authorized high-risk activities, disregarded warning
15 signs, and overlooked the checks and balances that exist in regulatory assignments, while
16 mechanical BOP failure compounded the severity of the release (Winter 2010; National Oil Spill
17 Commission 2011). The new SEMS rule recognizes this gap and establishes a mandatory
18 program to ensure OCS operators identify, address, and manage safety and environmental
19 hazards and impacts during design, construction, start-up, operation, inspection, and maintenance
20 activities. This systemic approach to managing risk and ensuring safety and environmental
21 protection should provide more focus on the risk of system failures as well as on the human
22 factors that could contribute to an incident (SPE Advisory Summit 2011).

23
24 Level of training and safety culture are important factors in determining the number of
25 safety and well control incidents (Jablonowski 2007; Vinnem et al. 2010). A well-trained crew
26 that has participated in numerous practice exercises will decrease the probability of a spill caused
27 by human error. Lack of proper training has been a significant issue in the last decade, probably
28 because of a lack of incidents (Etkin 2011). Previously, standard industry practice often
29 permitted operation of technical equipment with on-the-job training or one-week training
30 courses. The MMS published final regulations for Well Control and Production Safety Training
31 (30 CFR 250, Subpart O) in 1997 (amended on August 14, 2000). Recently, the advent of new
32 regulations (the SEMS rule) and requirements for personnel on platforms and working on
33 drilling operations aims to eliminate the current gaps in industry-required trainings. Individuals
34 working in specific technical jobs are now required to attend annual training and certification,
35 and operators are required to perform job safety and hazards analyses (DOI 2010;
36 BOEMRE 2010; OGP 2011). Other factors such as climate and temperature could affect worker
37 performance. For instance, colder temperatures in the Arctic lead to higher probabilities of
38 human error due to the extreme working conditions (Eschenbach and Harper 2011).

39
40
41 **4.3.4.2.2 Containment and Response.** The effectiveness of containment and spill
42 response dictates the amount of oil released in the environment. Area and operation-specific oil
43 spill contingency plans, as well as actual containment and response efforts, will be designed
44 around many of factors that contribute to the risk of spill occurrence and fate of oil in the water.
45 Assuming the correct containment plan is in place, the risk of poor planning and containment
46 execution still exists (USCG 2011).

1 If the BOP fails, other options are available to control the blowout, including
2 capping/shut-in, capping/diverting, surface stinger, vertical intervention, offset kill, and relief
3 wells (Neal Adams Firefighters, Inc. 1991). Of these methods, a relief well is often considered
4 most important, and may be required immediately (even if it is not the first choice), since it is
5 typically considered the principal solution for well control. The amount of time required to drill
6 a relief well may depend upon the complexity of the intervention (e.g., depth of formation), the
7 location of a suitable rig, the operations that may be required to release the rig, and any problems
8 mobilizing personnel/equipment.
9

10 Once the oil has reached the sea's surface, the first few hours of a spill are the most
11 critical for response efforts. Boomers and skimmers should be deployed immediately to contain
12 the oil and *in situ* burning and dispersant use should be evaluated to supplement mechanical
13 collection methods. Since *in situ* burning and dispersant use are time sensitive, responders
14 should ensure the necessary supplies for either method (e.g., flame-resistant booms) are
15 available.
16

17 If a spill cannot be contained at the site's wellhead (subsea), a response effort may be
18 required to restrict the surface spreading of oil in the water, especially from the shore. The
19 following sections outline the methods of containment, as well as the risks and considerations
20 unique to each.
21

22 **Water Depth, Distance from Shore, and Other Variables.** As shown by the DWH
23 event, the loss of well control in deeper depths presents containment obstacles and challenges
24 that would not necessarily be encountered during a loss of well control in shallow waters.
25 Although many of the same techniques used in shallow water were used to attempt to control the
26 Macondo well, the well control efforts were hindered by water depth, which required reliance
27 solely upon the use of ROVs for all well intervention efforts. This is a concern in deep water
28 because the inability to quickly regain control of a well increases the size of a spill, as occurred
29 during the DWH event. Other complications associated with responding to a deepwater blowout
30 include inaccessibility of the well, methane hydrate formation at lower seafloor water
31 temperatures, and the need to work with larger and less-available support equipment due to the
32 greater water pressure. The inverse relationship holds true for emergency response to spills. The
33 closer the well is to shore, the quicker the potential response.
34

35 Distance from shore, coupled with response measures, fundamentally drive the size of the
36 impacted area. Oil-spill contact potential, the likelihood of released oils contaminating areas or
37 materials of interest (e.g., beaches, wildlife, sensitive environments), decreases with greater
38 distance from shoreline (IPIECA 2008; JITF 2010). As physical distance from sensitive areas
39 and shores increases, sea waters, currents, waves, and other biological processes are able to
40 dilute and digest more of the spilled oil. Volume alone does not determine the impact of the
41 releases. Releases close to shore may have greater effects, especially when concentrated into
42 inlets or smaller areas (IPIECA 2008).
43

44 In some respects, offshore spill events in the Arctic and sub-Arctic may offer a few
45 advantages to responders. Ice can serve as a natural oil boom and dampen surface waves, while
46 cold weather slows the rate of oil evaporation – making it easier to burn. Shore ice may also

1 provide a physical barrier, limiting shore contact to oil. However, spill removal companies have
2 testified that icy waters actually make traditional techniques (booming and skimming)
3 significantly less effective (CRRC 2009). A spill during the fall freeze-up would be the most
4 dangerous time for a spill, and even chemical response methods would be limited (Nuka and
5 Pearson 2011). The Arctic is sparsely populated and infrastructure is not abundant. Thus, the
6 ability to appropriately respond to incidents remains a concern (USGS 2011). Ice-free seasons
7 are relatively short (around three months a year), and ice state may influence the ability to drill a
8 relief well. The relatively shallow Arctic depths could result in more contact potential in the
9 event of a catastrophic spill. Should spilled oil persist in the water column, there is concern that
10 suspended oil could become trapped in ice.

11
12 **Status of Technology to Physically Contain.** OCS operators are now required to submit
13 documentation that they are able to deploy adequate containment resources to respond to a
14 blowout or other loss of well control. In general, subsea containment at the wellhead is ideal and
15 most effective because it contains the oil at the source. Perhaps the most significant hurdle to the
16 development of containment at the blowout point (subsea) has been cost (BOEMRE 2010;
17 PCCI 1999). Given the low historical probability of a significant blowout occurrence and
18 limited use of subsea containment equipment, industry development of cost-effective equipment
19 has not historically occurred, although that has changed in response to new regulatory
20 requirements.

21
22 As mentioned, containing oil at the wellhead is the ultimate goal in the event of a
23 blowout. However, subsea collector technologies have historically presented some operational
24 challenges given design and installation difficulties (PCCI 1999). For subsea oil containment,
25 the technical hurdles to be overcome during a deepwater blowout include the behavior of
26 deepwater currents; the ability to manipulate heavy objects on the seabed; the ability to design
27 subsea collectors that are flexible enough to cap a large range of subsea wellhead assemblies and
28 accommodate a high volume of recovered oil, gas, and water; the ability to approach the blowing
29 well and install containment devices on the seafloor; and the lack of standardization in subsea
30 wellhead design.

31
32 ROVs capable of manipulating heavy objects, especially collector technologies, near the
33 seafloor and in turbulent conditions caused by the blowout, are limited. In fact, even relatively
34 minor blowout plumes have rendered many ROVs useless. Aside from the risk of physical
35 damage from plumes, the following risk factors exist related to ROV use:

- 36
37 • Sufficient surface support or subsea lifting devices such as syntactic foam
38 buoys are required to assist the ROV with heavy object lifting;
- 39
40 • Subsea currents can complicate ROV use; and
- 41
42 • Navigation systems and/or sensors can be damaged from the blowout plume.

43
44 In comparison, subsea containment in shallow water is less complicated; for example, it
45 is easier to mobilize equipment and avoid hydrate formation at the relatively warmer seafloor
46 temperatures.

1 The DWH event and implementation of NTL No. 2010-N10, however, has created new
2 impetus for industry-driven containment technology. For example, Marine Well Containment
3 Company (MWCC) – a partnership between ExxonMobil, Chevron, ConocoPhillips, and Shell –
4 has announced the release of its seabed containment system (Helman 2011). According to the
5 company, the unit features the ability to do the following:

- 6
- 7 • Contain 60,000 bbl per day of liquid and 120 million standard ft³ of gas;
- 8
- 9 • Inject dispersants; and
- 10
- 11 • Be placed in water up to 3,048 m (10,000 ft) deep.
- 12

13 This system is intended to address the weakness of the BP containment dome that caused
14 its failure during the DWH event (Helman 2011). The system can inject antifreeze-like
15 chemicals to inhibit natural gas hydrate build-up, which created spill containment complications
16 during the DWH event. Of course, whether Marine Well Containment Company's system will
17 work as effectively as it claims will not be known until another blowout event occurs.

18

19 Another option for source control and containment is through the use of the equipment
20 stockpiled by Helix Energy Solutions Group, Inc. The Helix initiative involves more than
21 20 smaller energy companies and supplements the MWCC response effort. Helix has maintained
22 the equipment it found useful in the DWH event response and is offering it to oil and gas
23 producers for use. Together, the ships and related equipment can accommodate up to 55,000 bbl
24 of oil/day, 70,000 bbl of liquid natural gas, and 95 MMcf of natural gas at depths up to 2,438 m
25 (8,000 ft).

26

27 Shell is developing equivalent shallow-water containment technology for use in the
28 Arctic. The company is under increasing scrutiny from industry stakeholders to ensure that an
29 event similar to the one that happened in the GOM will not occur in the Arctic. Shell has pre-
30 staged response equipment and vehicles designed for Arctic conditions that can be activated
31 immediately (Dyer 2011). For example, in the 2011 Revised Outer Continental Shelf Lease
32 Exploration Plan, Shell's spill response plan includes oil spill response (OSR) vessels with an
33 ice-capable Oil Spill Response Barge (OSRB) and associated tug (Point Oliktok tug and
34 Endeavor barge), a tank vessel for storage of any recovered liquids (Mikhail Ulyanov), and
35 associated smaller workboats. In addition, Shell's plan includes two vessel of opportunity
36 skimming systems (VOSSs) to assist with containment and recovery, along with an arctic oil
37 storage tanker to provide storage of recovered oil (BOEMRE 2011). Shell has committed to
38 having a pre-fabricated subsea collection system with surface capability to capture and dispose
39 of oil, and has indicated that this system is in final design.

40

41 Aside from subsea containment, subsea dispersant injection into the well or blowout jet
42 zone is considered to be one of the most promising measures to contain the *effects* of the oil spill.
43 Design concepts to date require advanced planning to incorporate the appropriate equipment for
44 dispersant injection into the drilling infrastructure/equipment (e.g., subsea stack or BOP). The
45 industry is now focused on wellhead-independent injection systems; this method involves
46 applying dispersants into the blowout plume. As noted above, MWCC's system includes a

1 subsea injection capability. However, the environmental tradeoffs of subsea dispersant use
2 (similar to surface dispersant use, discussed in the following section) continue to be debated and
3 have been poorly documented based on limited prior application (USEPA 2011b).
4

5 **Mechanical Recovery Methods.** Mechanical recovery methods include the use of
6 booms, barriers, and skimmers, as well as natural and synthetic sorbent materials (NRC 2003).
7 Of all response efforts, mechanical methods exhibit the least impact on the environment and are
8 considered to be the first line of defense against surface oil spread (USEPA 2011d).
9

10 Booming and skimming are the two most widely used mechanical containment methods.
11 The effectiveness of these two measures will depend on the volume of the oil spill, location of
12 the well, and sea conditions. For example, at remote open-sea well locations, the immediate
13 availability of sufficient oil storage and/or oil-water separators may be limited (BOEMRE 2010;
14 PCCI 1999). Booms and skimmers become less effective in higher wave swells and wind, and in
15 fast currents. Three main types of skimmers exist, each with characteristics that may make them
16 more effective given certain ocean and spill conditions. Weir and suction skimmers operate best
17 on smooth water with little debris; oleophilic skimmers are the most flexible, can be used on
18 spills of any thickness, and may work most effectively on water that has rough ice debris (e.g., in
19 Alaska) (USEPA 2011e). Although oil recovery efforts must withstand the harsher climate
20 conditions of the Arctic, a research program conducted by SINTEF in 2010 concluded that the
21 mechanical recovery of oil spills is possible despite difficulties associated with maneuvering
22 skimmers through ice (Sorstrom et al. 2010). In any environment, collection rates of 20% are
23 considered exceptional in most cases (USEPA 2011e). In the case of the DWH event, skimmers
24 only accounted for the removal of 3 or 4% of the released oil because of relatively low efficiency
25 (USCG 2011).
26

27 The DWH event tested new, “enhanced” booms and skimmers, which may help expand
28 the range and efficiency of recovery in open water and near shore. Advances have been made to
29 create booms that can withstand rough sea conditions and more viscous oil, including in cold-
30 water conditions offshore Norway (McKay 2011). As a result, the effectiveness of recovery both
31 on open water and near shore can be expected to increase, especially given the attention of the
32 USCG to this matter (USCG 2011).
33

34 Sorbent materials capture oil through absorption or adsorption and are often used to
35 supplement booming and skimming. Lighter oil products (e.g., gasoline, diesel fuel, benzene)
36 are absorbed more easily, while thicker oil responds better to adsorption (USEPA 2011f). While
37 generally effective, the use of sorbents is less practical with extremely large spills or in windy
38 conditions.
39

40 **Chemical and Biological Methods.** Surface dispersants (chemical-based) can be
41 applied via boats, aircraft, or helicopters. A two- to three-day window following an event
42 generally exists to use dispersants (BOEMRE 2010); therefore, pre-approval of dispersal as a
43 contingency method and of specific dispersant use is essential (NRC 2006). Since the toxicity of
44 dispersants is an important consideration (IPIECA 2008; NRC 2005), mechanical containment
45 methods are the preferred initial response. Very large spills may require immediate application
46 of dispersants.

1 The effectiveness of dispersants (compared to booming and skimming methods) is more
2 dependent on sea conditions. Studies indicate that dispersants are most effective at salinities
3 close to that of normal seawater (NRC 2005). In addition, dispersants work best in warmer water
4 (USEPA 2011b).

5
6 Gelling agents react with oil to form rubber-like solids that can then be removed from the
7 water via nets or skimmers. Gelling agents can be most effective for small to moderate spills in
8 moderately rough seas. The volume of gelling agent required can be as much as three times that
9 of the oil spill; therefore, for larger spills, it is impractical to use this method. Moderately rough
10 seas provide increased mixing effect of the agents with the oil, resulting in greater solidification
11 (USEPA 2011c).

12
13 The use of biological agents (i.e., bioremediation) for oil spill response is an emerging
14 area of research. Bioremediation is the act of adding materials (e.g., microorganisms) to the
15 environment to increase the rate of natural biodegradation. Currently, two technologies –
16 fertilization and seeding – are being used in the United States for oil spill remediation
17 (USEPA 2011a). Unlike the other methods covered in this section, bioremediation is a longer-
18 term response effort.

19
20 ***In Situ* Burning.** Burning is an effective method to remove much of the oil once it has
21 reached the water's surface and reduces the need for storage of recovered oil. Weathering
22 properties of the oil will affect whether or not surface burning is a viable option. For burning to
23 work effectively, oil thickness must be at least 1 to 2 mm and water-in-oil emulsion must be 50%
24 or less (NOAA 1997).

25
26 The weathering properties of oil in icy waters are also important for recovery efforts.
27 Studies have shown that, in general, oil in icy waters weathers at a slower rate than in open
28 waters. The slower weathering process of oil in the Arctic Ocean increases the opportunity of
29 successful *in situ* burning, which efficiently reduces free floating oil and oil collected in booms
30 (Sorstrom et al. 2010). *In situ* burning has been successful in cases where oil was trapped in ice
31 (Nuka and Pearson 2010; S.L. Ross Environmental 2010).

32
33 A factor that could limit the application of *in situ* burning is the impact on human health
34 due to gas and particulate release from oil burning. Studies estimate that 5 to 15% of the oil is
35 converted to particulates (mostly soot) but that public exposure is not expected unless the smoke
36 plume sinks to ground level. However, *in situ* burning raises general concerns over air quality
37 impacts (NOAA 1997).

38 39 40 **4.3.4.2.3 Fate.**

41
42 **Oil Type.** Various oil types have varying characteristics, including pour point, viscosity,
43 weight, and composition. In general, lighter oils tend to be less viscous and can be byproducts of
44 crude oils such as diesel and gasoline. Lighter oils tend to be less toxic, although some from the
45 GOM tend to have higher concentrations of toxic compounds (Etkin 2011). Heavier oils tend to

1 resist weathering and dispersant application, and then may persist in the water column for long
2 periods of time (USGS 2011; USDOJ 2010; Etkin 2011).

3
4 **Evaporation.** Evaporation occurs when oil comes in contact with air on the surface of
5 the water. Evaporation rates are a function of numerous dynamics including oil viscosity,
6 ambient temperature, sunlight exposure, and oil type (IPIECA 2008). In general, lighter oils
7 such as diesel or gasoline will dissipate quickly or evaporate from the water, although
8 evaporation is slower in colder temperatures. More viscous or heavy forms of oil will tend to
9 persist longer and resist evaporation (USDOJ 2011b). Compared to other oil-producing regions,
10 a greater portion of oils extracted from the GOM tend to be lighter crude oils. Because such oils
11 persist for a shorter period of time, they may cause less long-term damage and lower cleanup
12 costs. The viscosity of Arctic oils varies, but due to colder surface temperatures and a generally
13 cooler average climate, these oils are thought to evaporate more slowly, become trapped in ice,
14 or become viscous and suspended in the water column (USGS 2011; USDOJ 2011b).

15
16 **Weathering.** Weathering of oil in the sea results from a number of factors, including
17 exposure to atmosphere, currents, biological organisms, and tidal patterns. In general, lighter
18 oils such as diesel and gasoline weather quickly (Dickins 2011; IPIECA 2008; Etkin 2011).
19 Higher ambient temperatures also accelerate weathering. The warm waters of the GOM are
20 thought to help oil to dissipate, although this may not be the case for all oils, especially those
21 generated in deepwater environments where ambient temperatures can be lower (USDOJ 2010;
22 IPIECA 2008; Etkin 2011). In cases where releases become suspended in the water column,
23 long-term persistence may occur and potentially threaten marine life and economic activity tied
24 to the marine environment.

25
26 The weathering characteristics of spilled oil influence the range of drift and spreading
27 considered within spill trajectory assessments and dictate the effectiveness of chemical
28 dispersants, *in situ* burning, or mechanical responses. Conditions in the Arctic may lead to
29 longer term oil persistence. Denser, more viscous oils in colder temperatures weather at very
30 slow rates, potentially persisting on rocks for years (USGS 2011). Cold water also increases the
31 probability that oil from a spill will solidify in the water, persisting indefinitely and rendering
32 cleanup more difficult. However, weathering in the Arctic will be contingent on the season and
33 weather (Dickins 2011). If oil is exposed to more air and sunlight, evaporation and dispersion
34 due to weathering may also accelerate. Due to the variability in seasons (and in particular the ice
35 pack), it is important to consider the timing of the release in the Arctic to evaluate the potential
36 for long-term damage to the surrounding marine and coastal environments.

37
38 **Transport.** The transport and behavior of oil and gas released into oceans varies greatly
39 depending on the conditions of the area. The magnitude and spread of transport may depend on
40 water depth, ocean currents, meteorological events, and geographic specific factors including the
41 prevalence of ice. Fluids released into deep water, for instance, are subject to high hydrostatic
42 pressure and low ambient temperature, increasing the oil's persistence and its potential to
43 transport to coastlines. A shallow water release from a high-pressure formation with a high
44 velocity may result in a turbulent mixing of the gas, oil, and water, with the mixture quickly
45 transported to the surface by the expanding gas under decreasing hydrostatic pressure (PCCI
46 1999). Research as part of the DeepSpill Joint Industry Project indicates that above the point of

1 separation, gas bubbles and large oil droplets rise toward the surface while smaller, dispersed oil
2 droplets may be entrained in deepwater currents at the terminus of the jet phase (Johansen et al.
3 2001; S.L. Ross Environmental 1997). Deepwater spills increase the potential for oil remaining
4 trapped throughout the water column, and this increases the risk of oil transport to other regions
5 and water bodies, although the oil is expected to be highly dispersed.
6

7 Meteorological events specific to the GOM may potentially transport spilled oil to
8 shallow and coastal areas, increasing the risk of catastrophic consequences. Major
9 meteorological events specific to the GOM are cold fronts and hurricanes. The wind force and
10 magnitude of the storms in the area have the potential to expand the affected area of an oil spill.
11 Typically occurring between June 1 and November 30, hurricanes also have the potential to
12 destroy production facilities and precipitate releases. Data on platform spills also show that oil
13 spills that result from hurricane damage in the GOM have been larger in volume, accounting for
14 approximately 43% of large (>1,000 bbl) spills (Eschenbach and Harper 2011). During
15 hurricane passages in the GOM, production is shut-in and facilities are evacuated. This reduces
16 the probability of a very large release of oil from facilities.
17

18 Another major cause of physical transport that is specific to the GOM is the Loop
19 Current, a warm ocean current that wraps around the western coast of Cuba and the panhandle of
20 Florida. The current dominates upper ocean circulation in the eastern and central GOM, and
21 transports approximately 30 million m³ of water per second, with a variance of about 10%.
22 Speeds may exceed 150 cm/s at the surface with velocities as high as 5 cm/s at 1,000-m
23 (3,280-ft) depths. In both shallow and deep water, currents are dominated by cyclonic and
24 anticyclonic eddies that vary in magnitude and frequency, which increases the uncertainty
25 associated with effects on drilling operations (Donohue et al. 2006). The these characteristics
26 exhibited by the GOM Loop Current impose uncertainties during drilling operations and in the
27 event of an oil release. The vast amount of water transported throughout the GOM by the Loop
28 Current highlights the potential for the current and its associated eddies to transport oil from a
29 spill to the shelf and coastal areas, as well as water bodies outside of the GOM (USDOJ 2007).
30 Due to the proximity of the current to the shelf and sensitive coastal areas, there is concern
31 regarding the rapid transport of oil in the event of a release. In many cases, the frontal boundary
32 at the edge of the Loop Current may limit the extent of transport. In addition, highly persistent
33 oil, especially in deepwater locations, may remain in the ocean for an indefinite period of time,
34 increasing the potential for the Loop Current to carry oil to sensitive coastal areas
35 (USDOJ 2007).
36

37 In the Arctic Ocean, an important transport vehicle and barrier is ice. Offshore of the
38 shore-fast zone, the motion of the ice will be expected to transport the oil that is associated with
39 the ice. Field tests conducted by SINTEF Materials and Chemistry demonstrated that ice can
40 help contain a spill, and act as a natural barrier to the spread of oil (Brandvik et al. 2010).
41 Studies have shown that when ice coverage exceeds 10–20%, the higher ice coverage can trap
42 spilled oil within newly formed ice (Sorstrom et al. 2010). Oil trapped in ice naturally prevents
43 the spilled oil from affecting sensitive habitats and coastal areas, and prevents it from dispersing
44 and spreading to other bodies of water. Physically removing ice that encases spilled oil is a
45 potential solution in extreme cold temperatures. During the winter of 1998, 90% of the oil
46 spilled in the St. Lawrence River was recovered by removing 1,369 tons of ice (recovering

1 10 tons of oil) (S.L. Ross Environmental 2010). Ocean currents in the Arctic are influenced by
2 cyclonic and anticyclonic eddies pushing released oil in numerous directions.
3
4

5 **4.3.4.3 Regional Risk Profiles**

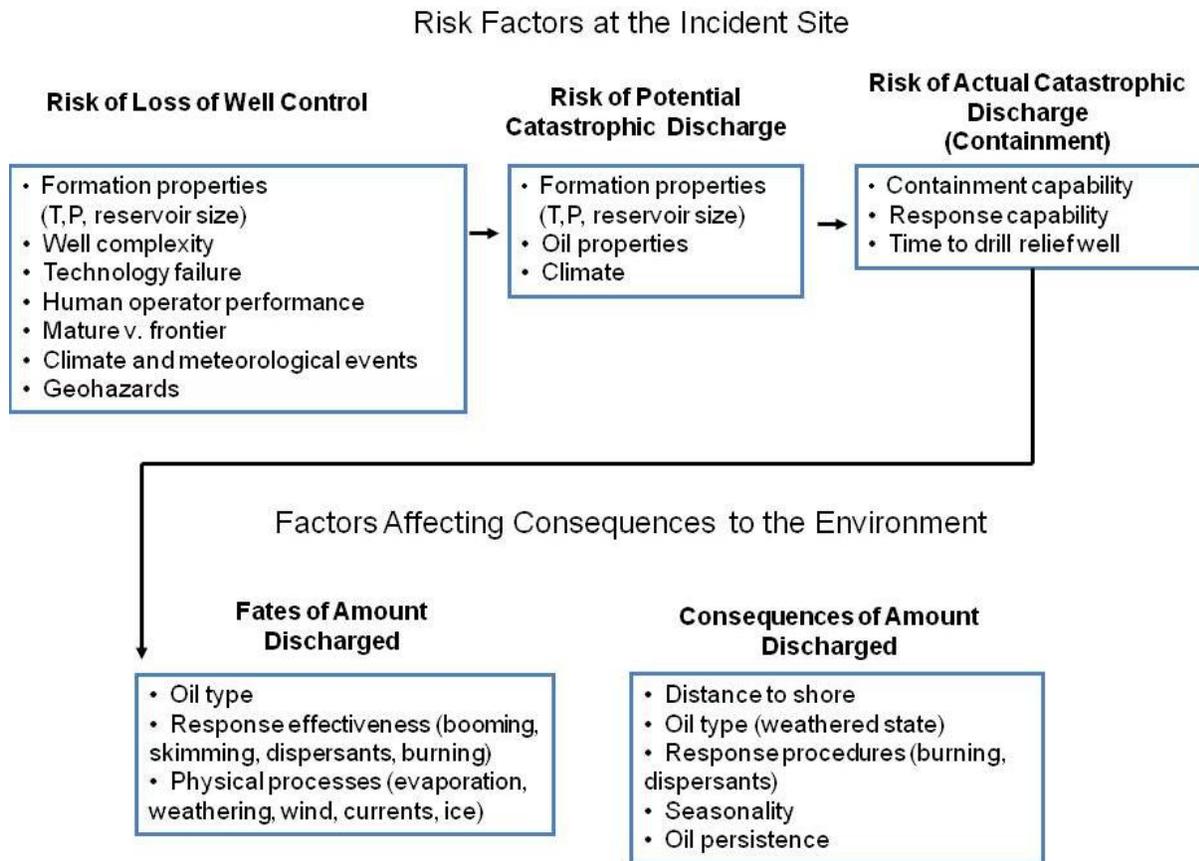
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7 The previous discussion of risk factors has been used to develop generalized regional risk
8 profiles for the areas under consideration for the Program. Figure 4.3.4-1 presents a conceptual
9 framework for considering the sequence of events, circumstances, and factors that define a low-
10 probability discharge event and contribute to the even lower potential for catastrophic
11 consequences. The catastrophic discharge event sequence is divided into two principal phases:
12 risk of occurrence and containment, and risk of fate and consequence. This framework
13 conservatively assumes that a relief well is needed to kill a wild well following a loss of well
14 control incident.
15

16 The top part of Figure 4.3.4-1 shows risk factors related to the occurrence of a well
17 incident and the ability to contain and recover oil discharge at the well site up to the time needed
18 to drill a relief well. The ability to mitigate these risks factors directly reduces the duration and
19 volume of the oil spill and likelihood that the spill will be a catastrophic event. Reducing the
20 risk of well control incidents, particularly for frontier exploration wells with the potential to
21 release catastrophic discharge volumes, is of primary importance to avoid any risk of oil in the
22 environment. As detailed in Section 4.3.4.3.4, BOEM implemented substantive regulatory
23 improvements following the DWH event to identify and mitigate risk factors that contribute to
24 well integrity and operational safety incidents.
25

26 If well barriers and intervention fails, containment and response at the well site becomes
27 the next critical line of defense to minimize the volume of oil being released into the ocean.
28 Mitigating the factors that constrain the ability to contain oil at the well site minimizes the degree
29 and duration of exposure that may otherwise occur prior to a relief well being completed weeks
30 to months later (or potentially longer in the Arctic depending on location and ice conditions).
31 New seabed containment systems developed for the GOM have the potential to contain
32 60,000 bbl of oil per day. This system, if as effective as stated, could contain over 5,000,000 bbl
33 of oil during a 90-day discharge period and significantly reduce the nature of exposure.
34 Equivalent systems and/or capabilities are being developed to enhance containment in the Arctic.
35 As detailed in the subsequent discussion in Section 4.3.4.3.4, BOEM has implemented
36 substantive regulatory improvements following the DWH event to ensure industry has
37 appropriate containment capability.
38

39 The lower part of Figure 4.3.4-1 shows factors that affect the fate and, in part, drive the
40 consequences of oil released into and transported through the larger environment. These factors
41 are not absolute risk factors, *per se*, because they do not operate in one direction, either
42 increasing or decreasing risk, across all ecological and human use resources. Usually response
43 actions taken to manage the fates or consequences of a spill involve considerations of tradeoffs
44 among potential impacts. For example, dispersants may be applied to protect coastal habitats
45 and resources from contact with a heavy, surface oil slick, but at the risk of exposing resources
46 occupying the marine water column to the effects of dispersants and dispersed oil. Physical



1

2 **FIGURE 4.3.4-1 Factors Affecting a Catastrophic Discharge Event**

3

4

5 processes such as the Loop Current in the GOM could transport dispersed oil across large areas
 6 within and outside the GOM, but whether or not this effect is considered a risk factor depends on
 7 whether the ecological or human use concerns focus on the effects of a widespread but dilute oil
 8 presence or on the effects of higher oil concentrations on critical resources within a more
 9 localized area. Even distance to shore does not operate unambiguously as a risk factor since
 10 drilling in deeper waters located farther offshore could increase drilling risk and potential
 11 impacts to pelagic marine resources, but at the same time reduce the risk of contact with coastal
 12 habitats and resources.

13

14

15 **4.3.4.3.1 Catastrophic Discharge Event Scenarios.** BOEM has prepared credible
 16 scenarios of catastrophic discharge for each planning area that are used in later effects analyses
 17 (Table 4.3.4-2). The scenarios do not account for potential discharge mitigating factors such as
 18 well barriers, well intervention, or effective containment and response. Instead, oil is
 19 conservatively assumed to flow from the well until the well is killed using a relief well. The
 20 volume presented is a potential volume released. When accounting for containment, subsurface
 21 and surface dispersion, evaporation, mechanical recovery, and *in situ* burning, the actual amount
 22 released is assumed to be less. The principal factors driving the potential release amount and
 23 duration are geologic, well design, and oil type properties (which determine maximum discharge

1 **TABLE 4.3.4-2 Program Area Catastrophic Discharge Scenarios^a**

Program Area	Volume (Mbbl)	Duration (days)	Factors Affecting Duration
Gulf of Mexico	0.9–7.2	30–90	Water depth and drill depth determines timing of relief well
Arctic			
Chukchi Sea	1.4–2.2	40–75	Timing relative to ice free season and/or
Beaufort Sea	1.7–3.9	60–300	availability of rig to drill relief well
Cook Inlet	0.075–0.125	50–80	Availability of rig to drill relief well

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^a The GOM OCS region has estimated the discharge rate, volume of a spill, and the extent and duration for a catastrophic spill event for both shallow and deep water (in part) based on information gathered and estimates developed for the 1979 Ixtoc (1979) and the DWH (2010) oil spills. The Alaska OCS Region has estimated a very large oil spill scenario based on a reasonable, maximum flow rate for each OCS planning area, taking into consideration existing geologic conditions and information from well logs. The number of days until a hypothetical blowout and discharge from a well could be contained was also estimated. These are discharge volumes and do not account for decreases in volume from containment or response operations.

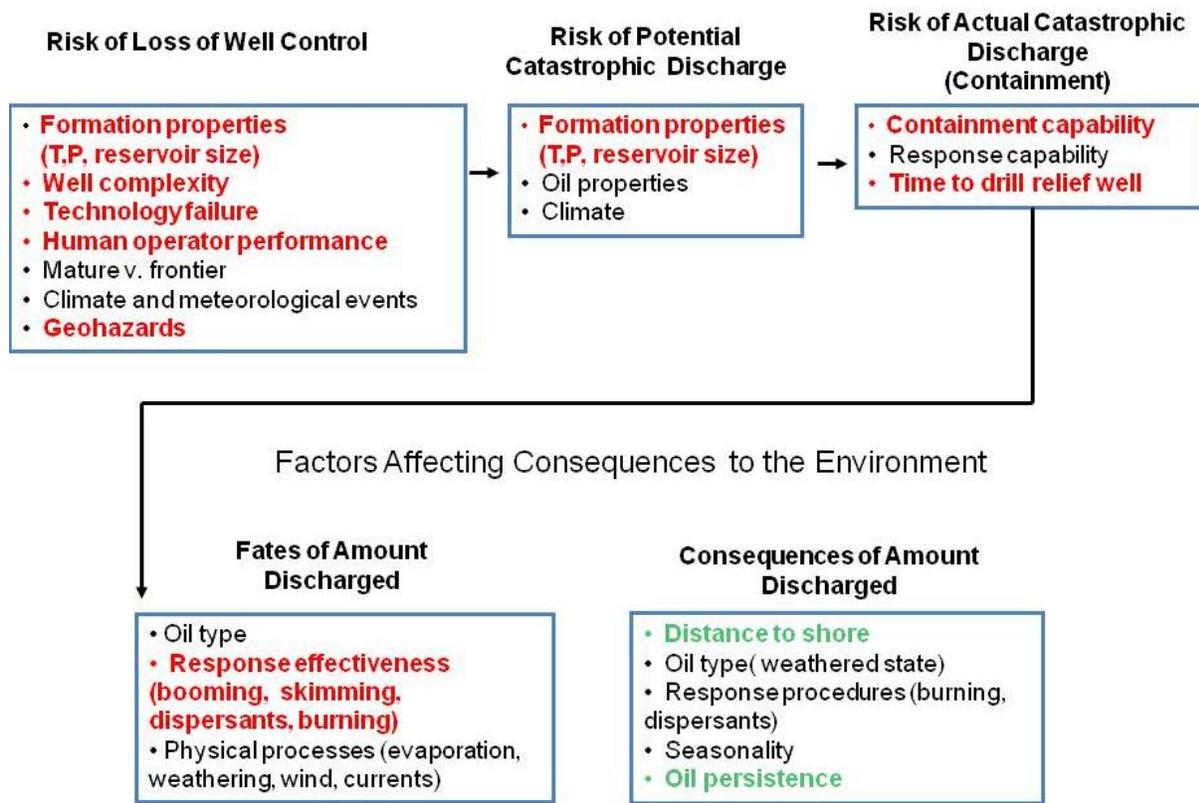
rate) and time frame required for drilling a relief well. The time frame required for drilling a relief well is principally governed by water and reservoir depth, timing of year, and availability of drilling rigs.

Such a scenario is a low-probability, accidental event. Bercha (2008) has reported the historical spill frequency for a spill greater than or equal to 150,000 bbl for GOM and North Sea well drilling as 3.42×10^{-4} per well. Accounting for Arctic specific variables, Bercha calculated a slightly smaller frequency of 3.94×10^{-4} per well for a spill greater than or equal to 150,000 bbl.

The principal risk factors that would affect drilling operations, containment, and response in Gulf of Mexico and Arctic program areas are summarized below. Cook Inlet is not considered further because of the relatively small size of the estimated catastrophic discharge event there compared to other program areas.

4.3.4.3.2 Gulf of Mexico Risk Profile. Drilling operations in deep water came under close scrutiny following the DWH event in April, 2010. A suspension on approving drilling plans and permits in deep water was imposed by the Secretary in July 2010. The Secretary lifted the suspension in October 2010 based on the implementation of new regulatory reforms to improve OCS drilling safety and a better understanding of the root causes of the DWH event. The safety of drilling in deepwater areas of the GOM remains an issue of concern, as witnessed by comments received during scoping. As stated earlier, water depth by itself does not impose risk; rather, it is the drilling technology and the relative inaccessibility of the well site on the seafloor that imposes risk from deepwater operations. Figure 4.3.4-2 highlights risk factors that

Risk Factors at the Incident Site (GOM)



1
 2 **FIGURE 4.3.4-2 Principal Factors Affecting a Catastrophic Discharge Event in the Gulf of Mexico**

3
 4
 5 apply to risks particular to deepwater wells (red text). The figure also highlights risk reduction
 6 factors associated with drilling in deep water compared to drilling in shallow water (green text).

7
 8
 9 **Loss of Well Control.**

10
 11 **Geologic Properties.** Deepwater geologic formations tend to have higher temperatures
 12 and pressures than shallow water formations. In addition to varying oil properties, the
 13 differences in pressure regimes may contribute to relatively greater discharge rates. In addition,
 14 deepwater formations tend to hold larger volumes of hydrocarbons. The combination of the high
 15 temperature and pressure regime and comparatively large reservoir volumes create conditions
 16 that favor potentially catastrophic releases. When considering all OCS wells, the average
 17 vertical drill depth for boreholes in shallow water (less than 201 m [660 ft]) is approximately
 18 2,864 m (9,400 ft), compared to 4,115 m (13,500 ft) in waters deeper than 201 m (660 ft). The
 19 drill depth required to reach target reservoirs requires more information about shallow and deep
 20 geologic hazards to avoid engineering and well integrity challenges. The time required to
 21 intervene using a relief well is also greater, because of the relative depth of the intervention zone.
 22 Because of the steeper gradient of the continental slope where deepwater wells are often drilled,
 23 compared to the gentler slope on the continental shelf, deepwater wells may be more subject to

1 mass movement and other seafloor instabilities that, if unanticipated, may increase the risk of a
2 loss of well control incident. To avoid these complications, BOEM requires well shut-in prior to
3 the passage of hurricanes, which are the most frequent cause of large-scale seafloor movements.
4

5 **Well Complexity, Technology Failure and Human Performance.** More complex wells
6 and technology are often required in deepwater drilling to address the higher pressures and
7 temperatures and greater drilling depths that will be encountered. This places greater demands
8 on human and technology performance, especially where hydrostatic pressures are substantial
9 greater due to an average 762-m (2,500-ft) greater water depth. Furthermore, the inaccessibility
10 of the seafloor to humans at deepwater well sites means that the subsea BOP systems used at
11 deepwater drill sites are inaccessible to human maintenance, inspection, and intervention in the
12 event they are activated as a result of a loss of well control event. Deepwater drilling sites use
13 ROVs and other indirect methods of intervening in a loss of well control incident at the seafloor.
14

15 **Containment and Response.** The drilling of a relief well in deep water will likely take
16 longer than in shallow water because of the greater water depth, greater drill depth, and more
17 complex drilling conditions the relief well would encounter. Table 4.3.4-2 estimates that up to
18 90 days may be needed after the loss of well control event to drill the relief well and kill the wild
19 well. During that time, the success of containment and response at the well site would be a
20 critical factor governing whether sufficient oil is released into the environment to have
21 catastrophic consequences. Containment and response is expected to be more challenging in
22 areas with deeper water because of the greater distances from land support bases and staging
23 areas. Progress has been made in the GOM to develop effective containment and response
24 technology for deepwater conditions, including deep dispersant application.
25

26 **Fate and Consequence.** Should containment and response at the well site fail to prevent
27 discharge of oil into the ocean environment, response and oil recovery would continue as the oil
28 discharge spreads. Response operations could be more challenging to support in deeper water
29 because of the greater distances from shore bases, as well as the fact that the area of surfaced oil
30 would continue to increase as deepwater currents exported oil to the shelf.
31

32 Because deepwater wells are located at greater distances offshore than shallow wells,
33 high concentrations of oil are less likely to contact important ecological and human use coastal
34 resources. In addition, the risk of persistence of the oil in the environment would likely be less
35 in deepwater events because oil released there would be less likely to contact coastal wetland and
36 estuarine areas where it could become incorporated into wetland soils and persist for long
37 periods of time.
38

39 **Summary.** The principal risk that applies to deepwater drilling in the GOM occurs as a
40 result of drilling and containment/response risks associated with the use of drilling technologies
41 at these depths. As described below, BOEM has been aggressively pursuing regulatory changes
42 to address and mitigate risks associated with these deepwater drilling and containment issues. It
43 is not necessarily true that a deepwater, large volume spill would have more environmental
44 consequences than a smaller spill occurring in shallow water. Deepwater spills may, in part,
45 impose less risk on highly valued coastal areas because of their distance offshore, which allows

1 for more natural weathering and dispersion. In comparison, shallow shelf spills may more
2 rapidly contact low-energy estuarine and wetland areas.
3
4

5 **4.3.4.3.3 Arctic Risk Profile.** An ongoing concern in the Arctic is the environmental
6 effects of a large oil spill on sensitive marine and coastal habitats that occur there within a land-
7 sea-ice biome that supports a traditional subsistence life style for Alaska native populations and
8 provides important habitats for migratory and local faunal populations. The ability to respond to
9 and contain a very large discharge event under the extreme climatic conditions and seasonal
10 presence of ice is of particular concern. Figure 4.3.4-3 highlights factors that apply to risks
11 particular to operations in the Arctic related to extreme cold and the presence of ice.
12

13 **Loss of Well Control.** While some formation properties of the Arctic OCS are expected
14 to have pressures, temperatures, and volumes sufficient to produce a discharge that could result
15 in catastrophic consequences (Table 4.3.4-2), drilling risks associated with these formation
16 characteristics are not directly related to issues of extreme cold and presence of ice. Instead, the
17 fact that the Arctic OCS is largely a frontier geologic province contributes risk to Arctic drilling
18 operations (USGS 2011).
19

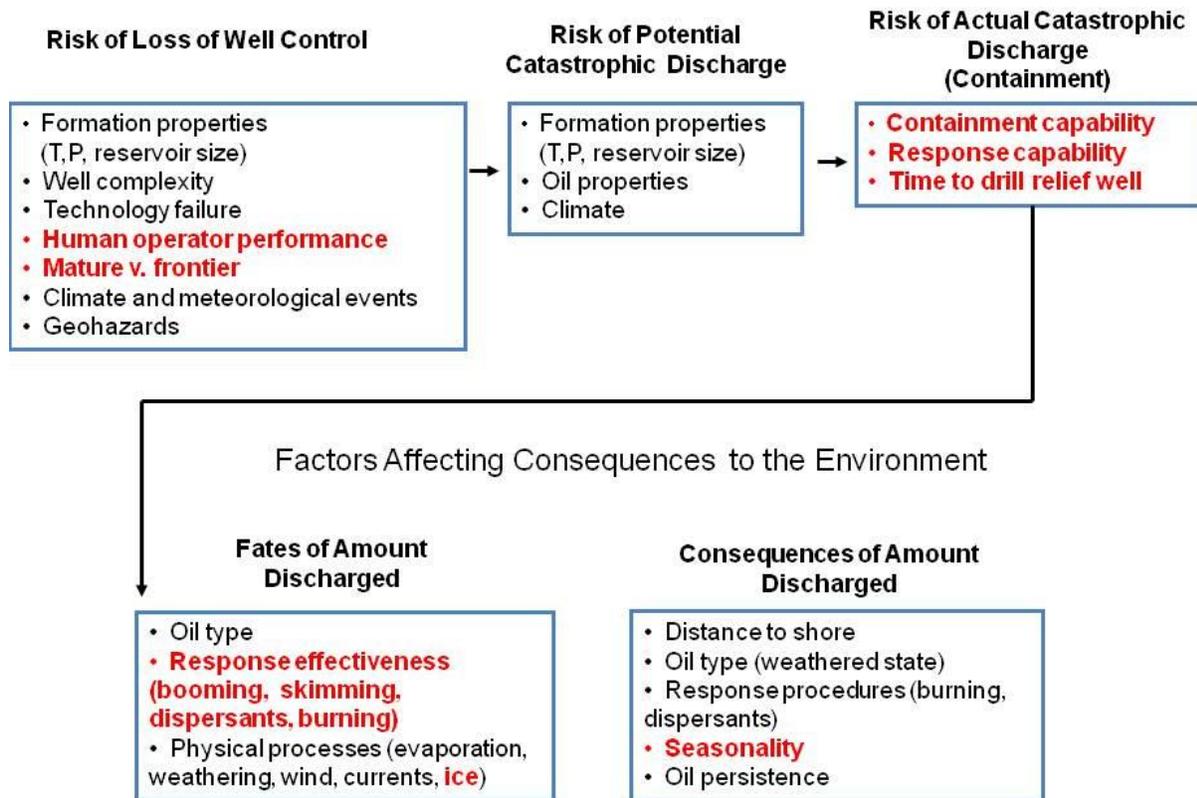
20 Human error while working under extreme weather conditions on the Arctic OCS could
21 increase the risk of loss of well control in certain circumstances where established procedures are
22 not followed. However, when accounting for other Arctic specific variables, the incident rate of
23 loss of well control is expected to be lower than for exploration and development operations in
24 the GOM (Bercha et al. 2008).
25

26 To address some of the risk inherent in Arctic operations, the BOEM regulations include
27 specific requirements for conducting operations in the Arctic, such as locating the BOP in a well
28 cellar (a hole constructed in the sea bed) to position the top of the BOP below the maximum
29 potential ice gouge depth, using special cements in areas where permafrost is present, enclosing
30 or protecting equipment to assure it will function under subfreezing conditions, and developing
31 critical operations and curtailment procedures which detail the criteria and process through
32 which the drilling program would be stopped, the well shut in and secured and the drilling unit
33 moved off location before environmental conditions (such as ice) exceed the operating limits of
34 the drilling vessel.
35

36 **Containment and Response.** Much of risk from a catastrophic event that is particular to
37 the extreme climate of the Arctic is associated with containment and response issues at the well
38 site. The time needed to drill a relief well varies from 40 to 300 days depending on the timing of
39 the event relative to the ice free season, since the well site may become inaccessible when solid
40 or broken ice is present. During that time, the ability to mount effective containment and
41 response efforts under broken or solid ice conditions is a critical factor.
42

43 **Fate and Consequence.** Response away from the well site could also be hindered and/or
44 aided by broken and solid ice. In addition, some options available to manage fates of spills have
45 not been previously used in larger-scale operations the Arctic to fully evaluate their
46

Risk Factors at the Incident Site (Arctic)



1
 2 **FIGURE 4.3.4-3 Principal Factors Affecting a Catastrophic Discharge Event in the Arctic**

3
 4
 5 effectiveness, such as burning and dispersant use, although state-of-the art research on these
 6 response techniques suggest they could decrease the volume of oil in the water (SINTEF 2010).

7
 8
 9 **4.3.4.3.4 Recent Regulatory Reforms Implemented to Reduce Risk.** In the event of a
 10 spill, there is no single method of containment and response that would be 100% effective.
 11 While recent enhancements in intervention, containment, and response should reduce spill
 12 volume and mitigate certain environmental effects, the principal corrective action is still a relief
 13 well, and drilling a relief well to kill a wild well takes time. This highlights the fundamental
 14 importance of prevention. In response to the DWH event and in recognition that advances in
 15 prevention were critical, BOEM overhauled the offshore regulatory process reforming, through
 16 both prescriptive and performance-based regulation and guidance, as well as OCS safety and
 17 environmental protection requirements. The reforms strengthen the requirements for all aspects
 18 of OCS operations from well design to workplace safety to corporate accountability. The other
 19 logical capability needing improvement is spill response. New measures and reforms adopted by
 20 BOEM to strengthen safety, spill prevention, and spill response include the following:

- 21
 22
 23
- Drilling Safety Rule, Interim Final Rule to Enhance Safety Measures for Energy Development on the Outer Continental Shelf (Drilling Safety Rule);

- 1 • Workplace Safety Rule, Safety and Environmental Management Systems
2 (SEMS Rule);
3
- 4 • NTL 2010-N06, Information Requirements for Exploration Plans,
5 Development and Operations Coordination Documents on the OCS
6 (Plans NTL);
7
- 8 • NTL 2010-N10, Statement of Compliance with Applicable Regulations and
9 Evaluation of Information Demonstrating Adequate Spill Response and Well
10 Containment Resources (Certification NTL); and
11
- 12 • Enhanced inspection and enforcement procedures, including strengthened
13 training program.
14

15 **Drilling Safety Rule.** The prescriptive Drilling Safety Rule addresses well bore integrity
16 and well control equipment and procedures. The rule effectively implements many of the
17 recommendations made in the May 27, 2010, USDOJ report Increased Safety Measures for
18 Energy Development on the Outer Continental Shelf (USDOJ 2010). BOEMRE amended
19 drilling regulations related to subsea and surface blowout preventers, well casing and cementing,
20 secondary intervention, unplanned disconnects, recordkeeping, well completion, and well
21 plugging.
22

23 Well integrity provides the first line of defense against a blowout by preventing a loss of
24 well control. It includes the appropriate use of drilling fluids and the well bore casing and
25 cementing program. These are used to balance pressure in the borehole against the fluid pressure
26 of the formation, preventing an uncontrolled influx of fluid into the wellbore. Provisions in the
27 rule addressing well bore integrity include the following:
28

- 29 • Making mandatory American Petroleum Institute's (API) standard, RP 65 –
30 Part 2, Isolating Potential Flow Zones During Well Construction (an industry
31 standard program);
32
- 33 • Requiring submittal of certification by a professional engineer that the casing
34 and cementing program is appropriate for the purposes for which it is intended
35 under expected wellbore pressure;
36
- 37 • Requiring two independent test barriers across each flow path during well
38 completion activities (certified by a professional engineer);
39
- 40 • Ensuring proper installation, sealing, and locking of the casing or liner;
41
- 42 • Requiring BOEM approval before replacing a heavier drilling fluid with a
43 lighter fluid; and
44
- 45 • Requiring enhanced deepwater well control training for rig personnel.
46

1 Well control equipment is used to bring a well back under control in the event of a loss of
2 well control. Well control equipment includes the BOP and control systems that activate the
3 BOP, either through a control panel on the drilling rig or through ROVs that directly
4 interface with the BOP to activate appropriate rams. Provisions in the rule that focus on the
5 enhancement of well control equipment include the following:
6

- 7 • Submittal of documentation and schematics for all control systems;
- 8
- 9 • Requirements for independent third party verification that the blind-shear
10 rams are capable of cutting any drill pipe in the hole under maximum
11 anticipated surface pressure;
- 12
- 13 • Requirement for a subsea BOP stack equipped with ROV intervention
14 capability (at a minimum the ROV must be capable of closing one set of pipe
15 rams, closing one set of blind-shear rams, and unlatching the lower marine
16 riser package);
- 17
- 18 • Requirement for maintaining a ROV and having a trained ROV crew on each
19 floating drilling rig on a continuous basis;
- 20
- 21 • Requirement for auto shear and deadman systems for dynamically positioned
22 rigs;
- 23
- 24 • Establishment of minimum requirements for personnel authorized to operate
25 critical BOP equipment;
- 26
- 27 • Requirement for documentation of subsea BOP inspections and maintenance
28 according to API RP 53, *Recommended Practices for Blowout Prevention*
29 *Equipment Systems for Drilling Wells*;
- 30
- 31 • Require testing of all ROV intervention functions on subsea BOP stack during
32 stump test and testing at least one set of rams in initial seafloor test;
- 33
- 34 • Require function testing auto shear and deadman systems on the subsea BOP
35 stack during the stump test and testing the deadman system during the initial
36 test on the seafloor; and
- 37
- 38 • Require pressure testing if any shear rams are used in an emergency.

39
40 A section-by-section summary of major regulatory changes is provided below.
41

42 ***Subsea ROV and Deadman Function Testing — Drilling.*** Previous regulations at
43 30 CFR 250.449(b) required a stump test of the subsea BOP system. In a stump test, the subsea
44 BOP system is placed on a simulated wellhead (the stump) on the rig floor. The BOP system is
45 tested on the stump to ensure that the BOP is functioning properly. The new regulatory section
46 at 30 CFR 250.449(j) requires that all ROV intervention functions on the subsea BOP stack must

1 be tested during the stump test and one set of rams must be tested by an ROV on the seafloor.
2 Autoshear and deadman control systems activate during an accidental disconnect or loss of
3 power, respectively. The new regulatory section at 30 CFR 250.449(k) requires that the
4 autoshear and deadman systems be function-tested during the stump test, and the deadman
5 system tested during the initial test on the seafloor. The initial test on the seafloor is performed
6 as soon as the BOP is attached to the subsea wellhead. These new requirements will confirm that
7 a well will be secured in an emergency situation and prevent a possible loss of well control. The
8 ROV test requirement will ensure that the dedicated ROV has the capacity to close the BOP
9 functions on the seafloor. The deadman-switch test on the seafloor verifies that the wellbore
10 closes automatically if both hydraulic pressure and electrical communication are lost with the
11 drilling rig. These regulatory changes will not affect shallow wells or facilities since they do not
12 use subsea BOPs or ROVs.

13
14 ***Subsea ROV and Deadman Function Testing—Workover/Completions.*** Previous
15 regulations did not require subsea ROV function testing of the BOP during workover or well
16 completion operations. The new regulatory sections 30 CFR 250.516(d)(8) and 250.616(h)(1)
17 extend the requirements added to deepwater drilling operations (discussed in the previous
18 section) to well completion operations and workover operations using a subsea BOP stack.

19
20 ***Negative Pressure Tests.*** Previous regulation at 30 CFR 250.423 required a positive
21 pressure test for each string of casing, except for the drive or structural casing string. This test
22 confirms that fluid from the casing string is not flowing into the formation. The new regulatory
23 section at 30 CFR 250.423(c) requires that a negative pressure test be conducted for all
24 intermediate and production casing strings. This test will reveal whether gas or fluid from
25 outside the casing is flowing into the well and ensures that the casing and cement provide an
26 effective seal. Maintenance of pressure under both tests ensures proper casing installation and
27 the integrity of the casing and cement.

28
29 ***Installation of Dual Mechanical Barriers.*** Previous regulations did not require the
30 installation of dual mechanical barriers. The new regulatory section at 30 CFR 250.420(b)(3)
31 requires the operator install dual mechanical barriers in addition to cement barriers for the final
32 casing string. These barriers prevent hydrocarbon flow in the event of cement failure at the
33 bottom of the well. The operator must document the installation of the dual mechanical barriers
34 and submit this documentation to BOEM within 30 days after installation. These new
35 requirements will ensure that the best casing and cementing design will be used for a specific
36 well.

37
38 ***Professional Engineer Certification for Well Design.*** Previous regulations at 30 CFR
39 250.420(a) specified well casing and cementing requirements, but did not require verification by
40 a registered professional engineer. The new regulatory section at 30 CFR 250.420(a)(6) requires
41 that well casing and cementing specifications must be certified by a registered professional
42 engineer. The registered professional engineer will verify that the well casing and cementing
43 design is appropriate for the purpose for which it is intended under expected wellbore conditions.

44
45 ***Emergency Cost of Activated Shear Rams.*** Previous regulations did not address BOP
46 inspection following use of the blind-shear ram or casing shear ram. The new regulatory section

1 at 30 CFR 250.451(i) requires that, if a blind-shear ram or casing shear ram is activated in a well
2 control situation where the pipe is sheared, the BOP stack must be retrieved, fully inspected, and
3 tested. This provision will ensure the integrity of the BOP and that the BOP will still function
4 and hold pressure after the event.

5
6 **Third Party Shearing Verification.** Regulation 30 CFR 250.416(e) requires information
7 verifying that BOP blind-shear rams are capable of cutting through any drill pipe in the hole
8 under maximum anticipated conditions. This regulation has been modified to require the BOP
9 verification be conducted by an independent third party. The independent third party provides an
10 objective assessment that the blind-shear rams can shear any drill pipe in the hole if the shear
11 rams are functioning properly.

12
13 **Workplace Safety Rule.** The BOEMRE promulgated the performance-based SEMS rule
14 on October 15, 2010, requiring full implementation for all OCS facilities and operators no later
15 than November 15, 2011. The SEMS Rule establishes a holistic, performance-based
16 management tool in which offshore operators are required to establish and implement programs
17 and systems to identify potential safety and environmental hazards when they drill, clear
18 protocols for addressing those hazards, and strong procedures and risk-reduction strategies for all
19 phases of activity, from well design and construction to operation, maintenance, and
20 decommissioning. It also requires operators to have a comprehensive safety and environmental
21 impact program designed to reduce human and organizational errors. SEMS applies to all OCS
22 oil and gas operations and facilities under BOEM and BSEE jurisdiction including drilling,
23 production, construction, well workover, well completion, well servicing, and DOI pipeline
24 activities. SEMS also applies to all OCS oil and gas operations on new and existing facilities
25 under BOEM and BSEE jurisdiction including design, construction, start-up, operation,
26 inspection, and maintenance. The performance-based SEMS rule helps to define clear roles and
27 responsibilities, in which BOEM define the performance goals while the operator is responsible
28 to ensure that these goals are met. Operators do not rely on the authorities to ensure safety.
29 Empowering industry to develop the framework specific to improve safety and environmental
30 performance of facilities and operations and holding them responsible to that greater standard
31 should eliminate the most frequent causes of historic incidents that have occurred during OCS
32 activities. Training and auditing are an integral part of the SEMS rule to ensure contractors and
33 subcontractors have robust policies and procedures in place.

34
35 The SEMS Rule is based on API RP 75, which was previously a voluntary program to
36 identify, address, and manage safety hazards and environmental impacts in oil and gas
37 operations. The 13 elements of API RP 75 that 30 CFR 250 Subpart S now make mandatory
38 include:

- 39
- 40 • Defining the general provisions for implementation, planning and
41 management review, and approval of the SEMS program;
- 42
- 43 • Identifying safety and environmental information needed for any facility such
44 as design data, facility process such as flow diagrams, and mechanical
45 components such as piping and instrument diagrams;
- 46

- 1 • Requiring a facility-level hazard risk assessment;
- 2
- 3 • Addressing any facility or operational changes including management
- 4 changes, shift changes, contractor changes;
- 5
- 6 • Evaluating operations and written procedures;
- 7
- 8 • Specifying safe work practices, manuals, standards, and rules of conduct;
- 9
- 10 • Training, safe work practices, and technical training, including contractors;
- 11
- 12 • Defining preventive maintenance programs and quality control requirements
- 13
- 14 • Requiring a pre-startup review of all systems;
- 15
- 16 • Responding to and controlling emergencies, evacuation planning, and oil-spill
- 17
- 18 • Contingency plans in place and validated by drills;
- 19
- 20 • Investigating incidents, procedures, corrective action, and follow-up;
- 21
- 22 • Requiring audits every 4 yr, to an initial 2-yr reevaluation and then subsequent
- 23 3-yr audit intervals; and
- 24
- 25 • Specifying records and documentation that describes all elements of the
- 26 SEMS program.
- 27

28 Implementation of SEMS requires periodic lessee or independent third party
29 comprehensive audits of the 13 elements defined in API RP 75 and included above. BSEE may
30 participate in lessee or independent third party audits and may also conduct independent audits.
31 BSEE-conducted audits may be announced or unannounced. Any deficiencies found in SEMS
32 audits must be addressed in a corrective action plan (CAP) and must be submitted to BSEE
33 within 30 days of submittal of the audit report. If BSEE determines that an operator's SEMS
34 program is not in compliance, BSEE may issue an incidence of non-compliance (INC), assess
35 civil penalties, or initiate probationary or disqualification procedures from serving as an OCS
36 operator. The required SEMS plan and audits are designed to improve, enhance, communicate
37 and document the identification and mitigation of safety and environmental hazards for offshore
38 facilities and activities resulting in safer and environmentally sound working conditions through
39 teamwork, training and communication among all parties for all activities on the OCS.

40
41 One of the most important elements that fosters improved industry-wide risk
42 management is the facility-level hazard analysis. The purpose of the analysis is to identify,
43 evaluate, and reduce the likelihood and/or minimize the consequences of uncontrolled releases of
44 oil and gas and other safety or environmental incidents. API RP 14 C, *Recommended Practice*
45 *for Analysis, Design, Installation, and Testing of Basic Surface Safety Systems for Offshore*
46 *Production Platforms* and API RP 14J, *Recommended Practice for Design and Hazards Analysis*

1 *for Offshore Production Facilities*, identify accepted practices. In addition, this element requires
2 a job hazard analysis (operations/task level) be performed to identify and evaluate hazards of a
3 job/task for the purpose of hazards control or elimination.
4

5 ***Information Requirements for Exploration Plans, Development and Production Plans,***
6 ***and Development Operations Coordination Documents on the OCS (Plans NTL).*** The Plans
7 NTL, effective June 18, 2010, set new standards regarding the content of information needed in
8 exploration and development plan submittals to describe a blowout and worse-case discharge
9 scenario. This NTL explains the procedures for the lessee or operator to submit supplemental
10 information for new or previously submitted Exploration Plans (EP) or Development and
11 Production Plans (DPP). The required supplemental information includes the following: (1) a
12 description of the blowout scenario as required by 30 CFR 250.213(g) and 250.243(h); (2) a
13 description of their assumptions and calculations used in determining the volume of the worst-
14 case discharge required by 30 CFR 250.219(a)(2)(iv) or 30 CFR 250.250(a)(2)(iv) and (3) a
15 description of the measures proposed that would enhance the ability to prevent a blowout, to
16 reduce the likelihood of a blowout, and to conduct effective and early intervention in the event of
17 a blowout, including the arrangements for drilling relief wells and any other measures proposed.
18 The early intervention methods of the third requirement could include the surface and subsea
19 containment resources that BOEMRE announced in NTL2010-N10 (Certification NTL).
20

21 ***Statement of Compliance with Applicable Regulations and Evaluation of Information***
22 ***Demonstrating Adequate Spill Response and Well Containment Resources (Certification***
23 ***NTL).*** The Certification NTL, effective on November 8, 2010, requires lessees and operators
24 using subsea or surface BOPs on floating facilities (i.e., deepwater) to provide a statement
25 verifying compliance with new well containment and oil spill response requirements prior to
26 being granted a Permit to Drill/Modify (APD/APM). Specifically, the statement, signed by an
27 authorized company official, indicates that authorized activities will be in compliance with all
28 applicable regulations, including the requirements of the Drilling Safety Rule.
29

30 The NTL also informs lessees that BOEM will be evaluating whether or not each
31 operator has submitted adequate information demonstrating that it has access to and can deploy
32 surface and subsea containment resources to promptly respond to a blowout or other loss of well
33 control. Although the NTL does not provide that operators submit revised OSRPs that include
34 this containment information at this time, operators were notified of BOEM's intention to
35 evaluate the adequacy of each operator to comply in the operator's current OSRP; therefore,
36 there is an incentive for voluntary compliance.
37

38 The benefits of the new requirements include the following:
39

- 40 • Improving the response time for offshore vessels to remove damaged
41 equipment and install a capping stack;
- 42
- 43 • Reducing the amount of time a well flows into the sea compared with
44 previous well blowouts;
- 45

- 1 • Providing more robust well designs relative to expected pressures and fluids
2 in the well to fully contain the well after installation of the capping stack;
3
- 4 • Determining the well's potential to broach to the seafloor if the well design
5 fails under the shut-in pressure with installed capping stack, and
6
- 7 • Determining the surface vessels configuration and containment capacities if
8 the well has to flow to the surface for processing and capture.
9

10 In the event of a well blowout, OCS operators must demonstrate the capability to remove
11 damaged well equipment and install a capping stack (with a pressure rating higher than the
12 calculated mud line shut-in pressure) to stop the uncontrolled flow of oil from the well. If the
13 well design fails under the shut-in pressure, the operator must demonstrate the capability to flow
14 and process the oil and gas from the well into surface containment vessels. Although not
15 explicitly stated in the Certification NTL notice, BOEM requires operators to demonstrate that
16 the well design is adequate to contain an uncontrolled flow. BOEM uses a Level 1 Well
17 Containment Screening Tool (WCST) for all initial reviews prior to APD approval. The Level 1
18 WCST is useful for wells that can be fully shut-in without causing underground flow, using very
19 conservative assumptions and simple calculations (no requirement for computer simulations).
20 However, not all wells can pass a Level 1 screening successfully due to high pressure and/or
21 light formation fluids expected in the well. The Level 2 WCST Analysis uses field/offset data
22 and more advanced calculations to demonstrate equipment and well integrity. The Level 2
23 WCST Analysis also identifies failure points and possible loss zones which must be addressed in
24 a consequence analysis. The WCST developed by BOEM and offshore operators working
25 together on the design of the containment approval process under oil spill response has resulted
26 in more robust well designs that reduce the risk of prolonged well flow into the sea and increase
27 the chance of successfully capping and stopping the flow of oil in less than 15 to 30 days.
28

29 On December 13, 2010, BOEMRE issued additional guidance to encourage operators to
30 voluntarily include additional subsea containment information in their OSRPs. The guidance
31 indicates that BOEM will review OSRPs, in support of plan submittals, for the following specific
32 information relating to subsea containment (in addition to that listed in the Certification NTL):
33

- 34 • Source abatement through direct intervention;
35
- 36 • Relief wells;
37
- 38 • Debris removal; and
39
- 40 • If a capping stack is the single containment option offered, the operator must
41 provide
42
- 43 • the reasons that the well design is sufficient to allow shut-in without broach to
44 the
45
- 46 • seafloor.

1 ***Enhanced Inspection and Enforcement Procedures, Including Strengthened Training***
2 ***Program.*** As of October 1, 2011 the new BSEE is responsible for enforcement of safety and
3 environmental regulations. BSEE undertakes both annual scheduled inspections and periodic
4 unscheduled (unannounced) inspections of oil and gas operations on the OCS. The inspections
5 are to assure compliance with all regulatory constraints that allowed commencement of the
6 operation. The annual inspection examines all safety equipment designed to prevent blowouts,
7 fires, spills, or other major accidents. These annual inspections involve the inspection for
8 installation and performance of all facilities' safety-system components. The primary objective
9 of an initial inspection is to assure proper installation and functionality of their safety and
10 pollution prevention equipment. After operations begin, additional announced and unannounced
11 inspections are conducted. Unannounced inspections are conducted to foster a climate of safe
12 operations, to maintain a BSEE presence, and to focus on operators with a poor performance
13 record. These inspections are also conducted after a critical safety feature has previously been
14 found defective. Poor performance generally means that more frequent, unannounced
15 inspections may be conducted on a violator's operation. The inspectors follow the guidelines as
16 established by the regulations, API RP 14C, and the specific BOEM-approved plan. The BSEE
17 inspectors perform these inspections using a national checklist called the PINC list. This list is a
18 compilation of yes/no questions derived from all regulated safety and environmental
19 requirements.
20

21 BSEE administers an active civil penalties program (30 CFR 250 Subpart N). A civil
22 penalty in the form of substantial monetary fines may be issued against any operator that
23 commits a violation that may constitute a threat of serious, irreparable, or immediate harm or
24 damage to life, property, or the environment. BSEE may make recommendations for criminal
25 penalties if a willful violation occurs. In addition, the regulation at 30 CFR 250.173(a)
26 authorizes suspension of any operation if the lessee has failed to comply with a provision of any
27 applicable law, regulation, or order or provision of a lease or permit. Furthermore, the Secretary
28 may invoke his authority under 30 CFR 250.185(c) to cancel a nonproductive lease with no
29 compensation. Exploration and development activities may be canceled under 30 CFR 250.182
30 and 250.183.
31

32 Predecessor bureaus to BSEE established a robust training program for inspectors to
33 ensure that personnel involved in installing, inspecting, testing, and maintaining safety devices
34 are qualified. As a preventive measure, all offshore personnel must be trained to operate oil-spill
35 cleanup equipment, or the lessee must retain a trained contractor(s) to operate the equipment for
36 them. BSEE offers numerous technical seminars to ensure that personnel are capable of
37 performing their duties and are incorporating the most up-to-date safety procedures and
38 technology in the petroleum industry. In 1994, the Office of Safety Management created this
39 Agency's Offshore Training Institute to develop and implement an inspector training program.
40 The Institute introduced state-of-the-art multimedia training to the inspector work force and has
41 produced a series of interactive computer training modules. As of June 2011, BOEMRE
42 established the National Offshore Training Center, thereby developing the agency's first formal
43 training curriculum, which has been piloted with new inspectors. Twenty-four additional courses
44 will be developed covering specific areas of offshore inspections.
45

1 Following the DWH oil spill, BSEE now requires multiple-person inspection teams for
2 offshore oil and gas inspections. This internal process will improve oversight and help ensure
3 that offshore operations proceed safely and responsibly. The new process will allow teams to
4 inspect multiple operations simultaneously and thoroughly, and enhance the quality of
5 inspections on larger facilities. In addition, BSEE engineers and inspectors now fly offshore to
6 witness required testing of all ROV intervention functions on the subsea BOP stack during the
7 stump test (on the rig floor at surface) and testing at least one set of rams during the initial test on
8 the seafloor, and required function testing of autoshear and deadman systems on the subsea BOP
9 stack during the stump test and testing the deadman system during the initial test on the seafloor.
10 These reviews and inspections of the BOP systems and maintenance provide additional oversight
11 by BSEE to reduce the risk of an uncontrolled blowout by ensuring that BOP systems are
12 maintained and functional in the event of a well control event.
13

14 **Relevance to Risk Reduction in Drilling Operations (including deep water).** In the
15 aftermath of the DWH Event, President Obama directed the Secretary of the Interior to identify
16 new precautions, technologies, and procedures needed to improve the safety of oil and gas
17 development on the OCS. At the same time, the Secretary directed BOEMRE to exercise its
18 authority under the OCSLA to suspend certain drilling activities so that the bureau could
19 (1) ensure that drilling operations similar to those that lead to the DWH oil spill could operate in
20 a safe manner when drilling resumed, (2) ensure extensive spill response resources directed
21 toward the spill would be available for other spill events, and (3) provide adequate time to obtain
22 input enhance intervention and containment capability and promulgate regulations that address
23 issues described in the Safety Measures Report (USDOJ 2010).
24

25 BOEMRE collected a large amount of information through public hearings and other
26 meetings held specifically on the DWH oil spill and through public comments on rulemaking
27 efforts. The information collection, review, and analysis efforts resulted in new regulations,
28 planned Notices to Lessees and Operators (NTLs), and BOEM/BSEE procedures that address
29 drilling safety, oil-spill response, and enhanced inspection procedures. New exploration plans,
30 applications for permits to drill, and OSRP plans are be subject to higher engineering and
31 environmental review standards. In addition, the oil and gas industry has cooperatively formed
32 Joint Industry Task Forces in subsea well control and containment and oil spill preparedness and
33 response. While Joint Industry Task Force recommendations will not have the force of
34 regulation, the recommendations may provide the basis for enhanced industry standards or future
35 rulemaking processes. Similarly, the Secretary of the Interior established the Ocean Energy
36 Safety Advisory Committee to facilitate the development of new regulations, collaborative
37 research and development, advanced training, and implementation of best practices in drilling
38 safety, well intervention and containment, and oil spill response.
39

40 The DWH event demonstrated that advances in drilling, safety, and spill response did not
41 keep pace with increasingly complex operations, and evidenced the need to strengthen oversight
42 of offshore drilling operations by raising the standards for drilling and workplace safety, spill
43 containment, and spill response. The measures described above create a more robust regulatory
44 system that strikes the right balance to ensure that energy development is conducted safely and in
45 an environmentally responsible manner, while also being more efficient, transparent and
46 responsive.
47

1 **4.4 ENVIRONMENTAL IMPACTS OF ALTERNATIVE 1 – PROPOSED ACTION**

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4 **4.4.1 Exploration and Development Scenario**

5
6
7 **4.4.1.1 Gulf of Mexico**

8
9 Oil and gas leasing and development have been occurring in the GOM for over 50 years.
10 There are a total of 29,097 lease blocks (each approximately 23 km² [3 mi × 3 mi]) and a total of
11 3,280 active platforms in the Western, Central, and Eastern GOM OCS Planning Areas.
12 Predictable patterns of activity have become established for the planning areas, and these were
13 used to estimate future activity within the GOM OCS Region Planning Areas that could occur
14 under this scenario (Table 4.4.1-1). This scenario of future development and activity was
15 generated using best professional judgment for the purpose of analysis only and does not
16 constitute official forecasts or policy recommendations.

17
18 The scenario information in Table 4.4.1-1 is initially assumed to have the potential to
19 occur anywhere within the areas of the GOM Planning Areas included in the proposed action
20 (Figure 4.4.1-1).

21
22 In the analysis of potential environmental impacts associated with the leasing program,
23 additional assumptions are used to identify potential oil and gas development activity levels to
24 more specific marine and coastal areas under consideration in a particular analysis. The GOM
25 OCS may be divided into continental shelf and slope regions, and this distinction is important to
26 both the occurrence of oil and gas within the GOM hydrocarbon basin and to ecosystem
27 characteristics and processes within the GOM Large Marine Ecosystem. Assumed levels of oil
28 and gas infrastructure and production that would occur on the continental slope and shelf are
29 shown in Table 4.4.1-2. This information suggests that while the amounts of well drilling and
30 gas production will be approximately the same on the shelf as on slope (51% versus 49%,
31 respectively), most new platforms will be installed in shallow water (in depths <200 m [<660 ft])
32 on the continental shelf. In contrast, most oil production (93%) will occur in deeper water (at
33 depths >200 m [>660 ft]) on the continental slope.

34
35 This assumed difference by depth of infrastructure development and oil and gas
36 production suggests similar differences in the resources that could be affected by normal
37 exploration and development (E&D) activities on the OCS. For example, 87% of all new
38 platform development is assumed to occur in waters of the inner continental shelf at depths of
39 60 m (about 200 ft) or less (Table 4.4.1-2). Thus, resources occurring in these shallower areas
40 may be expected to be more likely to encounter, and be affected by, normal well development
41 and operation than would resources restricted to deeper areas of the OCS.
42

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**TABLE 4.4.1-1 Proposed Action (Alternative 1) –
Exploration and Development Scenario for the GOM**

Scenario Element	Gulf of Mexico
Number of sales	12
Years of activity	40–50
Potentially available oil (Bbbl) ^a	2.7–5.4
Potentially available natural gas (tcf)	12–24
Platforms	200–450
FPSOs ^b	0–2
No. of exploration and delineation wells	1,000–2,100
No. of development and production wells	1,300–2,600
Miles of new pipeline	2,400–7,500
Vessel trips/week	300–600
Helicopter trips/week	2,000–5,500
New pipeline landfalls	0–<12
New pipe yards	4–6
New natural gas processing facilities	0–12
Platforms removed with explosives	150–275
<i>Drill Muds/Well (tons)</i>	
Exploration and delineation wells	1,000
Development and production wells	1,000
<i>Drill Cuttings/Well (tons)</i>	
Exploration and delineation wells	1,200
Development and production wells	1,200
<i>Produced Water/Well/yr (tbbl)^c</i>	
Oil well	130 (highly variable)
Natural gas well	35 (highly variable)
<i>Bottom Area Disturbed (ha)^d</i>	
Platforms	150–2,500
Pipeline	2,000–11,500

^a Bbbl = billion barrels.

^b Floating production, storage, and offloading systems.

^c Based on 1.04 bbl produced water/bbl of oil, and 86 bbl produced water/1 million cf gas (Clark and Veil 2009); tbbl = thousand barrels.

^d Assumes 0.67 ha (1.6 ac) per platform and 0.8–1.6 ha (2.0–4.0 ac) per mile of pipeline.

3

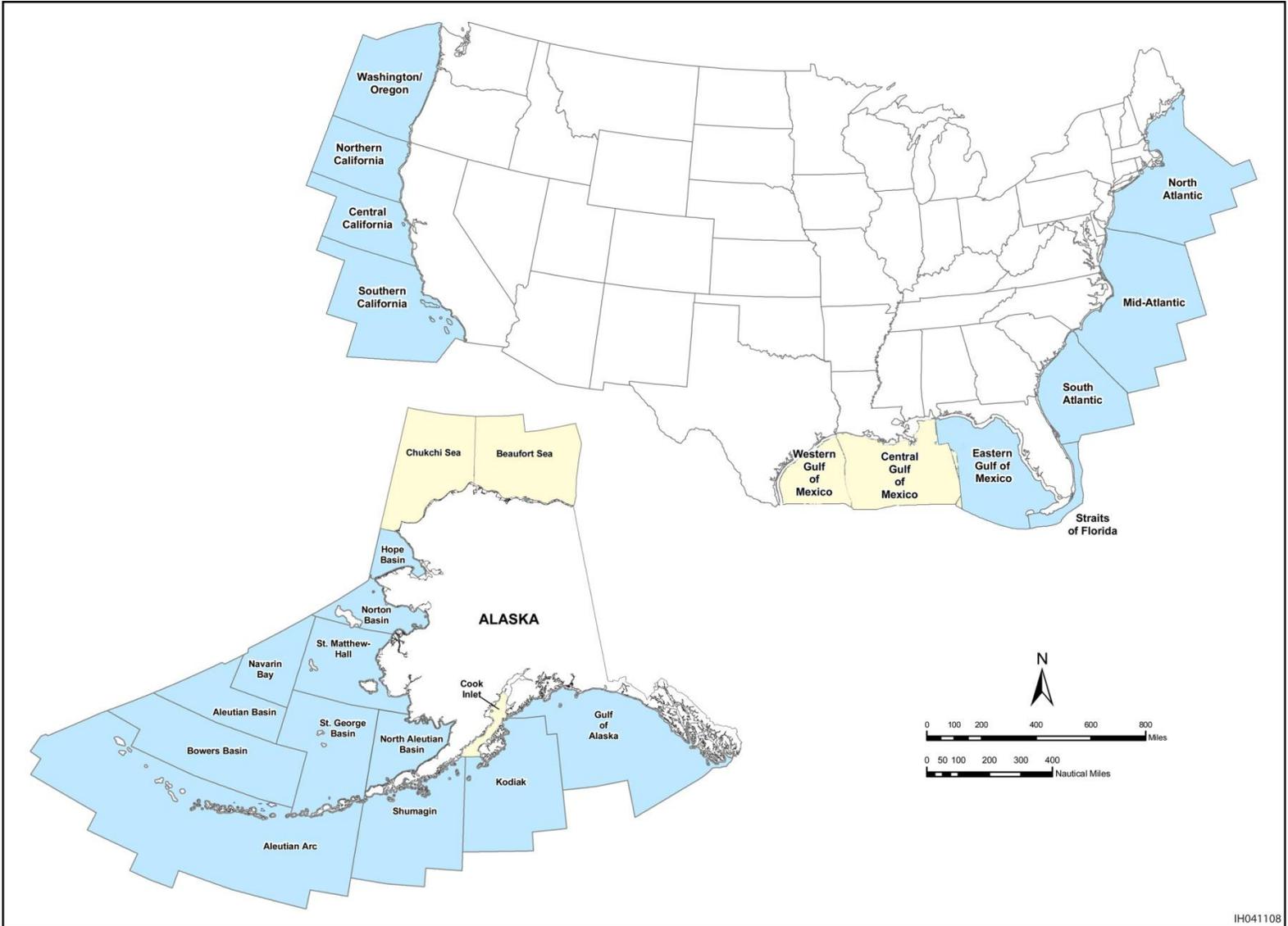


FIGURE 4.4.1-1 OCS Planning Areas Where Leasing for Oil and Gas Development May Occur under the 2012-2017 OCS Leasing Program

1 **TABLE 4.4.1-2 Depth Distribution of New Infrastructure and Expected Natural Gas and Oil**
2 **Production on the GOM OCS**

OCS Depth Zone (m)	OCS Area	OCS Sub- area	% of New Wells		% of New Platforms		% of New Gas Production		% of New Oil Production	
			OCS Area	OCS Sub- area	OCS Area	OCS Sub- area	OCS Area	OCS Sub- area	OCS Area	OCS Sub- area
0-60	Shelf	Inner	52	37	95	87	51	37	7	5
60-200		Outer		15		8		14		2
200-800	Slope	Upper	48	12	5	2	49	7	93	12
800-1,600		Mid		20		2		22		44
1,600-2,400					- ^a		-		-	
>2,400		Lower		16		1		20		37

^a No wells, platforms, or production are expected for this depth range.

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5 **4.4.1.2 Alaska – Cook Inlet**
6

7 The Cook Inlet has had oil and gas operations in State waters since the late 1950s and
8 currently possesses a well-established oil and gas infrastructure. There has been no oil and gas
9 activity in the Cook Inlet Planning Area. A single sale in Cook Inlet is included in the proposed
10 action as a special interest sale, meaning that the planning process for the sale will not start until
11 industry expresses an interest in holding the sale. The most recent OCS lease sale in Cook Inlet
12 was in 2004 when no leases were purchased. The most recent sale in which OCS leases were
13 purchased occurred in 1997 when two leases were purchased.
14

15 Table 4.4.1-3 summarizes the assumed levels of exploration and development that could
16 occur under the proposed action (Alternative 1). Oil and gas development that could occur in the
17 Cook Inlet OCS Planning Area under the proposed action is expected to use both new and
18 existing infrastructure. Exploration drilling would employ fixed rigs (such as jack-up and mobile
19 gravity-base rigs) in water depths up to 150 ft (46 m) and floating rigs (semisubmersible rigs,
20 drill ships, or barges) in deeper water areas. Production wells will most likely use fixed
21 platforms with subsea well tie-backs to supplement on-platform wells. New subsea pipelines
22 would connect offshore installations to existing onshore facilities. Oil and gas would be carried
23 by new onshore pipelines over relatively short distances to existing oil refineries in Nikishi and
24 natural gas transmission facilities in the Kenai area, respectively.
25
26

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TABLE 4.4.1-3 Proposed Action (Alternative 1) – Exploration and Development Scenario for Cook Inlet

Scenario Element	Cook Inlet
Number of sales	1
Years of activity	40
Oil production (Bbbl) ^a	0.1–0.2
Natural gas production (tcf) ^a	0–0.7
Platforms	1–3
No. of exploration and delineation wells	4–12
No. of development and production wells	42–114
Miles of new offshore pipeline	25–150
Miles of new onshore pipeline ^b	50–105
Vessel trips/week	1–3
Helicopter trips/week	1–3
New pipeline landfalls	0–1
New shore bases	0
New processing facilities	0
New waste disposal facilities	0
Platforms removed with explosives	0
<i>Drill Fluids/Well (bbl)</i>	
Exploration and delineation wells	500 – discharged at well site.
Development and production wells	All treated and disposed of in the well.
<i>Drill Cuttings (dry rock)/Well (tons)</i>	
Exploration and delineation wells	600 – discharged at well site.
Development and production wells	All treated and disposed in the well.
<i>Bottom Area Disturbed (ha)</i>	
Platforms (1.5 ha/platform)	1.5–4.5
Pipeline (1.4 ha/mile)	35–210

^a Bbbl = billion barrels; tcf = trillion cubic feet.

^b New onshore pipelines would deliver oil to existing refineries in Nikiski and natural gas to transmission facilities in the Kenai area.

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4.4.1.3 Alaska – Arctic

In contrast to oil and gas development in the GOM OCS, and with the exception of a single production site (Northstar) that has an actual surface location in Alaskan State waters, there has been no development activity from a structure in Arctic OCS areas. Since 1979, ten lease sales have been held in the Beaufort Sea Planning Area and three in the Chukchi Sea Planning Area (http://www.alaska.boemre.gov/lease/hlease/LeasingTables/lease_sales.pdf). The 2008 Lease Sale 193 for the Chukchi Sea Planning Area (MMS 2007a) is of note because of the high industry interest expressed through the acquisition of 487 leases and the more than \$2.7 billion received by the government in high bids. No activity has resulted from this lease

1 sale because of litigation that remains unresolved at the time this draft PEIS is being written.
2 The scenario put forth for the Arctic in the 2012–2017 program in Table 4.4.1-4, however,
3 assumes that the exploration and development activities anticipated as a result of Sale 193 will
4 have occurred prior to the beginning of the development and production activities listed in the
5 table. In particular, the scenario was developed using the assumptions that the discovery and
6 development of a 1-Bbbl oil field has already occurred, a pipeline has been installed from the
7 OCS production area in the Chukchi Sea to Point Belcher near Wainwright, Alaska, and support
8 base facilities have been constructed there as well. As a result of these assumptions, the scenario
9 in Table 4.4.1-4 includes no new pipeline landfalls or support bases, since these would have
10 already been constructed as a result of Sale 193 (BOEMRE 2011n). Also, oil discoveries less
11 than 1 Bbbl were assumed not to be economically feasible in the Program, because an initial
12 larger field needed to justify the construction of a pipeline to shore and coastal service facilities.
13 It is assumed that development as a result of lease sales under the Proposed Action Alternative
14 would utilize existing infrastructure, and that fields smaller than 1.0 Bbbl could be produced.
15

16 The draft PEIS assumes that the most likely locations for oil and gas activities in the
17 Arctic OCS will be in the areas that have been already leased in recent sales. While activities
18 within the entire Chukchi and Beaufort Sea Planning Areas will be considered in the analyses
19 that follow, the analyses assume that the most likely locations for exploration and development
20 activities will occur in the areas shown in Figure 4.4.1-2. It is assumed that these areas reflect
21 industry’s current assessment of the best hydrocarbon prospects through its large investments in
22 acquiring the leases. It is reasonable to assume that industry will explore and develop these areas
23 before moving into other areas currently considered less promising.
24

25 In the Beaufort Sea Planning Area, exploration is assumed to use artificial gravel islands
26 or extended-reach drilling in shallow waters (<6 m [20 ft]), mobile platforms in mid-depths (6–
27 18 m [20–60 ft]), and drill ships in deeper areas of the shelf. Because of severe winter ice pack
28 conditions, it is assumed that development would be limited to the shelf and to depths less than
29 91 m (300 ft) and platform installation would occur only in the summer (open water) season.
30 Production operations will use gravity-base platforms or gravel islands in shallow water (<12 m
31 [40 ft]) and larger gravity-base platforms in deeper waters (up to 91 m [300 ft]). Oil produced at
32 the platforms will be delivered via trenched subsea pipelines to existing onshore facilities.
33

34 In the Chukchi Sea Planning Area, with its greater water depths (>30 m [100 ft]) and
35 more remote location, exploration drilling is expected to employ drill ships. As in the Beaufort
36 Sea, concerns regarding severe winter ice conditions will also limit exploration and development
37 to the shelf and depths <91 m (300 ft) and only in the summer (open water) season. Production
38 operations will use large gravity-base structures with trenched subsea pipelines to transport the
39 oil to landfalls.
40

41 In both areas, elevated onshore pipelines will convey the oil and gas from the landfall
42 facilities to production facilities at Prudhoe Bay for ultimate entry to the Trans-Alaska Pipeline
43 System (TAPS). Based on the assumption that a natural gas pipeline connecting the North Slope
44 with the lower 48 States will be in place and operational by 2020, natural gas from the Chukchi
45 and Beaufort Seas may be transported by new and existing aboveground pipelines for entry into
46 such a pipeline (assuming capacity is available in the 2030–2035 time frame).

1 **TABLE 4.4.1-4 Proposed Action (Alternative 1) – Exploration and Development**
2 **Scenario for Arctic Alaska**

Scenario Element	Beaufort Sea	Chukchi Sea
Number of sales	1	1
Years of activity	50	50
Oil production (Bbbl) ^a	0.2–0.4	0.5–2.1
Natural gas production (tcf) ^b	0–2.2	0–8.0
Platforms	1–4	1–5
No. of exploration wells	6–16	6–20
No. of production wells	40–120	60–280
No. of subsea production wells	10	18–82
Miles of new offshore pipeline	30–155	25–250
Miles of new onshore pipeline	10–80	0
Vessel trips/week	1–12	1–15
Helicopter trips/week	1–12	1–15
New pipeline landfalls	0	0
New shore bases	0	0
<i>Drill Fluids/Well (bbl)</i>		
Exploration and delineation wells	500 – discharged at well site	500 – discharged at well site
Development and production wells	All treated and disposed of in the well.	All treated and disposed of in the well.
<i>Drill Cuttings (dry rock)/Well (tons)</i>		
Exploration and delineation wells	600 – discharged at well site	600 – discharged at well site
Development and production wells	All treated and disposed in the well.	All treated and disposed in the well.
<i>Bottom Area Disturbed</i>		
Platforms (1.5 ha/platform)	1.5–6.0	1.5–7.5
Pipeline (1.4 ha/mile)	42–217	35–350
<i>Surface Soil Disturbed</i>		
Pipeline ^c	73–584	0

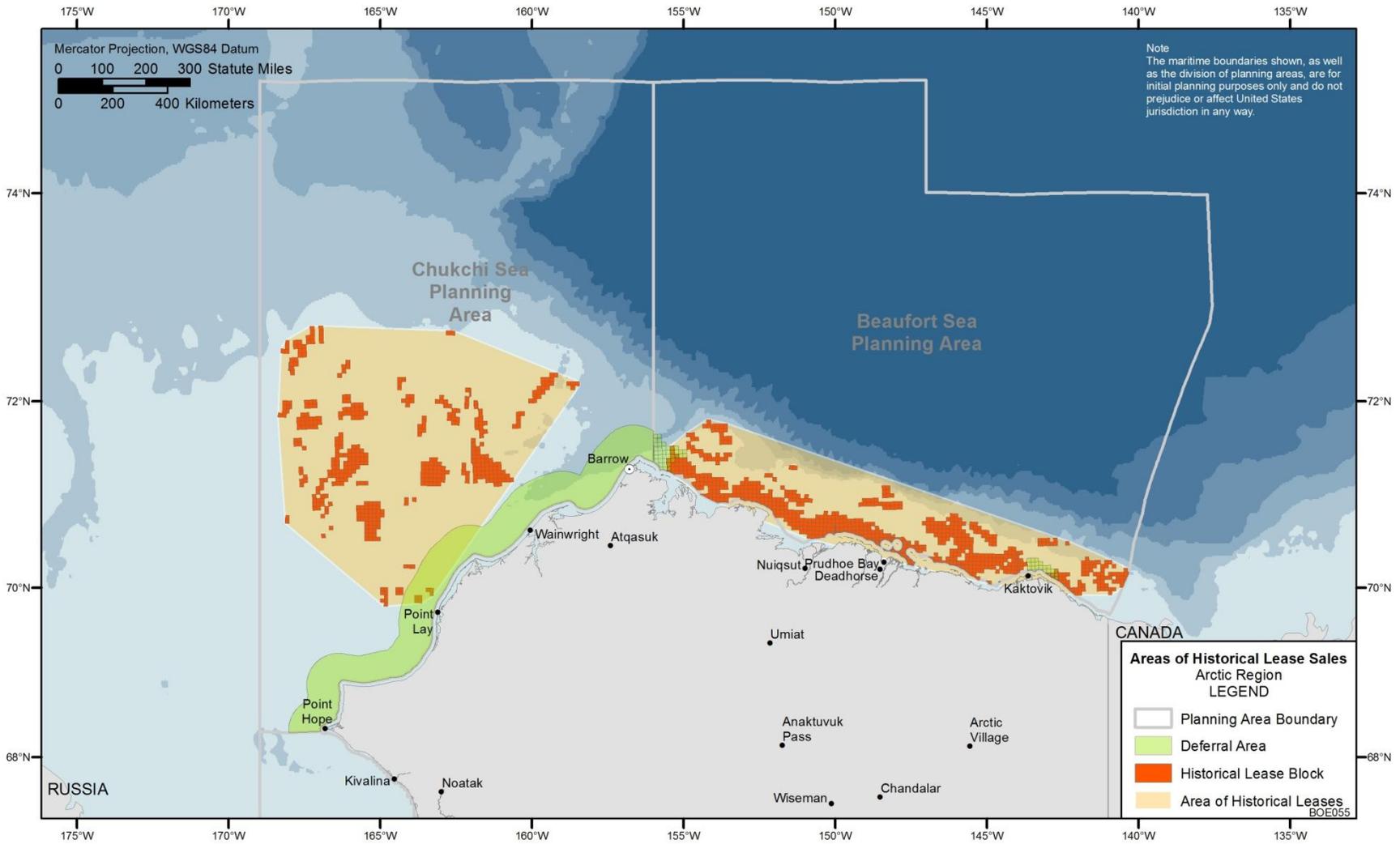
^a Bbbl = billion barrels.

^b Assumes that a natural gas pipeline from the North Slope will be operating by 2020 and have capacity for new supplies in 2030–2035; tcf = trillion cubic feet.

^c Assumes 46 m (150 ft) wide construction ROW; 7.3 ha (18 ac)/mi.

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5 **4.4.2 Accidental Spill Scenario**
6

7 Oil spills are unplanned accidental events. Depending on the phase of O&G development
8 and the location, magnitude, and duration of a spill, natural resources that may be affected
9 include marine mammals, marine and coastal birds, sea turtles, fish, benthic and pelagic
10 invertebrates, water quality, marine and coastal habitats, and areas of special concern (such as
11 marine parks and protected areas). Spills may also affect a variety of socioeconomic conditions
12 such as local employment, commercial and recreational fisheries, tourism, and subsistence. For



1
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FIGURE 4.4.1-2 Areas of Historical Lease Sales in the Beaufort and Chukchi Seas OCS Planning Areas

1 this draft PEIS, assumptions have been made about the occurrence and location of small and
2 large oil spills associated with the Program. Table 4.4.2-1 presents the assumptions for the
3 GOM, the Beaufort and Chukchi Seas, and Cook Inlet. The draft PEIS also considers the
4 potential impacts of a very large but low probability catastrophic discharge events (CDE), and
5 the assumptions for such events are presented in Table 4.4.2-2.
6

7 The source and number of assumed accidental spills were based on the volume of
8 anticipated oil production in each area, the assumed mode of transportation (pipeline and/or
9 tanker), and the spill rates for large spills. It is also assumed that these spills would occur with
10 uniform frequency over the life of the proposed action. Platform spills are assumed to occur in
11 areas proposed for lease consideration. Pipeline spills are assumed to occur between the
12 proposed lease areas and existing infrastructure. Tanker and barge spills are assumed to occur
13 along the tanker and barge routes from the lease areas to shore facilities.
14

15 Spills from tankers carrying oil produced in the Beaufort and Chukchi Sea Planning
16 Areas are assumed to occur outside of those planning areas. It is assumed that oil produced in
17 the Beaufort and Chukchi Sea Planning Areas would be delivered by offshore and onshore pipe
18 to TAPS, with subsequent delivery to the Valdez terminal facilities followed by tanker transport
19 to West Coast ports. Some tankering could also occur in the GOM to transport oil from floating
20 production, storage, and offloading (FPSO) facilities expected to operate in areas of the GOM
21 distant from existing pipelines.
22

23 24 **4.4.2.1 Spill Size Assumptions** 25

26 Spill size will vary greatly depending on the amount of oil released over a period of time
27 as a result of a single accidental event. For this draft PEIS, hypothetical spill sizes were
28 developed using OCS and U.S. tanker spill databases. The sizes of the assumed spills for each
29 spill type (platform, pipeline, tanker, or barge) are approximately equal to the median spill sizes
30 of historical spills for each spill type. Three categories of spill sizes are considered: small, large,
31 and catastrophic.
32

33 **Small Spills.** Analysis of historical data from the GOM, Pacific, and Alaska OCS
34 regions (Anderson, in preparation; MMS 2007b, 2008a). Examination of these data shows that
35 most offshore oil spills have been <1 bbl, accounting for approximately 95% of all OCS spills,
36 yet only less than 5% of the total volume of oil spills on the OCS (Anderson, in preparation;
37 Anderson and LaBelle 2000). Most of the total volume of OCS oil spilled (95%) has been from
38 spills ≥ 10 bbl. Between 1971 and 2009, 41,514 exploratory and development/production
39 operation wells were drilled on the OCS, and almost 16 billion bbl (Bbbl) of oil was produced.
40 During this period, there were 249 well control incidents during exploratory and
41 development/production operations on the OCS. These incidents were associated with
42 exploratory and development drilling, completion, workover, and production operations. Of
43 these well control incidents, 50 resulted in releases of crude oil ranging from <1 bbl to 450 bbl.
44 In 2010, there were 4 additional well control events. The loss of well control, explosion, and fire
45 on the DWH MODU resulted in the release of an estimated 4.9 million bbl of crude oil until the
46 well was capped on July 15, 2010.

1 **TABLE 4.4.2-1 Oil Spill Assumptions for the Proposed Action (Alternative 1)**

Scenario Elements	Assumed Spill Volume	Number of Spill Events ^a		
		Gulf of Mexico Region		Arctic Region
		Western, Central, and Eastern Planning Areas	Beaufort and Chukchi Planning Areas	South Alaska Region
				Cook Inlet
<i>Oil Production (Bbbl)^b</i>		2.7–5.4	0.7–2.5	0.1–0.2
Large (bbl)	≥1,000			
pipeline	1,700 ^c	2–5	1–2	1 spill from
platform	5,100 ^d	1–2	1	either
tanker	3,100–5,800 ^e	1		
Small (bbl) ^f	≥50 to <1,000	35–70	10–35	1–3
	≥1 bbl to <50	200–400	50–190	7–15

^a The assumed number of spills are estimated using the 1996–2010 spill rates in Anderson (in preparation). For the Alaska OCS region, the 1996–2010 spill rates were compared to fault-tree rates in Bercha Group Inc (2008a, b, 2006). The greater number of spills from Anderson (in preparation) is represented here.

^b Bbbl = billion barrels.

^c During the last 15 years (1996–2010), 7 oil spills ≥1,000 bbl occurred from U.S. OCS pipelines. The median spill size was 1,720 bbl. The maximum spill size between 1996 and 2010 from U.S. OCS pipelines was 8,212 bbl.

^d During the last 15 years (1996–2010), 2 oil spills ≥1,000 bbl occurred from U.S. OCS platforms. During Hurricane Rita, one platform and two jack-up rigs were destroyed, and a combined total of 5,066 bbl was spilled. The median spill size, when not accounting for a decreasing trend in the rate of platform spills, over 1964–2010, is 7,000 bbl.

^e 3,100 bbl for tankers in the GOM; 5,800 bbl for TAPS tankers transporting Alaska OCS oil.

^f The number of spills <1000 bbl is estimated using the total spill rate for both pipeline and platform spills.

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On the basis of the historical OCS spill data, for this draft PEIS small spills are considered to be ≤1,000 bbl in volume (Table 4.4.2-1). Small spills are further divided into two groups: small spills ≤50 bbl and small spills >50 bbl but ≤1,000 bbl (Table 4.4.2-1).

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Large Spills. The spill-size assumptions used for large spills are based on the reported spills from production in the GOM and Pacific OCS and what is anticipated as likely to occur (Anderson, in preparation; MMS 2007b, 2008a; Anderson and LaBelle 2000); there have been no large oil spills in the Alaska OCS region. For this PEIS, a large spill is considered to be ≥1,000 bbl. Between 1964 and 1999, there were 11 platform spills and 16 pipeline spills ≥1,000 bbl on the OCS (Anderson and LaBelle 2000). Between 2000 and 2010, there were 2 platform spills and 4 pipeline spills ≥1,000 bbl (Anderson, in preparation). The median sizes of these large spills from pipelines and platforms for 1964–2010 are 4,550 and 7,000 bbl,

1 **TABLE 4.4.2-2 Catastrophic Discharge Event Assumptions^a**

Program Area	Volume (million bbl)	Duration (days)	Factors Affecting Duration
Gulf of Mexico	0.9–7.2	30–90	Water depth
Arctic			
Chukchi Sea	1.4–2.2	40–75	Timing relative to ice-free season and/or availability of rig to drill relief well
Beaufort Sea	1.7–3.9	60–300	
Cook Inlet	0.075–0.125	50–80	Availability of rig to drill relief well

^a The Gulf of Mexico OCS region has estimated the discharge rate, volume of a spill, and the extent and duration for a catastrophic spill event for both shallow and deep water (in part) based on information gathered and estimates developed for the Ixtoc (1979) and the Deepwater Horizon (2010) oil spills. The Alaska OCS region has estimated a very large oil spill scenario based on a reasonable, maximum flow rate for each OCS Planning Area, taking into consideration existing geologic conditions and information from well logs. The number of days until a hypothetical blowout and discharge from a well could be contained was also estimated. These are discharge volumes and do not account for decreases in volume from containment or response operations.

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 4 respectively (Anderson, in preparation). The median sizes of these large spills from pipelines
 5 and platforms for 1996–2010 are 1,700 and 5,100 bbl, respectively (Anderson, in preparation).
 6 From 1971 to 2010, the DWH event in 2010 was the only loss of well control incident on the
 7 OCS that resulted in a spill volume $\geq 1,000$ bbl. This catastrophic discharge event is discussed
 8 separately below.

9
 10 **Catastrophic Discharge Event.** The CDE estimate is intended to provide a scenario for
 11 a low-probability event with the potential for catastrophic consequences. Past oil spills that may
 12 be relevant include the *Exxon Valdez* oil spill (262,000 bbl) (non-OCS program related) in
 13 Prince William Sound, south central Alaska, the Ixtoc oil spill (3,500,000 bbl) (non-OCS
 14 program related) in the western GOM, and the DWH event (4,900,000 bbl) in the northern GOM
 15 (McNutt et al. 2011). For this draft PEIS, CDEs were developed for each program area, taking
 16 into account considerations of water depth, weather conditions (such as ice cover) and the
 17 potential availability of response equipment for drilling relief wells. For the GOM Planning
 18 Areas, the CDE volumes range from 900,000 to 7,200,000 bbl, depending on the depth at which
 19 the loss of well control occurs (Table 4.4.2-2). For the Cook Inlet Planning Area, the CDE
 20 volume estimates range from 75,000 to 125,000 bbl, depending on the availability of a rig to drill
 21 a relief well. For the Chukchi Sea and Beaufort Sea Planning Areas, the CDE volume estimates
 22 range from 1,400,000 to 2,100,000 bbl and 1,700,000 to 3,900,000 bbl, respectively. For these
 23 CDE estimates, the range in volumes depends on the timing of the CDE relative to the ice-free
 24 (open water) season and on the availability of a rig to drill a relief well.

25
 26

1 **4.4.2.2 Spill Number Assumptions**

2
3 The number of spills <1,000 bbl assumed to occur during the years of activity of the
4 proposed action is estimated by multiplying the oil spill rate for each of the spill size groups by
5 the projected oil production as a result of the proposed action. Details on the methodology for
6 estimating spill rates (and thus spill number) can be found in Anderson (in preparation). As
7 shown in Table 4.4.2-1, most spills assumed to occur during the duration of the proposed action
8 would be in the small-volume category ($\leq 1,000$ bbl). As the spill size increases, the occurrence
9 rate decreases, so the number of estimated spills decreases. Estimates of the number of large
10 spills for the Beaufort and Chukchi Sea Planning Areas were also derived from fault-tree
11 modeled rates and compared to the rates from Anderson (in preparation) (Bercha Group,
12 Inc. 2008).

15 **4.4.3 Potential Impacts on Water Quality**

18 **4.4.3.1 Gulf of Mexico**

19
20 This section analyzes impacts on GOM coastal and marine waters. Coastal waters, as
21 defined here, include the bays and estuaries along the coast and State waters extending out to the
22 inward boundary of the territorial seas. Marine waters extend from this boundary out to the
23 Exclusive Economic Zone, or approximately 322 km (200 mi) from the coast.

24
25 Table 4.1.1-1 details impacting factors associated with oil and gas activities and the
26 development phase in which they can occur. The following factors affecting water quality have
27 been identified: disturbance of bottom sediments, wastes and disposal, vessel traffic, and
28 accidental spills. The water quality stressor activities associated with oil and gas development
29 are shown in Table 4.4.3-1.

30
31 Discharges to waters of the GOM are regulated by National Pollution Discharge
32 Elimination System (NPDES) OCS General Permit No. GMG290000 until Sept 30, 2012, for the
33 western GOM (off of Texas and Louisiana) and NPDES OCS General Permit No. GMG460000
34 until March 31, 2015, for the eastern GOM, including the Mobile and Viosca Knoll lease blocks
35 in the Central Planning Area.

36
37 Common impacts on water quality in both coastal and marine areas include impacts from
38 vessel traffic, well drilling, and operational discharges. During drilling, drilling muds are
39 circulated down a hollow drill pipe, through the drill bit, and up the annulus between the drill
40 pipe and the borehole. Drilling muds are used for the lubrication and cooling of the drill bit and
41 pipe. The muds also remove the cuttings that come from the bottom of the oil well and help
42 prevent loss of well control by acting as a sealant. The drilling muds carry drill cuttings
43 (i.e., crushed rock produced by the drill bit) to the surface. The drilling muds are then processed
44 on the platform to remove the cuttings and recycled back down the well. The separated cuttings
45 are, in most cases, discharged to the ocean. There are three classes of drilling muds used in the

1 **TABLE 4.4.3-1 Water Quality Impact Matrix**

Stressor and O&G Activity	Water Quality			
	Coastal Water	Shelf Water	Deepwater	Marine Water
Vessel Traffic Exploration, Construction, Operation, Decommissioning	X	X	X	X
Well Drilling: Exploration, Development	X	X	X	X
Pipelines: Trenching, Landfalls, Construction	X	X		X
Chemical Releases: Drilling, Normal Operational Discharges, Sanitary Wastes	X	X	X	X
Platforms: Anchoring, Mooring, Removal	X	X	X	X
Onshore Construction	X			
Oil Spills	X	X	X	X

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industry: water-based muds (WBM), oil-based muds (OBMs), and synthetic-based muds (SBMs) (Neff et al. 2000). The WBMs used in most offshore drilling operations in U.S. waters consist of fresh- or saltwater, barite, clay, caustic soda, lignite, lignosulfonates, and/or water-soluble polymers. The OBMs use mineral oil or diesel oil as the base fluid rather than fresh- or saltwater. They offer several technical advantages over WBMs for difficult drilling operations; however, because of their persistence and adverse environmental effects, OBMs and associated cuttings have been banned from ocean discharges in U.S. waters and must be transported to shore for disposal (Neff et al. 2000). The synthetic-based fluids (SBFs) are a family of products developed in the 1990s to provide drilling performance similar to that of oil-based fluids, but with improved biodegradation characteristics and decreased ecotoxicity (Neff et al. 2000). The types that would be used most frequently would be those that meet the requirements of the NPDES permit. The SBF-wetted cuttings are permitted for ocean discharge, while the spent fluid is transported to shore for reuse or disposal (Neff et al. 2000).

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Discharges of drilling muds and cuttings during normal operations are regulated by NPDES general permits issued by the U.S. Environmental Protection Agency (USEPA). In areas where disposal of drilling muds and/or cuttings at sea are permitted under an NPDES general permit and BOEM and BSEE regulations, their environmental effects are localized because of settling, mixing, and dilution (Montagna and Harper 1996; Neff et al. 2000; Continental Shelf Associates 2004c). The majority of cuttings are found within 250 m (820 ft) of a drilling site (Continental Shelf Associates 2004c). Constituents of SBF cuttings have been found in an approximately 1 ha (2.5 ac) area surrounding a drilling rig at concentrations that may cause harm to wildlife (Neff et al. 2000).

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Produced water is water that is brought to the surface from an oil-bearing formation during oil and gas extraction. It is the largest individual discharge produced by normal operations. Small amounts of oil are routinely discharged in produced water during OCS operations. The USEPA has set an effluent limitation of 29 mg/L for the oil content of produced waters (MMS 2007b). Produced water may contain specialty chemicals added to the well for process purposes (e.g., biocides and corrosion inhibitors) and chemicals added during treatment

1 of the produced water before its release to the environment (e.g., water clarifiers). Produced
2 water can have elevated concentrations of several constituents, including salts, petroleum
3 hydrocarbons, some metals, and naturally occurring radioactive material (NORM). Petroleum
4 hydrocarbons in produced water discharges are a major environmental concern. The most
5 abundant hydrocarbons in produced water are benzene, toluene, ethylbenzene, and xylenes
6 (BTEX) and low-molecular-weight saturated hydrocarbons. The BTEX compounds rapidly
7 evaporate into the atmosphere, leaving behind less volatile, heavier compounds (weathering)
8 (NRC 2003b). Polycyclic aromatic hydrocarbons (PAHs) are heavier hydrocarbons in produced
9 water and are a concern because of the toxicity of some PAHs and their persistence in the marine
10 environment (Rabalais et al. 1991).

11
12 The NORM waste in produced water includes the radium isotopes Ra-226 and Ra-228
13 and is a concern because it is radioactive. However, in produced water discharges, radium
14 coprecipitates with barium sulfate and is not available for uptake by organisms (Neff 2002).

15
16 Generally, the amount of produced water is low when production begins but increases
17 over time near the end of the field life. In a nearly depleted field, production may be as high as
18 95% water and 5% fossil fuels (Rabalais et al. 1991). The National Research Council (2003a)
19 estimated that the total amount of produced water being released into GOM waters was
20 660 million bbl/yr in the 1990s. Between 1996 and 2005, the annual volume of produced water
21 varied between 432 million bbl/yr and 686 million bbl/yr, with an average discharge of 596
22 million bbl/yr (MMS 2007b).

23
24 Before being discharged into the ocean, produced water is typically treated and must
25 meet NPDES requirements regarding discharge rate, contaminant concentration, and toxicity,
26 thereby reducing the potential for contamination. However, the discharge of produced water into
27 the sea may degrade water and sediment quality in the immediate vicinity of the discharge point
28 because of its potential constituents. Studies have shown contaminated sediments exist in areas
29 up to 1,000 m (3,280 ft) from a produced water discharge point, indicating water quality in that
30 zone has been affected by produced water discharges (Rabalais et al. 1991). Because discharge
31 points are typically much farther apart than 1,000 m (3,280 ft), no interactions that would
32 measurably affect water quality are expected between them, and background concentrations are
33 expected to exist away from the immediate discharge location. Two recent studies have shown
34 that produced water discharges do not make a significant contribution to the hypoxic conditions
35 that are seen in the GOM (Veil et al. 2005; Bierman et al. 2007).

36
37 Normal operations for the proposed action would also involve the use of vessels with
38 associated impacts. Compliance with NPDES permits and USCG regulations would prevent or
39 minimize most impacts on the environment caused by ship traffic.

40
41 The placement of drilling units and platforms would disturb bottom sediments and
42 produce turbidity in the water. This impact would be unavoidable; however, these impacts
43 would be temporary and water quality would return to normal (e.g., background concentrations
44 of suspended solids) within minutes to hours without mitigation because of mixing, settling, and
45 dilution.

46

1 **4.4.3.1.1 Routine Operations.**
2

3 **Coastal Waters.** Routine activities potentially affecting coastal water quality include
4 pipeline landfalls, well completion activities, platform construction, and operation discharges.
5 The estimated exploration and development scenario for the GOM for the proposed action is
6 presented in Table 4.4.1-1 and estimated depth distribution of the activities in Table 4.4.1-2.
7

8 Construction and installation of exploratory and development wells (up to 100 and 600,
9 respectively), platforms (up to 450), and offshore pipelines (up to 12,000 km [7,500 mi]) would
10 affect water quality and disturb habitats (see Table 4.4.1-1). Such activities would disturb
11 bottom sediments and increase the turbidity of the water in the area of construction. Trenching
12 operations to bury pipelines would produce turbidity (i.e., increased suspended solids) in the
13 coastal waters along pipeline corridors. The disturbance of bottom sediments caused by these
14 operations would be unavoidable. However, these impacts would be temporary, and water
15 quality would return to normal (i.e., background concentrations) without mitigation, once these
16 activities were completed because of settling and mixing.
17

18 Construction of new onshore support facilities (up to 11 pipeline landfalls, 6 pipe yards,
19 and 12 processing facilities) could affect the quality of nearshore and fresh waters in the GOM
20 Planning Areas. During land site preparation, vegetation is typically cleared from the area,
21 compacting the topsoil, because of the constant movement of heavy machinery. This
22 compaction would reduce the water retention properties of the soil and increase erosion and
23 surface runoff from the site. Water quality would be degraded by increases in site runoff of
24 particulate matter, heavy metals, petroleum products, and chemicals to local streams, estuaries,
25 and bays. Proper siting of facilities and requirements associated with NPDES construction
26 permits should largely mitigate these impacts.
27

28 The OCS service and construction vessel traffic to and from platform sites within the
29 planning area (up to 600 vessel trips per week) would also affect water quality through the
30 permitted release of operational wastes. Routine vessel-associated discharges that could affect
31 coastal water quality include sanitary wastes and bilge water. Bilge water discharges from
32 support vessels could contain petroleum and metals from machinery. Bilge water and sanitary
33 discharges to larger coastal water channels would produce local and temporary effects because of
34 the large volume of water available to dilute the discharges and the presence of currents that
35 would promote mixing. However, in confined portions of some channels, there might be
36 insufficient water volume or currents for mixing and dilution. In such regions, water quality
37 could be degraded. Compliance with applicable NPDES permits and USCG regulations would
38 prevent or minimize most impacts on receiving waters. Discharges in coastal areas are regulated
39 by State-issued or Federal NPDES permits specifically for coastal areas.
40

41 Produced water discharges were banned in coastal waters of the GOM in the late 1990s,
42 and reinjection of produced water is practiced in coastal areas to avoid discharges (NRC 2003b;
43 Wilson 2007).
44

45 **Marine Waters.** Marine waters can be divided into continental shelf waters and deep
46 waters. Continental shelf waters are defined as those waters that lie outside of the coastal waters

1 and have a depth less than 305 m (1,000 ft). Deep waters are located in regions that are equal to
2 or deeper than 305 m (1,000 ft).

3
4 Routine operations that could affect water quality include anchoring, mooring, drilling
5 and well completion activities, well testing and cleanup operations, flaring/burning, facility
6 installation and operations, support service activities, decommissioning, and site clearance.
7 Construction and installation of exploratory and development wells (up to 1,200), platforms
8 (up to 450), and offshore pipelines (up to 12,000 km [7,500 mi]) would affect water quality and
9 disturb habitats (see Table 4.4.1-1).

10
11 As with coastal areas, OCS vessel traffic to and from platform sites within the planning
12 area (up to 600 vessel trips per week) would also affect water quality through the permitted
13 release of operational wastes (such as bilge water). Because of the relatively small volumes that
14 would be discharged, these waste materials would be quickly diluted and dispersed, and any
15 impacts on water quality would be highly localized and temporary. Compliance with applicable
16 NPDES permits and USCG regulations would prevent or minimize most impacts on receiving
17 waters.

18
19 Sanitary and domestic waste and deck drainage would occur from platforms, drilling
20 vessels, and service vessels as part of normal operations and could contribute to water quality
21 degradation. However, sanitary and domestic wastes would be routinely processed through
22 onsite waste treatment facilities before being discharged overboard, and deck drainage would be
23 treated onsite to remove oil and then discharged. Sand and sludge recovered from the treatment
24 processes would be containerized and shipped to shore for disposal. Impacts on water quality
25 from such discharges would require no mitigation because of the treated nature of the wastes, the
26 small quantities of discharges involved, and the mixing and dilution of the wastes with large
27 volumes of water.

28
29 Discharges associated with drilling and production are discussed in Section 4.4.3.1.
30 Normal operations for the proposed action would also involve the use of vessels with associated
31 impacts, such as those discussed for related impacts on coastal areas. Compliance with NPDES
32 permits and USCG regulations would prevent or minimize most impacts on the environment.

33
34 The placement of drilling units and platforms would disturb bottom sediments and
35 produce turbidity in the water. Pipeline trenching, required in water depths less than 61 m
36 (200 ft), would also produce turbidity along pipeline corridors. This impact would be
37 unavoidable; however, these impacts would be temporary, and water quality would return to
38 normal (e.g., background concentrations of suspended solids) within minutes to hours without
39 mitigation because of mixing, settling, and dilution.

40
41 As discussed in Section 3.4.1.2, hypoxic conditions exist on the Louisiana-Texas shelf.
42 The size of the hypoxic zone varies from year to year. The hypoxic zone attained a maximum
43 measured extent in 2002, when it encompassed about 22,000 km² (8,494 mi²). Normal
44 operations from oil and gas production in the GOM could affect the extent and severity of the
45 hypoxic zone through discharges and accidental releases. Very preliminary calculations reveal
46 that ammonium and oil and grease contained in produced water are a small percentage of that

1 contributed by the Mississippi River to the hypoxic zone (Rabalais 2005). A study that
2 monitored oxygen-demanding substances and nutrients in the produced water discharges from
3 50 platforms found that produced water discharges contributed less than 1% of the oxygen-
4 demanding substances to the hypoxic zone (Veil et al. 2005).

5
6 For the proposed action, the compositions and volumes of discharges would be expected
7 to be about the same as those observed historically, and compliance with existing NPDES
8 permits would minimize impacts on receiving waters (e.g., through limitations on concentrations
9 of toxic constituents). Water quality likely would recover without mitigation when discharges
10 ceased because of dilution and dispersion.

11
12 Although deepwater operations and practices are similar to those used in shallower
13 environments, there are some significant differences. Three of these are seafloor discharges
14 from pre-riser and riserless drilling operations, discharge of cuttings wetted with SBFs, and more
15 extensive and frequent use of chemical products to enhance oil and gas throughput because of
16 the temperatures and pressures present at the seafloor, including their use within pipelines to
17 facilitate the transport of large quantities of methanol and other chemicals to and from the shore.

18
19 Floating production facilities are used in deepwater rather than conventional, bottom-
20 founded (i.e., fixed) platforms. These deepwater facilities include floating production
21 semisubmersibles, tension leg platforms, and spars (Harbinson and Knight 2002). Often these
22 facilities are surface hubs for several subsea systems. Therefore, in deep water, there will be far
23 fewer and more widely spaced surface facilities than on the shelf, but these facilities will have
24 increased discharges of produced waters over time due to the larger volume being processed.

25
26 In order to enhance the throughput of oil and gas in deep water, more extensive and
27 frequent use of some chemical products is anticipated because of the temperatures and
28 pressures encountered at the seafloor. Chemicals most likely to be present in deepwater
29 operations and drilling include monoethylene glycol, methanol, corrosion inhibitors, and
30 biocides (Grieb et al. 2008). The toxicity of these substances varies, but the impact on water
31 quality would be temporary and localized (within feet of a release), due to the small quantities in
32 which they would likely be released and the amount of dilution and mixing that would occur in a
33 subsea environment (Grieb et al. 2008).

34
35 Deepwater activities could incrementally increase support activities and the expansion,
36 construction, or modification of onshore support bases due to the deeper draft of these support
37 vessels. The impacts resulting from this growth would be common to all OCS support facilities
38 (point-source waste discharges, runoff, dredging, and vessel discharges) and not specific to
39 deepwater activities. Short-term degradation of water quality might increase at a few support
40 base locations that would be expected to grow as a consequence of deepwater activities
41 (including Corpus Christi, Galveston, and Port Fourchon).

1 **4.4.3.1.2 Accidents.**

2
3 **Coastal Waters.** Accidental releases could affect the quality of coastal water in the
4 GOM. The magnitude and severity of impacts would depend on spill location and size, type of
5 product spilled, weather conditions, and the water quality and environmental conditions at the
6 time of the spill.

7
8 Under the proposed action, the number and types of spills assumed to occur in the GOM
9 Planning Area include up to seven large spills (i.e., $\geq 1,000$ bbl), up to five spills at a volume of
10 1,700 bbl from pipelines, up to two spills at a volume of 5,000 bbl from platforms, and up to one
11 spill at a volume of 3,100 bbl from a tanker. Between 35 and 70 small spills with volumes
12 between 50 and 999 bbl are assumed to occur, as well as between 200 and 400 very small spills
13 with volumes between 1 and 50 bbl (Table 4.4.2-1).

14
15 Weathering processes that transform the oil, such as volatilization, emulsification,
16 dissolution, chemical oxidation, photo-oxidation, and microbial oxidation, may reduce impacts
17 of oil spills in the GOM Planning Areas on coastal water quality (NRC 2003b; NOAA 2005).
18 Dissolution, which is a small component of weathering, can be important to biological
19 communities because the most soluble fractions are often the most toxic (Shen and Yapa 1988).
20 Because oil is generally less dense than water, it would tend to float on the sea surface. Lighter
21 oil fractions such as BTEX would readily evaporate from the surface and, therefore, would not
22 be a continuing source of potential water contamination. Following a spill, light crude oils can
23 lose as much as 75% of their initial volume to evaporation as the lighter components
24 (e.g., BTEX) change from the liquid to the gas phase; medium-weight crude oils can lose as
25 much as 40% (NRC 2003b).

26
27 If a large spill occurred in enclosed coastal waters or was driven by winds, tides, and
28 currents into an enclosed coastal area, water quality would be adversely affected. These impacts
29 could be increased if they occurred in areas with degraded water quality, such as areas
30 continuing to be affected by the DWH. Similarly, if a large tanker spill were to happen near
31 port, adverse impacts on coastal waters could occur. In such a low-energy environment (i.e., an
32 environment in which there is limited wave and current activity), the oil would not be easily
33 dispersed, and weathering could be slower than it would be in the open sea. Effects on water
34 quality could persist if oil reached coastal wetlands and was deposited in fine sediments,
35 becoming a long-term source of pollution because of remobilization. In such locations, spill
36 cleanup might be necessary for the recovery of the affected areas. Potential impacts from spill
37 response and cleanup activities are discussed below. As a result of the DWH event, residual oil
38 was still being removed from shorelines as of January 2011 (Geoplatform 2011a, b). However,
39 supratidal buried oil, small surface residue balls, and submerged oil mats are three types of
40 residual oil from the DWH spill in the nearshore zone that were identified as being more
41 damaging to completely remove from coastal habitats than to let them remain and naturally
42 attenuate (OSAT-2 2011). Oiled shorelines might also be washed with warm or cold water,
43 depending on the shore's location.

44
45 Small oil spills (<1,000 bbl) or very small oil spills (<50 bbl) would produce small but
46 measurable impacts on water quality. Assuming that all small and very small spills would not

1 occur at the same time and place, water quality would rapidly recover without mitigation because
2 of mixing, dilution, and weathering. However, impacts could be increased if they occurred in
3 areas with degraded water quality, such as areas continuing to be affected by the DWH event.
4

5 **Marine Waters.** Accidental releases could affect the quality of marine waters in the
6 GOM Planning Areas. The number and types of spills assumed to occur in the GOM Planning
7 Areas are the same as those discussed above for coastal waters. The magnitude of these impacts
8 and the rate of recovery would depend on the location and size of the spill, the type of product
9 spilled, weather conditions, and environmental conditions at the time of the spill. Failures of
10 production-related piping, seals, and connections have been identified as key risks for releases
11 that may affect water quality in deepwater environments, with loss of well control presenting the
12 highest risk of environmental impacts (Grieb et al. 2008). Because of the depths of some
13 deepwater drilling operations, servicing any leak identified during subsea drilling and production
14 operations would be more difficult and require remotely operated vehicles for depths greater than
15 610 m (2,000 ft) (Grieb et al. 2008). Each piping connection presents a potential for leakage due
16 to human error, corrosion, or erosion (Grieb et al. 2008). In general, oil spilled below the surface
17 rises rapidly as droplets that coalesce to form a slick. Standard response procedures for a spill
18 could then be used.
19

20 Because deepwater operations can be located far from shore, tankers could be used to
21 shuttle crude oil to shore stations. This transport of oil from operations in deep water has the
22 potential to produce spills that could affect coastal waters within a very short time if the spill
23 occurred near the port. It is expected that such spills could release approximately 3,100 bbl of
24 oil. Such a release could retain a large volume of oil in the slick at the time it contacted land.
25

26 Small oil spills (<1,000 bbl) and very small oil spills (<50 bbl) would have measurable
27 impacts on water quality. If it is assumed that all small and very small spills would not occur at
28 the same time and place, water quality would rapidly recover without mitigation because of
29 mixing, dilution, and weathering.
30

31 **Spill Response and Cleanup.** Spill response and cleanup activities in coastal and marine
32 water could include, depending on location, use of chemical dispersants, *in situ* burning, use of
33 vessels and skimmers, and beach cleaning and booming (BOEMRE 2011k).
34

35 Dispersants are combinations of surfactants and solvents that work to break surface oil
36 into smaller droplets that then disperse on the surface and into the water column. Many factors
37 affect the behavior, efficacy, and toxicity of a particular dispersant, including water temperature,
38 surface salinity, wave and wind energy, light regime, water depth, type of oil, concentration of
39 dispersant, how the dispersant is applied (constant or intermittent spikes), and exposure time to
40 organisms. Dispersants are used to degrade an oil spill more quickly through increasing surface
41 area and to curtail oil slicks from reaching shorelines (Word et al. 2008). As oil breaks into
42 smaller droplets, it can distribute vertically in the water column. If oil droplets adhere to
43 sediment, the oil can be transported to the seafloor and interstitial water in the sediment. In
44 shallow nearshore waters, wind, wave, and current action would more likely mix the dispersant-
45 oil mixture into the water column and down to the seafloor environment. Chemically dispersed
46 oil is thought to be more toxic to water column organisms than physically dispersed oil, but the

1 difference is not clear-cut, and generally the toxicity is within the same order of magnitude
2 (NRC 2005b).

3
4 *In situ* burning is used to reduce an oil spill more quickly and to curtail oil slicks from
5 reaching shorelines. *In situ* burning could increase the surface water temperature in the
6 immediate area and produce residues. The uppermost layer of water (upper millimeter or less)
7 that interfaces with the air is referred to as the microlayer. Important chemical, physical, and
8 biological processes take place in this layer, and it serves as habitat for many sensitive life stages
9 and microorganisms (GESAMP 1995). Disturbance to this layer through temperature elevation
10 could cause negative effects on biological, chemical, and physical processes.

11
12 Residues from *in situ* burning can float or sink depending on the temperature and age of
13 the residue. Floating residue can be collected; however, residues that sink could expose the
14 benthic waters and sediment to oil components as the residue degrades on the seafloor.

15
16 The NOAA Office of Response and Restoration states, “Overall, these impacts [from
17 open water *in situ* burning] would be expected to be much less severe than those resulting from
18 exposure to a large, uncontained oil spill” (NOAA 2011d).

19
20 Oiled shorelines might be washed with warm or cold water, depending on the shore’s
21 location. Oil dispersants and surface washing agents used to clean up a spill could also be a
22 source of impacts to water quality for coastal areas in the event of a spill (EIC and NCSE 2010;
23 Coastal Response Research Center 2010). Beach cleaning and booming activities could result in
24 effects from suspended sediment in waters and resettlement of sediments elsewhere, possible
25 resuspension of hydrocarbons, and runoff of treatment-laden waters that could affect nearshore
26 temperature and nutrient concentrations (BOEMRE 2011k).

27
28 **Catastrophic Discharge Event.** For the GOM Planning Areas, a low-probability CDE
29 could have a volume of 900,000 to 7,200,000 bbl (Table 4.4.2-2). A catastrophic discharge
30 event in either coastal or marine water could present sustained degradation of water quality from
31 hydrocarbon contamination in exceedence of State and Federal water and sediment quality
32 criteria. These effects could be significant depending upon the duration and area impacted by the
33 spill. Additional effects on water quality would occur from response and cleanup vessels, *in situ*
34 burning of oil, dispersant use, discharges and seafloor disturbance from relief well drilling, and
35 activities on shorelines associated with cleanup, booming, beach cleaning, and monitoring.

36 37 38 **4.4.3.2 Alaska Cook Inlet**

39
40 This section analyzes impacts on coastal and marine waters in the Cook Inlet Planning
41 Area. Coastal waters, as defined here, include the bays and estuaries along the coast and State
42 waters extending out to the inward boundary of the territorial seas. Marine waters extend from
43 this boundary out to a water depth of 200 m (656 ft).

44
45 Section 4.1.1 details impacting factors for activities associated with oil and gas activities
46 and the development phases in which they can occur. The following factors affecting water

1 quality have been identified: disturbance of bottom sediments, wastes and disposal, vessel
2 traffic, and accidental spills. The water quality stressor activities associated with oil and gas are
3 shown in Table 4.4.3-1. Note that no onshore construction or pipeline landfalls are anticipated
4 for the Cook Inlet Planning Area for the lease sales during 2012-2017 period.

5
6 Discharges to waters of Cook Inlet are regulated by NPDES OCS General Permit
7 No. AKG-31-5000 until July 2, 2012.

8
9 Common impacts on water quality in both coastal and marine areas include those from
10 vessel traffic, well drilling, and operational discharges. The types of impacts expected are the
11 same as those discussed above in Section 4.4.3.1.

12 13 14 **4.4.3.2.1 Routine Operations.**

15
16 **Coastal Waters.** Routine activities potentially affecting coastal water quality include
17 pipeline landfalls, well completion activities, platform construction, and operational discharges.
18 The estimated exploration and development scenario for Cook Inlet is presented in Table 4.4.1-3.

19
20 Construction and installation of exploratory and development wells (up to 12 and 114,
21 respectively), platforms (up to 3), and offshore pipelines (up to 240 km [150 mi]) would affect
22 water quality and disturb habitats (see Table 4.4.1-3). Trenching operations to bury pipelines
23 would produce turbidity (i.e., increased suspended solids) in the coastal waters along pipeline
24 corridors. Increased water turbidity would also result from placing drilling units and platforms.
25 The disturbance of bottom sediments caused by these operations would be unavoidable.
26 However, these impacts would be temporary, and water quality would return to normal
27 (i.e., background concentrations) without mitigation, once these activities were completed,
28 because of settling and mixing.

29
30 Construction of new onshore pipelines (up to 169 km [105 mi]) would also impact coastal
31 water quality in the Cook Inlet Planning Area. Proper siting of facilities and requirements
32 associated with NPDES construction permits would largely mitigate these impacts. The impacts
33 on water quality would range from negligible to minor, depending on site location and
34 construction and mitigation activities.

35
36 Increased turbidity from construction and installation activities would occur in the
37 immediate area of the activity. Contaminants introduced into Cook Inlet waters by these
38 activities would be diluted and dispersed by complex currents associated with the tides (diurnal
39 tidal variations at the upper end of the Cook Inlet at Anchorage can be 9 m [30 ft]), estuarine
40 circulation, wind-driven waves, and Coriolis forces (MMS 2003a; Royal Society of
41 Canada 2004). Seawater enters the Lower Cook Inlet from the Gulf of Alaska at the Kennedy
42 Entrance south of the Kenai Peninsula, and fresh water enters the inlet from numerous streams
43 along the east, north, and west shorelines; major freshwater inputs include the Susitna and Kenai
44 Rivers. Seawater circulates northward in Cook Inlet along its eastern boundary, mixes with fresh
45 water in the northern end, and flows southward along the western boundary. Water exits the
46 lower Cook Inlet through Shelikof Strait and discharges into the Gulf of Alaska (MMS 2002a).

1 Surface currents in Cook Inlet can exceed 5 knots (5.7 mph), and bottom currents can reach
2 1.5 knots (1.7 mph) (Royal Society of Canada 2004). Approximately 90% of waterborne
3 contaminants would be flushed from the lower Cook Inlet within about 10 months
4 (MMS 2003a). Contaminants flushed from Cook Inlet would pass through Shelikof Strait and
5 enter the Gulf of Alaska. Because of dilution, settling, and flushing, impacts from these
6 activities would be local and temporary.
7

8 In addition to affecting the turbidity of coastal waters in the Cook Inlet, construction
9 activities would produce waste materials. The majority of wastes generated during construction
10 and developmental drilling would consist of drill cuttings and spent muds (MMS 2002a).
11 Drilling muds and cuttings generated when installing exploration and delineation wells would be
12 discharged at the well site. The volume of drilling fluids and cuttings vary depending upon the
13 well characteristics, but, in general, fluids average approximately 500 bbl/well, and drill cuttings
14 would comprise the equivalent of approximately 600 tons/well of dry rock. Thus, under the
15 proposed action, up to 6,000 bbl of drilling fluids and up to 7,200 tons of drill cuttings could be
16 disposed of in the waters of the Cook Inlet Planning Area. All drilling muds and cuttings
17 associated with development and production wells would be treated and reinjected into the well.
18 Discharge of drilling muds and cuttings would increase turbidity in the vicinity of the well. The
19 discharge would contain trace metal and hydrocarbon constituents that would be suspended in
20 the water column and subsequently deposited on the seafloor. These drilling discharges must
21 comply with NPDES permit requirements regarding the discharge amount, rate, and toxicity,
22 which would greatly reduce the impact to water quality.
23

24 Because all produced water would be discharged down hole, there would be no impacts
25 on water quality from these operational discharges. Domestic wastewater would also be
26 generated by these activities. This material would be injected into a disposal well. Solid wastes,
27 including scrap metal, would be hauled offsite for disposal at an approved facility.
28

29 The OCS service and construction vessel traffic to and from platform sites within the
30 planning area (up to nine vessel trips per week) would also affect quality through the permitted
31 release of operational wastes. Routine vessel-associated discharges that could affect coastal
32 water quality include sanitary wastes and bilge water. Bilge water discharges from support
33 vessels could contain petroleum and metals from machinery. Bilge water and sanitary discharges
34 to larger coastal water channels would produce local and temporary effects because of the large
35 volume of water available to dilute the discharges and the presence of currents that would
36 promote mixing. However, in confined portions of some channels, there might be insufficient
37 water volume or currents for mixing and dilution. In such regions, water quality could be
38 degraded. Compliance with applicable NPDES permits and USCG regulations would prevent or
39 minimize most impacts on receiving waters. Discharges in coastal areas are regulated by State-
40 issued or Federal NPDES permits specifically for coastal areas.
41

42 The National Research Council (2003b) estimated that the total amount of produced
43 water being released into Cook Inlet waters was 45.7 million bbl/yr in the 1990s. Produced
44 water can contain hydrocarbons, salts, and metals at levels toxic to marine organisms. Before
45 being discharged into the ocean, produced water is typically treated and must meet NPDES
46 requirements regarding discharge rate, contaminant concentration, and toxicity, thereby reducing

1 the potential for sediment contamination. However, under the current NPDES permits, new
2 facilities would not be allowed to discharge produced water into Cook Inlet. Under the proposed
3 action, it is anticipated that all produced waters would be treated and reinjected into the well.
4 Therefore, no impacts on water quality are expected to result from produced water.
5

6 **Marine Waters.** Routine operations that could affect marine water quality in the Cook
7 Inlet Planning Area include anchoring, mooring, drilling and well completion activities, well
8 testing and cleanup operations, flaring/burning, facility installation and operations, support
9 service activities, decommissioning, and site clearance. These activities would disturb the
10 seafloor and increase the suspended sediment load in the water column. Offshore pipelines in
11 Alaska are normally placed in a dredged trench in waters less than about 60 m (197 ft) deep.
12 Dredged material from the trenches can be used to cover the pipeline. Fill deposited during
13 artificial island construction also increases turbidity. As these operations are reversed and
14 structures removed, increased turbidity would reoccur. In general, plumes from these activities
15 extend a few hundred meters to a few kilometers down current, but the length of the plume
16 would depend on rate and duration of discharge, sediment grain size, current regime, source type,
17 water column turbulence, and season. The direction of plume movement would be influenced by
18 the general circulation pattern in the planning area and local ambient conditions. Suspended
19 sediments in the plumes are expected to have toxicity ranges that are generally described as
20 nontoxic to slightly toxic (National Academy of Sciences 1983). Overall, it is anticipated that
21 the impacts on water quality from routine operations would be localized and temporary. As with
22 coastal water impacts, dilution, settling, and rapid flushing would minimize any long-lasting
23 impacts on water quality.
24

25 Adverse water quality impacts would also be produced by routine discharges of domestic
26 waste (e.g., wash water, sewage, and galley wastes) and deck drainage (platform and deck
27 washings, and gutters and drains, including drip pans and work areas). Domestic waste would
28 increase suspended solids in the receiving water, thereby increasing turbidity and biological
29 oxygen demand. Sanitary and domestic wastes are monitored in accordance with the NPDES
30 permit. Established effluent limitations and guidelines published in 40 CFR Part 435, and
31 operator compliance should minimize impacts on ambient water quality. Such impacts would be
32 local and temporary.
33

34 The principal discharges of concern during drilling would be muds and cuttings. Drilling
35 muds and cuttings generated when installing exploration and delineation wells would be
36 discharged at the well site. All drilling muds and cuttings associated with development and
37 production wells would be treated and reinjected into the well. See the discussion above for
38 coastal waters for further information on potential impacts of discharging drilling muds and
39 cuttings.
40

41 During operations, all produced water would be reinjected into the well in the Cook Inlet
42 Planning Area, there produced water generated from activities associated with the proposed
43 action would have no impacts on marine water quality.
44

45 As with coastal waters, OCS vessels traveling to and from platform sites within the
46 planning area (up to three vessel trips per week per platform) could affect local water quality as a

1 result of operational discharge of waste fluids. Because of dilution, settling, and flushing, water
2 quality impacts from such discharges would be localized and temporary.
3

4 5 **4.4.3.2.2 Accidents.** 6

7 **Coastal Waters.** Accidental releases could affect the quality of coastal water in the
8 Cook Inlet. The magnitude and severity of impacts would depend on the spill location and size,
9 type of product spilled, weather conditions, and the water quality and environmental conditions
10 at the time of the spill.
11

12 Under the proposed action, the number and types of spills assumed to occur in the Cook
13 Inlet Planning Area include up to one large spill (i.e., $\geq 1,000$ bbl) from either a platform
14 (5,100 bbl) or a pipeline (1,700 bbl), up to three small spills with volumes between 50 and
15 999 bbl; and up to 15 very small spills with volumes between 1 and 50 bbl (Table 4.4.2-1). For
16 conservative analysis (i.e., one in which impacts would be greater than those that would actually
17 occur), all the spills are assumed to occur in Cook Inlet coastal waters. Such spills would
18 adversely affect water quality. A spill in isolated coastal waters, in shallow waters under thick
19 ice, or in rapidly freezing ice could cause sustained degradation of water quality to levels that are
20 above State or Federal criteria for hydrocarbon contamination. Concentrations could exceed the
21 chronic criterion of 0.015 ppm total hydrocarbons, but this exceedance would probably occur
22 over a relatively small area. Persistent small spills in such areas could result in local chronic
23 contamination. In most cases, spills would be rapidly diluted. In some cases, however, water
24 quality could be degraded to a greater extent.
25

26 Weathering processes that transform the oil, such as volatilization, emulsification,
27 dissolution, chemical oxidation, photo-oxidation, and microbial oxidation, may reduce impacts
28 of oil spills on coastal water quality in the Cook Inlet Planning Area (NRC 2003b; NOAA 2005).
29 Dissolution, which is a small component of weathering, can be important to biological
30 communities because the most soluble fractions are often the most toxic (Shen and Yapa 1988).
31 Because oil is generally less dense than water, it would tend to float on the sea surface. Lighter
32 oil fractions such as BTEX would readily evaporate from the surface and, therefore, would not
33 be a continuing source of potential water contamination. Following a spill, light crude oils can
34 lose as much as 75% of their initial volume to evaporation as the lighter components
35 (e.g., BTEX) change from liquid to gas phase; medium-weight crude oils can lose as much as
36 40% (NRC 2003b).
37

38 Spills would tend to move in directions consistent with established circulation patterns
39 for the planning area (i.e., northward along the Kenai Peninsula and southward along the Alaska
40 Peninsula). Actual flow paths would be affected by winds, tides, ice cover, temperature, and
41 cleanup activities.
42

43 If a large spill were to happen near port, there could be adverse impacts on coastal waters.
44 In such a low-energy environment (i.e., an environment in which there is limited wave and
45 current activity), the oil would not be easily dispersed, and weathering could be slower than it
46 would be in the open sea. Effects on water quality could persist if oil reached coastal wetlands

1 and was deposited in fine sediments, becoming a long-term source of pollution because of
2 remobilization. In such locations, spill cleanup might be necessary for the recovery of the
3 affected areas. Potential impacts to water quality from spill cleanup activities are discussed
4 below.

5
6 Small oil spills (<1,000 bbl) or very small oil spills (<50 bbl) would produce small but
7 measurable impacts on water quality. Assuming that all intermediately sized and small spills
8 would not occur at the same time and place, water quality would rapidly recover without
9 mitigation because of mixing, dilution, and weathering.

10
11 Under arctic conditions (i.e., cold water and cold air temperatures), weathering processes,
12 such as volatilization, would also be much slower than in warmer climates (MMS 2008b); under
13 calm conditions and cold temperatures in restricted waters, vertical mixing and dissolution would
14 be reduced (MMS 2008b). If the spill were to occur on ice or under ice, oil would be trapped
15 and essentially remain unchanged until breakup occurred and the ice began to melt. The volatile
16 compounds from such a spill would be more likely to freeze into the ice within hours to days
17 rather than dissolve or disperse into the water below the ice. A hydrocarbon plume in the water
18 column underneath the ice could persist with concentrations that exceed ambient standards and
19 background levels for a distance greater than that in the open sea (MMS 2008b). Impacts on
20 coastal waters from a large spill would depend on the season, type, and composition of the spill,
21 weather conditions, and size of the spill.

22
23 **Marine Waters.** Accidental hydrocarbon releases in the marine environment can occur
24 at the surface from tankers or platforms or at the seafloor from the wellhead or pipelines. The
25 number of potential spills estimated for Cook Inlet marine waters are conservatively assumed to
26 be the same as those discussed above for coastal waters. In general, oil spilled below the surface
27 rises rapidly as droplets that coalesce to form a slick. Standard response procedures for a spill
28 could then be used. In open marine waters, evaporation, advection, and dispersion generally
29 reduce the effects of toxic oil fractions and their degradation products to below State and Federal
30 criteria for hydrocarbon contamination. Sustained degradation of water quality to levels
31 exceeding the chronic criterion of 0.015 ppm total hydrocarbon contamination is unlikely.
32 However, levels could exceed this standard over several thousand square kilometers for a short
33 period of time (about 30 days), depending on the size, location, and season of the spill. Marine
34 spills would tend to move in directions consistent with established circulation patterns for the
35 planning area (i.e., northward along the Kenai Peninsula and southward along the Alaska
36 Peninsula). Actual flow paths would be affected by winds, tides, ice cover, temperature, and
37 cleanup activities. The persistence of oil slicks would generally last less than 1 year. Large oil
38 spills assumed under this alternative would become more likely as the volume of assumed oil
39 production increases. Water quality would eventually recover, but recovery time could be
40 decreased by oil-spill cleanup activities.

41
42 **Spill Response and Cleanup.** Spill response and cleanup activities in both coastal and
43 marine waters could include, depending on location, use of chemical dispersants, *in situ* burning,
44 use of vessels and skimmers, drilling of a relief well, and beach cleaning and booming
45 (BOEMRE 2011k). Potential impacts to water quality from each of these spill response and
46 cleanup activities are discussed above in Section 4.4.3.1.2. However, clean up of large spills in

1 the open sea off of south central Alaska could be hindered by several factors. There could be
2 limited access to oil slicks contained between ice floes during a large part of the year. There
3 could also be reduced oil flow into recovery devices because of increased viscosity and
4 precipitation of wax crystals, as well as decreased oil adhesion to the recovery unit material and
5 a high percentage of free water in the recovered product due to mixing of the oil slick with slash
6 ice and snow (MMS 2008b). In winter, icebreakers could affect the movement of spilled oil that
7 may be trapped beneath or in the ice (BOEMRE 2011k).

8
9 If an oil spill occurred in winter, *in situ* burning would be limited by the lack of open
10 water to collect oil and open water in which to burn it. If burning could occur in winter on a
11 limited scale, sea ice would melt in the immediate vicinity of the burn.

12
13 **Catastrophic Discharge Event.** For the Cook Inlet Planning Area, a low-probability
14 CDE could have a volume of between 75,000 and 125,000 bbl (Table 4.4.2-2). A catastrophic
15 discharge event in coastal or marine water could present sustained degradation of water quality
16 from hydrocarbon contamination in exceedence of State and Federal water and sediment quality
17 criteria. These effects could be significant depending upon the duration and area impacted by the
18 spill. Additional effects on water quality could occur from response and cleanup vessels, *in situ*
19 burning of oil, dispersant use, discharges and seafloor disturbance from relief well drilling, and
20 activities on shorelines associated with cleanup, booming, beach cleaning, and monitoring.
21 Impacts from the spill would again depend on the spill size and composition, weather conditions,
22 and the location of the spill.

23 24 25 **4.4.3.3 Alaska – Arctic**

26
27 This section analyzes impacts on coastal and marine waters in the Arctic region. Coastal
28 waters, as defined here, include the bays and estuaries along the coast and State waters extending
29 out to the inward boundary of the territorial seas. Marine waters extend from this boundary out
30 to a water depth of 200 m (656 ft).

31
32 Table 4.1.1-1 details impacting factors associated with oil and gas activities and the
33 development phase in which they can occur. The following factors affecting water quality have
34 been identified: disturbance of bottom sediments, wastes and disposal, vessel traffic, and
35 accidental spills. The water quality stressor activities associated with oil and gas development
36 are shown in Table 4.4.3-1.

37
38 The current Arctic NPDES General Permit for wastewater discharges from Arctic oil and
39 gas exploration (No. AKG-33-0000) expired on June 26, 2011. USEPA will reissue separate
40 NPDES exploration General Permits for the Beaufort Sea and the Chukchi Sea prior to the 2012
41 drilling season. USEPA expects that tribal consultation and public comment on the new
42 proposed Arctic oil and gas exploration permits would occur in fall 2011. The USEPA Region
43 10 website will post updates to its website as they become available at <http://yosemite.epa.gov/r10/water.nsf/npdes+permits/arctic-gp>.
44
45

1 Common impacts on water quality in both coastal and marine areas include those from
2 vessel traffic, well drilling, and operational discharges. The types of impacts expected are the
3 same as those discussed above in Section 4.4.3.1.
4

6 **4.4.3.3.1 Routine Operations.**

7
8 **Coastal Waters.** Construction and installation of exploratory wells (up to 16 in the
9 Beaufort Sea Planning Area and up to 20 in the Chukchi Sea Planning Area), development wells
10 (up to 120 in the Beaufort Sea Planning Area and up to 280 in the Chukchi Sea Planning Area),
11 subsea production wells (up to 10 in the Beaufort Sea Planning Area and up to 82 in the Chukchi
12 Sea Planning Area), platforms (up to 4 in the Beaufort Sea Planning Area and up to 5 in the
13 Chukchi Sea Planning Area), and offshore pipelines (up to 249 km [155 mi] in the Beaufort Sea
14 Planning Area and up to 402 km [250 mi] in the Chukchi) would affect water quality. Such
15 activities would disturb bottom sediments and increase the turbidity of the water in the area of
16 the construction. Because pipelines in shallow waters are buried using a trenching method,
17 installation would initially release sediment to the water column. Moderate impacts on water
18 quality (i.e., turbidity) from such construction and installation activities would occur in the
19 immediate area of the activity. These impacts would be local and short term as settling and
20 mixing occurred.
21

22 Drilling muds and cuttings generated when installing exploration and delineation wells
23 would be discharged at the well site. All drilling muds and cuttings associated with development
24 and production wells would be treated and reinjected into the well. For exploration wells, the
25 volume of drilling fluids and cutting vary depending upon the well characteristics, but, in
26 general, fluids average approximately 500 bbl/well and drill cuttings would comprise the
27 equivalent of approximately 600 tons/well of dry rock. Thus, under the proposed action, up to
28 8,000 bbl of drilling fluids and up to 9,600 tons of drill cuttings could be disposed of in the
29 waters of the Beaufort Sea Planning Area and up to 10,000 bbl of drilling fluids and up to
30 12,000 tons of drill cuttings could be disposed of in the waters of the Chukchi Sea Planning
31 Area. Discharge of drilling muds and cuttings would increase turbidity in the vicinity of the
32 well. The discharge would contain trace metal and hydrocarbon constituents that would be
33 suspended in the water column and subsequently deposited on the sea floor. These drilling
34 discharges must comply with NPDES permit requirements regarding the discharge amount, rate,
35 and toxicity, which would greatly reduce the impact to water quality.
36

37 Because of climatic conditions in the Arctic region, there would be a number of
38 additional operations specific to the Arctic (e.g., constructing and maintaining ice roads
39 [MMS 2002c] and ice islands). In addition to affecting the turbidity of coastal waters in the
40 Arctic region, construction activities would also produce waste materials. Contaminants would
41 also be released to the coastal waters during every ice breakup from fluids entrained in ice roads
42 and ice islands (Skolnik and Holleyman 2005). Entrained contaminants from vehicle exhaust,
43 grease, antifreeze, oil, and other vehicle-related fluids would pass directly into the sea at each
44 breakup (MMS 2002c). These discharges are not expected to be major; however, they would
45 occur throughout the life of a development area.
46

1 Construction of new onshore pipelines (up to 129 km [80 mi] in the Beaufort Sea
2 Planning Area and none in the Chukchi Sea Planning Area) would also affect coastal water
3 quality in the Arctic region. Proper siting of facilities and requirements associated with
4 construction permits would largely mitigate these impacts. The impacts on water quality would
5 range from negligible to minor, depending on site location and construction and mitigation
6 activities.

7
8 The OCS service and construction vessel traffic to and from platform sites within the
9 planning area (up to 12 vessel trips per week in the Beaufort Sea Planning Area and up to
10 15 vessel trips per week in the Chukchi Sea Planning Area) would also affect water quality
11 through the permitted release of operational wastes. Compliance with applicable NPDES
12 permits and USCG regulations would prevent or minimize most impacts on receiving waters.

13
14 **Marine Waters.** Routine operations that could affect marine water quality in the Arctic
15 region include anchoring, mooring, drilling and well completion activities, well testing and
16 cleanup operations, flaring/burning, facility installation and operations, support service activities,
17 decommissioning, and site clearance. Activities such as dredging trenches for pipelines and
18 constructing artificial islands would disturb the seafloor and increase the suspended sediment
19 load in the water column. These suspended sediments have toxicity ranges that are generally
20 described as nontoxic to slightly toxic (National Academy of Sciences 1983). Turbidity and
21 plumes containing sediments would depend on the season, sediment grain size, the rate and
22 duration of discharge within the disturbed areas, and the currents present. This additional
23 suspended sediment load would be temporary, and impacts on water quality would be localized.

24
25 The majority of wastes generated during construction and development would consist of
26 drill cuttings and spent muds (MMS 2002c). Drilling muds and cuttings generated when
27 installing exploration and delineation wells would be discharged at the well site. All drilling
28 muds and cuttings associated with development and production wells would be treated and
29 reinjected into the well. Some waste also would be generated during operations from
30 well-workover rigs. Domestic wastewater and produced waters generated by these activities
31 would also be injected into the disposal well. Solid wastes, including scrap metal, would be
32 hauled offsite for disposal at an approved facility. Impacts on water quality from these activities
33 would be negligible.

34
35 Turbidity on a smaller scale would also result from retrieving anchors used to control the
36 movement of vessels while dredging and setting pipes or placing platforms. These types of
37 disturbances would not occur if drillships, which use dynamic positioning rather than anchors,
38 were used, a standard procedure in Chukchi Sea exploration.

39
40 The OCS service and construction vessel traffic to and from platform sites within the
41 planning area (up to 12 vessel trips per week in the Beaufort Sea Planning Area and up to 15
42 vessel trips per week in the Chukchi Sea Planning Area) would also affect water quality through
43 the permitted release of operational wastes. Compliance with applicable NPDES permits and
44 USCG regulations would prevent or minimize most impacts on receiving waters.

1 **4.4.3.3.2 Accidents.**
2

3 **Coastal Waters.** Accidental releases could affect the quality of coastal water in the
4 Arctic region. The magnitude and severity of impacts would depend on the location of the spill,
5 spill size, type of product spilled, weather conditions, and the water quality and environmental
6 conditions at the time of the spill. Under the proposed action, the number and types of spills
7 assumed to occur in the Arctic region include up to three large spills (i.e., $\geq 1,000$ bbl): up to two
8 spills at a volume of 1,700 bbl from pipelines and up to one spill at a volume of 5,000 bbl from a
9 platform. Between 10 and 35 small spills with volumes between 50 and 999 bbl are assumed to
10 occur and between 50 and 190 very small spills with volumes between 1 and 50 bbl
11 (Table 4.4.2-1).
12

13 If a large spill were to occur in enclosed coastal waters or were driven by winds, tides,
14 and currents into a semi-enclosed coastal area, water quality would be adversely affected. With
15 limited wave and current activity in coastal waters, the oil would not be easily dispersed, and
16 weathering could be slower than in the open sea (see discussion in Section 4.4.3.1.2). Under
17 arctic conditions (i.e., cold water and cold air temperatures), weathering processes, such as
18 volatilization, would also be much slower than in warmer climates (MMS 2008b); under calm
19 conditions and cold temperatures in restricted waters, vertical mixing and dissolution would be
20 reduced (MMS 2008b). If the spill were to occur on ice or under ice, oil would be trapped and
21 essentially remain unchanged until breakup occurred and the ice began to melt. The volatile
22 compounds from such a spill would be more likely to freeze into the ice within hours to days
23 rather than dissolve or disperse into the water below the ice. A hydrocarbon plume in the water
24 column underneath the ice could persist with concentrations that exceed ambient standards and
25 background levels for a distance greater than that in the open sea (MMS 2008b). Impacts on
26 coastal waters from a large spill would depend on the season, type and composition of the spill,
27 weather conditions, and size of the spill.
28

29 Effects on water quality could persist even longer if oil were to reach coastal wetlands
30 and be deposited in fine sediments, becoming a long-term source of pollution because of
31 remobilization. In such locations, spill cleanup could be necessary for recovery of the affected
32 areas. Shoreline cleanup operations could involve crews working with sorbents, hand tools, and
33 heavy equipment. The magnitude and severity of impacts from such spills would depend on the
34 nature of the coastal area associated with the spill, the spill size and composition, and the water
35 quality and condition of resources affected by the spill.
36

37 Cleanup of large spills in the open sea could be hindered by several factors. There could
38 be limited access to oil slicks contained between ice floes during a large part of the year. There
39 could also be reduced oil flow into recovery devices because of increased viscosity and
40 precipitation of wax crystals, as well as decreased oil adhesion to the recovery unit material and
41 a high percentage of free water in the recovered product due to mixing of the oil slick with slash
42 ice and snow (MMS 2008b). Impacts from the spill would again depend on the spill size and
43 composition, weather conditions, and the location of the spill.
44

45 Small oil spills (<1,000 bbl) or very small oil spills (<50 bbl) would produce measurable
46 impacts on water quality. Based on the assumption that all small and very small spills do not

1 occur at the same time and place, water quality would rapidly recover without mitigation, due to
2 mixing, dilution, and weathering.

3
4 **Marine Waters.** Under arctic conditions (i.e., cold water and air temperatures),
5 weathering processes would be much slower than in warmer climates (MMS 2008b).
6 Seasonality and the specific spill location would cause variability in effects (e.g., summer versus
7 winter in the Beaufort and Chukchi Seas). If a spill were to occur, oil would be trapped and
8 essentially remain unchanged until breakup occurred and the ice began to melt. The volatile
9 compounds from such a spill would be more likely to freeze into the ice within hours to days
10 rather than dissolve or disperse into the water below the ice. A hydrocarbon plume in the water
11 column underneath the ice could persist with concentrations that are above ambient standards
12 and background levels for a distance that would be five times greater than that in the open sea
13 (MMS 2008b).

14
15 Small oil spills (<1,000 bbl) or very small oil spills (<50 bbl) would have measurable
16 impacts on water quality. If it is assumed that all small and very small spills would not occur at
17 the same time and place, water quality would rapidly recover without mitigation because of
18 mixing, dilution, and weathering.

19
20 **Spill Response and Cleanup.** Spill response and cleanup activities in both coastal and
21 marine waters could include, depending on location, use of chemical dispersants, *in situ* burning,
22 use of vessels and skimmers, drilling of a relief well, and beach cleaning and booming
23 (BOEMRE 2011k). Potential impacts to water quality from each of these spill response and
24 cleanup activities are discussed above in Section 4.4.3.1.2. However, cleanup of large spills in
25 the open sea within the Beaufort and Chukchi Seas could be hindered by several factors. There
26 could be limited access to oil slicks contained between ice floes during a large part of the year.
27 There could also be reduced oil flow into recovery devices because of increased viscosity and
28 precipitation of wax crystals, as well as decreased oil adhesion to the recovery unit material and
29 a high percentage of free water in the recovered product due to mixing of the oil slick with slash
30 ice and snow (MMS 2008b). In winter, icebreakers could affect the movement of spilled oil that
31 may be trapped beneath or in the ice (BOEMRE 2011k).

32
33 If an oil spill occurred in winter, *in situ* burning would be limited by the lack of open
34 water to collect oil and open water in which to burn it. If burning could occur in winter on a
35 limited scale, sea ice would melt in the immediate vicinity of the burn.

36
37 **Catastrophic Discharge Event.** For the Chukchi Sea Planning Area, a low-probability
38 CDE could have a volume of between 1,400,000 and 2,200,000 bbl (Table 4.4.2-2). For the
39 Beaufort Sea Planning Area, a catastrophic discharge event could have a volume of between
40 1,700,000 and 3,900,000 bbl (Table 4.4.2-2). A catastrophic discharge event in either coastal or
41 marine waters could present sustained degradation of water quality from hydrocarbon
42 contamination in exceedence of State and Federal water and sediment quality criteria. These
43 effects could be significant depending upon the duration and area impacted by the spill.
44 Additional effects on water quality could occur from response and cleanup vessels, *in situ*
45 burning of oil, dispersant use, discharges and seafloor disturbance from relief well drilling, and
46 activities on shorelines associated with cleanup, booming, beach cleaning, and monitoring.

1 Impacts from the event would again depend on the spill size and composition, weather
2 conditions, and the location of the spill.

3 4 5 **4.4.3.4 Conclusions**

6
7 Overall coastal and marine water quality impacts due to routine operations and
8 operational discharges under the proposed action would be unavoidable. Compliance with
9 NPDES permit requirements would reduce or prevent most impacts on receiving waters caused
10 by discharges from normal operations. Water quality would recover when discharges ceased
11 because of dilution, settling, and mixing. Impacts on water quality from routine operations
12 associated with the Program are expected to be minor to moderate.

13
14 Oil spills could reduce water quality, and these impacts would be unavoidable. In the
15 presence of cold temperatures and ice, cleanup activities could be more difficult than in more
16 temperate environments. The magnitude of the impacts would depend on the specific location
17 affected and the nature and magnitude of the activity/accident. Small spills would be expected to
18 result in short-term, temporary impacts on coastal and marine water quality. A large spill in
19 coastal waters could result in longer term impacts on water quality, but cleanup efforts would
20 reduce the likelihood of permanent impairment. A large spill in marine waters would be
21 expected to have temporary impacts on water quality; however, cleanup efforts and evaporation,
22 dilution, and dispersion would minimize the long-term impacts.

23
24 A catastrophic discharge event could present sustained degradation of water quality from
25 hydrocarbon contamination in exceedence of State and Federal water and sediment quality
26 criteria. These effects would be significant depending upon the duration and area impacted by
27 the spill. Impacts from the event would again depend on the spill size and composition, weather
28 conditions, and the location of the spill.

29 30 31 **4.4.4 Potential Impacts on Air Quality**

32 33 34 **4.4.4.1 Gulf of Mexico**

35
36 In the GOM west of 87.5° W longitude, OCS air emissions are regulated by BOEM
37 according to 30 CFR 250.302-304. BOEM reviews projected air emissions information from an
38 operator submitting a plan for exploration or development activities. If the projected annual
39 emissions exceed a certain threshold, which is determined by the distance from shore, the
40 operator needs to perform a modeling analysis to assess air quality impacts on onshore areas. If
41 the modeled concentrations exceed defined significance levels in an attainment area, which is an
42 area that meets the National Ambient Air Quality Standards (NAAQS), best available control
43 technology would be required on the facility. If the affected area is classified nonattainment,
44 further emission reductions or offsets may be required. Projected contributions to onshore
45 pollutant concentrations are also subject to the same limits that the USEPA applies to the
46 onshore areas under its Prevention of Significant Deterioration (PSD) program (MMS 2007c).

1 Facilities located east of 87.5° W longitude would be under the USEPA jurisdiction,
2 which regulates air emissions as prescribed in 40 CFR Part 55. For facilities located within
3 40 km (25 mi) of a State's seaward boundary, the regulations are the same as would be
4 applicable if the emission source were located in the corresponding onshore area and would
5 include State and local requirements for emission controls, emission limitations, offsets,
6 permitting, testing, and monitoring. For facilities located beyond 40 km (25 mi) of a State's
7 seaward boundary, the basic Federal air quality regulations apply, which include the USEPA
8 emission standards for new sources, the PSD regulations, and Title V permits. Both PSD and
9 Title V requirements apply to major sources that, depending on the source type, could potentially
10 emit more than either 100 tpy or 250 tpy of a criteria pollutant. Which threshold applies to a
11 particular source, how the potential emissions are calculated, and what controls are required if
12 the applicable threshold is exceeded are all issues determined in discussions with regulators
13 during the air permit application and approval process (MMS 2007c).

14
15 The USEPA has established NAAQS for six criteria pollutants — nitrogen dioxide
16 (NO₂), sulfur dioxide (SO₂), particulate matter (PM; PM₁₀, PM with an aerodynamic diameter of
17 10 µm or less; and PM_{2.5}, PM with an aerodynamic diameter of 2.5 µm or less), carbon
18 monoxide (CO), lead (Pb), and ozone (O₃) — because of their potential adverse effects on
19 human health and welfare. The health and environmental effects of air pollutants have been
20 summarized by the USEPA (USEPA 2011a). Ambient levels of criteria pollutants except Pb can
21 contribute to respiratory illnesses, especially in persons with asthma, children, and the elderly,
22 and PM and CO can also aggravate cardiovascular diseases.

23
24 **Ozone Formation.** O₃ in the atmosphere is formed by photochemical reactions
25 involving primarily nitrogen oxides (NO_x) and volatile organic compounds (VOCs). It is formed
26 most readily in the summer season, with high temperatures, lower wind speeds, intense solar
27 radiation, and an absence of precipitation; high O₃ episodes are typically associated with slow-
28 moving, high-pressure systems characterized by light winds and a shallow boundary layer
29 (NRC 1992). O₃ can irritate the respiratory system, reduce lung function, and aggravate asthma.
30 Repeated exposure to O₃ pollution for several months may cause permanent lung damage.
31 Children, adults who are active outdoors, and people with respiratory problems are the most at
32 risk from high O₃. High levels of O₃ are also accompanied by a mix of organic radicals, which
33 also causes adverse health effects. O₃ interferes with the ability of plants to produce and store
34 food, which makes them more susceptible to disease, insects, other pollutants, competition, and
35 harsh weather. It may also cause damage to the leaves of trees and other plants, thereby
36 affecting the health and appearance of vegetation in cities, National Parks, and recreation areas.
37 O₃ may reduce forest growth and crop yields, potentially affecting species diversity in
38 ecosystems (USEPA 2011a).

39
40 **Acid Deposition and Visibility.** Gaseous pollutants undergo various chemical reactions
41 in the atmosphere to form small particles, which remain airborne for extended periods of time.
42 NO_x compounds react with ammonia and moisture to form ammonium nitrate particles, which
43 contribute to PM_{2.5} concentrations. SO₂ combines with moisture to form tiny sulfate particles,
44 which may also contribute to adverse health effects. In addition, gaseous NO_x and SO₂ can
45 dissolve into cloud water. These acidic chemicals eventually return to the ground in either wet
46 (e.g., rain, snow) or dry (e.g., gases, particles) forms, commonly referred to as acid deposition or

1 acid rain (USEPA 2011b). Dry deposition is equally as important as wet deposition. The
2 deposition often takes place hundreds of kilometers from the source. Acid deposition can
3 damage forests and crops, change the makeup of soil, and may, in some cases, make lakes and
4 streams acidic and unsuitable for fish. Deposition of nitrogen from NO_x emissions also
5 contributes to nitrogen load in water bodies, especially estuaries and near-coastal ecosystems.
6 Acid deposition accelerates the decay of building materials and paints, including irreplaceable
7 monuments, statues, sculptures, and other cultural resources. Particulate matter, including
8 sulfate and nitrate particles and organic aerosols that form part of photochemical smog,
9 significantly reduce atmospheric visibility in areas including National Parks, Monuments, and
10 Wilderness Areas (USEPA 2011b).

11
12 In general, the most important source of visibility degradation is from PM_{2.5} in the 0.1 to
13 1 μm size range, which covers the range of visible light (0.4–0.7 μm) (Malm 1999). These
14 particles are directly emitted into the atmosphere through fuel burning. However, other sources
15 arise through chemical transformation of NO₂, SO₂, and VOCs into nitrates, sulfates, and
16 carbonaceous particles. Existing visibility in the eastern United States, including the GOM
17 States, is impaired due to PM_{2.5} containing primarily sulfates and carbonaceous material. High
18 relative humidity (over 70%) can play an important factor in visibility impairment, especially in
19 the GOM coastal areas, where relative humidity is higher than 70% throughout the year. These
20 particles are generally hygroscopic, and thus the absorption of water by the particulate matter
21 makes them grow to a size that enhances their ability to scatter light and hence aggravates
22 visibility reduction. Over the open waters of the GOM, a study of visibility from platforms off
23 Louisiana revealed that significant reductions in Louisiana coastal and offshore visibility are
24 almost entirely due to transient natural occurrences of fog (Hsu and Blanchard 2005). Episodes
25 of haze are short-lived and affect visibility much less. Offshore haze can result from plume drift
26 generated from coastal sources (MMS 2007c).

27 28 29 **4.4.4.1.1 Routine Operations.**

30
31 Under the proposed action, construction and operation of up to 2,100 exploration and
32 delineation wells, up to 2,600 development and production wells, and up to 12,100 km
33 (7,500 mi) of new pipeline as well as up to 12 new pipeline landfalls, up to 6 new pipe yards, and
34 up to 12 new natural gas processing facilities and the removal of up to 275 platforms with
35 explosives will result in emissions that could affect air quality in the GOM. These activities
36 would generate emissions from stationary sources at the drilling/well sites and from support
37 vessels and aircraft over the 40- to 50-year period of the Program (Table 4.4.1-1). There could
38 be up to 600 vessel trips/wk and 5,500 helicopter trips/wk under the proposed action.

39
40 **Emissions.** The type and relative amounts of air pollutants generated by offshore
41 operations vary according to the phase of activity. There are three principal phases of oil and gas
42 activities operations: exploration, development, and production. Activities affecting air quality
43 include seismic surveys, drilling activities, platform construction and emplacement, pipeline
44 laying and burial operations, platform operations, flaring, fugitive emissions, support vessel and
45 helicopter operations, and evaporation of VOCs during transfers and spills. Principal emissions

TABLE 4.4.4-1 Estimated Highest Annual Air Emissions from OCS Activities in the Gulf of Mexico Planning Areas, Proposed 2012-2017 Leasing Program

Activity	Pollutant (tons/yr)					
	NO _x	SO _x	PM ₁₀	PM _{2.5}	VOC	CO
Exploration/Delineation Well Drilling	15,359–29,403 ^a	1,956–3,745	271–518	267–511	364–696	3,662–7,002
Development/Production Well Drilling	8,190–15,529	1,043–1,978	144–274	142–270	194–368	1,952–3,698
Platform Installation and Removal	540–998	77–142	18–21	18–23	18–23	98–129
Pipeline Installation	3,180–9,939	540–1,688	120–375	120–375	120–375	660–2,063
Production Platforms	11,634–21,887	284–535	108–204	107–202	7,432–13,981	13,031–24,514
Support Vessels	20,943–39,400	2,822–5,309	363–682	363–682	363–682	1,995–3,753
Helicopters	173–325	43–80	34–63	34–63	417–785	2,112–3,973
Tankers Loading	0–326	0–55	0–12	0–12	0–2,456	0–68
Tankers in Transit	0–7,035	0–853	0–107	0–107	0–2,164	0–586
Tankers Unloading	0–326	0–55	0–12	0–12	0–1,162	0–68
Total	60,019–125,167	6,765–14,440	1,058–2,268	1,051–2,257	8,907–22,692	23,510–45,853

^a The range of values reflects the low and high end of the exploration and development scenarios for the Program.

Source: Herkhof 2011; Wilson et al. 2010.

1 of concern are the criteria pollutants and their precursors: NO_x, sulfur oxides (SO_x),¹³ PM₁₀ and
2 PM_{2.5}, CO, and VOC. Releases of toxic chemicals could be a concern around oil spills and
3 *in situ* burning and especially during accidental releases of hydrogen sulfide (H₂S) at platforms.
4

5 Wilson et al. (2010) provided a comprehensive emission inventory of oil and gas
6 activities in the GOM for the year 2008, showing that support vessels and platforms rank first
7 and second, respectively, as NO_x emitters with natural gas engines being the largest source on
8 platforms. Support vessels are the largest SO_x emitters, while the drilling rigs also emit
9 significant SO_x. Albeit small, the primary SO_x sources on platforms are diesel engines used in
10 drilling. The largest sources of PM₁₀ are support vessels, drilling rigs, and production platforms.
11 VOCs come mostly from production platforms, where the primary sources are cold vents,
12 followed by fugitive sources. Fugitive sources include oil and gas processing, pump and
13 compressor seals, valves, connectors, and storage tanks. Natural gas engines on platforms
14 account a considerable portion of CO emissions (Wilson et al. 2010).
15

16 Air emissions from the proposed action were estimated using the most recently available
17 exploration and development scenario for 2012-2017, as shown in Table 4.4.4-1. These
18 emissions were estimated by BOEM (Herkhof 2011) using emission factors from the 2008
19 *Gulfwide Emission Inventory Study* (Wilson et al. 2010).
20

21 In terms of absolute amounts, the largest emissions would be NO_x followed by CO, with
22 lesser amounts of VOC, SO_x, PM₁₀, and PM_{2.5} in order of descending emissions. Under both
23 the high and low scenarios, support vessels would be the largest source of NO_x, SO_x, PM₁₀, and
24 PM_{2.5} and production platforms would be the largest source of VOC and CO. Emissions from
25 the Program would initially be lower in the first few years as exploratory wells were drilled and
26 platforms started producing oil and gas. During the last half of the Program, emissions would
27 decrease as production decreased and some platforms were removed (MMS 2007c).
28

29 It is estimated that about 10% of the crude oil produced in deep water in the GOM would
30 be transported to shore via tanker, while in shallow waters about 1% of production would be
31 transported by barge. The transport of crude oil would result in VOC emissions from loading
32 operations and breathing losses during transit. VOC emissions would also occur during
33 unloading and ballasting in port. There would also be emissions of NO_x, SO₂, and PM₁₀ from
34 the ships' engines (MMS 2007c).
35

36 **Impacts on Criteria Pollutants Other Than Ozone.** BOEM performed a cumulative
37 air quality modeling analysis of platform emissions in a portion of the GOM in 1992
38 (MMS 1997b). The area modeled included most of the coastline of Louisiana and extended
39 eastward to include coastal Mississippi and Alabama. Facility emissions were obtained from the
40 emissions inventory used in the GOM air quality study (MMS 1995b). The emission values
41 were multiplied by a factor of 1.4 to account for growth. The modeled onshore annual average
42 NO₂ concentrations were generally somewhat greater than 1 microgram per cubic meter (µg/m³).
43 The highest values appeared in the Mississippi River Delta region, where a maximum

¹³ Sulfur dioxide (SO₂) belongs to the family of sulfur oxides (SO_x). For emissions, SO₂ accounts for most of SO_x, and thus these are used interchangeably.

1 concentration of $6 \mu\text{g}/\text{m}^3$ was calculated, which is 6% of the national standard for NO_2 . The
2 highest predicted annual, maximum 24-hr, and maximum 3-hr average SO_2 concentrations were
3 1.1, 13, and $98 \mu\text{g}/\text{m}^3$, respectively. These values are 1, 4, and 7% of the NAAQS for the
4 respective averaging periods. Modeling was not performed for PM_{10} or $\text{PM}_{2.5}$, but the
5 concentrations would be lower because of lower emission rates. The projected emissions for the
6 proposed action would be lower than the emissions used in the modeling and scattered further
7 offshore; thus, the impacts would be correspondingly lower. Existing concentrations of NO_2 ,
8 SO_2 , PM_{10} , and $\text{PM}_{2.5}$ in the GOM coast States are well within the NAAQS, so emissions from
9 the proposed action would not result in any exceedance of the NAAQS.

10
11 The highest predicted NO_2 and SO_2 concentrations in the 1992 emissions modeling were
12 well within the maximum allowable PSD Class II increments for those pollutants. Any
13 concentrations resulting from the emissions associated with the proposed action should also be
14 within the PSD Class II increments.

15
16 The maximum allowable increase for the annual average NO_2 concentration in the Class I
17 Breton National Wilderness Area (NWA) is $2.5 \mu\text{g}/\text{m}^3$. The highest predicted annual average
18 NO_2 concentration in Breton from the year 1992 emission sources was $3.6 \mu\text{g}/\text{m}^3$, which exceeds
19 the Class I increment and indicates that the question of increment consumption at Breton NWA
20 could be of concern (MMS 2007c, 1997b).

21
22 The highest predicted SO_2
23 concentrations in Breton NWA were 0.3, 4.5,
24 and $9.7 \mu\text{g}/\text{m}^3$ for the annual, maximum 24-hr
25 average, and maximum 3-hr average
26 concentrations, respectively. The maximum
27 allowable concentration increases for PSD
28 Class I areas are 2.0, 5.0, and $25 \mu\text{g}/\text{m}^3$,
29 respectively. Based on this result, SO_2
30 concentrations from the proposed action would
31 be within the Class I maximum allowable
32 increases (MMS 1997b, 2007c).

33
34 Because of continuing concern about
35 the combined impact of offshore and onshore
36 emission sources on the PSD Class I increments
37 in Breton NWA, BOEMRE has collected an
38 emission inventory for OCS facilities located
39 within 100 km (62 mi) of the Breton Class I
40 area. A modeling study (2000–2001) to the
41 baseline years (1977 for SO_2 and 1988 for
42 NO_2) revealed that none of the allowable SO_2
43 or NO_2 increments had been fully consumed
44 (Wheeler et al. 2008). The maximum annual,
45 24-hr, and 3-hr SO_2 increments consumed with the Breton NWA were -1.07 , 1.18, and
46 $1.80 \mu\text{g}/\text{m}^3$, respectively. A decrease in annual SO_2 concentration resulted from a general

Comparing Impacts to PSD Increments

Several points should be considered when air quality impacts are compared to PSD increments. First, the PSD program applies to individual sources, not programs. Emissions from an individual source such as a platform or set of platforms could differ from the emissions being modeled in a particular study. Second, increment tracking is a cumulative process that sets a maximum allowable increase above a baseline concentration. It is unlikely that a permitting agency would permit a single source to consume all of the increment. Last, PSD applies only to major sources, generally sources with the potential to emit more than 250 tons/yr, except for the 100 tons/yr threshold for 28 source categories. OCS oil and gas production activities are subject to a 250 tons/yr threshold. Regardless of the *actual* emissions, a source's *potential* emissions could exceed the 250 tons/yr threshold. Determining potential emissions and available PSD increment allowances requires consultation with the cognizant regulators.

1 decrease in SO₂ emissions from onshore and offshore sources since 1977. The maximum
2 allowable concentration increases for PSD Class I areas are 2.0, 5.0, and 25 µg/m³, respectively.
3 The maximum annual NO₂ increment consumed within the Breton NWA was 0.10 µg/m³, for
4 which the maximum allowable NO₂ increment is 2.5 µg/m³. In addition, the BOEM consults
5 with the U.S. Fish and Wildlife Service (USFWS), the Federal land manager of the Breton NWA
6 area, for plans within 100 km (62 mi) of Breton that exceed a certain emission threshold.
7 Mitigation measures, such as the use of low-sulfur fuel, may be applied (MMS 2007c).
8

9 No modeling has been performed for CO. In OCS waters, CO emission sources less
10 than about 7,000 tons/year would not have any significant effect on onshore air quality and
11 are exempt from air quality review under BOEM air quality regulations (MMS 2007c). This is
12 based on air quality modeling that was performed to support the BOEM air quality rules. As
13 shown in Table 4.4.4-1, CO emissions from the proposed action are higher than 7,000 tons/year.
14 However, CO emissions are comparable to NO₂ and SO₂ emissions, and their associated impacts
15 are well within the NAAQS discussed above. In addition, CO standards (40,000 and
16 10,000 µg/m³ for 1- and 8-hr averages, respectively) are more than one order of magnitude
17 higher than those for NO₂ and SO₂. Therefore, no significant impacts from CO associated with
18 the proposed action would be anticipated.
19

20 **Impacts on Ozone.** As discussed in MMS (2007c), the impacts from OCS activities on
21 O₃ were evaluated in the GOM air quality study (MMS 1995b). The study focused on the O₃
22 nonattainment areas in southeast Texas and the Baton Rouge, Louisiana, areas. It was
23 determined through modeling that OCS sources contributed little to onshore O₃ concentrations in
24 either of these areas. At locations where the model predicted 1-hr average O₃ levels above
25 120 parts per billion (ppb), which was then the NAAQS, the OCS emissions contributed less
26 than 2 ppb to the total concentrations. These contributions occurred in only a small geographic
27 area during any particular episode. At locations where the model predicted O₃ levels were much
28 less than 120 ppb, the highest OCS contributions were about 6–8 ppb. When the modeling was
29 performed after doubling the OCS emissions, the highest OCS contributions at locations where
30 the predicted O₃ levels exceeded the standard was 2–4 ppb.
31

32 Again, as noted in MMS (2007c), more recent O₃ modeling was performed using a
33 preliminary GOM-wide emissions inventory for the year 2000 to examine the O₃ impacts with
34 respect to the 1997 8-hr O₃ standard of 80 ppb (effective May 27, 2008, the 8-hr O₃ standard was
35 lowered to 75 ppb). One modeling study focused on the coastal areas of Louisiana extending
36 eastward to Florida (Haney et al. 2004). This study showed that the impacts of OCS emissions
37 on onshore O₃ levels were very small, with the maximum contribution of 1 ppb or less at
38 locations where the standard was exceeded. The other modeling effort dealt with O₃ levels in
39 southeast Texas (Yarwood et al. 2004). The results of this study indicated a maximum
40 contribution of 0.2 ppb or less to areas exceeding the standard.
41

42 Due to the complex, nonlinear nature of the photochemical production of ozone in the
43 atmosphere, changing emissions of ozone precursors by a given percentage may not produce a
44 corresponding percentage change in O₃ concentrations. However, the projected emissions from
45 the proposed action would be smaller than the emissions used in the models to ensure that

1 contributions to O₃ levels from actions associated with the proposed action would be smaller
2 than the figures above.

3
4 **Impacts on Visibility.** The application of the VISCREEN visibility screening model
5 (USEPA 1992) to individual OCS facilities has shown that the emissions are not large enough to
6 significantly impair visibility. It is not known to what extent aggregate OCS sources contribute
7 to visibility reductions. However, the individual emission sources from the proposed action are
8 relatively small and scattered over a large area, and it is not expected that they would have a
9 measurable impact on acid deposition or visibility. The impacts on visibility would be negligible
10 (MMS 2007c).

11
12 **Greenhouse Gas Emissions and Climate Change.** Estimates were made of the total
13 greenhouse gas (GHG) emissions of CO₂, CH₄, and N₂O for all projected OCS oil and gas
14 Program activities (Herkhof 2011). Emission estimates for the various activities were largely
15 based on a comprehensive inventory of air emissions from oil and gas activities in the GOM for
16 2008 (Wilson et al. 2010). Air emissions resulting from the Program were estimated by
17 considering the exploration and development scenarios presented in Table 4.4.4-1. Emissions
18 are given in terms of teragrams (Tg) of CO₂-equivalent, where one Tg is 10¹² g (10⁶ metric
19 tons). This measure takes into account a global warming potential (GWP) factor, which accounts
20 for the relative effectiveness of a gas to contribute to global warming with respect to the same
21 amount CO₂. In these calculations, CH₄ is given a GWP of 21, while N₂O is given a GWP
22 of 310.

23
24 Table 4.4.4-2 lists the total calculated emissions of CO₂, CH₄, and N₂O from activities
25 associated with the Program and compare them with current (2009) U.S. greenhouse gas
26 emissions from all sources (USEPA 2011). The projected CO₂ emissions from the Program are
27 about 0.068–0.14% of all current CO₂ emissions in the United States. The Program CH₄
28 emissions are about 0.087–0.17% of the current CH₄ emissions in the United States, which is
29 slightly higher than that for CO₂. The projected N₂O emissions from the Program are about
30 0.009–0.020% of all current N₂O emissions in the United States. If CO₂, CH₄, and N₂O
31 emissions are combined, the Program emissions are about 0.067–0.14% and 0.066–0.13% of the
32 Nationwide total of three GHG emissions and of all GHG emissions, respectively. The estimated
33 total global GHG emissions in 2005 were approximately 38,726 Tg CO₂-equivalent
34 (74 FR 66539). The estimated Program GHG emissions are about 0.011–0.023% of the total
35 global GHG emissions.

36
37 As noted in Section 3.3, GHG emissions are one of the causes of climate change.
38 Climate change is a global phenomenon and predicting climate change impacts requires
39 consideration of large scale or even worldwide GHG emissions, not just emissions at a local
40 level. Climate change predictive capability (modeling) lacks the ability to estimate the impact of
41 GHGs from a particular source or sources such as oil and gas activities associated with the
42 Program. What their impact, if any, would be is determined not only by the emissions from the
43 oil and gas activities themselves, but also by the GHG emissions of other sources throughout the
44 world and whether these other emissions are expected to increase or decrease. In addition, since
45 some GHG gases, such as CO₂, may persist in the atmosphere for up to a century, the potential
46 impacts of any source may extend well beyond the active lifetime of the source or program. This

1 **TABLE 4.4.4-2 Projected Greenhouse Gas Emissions from Oil and Gas Activities in**
2 **the Gulf of Mexico Planning Areas, 2012-2017 Leasing Program**

Pollutant	2012-2017 Program (Tg CO ₂ -equivalent) ^a	Total 2009 U.S. Emissions from All Sources (Tg CO ₂ -equivalent)	2012-2017 Program as Percentage of Total 2009 U.S. Emissions
CO ₂	3.75–7.65	5,505.2	0.068–0.39
CH ₄	0.59–1.14	686.3	0.087–0.166
N ₂ O	0.03–0.06	295.6	0.009–0.020
CO ₂ + CH ₄ + N ₂ O	4.37–8.85	6,487.1	0.067–0.136
All GHG ^b	4.37–8.85	6,633.2 ^b	0.066–0.133

^a One Tg is equal to 10¹² g, or 10⁶ metric tons. The CO₂-equivalent for a gas is derived by multiplying the mass of the gas by the associated GWP, which accounts for the relative effectiveness of a gas to contribute to global warming with respect to the same amount CO₂. In these calculations, CH₄ is given a GWP of 21, while N₂O is given a GWP of 310.

^b Total U.S. GHG emissions also include hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride emissions. Estimates of emissions from the Program were not made for these compounds, but they are assumed to be very small.

Source: USEPA 2011i; Herkhof 2011.

3
4
5 said, given the small percentage contributions of oil and gas activities in the GOM to global
6 GHG emissions, the potential impact on climate change would probably be small. Section 3.3
7 provides some baseline considerations for climate change and Section 4.4.3 and Sections 4.4.6
8 through 4.4-15 discuss potential impacts to specific impact areas.

9
10
11 **4.4.4.1.2 Accidents.**

12
13 Under the proposed action, the number and types of spills assumed to occur in the GOM
14 include up to eight large spills (≥1,000 bbl) from both pipeline and platforms including one
15 tanker spill and between 235 and 470 small spills (<1,000 bbl) over the 40- to 50-year period of
16 the Program (Table 4.4.2-1). Evaporation of oil from these spills and emissions from spill
17 response and cleanup activities including *in situ* burning, if used, have the potential to affect air
18 quality in the GOM.

19
20 **Spills and *In Situ* Burning.** Evaporation of small accidental oil spills would cause
21 small, localized increases in VOCs. Most of the emissions would occur within a few hours of
22 the spill and would decrease after that period. Large spills would result in emissions over a large
23 area and a longer period of time. Hanna and Drivas (1993) modeled the emissions of various
24 hydrocarbon compounds from a large spill. A number of these compounds, including BTEX and
25 hexane, are classified by the USEPA as hazardous air pollutants. The results showed that these
26 compounds evaporate almost completely within a few hours after the spill occurs. Ambient
27 concentrations peak within the first several hours after the spill starts and are reduced by two
28 orders of magnitude after about 12 hr. The heavier compounds take longer to evaporate and may

1 not peak until about 24 hr after spill occurrence. Total ambient VOC concentrations are
2 significant in the immediate vicinity of an oil spill, but concentrations are much reduced after the
3 first day (MMS 2007c). Spreading of the spilled oil and action by winds, waves, and currents
4 would further disperse VOC concentrations to extremely low levels over a relatively larger area.
5 Concentrations of criteria pollutants would remain well within NAAQS (MMS 2008b).
6

7 Diesel fuel oil could be spilled either in transit or from accidents involving vehicles,
8 vessels, or equipment. A diesel spill would evaporate faster than a crude oil spill. Ambient
9 hydrocarbon concentrations would be higher than those of a crude oil spill but would persist for a
10 shorter time. Also, because any such spill probably would be smaller than some potential crude
11 oil spills, any air quality effects from a diesel spill likely would be lower than those for other
12 spills (MMS 2008b).
13

14 *In situ* burning of spilled crude or diesel would generate a plume of black smoke and
15 emissions of NO₂, SO₂, CO, PM₁₀, and PM_{2.5} that would temporarily affect air quality, but the
16 effects would be small. Fingas et al. (1995) describe the results of a monitoring program of a
17 burn experiment at sea. The program involved extensive ambient measurements during two
18 experiments in which approximately 300 bbl of crude oil was burned. During the burn, CO,
19 SO₂, and NO₂ were measured only at background levels and were frequently below detection
20 levels. Ambient levels of VOCs were high within about 100 m (328 ft) of the fire, but were
21 significantly lower than those associated with a nonburning spill. It appeared that a major
22 portion of these compounds was consumed in the burn. Effects of *in situ* burning for spilled
23 diesel fuel would be similar to those associated with a crude oil spill (MMS 2008b).
24

25 A significant component of the pollution from a fire would be soot. Soot would cling
26 to plants near the fire but would tend to clump and wash off vegetation in subsequent rains.
27 Potential contamination of shoreline and onshore vegetation would be limited, however, because
28 oil and gas activities under the proposed action would be at least 15 km (8 NM) offshore, with
29 the exception of any oil- or gas-transport pipelines (MMS 2008b).
30

31 Smoke from burning crude oil would contain PAHs. Benzo(a)pyrene, which often is
32 used as an indicator of the presence of carcinogenic varieties of PAHs, is present in crude oil
33 smoke in very small amounts, but in quantities approximately three times larger than in unburned
34 oil (Evans 1988). Investigators have found that, overall, the oily residue in smoke plumes from
35 crude oil is mutagenic, although not highly so. McGrattan et al. (1995) modeled smoke plumes
36 associated with *in situ* burning. Modeling has shown that the surface concentrations of
37 particulate matter do not exceed the health criterion of 150 µg/m³ beyond about 5 km (3 mi)
38 downwind of an *in situ* burn. This result appears to be supported by field experiments conducted
39 off Newfoundland and in Alaska (MMS 2007c). This is quite conservative, as this health
40 standard is based on a 24-hr average concentration rather than a 1-hr average concentration.
41

42 **Catastrophic Discharge Events.** In the GOM, a low-probability CDE event could range
43 in size from 900,000 and 7,200,000 bbl, and have a duration of 30–90 days (Table 4.4.2-2).
44 Evaporation of oil from these spills and emissions from spill response and cleanup activities
45 including *in situ* burning, if used, have the potential to affect air quality in the GOM.
46

1 In a catastrophic discharge event, oil may be burned to prevent it from entering sensitive
2 habitats. During an *in situ* burn, the conditions exist (i.e., incomplete hydrocarbon combustion
3 and the presence of chlorides in seawater) such that dioxins and furans could potentially form.
4 (Dioxins and furans are a family of extremely persistent chlorinated compounds that magnify in
5 the food chain, and dioxins are a group of potentially cancer-causing chemicals.) A total of
6 410 controlled burns (corresponding to about 5% of the total leaked oil) were conducted during
7 the DWH event (Lubchenco 2010). Measurements of dioxins and furans during the DWH event
8 *in situ* burning were made and their emission factors were derived (Aurell and Gullett 2010).
9 The estimated levels of dioxins and furans produced by the *in situ* burns were similar to those
10 from residential woodstove fires and slightly lower than those from forest fires, according to
11 USEPA researchers (Schaum et al. 2010), and thus, concerns about bioaccumulation in seafood
12 were alleviated. The reports found that while small amounts of dioxins were created by the
13 burns, the levels that workers and residents would have been exposed to were below USEPA's
14 levels of concern.

15
16 The effects of a catastrophic discharge event on public health and the environment can be
17 classified as short-term and long-term effects. The short-term effects include watery and irritated
18 eyes, skin itching and redness, coughing, and shortness of breath or wheezing.

19
20 Although there are relatively few studies on air quality impacts to human health
21 following oil spills, some lessons can be learned from the 1991 Kuwaiti oil field fires and the
22 effects of oil burning during the DWH event. In the Kuwaiti event, 600 oil wells were set on
23 fire. These burnings produced a composite smoke plume of gaseous constituents (e.g., NO_x,
24 SO_x, CO₂, etc.), acid aerosols, VOCs, metal compounds, PAHs, and particulate matter. Military
25 personnel deployed to the Persian Gulf War have reported a variety of symptoms attributed to
26 their exposures, including asthma and bronchitis, but Lange et al. (2002) did not find that
27 exposures to oil fire smoke caused respiratory symptoms among veterans.

28
29 There would be some residual air quality impacts after the well is capped or "killed." As
30 most of the oil would have been burned, evaporated, or weathered over time, air quality would
31 return to pre-oil spill conditions. While impacts on air quality are expected to be localized and
32 temporary, adverse effects that may occur from the exposure of humans and wildlife to air
33 pollutants could have long-term consequences (BOEMRE 2011).

34
35 **Hydrogen Sulfide.** An accidental release of H₂S in the atmosphere could present a
36 serious hazard to platform workers and persons in close proximity to a platform. H₂S
37 concentrations of 20 ppm, the OSHA ceiling level that must not be exceeded during any part of
38 the workday, causes irritation to exposed persons within minutes and concentrations of 500 ppm
39 are deadly. All OCS operators involved in production of sour gas or oil that could result in
40 atmospheric H₂S concentrations above 20 ppm are required to file an H₂S Contingency Plan
41 with BOEM. The plan contains measures to prevent serious injury or death to personnel. Under
42 a worst-case scenario of an accidental release at a very large facility with a throughput of
43 100 million cubic feet of gas per day with high H₂S concentration levels (on the order of
44 20,000 ppm), near-calm wind, and stable atmospheric conditions, the H₂S levels are predicted to
45 be 500 ppm at about 1 km (0.6 mi) from the facility and 20 ppm at several kilometers from the
46 source (MMS 2001c). Most "sour gas" facilities have H₂S concentrations below 500 ppm,

1 which would result in H₂S levels of 20 ppm that are confined to an area within the dimensions of
2 a typical platform (MMS 2007c).

3
4 In the case of an aquatic H₂S release, the gas is soluble in water, so a small gas leak
5 would result in almost complete dissolution into the water column. Larger leaks would result in
6 less dissolution and could result in release into the atmosphere if the surrounding waters reach
7 saturation. Because the oxidation of H₂S in water takes place slowly, there should not be any
8 appreciable zones of hypoxia. H₂S levels can have adverse impacts on mammals, birds, and fish
9 (MMS 2001c).

10 11 12 **4.4.4.2 Alaska – Cook Inlet**

13
14 The OCS facilities located off the coast of Alaska would be under the jurisdiction of the
15 USEPA, which regulates air emissions as prescribed in 40 CFR Part 55. For facilities located
16 within 40 km (25 mi) of a State's seaward boundary, the regulations are the same as would be
17 applicable if the emission source were located in the corresponding onshore area, and would
18 include State and local requirements for emission controls, emission limitations, offsets,
19 permitting, monitoring, testing, and reporting. For facilities located more than 40 km (25 mi)
20 from a State's seaward boundary, the basic Federal air quality regulations apply, including the
21 USEPA emission standards for new sources, PSD regulations, and Title V permits. Both PSD
22 and Title V requirements apply to major sources that, depending on the source type, could
23 potentially emit more than either 100 tons/yr or 250 tons/yr of a criteria pollutant. Which
24 threshold applies to a particular source, how the potential emissions are calculated, and what
25 controls are required if the applicable threshold is exceeded are all issues determined in
26 discussions with regulators during the air permit application and approval process.

27
28 The USEPA has established NAAQS for six criteria pollutants — NO₂, SO₂, PM₁₀ and
29 PM_{2.5}, CO, Pb, and O₃ — because of their potential adverse effects on human health and
30 welfare. The health and environmental effects of air pollutants have been summarized by the
31 USEPA (USEPA 2011a). Ambient levels of criteria pollutants other than Pb can contribute to
32 respiratory illnesses, especially in persons with asthma, children, and the elderly, and PM and
33 CO can also aggravate cardiovascular diseases.

34
35 **Ozone Formation.** O₃ in the atmosphere is formed by photochemical reactions
36 involving primarily NO_x and VOCs. It is formed most readily in the summer season, with high
37 temperatures, lower wind speeds, intense solar radiation, and an absence of precipitation; high-
38 O₃ episodes are typically associated with slow-moving, high-pressure systems characterized by
39 light winds and shallow boundary layers (NRC 1992). However, conditions in Alaska are
40 seldom favorable for significant O₃ formation, primarily due to low ambient temperature. At
41 Kodiak, for example, the highest monthly mean daily maximum of 61.0°F occurs in August,
42 when the highest temperature is 86°F (NCDC 2011a).

43
44 **Acid Deposition and Visibility.** Gaseous pollutants undergo various chemical reactions
45 in the atmosphere to form small particles, which remain airborne for extended periods of time.
46 NO_x compounds react with ammonia and moisture to form ammonium nitrate particles, which

1 contribute to PM_{2.5} concentrations. SO₂ combines with moisture to form tiny sulfate particles,
2 which may also contribute to adverse health effects. In addition, gaseous NO_x and SO₂ can
3 dissolve into cloud water. These acidic chemicals eventually return to the ground in either wet
4 (e.g., rain, snow) or dry (e.g., gases, particles) forms, commonly referred to as acid deposition or
5 acid rain (USEPA 2011b). Dry deposition and wet deposition are equally important. The
6 deposition often takes place hundreds of miles from the source. Acid deposition can damage
7 forests and crops, change the makeup of soil, and in some cases may make lakes and streams
8 acidic and unsuitable for fish. Deposition of nitrogen from NO_x emissions also contributes to
9 nitrogen load in water bodies, especially estuaries and near-coastal ecosystems. Acid deposition
10 accelerates the decay of building materials and paints, including those of irreplaceable
11 monuments, statues, sculptures, and other cultural resources. Particulate matter, including
12 sulfate and nitrate particles and organic aerosols that form part of photochemical smog,
13 significantly reduce atmospheric visibility. Atmospheric pollutants adversely affect visibility in
14 many national parks and monuments, as well as wilderness areas (USEPA 2011b).

15
16 The most important source of visibility degradation is from PM_{2.5} in the 0.1- to 1- μ m
17 size range, which covers the range of visible light (0.4–0.7 μ m) (Malm 1999). These particles
18 are directly emitted into the atmosphere through fuel burning. However, other sources arise
19 through the chemical transformation of NO₂, SO₂, and VOCs into nitrates, sulfates, and
20 carbonaceous particles. Existing visibility in Alaska is generally good because of the absence of
21 large emission sources.

22
23 **Arctic Haze.** Arctic haze is a reduction in visibility that often appears in distinct bands
24 at different heights. It was initially observed during weather reconnaissance flights in the High
25 Arctic. The haze is seasonal, with a peak in the spring, and originates from anthropogenic
26 sources outside the Arctic. The most severe episodes occur when stable high-pressure systems
27 produce clear, calm weather; these episodes can reduce visibility (~30.6 km [~19 mi]) in spite of
28 the otherwise clear weather. Coal burning appears to be the principle source of haze particles.
29 Haze particles consist of sulfate (up to 90%), soot, and sometimes dust, most of which originate
30 in Eurasia and are picked up by the Arctic airmass that moves northward over the North Pole in
31 winter. The cold, dry air in the polar regions allows particles to remain airborne for weeks, thus
32 permitting the contaminants to spread over the Arctic and into North America. Arctic haze
33 reduces visibility, but the levels of sulfur compounds in haze are lower than those found in
34 heavily polluted cities (AMAP 1997).

35
36
37 **4.4.4.2.1 Routine Operations.** The Cook Inlet OCS experiences open-water conditions
38 throughout the year, except in small northern portions of the planning area from January to
39 March (MMS 2003a).

40
41 Under the proposed action, construction and operation of up to 12 exploration and
42 delineation wells, up to 114 development and production wells, up to 241 km (150 mi) of new
43 offshore pipeline, up to 169 km (105 mi) of new onshore pipeline, and up to 1 new pipeline
44 landfall will result in emissions that could affect air quality in Cook Inlet. These activities would
45 generate emissions from stationary sources at the drilling/well sites and from support vessels and

1 aircraft over the 40-year period of the Program (Table 4.4.1-3). There could be up to 3 vessel
2 trips/wk and 3 helicopter trips/wk under the proposed action.

3
4 **Emissions.** The type and relative amounts of air pollutants generated by offshore
5 operations vary according to the phase of activity. There are three principal phases of OCS
6 operations: exploration, development, and production. Activities affecting air quality include
7 seismic surveys; drilling activities; platform construction and emplacement; pipeline laying and
8 burial operations; platform operations; flaring; fugitive emissions; support vessel and helicopter
9 operations; and evaporation of VOCs during transfers and spills. Principal emissions of concern
10 are the criteria pollutants and their precursors: NO_x, SO₂, PM₁₀, and PM_{2.5}, CO, and VOCs.

11
12 Releases of toxic chemicals could be a concern around oil spills and *in situ* burning and
13 especially during accidental releases of H₂S at platforms. Other sources of pollutants related to
14 OCS operations are accidents such as losses of well control and oil spills. Spill emissions consist
15 primarily of VOCs, while fires and *in situ* burning produce criteria pollutants along with
16 hazardous air pollutants.

17
18 Air emissions from the proposed action in the Cook Inlet were estimated using the
19 most recent available exploration and development scenarios for 2012–2017 as shown in
20 Table 4.4.4-3. These emissions were estimated by BOEM (Herkhof 2011) using emission
21 factors from the *2008 Gulfwide Emission Inventory Study* (Wilson et al. 2010). Although the
22 study is specific to the GOM, these factors should be applicable in the Cook Inlet, since many of
23 the same types of sources are involved in oil and gas activities in both areas.

24
25
26 **TABLE 4.4.4-3 Estimated Highest Annual Air Emissions from OCS Activities in the Cook**
27 **Inlet Planning Area, Proposed 2012-2017 Leasing Program**

Activity	Pollutant (tons/yr)					
	NO _x	SO _x	PM ₁₀	PM _{2.5}	VOC	CO
Exploration/Delineation Well Drilling	38–38 ^a	8–8	3–3	3–3	7–7	0–0
Development/Production Well Drilling	229–382	46–77	16–27	16–27	41–68	1–2
Platform Installation and Removal	213–213	31–31	5–5	5–5	5–5	28–28
Pipeline Installation	331–663	56–113	13–25	13–25	13–25	69–138
Production Platforms	53–53	1–1	0–0	0–0	34–34	60–60
Support Vessels	96–96	13–13	2–2	2–2	2–2	9–9
Helicopters	1–1	0–0	0–0	0–0	2–2	10–10
Tankers Loading	0–0	0–0	0–0	0–0	0–0	0–0
Tankers in Transit	0–0	0–0	0–0	0–0	0–0	0–0
Tankers Unloading	0–0	0–0	0–0	0–0	0–0	0–0
Total	961–1,445	156–243	39–62	39–62	103–143	177–246

^a The range of values reflects the low and high end of the exploration and development scenarios for the Program.

Source: Herkhof 2011; Wilson et al. 2010.

1 Oil and gas activity emissions from the Program for the Cook Inlet are relatively small in
2 comparison to those other planning areas. For all pollutants under both low and high scenarios,
3 Cook Inlet emissions are 4% or less of the GOM emissions. They are up to 12% of Arctic
4 regions emissions. In terms of absolute amount, the main emissions would be NO_x followed by
5 CO, with lesser amounts of SO_x, VOCs, PM₁₀ and PM_{2.5} in order of descending emissions.
6 Emissions from the Program would initially be lower in the first few years as exploratory wells
7 were drilled and platforms started producing oil and gas. During the last half of the 40-yr
8 Program, emissions would decrease as production decreased and some platforms were removed
9 (MMS 2007c).

10
11 **Impacts on Criteria Pollutants Other**
12 **Than Ozone.** Air quality modeling for NO₂,
13 SO₂, and PM₁₀ were conducted for a lease sale
14 in the Cook Inlet Planning Area (MMS 2003a).
15 Potential air quality impacts were estimated by
16 using the Offshore and Coastal Dispersion
17 model for both exploratory drilling and a
18 production facility. Potential emission sources
19 were placed so as to maximize potential air
20 quality impacts on the Tuxedni Wilderness
21 Area (WA), which is a PSD Class I area in the
22 Cook Inlet. The highest predicted NO₂
23 concentration in the Tuxedni WA was
24 0.27 µg/m³, about 11% of PSD Class I
25 maximum allowable increment of 2.5 µg/m³.
26 For SO₂, the highest predicted annual average,
27 maximum 24-hr, and maximum 3-hr average
28 concentrations in the Tuxedni WA were 0.02,
29 0.58, and 2.7 µg/m³, respectively, for which
30 PSD Class I incremental limits are 2, 5, and
31 25 µg/m³. For PM₁₀, the highest annual
32 average and 24-hr average concentrations in
33 Tuxedni WA were predicted to be 0.02 and
34 0.51 µg/m³, for which PSD Class I incremental limits are 4 and 8 µg/m³. The highest onshore
35 pollutant concentrations were lower than or comparable to those in the Tuxedni WA and thus
36 less than the NAAQS and the PSD Class II incremental limits.
37

38 Each project in the Program would apply the best available control technology according
39 to USEPA and State regulations, and pollutant concentrations would have to meet the PSD
40 incremental limits. Existing pollutant concentrations in the Cook Inlet are well within the
41 NAAQS (MMS 2003a). The small additional concentrations from the Program would result in
42 levels that are still well within the NAAQS.
43

44 **Impacts on Ozone.** As noted above, conditions in Alaska are seldom favorable for
45 significant O₃ formation because of the low ambient temperature. Precursor emissions NO_x and
46 VOCs are relatively small, and a significant increase in O₃ concentrations onshore is not likely to

Comparing Impacts to PSD Increments

Several points should be considered when air quality impacts are compared to PSD increments. First, the PSD program applies to individual sources, not programs. Emissions from an individual source such as a platform or set of platforms could differ from the emissions being modeled in a particular study. Second, increment tracking is a cumulative process that sets a maximum allowable increase above a baseline concentration. It is unlikely that a permitting agency would permit a single source to consume the entire increment. Last, PSD applies only to major sources, generally sources with the potential to emit more than 250 tons/yr, except the 100 tons/yr threshold for 28 source categories. OCS oil and gas production activities are subject to a 250 tons/yr threshold. Regardless of the *actual* emissions, a source's potential emissions could exceed the 250 tons/yr threshold. Determining *potential* emissions and available PSD increment allowances require consultation with the cognizant regulators.

1 result from oil and gas activities associated with the proposed action. OCS activities would also
2 be relatively small and separated from each other, diminishing the combined effects from these
3 activities and greatly increasing atmospheric dispersion of pollutants before they reach shore.
4 The proposed activities would not be expected to cause any exceedances of the O₃ standard
5 (MMS 2008b).
6

7 **Impacts on Visibility.** A number of visibility screening runs were performed using the
8 VISCREEN model to evaluate potential effects of oil and gas activities on visibility in the
9 Tuxedni WA (MMS 2003a). For an exploration project located 12 km (7.5 mi) distant from the
10 Tuxedni WA, the model results exceed the screening criteria when the wind blows directly from
11 the facility to the Tuxedni WA, under the worst-case meteorological conditions with a wind
12 speed of 1 m/s (2.2 mph) and stable atmosphere. If the screening criteria are exceeded, it
13 indicates the possibility that a plume generated by the emissions would be visible by an observer
14 within Tuxedni WA. However, it does not provide a measure of any general visibility effects in
15 the area, such as regional haze. It is estimated that this scenario would occur less than 1% of the
16 time. For distances larger than 50 km (31 mi), the screening criteria were not exceeded. Under
17 average meteorological conditions, it is estimated that a plume would not be visible.
18

19 Given that oil and gas sources are relatively small and would be scattered over a large
20 area, it is not expected that they would have a measureable impact on visibility. However, a
21 more refined analysis might be needed during the permitting process to more precisely evaluate
22 any effects of oil and gas activities on visibility.
23

24 **Greenhouse Gas Emissions.** Estimates were made of the total GHG emissions of CO₂,
25 CH₄, and N₂O for all projected activities associated with the Program (Herkhof 2011). Emission
26 estimates for the various activities were largely based on a comprehensive inventory of air
27 emissions from oil and gas activities in the GOM for 2008 (Wilson et al. 2010). Air emissions
28 resulting from the Program were estimated by considering the exploration and development
29 scenarios presented in Table 4.4.1-3. Emissions are given in terms of Tg of CO₂-equivalent,
30 where 1 Tg is 10¹² g (10⁶ metric tons). This measure takes into account a GWP factor that
31 accounts for the relative effectiveness of a gas to contribute to global warming with respect to the
32 same amount of CO₂. In these calculations, CH₄ is given a GWP of 21, while N₂O is given a
33 GWP of 310.
34

35 Table 4.4.4-4 lists the total calculated emissions of CO₂, CH₄, and N₂O from activities
36 associated with the Program and compares them with current (2009) U.S. greenhouse gas
37 emissions from all sources (USEPA 2011). The projected CO₂ emissions from the Program are
38 about 0.0025–0.0038% of all current CO₂ emissions in the United States. The Program CH₄ and
39 N₂O emissions are about 0.0004% or less of the current their respective emissions in the
40 United States. If CO₂, CH₄, and N₂O emissions are combined, the Program emissions are about
41 0.0022–0.0033% and 0.0021–0.0032% of the nationwide total of three GHG emissions and of all
42 GHG emissions, respectively. The estimated total global GHG emissions in 2005 were
43 approximately 38,726 Tg CO₂-equivalent (74 FR 66539). The estimated Program GHG
44 emissions are about 0.00036–0.00055% of the total global GHG emissions.
45

1 **TABLE 4.4.4-4 Projected Greenhouse Gas Emissions from Oil and Gas Activities in**
2 **the Cook Inlet Planning Area, 2012-2017 Leasing Program**

Pollutant	2012-2017 Program (Tg CO ₂ -equivalent) ^a	Total 2009 U.S. Emissions from All Sources (Tg CO ₂ -equivalent)	2012-2017 Program as Percentage of Total 2009 U.S. Emissions
CO ₂	0.1363–0.2100	5,505.2	0.00247–0.00382
CH ₄	0.0028–0.0028	686.3	0.00041–0.00041
N ₂ O	0.0006–0.0010	295.6	0.00021–0.00032
CO ₂ + CH ₄ + N ₂ O	0.1397–0.2138	6,487.1	0.00215–0.00330
All GHG ^b	0.1397–0.2138	6,633.2 ^b	0.00211–0.00322

^a One Tg is equal to 10¹² g, or 10⁶ metric tons. The CO₂-equivalent for a gas is derived by multiplying the mass of the gas by the associated GWP, which accounts for the relative effectiveness of a gas to contribute to global warming with respect to the same amount CO₂. In these calculations, CH₄ is given a GWP of 21, while N₂O is given a GWP of 310.

^b Total U.S. GHG emissions also include hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride emissions. Estimates of emissions from the Program were not made for these compounds, but they are assumed to be very small.

Source: USEPA 2011i; Herkhof 2011.

3
4
5 As noted in Section 3.3, GHG emissions are one of the causes of climate change.
6 Climate change is a global phenomenon and predicting climate change impacts requires
7 consideration of large-scale or even worldwide GHG emissions, not just emissions at a local
8 level. Climate change predictive capability (modeling) lacks the ability to estimate the impact of
9 GHGs from a particular source or sources such as oil and gas activities associated with the
10 Program. What their impact, if any, would be is determined not only by the emissions from the
11 oil and gas activities themselves, but also by the GHG emissions of other sources throughout the
12 world and whether these other emissions are expected to increase or decrease. In addition, since
13 some GHG gases, such as CO₂, may persist in the atmosphere for up to a century, the potential
14 impacts of any source may extend well beyond the active lifetime of the source or program. This
15 said, given the small percentage contributions of oil and gas activities in Cook Inlet to global
16 GHG emissions, the potential impact on climate change would probably be small. Section 3.3
17 provides some baseline considerations for climate change and Section 4.4.3 and Sections 4.4.6
18 through 4.4-15 discuss potential impacts on specific impact areas.

19
20
21 **4.4.4.2.2 Accidents.** Under the proposed action, the number and types of spills assumed
22 to occur in Cook Inlet include up to one large spill (≥1,000 bbl) from either a pipeline or
23 platform and between 8 and 18 small spills (<1,000 bbl) over the 40-year period of the Program
24 (Table 4.4.2-1). Evaporation of oil from these spills and emissions from spill response and
25 cleanup activities including *in situ* burning, if used, have the potential to affect air quality in
26 Cook Inlet.

27

1 **Spills and *In Situ* Burning.** Small accidental oil spills would cause small, localized
2 increases in concentrations of VOCs because of evaporation of the spill. Most of the emissions
3 would occur within a few hours of the spill and would decrease drastically after that period.
4 Large spills would exhibit similar behavior but would affect a somewhat larger area and cause
5 elevated pollutant concentrations to persist somewhat longer. Hanna and Drivas (1993) modeled
6 the emissions of various hydrocarbon compounds from a large spill. A number of these
7 compounds, including BTEX and hexane, are classified by the USEPA as hazardous air
8 pollutants. Many of these contaminants may be carcinogenic to humans and/or animals. The
9 results showed that these compounds evaporate almost completely within a few hours after the
10 spill occurs. Ambient concentrations peak within the first several hours after the spills starts and
11 are reduced by two orders of magnitude after about 12 hr. The heavier compounds take longer to
12 evaporate and may not peak until about 24 hr after spill occurrence. Total ambient VOC
13 concentrations are significant in the immediate vicinity of an oil spill, but concentrations are
14 much reduced after the first day (MMS 2007c). There is no information about any possible
15 effect from the inhalation of air contaminants by subsistence animals, but this effect would be
16 expected to be much less than any contamination by contact with hazardous compounds in the
17 water. These effects on subsistence are described in Section IV.B.3.k of MMS (2007c).
18

19 *In situ* burning is a potential technique for cleanup and disposal of spilled oil. *In situ*
20 burning of a spill results in emissions of NO₂, SO₂, CO, and PM₁₀ and generates a plume of
21 black smoke. Fingas et al. (1995) describes the results of a monitoring program of a burn
22 experiment at sea. The program involved extensive ambient measurements during two
23 experiments in which approximately 300 bbl of crude oil was burned. It found that during the
24 burn, CO, SO₂, and NO₂ were measured only at background levels and were frequently below
25 detection levels. Ambient levels of VOCs were high within about 100 m (328 ft) of the fire but
26 significantly lower than those associated with a nonburning spill. Measured concentrations of
27 PAHs were low. It appeared that a major portion of these compounds was consumed in the burn.
28 The appearance of a black plume from *in situ* burning around a subsistence hunting area could
29 have an adverse effect on subsistence hunting practices because of the creation of a perception
30 that wildlife has been contaminated. Subsistence hunters may avoid areas where such incidents
31 have occurred.
32

33 McGrattan et al. (1995) modeled smoke plumes associated with *in situ* burning. The
34 results showed that the surface concentrations of particulate matter did not exceed the health
35 criterion of 150 µg/m³ beyond about 5 km (3 mi) downwind of an *in situ* burn. This appears to
36 be supported by field experiments conducted off Newfoundland and in Alaska (MMS 2007c).
37 This is quite conservative because this health standard is based on a 24-hr average concentration
38 rather than a 1-hr average concentration.
39

40 Air quality impacts from accidental oil spills in open water during the proposed action
41 would be similar to those described above. However, albeit limited to a small northern area and
42 short duration (January to March), a spill in Cook Inlet during broken ice or melting ice
43 conditions could result in more concentrated emissions over a smaller area than would be the
44 case under open-water conditions because the ice would act to reduce spreading of the oil
45 compared to the spreading of a spill in open water. An oil spill on solid sea ice would spread
46 relatively slowly compared to a spill in open water. The more volatile components of the oil

1 would evaporate rather rapidly, but the heavier compounds would linger on the surface. The
2 effects on air quality would result in more concentrated emissions over a smaller area than would
3 be the case for a spill in open water.

4
5 **Catastrophic Discharge Event.** In the Cook Inlet Planning Area, a low-probability
6 CDE could range in size from 75,000 and 125,000 bbl, with a duration of 50–80 days
7 (Table 4.4.2-2). Evaporation of oil from these spills and emissions from spill response and
8 cleanup activities including *in situ* burning, if used, have the potential to affect air quality in
9 Cook Inlet.

10
11 The air impacts of a CDE and any associated *in situ* burning in the Cook Inlet would be
12 similar to those open water impacts discussed in Section 4.4.4.1.2. Potential impacts from a
13 large spill under the ice are discussed in the “Spills and *In Situ* Burning” subsection above.

14
15 A CDE in South Central Alaska could emit regulated pollutants into the atmosphere.
16 This may cause major air quality impacts during some phases of the event. The greatest impacts
17 on air quality conditions would occur during the initial explosion of gas and oil and during the
18 spill response and cleanup, particularly if the event occurs during the winter. Impacts could
19 continue for days during the initial event and could continue for months during spill response
20 and clean up. Therefore, while the impacts may be major during these two phases, overall, the
21 emissions from a CDE would be temporary and, over time, air quality in South Central Alaska
22 would return to pre-oil-spill conditions (BOEMRE 2011k).

23
24 **Hydrogen Sulfide.** An accidental release of H₂S at a platform and its associated impacts
25 on platform workers and persons in close proximity to a platform are discussed in detail in
26 Section 4.4.4.1.2 for the GOM. Potential impacts at or around the platform would be similar in
27 the Cook Inlet.

28 29 30 **4.4.4.3 Alaska – Arctic**

31
32 General air emission sources and potential impacts on ambient air quality associated with
33 OCS oil and gas activities are covered in detail in Section 4.4.4.1 for the GOM. Air quality
34 impacts for both the Beaufort and the Chukchi Seas are similar and are discussed together.
35 Differences are noted where appropriate.

36
37 The OCS facilities located off Alaska would be under the jurisdiction of the USEPA,
38 which regulates air emissions as prescribed in 40 CFR Part 55. For facilities located within
39 40 km (25 mi) of a State’s seaward boundary, the regulations are the same as would be
40 applicable if the emission source were located in the corresponding onshore area, and would
41 include State and local requirements for emission controls, emission limitations, offsets,
42 permitting, testing, and monitoring. For facilities located more than 40 km (25 mi) from a
43 State’s seaward boundary, the basic Federal air quality regulations apply, which include the
44 USEPA emission standards for new sources, the PSD regulations, and Title V permits. Both
45 PSD and Title V requirements apply to major sources that, depending on the source type, could
46 potentially emit more than either 100 tpy or 250 tpy of a criteria pollutant. Which threshold

1 applies to a particular source, how the potential emissions are calculated, and what controls are
2 required if the applicable threshold is exceeded are all issues determined in discussions with
3 regulators during the air permit application and approval process (MMS 2007c).

4
5 The USEPA has established NAAQS for six criteria pollutants — NO₂, SO₂, PM₁₀ and
6 PM_{2.5}, CO, Pb, and O₃ — because of their potential adverse effects on human health and
7 welfare. The health and environmental effects of air pollutants have been summarized by the
8 USEPA (USEPA 2011a). Ambient levels of criteria pollutants other than Pb can contribute to
9 respiratory illnesses, especially in persons with asthma, children, and the elderly, and PM and
10 CO can also aggravate cardiovascular diseases.

11
12 **Ozone Formation.** O₃ in the atmosphere is formed by photochemical reactions
13 involving primarily NO_x and VOCs. It is formed most readily in the summer season, with high
14 temperatures, lower wind speeds, intense solar radiation, and an absence of precipitation; high-
15 O₃ episodes are typically associated with slow-moving, high-pressure systems characterized by
16 light winds and shallow boundary layers (NRC 1992). However, conditions in Alaska are
17 seldom favorable for significant O₃ formation, primarily due to low ambient temperature. At
18 Barrow, for example, the highest monthly mean daily maximum of 45.9°F occurs in July, when
19 the highest temperature is 79°F (NCDC 2011b).

20
21 **Acid Deposition and Visibility.** Gaseous pollutants undergo various chemical reactions
22 in the atmosphere to form small particles, which remain airborne for extended periods of time.
23 NO_x compounds react with ammonia and moisture to form ammonium nitrate particles, which
24 contribute to PM_{2.5} concentrations. SO₂ combines with moisture to form tiny sulfate particles,
25 which may also contribute to adverse health effects. In addition, gaseous NO_x and SO₂ can
26 dissolve into cloud water. These acidic chemicals eventually return to the ground in either wet
27 (e.g., rain, snow) or dry (e.g., gases, particles) forms, commonly referred to as acid deposition or
28 acid rain (USEPA 2011b). Dry deposition is just as important as wet deposition. The deposition
29 often takes place hundreds of miles from the source. Acid deposition can damage forests and
30 crops, change the makeup of soil, and in some cases may make lakes and streams acidic and
31 unsuitable for fish. Deposition of nitrogen from NO_x emissions also contributes to nitrogen load
32 in water bodies, especially estuaries and near-coastal ecosystems. Acid deposition accelerates
33 the decay of building materials and paints, including those of irreplaceable monuments, statues,
34 sculptures, and other cultural resources. Particulate matter, including sulfate and nitrate particles
35 and organic aerosols that form part of photochemical smog, significantly reduce atmospheric
36 visibility. Atmospheric pollutants adversely affect visibility in many of national parks and
37 monuments, and in wilderness areas (USEPA 2011b).

38
39 The most important cause of visibility degradation is from PM_{2.5} in the 0.1- to 1-μm size
40 range, which covers the range of visible light (0.4–0.7 μm) (Malm 1999). These particles are
41 directly emitted into the atmosphere through fuel burning. However, other sources arise through
42 chemical transformation of NO₂, SO₂, and VOCs into nitrates, sulfates, and carbonaceous
43 particles. Existing visibility in Alaska is generally good because of the absence of large emission
44 sources. However, the phenomenon of arctic haze, which occurs in Arctic Alaska during the
45 winter and spring, is caused primarily by long-range transport of pollutants from industrial
46 Eurasia (Rahn 1982).

1 **Arctic Haze.** Arctic haze is a reduction in visibility that often appears in distinct bands
2 at different heights. It was initially observed during weather reconnaissance flights in the High
3 Arctic. The haze is seasonal, with a peak in the spring, and originates from anthropogenic
4 sources outside the Arctic. The most severe episodes occur when stable high pressure systems
5 produce clear, calm weather and can reduce visibility (~30.6 km [~19 mi]) in spite of the
6 otherwise clear weather. Coal burning appears to be the principle source of haze particles. Haze
7 particles consists of sulfate (up to 90%), soot, and sometimes dust, most of which originate in
8 Eurasia and are picked up by the Arctic airmass that moves northward over the North Pole in
9 winter. The cold, dry air in the polar regions allows particles to remain airborne for weeks, thus
10 permitting the contaminants to spread over the Arctic and into North America. Arctic haze
11 reduces visibility, but the levels of sulfur compounds in haze are lower than those found in
12 heavily polluted cities (AMAP 1997).

13
14
15 **4.4.4.3.1 Routine Operations.** OCS operations in the Arctic Ocean are unique in a
16 number of ways because of the sea ice that is present much of the year. In waters 5–10 m
17 (16–33 ft) deep, exploratory wells may be drilled from an ice or gravel island (MMS 2003e).
18 Construction of an ice island would need to take place in winter (November–January), and
19 material and personnel would be carried to the site by vehicles operating on an ice road. In
20 water 10–20 m (33–66 ft) deep, movable platforms attached to the seafloor may be used for
21 exploration. Drilling operations from these platforms are usually conducted during open-water
22 season from July through October. Ice islands are not projected for the Chukchi Sea, because
23 activities there would not occur close to shore. In deeper waters, drillships or floating platforms
24 would be used, and drilling would be limited less than 4 months during the summer. Material
25 and supplies would be ferried using barges or supply boats. In addition, icebreakers would
26 operate in the vicinity of the drilling rig and vessels to control incursions of sea ice. Because of
27 the arctic conditions, the pace of development is slower as activities are limited to certain rather
28 narrow time frames. Air emission rates tend to be higher because activities are more
29 concentrated and additional vessels such as icebreakers may be needed. In shallow waters,
30 production may take place from gravel islands, while in deeper waters production facilities
31 would be installed on large gravity-base platforms. As in the case of exploration, a gravel island
32 would be constructed during winter. The modules for production facilities would be installed
33 during the ice-free period using barges, tugboats, and supply vessels (MMS 2007c).

34
35 Under the proposed action, construction and operation of up to 36 exploration wells, up
36 to 400 production wells, up to 92 subsea wells, up to 652 km (405 mi) of new offshore pipeline,
37 and up to 129 km (80 mi) of new onshore pipeline will result in emissions that could affect air
38 quality in the Arctic Alaska. These activities would generate emissions from stationary sources
39 at the drilling/well sites and from support vessels and aircraft over the 50-year period of the
40 Program (Table 4.4.1-4). There could be up to 27 vessel trips/wk and 27 helicopter trips/wk
41 under the proposed action.

42
43 **Emissions.** The type and relative amounts of air pollutants generated by offshore
44 operations vary according to the phase of activity. There are three principal phases of OCS
45 operations: exploration, development, and production. Activities affecting air quality include
46 seismic surveys; drilling activities; platform construction and emplacement; pipeline laying and

1 burial operations; platform operations; flaring; fugitive emissions; support vessel and helicopter
2 operations; and evaporation of VOCs during transfers and spills.

3
4 Releases of toxic chemicals could be a concern around spills and during *in situ* burning
5 and especially during accidental releases of H₂S at platforms. Other sources of pollutants related
6 to OCS operations are accidents such as losses of well control and oil spills. Spill emissions
7 consist primarily of VOCs, while fires and *in situ* burning produce criteria pollutants along with
8 hazardous air pollutants.

9
10 Air emissions from the proposed action for the Beaufort Sea and the Chukchi Sea were
11 estimated by using the most recent available exploration and development scenarios for 2012–
12 2017, as shown in Table 4.4.4-5. These emissions were estimated by BOEM (Herkhof 2011)
13 using emission factors from the *2008 Gulfwide Emission Inventory Study* (Wilson et al. 2010).
14 Although the study is specific to the GOM, these factors should be applicable in the Arctic
15 region, since many of the same types of sources are involved in oil and gas activities in both
16 areas.

17
18 In terms of absolute amount, the main emissions would be NO_x, followed by CO, with
19 lesser amounts of VOCs, SO₂, PM₁₀, and PM_{2.5}. Tankers in transit are projected to be the
20 largest source of emissions associated with oil and gas activities in the Arctic. However, much
21 of the emissions would be at some distance from the lease areas. For sources located in or near
22 the lease areas, platform installation and removal would be the largest source of NO_x, SO_x,
23 PM₁₀, and PM_{2.5} emissions under the low scenario, while pipeline installation would be the
24 largest source of these pollutants under the high scenario. Production platforms would be the
25 largest source of VOC and CO emissions under both scenarios. Emissions from the Program
26 would initially be lower in the first few years as exploratory wells were drilled and platforms
27 started producing oil and gas. During the last half of the Program, emissions would decrease as
28 production decreased and some platforms were removed (MMS 2007c).

29
30 **Impacts on Criteria Pollutants Other Than Ozone.** Air quality modeling using the
31 Offshore and Coastal Dispersion Model (OCD) has been performed in past studies to assess
32 impacts from planned lease sales in the Beaufort Sea (MMS 1996). The highest predicted
33 onshore annual average NO₂ concentrations were in the range of 0.5–1.5 µg/m³, which is well
34 below the PSD Class II maximum allowable increment of 25 µg/m³. Concentrations of SO₂ and
35 PM₁₀ were not modeled; however, when the results are scaled according to the respective
36 emission rates, the levels would be below the PSD Class II maximum allowable increments.

37
38 An examination of the air quality modeling analysis performed for the Northstar facility
39 and proposed Liberty development project in the Beaufort Sea provides a measure of the
40 expected impacts over water near an OCS production facility on a gravel island in the Beaufort
41 Sea. The highest predicted concentrations for NO₂, SO₂, and PM₁₀ for the Northstar and Liberty
42 projects occurred within 200 m (656 ft) of the facility boundary and were close to but still lower
43 than PSD Class II maximum allowable increments (MMS 2002c; USACE 1999). The highest
44 onshore concentrations were considerably lower. The combined facility concentrations for
45 Liberty plus background were well within NAAQS (between 2 and 30% of the standards).

TABLE 4.4.4-5 Estimated Highest Annual Air Emissions from OCS Activities in the Arctic (Beaufort and Chukchi Seas) Planning Area, Proposed 2012-2017 Leasing Program

Activity	Pollutant (tons/yr)					
	NO _x	SO _x	PM ₁₀	PM _{2.5}	VOC	CO
Exploration/Delineation Well Drilling	1,977–1,977 ^a	512–512	89–89	82–82	86–86	2–2
Development/Production Well Drilling	535–1,375	108–279	38–97	38–97	96–246	2–6
Platform Installation and Removal	925–1,851	217–435	37–73	34–67	32–64	29–58
Pipeline Installation	398–861	68–146	15–33	15–33	15–33	83–179
Production Platforms	53–106	1–3	0–1	0–1	34–68	60–119
Support Vessels	96–191	13–26	2–3	2–3	2–3	9–18
Helicopters	1–2	0–0	0–0	0–0	2–4	10–19
Tankers Loading (Valdez)	47–158	8–27	2–6	2–6	878–2,955	10–33
Tankers in Transit	6,016–20,253	1,022–3,439	227–764	227–764	1,264–4,256	1,249–4,203
Tankers Unloading (West Coast Port)	47–158	8–27	2–6	2–6	440–1,481	10–33
Total	10,095–26,933	1,957–4,893	411–1,072	401–1,059	2,848–9,194	1,462–4,669

^a The range of values reflects the low and high end of the exploration and development scenarios for the Program.

Source: Herkhof 2011; Wilson et al. 2010.

1 Results of OCD modeling for
2 development from a proposed lease sale in the
3 Chukchi Sea indicated that the highest annual
4 average NO₂ concentration was 1.29 µg/m³,
5 which is about 5% of PSD Class II maximum
6 allowable increment of 25 µg/m³ (MMS 1991).
7 No modeling was performed for SO₂ and
8 PM₁₀, but concentration should be well within
9 the PSD Class II increments considering that
10 NO_x emissions are an order of magnitude
11 higher than SO₂ and PM₁₀ emissions.

12
13 These activities in the Arctic Alaska are
14 not anticipated to affect Class I areas in Alaska,
15 which are several hundred miles away.

16
17 The most significant source of industrial
18 emissions in the Arctic Alaska, the Prudhoe
19 Bay-Kuparuk-Endicott oil-production complex,
20 was the subject of monitoring programs during
21 1986–1987 and from 1990 through 1996. Five
22 monitoring sites were selected; three were
23 considered subject to maximum air pollutant
24 concentrations, and two were considered more representative of the air quality of the general
25 Prudhoe Bay area. All the values meet Federal and State ambient air quality standards. These
26 results indicate that ambient pollutant concentrations from oil and gas activities, even for sites
27 subject to maximum concentrations, are likely to meet the ambient air quality standards
28 (MMS 2008b).

29
30 The Program would result in a rather slow rate of development involving a small number
31 of facilities that would be spread over a wide area. Each project would apply the best available
32 control technology according to USEPA and State regulations, and pollutant concentrations
33 would have to meet the PSD incremental limits. Existing pollutant concentrations in coastal
34 Alaska are well within the NAAQS. The small additional concentrations from the Program
35 would result in levels that are still well within the NAAQS.

36
37 **Impacts on Ozone.** As noted above, conditions in Alaska are seldom favorable for
38 significant O₃ formation. Precursor NO_x and VOC emissions are relatively small, and a
39 significant increase in O₃ concentrations onshore is not likely to result from oil and gas activity
40 scenarios associated with the proposed action. Although sunshine is present in the Beaufort Sea
41 program area most of each day during summer, temperatures remain relatively low. At a number
42 of air-monitoring sites in the Prudhoe Bay and Kuparuk areas, O₃ measurements show that the
43 highest 1-hr maximum O₃ concentrations generally are in the range of 0.04–0.09 ppm. The
44 highest 8-hr average ozone concentrations would be well below the NAAQS of 0.075 ppm.
45 Because the projected O₃ precursor emissions from any of the proposed activities are
46 considerably lower than the existing emissions from the Prudhoe Bay-Kuparuk-Endicott

Comparing Impacts to PSD Increments

Several points should be considered when air quality impacts are compared to PSD increments. First, the PSD program applies to individual sources, not programs. Emissions from an individual source such as a platform or set of platforms could differ from the emissions being modeled in a particular study. Second, increment tracking is a cumulative process that sets a maximum allowable increase above a baseline concentration. It is unlikely that a permitting agency would permit a single source to consume all the increment. Last, PSD applies only to major sources, generally sources with the potential to emit more than 250 tons/yr, other than the 100 tons/yr threshold for 28 source categories. OCS oil and gas production activities are subject to 250 tons/yr threshold. Regardless of the *actual* emissions, a source's *potential* emissions could exceed the 250 tons/yr threshold. Determining potential emissions and available PSD increment allowances requires consultation with the cognizant regulators.

1 complex, the proposed activities would not be expected to cause any violations of the O₃
2 standard (MMS 2008b).

3
4 **Impacts on Visibility.** For the proposed Liberty Project in the Beaufort Sea, British
5 Petroleum (Exploration) Alaska (BPXA) ran the VISCREEN model, which calculates the
6 potential impact of a plume of specified emissions for specific transport and dispersion
7 conditions (MMS 2002c). It found noticeable effects on a limited number of days, ones that had
8 the most restrictive meteorological conditions, but no effects at all during average meteorological
9 conditions. This model tends to overestimate impacts, and it is not known to what extent OCS
10 sources contribute to the predicted visibility reductions. The OCS sources are relatively small
11 and would be scattered over a large area. It is not expected that they would have a measureable
12 impact on visibility. Overall, the impacts from the proposed action would be expected to be
13 small or negligible (MMS 2007c).

14
15 **Greenhouse Gas Emissions.** Estimates were made of the total GHG emissions of CO₂,
16 CH₄, and N₂O for all projected activities associated with the Program (Herkhof 2011). Emission
17 estimates for the various activities were largely based on a comprehensive inventory of air
18 emissions from oil and gas activities in the GOM for 2008 (Wilson et al. 2010). Air emissions
19 resulting from the Program were estimated by considering the exploration and development
20 scenarios presented in Table 4.4.1-4. Emissions are given in terms of Tg of CO₂-equivalent,
21 where 1 Tg is 10¹² g (10⁶ metric tons). This measure takes into account a GWP factor, which
22 accounts for the relative effectiveness of a gas to contribute to global warming with respect to the
23 same amount CO₂. In these calculations, CH₄ is given a GWP of 21, while N₂O is given a GWP
24 of 310.

25
26 Table 4.4.4-6 lists the total calculated emissions of CO₂, CH₄, and N₂O from activities
27 associated with the Program and compares them with current (2009) U.S. GHG emissions from
28 all sources (USEPA 2011). The projected CO₂ emissions from the Program are about
29 0.014–0.038% of all current CO₂ emissions in the United States. Both the projected CH₄ and
30 N₂O emissions from the Program are about 0.002–0.006% of all their current respective
31 emissions in the United States. If CO₂, CH₄, and N₂O emissions are combined, the Program
32 emissions are about 0.013–0.033% and 0.012–0.032% of the Nationwide total of three GHG
33 emissions and of all GHG emissions, respectively. The estimated total global GHG emissions in
34 2005 were approximately 38,726 Tg CO₂-equivalent (74 FR 66539). The estimated Program
35 GHG emissions are about 0.002–0.006% of the total global GHG emissions.

36
37 As noted in Section 3.3, GHG emissions are one of the causes of climate change.
38 Climate change is a global phenomenon and predicting climate change impacts requires
39 consideration of large scale or even worldwide GHG emissions, not just emissions at a local
40 level. Climate change predictive capability (modeling) lacks the ability to estimate the impact of
41 GHGs from a particular source or sources such as oil and gas activities associated with the
42 Program. What their impact, if any, would be is determined not only by the emissions from the
43 oil and gas activities themselves, but also by the GHG emissions of other sources throughout the
44 world and whether these other emissions are expected to increase or decrease. In addition, since
45 some GHG gases, such as CO₂, may persist in the atmosphere for up to a century, the potential
46 impacts of any source may extend well beyond the active lifetime of the source or program. This

1 **TABLE 4.4.4-6 Projected Greenhouse Gas Emissions from Oil and Gas Activities in**
2 **the Arctic (Beaufort and Chukchi Seas) Planning Area, 2012-2017 Leasing Program**

Pollutant	2012-2017 Program (Tg CO ₂ -equivalent) ^a	Total 2009 U.S. Emissions from All Sources (Tg CO ₂ -equivalent)	2012-2017 Program as Percentage of Total 2009 U.S. Emissions
CO ₂	0.80–2.07	5,505.2	0.014–0.038
CH ₄	0.01–0.04	686.3	0.002–0.006
N ₂ O	0.006–0.019	295.6	0.002–0.006
CO ₂ + CH ₄ + N ₂ O	0.82–2.14	6,487.1	0.013–0.033
All GHG ^b	0.82–2.14	6,633.2b	0.012–0.032

^a One Tg is equal to 10¹² g or 10⁶ metric tons. The CO₂-equivalent for a gas is derived by multiplying the mass of the gas by the associated GWP, which accounts for the relative effectiveness of a gas to contribute to global warming with respect to the same amount CO₂. In these calculations, CH₄ is given a GWP of 21, while N₂O is given a GWP of 310.

^b Total U.S. GHG emissions also include hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride emissions. Estimates of emissions from the Program were not made for these compounds, but they are assumed to be very small.

Source: USEPA 2011i; Herkhof 2011.

3
4
5 said, given the small percentage contributions of oil and gas activities in Arctic region to global
6 GHG emissions, the potential impact on climate change would probably be small. Section 3.3
7 provides some baseline considerations for climate change and Section 4.4.3 and Sections 4.4.6
8 through 4.4-15 discuss potential impacts to specific impact areas.

9
10
11 **4.4.4.3.2 Accidents.** Under the proposed action, the number and types of spills assumed
12 to occur in Arctic Alaska include up to 3 large spills (≥1,000 bbl) from pipelines or platforms
13 and between 60 and 225 small spills (<1,000 bbl) over the 50-year period of the Program
14 (Table 4.4.2-1). Evaporation of oil from these spills and emissions from spill response and
15 cleanup activities including *in situ* burning, if used, have the potential to affect air quality in the
16 Arctic Alaska.

17
18 **Spills and *In Situ* Burning.** Small accidental oil spills would cause small, localized
19 increases in concentrations of VOCs because of evaporation of the spill. Most of the emissions
20 would occur within a few hours of the spill and would decrease drastically after that period.
21 Large spills would exhibit similar behavior but would affect a somewhat larger area and cause
22 elevated pollutant concentrations to persist somewhat longer. Hanna and Drivas (1993) modeled
23 the emissions of various hydrocarbon compounds from a large spill. A number of these
24 compounds, including BTEX and hexane, are classified by the USEPA as hazardous air
25 pollutants. Many of these contaminants may be carcinogenic to humans and/or animals. The
26 results showed that these compounds evaporate almost completely within a few hours after the
27 spill occurs. Ambient concentrations peak within the first several hours after the spills starts and
28 are reduced by two orders of magnitude after about 12 hr. The heavier compounds take longer to

1 evaporate and may not peak until about 24 hr after spill occurrence. Total ambient VOC
2 concentrations are significant in the immediate vicinity of an oil spill, but concentrations are
3 much reduced after the first day (MMS 2007c). There is no information about any possible
4 effect from the inhalation of air contaminants by subsistence animals, but this effect would be
5 expected to be much less than any contamination by contact with hazardous compounds in the
6 water. These effects on subsistence are described in Section IV.B.3.k of MMS (2007c).

7
8 *In situ* burning is a potential technique for cleanup and disposal of spilled oil. *In situ*
9 burning of a spill results in emissions of NO₂, SO₂, CO, and PM₁₀ and generates a plume of
10 black smoke. Fingas et al. (1995) describes the results of a monitoring program of a burn
11 experiment at sea. The program involved extensive ambient measurements during two
12 experiments in which approximately 300 bbl of crude oil was burned. It found that during the
13 burn, CO, SO₂, and NO₂ were measured only at background levels and were frequently below
14 detection levels. Ambient levels of VOCs were high within about 100 m (328 ft) of the fire, but
15 were significantly lower than those associated with a nonburning spill. Measured concentrations
16 of PAHs were low. It appeared that a major portion of these compounds was consumed in the
17 burn. The appearance of a black plume from *in situ* burning around a subsistence hunting area
18 could have an adverse effect on subsistence hunting practices because of the creation of a
19 perception that wildlife has been contaminated. Subsistence hunters may avoid areas where such
20 incidents have occurred.

21
22 McGrattan et al. (1995) modeled smoke plumes associated with *in situ* burning. The
23 results showed that the surface concentrations of particulate matter did not exceed the health
24 criterion of 150 µg/m³ beyond about 5 km (3 mi) downwind of an *in situ* burn. This appears to
25 be supported by field experiments conducted off Newfoundland and in Alaska (MMS 2007c).
26 This is quite conservative as this health standard is based on a 24-hr average concentration rather
27 than a 1-hr average concentration.

28
29 Air quality impacts from accidental oil spills in open water during the proposed action
30 would be similar to those described above. However, a spill in the Arctic during broken ice or
31 melting ice conditions could result in more concentrated emissions over a smaller area than
32 would be the case under open-water conditions because the ice would act to reduce spreading of
33 the oil compared to the spreading of a spill in open water. An oil spill on solid sea ice would
34 spread relatively slowly compared to a spill in open water. The more volatile components of the
35 oil would evaporate rather rapidly, but the heavier compounds would linger on the surface. The
36 effects on air quality would result in more concentrated emissions over a smaller area than would
37 be the case for a spill in open water.

38
39 **Catastrophic Discharge Event.** In the Arctic, a low-probability CDE could range in
40 size from 1,700,000 and 3,900,000 bbl with a duration of 60–300 days in the Beaufort Planning
41 Area, and from 1,400,000 and 2,100,000 bbl with a duration of
42 40–75 days in the Chukchi Planning Area (Table 4.4.2-2). Evaporation of oil from these spills
43 and emissions from spill response and cleanup activities including *in situ* burning, if used, have
44 the potential to affect air quality in Arctic Alaska.

1 The air impacts of a CDE and any associated *in situ* burning in the Arctic would be
2 similar to impacts discussed in Section 4.4.4.1.2. Potential impacts from a large spill under the
3 ice are discussed in the “Spills and *In Situ* Burning” subsection above.
4

5 A CDE in Arctic Alaska could emit regulated pollutants into the atmosphere. This may
6 impact local air quality during some phases of the event. The greatest impacts on air quality
7 conditions would occur during the initial explosion of gas and oil and during spill response and
8 clean up, particularly if the event occurs during the winter. Impacts could continue for days
9 during the initial event and could continue for months during spill response and clean up.
10 Therefore, while the impacts may be large during these two phases, overall, the emissions from a
11 CDE would be temporary and, over time, air quality in Arctic Alaska would return to pre-oil-
12 spill conditions (BOEMRE 2011k).
13

14 **Hydrogen Sulfide.** An accidental release of H₂S at a platform and its associated impacts
15 on platform workers and persons in close proximity to a platform are discussed in detail in
16 Section 4.4.4.1.2 for the GOM. Potential impacts at or around the platform would be similar in
17 Arctic Alaska.
18

19 4.4.4.4 Conclusions

20
21
22 Routine Program operations in any of the GOM and Alaska Planning Areas would result
23 in levels of NO₂, SO₂, PM₁₀, and CO that are well within NAAQS. The incremental
24 concentrations of NO₂, SO₂, and PM₁₀ would be within the maximum allowable PSD increases.
25 Routine Program activities were modeled to contribute less than 1% of the total O₃
26 concentrations from all OCS oil and gas activities in the GOM, where at some locations,
27 concentrations from all sources (OCS-related and non-OCS sources) exceed standards at times;
28 no exceedance of O₃ standards are expected in the Cook Inlet and Arctic Planning Areas.
29 Therefore, impacts to air quality from routine operations associated with the Program are
30 expected to be minor.
31

32 Air quality impacts from large and small accidental oil spills or *in situ* burning would be
33 localized and short-term. Air quality impacts from a large spill (and especially from a CDE)
34 would emit regulated pollutants into the atmosphere. This may cause localized large air quality
35 impacts during some phases of the event. The greatest impacts on air quality conditions would
36 occur during the initial explosion of gas and oil and during the spill response and cleanup,
37 particularly if the spill occurs during the winter. Impacts could continue for days during the
38 initial event and could continue for months during spill response and cleanup. Therefore, while
39 the impacts may be large at times, overall, the emissions from a CDE would be temporary and,
40 over time, air quality would return to pre-oil-spill conditions.
41
42

4.4.5 Potential Impacts on the Acoustic Environment

This section identifies impact producing factors and potentially impacted resources (such as marine mammals). Details on impacted resources (such as individual species) are provided in the specific resource sections of Chapter 4.

4.4.5.1 Introduction

The BOEM has screened seismic, deep-tow sonar, electromagnetic survey, geological and geological sampling, remote sensing, and marine magnetic survey activities for potential impacts on marine mammals; sea turtles; fishes; commercial, personal, and recreational fisheries; coastal and marine birds; benthic communities; cultural resources; subsistence uses of natural resources; military uses; and recreational and commercial diving in the GOM (BOEM unpublished), but did not cover other routine operations such as construction, drilling, explosives, and support vessels and aircraft. The study reviewed EAs, EISs, and relevant literature pertinent to OCS activities and identified resources such as marine mammals for impact analysis. A preliminary screening using resource-specific significance criteria based on accepted threshold levels was conducted to identify those G&G seismic survey activities and resources with potential for non-negligible impacts. Various technologies were evaluated for each type of activity, and impacts from air gun noise, sonar noise, vessel traffic, towed streamers, and aircraft traffic were considered. Only seismic surveys were determined to have potential adverse impacts on marine mammals, sea turtles, fishes, and commercial and recreational fisheries. The other survey activities screened were determined to have negligible or no measurable acoustic impacts. These results should also be relevant to the Arctic region and south central Alaska and include potential for impacts to personal-use and subsistence fisheries and taking of marine mammals.

4.4.5.1.1 Routine Operations. Table 4.4.1-1 details impact producing factors for routine activities associated with oil and gas activities and the project phases in which they can occur. Noise associated with offshore OCS oil and gas activities results from exploration activities, construction of onshore and offshore facilities and pipelines involving activities such as pile driving, trenching, earth moving, and building, the operation of fixed structures such as offshore platforms and drilling rigs, maintenance, aircraft and service-vessel traffic including icebreakers, and platform removal, and results in changed ambient noise conditions during those activities.

During exploration, noise is generated by operating air gun arrays, drilling, and support vessels and aircraft. During the development phase, noise is generated by drilling, ship and aircraft traffic, pipeline trenching, platform and other offshore construction, and onshore construction. During production operations, noise is generated by maintenance activities, ship and aircraft traffic, and various production activities and associated equipment such as pumps. During production, air gun-supported deep penetration 4D seismic operations that incorporate changes in reservoirs over time, if used, will also cause noise. Workover rigs also conduct drilling activity during the production phase, albeit with lesser noise levels than original drilling.

1 Decommissioning noise is generated by explosive and nonexplosive structure removal, and
2 supporting ship and aircraft traffic.

3
4 Noise generated from these activities can be transmitted through both air and water and
5 may be extended or transient, and pulsed or constant. Offshore drilling and production involves
6 various activities that produce a composite underwater noise field. As described in Section 3.6,
7 the intensity level and frequency of the noise emissions are highly variable, both between and
8 among the various industry sources. Noise from proposed OCS activities may affect resources.
9 Whether a sound is or is not detected by marine organisms will depend both on the acoustic
10 properties of the source (spectral characteristics, intensity, and transmission patterns) and
11 sensitivity of the hearing system in the marine organism. Anthropogenic noise can cause
12 physical damage to or death of an exposed animal; intense levels can damage hearing, and, if
13 particularly loud or novel, may induce disruptive behavior and cause stress-related responses,
14 such as endocrine responses (MMS 2006a, 2008a).

15
16
17 **4.4.5.1.2 Accidents.** Accidental events with the potential for affecting ambient noise
18 conditions include oil spills involving transport and support vessels and tankers, loss of well
19 control, and spill response activities. Oils spills can occur both offshore and at coastal facilities
20 and have occurred in coastal waters at shoreline storage, processing, or transport facilities.

21
22 Improperly balanced well pressures that result in sudden, uncontrolled releases of fluids
23 from a wellhead or wellbore are referred to as loss of well control. Loss of well control can
24 occur during exploratory drilling, development drilling, production, completion, or workover
25 operations. In the event of a loss of well control, the eruption of gases and fluids may generate
26 significant pressure waves and noise. During a loss of well control, the pressure waves and noise
27 generated by the eruption of gases and fluids might be significant enough to harass or injure
28 marine mammals, depending on the proximity of the animal to the site of the loss of well control
29 (MMS 2006a).

30
31 Accident response and support activities, including support aircraft and vessels, involved
32 in mitigating loss of well control and spills affect ambient noise conditions. For smaller spills,
33 response actions (and associated changes in ambient noise) in open water would be expected to
34 be localized and of relatively short duration. In the event of a large spill or a catastrophic spill
35 event covering a greater ocean area and contacting the shore or moving into coastal and inland
36 wetlands, longer term response activities including seismic surveys, skimmers, and other
37 mechanical equipment, would affect ambient noise conditions over a wider area and for a longer
38 time than would response activities for small spills. The nature, magnitude, and duration of
39 noise-related impacts depends on the magnitude, frequency, location, and date of accidents,
40 characteristics of spilled oil, spill-response capabilities and timing, and various meteorological
41 and hydrological factors (MMS 2006a, 2007c). For spills, accident response and cleanup
42 activities, including intentional hazing, would be the primary sources of acoustic impacts.

1 **4.4.5.2 Gulf of Mexico**
2
3

4 **4.4.5.2.1 Routine Operations.** Routine activities that affect ambient noise conditions in
5 some portions of the GOM include seismic surveys, drilling noise, ship and aircraft noise,
6 offshore and onshore construction, operational activities, and decommissioning (see
7 Section 3.6.1 for details on the noise levels and frequencies associated with routine operational
8 activities).
9

10 Under the proposed action, seismic surveys would be conducted to identify locations for
11 up to 2,100 exploration wells (Table 4.4.1-1). Noise from these seismic surveys and the
12 associated survey and support vessels would affect the acoustic environment. Air gun noise can
13 be detected up to 100 km (62 mi) from the source, so, under appropriate conditions (see
14 Section 3.6.1.4.4), the affected area can be extensive, but the greatest changes to ambient noise
15 levels would occur at locations closer to the air gun. Effects could include behavioral and
16 physical effects on marine mammals and sea turtles. Impacts of seismic surveys on marine
17 mammals and sea turtles are presented in Sections 4.4.7.1 and 4.4.7.4, respectively. In addition
18 to the noise, the high-pressure pulse and associated particle motion in the near field is a concern
19 for fish. Potential impacts on fish are discussed in Section 4.4.7.3. Commercial and recreational
20 fishing could be affected if behavioral changes in target species (MMS 2007c) occur as a result
21 of exposure to seismic surveys (see Section 4.4.11). These impacts would continue for the
22 duration of the survey, and the affected area would move along with the survey and support
23 vessels. Because these activities would be short term, potential impacts on ecological resources
24 may be equated to incur short-term effects.
25

26 Under the proposed action, construction and installation of exploration and delineation
27 wells (up to 2,100), development and production wells (up to 2,600), platforms (up to 450),
28 FPSOs (up to 2), and offshore pipelines (up to 12,000 km [7,500 mi]) will result in increases in
29 noise levels in the vicinity of these construction activities. With the exception of pipeline
30 trenching, construction and installation activities would generate noise from stationary noise
31 sources at the drilling/well sites and from support vessels and aircraft.
32

33 Noise from pile driving, construction of offshore platforms and pipelines and noise from
34 the associated support vessels and aircraft would cause noise that would disturb marine
35 mammals (Section 4.4.7.1) and sea turtles (Section 4.4.7.4) in the vicinity of the construction
36 activity and may cause fish to leave the construction area (see Section 4.4.7.3). Pipeline
37 trenching and onshore construction could cause behavioral effects in birds, especially if the
38 noises occur near nesting colonies during nesting periods (see Section 4.4.7.2). Marine species
39 in nearby waters could also be affected. These effects would persist for the duration of the
40 activity and would be strongest at the construction site or along the line of the trenching activity
41 or routes of the vessels or aircraft. Multiple construction projects in the same vicinity could have
42 increased noise impacts.
43

44 Additional noise-related impacts could be caused by dredging operations. Noise from
45 dredging generally reaches background levels within 25 km (16 mi), but can extend even farther
46 and thus can affect a fairly wide area.

1 Under the proposed action, drilling noise during exploration and production would be
2 relatively constant for the duration of the drilling. Drilling noise generally would be less than
3 ambient background levels beyond 30 km (19 mi) from the drill site (see Section 3.6.1.4) and
4 would be strongest near the well. Noise levels would increase if several wells were located in
5 proximity to one another. The principal noise concern in the GOM is the potential to affect
6 marine mammals, sea turtles, and fish (see Sections 4.4.7.1, 4.4.7.4, and 4.4.7.3, respectively).
7

8 In addition to drilling noise, machinery on platforms also generates noise during
9 operation. Such noise could be continuous or transient and variable in intensity, depending on
10 the nature and role of the machinery. Underwater noise would be relatively low intensity
11 because the noise sources are on decks well above the surface of the water and because of the
12 small surface area of the legs in contact with the water, but it could affect marine mammals (see
13 Section 3.6.1.4.3).
14

15 Under the proposed action, vessel traffic (up to 600 trips per week for up to 45 platforms)
16 and helicopter traffic (up to 5,500 trips per week) will result in increases in noise levels along the
17 traffic routes and at the platforms during construction and operation. Sound generated by these
18 activities will be transient at any one location, may be variable in intensity (MMS 2006a), and
19 may affect marine mammals, sea turtles, and birds (see discussions in Section 4.4.7). Noise from
20 vessel traffic generally reaches background levels within 10 km (6 mi) of the source, but may be
21 detectable at very large distances in deep water. Flights over land would also affect terrestrial
22 mammals (see Section 4.4.7.1). How far sounds travel from vessels is highly variable,
23 depending on environmental conditions and the type of vessel. However, noise would be
24 transient along the traffic path but would recur as long as trips continue. Frequent overflights
25 could produce longer term consequences (MMS 2007c, 2008a).
26

27 Noise from decommissioning could result from dismantlement of above-platform
28 structures and the use of underwater explosive or mechanical means to collapse or sever the
29 platform. Marine mammals, sea turtles, and fish could be affected by the noise and shock wave,
30 especially that associated with the use of explosives (see Sections 4.4.6 and 4.4.7).
31 Nonexplosive impacts from dismantling activities and support vessels and aircraft would
32 continue for the duration of the activity and be localized around the facility being
33 decommissioned. Noise and the pressure pulse from explosive detonation would be short term,
34 but the pressure pulse could cause serious impacts on nearby marine mammals (MMS 2007c,
35 2008a) (also see Section 4.4.7.1). Explosive detonation impacts would be strongest near the
36 detonation site.
37
38

39 **4.4.5.2.2 Accidents.**

40
41 **Spills.** Under the proposed action, the number and types of spills assumed to occur in the
42 GOM Planning Area include up to 7 large spills ($\geq 1,000$ bbl) from both pipeline and platforms,
43 and as many as 470 smaller spills ($< 1,000$ bbl) and up to one tanker spill of up to 3,100 bbl
44 (Table 4.4.2-1). Noise from emergency and spill-response activities and support vessels and
45 aircraft has the potential to disturb marine mammals, sea turtles, fish, and birds. For smaller
46 spills, noise generated from response actions in open water would be expected to be localized

1 and of relatively short duration. In the event of a large spill covering a greater ocean area and
2 contacting the shore or moving into coastal and inland wetlands, longer term response activities,
3 including seismic surveys, skimmers, and other mechanical equipment, over a wider area would
4 be required and associated noise would occur over a wider area. Noise from response equipment
5 and support vessels and aircraft could disturb animals in the vicinity of the response action,
6 temporarily for smaller spills and for longer periods for larger spills (see the biota-specific
7 discussion in Section 4.4.7). Noise along the trajectories of support vessels and aircraft would be
8 transient and localized along the trajectory but would recur for the duration of the spill response.
9 Response activities for onshore spills or offshore spills that reached the land would have similar
10 impacts but would also affect terrestrial species (MMS 2006a, 2007c).

11
12 **Catastrophic Discharge Event.** The PEIS analyzes a CDE that may range in size from
13 900,000 to 7,200,000 bbl (Table 4.4.2-2). Sources of noise and impacts would be similar to
14 those above for spills. The pressure wave and noise generated from an incident involving a loss
15 of well control could affect marine mammals and could be large enough to harass or disturb them
16 if they were close enough to the site of the event (MMS 2006a). In addition, accident response
17 and support activities, including support aircraft and vessel activity, have the potential to cause
18 noise impacts. These impacts would occur both at the site of the response activity and along the
19 trajectories of support vessels and aircraft. For smaller spills, the noise would be localized and
20 occur throughout the duration of the response activities. Noise along support vessel and aircraft
21 routes would be transient and localized along the route but would recur for the duration of the
22 response. For larger spills and CDEs, the ensonified area would depend on the size of the spill
23 and the extent of the response area. The impacts could cover a larger area, as was the case for
24 the DWH event, and be more sustained over a longer time depending on the volume, location,
25 duration, and weather conditions during the CDE and the response and cleanup activities.

26 27 28 **4.4.5.3 Alaska – Cook Inlet** 29

30 The impact producing factors for noise that may be expected for the Cook Inlet Planning
31 Area under the proposed action include seismic surveys, ship and aircraft traffic, drilling and
32 trenching, offshore construction, and production operations. There would be no onshore new
33 construction involving pipeline landfalls, shore bases, processing facilities, or waste facilities and
34 no platform removals in the Cook Inlet Planning Area under the proposed action (see
35 Table 4.4.1-3).

36
37
38 **4.4.5.3.1 Routine Operations.** Routine activities that could potentially cause changes in
39 ambient noise levels in Cook Inlet include seismic surveys, drilling noise, ship and aircraft noise,
40 offshore construction, and operational activities. See Section 3.6.1.4 for details on the noise
41 levels and frequencies associated with routine operational activities.

42
43 Under the proposed action, seismic surveys would be conducted to identify locations for
44 up to 12 exploration and delineation wells (Table 4.4.1-3). Air gun noise can be detected up to
45 100 km (62 mi) from the source and beyond under appropriate conditions (see Section 3.6.1.4.4),
46 so the affected area can be extensive, although changes in ambient noise levels would be greatest

1 at locations closest to the air gun. Noise from these seismic surveys and the associated survey
2 and support vessels would alter the acoustic environment and affect ecological resources in the
3 planning area. Effects could include physical and behavioral changes in marine mammals and
4 fish and disturbance of birds. See Section 4.4.7 for discussions of noise impacts on ecological
5 resources of the planning area. Targeted species for commercial, personal-use, subsistence, and
6 recreational fishing could also be affected (MMS 2007c). These impacts would continue for the
7 duration of the survey, and the affected area would move along with the survey and support
8 vessels.

9
10 Noise from construction of as many as 3 offshore platforms, up to 114 development and
11 production wells, 241 km (150 mi) of offshore pipeline, and 169 km (105 mi) of onshore
12 pipeline, as well as noise from the associated support vessels and aircraft, could disturb marine
13 mammals (see Section 4.4.7.1) as well as birds (see Section 4.4.7.2) in the vicinity of the
14 construction activity. Construction activity may cause fish to leave the construction area (see
15 Section 4.4.7.3). These effects would persist for the duration of the activity and could persist for
16 weeks after the end of the activity and would be strongest at the construction site or along the
17 line of any required offshore trenching activity. Multiple construction projects occurring
18 simultaneously in the same vicinity or over multiple years would have increased noise impacts.
19 Any effects would persist for the duration of the construction and be strongest near the
20 construction site.

21
22 Under the proposed action, pile driving drilling noise during exploration, development,
23 and production would be relatively constant for the duration of the drilling. Drilling noise
24 generally would be less than ambient background levels beyond 30 km (19 mi) from the drill site
25 (see Section 3.6.1.4.3) and would be strongest near the well. Noise levels would increase if
26 several wells were operating simultaneously in close proximity to one another. The noise could
27 have impacts on mammals, fish, and birds in Cook Inlet as discussed in Section 4.4.7. Noise
28 and vessel traffic associated with oil and gas activities in offshore areas adjacent to boundaries of
29 the Lake Clark National Park and Preserve, the Katmai National Park and Preserve, and State
30 wildlife refuges and ranges bordering Cook Inlet could temporarily disturb some wildlife and
31 negatively affect recreational values for park users (Section 4.4.12) (MMS 2007c).

32
33 In addition to drilling noise, machinery on platforms generates noise during operation.
34 Such noise could be continuous or transient and variable in intensity depending on the nature and
35 the role of the machinery. Underwater noise would be relatively weak because of the small
36 surface area in contact with the water, but it could affect marine mammals (MMS 2006a).
37 Because there would be no more than three platforms developed as a result of leasing under the
38 Proposed Action Alternative, noise impacts from platform operation are anticipated to be localized.

39
40 Under the proposed action, vessel traffic (up to three trips per week) and helicopter traffic
41 (up to three trips per week) will result in increases in noise levels along the traffic routes and at
42 platforms during construction and operation. Sound generated by these activities is transient and
43 variable in intensity; it may affect mammals, fish, and birds, as discussed in Section 4.4.7. Noise
44 from vessel traffic generally reaches background levels within 10 km (6 mi) of the source, but
45 may be detectable at very great distances in deep water. Flights over land would also affect
46 terrestrial mammals (see Section 4.4.7.1). The noise would be transient along the traffic path but

1 would recur as long as trips continue. Frequent overflights could produce longer term
2 consequences (MMS 2007c, 2008a).
3

4 Although Cook Inlet is generally more than 90% ice free and the Federal waters of Cook
5 Inlet are not seasonally icebound, any icebreaker activity may increase as a result of the proposed
6 action and could result in increased disturbance of marine mammals. However, most exploration
7 activity takes place during the open-water season, minimizing the effects on polar bears
8 (MMS 2008b). Icebreakers operate in support of exploration including seismic survey,
9 construction, and operation activities. Icebreakers do not operate during the open-water season.
10 Icebreaking vessels produce louder, but also more variable, sounds than those associated with
11 other vessels of similar power and size. Icebreaker noise can be substantial out to at least 5 km
12 (3 mi) and may be detectable from more than 50 km (31 mi) away. Icebreaker noise would add
13 to the impacts discussed above for the particular activity they were supporting, but any increases
14 would not occur during the open-water season. Impacts would be transient along the path of the
15 icebreaker and would be strongest near the path.
16

17 There is currently no subsistence whaling in Cook inlet, but there is some potential for
18 noise-induced alterations in marine mammal behavior. Local residents have consistently
19 indicated that whales and other marine mammals are very sensitive to noise and that they have
20 been disturbed from their normal patterns of behavior by past seismic and drilling activities
21 (Section 4.4.13). Lease stipulations have minimized such problems in the recent past, so noise
22 and disturbance effects are expected to be effectively mitigated (MMS 2006a). See
23 Sections 4.4.10.2.1 and 4.4.13.2.1 for discussions of noise impacts on land use and subsistence
24 harvests, respectively.
25
26

27 **4.4.5.3.2 Accidents.**

28
29 **Spills.** Under the proposed action, the number and types of spills assumed to occur in the
30 Cook Inlet Planning Area include up to one large spill ($\geq 1,000$ bbl) from either a pipeline or a
31 platform and as many as 18 small ($< 1,000$ bbl) spills (Table 4.4.2-1). Noise from emergency and
32 spill-response activities and support vessels and aircraft has the potential to disturb marine
33 mammals, fish, and birds. For smaller spills, noise generated from response actions in open
34 water would be expected to be localized and of relatively short duration. In the event of a large
35 spill covering a greater ocean area and contacting the shore or moving into coastal and inland
36 wetlands, longer term response activities over a wider area would be required and associated
37 noise would occur over a wider area. Noise from response equipment and activities including
38 seismic surveys, skimmers, and other mechanical equipment and support vessels and aircraft
39 could disturb animals in the vicinity of the response action, temporarily for smaller spills and for
40 longer periods for larger spills and catastrophic discharge events (see biota-specific discussions
41 in Section 4.4.7). Noise along the routes of support vessels and aircraft would be transient and
42 localized along the route but would recur for the duration of the response. Response activities
43 for onshore spills or offshore spills that reached coastal areas would have similar acoustic
44 impacts on nearby marine mammals and birds and affect terrestrial species (see Section 4.4.7).
45

1 **Catastrophic Discharge Event.** The PEIS analyzes a CDE that may range in size from
2 75,000 to 125,000 bbl (Table 4.4.2-2). Sources of noise and impacts would be similar to those
3 above for spills. The pressure wave and noise generated from an incident involving a loss of
4 well control could affect marine mammals and could be large enough to harass or disturb them if
5 they were close enough to the site of the event (MMS 2006a). In addition, accident response and
6 support activities, including support aircraft and vessel activity, have the potential to cause noise
7 impacts. These impacts would occur both at the site of the response activity and along the routes
8 of support vessels and aircraft. Noise would be localized and occur throughout the duration of
9 the response activities. Noise along support vessel and aircraft routes would be transient and
10 localized along the route but would be recurring for the duration of the response. However, the
11 spill itself and the response and cleanup activities would likely occur over a larger ocean area,
12 could contact larger coastal and inland areas, and take place over a longer time. Thus, the
13 impacts could cover a larger area and be more sustained over a longer time depending on the
14 volume, location, duration, and weather conditions during the CDE and the response and cleanup
15 activities.

16 17 18 **4.4.5.4 Alaska – Arctic**

19
20 The impact-producing factors for noise that may be expected in Arctic Alaska under the
21 proposed action include seismic surveys, ship and aircraft traffic, drilling and trenching, offshore
22 construction, construction of onshore pipeline, and production operations. There would be no
23 onshore construction involving pipeline landfalls or shore bases and no platform removals in
24 Arctic Alaska under the proposed action (see Table 4.4.1-4).

25
26
27 **4.4.5.4.1 Routine Operations.** Routine activities that will affect ambient noise
28 conditions in the Beaufort Sea and Chukchi Sea Planning Areas include seismic surveys, drilling
29 noise, ship and aircraft noise, icebreaker noise, offshore construction, onshore pipeline
30 construction, and operational activities. See Section 3.6.1.4 for details on the noise levels and
31 frequencies associated with routine operational activities.

32
33 Under the proposed action, seismic surveys would be conducted to identify locations for
34 up to 36 exploration wells (16 in the Beaufort Sea Planning area and 20 in the Chukchi Sea
35 Planning Area). Air gun noise can be detected up to 100 km (62 mi) from the source and beyond
36 under appropriate conditions (see Section 3.6.1.4.4), so the affected area can be extensive,
37 although changes in ambient noise levels would be greatest at locations closest to the air gun.
38 Noise from these seismic surveys and the associated survey and support vessels would alter the
39 acoustic environment and affect ecological resources in the planning area. Effects would include
40 physical and behavioral changes and disturbance in marine mammals and fish. Marine and
41 coastal birds could also be affected. See Section 4.4.7 for discussions of noise impacts on
42 ecological resources of the two planning areas. The potential for affecting ecological resources
43 would continue for the duration of the survey activities.

44
45 Under the proposed action, construction and installation of exploratory and production
46 wells (up to 36 and 400, respectively), platforms (up to 9), onshore pipelines (up to 129 km

1 [80 mi]), offshore pipelines (up to 652 km [405 mi]), and subsea wells (up to 92 [up to 10 in the
2 Beaufort Sea Planning Area and up to 81 in the Chukchi Sea Planning Area]) will result in
3 increases in noise levels in the vicinity of these construction activities. With the exception of
4 pipeline trenching, construction and installation activities would generate noise from stationary
5 noise sources at the drilling/well sites and from support vessels and aircraft.
6

7 Noise from pile driving, construction of offshore platforms and pipelines, support vessel
8 and aircraft traffic, and gravel placement activities could disturb normal behaviors in marine
9 mammals, birds, and fish in the vicinity of the construction activities (see Section 4.4.7). These
10 effects would persist for the duration of the activity and would be strongest at the construction
11 site(s) or along the line of any required trenching activity. Multiple construction projects
12 occurring simultaneously in the same vicinity or over multiple years would have increased noise
13 impacts.
14

15 Construction of up to 129 km (80 mi) of onshore pipeline on areas adjacent to the
16 Beaufort Sea would cause noise that would disturb terrestrial mammals (see Section 4.4.7.1).
17 Impacts would depend on the season and proximity to critical habitat and would persist for the
18 duration of the construction activity. Affected areas would move as the active construction area
19 progressed along the pipeline route. Marine mammals, birds, and fish in nearby waters could be
20 affected. Given that there would be no new pipeline landfalls and no new shore bases
21 constructed, little or no additional onshore construction is anticipated under the proposed action,
22 any noise-related impacts would be limited to relatively few terrestrial mammals and birds. Any
23 effects would persist for the duration of the construction and be strongest near the construction
24 site. Additional noise-related impacts could be caused by gravel excavation activities.
25

26 Under the proposed action, drilling noise would be relatively constant during exploration
27 phase drilling and during development and production phase drilling. Drilling noise generally
28 would be less than ambient background levels beyond 30 km (19 mi) from the drill site (see
29 Section 3.6.1.4.3) and strongest near the well. Noise levels would increase if several wells were
30 located in close proximity to one another. The drilling noise could affect marine mammals,
31 birds, and fish (see the biota-specific discussion in Section 4.4.7).
32

33 In addition to drilling noise, machinery on platforms generates noise during operation.
34 Such noise could be continuous or transient and variable in intensity depending on the nature and
35 the role of the machinery. Underwater noise would be relatively weak because of the small
36 surface area in contact with the water, but it could affect marine mammals (MMS 2006a).
37

38 Under the proposed action, vessel traffic (up to 27 trips per week) and helicopter traffic
39 (up to 27 trips per week) will result in increases in noise levels along the traffic routes and at the
40 platforms during construction and operation. Vessel traffic in Arctic Alaska occurs primarily in
41 the summer (MMS 2007c). Sound generated by these activities is transient and variable in
42 intensity and may affect terrestrial and marine mammals, marine and coastal birds, and fish, as
43 discussed in Section 4.4.7. Noise from vessel traffic generally reaches background levels within
44 10 km (6 mi) of the source, but may be detectable at very large distances in deep water. Flights
45 over land would also affect terrestrial mammals (see Section 4.4.7.1). The noise would be

1 transient along the traffic path but would recur as long as trips continue. Frequent overflights
2 could produce longer term consequences (MMS 2007c, 2008a).

3
4 Icebreaker activity in the Beaufort Sea and Chukchi Sea areas could increase under the
5 proposed action if needed to support exploration, construction, and operation activities. In
6 addition to icebreaking activities when there is ice cover, icebreakers also engage in ice
7 management activities during the summer. Icebreakers do not operate during the open-water
8 season. Icebreaking vessels produce louder, but also more variable, sounds than those associated
9 with other vessels of similar power and size. Icebreaker noise can be substantial out to at least
10 5 km (3 mi) and may be detectable from more than 50 km (31 mi) away (see Section 3.6).
11 Icebreaker noise would add to the impacts discussed above for the particular activity they were
12 supporting. Impacts would be transient along the path of the icebreaker and would be strongest
13 near the path.

14
15 Noise during staging activities for exploration, development, and production would likely
16 occur in areas with existing infrastructure, such as Deadhorse, and cause little direct impact on
17 local native communities. Noise from vessel and aircraft traffic, seismic surveys, and
18 icebreakers could also disturb marine mammals, birds, and fish and thus potentially affect
19 subsistence harvests and resources. Lease stipulations have minimized such problems in the
20 recent past, so noise and disturbance effects are expected to be effectively mitigated
21 (ArcMS 2008).

22 23 24 **4.4.5.4.2 Accidents.**

25
26 **Spills.** Under the proposed action, the number and types of spills assumed to occur in the
27 Arctic region include up to 3 large spills ($\geq 1,000$ bbl) from pipelines and platforms and between
28 60 and 225 small ($< 1,000$ bbl) spills over the 50-yr period of the Program (Table 4.4.2-1). Noise
29 generated from response actions in open water would be expected to be localized and of
30 relatively short duration. In the event of large spills covering a greater ocean area and contacting
31 the shore or moving into coastal and inland wetlands, longer term response activities over a
32 wider area would be required and the associated noise would occur over a wider area. Noise
33 from response equipment and activities including seismic surveys, skimmers, and other
34 mechanical equipment and support vessels and aircraft could disturb marine mammals, birds, and
35 fish, as well as invertebrate prey species in the vicinity of the response action; the impact would
36 be temporary for smaller spills and of longer duration for larger spills (see biota-specific
37 discussions in Section 4.4.7). Noise along the routes of support vessels and aircraft would be
38 transient and localized but would recur for the duration of the spill response. Response activities
39 for onshore spills or offshore spills that reached the land could have similar impacts but would
40 also affect terrestrial species (MMS 2006a, 2007c).

41
42 **Catastrophic Discharge Events.** In the Arctic Planning Areas, the PEIS analyzes a
43 CDE that may range in size between 1,700,000 and 3,900,000 bbl in the Beaufort Planning Area
44 and a CDE of between 400,000 and 2,100,000 bbl in the Chukchi Planning Area (Table 4.4.2-2).
45 Sources of noise and impacts would be similar to those above for spills. The pressure wave and
46 noise generated from an incident involving a loss of well control would affect marine mammals

1 and could be large enough to harass or disturb them if they were close enough to the site of the
2 event (MMS 2006a). In addition, accident response and support activities, including support
3 aircraft and vessel activity, have the potential to cause noise impacts. These impacts would
4 occur both at the site of the response activity and along the routes of support vessels and aircraft.
5 Noise would be localized and occur throughout the duration of the response activities. Noise
6 along support vessel and aircraft routes would be transient and localized along the route but
7 would recur for the duration of the response. However, the spill itself and the response and
8 cleanup activities would likely occur over a larger ocean area, could contact larger coastal and
9 inland areas, and take place over a longer time. Thus, the impacts could cover a larger area, as
10 was the case for the DWH event, and be more sustained over a longer time depending on the
11 volume, location, duration, and weather conditions during the CDE and the response and cleanup
12 activities.

15 **4.4.5.5 Conclusion**

17 Noise impacts due to routine operations under the proposed action would be unavoidable.
18 Noise could affect terrestrial and marine mammals, fish, and birds primarily through disturbance
19 and disruption of normal activities (see Section 4.4.7). Terrestrial mammals could be similarly
20 affected by onshore construction activities. Noise may also affect the ability of subsistence users
21 and others to gather resources. The magnitude of the impact would vary with the type of
22 resource affected, the timing of the noise-generating activity, the noise footprint, and location of
23 the resource in relationship to the noise-generating activity. In general, the nature and magnitude
24 of impacts from single transient and short-term noises would be different than those associated
25 with continuous, long-term noise. Impacts to ambient noise levels from routine operations
26 associated with the Program are expected to be minor.

28 Noise from emergency and spill-response activities and activities including seismic
29 surveys, skimmers, and other mechanical equipment and support vessels and aircraft has the
30 potential to disturb marine mammals, fish, and birds. The noise impacts would persist for the
31 duration of the response efforts. Response noise for small spills would be expected to have
32 short-term temporary impacts; response noise for large spills (and especially for CDE-level
33 spills) would have longer term impacts because of the longer duration of spill response activities.
34 As the time over which the response activities continue increases, the chance for permanent
35 noise impacts on some resources (e.g., mammals, birds) may also increase.

38 **4.4.6 Potential Impacts on Marine and Coastal Habitats**

41 **4.4.6.1 Coastal and Estuarine Habitats**

44 **4.4.6.1.1 Gulf of Mexico (GOM).** Coastal and estuarine habitats could be directly or
45 indirectly affected by a number of factors associated with oil and gas activities (Table 4.4.6-1).
46 These factors include vessel traffic, maintenance dredging of navigational canals, construction

1 **TABLE 4.4.6-1 Impacting Factors for Coastal and Estuarine Habitats in the Gulf**
 2 **of Mexico**

Oil and Gas Impacting Factors ^a	Habitat Type		
	Barrier Landforms	Wetlands	Seagrasses
Vessel traffic (all phases)	X	X	X
Navigation channel maintenance dredging (operations)	X	X	X
Pipeline emplacement (construction)	X	X	X
Construction of onshore facilities (construction)		X	X
Expansion of onshore facilities (construction)	X	X	X
Use of existing facilities (operations)	X	X	X
Expansion of ports and docks (construction)	X	X	X
Disposal of OCS-related wastes (all phases)		X	X
Accidental spills (all phases)	X	X	X

^a X = Potential impacts on the resource attributable to the impacting factor.

3
 4
 5 and operation of onshore facilities, installation and maintenance of pipelines, expansion of ports
 6 and docks, and operation of offshore oil and gas facilities. The potential for impacts would be
 7 largely influenced by site-specific factors, such as the habitat types and distribution in the
 8 vicinity of oil and gas activities. Many of the activities associated with oil and gas, such as
 9 platform construction, would occur in offshore waters, with minimal impacts on coastal habitats
 10 other than for potential accidents.

11
 12
 13 **Routine Operations.**

14
 15 **Barrier Landforms.** The potential effects on coastal barrier islands, beaches, and dunes
 16 from routine operations would primarily be associated with indirect effects from maintenance
 17 dredging and vessel traffic. Impacts of pipeline landfalls and use or expansion of coastal
 18 facilities could also occur.

19
 20 Maintenance dredging of navigation channels in barrier inlets and bar channels can
 21 remove sediments from the longshore sediment drift. Maintained channels intercept and capture
 22 sediments, and dredged materials are often discharged to ocean dump sites. Dredging may
 23 contribute to the reduction of sediment deposition and affect the stability of downdrift barrier
 24 landforms (MMS 2007b). Reductions in sediment supply could subsequently contribute to
 25 minor local losses of adjacent downdrift barrier beach habitat, with impacts over a broader area
 26 where the sediment supply is low, such as along the Louisiana coastal barrier islands in the
 27 Central Planning Area (CPA). However, dredged sediments are used in beach restoration
 28 projects where feasible (MMS 2008a). The installation of erosion control structures, such as
 29 jetties, for OCS-related facilities built near barrier shorelines may also accumulate sediments and
 30 induce erosion of downdrift areas (MMS 2007b). In some locations, the potential exists for
 31 dredging to result in the resuspension and transport of oil spilled during the DWH event.

1 Service vessel traffic to exploration and production wells could contribute to erosion of
2 barrier beaches. Approximately 300 to 600 vessel trips per week would occur in the GOM under
3 the proposed action. Waves generated by service vessels can erode unprotected shorelines and
4 areas that currently experience barrier beach losses from ongoing shoreline degradation,
5 particularly the coastal areas of Louisiana; vessel traffic can contribute to the accelerated erosion
6 of sediments along beaches through increased wave activity. Erosion from vessel activity along
7 unarmored navigation channels has resulted in channel widening in the Western Planning Area
8 (WPA) and CPA and land loss in some areas. However, restoration and stabilization of channel
9 margins have been effective in minimizing channel widening. Wave activity could be minimized
10 by maintaining reduced vessel speeds in the vicinity of barrier islands.

11
12 The proposed action would include approximately less than 12 new pipeline landfalls in
13 the GOM region. Impacts on barrier landforms would likely be avoided during pipeline
14 construction by the use of modern construction techniques, such as directional (trenchless)
15 boring, under barrier islands and beaches (MMS 2008a). These construction methods result in
16 minimal impacts on the barrier systems (Wicker et al. 1989). If nonintrusive techniques were not
17 used, impacts on beach and dune communities from ground-disturbing activities during pipeline
18 construction could occur, with the potential for accelerated beach erosion and island breaching.

19
20 Up to 12 new natural gas processing facilities and 4 to 6 new pipe yards would be
21 constructed. No new facilities would be expected to be constructed on barrier beaches or
22 associated dunes; however, impacts on other coastal upland habitats would likely occur. Habitat
23 losses would be minimized if facilities were located in previously disturbed areas. Expansion of
24 existing facilities located on barrier beaches or dunes would result in losses of those habitats.
25 The continued use of facilities that have become located in the barrier beach and dune zone
26 because of ongoing shoreline recession may result in accelerated erosion of those habitats.

27
28 **Wetlands.** The potential effects on wetlands from routine operations would primarily be
29 associated with direct impacts from pipeline emplacement and maintenance and navigation
30 channel maintenance dredging, as well as indirect impacts from decreased water quality (such as
31 from disposal of OCS-related wastes), altered hydrology, and vessel traffic. Impacts from
32 ground-disturbing activities during construction or expansion of support facilities, such as
33 processing facilities and pipeline yards, could also occur.

34
35 The construction of pipelines through coastal wetlands could result in direct losses of
36 marsh habitat, depending on avoidance of wetlands in pipeline route selection and the
37 emplacement technique used. The use of directional boring under wetlands during pipeline
38 construction would likely avoid impacts, or result in negligible impacts, on wetlands. Trenching
39 for pipeline emplacement would result in direct impacts on marsh habitat from excavation.
40 Long-term reduction in vegetation productivity above and adjacent to the pipeline, including
41 areas backfilled, would likely occur, with potential losses of wetland habitat, depending on
42 factors such as the success of backfilling, time of year, and duration of construction
43 (Turner et al. 1994; MMS 2007b).

44
45 Maintenance dredging of navigation channels would contribute to increased flushing and
46 draining of interior marsh areas by tides and storms, which could result in shifts in species

1 composition, habitat deterioration, erosion, and wetland loss (LCWCRTF 1998, 2003). Channels
2 alter the hydrology of coastal marshes by affecting the amount, timing, and pathways of water
3 flow (Day et al. 2000a). Hydrologic alterations can result in changes in salinity and inundation,
4 causing a dieback of marsh vegetation and a subsequent loss of substrate and conversion to open
5 water (LCWCRTF 2001; Day et al. 2000a). Saltwater intrusion into brackish and freshwater
6 wetlands further inland could result in mortality of salt-intolerant species and loss of some
7 wetland types such as cypress swamp, or transition of wetland types such as freshwater marsh to
8 brackish and saltmarsh or open water (MMS 2007b). The deposition of dredged material onto
9 adjacent disposal banks could potentially result in a localized and minor contribution to ongoing
10 impacts of disposal banks, such as preventing the effective draining of some adjacent areas,
11 resulting in higher water levels or more prolonged tidal inundation, or restricting the movement
12 of water, along with sediments and nutrients, into other marsh areas (Day et al. 2000a). Impacts
13 on marsh habitats from navigation channels would be expected to be mitigated by the beneficial
14 use of dredged material (MMS 2008a), through the application of dredged material onto marsh
15 surfaces to increase substrate elevations for marsh restoration or creation. Small areas of marsh
16 would likely be lost during dredging by the occasional inadvertent deposition of dredged
17 material, as well as created by material deposition into shallow water (MMS 2007b).

18
19 Service vessel traffic to exploration and production wells would contribute to erosion of
20 marsh habitat. Wetland losses would likely occur along unarmored navigation channels because
21 of the widening that would result from the continued erosion of adjacent marsh substrates due to
22 waves generated by vessel traffic (LCWCRTF 2003). Erosion from vessel activity along
23 navigation channels has resulted in channel widening in the WPA and CPA and land loss in
24 some areas. However, restoration and stabilization of channel margins have been effective in
25 minimizing channel widening. Erosion of wetlands would not occur along armored channels,
26 which are frequently used by OCS-related vessel traffic.

27
28 The construction or expansion of facilities near the coastline, including the potential
29 expansion of port facilities, could potentially result in the direct loss of wetlands from the
30 placement of fill material during building construction, as well as the construction of pipelines,
31 access roads, and transmission corridors. However, construction in wetlands is discouraged by
32 State and Federal permitting agencies. Indirect impacts of construction could include habitat
33 fragmentation, altered hydrology from changes in surface drainage patterns or isolation of
34 wetland areas from water sources, conversion to upland communities or open water,
35 sedimentation and turbidity, and introduction of contaminants in stormwater runoff. Resulting
36 changes in affected wetlands could include a reduction in biodiversity and the establishment and
37 predominance of invasive plant species. Impacts on wetlands from construction could be
38 minimized by maintaining buffers around wetlands and by using best management practices for
39 erosion and sedimentation control. Construction in wetlands is managed and regulated by the
40 appropriate State agencies and the USACE. It is assumed that standard mitigation measures
41 would be applied to any construction project associated with the Program.

42
43 Impacts on wetlands near constructed facilities might also result from other factors, such
44 as disposal of wastes at upland disposal sites, which could introduce contaminants into wetlands.
45 Contaminants from land storage or disposal sites might migrate into groundwater or could be
46 present in stormwater runoff that could flow into wetlands. Contaminants might also be released

1 to surface water in service vessel discharges, which might affect wetlands. State requirements
2 would be enforced to prevent and address potential occurrences. Impacts on wetlands would be
3 minimized by implementing water quality practices.
4

5 **Seagrasses.** The potential effects on seagrass communities from routine operations
6 would primarily be associated with effects from vessel traffic, pipeline emplacement, and
7 maintenance dredging. Impacts from use or expansion of coastal facilities could also occur.
8

9 Coastal seagrass communities might be damaged by vessel traffic outside established
10 traffic routes, which could result in long-term scars on seagrass beds (MMS 2003d). The
11 recovery rate would be greater for larger scars and low-density vegetation. Seagrass
12 communities might also be affected by trenching for pipeline installation, which could bury
13 adjacent seagrasses and deposit lighter sediments onto leaves of more distant seagrasses.
14 Turbidity from pipeline emplacement, maintenance dredging of navigation canals, or vessel
15 traffic might adversely affect seagrass communities by decreasing seagrass cover and
16 productivity, and changing species composition, as a result of reduced light levels (MMS 2007b).
17 It is assumed that the USACE and State agency requirements regarding the mitigation of
18 turbidity impacts on submerged vegetation from pipeline emplacement and maintenance
19 dredging of navigation channels would be followed. Salinity changes resulting from dredging
20 can also result in changes in species composition of seagrass communities. Because activities
21 associated with the Program would be located far from Florida coastal waters, which contain
22 approximately 98.5% of all coastal seagrasses in the U.S. GOM, the Program would be expected
23 to have minimal effects on the overall condition of seagrass communities in the GOM.
24 However, localized impacts on small areas of seagrass could occur in coastal areas west of
25 Florida.
26

27 **Accidents.** The potential effects on coastal and estuarine habitats from accidents would
28 primarily be associated with impacts from spills of oil and other petroleum hydrocarbons, such
29 as fuel oil or diesel fuel, and subsequent cleanup efforts. Large ($\geq 1,000$ bbl) and small
30 ($< 1,000$ bbl) oil spills could occur as a result of tanker and barge spills, pipeline spills, or
31 platform spills. Spills from vessels should be minimized by compliance with USCG
32 requirements for spill prevention and control. Section 4.4.2 provides details of spill assumptions.
33 Oil or other spilled materials might be transported to barrier landforms and wetland habitats by
34 currents or tides. The amount of oil deposited on coastal habitats would depend on various
35 factors, such as spill volume, distance from shoreline, ambient conditions, degree of weathering,
36 and effectiveness of response actions. Large spills would potentially result in heavy or
37 widespread deposits of oil.
38

39 Beaches could be affected by oil spills, and the direct mortality of biota could result.
40 Spilled oil that reaches barrier beaches might be restricted to beach surfaces, or it could penetrate
41 into subsurface layers. Permeable substrates, generally associated with larger sand grain sizes,
42 and holes created by infauna could increase oil penetration, especially that of light oils and
43 petroleum products (NOAA 2000). Oil may become buried under sediments by wave action.
44 Although beach and foredune areas are often sparsely vegetated, impacts on vegetation might
45 occur if oil was carried to higher elevations by storm waves and tides. Oiled beach sediments
46 could weaken dune and other beach vegetation, resulting in accelerated erosion. Because of the

1 changes in barrier beach and dune profiles as a result of hurricanes, such as Katrina and Rita,
2 habitat between the shoreline and beach ridge may be more vulnerable to impacts of spills
3 (MMS 2008a).
4

5 Impacts on coastal marsh vegetation from oil spills could range from a short-term
6 reduction in photosynthesis to extensive mortality and subsequent loss of marsh habitat as a
7 result of substrate erosion and conversion to open water (Hoff 1995; Proffitt 1998). Vegetation
8 that dies back could recover, even following the death of all existing leaves. Long-term impacts
9 could include reduced stem density, biomass, and growth (Proffitt 1998). Mangroves might
10 decrease canopy cover or die over a period of weeks to months (Hensel et al. 2002;
11 Hayes et al. 1992). Other effects of spills could include a change in plant community
12 composition or the displacement of sensitive species by more tolerant species. In locations
13 where soil microbial communities were affected, effects might be long term, and wetland
14 recovery might be slowed. The degree of impacts on wetlands from spills are related to the oil
15 type and degree of weathering, amount of oil, duration of exposure, season, plant species,
16 percentage of plant surface oiled, substrate type, and oil penetration (Hayes et al. 1992;
17 Hoff 1995; Proffitt 1998; Hensel et al. 2002). Higher mortality and poorer recovery of
18 vegetation generally result from spills of lighter petroleum products (such as diesel fuel), heavy
19 deposits of oil, spills during the active growing period of a plant species, contact with sensitive
20 plant species (especially those located in coastal fresh marsh), completely oiled plants, and deep
21 penetration of oil and accumulation in substrates. Most spills in deepwater areas would require
22 an extended period of time to reach a shoreline or marsh and would undergo natural degradation
23 and dispersion, which, in addition to expected containment actions, would reduce potential
24 impacts. Because of the changes in barrier island profiles as a result of hurricanes Katrina, Rita,
25 and Ivan, there is a greater potential for oil spill impacts on coastal marshes (MMS 2008a).
26

27 Impacts on seagrass communities would generally be short term, resulting from contact
28 with oil dispersed in the water column, from reduced light and oxygen levels due to the sustained
29 presence of an oil slick in protected areas, or from reduced populations of epiphyte grazers
30 (MMS 2007b). Recovery would generally occur in about 1 yr. Permanent losses of seagrass
31 habitat would not be expected to occur from a spill unless unusually low tides result in direct
32 contact of seagrass leaf surfaces with an oil slick.
33

34 Although any residual oil that might remain on barrier beaches following cleanup could
35 be largely removed in highly exposed locations through wave action, oil could remain in the
36 shallow subsurface for extended periods of time. In some locations, oil might become buried by
37 new sand deposition (NOAA 2000). Natural degradation and persistence of oil on beaches are
38 influenced by the type of oil spilled, the amount present, sand grain size, the degree of
39 penetration into the subsurface, the exposure to the weathering action of waves, and sand
40 movement onto and off the shore. Spilled oil might be entirely absent from affected beaches
41 within a year or less, or it might persist for many years (Dahlin et al. 1994; Hayes et al. 1992;
42 Petrae 1995; Irvine 2000). On sheltered beaches, heavy oiling left for long periods could form
43 an asphalt pavement relatively resistant to weathering (Hayes et al. 1992). Spilled oil remaining
44 in wetlands after cleanup degrades naturally by weathering processes and biodegradation caused
45 by microbial communities in the soil. Full recovery of coastal wetlands might occur in less than
46 1 yr or might require more than 5 yr, depending on site and spill characteristics (Hoff 1995). Oil

1 might degrade very slowly in saturated soils under mangroves; more than 30 yr could be required
2 for mangroves to recover (Hensel et al. 2002). Oil could remain in some coastal substrates for
3 decades, even if it was cleaned from the surface. Heavy deposits of oil in sheltered areas or in
4 the supratidal zone could form asphalt pavements resistant to degradation (Hoff 1995).

5
6 Spill cleanup operations might adversely affect barrier beaches and dunes if large
7 volumes of contaminated substrates were removed. Such removal could affect beach stability,
8 resulting in accelerated shoreline erosion, especially in areas of sand deficit, such as along the
9 Louisiana coastline in the CPA. However, sand removal is generally minimized during spill
10 cleanup (MMS 2007b). Foot traffic during cleanup might mix surface oil into the subsurface,
11 where it might persist for a longer time. Spill cleanup actions might damage coastal wetlands
12 through trampling of vegetation, incorporation of oil deeper into substrates, increased erosion,
13 and inadvertent removal of plants or sediments, all of which could have long-term effects
14 (Hoff 1995; Proffitt 1998; NOAA 2000). These actions could result in plant mortality and delay
15 or prevent recovery. In locations where spill cleanup would include the excavation and removal
16 of contaminated soils and biota, increased erosion and lowered substrate elevation could result in
17 marsh loss by conversion to open water, unless new sediments were applied. Effective low-
18 impact cleanup actions could include bioremediation, low-pressure flushing, or use of chemical
19 cleaners (Mendelssohn and Lin 2003; Hoff 1995; Proffitt 1998).

20
21 **Catastrophic Discharge Event.** The PEIS analyzes a CDE with an assumed volume of
22 0.9–7.2 million bbl (Table 4.4.2-2). The amount of oil deposited on coastal habitats would
23 depend on various factors, such as spill volume, distance from shoreline, ambient conditions,
24 degree of weathering, and effectiveness of response actions. A CDE would potentially result in
25 heavy or widespread deposits of oil and would have a greater likelihood for extensive areas of
26 shoreline affected and heavy deposits of oil in multiple locations. For example, the DWH event
27 affected more than 1,046 km (650 mi) of the GOM coastal habitat, from the Mississippi River
28 Delta to the Florida panhandle. More than 209 km (130 mi) of coastal habitat were moderately
29 to heavily oiled, including a substantial number of Louisiana beaches (see Section 3.7.1.1.5).

30 31 32 **4.4.6.1.2 Alaska Region – Cook Inlet.**

33
34 **Routine Operations.** The potential effects on coastal habitats from routine operations
35 would primarily be associated with direct impacts from ground-disturbing activities during
36 pipeline construction as well as indirect impacts from service vessels and the operation of
37 existing facilities (see Table 4.4.6-2).

38
39 Up to one new pipeline landfall would be constructed in the Cook Inlet Planning Area.
40 Pipeline installation would include trench excavation through intertidal and shallow subtidal
41 areas. Installation could directly disturb tidal marshes, beaches, rocky shores, or other coastal
42 habitats, depending on the location of the landfall. A few acres of habitat would likely be altered
43 at each landfall site, and some intertidal and shallow subtidal organisms would be displaced
44 (MMS 2003b). Intertidal and shallow subtidal vegetation could be indirectly impacted by
45 excavation for pipeline installation. Areas adjacent to the trench may be covered by excavated
46 sediments, and organisms could be affected by sedimentation and turbidity associated with the

1 **TABLE 4.4.6-2 Impacting Factors for Coastal and Estuarine Habitats in the Alaska Region –**
 2 **Cook Inlet**

Oil and Gas Impacting Factors ^a	Habitat Type		
	Cook Inlet Coastal Habitats	Arctic Barrier Landforms	Arctic Wetlands
Vessel traffic (all phases)	X	X	X
Construction of onshore pipelines (construction)	X		X
Use of existing facilities (operations)	X		X
Disposal of OCS-related wastes (all phases)	X		X
Accidental spills (all phases)	X	X	X

^a X = Potential impacts on the resource attributable to the impacting factor.

3
 4
 5 disturbance of bottom sediments during trench excavation and backfilling. Impacts could be
 6 reduced by implementing measures to restrict the dispersal of sediments.

7
 8 Approximately 80–169 km (50–105 mi) of new onshore pipeline would be constructed.
 9 Pipelines would deliver oil to existing refineries in Nikiski and natural gas to transmission
 10 facilities in the Kenai area, both on the eastern side of Cook Inlet. Indirect effects could include
 11 habitat fragmentation, reduced infiltration and increased surface runoff from soil compaction on
 12 the construction site, altered hydrology including increased or reduced inundation or saturation
 13 of substrates, sedimentation and turbidity, deposition of fugitive dust, and introduction of
 14 contaminants in stormwater runoff. Impacts to local streams could affect coastal wetlands.
 15 Impacts could result in changes in plant community structure, reduction in plant biodiversity, and
 16 the establishment and dominance of invasive plant species. However, activities that may
 17 potentially impact wetlands are regulated by State agencies and the USACE. Standard
 18 mitigation measures would be applied to any construction project associated with these activities.
 19 For example, construction-related impacts could be minimized by maintaining buffers around
 20 wetlands and implementing best management practices for erosion and sediment control.
 21 Although wetlands along the pipeline route could be affected by construction, impacts could be
 22 reduced if pipelines were located in existing utility or transportation system rights-of-way, when
 23 possible, and if natural drainage patterns were maintained. Indirect impacts to coastal habitats
 24 from sedimentation originating along the pipeline route could be reduced by minimizing
 25 crossings of anadromous fish streams and consolidating pipeline crossings with other utility and
 26 road crossings.

27
 28 Construction of a pipeline gravel service road, haul road, and access roads would replace
 29 habitat with unvegetated surfaces or result in altered habitat having few species in common with
 30 nearby undisturbed habitats. Habitat may also be disturbed by the establishment of work camps.
 31 Resulting changes in affected wetlands could include a reduction in biodiversity, replacement of
 32 one wetland type for another (such as by dewatering or ponding), conversion to upland
 33 communities, or conversion of vegetated wetlands to open water.

1 No new shore bases, processing facilities, or waste disposal facilities would be
2 constructed. Existing shore bases, gas processing facilities, and waste disposal facilities would
3 be used for all new oil and gas activities in the planning area. Operation of existing facilities
4 could have local indirect effects on wetland vegetation from exhaust emissions or atmospheric
5 releases from processing facilities. Contaminants could be introduced into wetlands from the use
6 of existing waste storage or disposal sites, if contaminants migrate into groundwater or enter
7 stormwater that flows into wetlands. Service vessels would make one to three trips per week for
8 each of the one to three new platforms in the planning area. Discharges from service vessels that
9 support drilling platforms may contain materials that adversely affect coastal wetlands or other
10 intertidal or shallow subtidal habitats. Wetland impacts could be avoided or minimized by
11 implementing practices that eliminate or minimize impacts on water quality.
12

13 **Accidents.** The potential impacts on coastal habitats from accidents would primarily
14 be associated with impacts from spills of oil or other petroleum hydrocarbons, such as fuel
15 oil or diesel fuel, and the methods used for spill cleanup. This analysis assumes 1 large spill
16 of 4,600 bbl from a pipeline or 1,500 bbl from a platform, as well as 2 smaller spills
17 (>50–1,000 bbl) and 10 spills up to 50 bbl. Currents and tides within Cook Inlet could transport
18 oil or other materials to coastal habitats from drilling platforms, pipeline leaks, or vessel
19 accidents. The Cook Inlet Planning Area is unlike any other OCS Planning Area in that it is
20 almost entirely surrounded by coastal habitat. Therefore, there is a very high likelihood that
21 spills in the planning area would make contact with coastal habitats. Because of the patterns of
22 Cook Inlet surface currents, habitats along the western shoreline of the inlet and along Shelikof
23 Strait would have the greatest likelihood of contact from spills within the planning area, while
24 the eastern shoreline would have a lower potential for contamination from spills (MMS 2003a).
25 Extensive winter ice can develop along the western shores of Cook Inlet, and epibiota are
26 seasonally removed by ice scour. Along the Shelikof Strait mainland, intertidal communities are
27 affected by glacier ice melt and are subject to turbidity and freshwater stresses
28 (McCammon et al. 2002).
29

30 Intertidal habitats would be highly vulnerable to spills that reach the coastline, and
31 repeated influxes of oil may contaminate intertidal surfaces with each subsequent tidal cycle.
32 Because of the wide tidal range (more than 9 m [30 ft] in some portions of upper Cook Inlet,
33 north of the planning area), extensive areas of shoreline habitat may be affected by a spill,
34 especially soft bottom habitats (sands and muds), which typically have a relatively flat
35 topography. Shallow subtidal habitats could be affected by oil that slumps from intertidal areas
36 and accumulates below the low-tide line.
37

38 Vulnerable intertidal habitats sensitive to disturbance from oil spills extend around most
39 of lower Cook Inlet (MMS 2003a). Highly sensitive shoreline habitats include marshes,
40 sheltered tidal flats, and sheltered rocky shores (NOAA 1994). The vulnerability of intertidal
41 habitats is generally rated as highest for vegetated wetlands and semipermeable substrates, such
42 as mud, that are sheltered from wave energy and strong tidal currents. Oil contacting these
43 habitats is less likely to be removed by waves. Cleanup activities are very difficult to conduct on
44 soft mud substrates, such as on tidal flats (NOAA 1994, 2000).
45

1 Direct mortality of biota could result from spilled oil contacting intertidal habitats. Oil
2 readily adheres to marsh vegetation (NOAA 1994, 2000; Hayse et al. 1992), and effects may
3 range from a short-term reduction in photosynthesis to extensive vegetation injury or mortality.
4 Many invertebrates are sensitive to oil exposure. Studies of the *Exxon Valdez* oil spill provide
5 valuable information on oil spill effects and recovery. Following the *Exxon Valdez* oil spill,
6 the abundance of many species of algae and invertebrates were reduced at affected sites
7 (NOAA 1997; Peterson 2000; *Exxon Valdez* Oil Spill Trustee Council 2003). In particular, the
8 abundance and reproductive potential of *Fucus gardneri*, a common and important brown alga
9 species, was reduced in oiled areas and remained unstable at some locations for extended
10 periods (*Exxon Valdez* Oil Spill Trustee Council 2003, 2010a). Although adult *Fucus* appear
11 to have some resistance to oil toxicity, earlier life stages appear to be much more sensitive
12 (NOAA 1998). In shallow subtidal habitats, impacts were less severe, although kelp, eelgrass,
13 and many invertebrates were adversely affected (Peterson 2000).
14

15 Spilled oil that contacts intertidal habitats can cause changes in community structure and
16 dynamics. Toxic compounds in oil can selectively remove the more sensitive organisms, such
17 as echinoderms and some crustaceans, while organic enrichment from oil can stimulate the
18 growth and abundance of opportunistic infaunal invertebrates, such as some polychaetes and
19 oligochaetes (McCammon et al. 2002). Some opportunistic species, such as species of barnacle,
20 oligochaetes, and filamentous brown algae, colonized affected shorelines following the *Exxon*
21 *Valdez* oil spill and cleanup (Peterson 2000; *Exxon Valdez* Oil Spill Trustee Council 2003).
22 Indirect effects also included the spread of *Fucus gardneri* onto lower shoreline areas in some
23 regions, which inhibited the return of red algae (Peterson 2000). The reduction of predators or
24 herbivores can also result in changes in lower trophic levels for extended periods. The adverse
25 effects of oil on intertidal organisms, such as macroalgae, clams, and mussels, can last for more
26 than a decade (MMS 2003e; *Exxon Valdez* Oil Spill Trustee Council 2003).
27

28 Extended periods of time may be required for intertidal communities to fully recover
29 from an oil spill. The degree of effects and length of recovery depend on a number of factors
30 such as the type of oil, extent of biota exposure, substrate type, degree of sediment
31 contamination, time of year, and species sensitivity (NOAA 1998; Hayse et al. 1992; Hoff 1995).
32 Although the most acutely toxic components of crude oil are rapidly lost through weathering, the
33 more persistent components have been associated with long-term pathologies such as
34 carcinogenicity (NOAA 1997). Full recovery of wetlands including invertebrate communities
35 may require more than 10 years (Hoff 1995). Studies indicate that full recolonization of
36 sheltered rocky shorelines in Cook Inlet may require 5–10 years (Highsmith et al. 2001).
37 Although studies in Prince William Sound indicate that some organisms can recover quickly,
38 recovery in some intertidal and shallow subtidal habitats takes more than a decade
39 (Peterson 2000; *Exxon Valdez* Oil Spill Trustee Council 2003). More than 20 years after the
40 *Exxon Valdez* oil spill, intertidal communities were considered to be recovering, but had not yet
41 fully recovered from the effects of the spill (*Exxon Valdez* Oil Spill Trustee Council 2010a).
42

43 Spilled oil may penetrate into subsurface layers or may remain on the surface. Oil can
44 remain in intertidal sediments and organisms for more than a decade and may remain a long-term
45 source of exposure (NOAA 1997; MMS 2003e; Short et al. 2004; *Exxon Valdez* Oil Spill Trustee
46 Council 2003). Lingering oil, in some areas only slightly weathered, persists in intertidal beach

1 substrates at a number of locations more than 20 years after the *Exxon Valdez* oil spill (*Exxon*
2 *Valdez* Oil Spill Trustee Council 2009b, 2010a,b). Coarse-grained sand beaches are more
3 conducive to subsurface penetration than fine-grained sands (NOAA 2000), and subsequent
4 deposition of sand may bury oil deposits. Natural removal of subsurface oil from gravel beaches
5 is greatly reduced by surface armoring of boulders, as observed in Prince William Sound
6 (NOAA 1997). Although oil is not likely to adhere to the surface of mudflats, oil may be
7 deposited if concentrations are high; penetration of the surface is unlikely except for entering
8 burrows or crevices (NOAA 2000).

9
10 Cleanup activities may also adversely affect intertidal habitats and biota, as occurred
11 following the *Exxon Valdez* oil spill (NOAA 1997; McCammon et al. 2002; *Exxon Valdez* Oil
12 Spill Trustee Council 2003). The removal of organisms from affected surfaces and washing out
13 of fine particles from substrates likely inhibited and slowed the recovery of intertidal
14 communities in some areas. Trampling of vegetation and other biota during cleanup activities as
15 well as working oil deeper into sediments from foot traffic and equipment can also delay
16 recovery from oil spills. Extensive vessel traffic during cleanup operations may increase
17 turbidity and adversely affect organisms, such as eelgrass, in shallow subtidal communities
18 (*Exxon Valdez* Oil Spill Trustee Council 2003).

19
20 **Catastrophic Discharge Event.** For the Cook Inlet Planning Area, the PEIS analyzes a
21 CDE with an assumed volume of 75,000–125,000 bbl (Table 4.4.2-2). Currents and tides within
22 Cook Inlet could transport oil, and there is a very high likelihood that spills in the planning area
23 would make contact with coastal habitats. A CDE would potentially result in heavy or
24 widespread deposits of oil and would have a greater likelihood for extensive areas of shoreline
25 affected and heavy deposits of oil in multiple locations. The degree of effects and length of
26 recovery depend on a number of factors such as the type of oil, extent of biota exposure,
27 substrate type, degree of sediment contamination, time of year, and species sensitivity. More
28 than 20 years after the *Exxon Valdez* oil spill, intertidal communities were considered to be
29 recovering, but had not yet fully recovered from the effects of the spill (*Exxon Valdez* Oil Spill
30 Trustee Council 2010a).

31 32 33 **4.4.6.1.3 Alaska – Arctic.**

34 35 **Routine Operations.**

36
37 **Coastal Barrier Beaches.** The potential effects on coastal barrier beaches from routine
38 operations would primarily be associated with direct impacts from ground-disturbing activities
39 during pipeline construction and indirect effects from vessel traffic.

40
41 No new pipeline landfalls would be constructed in the Arctic region. However,
42 16–129 km (10–80 mi) of new onshore pipeline would be constructed for the Beaufort Sea,
43 connecting to existing infrastructure on the Arctic Coastal Plain (ACP). Pipeline construction
44 may affect sand beaches and dunes on the margins of lakes and rivers on the ACP, and erosion of
45 sand beaches and dunes adjacent to pipelines could be promoted. Stabilization of dune margins

1 could be difficult, and establishment of vegetation cover might be slow, possibly resulting in
2 prolonged losses of dune habitat near pipeline routes.

3
4 No new shore bases, processing facilities, or waste disposal facilities would be
5 constructed in the Arctic region. Existing shore bases, gas processing facilities, and waste
6 disposal facilities would be used for all new oil and gas activities in the region. Operation of
7 existing facilities could have local indirect effects on vegetation from exhaust emissions or
8 atmospheric releases from processing facilities.

9
10 Arctic coastal habitats are exposed to strong wave and sea ice action, and the shoreline is
11 generally unstable and prone to erosion (MMS 2002c; Viereck et al. 1992; Macdonald 1977).
12 Service vessel traffic to exploration and production wells and barge traffic in support of shore
13 bases could contribute to erosion along barrier beaches. Under the proposed action, up to three
14 vessel trips per week would be made to each of the up to five new platforms along the Chukchi
15 Sea and up to four along the Beaufort Sea. Increases in wave activity from vessel traffic could
16 contribute to the removal of sediments along barrier beaches. Wave activity could be minimized
17 by maintaining reduced vessel speeds in the vicinity of barrier islands.

18
19 **Wetlands.** The potential effects on wetlands from routine operations would primarily be
20 associated with direct impacts from ground-disturbing activities during construction of pipelines
21 and roads, as well as the indirect impacts from decreased water and air quality, altered
22 hydrology, and facility maintenance. Wetland losses could result in the localized reduction or
23 loss of wetland functions, such as fish and wildlife habitat, attenuation of flooding and shoreline
24 erosion, and removal of substances that reduce water quality. Avoidance of wetlands during
25 route selection for pipelines or roads might be difficult on the ACP because of the high density
26 of wetlands. Activities that would potentially affect wetlands are regulated by State agencies and
27 the USACE. Standard measures would help mitigate construction-related impacts.

28
29 Although no new pipeline landfalls would be constructed in the Arctic region,
30 16–129 km (10–80 mi) of pipeline would be constructed onshore to transport oil from the
31 Beaufort Sea to existing North Slope pipelines. With a 46-m (150-ft) wide construction ROW,
32 approximately 73–584 ha (180–1,443 ac) of land would be disturbed. A number of wetland
33 types, including wet or moist tundra habitat, lakes, ponds, or marshes (including those occurring
34 within lakes and ponds), could be affected by pipeline construction. Construction of a pipeline
35 gravel workpad (service roadway), haul road, and access roads would replace wetland habitat
36 with unvegetated surfaces or result in upland habitat having few species in common with nearby
37 undisturbed habitats. Because of the high density of wetlands on the coastal plain, wetland
38 habitat expected to constitute a large proportion of the disturbed area would likely be lost, as
39 occurred during the construction of the TAPS (Pamplin 1979; BLM 2002). Construction of
40 buried pipeline segments would affect similar amounts of wetland habitat as a workpad.
41 However, construction of aboveground pipeline segments without a workpad would result in the
42 loss of only small areas of wetland habitat at the locations of the vertical support members.
43 Wetland areas may also be disturbed by the establishment of work camps. Additional impacts of
44 construction could include altered hydrology from changes in surface drainage patterns or
45 isolation of wetland areas from water sources, such as from blocking natural surface flows.
46 Changes in the moisture regime, natural drainage patterns, or snow-drift patterns in adjacent

1 areas would likely result in thermokarst, with resulting changes in the species composition of
2 plant communities (NRC 2003a). Wetland impacts associated with degraded water quality could
3 include sedimentation and turbidity and introduction of contaminants in stormwater runoff.
4 Resulting changes in affected wetlands could include a reduction in biodiversity, replacement of
5 one wetland type for another (such as by dewatering or ponding), conversion to upland
6 communities, or conversion of vegetated wetlands to open water. Wetlands adjacent to a gravel
7 workpad would be indirectly affected by deposition of airborne dust. Additional wetland habitat
8 may be lost through thermokarst associated with new impoundments and heavy dust
9 accumulations (BLM 2002).

10
11 Deposition of fugitive dust can affect plant communities and alter wetland characteristics,
12 primarily by reducing canopy cover and altering species composition (Auerbach et al. 1997;
13 Everett 1980; Walker and Everett 1987). Impacts may include reduced growth and density of
14 vegetation and changes in community composition to more tolerant species. Reductions in plant
15 cover can reduce the insulation of the ground surface, leading to thawing of the underlying ice-
16 rich permafrost (NRC 2003a). Nonvascular species, primarily mosses and lichens, are highly
17 sensitive. The reduction or loss of sphagnum mosses, which are important components of many
18 plant communities on the ACP, can occur in acidic tundra habitat, especially within 10 m (33 ft)
19 of a road (Walker et al. 1987a), potentially contributing to thermokarst. Deposition of dust on
20 snowdrifts along roads promotes earlier melting. Roads and construction/excavation equipment
21 can also provide a means for the introduction and spread of non-native plants and noxious weeds.

22
23 The construction of access roads and transmission corridors would likely result in the
24 direct loss of wetlands from the placement of fill material during construction. Additional
25 wetland habitat could be disturbed by other forms of infrastructure such as employee camps,
26 airstrips, and power stations. The construction of these facilities could permanently eliminate
27 wetland habitat within the immediate footprints of the facilities. While this wetland loss would
28 be long term, the areas disturbed represent an extremely small portion of habitat that occurs on
29 the ACP adjacent to the Arctic region. Impacts on wetlands from construction could be
30 minimized by maintaining buffers around lakes and ponds and by using best management
31 practices for erosion and sedimentation control.

32
33 The impacts of road construction on the North Slope are often reduced by the restriction
34 of construction activities to the winter months when the ground is frozen and the use of ice roads
35 rather than gravel roads. Although ice roads avoid the permanent loss of habitat associated with
36 gravel roads, they may affect some vegetation communities. Effects may result from delayed
37 melting in spring, damage to plants, plant mortality, and removal of dead material from the
38 canopy (Walker et al. 1987a). Tundra communities generally recover from such effects,
39 however, within several years (MMS 2002c, 2003e). Drier communities, elevated microsites,
40 and tussock tundra are more affected (Pullman et al. 2003), while moist or wet meadow
41 communities are little affected (Payne et al. 2003).

42
43 Large amounts of gravel may be required for permanent road construction. On the North
44 Slope, gravel is often extracted from the floodplains of large rivers (Pamplin 1979; BLM 2002).
45 The excavation of gravel from these material sites and the creation of stockpile areas may affect
46 wetland communities on river floodplains. Wetland areas may be modified by gravel excavation

1 and other mining operations that alter stream channels. Revegetation of the affected area is
2 expected to be relatively rapid, within a few years.

3
4 Additional factors, such as reduced air quality, might also affect wetlands because of
5 activities associated with pipeline or platform construction. Exhaust emissions, such as from
6 construction equipment or pump stations, or fugitive dust generated from exposed soils or
7 roadways could have adverse effects on nearby wetland communities.

8
9 Existing shore bases, gas processing facilities, and waste disposal facilities would be used
10 for all new oil and gas activities in the region. Operation of existing facilities could have local
11 indirect effects on vegetation from exhaust emissions or atmospheric releases from processing
12 facilities. Contaminants could be introduced into wetlands from the use of existing land storage
13 or disposal sites, if contaminants migrate into groundwater or enter stormwater that flows into
14 wetlands. Contaminants might also be released to surface waters in service vessel discharges,
15 and might subsequently affect wetlands. Impacts on wetlands could be minimized by the
16 implementation of air and water quality practices.

17 **Accidents.**

18
19
20 ***Coastal Barrier Beaches.*** The potential effects on coastal barrier beaches and dunes
21 from accidents would primarily be associated with impacts from spills of oil and other petroleum
22 hydrocarbons, such as fuel oil or diesel fuel, and subsequent cleanup efforts. Oil or other spilled
23 materials might be transported to barrier island beaches, coastal beaches, or lagoon beaches by
24 currents or tides. Contamination of beaches from platform spills, pipeline spills, or vessel spills
25 could occur. Because platforms in the Chukchi Sea would be at least 40 km (25 mi) from the
26 coastline, platform spills there would have a lower potential for contacting beaches and dunes
27 than spills nearer the coast in the Beaufort Sea, and the point of contact may be a greater distance
28 down the coastline due to longshore currents. Greater weathering of the lighter, more acutely
29 toxic components of crude oil may therefore also occur prior to contact with the coastline.
30 Beach habitat could be affected by oil spills, and the direct mortality of biota could result.
31 Although beach and foredune areas are often sparsely vegetated, impacts on vegetation might
32 occur if oil were carried to higher elevations by storm waves and tides.

33
34 Spilled oil that becomes stranded on beaches might occur only on the surface, or it could
35 penetrate into subsurface layers. Permeable substrates, generally associated with larger sand
36 grain sizes, and holes created by infauna could increase oil penetration, especially that of light
37 oils and petroleum products. Penetration into coarse-grained sand beaches may be up to 25 cm
38 (0.8 ft) (NOAA 1994, 2000). Light oils may penetrate peat shores; however, peat resists
39 penetration by heavy oils (NOAA 2000).

40
41 Although any residual oil that could remain following cleanup might be largely removed
42 in highly exposed locations through wave action, oil could remain in the shallow subsurface for
43 extended periods of time. In some locations, oil might become buried by new sand or gravel
44 deposition. Natural degradation and persistence of oil on beaches are influenced by the type of
45 oil spilled, amount present, sand grain size, degree of penetration into the subsurface, exposure to

1 weathering action of waves, and sand movement onto and off shore. Although petroleum-
2 degrading microbial communities are present, biodegradation along arctic coastlines would
3 likely be slow (Prince et al. 2002; Braddock et al. 2003; Braddock et al. 2004) and is limited to
4 only a few months per year. Spilled oil might persist for many years, with continued effects on
5 infauna and potential recovery of infaunal communities. On sheltered beaches, heavy oiling
6 left for long periods could form an asphalt pavement relatively resistant to weathering
7 (Hayes et al. 1992). Lagoon shorelines include low-energy beaches where spilled oil would
8 likely persist for many years. Spilled oil may persist for extended periods on peat shores;
9 however, if cleaned up, it would be expected to persist for less than a decade (Owens and
10 Michel 2003).

11
12 Spill cleanup operations might adversely affect beaches and dunes, if the removal of
13 contaminated substrates affects beach stability and results in accelerated shoreline erosion.
14 Vehicular and foot traffic during cleanup could mix surface oil into the subsurface, where it
15 would likely persist for a longer time. Manual cleanup rather than use of heavy equipment
16 would minimize the amount of substrate removed.

17
18 **Catastrophic Discharge Event.** The PEIS analyzes a CDE in the Beaufort Sea of
19 1.7–3.9 million bbl, and in the Chukchi Sea of 1.4–2.2 million bbl. Oil might be transported to
20 barrier island beaches, coastal beaches, or lagoon beaches by currents or tides, even from a
21 discharge in the Chukchi Sea; however, the point of contact may be a greater distance down the
22 coastline due to longshore currents. Greater weathering of the lighter, more acutely toxic
23 components of crude oil may therefore also occur prior to contact with the coastline. A CDE
24 would potentially result in heavy or widespread deposits of oil and would have a greater
25 likelihood for extensive areas of shoreline affected and heavy deposits of oil in multiple
26 locations. Natural degradation and persistence of oil on beaches are influenced by the amount
27 present, sand grain size, degree of penetration into the subsurface, exposure to weathering action
28 of waves, and sand movement onto and off shore. Spilled oil might persist for many years, with
29 continued effects on infauna and potential recovery of infaunal communities.

30
31 **Wetlands.** The potential effects on wetlands from accidents would primarily be
32 associated with impacts from spills of oil and other petroleum hydrocarbons, such as fuel oil or
33 diesel fuel, and subsequent cleanup efforts. Oil or other spilled materials might be transported
34 from offshore areas to coastal wetlands by currents or tides, and may result from spills involving
35 platforms, pipelines, or service vessels. Because platforms in the Chukchi Sea would be at least
36 40 km (25 mi) from the coastline, platform spills there would have a lower potential for
37 contacting coastal wetlands than spills nearer the coast in the Beaufort Sea, and the point of
38 contact may be a greater distance down the coastline due to longshore currents. Greater
39 weathering of the lighter, more acutely toxic components of crude oil may therefore also occur
40 prior to contact with the coastline. The potential for impacts on marshes, estuaries, and low-
41 lying tundra would depend on wind and wave conditions, because the rates of abrasion and
42 dispersal of stranded oil by littoral processes are generally low, due to the small tidal range along
43 the arctic coast. Oil may be deposited at higher elevations of marshes, tundra, and river deltas by
44 spring tides or storm surges and would be expected to persist for long periods due to the low
45 rates of dispersion and degradation.

1 Freshwater wetlands on the ACP could be affected by spills from onshore pipelines. Oil
2 spilled on the ACP could potentially flow into a nearby stream. Vegetation along the path of the
3 spill would be injured or killed, including wetland vegetation along the stream. Oil reaching the
4 arctic coastline may persist for extended periods of time and slow or reduce vegetation recovery.
5 Wetlands in river deltas and estuaries could be affected by oil spilled in upstream areas.
6

7 Impacts on wetlands from oil spills could result in extensive injury or mortality of
8 vegetation and invertebrates in or on the substrate. Other effects of spills could include a change
9 in plant community composition or the displacement of sensitive species by more tolerant
10 species. Impacts on soil microbial communities might result in long-term wetland effects, and
11 wetland recovery would likely be slowed. Various factors influence the extent of impacts on
12 wetlands. Impacts would depend on site-specific factors at the location and time of the spill.
13 The degree of impacts is related to the oil type and degree of weathering, the quantity of the
14 spill (lightly or heavily oiled substrates), duration of exposure, season, plant species, percentage
15 of plant surface oiled, substrate type, soil moisture level, and oil penetration into the soil
16 (Hayes et al. 1992; Hoff 1995; NOAA 1994). Higher mortality and poorer recovery of
17 vegetation generally result from spills of lighter petroleum products (such as diesel fuel), heavy
18 deposits of oil, spills during the growing season, contact with sensitive plant species, completely
19 oiled plants, and deep penetration of oil and accumulation in substrates. Oil that reaches the root
20 system would result in high levels of mortality. Vegetation regrowth and recovery are generally
21 better where oil spills occur in flooded areas or on saturated soils, than on unsaturated soils
22 (BLM 2002). Coastal wetlands in sheltered areas, such as bays and lagoons, which are not
23 exposed to strong water circulation or wave activity, would be expected to retain oil longer with
24 longer-lasting effects on biota (Culbertson et al. 2008).
25

26 Oil spills on ice or snow in winter would likely be easily cleaned up with little oil
27 remaining; however, spills during other times may be difficult to clean up, and considerable
28 amounts of oil may remain. Following cleanup, the spilled oil remaining degrades naturally by
29 weathering and biodegradation by soil microbial communities. However, biodegradation would
30 likely be slow due to generally cool temperatures and a short growing season. Full recovery of
31 wetlands, including invertebrate communities, might require more than 10 years depending on
32 site and spill characteristics (Hoff 1995; Culbertson et al. 2008). Oil could remain in some
33 wetland substrates for decades, even if it was cleaned from the surface. Heavy deposits of oil in
34 sheltered areas of coastal wetlands or in the supratidal zone could form asphalt pavements
35 resistant to degradation (Hoff 1995; Culbertson et al. 2008).
36

37 Spill cleanup actions might damage wetlands through trampling of vegetation,
38 incorporation of oil deeper into substrates, increased erosion, and inadvertent removal of plants
39 or sediments, all of which could have long-term effects (NOAA 1994, 2000; Hoff 1995). These
40 actions could result in plant mortality and delay or prevent recovery. Complete recovery of
41 coastal wetlands disturbed by cleanup activities could take several decades. Effective low-
42 impact cleanup actions could include bioremediation, low-pressure flushing, or use of chemical
43 cleaners.
44

45 The NOAA Environmental Sensitivity Index (ESI) shoreline classification system
46 classifies coastal habitats on a scale of 1 to 10, according to habitat sensitivity to spilled oil,

1 oil-spill retention, and difficulty of cleanup (NOAA 1994). Habitats with high ESI values are
2 given a higher priority for protection. The ESI shoreline classification for the Beaufort and
3 Chukchi Sea coasts includes habitats with high values, such as inundated lowland tundra or
4 salt/brackish-water marshes, both ranked 10 (MMS 2002d, Owens and Michel 2003).
5

6 **Catastrophic Discharge Event.** The PEIS analyzes a CDE in the Beaufort Sea of
7 1.7–3.9 million bbl, and in the Chukchi Sea of 1.4–2.2 million bbl. Oil or other spilled materials
8 might be transported from offshore areas to coastal wetlands by currents or tides, even from a
9 discharge in the Chukchi Sea; however, the point of contact may be a greater distance down the
10 coastline due to longshore currents. Greater weathering of the lighter, more acutely toxic
11 components of crude oil may therefore also occur prior to contact with the coastline. A CDE
12 would potentially result in heavy or widespread deposits of oil and would have a greater
13 likelihood for extensive areas of shoreline affected and heavy deposits of oil in multiple
14 locations. The potential for impacts on marshes, estuaries, and low-lying tundra would depend
15 on wind and wave conditions. The degree of impacts is related to the degree of weathering,
16 whether substrates are lightly or heavily oiled, duration of exposure, season, plant species,
17 percentage of plant surface oiled, substrate type, soil moisture level, and oil penetration into the
18 soil.
19
20

21 **4.4.6.1.4 Conclusion.** Routine Program activities in the GOM, Cook Inlet, and the
22 Arctic would result in minor to moderate localized impacts. Although routine operations in the
23 GOM could have impacts on coastal barrier beaches and dunes, primarily as a result of pipeline
24 construction, maintenance dredging of inlets and channels, and vessel traffic, modern methods of
25 pipeline construction could result in minimal beach erosion. Studies have shown few effects of
26 pipeline landfalls and navigation channels on barrier beach stability.
27

28 Routine operations in the GOM could have direct impacts on wetlands as a result of
29 direct losses of habitat from construction activities, pipeline landfalls, and channel dredging, and
30 indirect impacts as a result of altered hydrology caused by channel dredging. Construction
31 impacts, while unavoidable, would be mitigated by State and Federal regulations governing
32 construction in wetland areas. Spills could potentially affect both the surface and subsurface of
33 beach and dune substrates in the GOM. Oiled beach sediments could weaken dune and other
34 beach vegetation, resulting in accelerated erosion. Oil spills could have direct impacts on
35 wetlands by weakening and killing vegetation. Weakened wetland vegetation could lead to long-
36 term or permanent loss of wetland areas, particularly in an already stressed environment such as
37 the Mississippi River deltaic plain. Cleanup operations themselves could also affect wetlands.
38

39 Routine operations in Cook Inlet could affect coastal habitats as a result of vessel traffic,
40 as well as infrastructure maintenance and repair activities. Direct loss of habitat could occur as
41 a result of damaging habitats during maintenance. Direct losses would be minimized through
42 existing Federal and State environmental review and permitting procedures that would attempt to
43 mitigate impacts through appropriate requirements. Secondary impacts on wetlands could occur
44 from water and air quality degradation. Because the Cook Inlet Planning Area is almost entirely
45 surrounded by coastal habitat, it is likely that a large spill would contact these habitats. Habitats

1 along the western shoreline have the greatest likelihood of contact based on surface currents in
2 the inlet. Spills could result in changes in community structure and direct loss of habitat.

3
4 Routine operations in the Arctic could affect coastal habitats as a result of pipeline
5 construction, gravel mining on floodplains (for pipeline workpads and offshore islands), vessel
6 traffic, and infrastructure maintenance and repair activities. These activities could result in direct
7 loss of habitat by replacing habitat with infrastructure and by damaging habitats during
8 maintenance. These direct losses would be minimized through existing Federal and State
9 environmental review and permitting procedures that would attempt to mitigate impacts through
10 appropriate siting and construction requirements. Secondary impacts on wetlands could occur
11 from water and air quality degradation, ice roads, fugitive dust, and altered drainage caused by
12 pipelines and roads.

13
14 A catastrophic discharge event with an assumed volume of 0.9–7.2 million bbl in the
15 GOM would be associated with a loss of well control; a 75,000–125,000 bbl CDE in Cook Inlet
16 would be associated with a loss of well control or pipeline break; a 1.7–3.9 million bbl CDE in
17 the Beaufort Sea or a 1.4–2.1 million bbl CDE in the Chukchi Sea would be associated with a
18 loss of well control. Oil or other spilled materials might be transported from offshore areas to
19 coastal wetlands by currents or tides. The amount of oil deposited on coastal habitats would
20 depend on various factors, such as spill volume, distance from shoreline, ambient conditions,
21 degree of weathering, and effectiveness of response actions. A catastrophic discharge event
22 would potentially result in heavy or widespread deposits of oil and would have a greater
23 likelihood for extensive areas of shoreline affected and heavy deposits of oil in multiple
24 locations. The degree of effects and length of recovery depend on a number of factors such as
25 the type of oil, extent of biota exposure, substrate type, degree of sediment contamination, time
26 of year, and species sensitivity.

27 28 29 **4.4.6.2 Marine Benthic Habitats**

30 31 32 **4.4.6.2.1 Gulf of Mexico.**

33 34 **Soft Sediments.**

35 36 ***Routine Operations.***

37
38 Exploration and Site Development. Impacting factors for the exploration and site
39 development phase are shown in Table 4.4.6-3. The vast majority of marine benthic habitat
40 affected by the Program would be soft sediments. Drilling wells would temporarily reduce
41 habitat quality by generating temporary turbidity and sedimentation for some distance around the
42 disturbed area. It is estimated that 1,000 to 2,100 exploration and delineation wells and 1,300 to
43 2,600 development and production wells will be drilled in the WPA and CPA. Drilling can
44 occur from fixed platforms, floating platforms, or drillships. The installation of floating or fixed
45 platforms would disturb soft sediment habitat where the legs or mooring structures (anchors and

1 **TABLE 4.4.6-3 Impacting Factors by Phase and Potential Effects on Marine Benthic Habitat in**
2 **the CPA and WPA of the GOM**

Disturbance	Potential Effects ^a
<i>Exploration and Site Development</i>	
Seismic surveys	Noise; localized anchoring disturbance
Anchoring and mooring of platforms, drillships, and seismic survey vessels	Sediment scour; temporary turbidity and sedimentation; localized alteration in sediment grain size and biogeochemical functions
Drilling and production platform placement	Noise; temporary sediment resuspension and turbidity; loss of natural habitat creation of artificial reef
Drilling	Noise; small habitat loss; local alteration of sediment characteristics; temporary turbidity and sedimentation in surrounding areas
Miscellaneous discharges (deck washing; sanitary waste; vessel releases of bilge and ballast water)	Sediment contamination
Solid wastes	Sediment contamination
Discharge of drilling muds/cuttings	Sediment and water column contamination; alteration in sediment granulometry and biogeochemical functions
Pipeline trenching and placement	Noise; long-term loss and degradation of existing benthic habitat; temporary sediment resuspension and turbidity; substrate for growth
<i>Production</i>	
Scour from anchors and the movement of pipelines and mooring structures	Chronic, long-term disturbance of bottom sediments; turbidity
Platform production	Noise; loss of natural habitat creation of artificial reef
Produced water discharge	Sediment contamination
Miscellaneous discharges	Sediment contamination
Solid wastes and debris	Sediment contamination
<i>Decommissioning</i>	
Miscellaneous discharge	Sediment contamination
Solid wastes and debris	Sediment contamination
Platform removal	Explosive noise; temporary turbidity and disturbance of bottom sediments

^a Colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

3
4
5 chains) encountered the seabed and where subsea equipment (such as reentry collars and blowout
6 preventers) was installed. Chronic local bottom disturbance would result from subsequent
7 movements of anchors and mooring lines associated with floating production platforms and
8 support vessels. The actual area of seafloor affected by anchoring operations would depend
9 upon water depth, currents, size of the vessels and anchors, and length of anchor chain. The
10 amount of bottom affected by anchored structures would increase with water depth because of
11 the use of larger anchors and longer anchor chains. Anchor scars were detected in a radial
12 pattern up to 3 km (2 mi) from a well located on the GOM continental slope (Continental Shelf
13 Associates, Inc. 2006). Drilling vessels would use either anchors or dynamic positioning to

1 maintain station. Drilling vessels using dynamic positioning systems rather than anchors would
2 not generate mooring impacts on the seafloor. Exploratory well platforms can be fixed or
3 floating.
4

5 Under the proposed action, it is estimated that 200 to 450 new production platforms will
6 be constructed, which is expected to disturb 150 to 2,500 ha (370 to 6,178 ac) of seafloor.
7 Ninety-five percent of these new platforms will be located in water depths less than 200 m
8 (656 ft). In deep water, floating platforms (including those associated with a FPSO system)
9 requiring mooring structures will typically be used, while platforms in more shallow water would
10 likely have legs and not require mooring. Impacts from fixed and floating production platforms
11 would be similar to those described above for the exploration phase.
12

13 Under the proposed action, it is estimated that 3,862 to 12,070 km (2,400 to 7,500 mi) of
14 new pipeline would be placed in the CPA and WPA, resulting in disturbance to 2,000 to
15 11,500 ha (4,942 to 28,417 ac) of seafloor. Up to two FPSO systems could potentially be used in
16 deep water, which would reduce the need for pipelines. In water depths less than 60 m (197 ft),
17 pipelines must be buried; benthic organisms within the trenched corridor could be killed or
18 injured and organisms to either side of the pipeline could be buried by sediments. Pipelines
19 placed on the sediment surface would permanently replace the existing soft sediments with man-
20 made substrate that sessile invertebrates may colonize over time. Vessel anchoring during
21 pipeline placement would also disturb soft sediment. Anchor and mooring impacts from pipeline
22 placement vessels would be eliminated if dynamic positioning systems rather than anchors were
23 used during pipeline placement. The recovery period for soft sediment benthic habitat disturbed
24 by pipeline placement would depend on factors such as water depth, sediment type, and
25 community composition. Disturbed sediments with a greater proportion of sand to mud may fill
26 in with fine silty material, which would alter grain size and potentially inhibit the colonization by
27 species that existed prior to the disturbance.
28

29 During the exploration and development phase, drill cuttings and drilling muds (including
30 synthetic drilling fluids adhering to the cuttings) could contaminate and alter the grain size of
31 sediments immediately around the wellhead and below the discharge area. Drilling wastes are
32 regulated by the USEPA under NPDES permits and can be discharged into the ocean only if they
33 meet USEPA toxicity and discharge rate requirements. These requirements greatly reduce the
34 potential for sediment contamination. Drill cuttings and muds rapidly reach the sediment
35 surface. Therefore, the discharged drilling muds and cuttings could be deposited in highly
36 concentrated thick layers if deposited in shallow water or near the sediment surface. In the case
37 of near-surface discharge in deep water, drilling muds would spread out in a thin veneer over a
38 wide area. Settled muds could cause smothering of organisms, changes in sediment
39 characteristics and biogeochemical functions, and the loss of food resources in the immediate
40 area. The biodegradable synthetic drilling fluids attached to the drilling waste may deplete
41 oxygen (Trannum et al. 2010) and therefore may create local sediment anoxia.
42

43 Studies at multiple sites on the Louisiana continental shelf and slope provide the most
44 relevant information on the potential ecological effects of drilling and drilling mud discharges on
45 soft sediment habitat. These studies found drill cuttings were detectable up to 1 km (0.6 mi)
46 from the well site, depending on whether cuttings were discharged near the water surface or near

1 the bottom (Continental Shelf Associates Inc. 2004, 2006). Concentrations of barium,
2 hydrocarbons, and synthetic drilling fluids in the sediment were patchily distributed within the
3 sampling radius (up to 500 m [1,640 ft] from the well) but, overall, were higher than at the
4 control sites (Continental Shelf Associates Inc. 2004, 2006). Several other alterations in habitat
5 were also detected, including anoxic bottom patches, elevated metal concentrations, coarser grain
6 size (all typically less than 300 m [984 ft] from well), and anchor scars (up to 3 km [1.9 mi] from
7 well). Within 250 m (820 ft) of the well, sediment toxicity to certain invertebrates based on
8 bioassays was also reported at several sites, and metrics of invertebrate community health were
9 lower and more variable (Continental Shelf Associates Inc. 2004). However, a greater
10 abundance of certain species of meiofauna, macrofauna, and fish compared to controls was also
11 detected, potentially because of the organic enrichment of sediments near the well (Continental
12 Shelf Associates Inc. 2006). The spatial extent of the biological, physical, and chemical effects
13 cannot be precisely determined, but drilling discharges, hydrocarbons, and sediment toxicity all
14 dropped off rapidly with distance from the well (Continental Shelf Associates Inc. 2004, 2006).
15 Habitat recovery time is also unknown, but evidence for biological, physical, and chemical
16 recovery was detected after 1 yr, so full recovery may occur over several years as sediment
17 contaminants are biodegraded and buried by natural deposition and bioturbation (Continental
18 Shelf Associates Inc. 2004, 2006).

19
20 Miscellaneous discharges (deck washing, sanitary waste, and vessel discharge) also have
21 the potential to disturb soft sediment habitats. Miscellaneous discharges could contaminate
22 sediments if discharged in relatively shallow water. However, contaminants in surface
23 discharges would most likely be diluted to negligible concentrations before reaching the
24 sediment, especially for platforms located in deep water. Many vessel and platform wastes are
25 disposed of on land, and those that are discharged at sea must meet USEPA and/or USCG
26 regulatory requirements that limit their environmental effects.

27
28 Noise from seismic surveys and drilling could kill or injure organisms close enough to
29 the noise source and reduce habitat suitability because some species would avoid the area. The
30 severity and duration of noise would vary with site and development scenario, but overall the
31 impacts would be temporary and localized with overall minimal effects on soft sediment habitat.
32 See Section 4.4.7 for detailed discussions of the effects of noise and different categories of biota.

33
34 Overall, site development and exploration represents a moderate, but localized, long-term
35 disturbance, with the severity of the impacts generally decreasing dramatically with distance
36 from the well site.

37
38 Production. Production activities that could affect soft sediment habitat are shown in
39 Table 4.4.6-3 and include operational noise, miscellaneous discharges, bottom disturbance from
40 the movement of anchors and mooring structures, and the releases of process water. In addition,
41 the platform would replace existing featureless soft sediments and serve as an artificial reef. The
42 potential impacts of miscellaneous discharges would continue on from the exploration and
43 development phase and are described above. Impacts on soft sediment habitats from vessel and
44 operational noise are expected to be negligible, but long term, with the impacts lasting the
45 duration of the production phase.

1 Chronic bottom disturbance from the movement of anchors and chains associated with
2 platforms and support vessels would affect soft sediment habitats as described above for the
3 exploration and site development phase. Pipelines in water less than 60 m (197 ft) must be
4 buried, which would reduce the potential for pipeline movement. However, pipelines could
5 become unearthed or moved following severe storms. These disturbances would be long term
6 and chronic and cause scour, turbidity, and sedimentation of soft sediment habitats.

7
8 The platforms and pipelines would also create novel hard substrate, and the area on and
9 immediately around the platform would have habitat functions and biological communities very
10 different from these in the preconstruction period. Algae and sessile invertebrates would attach
11 to the platform and would in turn attract reef-oriented organisms. The ecological function and
12 value of artificial reef habitat are controversial as some species may benefit while others do not.
13 In addition, sediment grain size and the biogeochemical processes around the platform could be
14 altered by the flux of biogenic material from the platform to the seafloor. For example, an
15 increase in shell material and organic matter would likely result along with a transition to benthic
16 species adapted to these conditions (Montagna et al. 2002). The replacement of soft sediment
17 with artificial reef would exist only during the production phase, unless the platform was
18 permitted to remain in place after decommissioning. In deep sea soft sediment, communities
19 may form on mooring structures, but colonization would likely be slow, and mooring structures
20 would be completely removed during decommissioning, so impacts, if any, would be temporary.

21
22 Produced water is a normal product of oil and gas extraction that contains contaminants
23 such as polycyclic aromatic hydrocarbons (PAHs) and heavy metals and therefore represents a
24 potential source of contamination to benthic habitats. Before being discharged into the ocean,
25 produced water is typically treated and must meet NPDES requirements regarding discharge rate,
26 contaminant concentration, and toxicity, thereby reducing the potential for sediment
27 contamination. In addition, contaminants in produced water would be rapidly diluted with
28 distance from the discharge point and are expected to reach sediments only in biologically
29 negligible concentrations. A major study of produced water discharges across the northern GOM
30 indicated that despite the large volume discharged, the contribution of produced water to bottom
31 water hypoxia is minimal when compared to riverine inputs (Bierman et al. 2007). Overall,
32 produced water did not make a significant contribution to the hypoxic zone (Rabalais 2005).

33
34 The results of the GOM Offshore Monitoring Experiment funded by BOEM provide a
35 good summary of the long-term changes to soft sediment habitats resulting from oil and gas
36 development (Kennicutt et al. 1995). For the study, stations at 30–50, 100, 200, 500, and
37 3,000 m (98–164, 328, 656, 1,640, and 9,842 ft) distances from petroleum wells were sampled in
38 a radial pattern surrounding the platforms. Elevated sediment concentrations of sand, organic
39 matter, hydrocarbons, and metals were generally restricted to sediments less than 200 m (656 ft)
40 from the platforms. PAH levels in sediments were well below levels considered to be toxic to
41 invertebrates, and no significant hydrocarbon bioaccumulation was observed in megafaunal
42 invertebrates near platforms. However, metal levels in invertebrate tissues were higher at the
43 study sites (Kennicutt et al. 1995). The physical and chemical changes to sediments near the
44 platforms were enough to alter the soft sediment communities, but the effects were restricted to
45 within 200 m (656 ft) of the platforms. Overall, the authors concluded that oil and gas

1 development and production resulted in moderate, highly localized changes to soft sediment
2 habitat (Montagna and Harper 1996).

3
4 Decommissioning. Miscellaneous discharges and solid waste releases discussed above
5 would continue during the decommissioning phase (Table 4.4.6-3). Platform and mooring
6 structure removal activities could result in increased turbidity, temporary suspension of bottom
7 sediments, and explosive shock-wave impacts. Impacts from decommissioning will vary with
8 platform removal scenario, which ranges from complete to partial removal. The impacts from
9 the explosive removals of the platforms would be attenuated by the movement of the shock wave
10 through the seabed, because the charges typically would be set at 5 m (16 ft) below the seafloor
11 surface. Under the proposed action, it is assumed that a total of 150 to 275 platforms would be
12 removed using explosives. A small area would be disturbed, compared with total seafloor area
13 in the entire GOM. In addition, because soft-bottom benthic habitats are typically recolonized
14 relatively quickly following disturbances, benthic communities in disturbed areas would be
15 expected to recover over a period of months to years without mitigation. If the platform is
16 toppled and left in place, the remains would serve as hard bottom habitat that would permanently
17 replace the existing soft sediment habitat. Artificial reefs provide habitat to fish, algae, and
18 invertebrates; however, their ecological and population effects are controversial. Overall,
19 impacts on soft sediment resources from decommissioning activities are expected to be
20 negligible.

21
22 Accidents. Accidental hydrocarbon releases in marine habitat can occur at the surface
23 from tankers or platforms or at the seafloor from the wellhead or pipelines. Natural gas would
24 quickly rise above the sediment surface, which would minimize its impacts on benthic habitat.
25 Natural gas is also less persistent in the environment than oil. Evidence from the DWH event
26 indicates that methane gas released from the well was rapidly broken down by bacterial action
27 with little oxygen drawdown (Camilli et al. 2010; Kessler et al. 2011). Consequently, the
28 remainder of the discussion focuses on oil spills. It is assumed that up to 8 large spills
29 ($\geq 1,000$ bbl), up to 70 spills between 50 and 999 bbl, and up to 400 smaller spills between 1 and
30 50 bbl could occur during the lease period under the proposed action (Table 4.4.2-1). Modeling
31 indicates that oil spilled at the surface could mix to a depth of 20 m (66 ft) at highly diluted
32 concentrations (MMS 2008a). Therefore, most surface spills would likely reach the sediment at
33 biologically negligible concentrations. Most subsea spills would be minor, and the hydrocarbon
34 concentrations would typically be diluted to background levels within a few hundred meters to a
35 few kilometers of the spill site. The soft sediment habitat would recover without mitigation
36 because of natural breakdown of the oil, sediment movement by currents, and reworking by
37 benthic fauna.

38
39 Oil spill-response activities such as burning, skimming, and chemical release
40 (e.g., dispersants or coagulants) could affect benthic habitat and biota. Skimming and burning
41 could kill pelagic live stages of benthic biota. The chemicals used during a spill response are
42 toxic, but there is controversy about whether the combination of oil and dispersant is more toxic
43 than oil alone (NRC 2005b; Fingas 2008; Holland-Bartels and Kolak 2011). The use of
44 dispersant would likely reduce oiling of nearshore benthic habitat, but may increase the exposure
45 of subtidal benthic habitat and biota to toxic fractions of oil (NRC 2005b). In shallow water, the
46 presence of, and noise generated by, oil spill-response equipment and support vessels could

1 temporarily disturb benthic habitat in the vicinity of the response action, potentially reducing
2 habitat use or disturbing migration. As with the spill itself, the location and time of the year the
3 cleanup occurs would be an important determinant of impacts on benthic habitat and biota.
4

5 **Catastrophic Discharge Event.** The PEIS analyzes a CDE up to 7.2 million bbl
6 (Table 4.4.2-2). Lethal or sublethal concentrations of hydrocarbons or mixtures of hydrocarbon
7 and dispersant (if used) could accumulate in soft sediments, reducing habitat function. The
8 magnitude of the impact depends primarily on the location of the well, the volume released, and
9 the speed at which the well is capped. Typically oil rises from the seafloor to the surface,
10 forming a surface slick. However, a subsurface plume capable of traveling long distances could
11 form if dispersants are used or if the well releases a mixture of oil and gas. However, even in the
12 case of a subsurface plume, most oil would stay above the sediment. Sediment contamination
13 could occur from the deposition of oiled sediment and organic matter (dead plankton and organic
14 flocculants) falling from the water column. Such deposition is expected to decrease significantly
15 with distance from the well.
16

17 Benthic habitat would probably recover more quickly from a shallow-water spill than
18 from a deepwater spill because of the greater microbial activity and potential for sediment
19 resuspension in shallow water, which would facilitate the breakdown of hydrocarbons. Because
20 of the widespread presence of soft-bottom habitats on the continental shelf and slope and the
21 tendency of oil to stay suspended above the sediment, it is anticipated that impacts from oil spills
22 would affect only a very small proportion of such habitat within the GOM. Oiled sediments
23 would eventually recover their habitat value as hydrocarbons broke down or were buried by
24 natural processes, and communities would soon recover through larval recruitment from adjacent
25 areas. However, recovery time would vary with local conditions and the degree of oiling.
26 Overall, impacts on soft sediment habitat from accidents could be moderate and potentially long
27 term, but no permanent degradation of soft sediment habitat is expected to result from accidental
28 spills.
29

30 **Warm Water Coral Reefs and Hard-Bottom Habitat.**

31
32 **Routine Operations.** BOEM has several protections in place to minimize and mitigate
33 the adverse effects of oil and gas exploration and development on coral reefs and hard-bottom
34 habitat. It is assumed that these current protections will also be implemented during this
35 Program. The mitigations as described in the Topographic Features Stipulation and NTL
36 No. 2009-G39 (available at [http://www.gomr.boemre.gov/homepg/regulate/regs/ntls/2009NTLs/
37 09-G39.pdf](http://www.gomr.boemre.gov/homepg/regulate/regs/ntls/2009NTLs/09-G39.pdf)) create avoidance and mitigation requirements for biologically sensitive hard bottom
38 areas and topographic features in waters 300 m (984 ft) or less.
39

40 Four hard bottom or reef habitats are designated for the various protections: (1) banks
41 offshore of Texas and Louisiana (including the Flower Garden Banks National Marine Sanctuary
42 [FGBNMS]), (2) the Pinnacle Trend off the Louisiana-Alabama coast, (3) seagrass and low-
43 relief live-bottom areas primarily located in the CPA and Eastern Planning Area (EPA), and
44 (4) potentially sensitive biological features of moderate to high relief that are not protected by
45 (1) and (2). These protections are explained in greater detail below.
46

1 Exploration and Site Development. Topographic features (banks). Because FGBNMS is
2 a national sanctuary, no oil and gas exploration or site development would be allowed there. To
3 protect other hard-bottom topographic features, BOEM instituted a Topographic Features
4 Stipulation that established No Activity Zones prohibiting structures, drilling rigs, pipelines, and
5 anchoring around 22 underwater topographic features out to a specified isobaths (typically 85 m
6 [279 ft]) (Table 4.4.6-3). The continuation of this same practice is assumed here. To limit
7 impacts from drilling discharges, the stipulation also requires all drilling muds and cuttings be
8 shunted to within 10 m (33 ft) of the seafloor at distances ranging from 1 to 6.4 km (0.6 to 4 mi)
9 away from topographic features depending on their nature and biological sensitivity. This
10 shunting protects biota by confining the effluent to a level deeper than that of the living
11 components of a high-relief topographic feature. For low-relief banks in the WPA, shunting
12 drilling effluents is not required because it would put the potentially harmful drilling muds and
13 cuttings in the same water depth range as the topographic features. In addition, NTL No. 2009-
14 G39 prohibits bottom-disturbing activities, including the use of anchors, chains, cables, and wire
15 ropes within 152 m (500 ft) of a No Activity Zone without first consulting NOAA. Maps of the
16 protected banks in the WPA and CPA are available at [http://www.gomr.mms.gov/homepg/
17 llesale/topo_features_package.pdf](http://www.gomr.mms.gov/homepg/llesale/topo_features_package.pdf).

18
19 Ninety five percent of the 200 to 450 anticipated new production platforms would be
20 located in water depths less than 200 m (656 ft), which is within the depth range at which coral
21 reefs and live-bottom features are found. Turbidity and sedimentation from bottom disturbance
22 and the discharge of drilling wastes can adversely affect coral in multiple ways, including
23 mortality, decreased growth, and loss of zooxanthelle (Thompson et al. 1980; Nugues and
24 Roberts 2003; Fabricius 2005). The protections described above would minimize the impacts
25 from direct bottom disturbance and sediment resuspension to designated banks from anchoring,
26 drilling, platform placement, and pipeline trenching and placement. It is possible but not likely
27 that turbidity would affect hard-bottom habitat if bottom disturbance occurred near the boundary
28 of a No Activity Zone. The shunting requirements should minimize the adverse effects of
29 discharged drilling muds and cuttings, although low-relief banks in more shallow water may be
30 adversely affected to some degree. The topographic feature stipulations have been very effective
31 in protecting the communities associated with topographic features. For example, despite the
32 proximity of oil and gas development activities, long-term monitoring studies do not indicate any
33 significant detrimental impact on the coral reefs of the FGBNMS (Gittings 1998).

34
35 *Pinnacle trend.* The Live-Bottom/Pinnacle Trend Stipulation, which currently applies to
36 certain blocks in the CPA and EPA, requires a biological interpretation of bathymetric and
37 geophysical surveys to determine the distribution of pinnacle features before any bottom-
38 disturbing activities can occur. Also, NTL No. 2009-G39 currently requires consultation with
39 NOAA before any bottom-disturbing activities (including those caused by pipelines, anchors,
40 chains, cables, or wire ropes) planned within 30 m (100 ft) bottoms/pinnacles with vertical relief
41 of 2.4 m (8 ft) or more. There are no specific measures requiring drilling muds and cuttings to
42 be discharged near the seafloor, because modeling studies suggest that the discharge would be
43 transported over the pinnacles (Continental Shelf Associates, Inc. and Texas A&M 2001).
44 Limitations on drilling mud discharges required by NPDES permit and the fact that the pinnacle
45 trend area is subject to high levels of natural turbidity and sedimentation should limit impacts on
46 pinnacle features. If it is determined that the live-bottoms might be adversely affected by the

1 proposed activity, BOEM can further require economically, environmentally, and technically
2 feasible measures to protect the pinnacle area. These measures may include, but are not limited
3 to, the relocation of operations and monitoring to assess the impact of the activity on the live-
4 bottoms. See the BOEM Web site at [http://www.gomr.mms.gov/homepg/regulate/envIRON/
5 topoblocks.pdf](http://www.gomr.mms.gov/homepg/regulate/envIRON/topoblocks.pdf) for the list and <http://www.gomr.mms.gov/homepg/regulate/envIRON/topomap.pdf>
6 for the map of the identified pinnacle trend features.

7
8 Continued implementation of the Live-Bottom/Pinnacle Trend Stipulations and the
9 requirements in NTL No. 2009-G39 would minimize bottom disturbance within 30 m (100 ft) of
10 the majority of known pinnacle features. Because of these protections, direct effects such as
11 benthic habitat disturbance from drilling, platform placement, trenching, and placement of
12 pipelines would be minimal. However, if these activities occurred in the vicinity of the
13 pinnacles, then sedimentation and turbidity could kill or inhibit respiration, filter feeding, and
14 photosynthesis by hard-bottom biota. Because of the lower vertical relief pinnacles, the effects
15 of turbidity and sedimentation could be greater in their vicinity. In addition, noise from seismic
16 surveys, construction, and drilling could injure, kill, or cause avoidance behavior in organisms
17 within a certain distance from the noise source. Noise disturbance would be temporary and the
18 community would recover if the initial impact did not result in major injury or mortality to
19 organisms associated with a pinnacle trend.

20
21 Impacts from drilling discharges would be reduced by compliance with the Pinnacle
22 Trend/Live-Bottom Stipulation, NPDES permit restrictions that limit the amounts and types of
23 drilling discharges and the depth at which the pinnacles are located. However, studies in the
24 pinnacle region indicated that discharges of drilling muds may reach background levels within
25 1,500 m (4,921 ft) of the discharge point (Shinn et al. 1993). Therefore, pinnacles could be
26 affected by discharges occurring at the surface and outside of the 30-m (98-ft) buffer required by
27 NTL-2009-G39. As described above, increased turbidity and sediment deposition from
28 discharges of muds and cuttings in the vicinity of pinnacles may reduce habitat quality and
29 ecological function. However, biota associated with live-bottom/pinnacle features are usually
30 adapted to life in somewhat turbid conditions and are often observed coated with a sediment
31 veneer (Continental Shelf Associates, Inc. and Texas A&M 2001). The existing bottom currents
32 would also prevent the accumulation of large amounts of mud and cuttings. Documentation of
33 an exploratory well adjacent to hard-bottoms in the pinnacle trend at a depth of 103 m (338 ft),
34 15 months after drilling, showed cuttings and other debris covering an area of approximately
35 0.6 ha (1.5 ac) (Shinn et al. 1993), but the hard-bottom feature was still found to support a
36 diverse community, including gorgonians, sponges, ahermatypic stony corals, and antipatharians.
37 If turbidity and sediment deposition did result in extensive damage, existing studies suggest that
38 recovery could take years (Continental Shelf Associates, Inc. and Texas A&M 2001).

39
40 Pinnacles not detected may be subject to direct damage from construction activities and
41 discharges during site exploration and development. Previously undiscovered pinnacle features
42 are also protected by the Potentially Sensitive Biological Features component of NTL
43 No. 2009-G39. To minimize impacts on unmapped pinnacle features, the BOEM also supports
44 investigations through its Environmental Studies Program to locate hard- and live-bottom
45 features and to understand their ecologies (Continental Shelf Associates, Inc. and Texas A&M
46 University 2001). The BOEM updates regulations and mitigations based on the data from these

1 studies and from the biological interpretations of geophysical surveys, which reduces the risk of
2 accidental damage.

3
4 *Live-bottom (low-relief) features (CPA and EPA) and potentially sensitive biological*
5 *features.* NTL No. 2009-G39 and the Live-Bottom (Low-Relief) Stipulation pertains to seagrass
6 communities and low-relief hard-bottom reef within the GOM EPA blocks in water depths of
7 100 m (328 ft) or less and portions of Pensacola Area Blocks and Destin Dome Area Blocks in
8 the CPA. NTL No. 2009-G39 also covers potentially sensitive biological features, which are
9 features of moderate to high relief (about 2.4 m [8 ft] or higher) that provide habitat but are not
10 protected by a biological lease stipulation.

11
12 NTL No. 2009-G39 requires that no bottom-disturbing activities (including drilling,
13 platform placement, or the use of anchors, chains, cables, or wire ropes) may cause impacts on
14 live-bottoms (low-relief features) or potentially sensitive biological communities. It is also
15 required that any exploration or development activity planned within 30 m (100 ft) of either must
16 be reviewed by BOEM. If it is determined that these habitats might be adversely affected by the
17 proposed activity, then BOEM will require measures that may include, but are not limited to,
18 relocation of operations, shunting of all drilling fluids and cuttings to avoid live-bottom areas,
19 and monitoring to assess the adequacy of any mitigating measures. For further information on
20 the live-bottom (low-relief) area stipulation and the protections for potentially sensitive
21 biological features in the GOM, see NTL No. 2009-G39.

22
23 Overall, the protections in NTL No. 2009-G39 should minimize the potential for direct
24 disturbance to coral reefs and live-bottom habitat. However, sediment disturbance and the
25 discharge of drilling muds and cuttings in nearby areas could result in turbidity and
26 sedimentation around these features that could kill or inhibit respiration, filter feeding, and
27 photosynthesis by hard-bottom biota. Because of their generally shallow depth, low-relief
28 habitats are particularly vulnerable to turbidity and sedimentation. In addition, low-relief live-
29 bottom areas and potentially sensitive biological features not detected would be subject to direct
30 mechanical damage from site exploration and development activities. Thus, appropriately siting
31 discharge locations in pre-disturbance mitigation plans would be critical in minimizing the
32 effects of bottom disturbance and discharges. NTL No. 2009-G39 states that the developer must
33 provide a map showing the activity, structures, and maximum area of disturbance in relation to
34 the feature. Such mapping would minimize impacts on these habitats and minimize the chance
35 of disturbing as-yet-unmapped features.

36
37 Overall, impacts on coral reef and live-bottom habitat from exploration and site
38 development activities should be minimized by existing protections. However, low-relief or
39 small, isolated, unmapped live-bottom habitat could be affected by direct mechanical damage
40 and turbidity and sedimentation. Given the frequent natural bottom disturbance that occurs in
41 the GOM shelf, coral reef and live-bottom communities should be resistant to some extent to the
42 adverse physiological impacts from periodic sedimentation. Live-bottom and coral reef habitat
43 should recover, if they are adversely affected by exploration and site development activities.
44 Recovery could be short term to long term depending on the extent and nature of the impact,
45 species affected, and the suitability for recolonization of the habitat affected.

1 **Production.** Impacts on hard-bottom and coral reef habitat during the production phase
2 could result from miscellaneous discharges, the movement of vessel anchors and mooring
3 structures, produced water discharge, and the creation of artificial reef habitat (Table 4.4.6-3).
4 Turbidity and sedimentation generated by chronic movement of anchors could affect coral reefs
5 and hard-bottom habitat if they were located close enough to the disturbance. Impacts on coral
6 and hard-bottom habitat from bottom disturbance would be minimized by existing mitigation
7 measures.

8
9 Ninety-five percent of the 200 to 450 anticipated new production platforms would be
10 located on the continental shelf. Algae and sessile invertebrates would rapidly colonize the
11 platform and pipelines and would also attract mobile reef-oriented organisms. Thus, platforms
12 would provide new hard-bottom habitat for a variety of species. However, oil and gas
13 production platforms have been implicated in promoting the establishment of new species
14 through natural range expansion or by providing suitable habitat for introduced exotic species
15 (Sammarco et al. 2004; Page et al. 2006; Hickerson et al. 2008). Introduced species could
16 displace native species and in doing so alter the ecological function of existing hard-bottom and
17 coral habitat. For example, oil and gas platforms may have expedited the establishment of
18 several exotic species on the FGBNMS including sergeant majors (*Abudefduf saxatilis*),
19 yellowtail snapper (*Ocyurus chrysurus*), and orange cup coral (*Tubastraea coccinea*)
20 (Hickerson et al. 2008). It is likely that these species would have spread even without the
21 platforms, although the platforms may have expedited the process. If floating platforms with
22 moorings are used, organisms could colonize mooring structures. Thus the overall benthic
23 footprint may be small depending on the design. Also, in deep sea areas, most platforms and
24 mooring structures would likely be completely removed during decommissioning, so impacts, if
25 any, would be temporary.

26
27 Produced water discharges could introduce petroleum hydrocarbons and metals into hard-
28 bottom habitat. However, impacts would be minimized by discharge and toxicity limitations
29 imposed by NPDES permits, as well as restrictions that prevent the placement of oil and gas
30 platforms in the immediate vicinity of these habitats. In addition, the depth of many of the coral
31 reef and hard-bottom habitats, the prevailing current speeds, and the offsets of the discharges
32 from these habitats would substantially dilute produced waters before they could come in contact
33 with sensitive biological communities. As a result, the impact of produced water discharges is
34 expected to be minor.

35
36 **Decommissioning.** Coral reefs are not likely to be affected by platform removal because
37 of existing stipulations. Hard-bottom habitat could be adversely affected by explosive platform
38 removal (estimated 150 to 275), which could cause turbidity and sedimentation in nearby hard-
39 bottom habitat. Deposition of suspended sediments could smother and kill the filter-feeding
40 sessile animals that inhabit much of the hard-bottom habitat. Explosive impacts on large
41 topographic features covered by the No Activity Zone Stipulations would be minimized because
42 of their distance from the seafloor and the existing stipulations precluding the placement of
43 structures on or near these communities. However, hard-bottom features located closer to
44 production platforms may be more susceptible to damage. In the event that live-bottom areas
45 were affected during removal of existing platforms, recovery times would vary with damage and
46 species.

1 Pipelines on the surface of the seafloor that are left in place would continue to provide
2 hard substrate of structure-oriented organisms. In addition, many of the decommissioned
3 platforms will be converted into artificial reefs. By acting as stepping stones across the GOM,
4 oil platforms have been implicated in the introduction of a non-native coral species (*Tubastraea*
5 *coccinea*) and fishes such as sergeant majors (*Abudefduf saxatilis*) and yellowtail snapper
6 (*Ocyurus chrysurus*) into the FGB (Hickerson et al. 2008).
7

8 **Accidents.** Accidental spills in the CPA and WPA could affect hard-bottom and coral
9 reef habitat from south Texas to the west Florida shelf in the EPA. Accidental hydrocarbon
10 releases in marine habitat can occur at the surface or at the seafloor. Natural gas would quickly
11 rise above the sediment surface, which would minimize its impacts on benthic habitat, although
12 natural gas could temporarily reduce the habitat quality of high-relief benthic features. Natural
13 gas is also less persistent in the environment than oil. Evidence from the DWH event indicates
14 that methane gas released from the well was rapidly broken down by bacterial action with little
15 oxygen drawdown (Camilli et al. 2010; Kessler et al. 2011). Consequently, the remainder of the
16 discussion focuses on oil spills.
17

18 It is assumed that up to 8 large spills ($\geq 1,000$ bbl), up to 70 spills between 50 and
19 999 bbl, and up to 400 smaller spills between 1 and < 50 bbl could occur during the lease period
20 under the proposed action (Table 4.4.2-1). Most spills would be small and occur at the surface
21 from the platform or vessels or at the seafloor from pipeline leaks. Oil from surface spills can
22 sometimes penetrate the water column to documented depths of 20 m (66 ft) or more, which is
23 within the depth range of the crests of some coral reefs and topographic features including the
24 FGBNMS. However, at these depths, the concentrations of the various chemical components of
25 spilled oil are typically several orders of magnitude lower than those demonstrated to have an
26 effect on marine organisms (MMS 2008a). Therefore, it is likely that only low concentrations of
27 oil from surface spills would reach the sensitive benthic habitats (MMS 2008a). Small
28 subsurface spills could rise and come into contact with corals and hard-bottom habitat. Offshore
29 banks are less likely to be affected because of the No Activity Zone stipulation that would create
30 a large buffer between the banks and oil and gas development and production activities. A
31 buffer of only 30 m (98 ft) applies to most hard-bottom areas and therefore low-relief, hard-
32 bottoms could be contacted by small subsurface oil spills. However, because rapid dilution
33 would occur as spilled oil was transported by currents and rose toward the water surface,
34 subsurface oil spills would likely have to come into contact with a topographic feature almost
35 immediately to have detrimental effects on the associated community. Consequently, the risk of
36 a most accidental oil spills to these communities is relatively small.
37

38 **Catastrophic Discharge Event.** The PEIS analyzes a CDE up to 7.2 million bbl
39 (Table 4.4.2-2). A CDE oil spill from a pipeline rupture, a loss of well control, or a tanker
40 associated with a FPSO system could degrade coral reef and hard-bottom habitat if it came into
41 contact with large quantities of oil as it moved through the water column. Hydrocarbons have
42 been shown to have lethal and sublethal (reproduction, larval settlement, photosynthesis, and
43 feeding) effects on corals, although no effects on corals following oil spills are also frequently
44 reported (Loya and Rinkevich 1980; Bak 1987; Guzman et al. 1991; Dodge et al. 1995;
45 Haapkyla et al. 2007). Water currents moving around the banks would tend to carry oil around
46 the banks rather than directly over the features, thereby lessening the severity of the impact

1 (Rezak et al. 1983). Corals have the capacity to recover quickly from hydrocarbon exposure.
2 For example, Knap et al. (1985) found that when *Diploria strigosa*, a common massive brain
3 coral at the Flower Garden Banks, was dosed with oil, it rapidly exhibited sublethal effects but
4 also recovered quickly. However, larval stages of coral are far more sensitive than adults.
5 Therefore, the impact magnitude of a spill is partly dependent on whether the spill occurs during
6 a period of coral spawning.

7
8 If dispersants were used or if oil released from the wellhead had a high ratio of gas, a
9 subsurface hydrocarbon plume covering a large area could form, which would increase the
10 potential for contact with hard-bottom and coral reef habitat. The effect of chemically dispersed
11 oil on corals is equivocal, with some studies finding large effects of oil and dispersant mixtures
12 on corals and others finding only minor effects (Dodge et al. 1984; Wyers et al. 1986; Epstein
13 et al. 2000; Haapkvla et al. 2007; Shafir et al. 2007). If used, dispersants may slow the natural
14 breakdown of oil, resulting in persistent toxicity. In most cases, effects on sensitive biota would
15 be sublethal, with recovery occurring within months to a few years (MMS 2002a). For lethal
16 exposures, the community would likely recover once the area had been cleared of oil, although
17 full recovery could take many years (Haapkvla et al. 2007). Consequently, it is anticipated that
18 impacts of lethal concentrations of oil reaching coral reef or hard-bottom habitat would be long
19 term but temporary.

20 21 **Deepwater Corals and Chemosynthetic Communities.**

22 23 ***Routine Operations.***

24
25 Exploration and Site Development. In the GOM, both deepwater coral and
26 chemosynthetic communities are currently protected under NTL No. 2009-G40 (available at
27 <http://www.gomr.boemre.gov/homepg/regulate/regs/netls/2009NTLs/09-G40.pdf>), which covers
28 all high-density deepwater communities (HDDC) in depths 300 m (984 ft) or greater. Impacts on
29 deepwater corals and chemosynthetic communities (HDDC) from exploration and site
30 development could potentially occur during platform and pipeline placement, the discharge of
31 drilling muds and cuttings, and miscellaneous discharges (Table 4.4.6-3). NTL No. 2009-G40
32 (MMS 2010b) currently prohibits the discharge of drilling muds and cuttings within 610 m
33 (2,000 ft) of HDDC. In addition, NTL No. 2009-G40 requires that all proposed seafloor
34 disturbances (including those caused by anchors, anchor chains, wire ropes, seafloor template
35 installation, and pipeline construction) must be maintained at a distance of at least 76 m (250 ft)
36 from HDDC habitat. In addition, any seafloor disturbances planned within 152 m (500 ft) of a
37 high-density deepwater coral community must be reviewed and approved by BOEM, and the
38 developer must demonstrate that the communities will not be adversely affected by exploration
39 or site development. It is assumed that BOEM will continue to require and implement these
40 measures at the lease sale phase. While these requirements and procedures are believed to be
41 effective in identifying and avoiding most HDDC, it is possible that some unmapped or lower
42 density communities could be mechanically damaged. In addition, despite the 76-m (250-ft)
43 buffer, turbidity and sedimentation created by ground-disturbing activities could contact HDDC
44 habitats. Although data are limited, studies in the GOM indicate that *Lophelia* corals are
45 generally tolerant of turbidity and sedimentation, but at high enough levels suspended sediments
46 can have lethal and sublethal effects (Brooke et al. 2009). Sediment could clog filtering organs,

1 thereby inhibiting food intake and increasing metabolic costs associated with sediment removal.
2 Chronic bottom disturbance by drilling platform moorings could be particularly large in the deep
3 ocean depending on the technology employed. Impacts from pipeline placement barges could be
4 minimized by the use of dynamic positioning when possible. An FPSO system may be
5 employed for deepwater wells. Under the FPSO system, oil would be transported from the well
6 to a surface vessel and ultimately to shore. By eliminating the need for pipelines, an FPSO
7 system would greatly reduce bottom disturbance and the chance for disturbing HDDC.
8

9 It is estimated that less than 1% of the deepwater GOM is occupied by features or areas
10 that could support HDDC (NTL No. 2009-G40). HDDC are spread throughout the deep areas of
11 the northern GOM (Figure 3.7.2-2 and Figure 3.7.2-3), which makes it unlikely that the damage
12 to small areas of the bottom would threaten this resource as a whole. The BOEM Environmental
13 Studies Program funds research to locate and understand the ecology of chemosynthetic
14 communities. The BOEM updates regulations and mitigations based on the data from studies
15 and from the biological interpretations of geophysical surveys, and this reduces the risk of
16 accidental damage. If affected by exploration and site development activities, HDDC could be
17 repopulated from nearby undisturbed areas, although the rate of recovery could be slow or
18 nonexistent, particularly for chemosynthetic communities (MacDonald 2000). Recent studies
19 have shown that chemosynthetic communities can be dynamic and that changes in species
20 composition and colonization rates can operate on the order of years to decades
21 (Lessard-Pilon et al. 2010). This suggests chemosynthetic communities could begin recovery
22 relatively quickly if adversely affected by oil and gas activities, although full recovery would
23 take much longer.
24

25 Miscellaneous discharges would occur at the surface and are not expected to reach
26 HDDC. HDDC communities are also not likely to be buried or stressed by drilling muds and
27 cuttings because NTL No. 2009-G40 (MMS 2010b) prohibits their discharge within 610 m
28 (2,000 ft) of HDDC. Also, drilling muds and cutting would typically be discharged at the
29 surface, and the depth of most HDDC communities make it unlikely that drilling muds and
30 cuttings would be deposited in thick layers capable of adversely affecting these habitats.
31

32 Overall, impacts on HDDC from exploration and site development activities are expected
33 to be minimal because of the provisions in place to protect HDDC and the review required for all
34 drilling plans in water deeper than 300 m (984 ft). The likelihood of the undetected communities
35 is greatly reduced through continuing improvements in the use of remote sensing data and
36 groundtruthing. However, small and unmapped HDDC may be completely or partially destroyed
37 by bottom-disturbing activities. In such cases, recovery would likely be long term, although
38 permanent loss of the affected feature is also possible.
39

40 Production. Impacts on HDDC from routine operations could result from production
41 platform placement; operational noise; miscellaneous discharges; the movement of anchors and
42 chains, and the releases of process water (Table 4.4.6-3). In addition, the platform, pipelines,
43 and mooring structure will create new artificial reef habitat. A general discussion of these
44 impacts can be found in the soft sediments section above.
45

1 Impacts from bottom disturbing activities would be similar to those discussed above in
2 the exploration and site development phase. The direct effects of production noise, platform
3 placement, and anchor and chain damage on HDDC would be minimized by the 76-m (250-ft)
4 buffer required between HDDC and ground-disturbing activities, although turbidity plumes
5 resulting from those activities could reach HDDC. Impacts from produced water discharge
6 should also be minimal, given the NPDES requirements and the distance of HDDC from the
7 surface where produced water will likely be discharged. Cold water coral species may colonize
8 the well, pipeline, and platform structures relatively quickly (Gass and Roberts 2005), although
9 growth in the GOM appears to be slower than in other areas (Brooke and Young 2009). Over
10 time, petroleum structures may become an artificial reef functioning in a manner similar to
11 existing coral habitat. Colonization could benefit cold water corals by increasing suitable habitat
12 and improving gene flow among populations (Macreadie et al. 2011). The artificial reef would
13 only exist during the production phase, except in the cases where pipelines remain on the seabed
14 and if tension leg platform templates are allowed to remain on the seabed. There is also possible
15 decommissioning options including leaving portions of deepwater platforms in place.

16
17 There is evidence from California that oil and gas extraction reduces the natural release
18 of hydrocarbons that support deep-sea chemosynthetic communities (Quigley et al. 1999).
19 However, there is no evidence for this in the GOM. More research may be needed, but oil and
20 gas operations are not likely to remove enough hydrocarbons to affect seep communities, given
21 the volume of the overall resource. Unlike chemosynthetic communities, *Lophelia* corals do not
22 depend on hydrocarbon seepage to meet their metabolic requirements (Becker et al. 2009) and
23 presumably would not be affected.

24
25 Overall, impacts on HDDC from routine operations are expected to be minimal.
26 However, small and unmapped HDDC may suffer major impacts.

27
28 **Decommissioning.** Explosive platform removals would not occur because floating
29 platforms would be used in the deep sea. The removal of anchors and chains could affect nearby
30 HDDC by suspending sediments in the water column as described above. Restrictions that
31 prevent oil and gas extraction activities on or near HDDC would reduce the impacts of sediment
32 disturbance. In the event that HDDC were affected during removal of existing platforms,
33 recovery times would vary with the species affected and the extent and nature of the damage.
34 Cold water corals are likely to recover much more rapidly than chemosynthetic communities.
35 Overall, the effects of decommissioning on HDDC should be negligible.

36
37 **Accidents.** It is assumed that up to 8 large spills ($\geq 1,000$ bbl), up to 70 spills between
38 50 and 999 bbl, and up to 400 smaller spills between 1 and <50 bbl could occur during the lease
39 period under the proposed action (Table 4.4.2-1). Most accidental spills would be small releases
40 at the surface that are not expected to reach waters deep enough to contact HDDC. Much of the
41 impact magnitude depends on the location of the spill, the direction of bottom currents, and the
42 amount of oil released. The impact of a small pipeline leak would also be reduced by the
43 requirement that pipelines be located 76 m (250 ft) away from HDDC habitats. Much of the
44 impact magnitude depends on the location of the spill, the direction of bottom currents, and the
45 amount of oil released. Oil from accidental releases would be dispersed by currents, rapidly

1 broken down by natural chemical and microbial processes, and would rise in the water column,
2 thereby limiting the extent of HDDC habitat that would be affected by any given spill.

3
4 **Catastrophic Discharge Event.** The PEIS analyzes a CDE up to 7.2 million bbl
5 (Table 4.4.2-2). A CDE resulting from pipeline ruptures, tanker spills, and a loss of well control
6 would cause high turbidity and sedimentation and the potential release of large quantities of oil.
7 A loss of well control or pipeline rupture in deep water would be particularly difficult to repair,
8 given the tremendous depth. Although petroleum hydrocarbons serve as a nutrient source for
9 symbiotic microorganisms associated with chemosynthetic communities, hydrocarbon toxicity
10 and the partial or complete destruction of the habitat could occur if a large concentration of oil
11 were to contact chemosynthetic communities. Similarly, oil covering deepwater corals could kill
12 all or part of the community or cause sublethal physiological and reproductive effects. Oil
13 typically rises to the surface over the release site. However, if dispersants are used in the
14 subsurface or if the released oil has a significant fraction of gas, a subsurface plume may form
15 that would increase the potential for contact with a HDDC habitat. A subsurface plume 200 m
16 (656 ft) high and 2 km (1.2 mi) wide was found at a 1,000 m (3,280 ft) depth for a distance of
17 35 km (22 mi) from the DWH site (Camilli et al. 2010). Whether there is a synergistic toxicity
18 from dispersants and oil mixtures for chemosynthetic communities or deepwater corals is not
19 known. There is evidence that oil released from the DWH event was mixed with dispersant
20 (Kujawinski et al. 2011) and may have killed deepwater corals located 11 km (7 mi) from the
21 well (see <http://www.boemre.gov/ooc/press/2010/press1104a.htm>). Certain organismal
22 components of chemosynthetic HDDC are slow-growing, and if damaged, recovery would be
23 long term (potentially hundreds of years), if they recover at all. Recent studies have shown that
24 seep communities can be dynamic and that changes in species composition and colonization
25 rates can operate on the order of years to decades (Lessard-Pilon et al. 2010). This suggests
26 chemosynthetic communities could begin recovery relatively quickly if adversely affected by oil
27 and gas activities, although full recovery would take much longer.

30 **4.4.6.2.2 Alaska – Cook Inlet.**

32 **Routine Operations.**

33
34 **Exploration and Site Development.** Impacting factors for the exploration and site
35 development phase are shown in Table 4.4.6-4. Noise from seismic surveys and drilling could
36 kill or injure organisms close enough to the noise source and reduce habitat suitability, because
37 some species would avoid the area. The severity and duration of noise would vary with site and
38 development scenario, but overall the impacts would be temporary and localized with overall
39 minimal effects on benthic habitat. See Section 4.4.7 for detailed discussions of the effects of
40 noise on different categories of biota.

41
42 Drilling exploratory wells would temporarily reduce habitat quality by generating
43 turbidity and sedimentation for some distance around the disturbed area. It is estimated that 4 to
44 12 exploration wells and 42 to 114 production wells will be drilled in the Cook Inlet Planning
45 Area. Exploration would use jack-up rigs and gravity rigs in water up to 46 m (150 ft), while

1 **TABLE 4.4.6-4 Impacting Factors by Phase and Potential Effects on Marine Benthic Habitat in the**
2 **Cook Inlet Planning Area**

Impacting Factor	Potential Effects ^a
<i>Exploration and Site Development</i>	
Seismic surveys	Noise; localized anchoring disturbance
Anchoring and mooring of platforms, drillships, and seismic survey vessels	Sediment scour; temporary turbidity and sedimentation; localized alteration in sediment grain size and biogeochemical functions
Drilling and production platform placement	Noise; temporary sediment resuspension and turbidity; loss of natural habitat creation of artificial reef;
Drilling	Noise; small habitat loss; local alteration of sediment characteristics; temporary turbidity and sedimentation in surrounding areas
Miscellaneous discharges (deck washing, sanitary waste, vessel discharges)	Sediment contamination
Solid wastes	Sediment contamination
Discharge of drilling muds/cuttings	Sediment and water column contamination; alteration in sediment granulometry and biogeochemical functions
Pipeline trenching and placement	Noise; long-term loss and degradation of existing benthic habitat; temporary sediment resuspension and turbidity
<i>Production</i>	
Scour from anchors and the movement of pipelines and mooring structures	Chronic long-term disturbance of bottom sediments; turbidity
Platform production	Noise; loss of natural habitat creation of artificial reef
Produced water	Sediment contamination
Miscellaneous discharges	Sediment contamination
Solid wastes and debris	Sediment contamination
<i>Decommissioning</i>	
Miscellaneous discharge	Sediment contamination
Solid wastes and debris	Sediment contamination
Platform removal	Temporary turbidity and disturbance of bottom sediments

^a Colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

3
4
5 drilling ships or semisubmersible or floating drilling rigs would be used in deeper water. One to
6 three production platforms may be installed under the proposed action. Production operations
7 will most likely be carried out from fixed platforms. The installation of floating or fixed
8 platforms would eliminate soft sediment where the legs or mooring structures (anchors and
9 chains) encountered the seabed and where subsea equipment (such as reentry collars and blowout
10 preventers) was installed. Chronic local bottom disturbance could result from subsequent
11 movements of anchors and mooring lines associated with floating drilling platforms and support
12 vessels. Because these types of drilling rigs affect only small areas of the bottom, the
13 disturbance to benthic habitat would be minor.
14

1 Under the proposed action, it is estimated that 80 to 241 km (50 to 150 mi) of offshore
2 pipeline may be placed in the Cook Inlet Planning Area, resulting in disturbance of up to 210 ha
3 (519 ac) of seafloor in Cook Inlet. Pipelines would be trenched or installed and anchored on the
4 sediment surface, which would temporarily disturb a large area of benthic habitat by generating
5 turbidity and sedimentation. Placing the pipeline on the sediment surface would result in
6 permanent loss of soft sediment habitat. Vessel anchoring during pipeline placement would also
7 disturb soft sediment. It is anticipated that pipeline placement would displace benthic
8 communities and temporarily alter grain size in areas of the seafloor with soft sediments. Cook
9 Inlet waters are naturally high in suspended sediments, and analyses conducted for pipeline
10 construction for previous lease sales indicated that turbidity from pipeline construction was
11 expected to be within the natural range of turbidities for Cook Inlet (MMS 2003a).
12

13 It is assumed that drilling muds and cutting would be discharged into Cook Inlet for
14 exploration wells only. Drilling wastes from development and production wells would be
15 reinjected into the wells. Drill cuttings and drilling muds (including synthetic drilling fluids
16 adhering to the cuttings) could contaminate and alter the sediments immediately around the
17 wellhead and below the area where drilling wastes are discharged. Drill cuttings and muds
18 rapidly reach the sediment surface and could be deposited in highly concentrated thick layers if
19 deposited in shallow water or near the sediment surface. In the case of near-surface discharge in
20 deep water, drilling muds would spread out in a thin veneer over a wide area. Settled muds
21 could cause smothering of organisms, local hypoxia, changes in sediment characteristics and
22 biogeochemical functions, and the loss of food resources in the immediate area. Although such
23 releases could result in temporary impacts, the amount of discharge would be small compared to
24 the more than 44 million tons of suspended sediment carried annually into Cook Inlet by runoff
25 from area rivers (Brabets et al. 1999). The currents in lower Cook Inlet are likely strong enough
26 to prevent the accumulation of muds and cuttings on the bottom; therefore, benthic habitats
27 affected by drilling discharges would recover their natural grain size. In addition, the discharge
28 of these drilling wastes is regulated by the USEPA under NPDES permits and can be discharged
29 into the ocean only if they meet USEPA toxicity and discharge rate requirements. These
30 requirements greatly reduce the potential for sediment contamination. A study of sediment
31 quality in depositional areas of Shelikof Strait and Cook Inlet in 1997–1998 found that the
32 concentrations of metals and polyaromatic hydrocarbons in sediments (1) posed no significant
33 risk to benthic biota or fish and (2) were not linked to oil and gas development in upper Cook
34 Inlet (MMS 2001a). Consequently, degradation of benthic habitat in Cook Inlet from drilling
35 waste is not expected.
36

37 Other miscellaneous discharges (deck washing, sanitary waste, and vessel discharge) also
38 have the potential to degrade benthic habitats. Miscellaneous discharges could contaminate
39 sediments if discharged in relatively shallow water. However, considering the high flow rate of
40 Cook Inlet, contaminants in surface discharges would most likely be diluted to negligible
41 concentrations before reaching the sediment (MMS 2003a). Many vessel and platform wastes
42 are disposed of on land, and those that are discharge at sea must meet USEPA and/or USCG
43 regulatory requirements that limit their environmental effects.
44

1 Overall, activities conducted during the exploration and site development phase are
2 expected to have minor to moderate effects on benthic habitat. Recovery of benthic habitat could
3 range from short term to long term.
4

5 **Production.** Production activities that could affect soft sediment habitat are shown in
6 Table 4.4.6-4 and include operational noise; miscellaneous discharges; bottom disturbance from
7 the movement of anchors and mooring structures, and releases of process water. In addition, the
8 platform would replace existing featureless soft sediments and serve as an artificial reef. The
9 potential impacts of miscellaneous discharges would continue on from the exploration and
10 development phase and are described above. Impacts on soft sediment habitats from vessel and
11 operational noise are expected to be negligible but long term, with the impacts lasting the
12 duration of the production phase.
13

14 Chronic bottom disturbance from the movement of anchors and chains associated with
15 support vessels would affect soft sediment habitats as described above for the exploration and
16 site development phase. Production platforms will most likely be fixed structures, but benthic
17 disturbance from the movement of mooring anchors is possible if floating production platforms
18 are used. The movement of pipelines following severe storms could be a long-term chronic
19 disturbance to benthic habitat causing scour, turbidity, and sedimentation of soft sediment
20 habitats. However, pipelines would either be anchored securely or trenched which would
21 minimize the potential for bottom disturbance.
22

23 The platform structure would also create novel hard substrate, and the area on and
24 immediately around the platform may have very different habitat functions and biological
25 communities compared to the preconstruction period. Algae and sessile invertebrates could
26 attach to the platform and in turn attract reef-oriented organisms. Sediments grain size, benthic
27 communities, and biogeochemical processes in sediments around the platform could be altered
28 by the flux of biogenic material (e.g., organic matter and shell material) from the platform to the
29 seafloor.
30

31 Produced water can contain hydrocarbons, salts, and metals at levels toxic to marine
32 organisms. Before being discharged into the ocean, produced water is typically treated and must
33 meet NPDES requirements regarding discharge rate, contaminant concentration, and toxicity,
34 thereby reducing the potential for sediment contamination. Under the proposed action, it is
35 assumed that all produced waters would be treated and reinjected into the disposal well.
36 Therefore, no impacts on pelagic habitat are expected to result from produced water.
37

38 Overall, activities conducted during the production phase are expected to have minor
39 effects on benthic habitat on a regional scale. Platforms would alter benthic habitat on a local
40 scale.
41

42 **Decommissioning.** Platform removal activities would result in loss of the platforms reef
43 function, bottom disturbance, and a temporary increase in turbidity and sedimentation
44 (Table 4.4.6-4). Over time, most sediments will recover their normal physical characteristics,
45 ecological functions, and biological communities. No explosives would be used during platform

1 removal. Pipelines installed and anchored on the seafloor would be capped and left in place,
2 although there is the potential for chronic sediment disturbance from pipeline movement.

3
4 Overall, impacts on benthic habitat associated with removal of platforms are expected to
5 be negligible.

6
7 **Accidents.** It is assumed that 1 to 3 small spills between 50 and 999 bbl and 7 to
8 15 smaller spills between 1 and <50 bbl, and large spills ($\geq 1,000$ bbl) could occur under the
9 proposed action (Table 4.4.2-1). Much of the impact magnitude depends on the location of the
10 spill, the direction of bottom currents, and the amount of oil released. Oil from accidental
11 releases would be dispersed by currents, rapidly broken down by natural chemical and microbial
12 processes, and would rise in the water column, thereby limiting the extent of benthic habitat that
13 would be affected by any given spill. A few of these spills might be large enough and persist
14 long enough to drift to shore where they could contaminate benthic habitat. However, it is
15 anticipated that only a small amount of shoreline would be affected by these spills and they
16 would not, therefore, present a substantial risk to the overall resource. The benthic habitat would
17 recover without mitigation because of natural breakdown of the oil, sediment movement by
18 currents, and reworking by benthic fauna.

19
20 Oil spill-response activities such as burning, skimming, and chemical release
21 (e.g., dispersants or coagulants) could affect benthic habitat and biota. Skimming and burning
22 could kill pelagic live stages of benthic biota. The chemicals used during a spill response are
23 toxic, but there is controversy about whether the combination of oil and dispersant is more toxic
24 than oil alone (NRC 2005b; Fingas 2008; Holland-Bartels and Kolak 2011). The use of
25 dispersant would likely reduce oiling of nearshore benthic habitat but may increase the exposure
26 of subtidal benthic habitat and biota to toxic fractions of oil (NRC 2005b). In shallow water, the
27 presence of, and noise generated by, oil spill-response equipment and support vessels could
28 temporarily disturb benthic habitat in the vicinity of the response action, potentially reducing
29 habitat use or disturbing migration. As with the spill itself, the location and time of the year the
30 cleanup occurs would be an important determinant of impacts to benthic habitat and biota.

31
32 **Catastrophic Discharge Event.** The PEIS analyzes a CDE of 75,000 to 125,000 bbl. In
33 the case of a CDE, the likelihood of oil contacting shoreline benthic habitat and biota is
34 relatively high because the Cook Inlet Planning Area is located within a confined estuary. Oil
35 reaching intertidal benthic habitat would likely be drawn below the sediment surface by capillary
36 action. Subsurface oil is more persistent because it is spread throughout a matrix of sediment
37 types and is less subject to physical weathering from sunlight and wave action (Taylor and
38 Reimer 2008). Decades after the *Exxon Valdez* spill, highly weathered, asphalt-like or tar
39 deposits may still be present beneath the surface of intertidal sediments of Prince William Sound,
40 especially in the intertidal zone of low-energy, protected, unexposed bays and beaches with
41 boulder/cobble or pebble/gravel sediments (Short et al. 2007; Taylor and Reimer 2008; *Exxon*
42 *Valdez* Oil Spill Trustee Council 2010c). NOAA reported that 97 metric tons (tonnes) (107 tons)
43 of oil may still be present in subsurface sediments in discontinuous patches, although this is only
44 a small fraction of the >20,000 metric tons of oil initially deposited on beaches. After a initial
45 rapid decline of 68% per year during 1991–1992, the oil is currently decreasing in concentration
46 at a rate of 0–4% per year (NOAA 2010d; Short et al. 2007). Overall, studies of the *Exxon*

1 *Valdez* spill indicate that a catastrophic spill could result in long-term degradation of benthic
2 habitat and sublethal effects on benthic biota. As of 2010, intertidal sediments and communities
3 are considered to still be recovering from the *Exxon Valdez* spill (*Exxon Valdez* Oil Spill Trustee
4 Council 2010c).

5
6 Following the *Exxon Valdez* oil spill in 1989, highly elevated hydrocarbon concentrations
7 in intertidal sediments were found at heavily oiled sites followed by an apparent migration of the
8 oil into the shallow subtidal zone in 1991 (Wolfe et al. 1993). Oil in the intertidal and subtidal
9 zones can affect not only lower trophic-level organisms but also higher trophic-level organisms,
10 such as marine and coastal birds (Section 4.4.7.2.2) and fish (Section 4.4.7.3.2;
11 Peterson et al. 2003). However, subtidal sediment may be less likely to suffer long-term
12 contamination because oil tends to float and natural weathering, bottom scour, and depositional
13 processes would reduce the oil concentration in the sediment. Biological impacts on subtidal
14 biota are also typically short term (Lee and Page 1997). Oiled subtidal sediments were detected
15 shortly after the *Exxon Valdez* spill, but not in follow-up studies conducted in 2001, and subtidal
16 sediment concentrations of oil are much lower than concentrations in intertidal sediments (Lee
17 and Page 1997). Subtidal habitat and communities are considered to be very likely recovered by
18 the *Exxon Valdez* Oil Spill Trustee Council (2010c).

19
20 Broken ice occurs in the northern and western portions of lower Cook Inlet during fall
21 and winter. If an open water spill were to occur at this time, the ice would contain the oil
22 somewhat and reduce spreading and contacting intertidal benthic habitat. However, oil cleanup
23 is also more difficult in broken ice conditions. Oil from spills occurring in the winter may be
24 trapped under ice, resulting in localized, persistent degradation of habitat quality and ecosystem
25 function.

26 27 28 **4.4.6.2.3 Alaska – Arctic.**

29 30 **Routine Operations.**

31
32 ***Exploration and Site Development.*** Impacting factors for the exploration and site
33 development phase relevant to seafloor habitat are shown in Table 4.4.6-5. It is assumed that oil
34 and gas development activity would be restricted to waters less than 91 m (300 ft). Exploration
35 drilling would employ gravel islands or mobile platforms in waters between 6 to 18 m (20 and
36 60 ft) in depth and drillships in deeper water. Production operations will be conducted from
37 subsea wells, gravel islands, or gravity-based platforms in water less than 12 m (40 ft) in depth,
38 and from larger gravity-based platforms in deeper waters. It is assumed that as many as
39 92 subsea production wells and 9 artificial islands could be constructed during the lease period
40 with a footprint of approximately 1.5 ha (4 ac) per platform or island. Under the proposed
41 action, it is estimated that 89 to 652 km (55 to 405 mi) of new offshore pipeline would be placed
42 in the Beaufort and Chukchi Sea Planning Areas, resulting in disturbance to 77 to 567 ha (190 to
43 1,402 ac) of seafloor.

44
45 Drilling, platform and pipeline placement, and construction and maintenance of artificial
46 islands have the potential to reduce benthic habitat quality by disturbing the seafloor and

1 **TABLE 4.4.6-5 Impacting Factors by Phase and Potential Effects on Marine Benthic Habitat in the**
2 **Beaufort and Chukchi Sea Planning Areas**

Impacting Factor	Potential Effects ^a
<i>Exploration and Site Development</i>	
Vessel traffic	Noise
Seismic surveys	Noise; localized anchoring disturbance
Anchoring and mooring of platforms, drillships, and seismic survey vessels	Sediment scour; temporary turbidity and sedimentation; localized alteration in sediment grain size and biogeochemical functions
Drilling and subsea well and production platform placement (including artificial islands)	Noise; temporary sediment resuspension and turbidity; loss of natural habitat creation of artificial reef; loss of benthic habitat due to artificial islands
Drilling	Noise; small habitat loss; local alteration of sediment characteristics; temporary turbidity and sedimentation in surrounding areas
Miscellaneous discharges (deck washing; sanitary waste, vessel discharges)	Sediment contamination
Solid wastes	Sediment contamination
Discharges of drilling muds/cuttings	Sediment and water column contamination; alteration in sediment grain size and biogeochemical functions
Pipeline trenching and placement	Noise; long-term loss and degradation of existing benthic habitat; temporary sediment resuspension and turbidity
<i>Production</i>	
Scour from anchors and the movement of pipelines and mooring structures	Chronic, long-term disturbance of bottom sediments; turbidity
Platform production	Noise; loss of natural habitat creation of artificial reef
Produced water	Sediment contamination
Miscellaneous discharges	Sediment contamination
Solid wastes and debris	Sediment contamination
<i>Decommissioning</i>	
Miscellaneous discharge	Sediment contamination
Solid wastes and debris	Sediment contamination
Platform removal	Temporary turbidity and disturbance of bottom sediments

^a Colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

3
4
5 generating noise, turbidity, and sedimentation for some distance around the disturbed area and
6 potentially adversely affecting benthic biota. Such activities could reduce benthic habitat quality
7 by displacing benthic organisms and interrupting the movement and dispersal of species of all
8 life stages. Chronic bottom disturbance would result from movements of anchors associated
9 with floating drilling vessels and support vessels. The installation of platforms would eliminate
10 soft sediment where the platform and mooring structures (anchors and chains) encountered the
11 seabed and where subsea equipment (such as reentry collars and blowout preventers) was
12 installed and depending on location, habitat loss for benthic feeders could be important. The
13 area of burial around constructed islands could increase over time because of erosion from storm
14 action and ice gouging on island slopes. The construction of subsea wells and gravel islands

1 would eliminate soft sediment habitat, but the total bottom area that could be disturbed would be
2 relatively small compared to the overall area of benthic habitat available in the Beaufort and
3 Chukchi Sea Planning Areas.

4
5 Pipelines would be buried in waters less than 50 m (156 ft) to prevent damage from ice
6 gouges, and pipelines in deeper water would be installed and anchored on the seafloor. Pipelines
7 installed and anchored on the seafloor would replace natural soft sediment habitat with hard-
8 bottoms, which would alter species composition and biogeochemical habitat function. For
9 buried pipelines, benthic organisms within the trenched corridor would be killed or injured, and
10 organisms to either side of the pipeline would be buried by sediments. Disturbed sediments with
11 a greater proportion of sand to mud may fill in with fine, silty material that would alter grain size
12 and potentially inhibit the colonization by species that existed prior to the disturbance. The
13 recovery period for soft sediment benthic habitat affected by bottom disturbance would depend
14 on factors such as water depth, sediment type, and community composition. In the Arctic, the
15 benthic community in these areas experiences a naturally high amount of disturbances from ice
16 gouging, strudel scour, and severe storms, and hyposaline and highly turbid conditions occur
17 naturally during spring breakup. Therefore, seafloor biota in the Beaufort and Chukchi Seas may
18 be adapted to such conditions. Turbidity plumes from construction activities under the proposed
19 action would be temporary and disturbed areas would probably be recolonized within a few years
20 (Woodward-Clyde Consultants 1996), although recovery could take more than a decade (Conlan
21 and Kvitek 2005).

22
23 Increased water turbidity and sedimentation from ground-disturbing activities discussed
24 above could directly affect kelp growth by burying kelps and other organisms, altering the
25 optical properties of the water column, and limiting photosynthesis (Maffione 2000;
26 Dunton et al. 2009). It is estimated that kelp contributes 50–56% of annual productivity in the
27 Boulder Patch and is an important source of organic matter that supports various members of the
28 epilithic community (Dunton 1984). Overall, measurements have indicated natural inputs of
29 suspended sediment from runoff and erosion are large relative to any anthropogenic inputs of
30 sediment (Trefry et al. 2004). Therefore, unless activities are located in the immediate vicinity
31 of the Boulder Patch, the proposed action is not expected to substantially increase turbidity or
32 sedimentation on the Boulder Patch. Planning and permitting procedures and requirements will
33 likely be sufficient to avoid such occurrences. Under current regulations, proposed development
34 near the Boulder Patch area requires detailed surveys to identify the boundaries of the Boulder
35 Patch habitat, and the expected levels of impacts from proposed activities must be identified,
36 which will likely be sufficient to minimize impacts from pipeline construction within the
37 Boulder Patch area. However, the construction of offshore pipelines could affect kelp habitat
38 area outside of the Boulder Patch. Recovery would be slow if kelp communities were
39 mechanically damaged by drilling or anchor and chain scour. It is estimated that recovery of
40 kelp growth in areas trenched for pipeline construction could occur within a decade in some
41 cases or could be much longer depending on the proportion of hard substrate exposed after
42 pipeline construction was completed (Konar 2006). Although habitat loss may be minor when
43 compared to the large size of the Arctic Planning Areas, even small habitat loss can be
44 significant to specific populations depending on where it occurs. Overall, moderate but
45 temporary impacts on seafloor habitat are expected to result from pipeline placement.

1 It is assumed that drilling muds and cutting would be discharged into the Beaufort and
2 Chukchi Sea Planning Areas for exploration wells only. Drilling wastes from development and
3 production wells would be reinjected into the wells. Drill cuttings and drilling muds (including
4 synthetic drilling fluids adhering to the cuttings) could contaminate and alter the grain size of
5 sediments immediately around the wellhead and below the area where these drilling wastes are
6 discharged. Drill cuttings and muds rapidly reach the sediment surface and could be deposited in
7 highly concentrated thick layers if deposited in shallow water or near the sediment surface. In
8 the case of near-surface discharge in deep water, drilling muds would spread out in a thin veneer
9 over a wide area. Settled muds could cause smothering of organisms, local hypoxia, changes in
10 sediment characteristics and biogeochemical functions, and the loss of food resources in the
11 immediate area. Arctic sediments are constantly changing in grain size (Neff & Associates
12 LLC 2010) due to natural disturbances. Thus, after they reach the sediment, discharged muds
13 and cuttings are likely over time to be redistributed over a broad area. Although such releases
14 could result in temporary, localized increases in sediment load and deposition, this amount of
15 discharge would be small compared to the more than 6.35 million tons of suspended sediment
16 carried annually into the Beaufort Sea alone by runoff from area rivers (Neff and Associates
17 LLC 2010). In addition, drilling muds or cuttings that are discharged into the ocean are
18 regulated by the USEPA under NPDES permits and can be discharged into the ocean only if they
19 meet USEPA toxicity and discharge rate requirements. These requirements greatly reduce the
20 potential for sediment contamination. Discharges of drilling wastes in the vicinity of the
21 Steffansson Sound Boulder Patch are regulated under NPDES Permit Number AKG280000.
22 Consequently, there should be minimal impacts on Boulder Patch habitat from drilling wastes.
23 Therefore, the impacts from drilling waste discharges are expected to be minor.

24
25 Miscellaneous discharges (deck washing, sanitary waste, and vessel discharge) also have
26 the potential to degrade seafloor habitats. Miscellaneous discharges could contaminate
27 sediments if discharged in relatively shallow water. However, many vessel and platform wastes
28 are disposed of on land, and those that are discharged at sea must meet USEPA and/or USCG
29 regulatory requirements that limit their environmental effects. In addition, stratification of the
30 water column prevents diffusion of chemicals to bottom layers in many areas.

31
32 Noise from seismic surveys and drilling could kill or injure organisms close enough to
33 the noise source and reduce habitat suitability as some species would avoid the area. The
34 severity and duration of noise would vary with site and development scenarios, but the impacts
35 would be temporary and localized with overall minimal effects on soft sediment habitat. See
36 Section 4.4.7 for detailed discussions of the effects of noise on different categories of biota.

37
38 Overall, activities conducted during the exploration and site development phase are
39 expected to have minor to moderate effects on seafloor habitat on a planning area scale.
40 Recovery of seafloor habitat could range from short-term (months) to long-term (decades).

41
42 **Production.** Production activities that could affect soft sediment habitat are shown in
43 Table 4.4.6-5. The potential impacts of miscellaneous discharges would continue on from the
44 exploration and development phase and are described above. Impacts on soft sediment habitats
45 from vessel and operational noise are expected to be negligible but long term, with the impacts
46 lasting the duration of the production phase. Chronic bottom disturbance from the movement of

1 anchors and chains associated with support vessels would affect soft sediment habitats as
2 described above for the exploration and site development phase. These disturbances would be
3 long term and chronic and cause scour, turbidity, and sedimentation of soft sediment habitats.
4

5 Platforms and gravel islands would provide additional habitat for marine plants and
6 animals (e.g., kelp and mussels) that require a hard substrate. Therefore, the overall probable
7 effect of platform placement and island construction would be to alter local species composition.
8 In addition, sediment grain size and biogeochemical processes around the platform would be
9 altered by the flux of biogenic material (shell and organic matter) from the platform to the
10 seafloor. Data from other hard-bottom habitats suggest colonization would be slow and seasonal
11 ice cover may restrict colonization to short-lived opportunistic species. Any artificial reef
12 function the platform does serve would exist only during the production phase, so impacts, if
13 any, would be temporary but lasting decades. However, gravel islands would remain in place.
14 The islands may eventually erode and form a subsea gravel bed that would provide habitat to
15 species attracted to hard substrate.
16

17 Produced water is a normal product of oil and gas extraction that contains contaminants
18 such as polycyclic aromatic hydrocarbons and heavy metals and therefore represents a potential
19 source of contamination to benthic habitats. It is assumed that all produced water will be
20 disposed of onshore or reinjected into the well rather than discharged into the ocean. If produced
21 water is discharged into the ocean, it is typically treated and must meet NPDES requirements
22 regarding discharge rate, contaminant concentration, and toxicity, thereby reducing the potential
23 for sediment contamination. Consequently, no impacts from the discharge of produced water are
24 expected.
25

26 The results of the Arctic Nearshore Impacts Monitoring in the Development Area study
27 funded by BOEM provide a good summary of the long-term changes to benthic habitats resulting
28 from oil and gas production in the Arctic (Neff and Associates LLC 2010). No relationship
29 between the location of oil and gas production and the concentration of metals and hydrocarbons
30 in sediment and marine animals was detected. The study concluded that metals and PAHs in
31 Beaufort Sea sediments were primarily derived from sediments delivered by rivers, not oil and
32 gas activities. Overall, activities conducted during the production phase are expected to have
33 minor effects on benthic habitat.
34

35 **Decommissioning.** Miscellaneous and solid waste releases discussed above would
36 continue during the decommissioning phase (Table 4.4.6-5). Platform and mooring structure
37 removal activities would result in bottom disturbance and a temporary increase in turbidity and
38 sedimentation. No platforms are expected to be removed using explosives. Over time,
39 sediments will recover their normal physical characteristics, ecological functions, and biological
40 communities. Overall, activities conducted during the decommissioning phase are expected to
41 have negligible effects on benthic habitat.
42

43 **Accidents.** It is assumed that large spills ($\geq 1,000$ bbl), up to 35 small spills (50 to
44 999 bbl), and up to 190 smaller spills (>1 and <50 bbl) could occur during the lease period under
45 the proposed action (Table 4.4.2-2). Much of the impact magnitude depends on the location of
46 the spill, the direction of bottom currents, and the amount of oil released. Oil from accidental

1 releases would rise in the water column, thereby limiting the extent of benthic habitat that would
2 be affected by any given spill. Oil from most small surface spills is likely to reach the sediment
3 only at biologically negligible concentrations. Most subsea spills would be minor, and the
4 hydrocarbon concentrations would typically be diluted to background levels within a few
5 hundred meters to a few kilometers of the spill site. Large spills would affect a wider area of
6 benthic habitat and potentially persist in the sediment for an extended period. Benthic habitat
7 would recover without mitigation because of natural breakdown of the oil, sediment movement
8 by currents, and reworking by benthic fauna.

9
10 Oil spill-response activities such as burning, skimming, and chemical release
11 (e.g., dispersants or coagulants) could affect benthic habitat and biota. Skimming and burning
12 could kill pelagic live stages of benthic biota. The chemicals used during a spill response are
13 toxic, but there is controversy about whether the combination of oil and dispersant is more toxic
14 than oil alone (NRC 2005b; Fingas 2008; Holland-Bartels and Kolak 2011). The use of
15 dispersant would likely reduce oiling of nearshore benthic habitat, but may increase the exposure
16 of subtidal benthic habitat and biota to toxic fractions of oil (NRC 2005b). In shallow water, the
17 presence of, and noise generated by, oil spill-response equipment and support vessels could
18 temporarily disturb benthic habitat in the vicinity of the response action, potentially reducing
19 habitat use or disturbing migration. As with the spill itself, the location and time of the year the
20 cleanup occurs would be an important determinant of impacts on benthic habitat and biota.

21
22 **Catastrophic Discharge Event.** This PEIS analyzes a CDE up to 2.2 million bbl in the
23 Chukchi Sea Planning Area and up to 3.9 million bbl in the Beaufort Sea Planning Area
24 (Table 4.4.2-2) that could result in lethal or sublethal concentrations of hydrocarbons or mixtures
25 of hydrocarbons and dispersants (if used), which could accumulate in soft sediments, reducing
26 habitat function. The magnitude of the impact depends primarily on the location of the well, the
27 volume released, and the speed at which the well was capped. Most oil released in a surface or
28 seafloor spill would float above the sediment, but sediment contamination could occur from the
29 deposition of oiled sediment and organic matter (dead plankton and organic flocculants) falling
30 from the water column. In addition, oil could reach the shoreline and contaminate coastal
31 benthic habitat (see Sections 4.4.6.1.3 and 4.4.6.2.2 for a detailed discussion of the impacts of oil
32 spills on coastal habitat). The soft sediment habitat would recover without mitigation because of
33 natural breakdown of the oil, sediment movement by currents, and reworking by benthic fauna.
34 However, the cold temperatures of the Arctic may allow hydrocarbons to persist in the sediments
35 longer than in temperate areas. Overall, impacts on soft sediments from catastrophic releases
36 could be major and potentially long-term.

37
38 The magnitude of impacts on the Boulder Patch from an oil spill would depend on the
39 location and severity of the spill. Oil spills contacting the Stefansson Sound Boulder Patch
40 community could cause both lethal and sublethal effects on marine plants and invertebrates.
41 Sublethal effects occur at lower concentrations and include reduced growth and/or fecundity,
42 increased physiological stress, and behavioral changes. *Laminaria solidungula*, found in the
43 Stefansson Sound Boulder Patch, has not been studied directly, but other *Laminaria* species from
44 the Canadian Beaufort Sea showed marked physiological impairment when exposed to oils of
45 several types and concentrations (Hsiao et al. 1978; Shiels et al. 1973). Photosynthesis would
46 probably be reduced by the floating oil because of reduced light penetration, and if the floating

1 oil persisted long enough, it could affect growth and reproduction of the kelp. Benthic animal
2 communities have also been shown to have major shifts in species composition following
3 exposure to oil (Dean and Jewett 2001). Impacts on kelp habitat from an oil spill could be long
4 term, but are not expected to be permanent. *Laminaria* beds oiled by the *Exxon Valdez* spill
5 recovered within 10 years (Dean and Jewett 2001).
6

7 If the spill were to occur during winter, cleanup would be much more difficult because
8 sea ice would limit access to the spill (reviewed in Holland-Bartels and Kolak 2011). Oil
9 cleanup response plans and technologies for ice-covered spills are still evolving, and the efficacy
10 of many proposed spill countermeasures is as yet unknown (Holland-Bartels and Kolak 2011). If
11 the spill were to occur under ice, oil would be trapped and essentially remain unchanged until
12 breakup occurred and the ice began to melt. Oil could float or freeze within the ice, which would
13 limit the potential for oil to reach deeper subtidal seafloor habitat. However, oil transported
14 under ice to nearshore areas would remain unweathered and could degrade intertidal and shallow
15 subtidal benthic habitat throughout the winter and after the ice thaws. The effects on primary
16 and secondary biological productivity could be severe as well, because of loss of epontic and ice-
17 associated fish assemblages due to oil toxicity. Oil under landfast ice would be more easily
18 accessed and cleaned, which could reduce the duration and severity of impacts.
19
20

21 **4.4.6.2.4 Conclusion.** Routine Program activities conducted during the exploration,
22 development, and production phases could result in moderate impacts on benthic habitat in the
23 GOM, Cook Inlet, and Beaufort and Chukchi Sea Planning Areas. The primary impacts would
24 be on soft sediments from ground disturbance during drilling and pipeline and platform
25 placement as well as the discharge of drilling muds and cuttings and produced water. Existing
26 mitigation measures, if applied, should ameliorate most direct impacts on sensitive benthic
27 marine habitats, including soft sediments, hard-bottoms, coral reefs, and HDDC in the GOM and
28 Boulder Patch communities in the Beaufort and Chukchi Seas. However, in some cases
29 activities that generate noise, turbidity, and sedimentation may affect sensitive habitats
30 depending on their proximity to these activities. In addition, unmapped sensitive benthic habitats
31 not covered by the stipulations may be damaged or destroyed. If sensitive benthic live-bottom
32 and associated biota were damaged or killed, the impacts could be long term or permanent
33 because living benthic habitats are slow-growing and have highly specific habitat requirements.
34 Overall, moderate, temporary, and localized impacts, primarily on soft sediment benthic habitats,
35 are expected to result from routine exploration, site development, and production activities.
36

37 Small hydrocarbon spills are not likely to result in the degradation of benthic marine
38 habitat because spills at the surface would likely reach the benthic marine habitats only in low
39 concentrations. However, large or CDE spills from a loss of well control and pipeline ruptures
40 would physically disturb the seafloor around the spill site, and a subsurface plume extending a
41 large distance from the spill could form if dispersants are used or if the oil released is mixed with
42 gas. The impact of accidental releases of oil depends on several factors such as the size,
43 duration, timing, and location of the spill, and the nature of the benthic habitat contacted by the
44 oil. The season in which the spill occurs is especially important in Alaskan waters due to heavy
45 seasonal ice cover that could hinder cleanup efforts. In the unlikely event that a CDE occurred,
46 sensitive benthic habitats could suffer long-term loss of ecological function because of both

1 hydrocarbon toxicity and the subsequent cleanup activities. Hydrocarbons could persist at
2 sublethal concentrations in sediments for decades, and sensitive habitats (i.e., kelp beds,
3 intertidal zones; live-bottom and coral reef) damaged by a spill would likely recover slowly and
4 possibly not recover at all. However, hydrocarbons would be broken down by natural processes,
5 and most benthic habitats are likely to eventually recover. Many sensitive benthic habitats are
6 widely scattered; therefore, individual spills would be unlikely to threaten the resource as a
7 whole.

10 **4.4.6.3 Marine Pelagic Habitats**

13 **4.4.6.3.1 Gulf of Mexico.**

15 **Water Column.**

17 ***Routine Operations.***

18
19 Exploration and Site Development. See Section 4.4.3.1.1 for a general discussion of the
20 impacts of exploration and site development on water quality. During the exploration and site
21 development phase, pelagic habitat would be affected by platform and pipeline placement,
22 drilling activity, seismic surveys, platform lighting, and aircraft and vessel traffic, and
23 miscellaneous vessel and platform discharges (Table 4.4.6-6). Noise impacts would be greatest
24 near the source and would temporarily reduce habitat quality (i.e., induce physiological stress,
25 injury, or behavioral changes) for certain species whose noise tolerance is below that of the noise
26 level generated by the exploration and development activities. See Section 4.4.7 for detailed
27 discussions of the effects of noise on different categories of biota. Construction lighting would
28 alter the pelagic light regime of a small area and would attract phototaxic organisms to the
29 platform. Studies in the northern GOM suggest that platform lighting could enhance
30 phytoplankton productivity around the platform, potentially increase prey availability, and
31 improve the visual foraging environment for fishes (Keenan et al. 2007).

32
33 Bottom water quality would be temporarily affected by turbidity from sediment
34 disturbance during drilling, platform placement, and pipeline trenching and placement. Turbidity
35 from bottom-disturbing activities could kill zooplankton, although the population-level effects
36 would be negligible. Photosynthetic productivity of phytoplankton that specialize in near-bottom
37 habitats may be reduced if the turbidity plume reduced solar irradiance at depth. However, the
38 turbidity plume would be temporary, and phytoplankton populations have rapid replacement
39 times (Behrenfeld et al. 2006). Therefore no permanent impacts on phytoplankton populations
40 are anticipated. FPSO systems could potentially be used in deep water, which would reduce the
41 need for pipeline placement and greatly reduce water quality impacts.

42
43 The discharge of drilling muds and cuttings can occur near the water's surface or the
44 seafloor. Releases at the seafloor would affect bottom waters in ways similar to those of bottom-
45 disturbing activities, resulting in a temporary reduction in water quality. Surface discharge of
46 drilling muds and cuttings would create a turbidity plume that would diminish within some

1 **TABLE 4.4.6-6 Impacting Factors by Phase and Potential Effects on Marine**
2 **Pelagic Habitat in the CPA and WPA of the GOM**

Impacting Factor	Disturbance ^a
<i>Exploration and Site Development</i>	
Vessel traffic	Noise
Seismic surveys	Noise
Miscellaneous discharges (deck washing, sanitary waste, bilge and ballast water)	Degraded water quality
Drilling and discharge of drilling muds/cuttings	Noise; degraded water quality
Pipeline trenching	Noise; turbidity
Drilling platform placement	Noise; turbidity
Offshore lighting	Alteration of light field
<i>Production</i>	
Production platform placement	Noise; turbidity
Production	Noise
Produced water discharge	Degraded water quality
Miscellaneous discharges (deck washing, sanitary waste)	Degraded water quality
Offshore lighting	Alteration of light field
<i>Decommissioning</i>	
Miscellaneous discharges (deck washing, sanitary waste, bilge and ballast water)	Degraded water quality
Explosive platform removal	Noise, turbidity
Offshore lighting	Alteration of light field

^a Colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

3
4
5 distance from the release point. The turbidity plume could smother or stress small zooplankton
6 and reduce phytoplankton productivity by decreasing the depth and intensity of light penetration.
7 While synthetic drilling fluids are not discharged directly, they do enter the pelagic environment
8 by adhering to drilling cuttings (Neff et al. 2000). These cuttings tend to aggregate and settle
9 rapidly to the sea floor. This tendency for aggregation increases the higher the concentration of
10 adhered synthetic fluid. The rapid settling of the cuttings reduces their dispersion in the water
11 column and water column turbidity (Neff et al. 2000). In addition, synthetic drilling fluids have
12 low toxicity (Neff et al. 2000). Consequently, the release of such cuttings and associated
13 synthetic drilling fluids should result in minor, short-term, and relatively localized impacts.
14 Similarly, in well-mixed ocean waters, water-based drilling muds and cuttings are diluted by
15 100-fold within 10 m (33 ft) of the discharge and by 1000-fold at a distance of about 100 m
16 (330 ft) from the platform (Neff 2005). These estimates are for well-mixed water, and therefore
17 the size of the turbidity field will vary with hydrology. The generally rapid dilution would limit
18 the degradation of pelagic habitat to a localized area, and impacts on pelagic habitat would be
19 minor. Degradation of pelagic habitat would also be limited by NPDES permits regulating the
20 discharge of drill cuttings in a way that reduced impacts on water quality (Neff et al. 2000;
21 Neff 2005).

1 Pelagic habitat would be affected minimally and temporarily by miscellaneous discharges
2 (deck drainage, sanitary and domestic waste, bilge and ballast water) during site development.
3 Such releases would be minor in quantity, would be rapidly diluted, and would likely have only
4 negligible impacts on pelagic habitat. In addition, many vessel and platform wastes are disposed
5 of on land, and those that are discharged at sea must meet USEPA and/or USCG regulatory
6 requirements that limit their environmental effects.
7

8 Production. Impacts from offshore lighting, miscellaneous discharges, and bottom
9 disturbance from the movement of platform and support vessel anchors and chains will also exist
10 in the production phase and are described above. In addition, production noise and produced
11 water discharge could affect pelagic habitat quality (Table 4.4.6-6). Production noise is not
12 expected to appreciably degrade habitat quality, as production platforms are known to have high
13 biological abundance and diversity. Impacts on pelagic habitat from produced water should be
14 minor because produced water is treated before being discharged and must meet NPDES
15 permitting guidelines regarding discharge rate and toxicity. Produced water is high in organic
16 matter and has the potential to generate local hypoxia (Rabalais 2005). However, a major study
17 of produced water discharges across the northern GOM indicated that despite the large volume
18 discharged, the contribution of produced water to bottom water hypoxia is minimal when
19 compared to riverine inputs, and produced water did not make a significant contribution to the
20 hypoxic zone in the GOM (Rabalais 2005; Bierman et al. 2007).
21

22 Algae and sessile invertebrates would rapidly colonize the platform and would in turn
23 attract mobile reef-oriented organisms. Thus, the platform structure would serve as a novel
24 artificial reef in formerly open water habitat. The platform would function in a manner similar to
25 existing reefs, banks, and topographic features and may increase zooplankton densities around
26 the platform. A floating platform would extend from the surface to some depth below the
27 waterline, potentially creating a floating reef habitat that would attract organisms to adjacent
28 surface waters. The artificial reef would only exist during the production phase, unless the
29 platform was permitted to remain in place after decommissioning. In deep sea areas, the
30 platform and mooring structures would likely be completely removed during decommissioning,
31 so impacts from bottom disturbance would be temporary.
32

33 Decommissioning. Impacts from vessel noise, platform lighting, and miscellaneous
34 discharges are discussed above and would continue throughout the decommissioning phase
35 (Table 4.4.6-6). In addition, bottom disturbance during platform removal (potentially including
36 the use of explosives) would temporarily disturb pelagic habitat by increasing noise and turbidity
37 for some length of the water column (see individual sections on marine biota for discussions of
38 the impacts of explosive platform removal). These impacts would temporarily degrade habitat
39 quality, but conditions would return to normal as suspended sediments dispersed and resettled,
40 and the long-term impacts to pelagic habitat would be negligible.
41

42 Accidents. Accidental hydrocarbon releases can occur at the surface or at the seafloor.
43 Natural gas would tend to rise in the water column and could degrade habitat quality in a large
44 portion of the water column. However, natural gas is also less persistent in the environment than
45 oil. Evidence from the DWH event indicates that methane gas released from the well was
46 rapidly broken down by bacterial action with little oxygen drawdown (Camilli et al. 2010;

1 Kessler et al. 2011). Consequently, the remainder of the discussion focuses on oil spills. It is
2 assumed that large spills ($\geq 1,000$ bbl), up to 70 spills between 50 and 999 bbl and 400 smaller
3 spills between 1 and 50 bbl could occur during the lease period under the proposed action
4 (Table 4.2.2-1). Impacts on pelagic habitat from accidental oil spills could result from surface
5 releases from platforms or vessels or from seafloor releases from pipelines and the wellhead.
6 Modeling indicates that oil spilled at the surface could mix to a depth of 20 m (66 ft) at highly
7 diluted concentrations (MMS 2008a). Accidental oil releases from pipeline leakage would
8 degrade bottom water quality at local scales, but would be broken down over time through
9 natural processes, and the long-term effects on pelagic habitat and biota would be minor. Large
10 spills would degrade pelagic habitat quality over a wider area and potentially reduce the habitat
11 value and ecosystem function in the areas affected. Eventually, the oil would be broken down by
12 natural processes, and pelagic habitat would recover. See Section 4.4.3.2.1 for a further
13 discussion of the effects of oil spills on water quality in the GOM.
14

15 Oil spill-response activities such as burning, skimming, and chemical release
16 (e.g., dispersants or coagulants) could affect pelagic habitat and biota. Burning would kill
17 pelagic biota in the burn area, and skimming would remove aquatic organisms from the water
18 column or trap them in oiled water. The chemicals used during a spill response are toxic, but
19 there is controversy about whether the combination of oil and dispersant is more toxic than oil
20 alone (NRC 2005b; Fingas 2008; Holland-Bartels and Kolak 2011). The use of dispersant would
21 likely increase the areal extent of oil dispersion and the exposure of pelagic biota to oil. The
22 presence of, and noise generated by, oil spill-response equipment and support vessels could
23 temporarily disturb pelagic habitat in the vicinity of the response action, potentially reducing
24 habitat use or disturbing migration. As with the spill itself, the location and time of the year the
25 cleanup occurs would be an important determinant of impacts on pelagic habitat and biota.
26

27 **Catastrophic Discharge Event.** The PEIS analyzes a CDE up to 7.2 million bbl
28 (Table 4.4.2-2). Pelagic organisms could be exposed to lethal or sublethal concentrations of
29 hydrocarbons or mixtures of hydrocarbons and dispersants (if used). The extent and magnitude
30 of the impact depend primarily on the location of the well, the volume of oil released, and the
31 season in which the spill occurs. Typically oil rises from the seafloor to the sea surface forming
32 a surface slick. However, a subsurface plume capable of traveling long distances could form if
33 dispersants are used or if the well releases a mixture of oil and gas. In the case of the DWH
34 event, hydrocarbons were detected as far as 56 km (35 mi) northeast and southwest of the well
35 (Camilli et al. 2010; Haddad and Murawski 2010). The DWH event also changed pelagic
36 microbial communities. Methanotropic and oil-eating bacteria were greatly increased following
37 the DWH event (Camilli et al. 2010; Kessler et al. 2011). However, the increase in microbial
38 biomass did not result in significant oxygen depletion, even in deep water. The hydrocarbons
39 appeared to be assimilated by bacteria and transferred up through the zooplankton food web
40 (Graham et al. 2010).
41

42 These studies suggest the GOM has a tremendous natural capacity to assimilate
43 accidental oil spills, and pelagic habitats would eventually recover their ecological function as
44 hydrocarbons broke down. However, recovery time would vary with local conditions and the
45 degree of oiling. For example, the shallow pelagic habitats would probably recover more
46 quickly than deepwater pelagic habitats because of the greater physical and biological activity in

1 shallow water. Overall, impacts on pelagic habitats from a CDE could be negligible to moderate
2 and potentially short term to long term, but no permanent degradation of pelagic habitats is
3 expected to result.

4
5 ***Sargassum.***

6
7 ***Routine Operations.***

8
9 Exploration and Site Development. *Sargassum* could be affected by several activities
10 during the exploration and site development phase of OCS oil and gas development including
11 vessel traffic, miscellaneous discharge, and drilling waste discharge. Drilling muds and cuttings
12 are typically discharged near surface waters and could come into contact with *Sargassum* mats.
13 Turbidity generated by the discharge could reduce photosynthesis in *Sargassum* and cause
14 physiological stress on associated animal communities. The cuttings should settle to the bottom
15 within 1,000 m (3,280 ft) of the release point (Continental Shelf Associates, Inc. 2006), so the
16 contact should be minimal. NPDES permit requirements regulating the toxicity and amount of
17 drilling wastes discharged would also limit the potential for impacts on *Sargassum*.
18 Miscellaneous discharges (deck drainage, sanitary and domestic waste, bilge and ballast water)
19 are not expected to affect *Sargassum* because the releases would be minor in quantity and would
20 be rapidly diluted. Service vessels and drilling ships could damage *Sargassum* mats with their
21 propeller or by entraining *Sargassum* in their cooling water intake. The effects on individual
22 *Sargassum* mats and the associated communities could be complete or partial loss of the
23 *Sargassum*. Given the small area affected relative to the size of known *Sargassum* habitat,
24 vessel traffic is not expected to measurably reduce the biomass or productivity of *Sargassum* in
25 the northern GOM.

26
27 *Sargassum* appears to originate in the northwestern GOM, and little new oil and gas
28 development is expected to occur in this region. Given the small overall area of seafloor affected
29 by new oil and gas development, and the new spring production of *Sargassum* that occurs in the
30 GOM (Gower and King 2008), no detectable population level effects on *Sargassum* are
31 anticipated.

32
33 Production. Miscellaneous discharges and vessel traffic will continue through the
34 production phase, but they are not expected to affect *Sargassum* for the reasons described above.
35 Contaminants in produced water discharged from the platform could affect *Sargassum* and
36 associated biota. However, produced water is treated before discharge and must meet NPDES
37 permitting guidelines. Consequently, impacts on *Sargassum* should be negligible. Other
38 production activities would primarily affect subsurface habitat and are not anticipated to affect
39 *Sargassum*.

40
41 Decommissioning. Miscellaneous discharges and vessel traffic will continue through the
42 decommissioning phase, but they are not expected to affect *Sargassum* for the reasons described
43 above. Platform removal activities would primarily affect subsurface communities, and while
44 they are not anticipated to affect adult *Sargassum*, they could affect sediment-dwelling
45 germlings. However, decommissioning impacts will be highly localized over a relatively small
46 area.

1 **Accidents.** Spills could occur at the surface or at the seafloor. Surface spills as well as
2 seafloor spills that rise to the surface could contact *Sargassum*, potentially resulting in complete
3 or partial mortality of the *Sargassum* mat and lethal or sublethal effects to associated biota.
4 Surface slicks would pose a potential threat to *Sargassum* communities until dilution and natural
5 chemical, physical, and biological processes reduced the toxicity of the oil. Upon release,
6 hydrocarbons would be rapidly diluted and broken down by natural processes, which would limit
7 the potential for contact with and toxicity to *Sargassum* communities. The warm waters of the
8 GOM are particularly conducive to rapid chemical and microbial breakdown of hydrocarbons.
9

10 **Catastrophic Discharge Event.** The effects from a CDE would depend on the location
11 of the particular spill and on various environmental factors, including water depth, currents, and
12 wave action. Seafloor releases could reach *Sargassum* in surface waters if the spill occurred in
13 shallow water or if dispersants were used or the oil released was well mixed with gas. A CDE
14 could affect a large portion of the *Sargassum* population if the spill occurred in an area of high
15 *Sargassum* density or if toxic concentrations of oil were spread over a large area of surface
16 water. Surprisingly little is known about the lifecycle of *Sargassum*. *Sargassum* is generally
17 only present in the WPA and CPA in spring through early fall, and recent data suggest
18 *Sargassum* originates in the northwest GOM and is exported from the GOM by ocean currents
19 (Gower and King 1998). Therefore, the potential for impacts on *Sargassum* are highly
20 dependent on when the spill occurs. *Sargassum* reproduces every year, so it is expected that the
21 population will recover if affected by an oil spill.
22
23

24 **4.4.6.3.2 Alaska – Cook Inlet.**

25 **Routine Operations.**

26 **Exploration and Site Development.** See the Section 4.4.3.2.1 for a general discussion of
27 the impacts of exploration and site development on water quality. During the exploration and
28 site development phase, pelagic habitat would be affected by platform and pipeline placement,
29 drilling activity, seismic surveys, platform lighting, and aircraft and vessel traffic (Table 4.4.6-7).
30 Noise impacts would be greatest near the source and would temporarily reduce habitat quality for
31 certain species. Construction lighting would alter the pelagic light regime of a small area and
32 would attract phototaxic organisms to the platform.
33
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36 Bottom water quality would be temporarily affected by turbidity from sediment
37 disturbance during drilling, platform placement, and pipeline placement. Turbidity from bottom-
38 disturbing activities could kill phytoplankton, although the population-level effects would be
39 negligible. Photosynthetic productivity of phytoplankton that specialize in near-bottom habitats
40 may be reduced if the turbidity plume reduced solar irradiance at depth. The turbidity plume
41 would be temporary, and the effects on pelagic habitat are expected to be short term and minor.
42

43 It is assumed that drilling muds and cutting would be discharged into Cook Inlet for
44 exploration wells only. Drilling wastes from development and production wells would be
45 reinjected into the wells. The discharge of drilling muds and cuttings can occur near the water's
46 surface or the seafloor, and both would create a turbidity plume that would diminish within some

1 **TABLE 4.4.6-7 Impacting Factors by Phase and Potential Effects on Marine Pelagic**
2 **Habitat in the Cook Inlet Planning Area**

Impacting Factor	Disturbance ^a
<i>Exploration and Site Development</i>	
Vessel traffic	Noise
Seismic surveys	Noise
Miscellaneous discharges (deck washing, sanitary waste, bilge and ballast water)	Degraded water quality
Drilling and discharge of drilling muds/cuttings	Noise; degraded water quality
Pipeline trenching	Noise; turbidity
Drilling platform placement	Noise; turbidity
Offshore lighting	Alteration of light field
<i>Production</i>	
Production platform placement	Noise; turbidity
Production	Noise
Produced water discharge	Degraded water quality
Miscellaneous discharges (deck washing, sanitary waste)	Degraded water quality
Offshore lighting	Alteration of light field
<i>Decommissioning</i>	
Miscellaneous discharges (deck washing, sanitary waste, bilge and ballast water)	Degraded water quality
Platform removal	Noise, turbidity
Offshore lighting	Alteration of light field

^a Colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

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4
5 distance from the release point. The turbidity plume could smother or stress small zooplankton
6 and reduce phytoplankton productivity by decreasing the depth and intensity of light penetration.
7 In well-mixed ocean waters, water-based drilling muds and cuttings are diluted by 100-fold
8 within 10 m (33 ft) of the discharge and by 1,000-fold at a distance of about 100 m (330 ft) from
9 the platform (Neff 2005). These estimates are for well-mixed water, and therefore the size of the
10 turbidity field will vary with hydrology. Because the waters of Cook Inlet generally are
11 vertically well mixed with a relatively large tidal range, dilution of drilling discharges would be
12 expected to occur rapidly. Drilling wastes that are discharged are regulated by the USEPA under
13 NPDES permits and must meet the toxicity, water quality, and discharge rate standards set by the
14 permits, thereby reducing impacts on water quality (Neff et al. 2000; Neff 2005). Although such
15 releases could result in temporary, localized increases in sediment load and deposition, this
16 amount of sediment is small compared to the more than 40 million tons of suspended sediment
17 carried annually into Cook Inlet by runoff from area rivers (Brabets et al. 1999). For all these
18 reasons, long-term impacts from drilling waste discharges are expected to be minor.

19
20 Pelagic habitat would be affected minimally and temporarily by miscellaneous discharges
21 (deck drainage, sanitary and domestic waste, bilge and ballast water) during site development.
22 Such releases would be minor in quantity and would be rapidly diluted and are expected to have

1 only negligible impacts on pelagic habitat. In addition, many vessel and platform wastes are
2 disposed of on land, and those that are discharged at sea must meet USEPA and/or USCG
3 regulatory requirements that limit their environmental effects.

4
5 Overall, activities conducted during the exploration and site development phase are
6 expected to have minor effects on pelagic habitat.

7
8 **Production.** Impacts from offshore lighting, miscellaneous discharges, and bottom
9 disturbance from the movement of support vessel anchors and chains will also exist in the
10 production phase and are described above. In addition, production noise and produced water
11 discharge could impact pelagic habitat quality (Table 4.4.6-7). Production noise is expected to
12 have negligible impacts on habitat quality, because production platforms are known to have high
13 biological abundance and diversity (Stanley and Wilson 2000). Impacts on pelagic habitat from
14 produced water should be negligible because it is assumed that all produced water will be
15 reinjected into the well. Overall, activities conducted during the production phase are expected
16 to have negligible effects on pelagic habitat.

17
18 **Decommissioning.** Impacts from vessel noise, platform lighting, and miscellaneous
19 discharges are discussed above and would continue throughout the decommissioning phase. In
20 addition, bottom disturbance during platform removal would temporarily disturb pelagic habitat
21 by increasing noise and turbidity for some length of the water column. These impacts would
22 temporarily degrade habitat quality, but conditions would return to normal as suspended
23 sediments dispersed and resettled. The use of explosives to remove platforms is not expected.
24 Overall, activities conducted during the decommissioning phase are expected to have minor
25 effects on pelagic habitat.

26
27 **Accidents.** Impacts on pelagic habitat from accidental oil spills could result from surface
28 releases from platforms or vessels or from seafloor releases from pipelines and the wellhead.
29 Spills could vary in size. It is assumed that 1 large spill ($\geq 1,000$ bbl), 1 to 3 small spills between
30 50 and 999 bbl and 7 to 15 smaller spills between 1 and 50 bbl could occur under the proposed
31 action (Table 4.4.2-1). Such releases would reduce the habitat value and ecosystem function of
32 pelagic habitat at local scales. Most spills would be small and the overall impacts on pelagic
33 habitat resources will be minor and short term, given the natural dilution and breakdown of
34 hydrocarbons. Large spills would degrade pelagic habitat quality over a wider area and
35 potentially reduce the habitat value and ecosystem function in the areas affected. Eventually, the
36 oil would be broken down by natural processes, and pelagic habitat would recover. Overall,
37 impacts on pelagic habitat from accidental hydrocarbon spills could be negligible to moderate,
38 and impacts could be short term to long term, but no permanent degradation of pelagic habitat is
39 expected. See Section 4.4.3.2.2 for a further discussion of the effects of oil spills on water
40 quality in Cook Inlet.

41
42 Oil spill-response activities such as burning, skimming, and chemical release
43 (e.g., dispersants or coagulants) could affect pelagic habitat and biota. Burning would kill
44 pelagic biota in the burn area, and skimming would remove aquatic organisms from the water
45 column or trap them in oiled water. The chemicals used during a spill response are toxic, but
46 there is controversy about whether the combination of oil and dispersant is more toxic than oil

1 alone (NRC 2005b; Fingas 2008; Holland-Bartels and Kolak 2011). The use of dispersant would
2 likely increase the areal extent of oil dispersion and the exposure of pelagic biota to oil. The
3 presence of, and noise generated by, oil spill-response equipment and support vessels could
4 temporarily disturb pelagic habitat in the vicinity of the response action, potentially reducing
5 habitat use or disturbing migration. As with the spill itself, the location and time of the year the
6 cleanup occurs would be an important determinant of impacts to pelagic habitat and biota.

7
8 **Catastrophic Discharge Event.** The PEIS analyzes a CDE of 75,000 to 125,000 bbl
9 (Table 4.4.2-2). Oil from a CDE (Table 4.4.2-2) would form a surface slick and kill, injure, or
10 displace pelagic biota over a large area of Cook Inlet. The extent and magnitude of the impact
11 depend primarily on the time of year, the location of the well, the volume released, and the speed
12 at which the well was capped. Most oil released would be rapidly diluted and broken down in
13 the water column by physical and biological processes, so pelagic habitats would eventually
14 recover their habitat value. Studies of water quality after the *Exxon Valdez* spill indicated that
15 the hydrocarbon concentrations were highest in the first two months after the spill, but were well
16 below the State of Alaska's water quality standard (Neff and Stubbenfield 1995). PAH
17 concentrations in the water column of the sound reached background concentrations by 5 to 6
18 months after the spill. Toxicity tests also indicated no lethal or sublethal toxicity to pelagic
19 phytoplankton, invertebrates, or larval fish test organisms due to exposure to water from Prince
20 William Sound (Neff and Stubbenfield 1995). Within 1 yr of the *Exxon Valdez* spill, PAH
21 concentrations generally declined to background levels (Boehm et al. 2007). However, in
22 heavily oiled areas, toxic fractions of oil trapped in intertidal sediments can be periodically
23 resuspended into the water column, where they are available to filter-feeding biota
24 (Boehm et al. 2007). However, data from the *Exxon Valdez* spill suggest resuspended oil
25 represented a contamination threat for biota less than 1 to 2 yr, with the highest PAH
26 concentrations in intertidal waters (Boehm et al. 2007).

27
28 Broken ice occurs in the northern and western portions of lower Cook Inlet during fall
29 and winter. If an open water spill were to occur at this time, the ice would contain the oil
30 somewhat and reduce spreading. However, oil cleanup is also made more difficult in broken ice
31 conditions. Oil from spills occurring in winter would likely freeze in ice where it could be
32 transported hundreds of kilometers. If the spilled oil became frozen in the ice, cleanup would not
33 be possible and the unweathered oil would be released into pelagic habitat as the ice melted.
34 However, oil frozen into shorefast ice could be recovered using terrestrial cleanup methods,
35 assuming the ice was stable and thick enough to support the cleanup activities.

36 37 38 **4.4.6.3.3 Alaska – Arctic.**

39 **Routine Operations.**

40
41
42 **Exploration and Site Development.** See Section 4.4.3.3.1 for a general discussion of the
43 impacts of exploration and site development on water quality. During the exploration and site
44 development phase, pelagic habitat would be affected by multiple activities (Table 4.4.6-8).
45 Noise impacts would be greatest near the source and would temporarily reduce habitat quality for
46 certain species. (See Section 4.4.7 for detailed discussions of the effects of noise on different

1
2

TABLE 4.4.6-8 Impacting Factors by Phase and Potential Effects on Marine Pelagic Habitat in the Beaufort and Chukchi Sea Planning Areas

Impacting Factor	Disturbance
<i>Exploration and Site Development</i>	
Vessel traffic	Noise; air emissions
Seismic surveys	Noise
Miscellaneous discharges (deck washing, sanitary waste, bilge and ballast water)	Degraded water quality
Drilling and discharge of drilling muds/cuttings	Noise; degraded water quality
Pipeline trenching	Noise; turbidity
Drilling and subsea well an platform placement	Noise; turbidity
Offshore lighting	Alteration of light field
<i>Production</i>	
Production platform placement	Noise; turbidity
Production	Noise
Produced water discharge	Degraded water quality
Miscellaneous discharges (deck washing, sanitary waste)	Degraded water quality
Offshore lighting	Alteration of light field
<i>Decommissioning</i>	
Miscellaneous discharges (deck washing, sanitary waste, bilge and ballast water)	Degraded water quality
Platform removal	Noise, turbidity
Offshore lighting	Alteration of light field

^a Colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

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categories of biota.) Construction lighting would alter the pelagic light regime of a small area and would attract phototaxic organisms to the platform.

Bottom water quality would be temporarily affected by turbidity from sediment disturbance during drilling, placement of subsea wells, platforms and pipelines, and the construction of artificial islands. In addition to lethal or sublethal impacts to benthic organisms (Section 4.4.7.5), turbidity from bottom-disturbing activities could kill plankton, although the population-level effects would be negligible. Photosynthetic productivity of phytoplankton that specialize in near-bottom habitats may be reduced if the turbidity plume reduced solar irradiance at depth. However, the turbidity plume would be temporary, and the effects on pelagic habitat are expected to be short term and minor.

It is assumed that drilling muds and cuttings would be discharged into the Beaufort and Chukchi Sea Planning Areas for exploration wells only. Drilling wastes from development and production wells would be reinjected into the wells. The discharge of drilling muds and cuttings can occur near the water’s surface or the seafloor, and both would create a turbidity plume that would diminish within some distance from the release point. The turbidity plume could smother

1 or stress small zooplankton and reduce phytoplankton productivity by decreasing the depth and
2 intensity of light penetration. In well-mixed ocean waters, water-based drilling muds and
3 cuttings are diluted by 100-fold within 10 m (33 ft) of the discharge and by 1,000-fold at a
4 distance of about 100 m (330 ft) from the platform (Neff 2005). These estimates are for well-
5 mixed water, and therefore the size of the turbidity field will vary with hydrology. Although the
6 release of drilling muds and cuttings could result in temporary, localized impacts, the amount of
7 material released is small compared to the more than 6.35 million tons of suspended sediment
8 carried annually into the Beaufort Sea alone by runoff from area rivers (Neff and Associates
9 LLC 2010). In addition, the drilling wastes that are discharged are regulated by the USEPA
10 under NPDES permits and must not exceed the toxicity, water quality, and discharge rate
11 standards set by the permits. These requirements greatly reduce the potential for sediment
12 alteration and contamination.

13
14 Pelagic habitat would be affected minimally and temporarily by miscellaneous discharges
15 (deck drainage, sanitary and domestic waste, bilge and ballast water) during site development.
16 Such releases would be minor in quantity and rapidly diluted and are expected to have negligible
17 impacts on pelagic habitat. In addition, many vessel and platform wastes are disposed of on
18 land, and those that are discharged at sea must meet USEPA and/or USCG regulatory
19 requirements that limit their environmental effects.

20
21 Overall, activities conducted during the exploration and site development phase are
22 expected to have minor effects on pelagic habitat.

23
24 **Production.** See Section 4.4.3.3.1 for a general discussion of the impacts of exploration
25 and site development on water quality. Impacts from offshore lighting, miscellaneous
26 discharges, and bottom disturbance from support vessel anchors and chains will also exist in the
27 production phase and are described above. In addition, production noise and produced water
28 discharge could impact pelagic habitat quality (Table 4.4.6-8). Recent analyses indicate that the
29 discharge of produced water into the Chukchi Sea could result in elevated PAH concentrations in
30 shallow water areas or in the winter (MMS 2007a). However, impacts on pelagic habitat from
31 produced water should be minor because it is assumed that all produced water will be reinjected
32 into the well.

33
34 Overall, activities conducted during the production phase are expected to have negligible
35 effects on pelagic habitat.

36
37 **Decommissioning.** Impacts from vessel noise, platform lighting, and miscellaneous
38 discharges are discussed above and would continue throughout the decommissioning phase. In
39 addition, bottom disturbance during platform removal would temporarily disturb pelagic habitat
40 by increasing noise and turbidity for some length of the water column. In addition, gravel
41 islands would be left in place where they would wash away and introduce fine sediments into the
42 water column over time. These impacts would temporarily degrade habitat quality, but
43 conditions would return to normal as suspended sediments dispersed and resettled. Overall, only
44 negligible impacts on pelagic habitat are expected to result from decommissioning activities.

45

1 **Accidents.** See Section 4.4.3.3.2 for a detailed discussion of the effects of oil spills on
2 water quality in the Beaufort and Chukchi Sea Planning Areas. Accidental oil spills could result
3 from surface releases from platforms or vessels or from seafloor releases from pipelines and the
4 wellhead. It is assumed that up to 3 large oil spills ($\geq 1,000$ bbl) up to 35 small spills (50 to
5 999 bbl) and up to 190 smaller spills (>1 and <50 bbl) could occur during the lease period under
6 the proposed action (Table 4.4.2-1). Small releases would degrade bottom water quality, but the
7 overall contaminant impacts on pelagic habitat resources will be minor and short term, given the
8 localized nature of a small release and the natural dilution and breakdown of hydrocarbons.
9 Large spills would degrade pelagic habitat quality over a wider area and potentially reduce the
10 habitat value and ecosystem function in the areas affected. Eventually, the oil would be
11 transported from the area as well as broken down by natural processes. Oil is not expected to
12 persist in marine pelagic habitat for an extended period (Section 4.4.3.3).

13
14 Spills in open water could be contained and much of the oil removed by standard oil
15 spill-response methods. Oil spill-response activities such as burning, skimming, and chemical
16 release (e.g., dispersants or coagulants) could affect pelagic habitat and biota. Burning would
17 kill pelagic biota in the burn area, and skimming would remove aquatic organisms from the
18 water column or trap them in oiled water. The chemicals used during a spill response are toxic,
19 but there is controversy about whether the combination of oil and dispersant is more toxic than
20 oil alone (NRC 2005b; Fingas 2008; Holland-Bartels and Kolak 2011). The use of dispersant
21 would likely increase the areal extent of oil dispersion and the exposure of pelagic biota to oil.
22 The presence of, and noise generated by, oil spill-response equipment and support vessels could
23 temporarily disturb pelagic habitat in the vicinity of the response action, potentially reducing
24 habitat use or disturbing migration. As with the spill itself, the location and time of the year the
25 cleanup occurs would be an important determinant of impacts on pelagic habitat and biota.

26
27 If the spill were to occur under ice or during winter, cleanup would be much more
28 difficult because sea ice would limit access to the spill (reviewed in Holland-Bartels and
29 Kolak 2011). For spills affecting areas of broken ice, the ice would contain the oil somewhat
30 and reduce spreading. However, cleanup is also more difficult in broken ice conditions. Oil
31 cleanup response plans and technologies for ice-covered areas are still evolving, and the efficacy
32 of many proposed spill countermeasures is as yet unknown (Holland-Bartels and Kolak 2011).
33 The oil could freeze into the ice where it could be transported hundreds of kilometers. Oil under
34 ice or frozen in ice would undergo little weathering (Holland-Bartels and Kolak 2011) and could
35 therefore degrade pelagic habitat for an extended period of time, with the extent of the impacts
36 increasing with the size of the oiled area. Sea ice habitat could be degraded or lost if contact
37 with oil spills results in lethal or sublethal effects on biota growing beneath the ice (e.g., fish,
38 invertebrates, and algae). Overall, moderate and potentially long-term degradation of pelagic
39 habitat could result from accidental spills occurring under ice or frozen in ice.

40
41
42 **Catastrophic Discharge Event.** The PEIS analyzes a CDE of up to 2.2 million bbl in
43 the Chukchi Sea Planning Area and 3.9 million bbl in the Beaufort Sea Planning Area. A CDE
44 may affect pelagic habitats (Table 4.4.2-2). The extent and magnitude of the impact depend
45 primarily on the time of year, the location of the well, the volume released, and the speed at
46 which the well was capped. Typically oil rises from the seafloor to the surface, forming a

1 surface slick capable of traveling greater than 50 km (31 mi) (MMS 2007a). Pelagic organisms
2 could be exposed to lethal or sublethal concentrations of hydrocarbons or mixtures of
3 hydrocarbons and dispersants (if used). Pelagic habitats would eventually recover their habitat
4 value as hydrocarbons broke down and were diluted. Recovery time would vary with local
5 conditions and the degree of oiling. Overall, impacts on pelagic habitat from accidental
6 hydrocarbon spills in open water could range from negligible to moderate, and impacts could be
7 short term to long term, but no permanent degradation of pelagic habitat is expected.
8
9

10 **4.4.6.3.4 Conclusion.** Impacts on pelagic habitat in the GOM, Cook Inlet, and Beaufort
11 and Chukchi Sea Planning Areas could occur during the exploration through decommissioning
12 phases. In all Planning Areas, most impacts would be negligible to minor for routine Program
13 activities and would range from short term for the exploration, site development, and
14 decommissioning phases to long term for those impacts occurring throughout the production
15 phase. Impacts would primarily occur from turbidity generated by bottom-disturbing activities.
16 Temporary reduction in habitat quality could also result from the discharge of produced water
17 and drilling muds and cuttings. Overall, no permanent degradation of pelagic habitat is
18 anticipated to result from routine OCS activities because of the nature of the impacts and the
19 small area potentially affected compared to the total area available.
20

21 Most accidental oil spills would be small and result in only negligible, localized impacts
22 on pelagic habitat. However, large or CDE spills could potentially reduce habitat quality over
23 potentially much broader areas. The effects from oil spills would depend on the size, timing,
24 duration, and location of the spill and on various environmental factors. Pelagic habitat in
25 nearshore areas would likely have the greatest potential for long-term contamination. Unique
26 pelagic habitat and associated biota such as *Sargassum* mats in the GOM and sea ice in the
27 Arctic could also be affected by oil spills. Contact with spilled oil could completely or partially
28 kill *Sargassum* and cause lethal or sublethal effects to associated biota.
29

30 In the Alaskan planning areas, oil could become trapped under sea ice for an extended
31 period, where it would remain relatively unweathered and capable of being transported large
32 distances. Oil under ice or frozen in ice could therefore degrade pelagic habitat for an extended
33 period of time with the extent of the impacts increasing with the size of the oiled area; the largest
34 area affected would occur with a CDE-level spill. Sea ice habitat could be degraded or lost if
35 contact with oil spills results in lethal or sublethal effects on biota growing beneath the ice. In all
36 pelagic habitats, hydrocarbons would be diluted and broken down by natural processes, and
37 pelagic habitat would eventually recover its ecological functions.
38
39

40 **4.4.6.4 Essential Fish Habitat**

41
42

43 **4.4.6.4.1 Gulf of Mexico.** As described in Section 3.7.4.1, most of the coastal and
44 marine waters of the GOM are considered EFH for life stages of one or more managed species,
45 and any oil and gas development activity that degrades coastal or marine benthic and pelagic
46 environments would affect EFH. Also, several offshore banks are considered HAPC

1 (Section 3.7.4.1). EFH consists of benthic and water column habitats in marine coastal areas.
2 The potential effects of exploration, site development, and production activities on these habitats
3 are discussed in individual sections including coastal and estuarine habitats (Sections 4.6.1.1),
4 marine benthic habitats (Section 4.4.6.2.1), and the marine water column (Section 4.4.6.3.1).
5 Impacts on fish and fisheries from the Program are discussed in Sections 4.4.7.3.1 and 4.4.1.1.1.
6

7 **Routine Operations.**

8
9 ***Exploration and Site Development.*** During the exploration and site development phase,
10 impacts on EFH could occur as a result of drilling and drilling waste discharge, seismic surveys,
11 and the placement of drilling units, production platforms, and pipelines. Noise from drilling,
12 construction, and seismic surveys would temporarily disturb EFH and potentially kill, injure, or
13 displace managed species. See Section 4.4.7.3.1 for a discussion of the impacts of noise on fish.
14 It is anticipated that behavioral and distributional responses to such acoustic stimuli would be
15 small and that these temporary effects would not persist for more than several hours after
16 acoustic surveys are ended. All the noise associated with these activities would be temporary
17 and affect a small area; therefore, it is expected to result in only negligible to minor impacts on
18 EFH and managed species in the northern GOM.
19

20 The vast majority of marine EFH affected by the Program would be soft sediments. The
21 estimated bottom habitat that may be directly disturbed by new pipeline and platform installation
22 ranges from 2,150 to 14,000 ha (5,313 to 34,594 ac) over the entire GOM. Pipelines placed on
23 the sediment surface would eliminate natural soft sediment EFH. Sediment-disturbing activities
24 would result in increased turbidity, which would lower the water quality of EFH in small areas
25 for a limited time. Although mobile, adult managed species are not likely to be directly affected
26 by bottom disturbance, bottom-disturbing activities could injure, displace, or kill early life stages
27 of managed species or bury the benthic prey of managed species. Bottom disturbance would
28 affect a small area relative to the size of the GOM, and no population-level effects on managed
29 species are expected. Also, FPSO systems could potentially be used in deep water, and would
30 reduce the need for pipelines.
31

32 The potential for bottom-disturbing activities to affect sensitive marine EFH such as
33 hard-bottoms, deepwater corals, and chemosynthetic communities would be reduced by
34 stipulations requiring buffers between these features and bottom-disturbing activities
35 (Section 4.4.6.2.1). Up to two FPSO systems may be employed for deepwater wells. Under the
36 FPSO system, oil would be transported from the well to a surface vessel and ultimately to shore.
37 By eliminating the need for pipelines, an FPSO system would greatly reduce bottom disturbance
38 and the chance for disturbing deepwater corals and chemosynthetic communities. Topographic
39 features classified as HAPC are also protected by the Topographic Features stipulation, which
40 prohibits direct bottom disturbance or the deposition of drilling muds and cuttings in areas
41 containing such habitat. Therefore, HAPC should be minimally affected by exploration and site
42 development activities.
43

44 Coastal EFH could be affected by the estimated 0 to 12 new pipeline landfalls that are
45 anticipated under the proposed action. Routing the pipelines through the most sensitive coastal
46 EFH (i.e., mangroves and seagrass) is not likely to be permitted, but saltmarsh wetlands may be

1 permanently lost due to construction activity. The overall area of coastal EFH affected by oil
2 and gas activities would be minor, and impacts are not expected to permanently reduce the EFH
3 available to managed species or result in population-level impacts on managed species.
4

5 A total of up to 4,700 exploration and production wells will be drilled in the WPA and
6 CPA under the proposed action. The subsequent discharges of drilling cuttings and muds would
7 alter the grain size distribution and chemical characteristics of sediments immediately
8 surrounding the drill sites and for some distance around the wells (typically less than 1 km
9 [3,281 ft]), depending on the depth at which the material is discharged (Kennicutt et al. 1994;
10 Continental Shelf Associates, Inc. 2004, 2006). The deposited material could alter benthic
11 habitat for EFH prey species and potentially affect spawning sites, which are often chosen on the
12 basis of sediment grain size. Elevated sediment metal and PAH concentrations near the well
13 (<500 m [1,640 ft]) would also likely result from drilling discharge, but with the exception of
14 some metals, elevated tissue concentrations of contaminants have not been found in demersal
15 fish or their benthic invertebrate food sources sampled around platforms in the GOM
16 (Kennicutt et al. 1994; Continental Shelf Associates, Inc. 2004, 2006).
17

18 It is expected that the overall impacts of exploration and site development activities on
19 marine EFH would be moderate, and impacts are not expected to permanently reduce the EFH
20 available to managed species or result in population-level impacts on managed species.
21 Recovery rates of EFH habitat and benthic food resources could range from short term to long
22 term depending on the spatial and temporal scope of the disturbance.
23

24 **Production.** The primary production activities that could affect EFH include chronic
25 bottom disturbance from the movement of platform mooring structures and the discharge of
26 produced water. Bottom disturbance represents chronic, long-term, but moderate and localized
27 impacts on marine EFH. NPDES permits would limit the potential for produced water
28 discharges to contaminate sediment and water column EFH. Fish and invertebrates collected
29 near platforms in the GOM do not appear to bioaccumulate the common contaminants in
30 produced water such as radionuclides, metals, and hydrocarbons and do not exceed the USEPA-
31 specified tissue concentrations considered to be harmful (Continental Shelf Associates,
32 Inc. 1997).
33

34 After new platforms have been established, sessile fouling organisms would colonize the
35 underwater portions of the structures, which would attract managed reef species such as snapper,
36 grouper, and some coastal migratory pelagics. Over time, this could change the spawning,
37 breeding, and feeding patterns of some managed fish. The effects of artificial reefs on fish
38 populations are controversial (Section 4.4.7.3.1), as the reefs may benefit some species and
39 adversely affect others. The benefit or detriment of artificial reefs as habitat depends on how
40 fisheries on the reef are managed and on the individual life histories and habitat requirements of
41 the species present (Bohnsack 1989; Macreadie et al. 2011). Unless platforms are permitted to
42 remain, the reef function of the platforms would last only through the production phase.
43

44 It is expected that the effects of production activities on marine EFH would be minor, and
45 impacts are not expected to permanently reduce the EFH available to managed species or result
46 in population-level impacts on managed species.

1 **Decommissioning.** During decommissioning and structure removal, both explosive and
2 nonexplosive methods may be used to sever conductors and pilings. With the exception of some
3 water quality concerns, nonexplosive removals (e.g., abrasive, mechanical, or diver cutters) have
4 little impact on the fish resources. With explosive removal, impacts on managed species range
5 from disturbance and habitat loss to injury and death. From 150 to 275 explosive platform
6 removals are expected, and most would occur in relatively shallow water. Floating platforms
7 would not require explosive removals, although the seafloor would be temporarily disturbed by
8 the removal of platform mooring structures. Removing structures would also remove the
9 associated fouling communities that serve as prey for managed fish species, thereby forcing these
10 species to relocate to other foraging areas. Pipelines would typically be left in place. Pipelines
11 on the sediment surface could periodically move, resulting in chronic bottom disturbance to soft
12 sediment EFH. Pipelines not buried, in both shallow and deepwater, would provide hard
13 substrate and habitat. Overall, it is expected that the effects of decommissioning activities on
14 marine EFH would be minor, and impacts are not expected to permanently reduce the EFH
15 available to managed species or result in population-level impacts on managed species.

16
17 **Accidents.** Small accidental hydrocarbon releases occurring in surface or near-bottom
18 offshore habitats would temporarily degrade EFH in the vicinity of the release, but are not likely
19 to reach large-scale sensitive marine EFH such as hard-bottom EFH (Section 4.4.6.2.1). Large
20 spills ($\geq 1,000$ bbl) have the potential to degrade EFH over a wider area that potentially reduce
21 the habitat value and ecosystem function in the areas affected. Impacts would be greatest if oil
22 from the spill were to contact sensitive marine habitat such as seagrass beds and wetlands.
23 However, in most cases, the area affected would likely be small compared to the overall
24 resources and eventually the oil would be transported from the area as well as broken down by
25 natural processes.

26
27 **Catastrophic Discharge Event.** The PEIS analyzes a CDE up to 7.2 million bbl
28 (Table 4.4.2-2). However, much of the hydrocarbon would likely be consumed relatively
29 quickly by bacteria (Camilli et al. 2010; Kessler et al. 2011). The potential for oil from an
30 accidental release to reach marine HAPC at lethal concentrations would be reduced by the
31 Topographic Features Stipulation prohibiting oil and gas development near these features.
32 However, topographic features as well as unique deepwater communities could be partly or
33 completely destroyed if contacted by a large quantity of oil. Oil from surface and subsurface
34 spills contacting nearshore EFH has the greatest potential to degrade EFH such as intertidal and
35 estuarine habitats with emergent and submerged vegetation, sand and mud flats, and shell and
36 oyster reefs. These areas provide food and rearing substrate for a variety of federally managed
37 juvenile fish and shellfish. Most nearshore spills would be small so they are not likely to
38 degrade a large fraction of EFH because the hydrocarbons would be rapidly metabolized and
39 diluted. However, moderate and long-term but temporary degradation of EFH could occur if a
40 catastrophic coastal area was oiled following a large offshore spill. In most cases, the coastal
41 habitat would recover as the hydrocarbons were metabolized or buried, but marsh grasses
42 currently stressed by subsidence may not recover.

43
44 A catastrophic spill occurring offshore could affect all life stages of federally managed
45 species and their food sources. Managed species could be affected by the spill directly due to
46 lethal or sublethal toxicity or indirectly by long-term reduction in food resources and juvenile

1 and reproductive habitat. Adult life stages will likely avoid heavily oiled areas, although
2 sublethal exposures are possible (Roth and Baltz 2009). Early life stages of managed species
3 may be most vulnerable to hydrocarbon spills, which could trap and kill planktonic eggs and
4 larvae in the affected area. Mortality to pelagic eggs and larvae contacting the oil could be
5 particularly high in the case of a catastrophic spill at the surface that spreads over a wide area. In
6 addition to the size of the spill, the location of the spill and the season in which the spill occurred
7 would be important determinants of the impact magnitude. For example, catastrophic spills
8 occurring during recruitment periods or spills that oil critical spawning areas could result in
9 temporary population-level impacts on managed fish and invertebrates. Also, managed species
10 currently in serious population decline, such as sharks and bluefin tuna, may experience
11 population-level impacts if the spill were to kill a significant number of eggs and larvae in a
12 given year. For example, the HAPC for bluefin tuna extends from the 100 m (328 ft) isobath and
13 could also be affected by oil spills, and population-level impacts to Bluefin tuna could result
14 from catastrophic spills (Teo et al. 2007; Atlantic Bluefin Tuna Status Review Team 2011). The
15 effects of a CDE on such managed species could be major.

16
17 Wave and wind action, weathering, and biological degradation would dissipate oil in the
18 surface water, and suitable habitat condition would eventually return. The period of time needed
19 to reestablish appropriate habitat conditions following a spill would depend upon the
20 characteristics of the individual spill and would be related to many factors, including the EFH
21 resource affected, the location of the spill, the nature of transporting currents, the magnitude of
22 the spill, and the chemical characteristics of the spilled oil. With the exception of sensitive
23 habitats such as corals and chemosynthetic communities, EFH affected by oil spills is expected
24 to fully recover within a few years. Sensitive habitats with slow-growing biota may take longer
25 to recover or may not recover at all. Overall, accidental large spills could have negligible to
26 moderate effects on marine EFH. The effects for a CDE could be more severe depending on the
27 volume, duration, and persistence.

28
29
30 **4.4.6.4.2 Alaska – Cook Inlet.** The Cook Inlet Planning Area contains EFH for a
31 variety of fish and invertebrate species that can be broadly categorized into three groups based
32 upon the relevant Fishery Management Plans (FMPs): Gulf of Alaska groundfish, Alaska
33 salmon, and Alaska weathervane scallop. As identified in the FMPs, the EFH includes bottom
34 and water-column habitat in streams, lakes, ponds, wetlands, and marine and coastal waters.
35 Consequently, activities that degrade these aquatic habitats could adversely affect EFH for one or
36 more species. For the purposes of this analysis, potential impacts on EFH resources in the Cook
37 Inlet Planning Area and adjacent waters are generally addressed. EFH in Cook Inlet potentially
38 affected by exploration, site development, and production activities are discussed in detail in
39 individual sections including coastal and estuarine (Sections 4.4.6.1.2) and marine benthic
40 habitats (Section 4.4.6.2.2) and the marine water column (Section 4.4.6.3.2). Impacts on Cook
41 Inlet fish and fisheries from the Program are discussed in (Sections 4.4.7.3.2 and 4.4.11.2).
42 Because of the connection with adjacent marine areas, this evaluation also considers the potential
43 for effects on fish populations in the overall Gulf of Alaska.

1 **Routine Operations.**

2
3 **Exploration and Site Development.** During the exploration and site development phase,
4 the primary impacts on EFH could occur as a result of drilling and drilling waste discharge,
5 seismic surveys, and the placement of drilling units, production platforms, and pipelines. Each
6 seismic survey would be completed within weeks. While it is anticipated that there would be no
7 permanent population-level effects on managed species in Cook Inlet or the Gulf of Alaska from
8 seismic surveys, individual fishes, especially egg and larval life stages in close proximity (1 to
9 5 m [3 to 16 ft]) to air gun arrays (Dalen and Knutsen 1986; Holliday et al. 1987; Turnpenny and
10 Nedwell 1984), could suffer mortality or injury, and adult fishes located farther from the noise
11 could exhibit short-term avoidance and behavioral alteration. The migration of managed salmon
12 could also be temporarily disrupted. Additional sources of noise from drilling, construction of
13 platforms and pipelines, and boat traffic could also temporarily disturb or displace individual
14 fish. All the noise associated with these activities would be temporary and is expected to result
15 only in minor impacts on EFH and managed species in Cook Inlet.

16
17 The vast majority of marine EFH affected by the Program would be soft sediments. It is
18 anticipated that 1.5 to 4.5 ha (4 to 11 ac) of seafloor habitat in the Cook Inlet Planning Area
19 could be affected by platform construction under the proposed action. It is also estimated that
20 80 to 241 km (50 to 150 mi) of new pipelines would be installed offshore. Pipelines could be
21 trenched or installed and anchored on the sediment surface. Placing the pipeline on the sediment
22 surface could result in permanent loss of soft sediment EFH. Ground-disturbing activities would
23 result in increased turbidity, which would lower the water quality of EFH in small areas for a
24 limited amount of time. Although adult managed fish are not likely to be killed or injured during
25 bottom disturbance, bottom-disturbing activities could injure, displace, or kill early life stages of
26 managed species or bury the benthic prey of managed species. Scallops have less mobility than
27 fish and may be killed, injured, or displaced by bottom disturbance. The migration of managed
28 salmon could also be temporarily disrupted by bottom disturbance.

29
30 Pipeline construction in nearshore subtidal habitats could damage marine plant EFH by
31 mechanically removing the plants or smothering them through sedimentation. Areas containing
32 high densities of aquatic vegetation are typically avoided during construction activities due to a
33 lease stipulation calling for protection of important or unique biological populations or habitats.
34 Pipeline crossings of streams could affect EFH for several life stages of anadromous salmon,
35 including eggs, larvae, juveniles, and adults. The Alaska Department of Fish and Game
36 (ADF&G) reviews plans for construction activities for potential impacts on salmon and other
37 fish species and requires permits to be issued before stream pipeline crossings can be installed.
38 Therefore, it is anticipated that impacts on anadromous salmon from freshwater pipeline
39 crossings would be minimized through appropriate permitting and management actions once
40 site-specific assessments are conducted.

41
42 It is anticipated that 4 to 12 exploration and delineation wells and 42 to 114 production
43 wells will be drilled in Cook Inlet under the proposed action. It is assumed that drilling muds
44 and cuttings from the exploration and delineation wells would be discharged into Cook Inlet and
45 could temporarily affect benthic and water-column EFH resources. While the toxicity of those
46 cuttings is expected to be low and within permitted levels, the drilling wastes that are discharged

1 would temporarily increase turbidity and sediment deposition, and small numbers of managed
2 species could be temporarily displaced. In the mixing area near the discharge site, eggs and
3 larvae of managed groundfish and scallops could be killed or injured. Settlement of discharged
4 cuttings on the seafloor could smother some prey species and change substrate composition in
5 the area where the cuttings settle. However, the discharge of all drilling muds and cuttings
6 would be subject to NPDES permitting requirements that would greatly reduce the impacts on
7 EFH and managed species.

8
9 Overall, exploration and site development activities are expected to result in moderate
10 impacts on EFH and managed species. Recovery of EFH habitat and benthic food resources
11 could range from short term to long term.

12
13 **Production.** The primary production activities that could affect EFH include bottom
14 disturbance from anchors and the discharge of produced water. Bottom disturbance represents a
15 chronic, long-term but moderate and localized impact on EFH. It is assumed that all produced
16 water would be disposed of by injection into permitted disposal wells. Therefore, the effects of
17 produced water discharges on sediment and water-column EFH are expected to be minimal.

18
19 After new platforms have been established, sessile fouling organisms would colonize the
20 underwater portions of the structures, and they would attract prey for unmanaged species as well
21 as managed species such as rockfish. Over time, this could change the spawning, breeding, and
22 feeding patterns of some managed fish.

23
24 Overall, production activities are expected to result in minor impacts on EFH and
25 managed species.

26
27 **Decommissioning.** During decommissioning and structure removal, only nonexplosive
28 methods would be used to sever conductors and pilings. Nonexplosive removals (e.g., abrasive,
29 mechanical, or diver cutters) are expected to have little impact on EFH resources and managed
30 species (Section 4.4.7.3.2). Many platforms would be floating, and the seafloor would be
31 temporarily disturbed by the removal of platform mooring structures. Removing structures
32 would also remove the associated biological communities that serve as prey for managed fish
33 species, thereby forcing these species to relocate to other foraging areas. Overall,
34 decommissioning activities are expected to result in negligible impacts on EFH and managed
35 species.

36
37 **Accidents.** Most accidental hydrocarbon releases in the Cook Inlet Planning Area would
38 be small and would result in only negligible effects on EFH and managed species, while larger
39 releases could have a greater adverse impact on EFH and various life stages of managed species
40 depending upon the timing, location, and magnitude of an oil spill. Impacts from spills would be
41 greatest if a large spill occurred during a reproductive period or contacted a location important
42 for spawning or growth such as intertidal and nearshore subtidal habitats. Small releases would
43 degrade bottom water quality, but the overall contaminant impacts on pelagic habitat resources
44 will be minor and short-term, given the localized nature of a small release and the natural
45 dilution and breakdown of hydrocarbons. Large spills have the potential to degrade EFH over a
46 wider area than small spills and could potentially reduce the habitat value and ecosystem

1 function in the areas affected. Eventually, the oil would be transported from the area as well as
2 broken down by natural processes.

3
4 The period of time needed to reestablish appropriate EFH conditions following a spill
5 would depend upon the characteristics of the individual spill and many factors, including the
6 location of the spill, the nature of transporting currents, the magnitude of the spill, and the
7 chemical characteristics of the spilled oil. For example, while most of the waters within the
8 Cook Inlet Planning Area remain open throughout the winter, currents could transport oil under
9 ice to surrounding areas. Oil spilled under ice is more difficult to locate and clean than surface
10 spills. As evidenced by effects of the *Exxon Valdez* oil spill, recovery of some EFH resources
11 could occur within less than a year, while shoreline resources could continue to be affected at
12 some level for 10 yr or more (*Exxon Valdez* Oil Spill Trustee Council 2009a). Wave and wind
13 action, weathering, and biological degradation would dissipate spilled oil in the surface water,
14 and water-column EFH resources would likely recover most quickly. Sediments could recover
15 much more slowly. Following the *Exxon Valdez* oil spill, contamination persisted in some
16 freshwater benthic habitats for at least 4 yr (Murphy et al. 1999) and oil contaminating intertidal
17 sediments continued to reduce survival of eggs for anadromous salmon for a number of years
18 after the spill (Peterson et al. 2003). Similarly, intertidal sediments and benthic communities are
19 still listed as recovering (*Exxon Valdez* Oil Spill Trustee Council 2010c). Like EFH, managed
20 species would eventually recover from catastrophic spills, although the recovery could take
21 many years. The *Exxon Valdez* Oil Spill Trustee Council evaluated the status of several
22 managed species following the *Exxon Valdez* spill, including sockeye salmon, pink salmon, and
23 rockfish. The salmon were listed as recovered within a decade after the spill and rockfish as very
24 likely recovered (*Exxon Valdez* Oil Spill Trustee Council 2010c).

25
26 Overall, accidental hydrocarbon releases could have negligible to moderate effects on
27 EFH largely depending on the size of spill, location, environmental factors, and uniqueness of
28 the affected EFH.

29
30 **Catastrophic Discharge Event.** The PEIS analyzes a CDE of 75,000 to 125,000 bbl
31 (Table 4.4.2-2). Deeper subtidal sediment EFH may be less affected because hydrocarbons
32 would tend to float over the sediments. The potential for severe impacts from accidents would
33 be greatest from oil washed inshore into wetlands, intertidal zones, and shorelines where spilled
34 oil could contaminate nearshore habitat and associated prey species. Spilled oil could also kill
35 kelp and other marine plants that provide food and nursery habitat for managed salmon and
36 groundfish. Spilled oil concentrated along the coastline at the mouths of streams or rivers may
37 disrupt migration patterns for some species, such as eulachon or salmon, by causing fish to avoid
38 contaminated areas. In some cases, toxic fractions (e.g., PAHs) of spilled oil could also reach
39 freshwater areas where salmon eggs are deposited in stream bottoms. PAHs in the parts-per-
40 billion range can cause sublethal impacts on developing fishes (MMS 2007a). Depending on the
41 timing and severity of an oil spill, adult anadromous fish migrating from marine waters to
42 freshwater to spawn and juveniles migrating seaward from freshwater could be harmed by high
43 concentrations of hydrocarbons. Large, mobile adult managed species in Cook Inlet would
44 likely avoid hydrocarbon spills by temporarily moving to other areas. However, small obligate
45 benthic species as well as pelagic eggs and larvae of some managed species and organisms that
46 serve as their prey may be unable to avoid the oil.

1 **4.4.6.4.3 Alaska – Arctic.** There are two FMPs designating EFH in the
2 Beaufort/Chukchi Planning Areas: one for Alaska salmon and one for arctic fishes (NPFMC and
3 NMFS 1990; NPFMC 2009). Activities that degrade these aquatic habitats could adversely
4 affect EFH for one or more species. For the purposes of this analysis, potential impacts on EFH
5 resources in the Beaufort/Chukchi Planning Area and adjacent waters are generally addressed.
6 EFH in the Beaufort and Chukchi Seas potentially affected by exploration, site development, and
7 production activities are discussed in detail in individual sections including coastal and estuarine
8 (Sections 4.4.6.13) and marine benthic habitats (Section 4.4.6.2.3) and the marine water column
9 (Section 4.4.6.3.3). Impacts on Beaufort/Chukchi Planning Area fish and fisheries from the
10 Program are discussed in Section 4.4.7.3.3 and Section 4.4.11.3.

11 **Routine Operations.**

12 ***Exploration and Site Development.*** During the exploration and site development phase,
13 impacts on EFH could occur as a result of drilling and drilling waste discharge, seismic surveys,
14 the placement of subsea drilling units, production platforms, pipelines, and construction of
15 artificial islands. While it is anticipated that there would be no permanent population-level
16 effects on fishes in the Beaufort/Chukchi Planning Area from seismic surveys, individual fishes,
17 especially egg and larval life stages, in close proximity (1 to 5 m [3 to 16 ft]) to air gun arrays
18 could suffer mortality or injury, and juvenile and adult fishes located farther away could exhibit
19 temporary behavioral alteration including spawning/migratory behavior (Dalen and
20 Knutsen 1986; Holliday et al. 1987; Turnpenny and Nedwell 1994). Additional sources of noise
21 from activities such as drilling, platform and pipeline placement, and boat traffic could also
22 temporarily disturb or displace individual fish. All the noise associated with these activities
23 would be temporary and affect a small area and therefore is expected to result in only minor
24 impacts on EFH and managed species in the Beaufort/Chukchi Planning Area.
25
26

27
28 The vast majority of marine EFH affected by the Program would be soft sediments on the
29 continental shelf in less than 91 m (300 ft) of water. Under the proposed action, up to 13.5 ha
30 (33 ac) of seafloor habitat could be permanently covered by up to 9 artificial islands, and as
31 much as 567 ha (1,401 ac) of seafloor habitat could be disturbed by pipeline placement.
32 Pipelines located in water less than 50 m (165 ft) would be trenched to avoid damage from ice
33 scour. In addition, up to 92 subsea production wells could be constructed. The construction of
34 artificial islands and the placement of pipelines on the sediment surface would alter existing
35 seafloor EFH and the associated communities. Sediment-disturbing activities would increase
36 turbidity, which would lower the water quality of EFH in small areas for a limited amount of
37 time, typically causing fish to leave the areas until water quality improves. The migration of
38 managed salmon could also be temporarily disrupted by bottom disturbance, although salmon are
39 relatively uncommon in the Beaufort and Chukchi Seas. Although adult managed species are
40 less likely to be killed or injured during bottom disturbance, bottom-disturbing activities could
41 injure, displace, or kill early life stages of managed species or bury the benthic prey of managed
42 species. However, the sediments would eventually settle out and would not experience
43 permanent effects. Pipeline trenching and island construction could damage marine plants
44 associated with EFH by mechanically removing the plants or smothering them through
45 sedimentation. Marine vegetation is concentrated in relatively few areas within the Beaufort Sea
46 and Chukchi Sea Planning Areas (e.g., the Stefansson Sound Boulder Patch Community), and

1 impacts on such areas are typically minimized during construction activities by stipulations
2 protecting sensitive biological habitats.

3
4 It is assumed that drilling muds and cuttings from the exploration and delineation wells
5 would be discharged into the Beaufort and Chukchi Seas. The discharges of drilling fluids and
6 cuttings could temporarily affect some EFH resources. While the toxicity of those cuttings is
7 expected to be low and within permitted levels, the drilling wastes that are discharged would
8 temporarily increase turbidity and sediment deposition, and a small number of managed species
9 could be temporarily displaced. In the mixing area near the discharge site, eggs and larvae of
10 managed arctic fishes could be killed or injured. Settlement of discharged cuttings on the
11 seafloor could smother some prey species and change substrate composition in the area where
12 the cuttings settle. However, the discharge of all drilling muds and cuttings would be subject to
13 NPDES permitting requirements that would greatly reduce the impacts on EFH and managed
14 species.

15
16 Gravel island and ice road construction may affect freshwater EFH depending on the
17 location and timing of the activities. Gravel for island construction is mined from river bars, and
18 water for construction of ice roads is pumped from local rivers and lakes to desired areas to build
19 a rigid surface. Removal of gravel and water could increase turbidity and reduce the water
20 quality of EFH in affected rivers. The ADF&G requires reviews of such activities for potential
21 impacts on salmon and other fish species and requires permits to be issued before gravel mining
22 and water withdrawals can be initiated.

23
24 Overall, the impacts of exploration and site development activities on EFH and managed
25 species are expected to be moderate.

26
27 **Production.** The primary production activities that could affect EFH include bottom
28 disturbance from anchors and the discharge of produced water. Bottom disturbance represents
29 chronic, long-term, but moderate and localized impacts on EFH. Pipelines not buried would be
30 anchored in place which would minimize their movement and potential to disturb sediment EFH.
31 It is assumed that all produced water would be disposed of by injection into permitted disposal
32 wells. Therefore, the effects of produced water discharges on sediment and water-column EFH
33 are expected to be minimal. Platform and island construction will introduce floating or benthic
34 hard substrate that may attract managed species and their prey. Over time, this could change the
35 spawning, breeding, and feeding patterns of some managed fish.

36
37 Chronic discharges of contaminants in ice roads would occur during every breakup from
38 fluids entrained in the roads. Entrained contaminants from vehicle exhaust, grease, antifreeze,
39 oil, and other vehicle-related fluids could potentially affect EFH. These discharges are not
40 expected to be major; however, they would exist over the life of the field.

41
42 Overall the impacts of production activities on EFH and managed species are expected to
43 be minor.

44
45 **Decommissioning.** Bottom disturbance during platform removal would temporarily
46 disturb EFH by increasing noise and turbidity for some length of the water column. During

1 decommissioning and structure removal, only nonexplosive methods would be used to sever
2 conductors and pilings. Nonexplosive removals (e.g., abrasive, mechanical, or diver cutters) are
3 expected to have little impact on EFH resources and managed species (Section 4.4.7.3.2). These
4 impacts would temporarily degrade EFH quality and potentially kill or injure managed species,
5 but conditions would return to normal as suspended sediments dispersed and resettled, and the
6 long-term impacts on EFH would be negligible. Removing structures would also remove the
7 associated fouling communities that serve as prey for managed fish species, thereby forcing these
8 species to relocate to other foraging areas. Gravel islands would be left in place where they
9 would wash away and introduce fine sediments into the water column over an extended period of
10 time.

11
12 Overall, only negligible impacts on EFH are expected to result from decommissioning
13 activities.

14
15 **Accidents.** Most accidental hydrocarbon releases in the Beaufort and Chukchi Planning
16 Areas would be small. Small releases would degrade bottom water quality, but the overall
17 contaminant impacts on pelagic habitat resources will be minor and short-term, given the
18 localized nature of a small release and the natural dilution and breakdown of hydrocarbons.
19 Large spills would degrade EFH over a wider area than small spills and potentially reduce the
20 habitat value and ecosystem function in the areas affected. Impacts from spills would be greatest
21 if a large spill occurred during a reproductive period or contacted a location important for
22 spawning or growth such as intertidal and nearshore subtidal habitats. Eventually, the oil would
23 be transported from the area as well as broken down by natural processes.

24
25 Toxic fractions of oil in the parts-per-billion range can cause sublethal impacts on
26 developing fishes (MMS 2007a). Depending on the timing and severity of an oil spill, adult
27 anadromous fish migrating from marine waters to fresh water to spawn and juveniles migrating
28 seaward from freshwater could be harmed by high concentrations of hydrocarbons. Most adult
29 managed species in the Beaufort and Chukchi Seas are highly mobile and would likely avoid oil
30 spills by temporarily moving to other areas. However, small obligate benthic species and egg
31 and larval life stages of managed species as well as planktonic organisms that serve as their prey
32 may be unable to avoid hydrocarbon spills. In addition, oil reaching the intertidal zone can
33 persist in the sediments and cause sublethal impacts on fish eggs and larvae for multiple years
34 (Peterson et al. 2003).

35
36 Wave and wind action, weathering, and biological degradation by microbes would
37 dissipate oil in the surface water, and EFH would be reestablished after some period of time.
38 The period of time needed to reestablish appropriate EFH conditions following a spill would
39 depend upon the characteristics of the individual spill and would be related to many factors,
40 including the habitat affected, the location of the spill, the nature of transporting currents, the
41 magnitude of the spill, and the chemical characteristics of the spilled oil. Studies following the
42 *Exxon Valdez* spill found that water column EFH recovered in less than 1 to 2 years
43 (Boehm et al. 2007). Subtidal habitat and communities are considered to be very likely
44 recovered by the *Exxon Valdez* Oil Spill Trustee Council (2010c), but as of 2010, intertidal
45 sediments and communities are considered to still be recovering from the *Exxon Valdez* spill
46 (*Exxon Valdez* Oil Spill Trustee Council 2010c). Impacts to kelp habitat from an oil spill could

1 be long-term, but are not expected to be permanent. Laminaria beds oiled by the *Exxon Valdez*
2 spill recovered within 10 years (Dean and Jewett 2001). Overall, accidental oil spill could have
3 negligible to moderate effects on EFH largely depending on the size of the spill, its location,
4 environmental factors, and the uniqueness of the affected EFH.
5

6 **Catastrophic Discharge Event.** The PEIS analyzes a CDE up to 2.2 million bbl in the
7 Chukchi Sea Planning Area and up to 3.9 million bbl in the Beaufort Sea Planning Area. Deeper
8 subtidal sediment EFH may be less affected because hydrocarbons would tend to float over the
9 sediments. The potential for severe impacts from accidents would be greatest if large quantities
10 of oil from catastrophic spills washed inshore into wetlands, intertidal zones, and shorelines
11 where spilled oil could contaminate nearshore EFH and associated prey species. Spilled oil
12 reaching wetland habitat could kill vegetation and associated invertebrates and small fish that are
13 prey species for managed species. Deeper subtidal sediment EFH may be less affected because
14 hydrocarbons would tend to float over the sediments. Similar effects are expected to those
15 described above, but managed species that suffer large losses of early life stages or that are
16 currently in decline could suffer population-level effects from catastrophic oil spills. A single
17 catastrophic spill could cause long-term declines of managed species that rely on shallow coastal,
18 intertidal, and freshwater areas. Spilled oil could smother kelp and other marine plants, reducing
19 habitat and substrate for potential prey of managed species. Oil spilled under ice is more
20 difficult to locate and remove than surface spills. Since weathering would be greatly reduced by
21 ice cover, managed species with mobility could continue to be harmed or killed as they drift into
22 the trapped oil. In addition, the sea ice that provides habitat for managed species such as
23 juvenile arctic cod could be uninhabitable.
24
25

26 **4.4.6.4.4 Conclusion.** Most impacts on EFH from oil and gas exploration and
27 production activities would likely result from bottom disturbance and the creation of artificial
28 reefs by production platforms. The magnitude of impacts on sensitive marine and coastal EFH
29 would be limited by specific lease stipulations and site-specific analyses conducted for particular
30 lease sales. Managed species, particularly egg and larval stages, could be killed, injured, or
31 displaced from the immediate vicinity of oil and gas activities. No more than moderate impacts
32 on EFH are expected to result from routine Program activities and no population-level impacts
33 on managed species are expected. Recovery of EFH habitat and benthic food resources from oil
34 and gas activities would range from short term to long term.
35

36 The severity of effects of accidental hydrocarbon spills on EFH would depend on the size
37 of the spill, its location, environmental factors, and the uniqueness of the affected EFH. While
38 most accidents would be small and would have relatively small impacts on EFH, large or CDE-
39 level spills that reach coastal EFH could have more persistent impacts and could require
40 remediation. A single CDE spill could cause long-term declines of managed species that rely on
41 shallow coastal, intertidal, and freshwater areas. Adult managed species would probably not be
42 greatly affected by a hydrocarbon spill in open water areas, but small obligate benthic species,
43 eggs, larvae, and some managed species and their prey could experience lethal and sublethal
44 effects from contact with hydrocarbons. In Alaskan waters, spills occurring under ice could
45 result in long-term degradation of EFH and managed species because of the cleanup difficulties;
46 largest impacts would be incurred with a CDE-level spill. Managed species that suffer large

1 losses of early life stages or that are currently in decline could suffer population-level effects
2 from catastrophic oil spills.

3 4 5 **4.4.7 Potential Impacts on Marine and Coastal Fauna**

6 7 8 **4.4.7.1 Mammals**

9
10 This section addresses the potential impacts to both marine mammals and terrestrial
11 mammals in context of each program area. It should be noted that both NMFS and FWS have
12 statutory and regulatory mandates under the ESA and MMPA for mammals. Under the MMPA
13 (16 USC 1371; 50 CFR Subpart 1), the taking of marine mammals without a permit or
14 exemption is prohibited. The term “take” under the MMPA means “to harass, hunt, capture, kill
15 or collect, or attempt to harass, hunt, capture, kill or collect.” The MMPA has defined takes by
16 “harassment” in two ways: (1) level A harassment is “any act of pursuit, torment, or annoyance
17 which has the potential to injure a marine mammal or marine mammal stock in the wild,” and
18 (2) level B harassment is “any act of pursuit, torment, or annoyance, which has the potential to
19 disturb a marine mammal or marine mammal stock in the wild by causing disruption of
20 behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding,
21 feeding, or sheltering but which does not have the potential to injure a marine mammal or marine
22 mammal stock in the wild.” In 30 CFR 250 Subpart B, BOEM requires operators of Federal oil
23 and gas leases to meet the requirements of ESA and MMPA. The regulations outline the
24 environmental, monitoring, and mitigation information that operators must submit with proposed
25 plans for exploration, development, and production.

26 27 28 **4.4.7.1.1 Gulf of Mexico.**

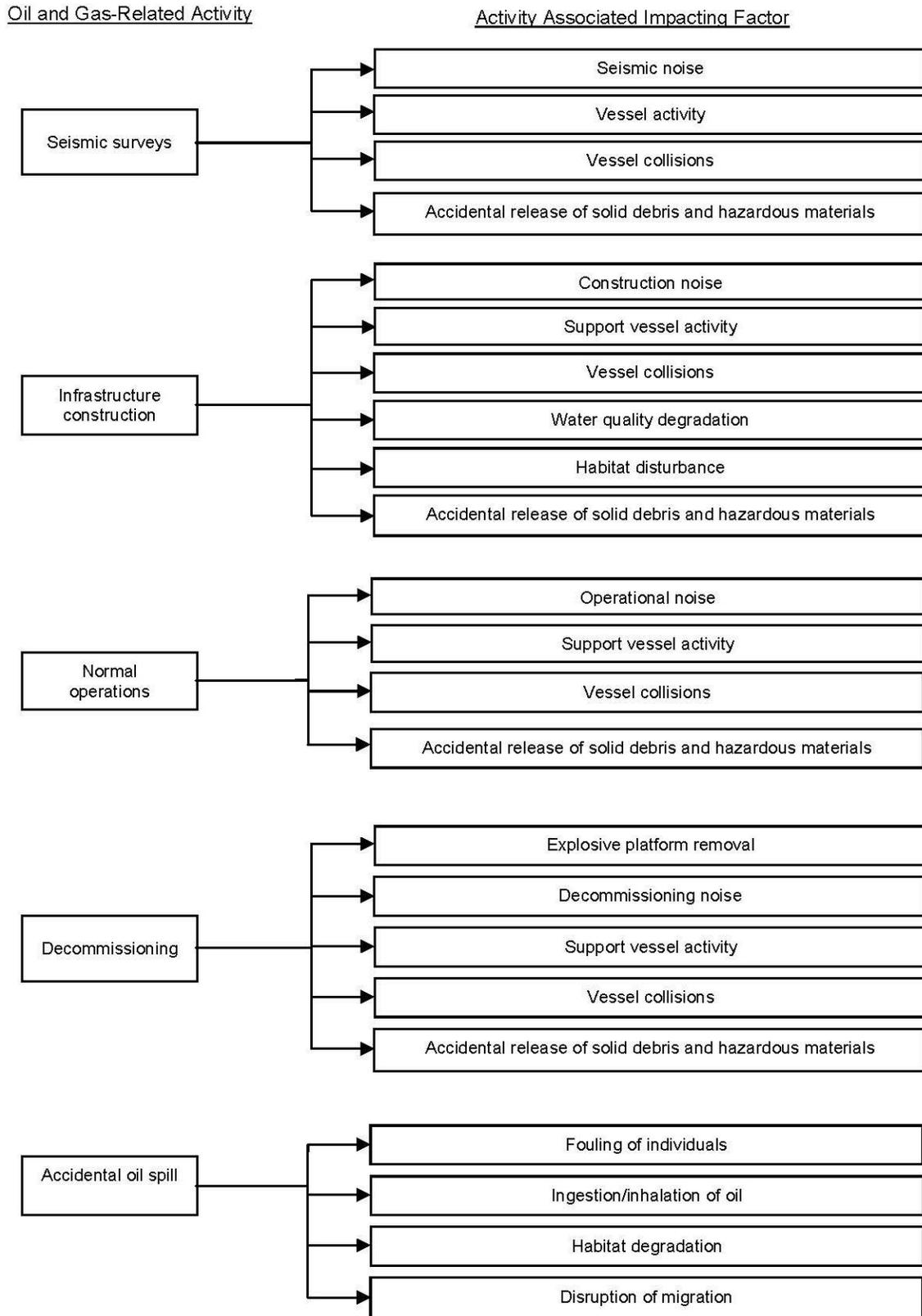
29
30 **Marine Mammals.** There are 29 species of marine mammals, including six endangered
31 whale species and the endangered West Indian manatee, that may occur in the northern GOM
32 (Section 3.4.4.2.1), and which therefore could be affected by normal operations associated with
33 the proposed action.

34
35 **Routine Operations.** As part of the proposed action, 1,000 to 2,100 exploration and
36 delineation wells and 1,300 to 2,600 development and production wells are projected to be
37 drilled, while 200 to 450 new platforms and up to 2 FPSOs are projected to be used. Additional
38 activities planned as part of the proposed action include 3,862 to 12,070 km (2,400 to 7,500 mi)
39 of new pipeline (Table 4.4.1-1). Although a specific scenario for geophysical operations has not
40 been prepared, exploratory and on-lease seismic surveys are expected to result from the Program.
41 Table 4.4.7-1 illustrates how each of the impacting factors associated with OCS oil and gas
42 development may affect marine mammals and their habitats, while Figure 4.4.7-1 presents a
43 conceptual model of potential impacting factors for marine mammals from oil- and gas-related
44 activities (including accidental oil spills).

1 **TABLE 4.4.7-1 Impact Factor Data Matrix for Marine Mammals^a**

Resource Receptor Category Potentially Affected	O&G Impacting Factor									
	Collisions with Support Vessels	Noise			Presence of Support Vessels	Onshore Construction and Operation	Offshore Infrastructure Construction, Operation, Decommissioning	Produced Water, Drill Cuttings and Mud	Solid Wastes and Debris	Accidental Oil Spills
		Seismic Exploration	Construction, Operation, and Decommissioning	Disruption of normal behavior						
Individuals (adults and juveniles)	Injury from ship strikes	Injury; disruption of normal behavior	Disruption of normal behavior	Disruption of normal behavior	Physical disturbance or reduced habitat quality associated with noise and/or human presence	Physical disturbance or reduced habitat quality associated with noise and/or human presence	Toxicity	Ingestion and/or entanglement	Fouling, toxicity	
Onshore Habitats (e.g., haul-out sites and rookeries)	–	–	–	–	Physical disturbance or loss; reduced habitat quality	–	–	–	Physical habitat loss; reduced quality	
Offshore Habitats (e.g., calving grounds, foraging areas, or wintering grounds)	–	–	–	–	–	Temporary habitat disturbance during construction; possible long-term increase in habitat	Reduced habitat quality	–	Physical habitat loss; reduced quality	
Migration	Displacement or impediment	Displacement or impediment	Displacement or impediment	Displacement or impediment	Displacement or impediment for terrestrial movements (e.g., polar bears)	Displacement or impediment	–	–	Displacement or impediment	

^a A dash indicates that no impact is anticipated.



1

2 **FIGURE 4.4.7-1 Conceptual Model for Anticipated Impacting Factors for Marine Mammals**

1 Because of differences in the distribution and ecology of marine mammal species, routine
2 operations under the proposed action would not equally affect marine mammal species. All of
3 the mysticetes (baleen whales), except for the Bryde's whale, are considered extralimital or rare
4 in the northern GOM (Würsig et al. 2000). Because of their rarity, it is unlikely that individuals
5 of these species would be present where OCS-related activities would occur, and thus they would
6 not be affected by routine operations of the proposed action. Although the Bryde's whale is the
7 most frequently sighted mysticete whale, it is uncommon. While the Bryde's whale is present
8 throughout the year, it occurs primarily in the Eastern Planning Area (Davis et al. 2000;
9 Würsig et al. 2000; MMS 2004a). Waring et al. (2010) estimate a population size of
10 15 individuals. Thus, it would not be expected to be affected to any great extent by routine
11 operations under the proposed action.

12
13 In contrast to the mysticetes, many of the odontocetes (toothed whales) are considered
14 relatively common in the GOM OCS (Davis et al. 2000; MMS 2004a). Thus, there is a greater
15 potential that some individuals of these species to occur in areas where OCS-related activities
16 occur and to be affected during routine operations. The only odontocete listed as endangered is
17 the sperm whale, which is the most common large whale in the GOM. Sperm whales occur year-
18 round in all deepwater areas of the U.S. GOM, with a well-documented aggregation consistently
19 found in the shelf-edge waters around the 305-m (1,000-ft) depth contour south of the
20 Mississippi River Delta (Davis et al. 2000; MMS 2004a). Thus, this species may encounter
21 OCS-related activities occurring within the northern GOM, especially in deepwater areas of the
22 Central Planning Area.

23
24 Although manatees appear to prefer nearshore habitats, there are rare observations around
25 structures at offshore sites. Negligible impacts on the West Indian manatee are anticipated
26 because the 2012-2017 proposed action does not include routine operations in most of the
27 Eastern Planning Area. The potential for impacts on manatees would occur in nearshore habitats
28 where interactions with OCS-related activities (i.e., vessel traffic) exist. Service vessel impacts
29 would mainly occur in the Central and Western Planning Areas where manatees occasionally
30 occur.

31
32 The following analysis presents an overview of impacts on marine mammals from the
33 following routine operations: (1) seismic surveys, (2) construction of offshore facilities and
34 pipelines, (3) operations of offshore facilities and drilling rigs, (4) discharges and waste
35 generation, (5) service vessel and helicopter traffic, and (6) decommissioning.

36
37 Seismic Surveys. Sections 4.4.1.1 and 4.4.5.1.1 provide descriptions of seismic survey
38 technologies, energy outputs, operations, and general acoustic impacts. The type of O&G
39 activities presently occurring in the GOM include:

- 40
41 • Seismic surveys (includes high-resolution site surveys and various types of
42 seismic exploration and development surveys, including narrow azimuth,
43 multi azimuth and wide azimuth);
- 44
45 • Side-scan sonar surveys;
- 46

- 1 • Electromagnetic surveys;
- 2
- 3 • Geological and geochemical sampling; and
- 4
- 5 • Remote sensing (including gravity, gravity gradiometry, and magnetic
- 6 surveys).
- 7

8 Marine mammals produce and use sound to communicate as well as to orient, locate and
9 capture prey, and to detect and avoid predators (Hofman 2004; Southall et al. 2007). A panel of
10 experts in acoustic research from behavioral, physiological, and physical disciplines generated a
11 report, *Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations*
12 (Southall et al. 2007), which summarized existing acoustic and marine mammal data and made
13 recommendations for regulatory criteria and research. Noise generated by seismic surveys may
14 have physical and/or behavioral effects on marine mammals, such as (1) permanent or temporary
15 hearing loss, discomfort, and injury; (2) masking of important sound signals; and (3) behavioral
16 responses such as fright, avoidance, and changes in physical or vocal behavior
17 (Richardson et al. 1995; Davis et al. 1998b; Gordon et al. 1998; Nowacek et al. 2004, 2007).
18 Seismic surveys may also indirectly impact marine mammals by altering prey availability
19 (Gordon et al. 2003, 2004).

20
21 Southall et al. (2007) synthesized the understanding of underwater and aerial hearing in
22 some marine mammal groups and recommended some acoustic criteria. A precautionary
23 approach was used to derive frequency-specific marine mammal weighting functions; the marine
24 mammal hearing groups are broken down into five categories: (1) low-frequency cetaceans,
25 which are the mysticetes, have an estimated lower and upper frequency range of 7 to 22 kHz;
26 (2) mid-frequency species are estimated to have lower and upper frequency limits of hearing at
27 approximately 150 Hz and 160 kHz, respectively; (3) high-frequency cetaceans have an
28 estimated functional hearing between approximately 200 and 180 kHz; (4) pinnipeds in air have
29 an estimated functional hearing between 75 and 30 kHz; and (5) pinnipeds in water have an
30 estimated functional hearing between 75 and 75 kHz.

31
32 Almost all impacts of seismic surveys have been inferred or assumed by implication
33 rather than observed. There have been no documented instances of deaths, physical injuries, or
34 auditory (physiological) effects on marine mammals from seismic surveys. Behavioral responses
35 have been observed but the biological importance of such behavioral responses (to the individual
36 animals and populations involved) has not been determined.

37
38 The types of potential effects can be broken down into non-auditory injury, auditory
39 effects, behavioral effects, and masking. Nowacek et al. (2007), Richardson et al. (1995), and
40 Southall et al. (2007) have reviewed the effects of anthropogenic sound on marine mammals and
41 are incorporated by reference.

42
43 Permanent loss of hearing in a marine mammal (i.e., permanent threshold shift [PTS]) is
44 defined as the deterioration of hearing due to prolonged or repeated exposure to sounds that
45 accelerate the normal process of gradual hearing loss (Kryter 1985), or the permanent hearing
46 damage due to brief exposure to extremely high sound levels (Richardson et al. 1995). PTS

1 results in a permanent elevation in hearing threshold — an unrecoverable reduction in hearing
2 sensitivity (Southall et al. 2007) and this is considered level A harassment under the MMPA.
3 Noise may cause a temporary threshold shift (TTS), a temporary and reversible loss of hearing
4 that may last for minutes to hours. Animals suffering from TTS over longer time periods, such
5 as hours or days, may be considered to have a change in a biologically significant behavior,
6 because they could be prevented from detecting sounds that are biologically relevant, including
7 communication sounds, sounds of prey, or sounds of predators. TTS is considered level B
8 harassment under the MMPA. To date, for level B harassment, NMFS uses the 160-decibel (dB)
9 root-mean squared (rms) isopleth to indicate where level B harassment begins for acoustic
10 impulse sounds, such as seismic surveying. Also, NMFS' policy has been to use the 180-dB rms
11 isopleth where on-set level A harassment from acoustic sources potentially begins for cetaceans
12 (whales, dolphins and porpoises) and 190-dB rms isopleth for pinnipeds (seals, sea lions).
13

14 For the purpose of analysis, it is assumed that operators will implement survey and
15 monitoring mitigation (e.g., ramp-up, marine mammal observers, speed restrictions, exclusion
16 zones) currently required in the GOM to minimize or avoid impacts of seismic on marine
17 mammals with an emphasis on prevention of injury (auditory and non-auditory). Assuming the
18 implementation of these mitigations, the potential for injury is minimized. There remains a
19 greater potential for behavioral effects; therefore, the following discussion focuses on the
20 potential behavioral changes resulting from exposure to seismic operations. More detailed
21 discussions of impacts to marine mammals from seismic surveys in the GOM can be found in
22 MMS (2004).
23

24 *Non-Auditory Injury.* Non-auditory injury could include direct acoustic impact on tissue,
25 indirect acoustic impact on tissue surrounding a structure, acoustically mediated bubble growth
26 within tissues from supersaturated dissolved nitrogen gas, or resonance. However, resonances
27 are not anticipated given that the resonance frequencies of marine mammal lungs are generally
28 below that of the G&G seismic survey source signal (Nowacek et al. 2007; Zimmer and
29 Tyack 2007).
30

31 *Auditory Effects (PTS and TTS).* The hearing of marine mammals varies based on
32 individuals, thresholds of the species, location in relation to the sound source, frequency
33 discrimination, and the motivation of an individual to change behaviors due to the sound
34 (Richardson et al. 1995). PTS results in a permanent elevation in hearing threshold — an
35 unrecoverable reduction in hearing sensitivity (Southall et al. 2007). TTS is defined as a
36 temporary and reversible loss of hearing that may last for minutes to hours. The duration of TTS
37 depends on a variety of factors including intensity and duration of the stimulus. Therefore,
38 animals suffering from TTS over longer time periods, may be considered to have a change in a
39 biologically significant behavior, as they could be prevented from detecting sounds that are
40 biologically relevant, including communication sounds, sounds of prey, or sounds of predators.
41

42 *Behavioral Effects.* A number of studies have documented behavioral effects in response
43 to seismic surveys, primarily for marine mammals (Richardson et al. 1995, Southall et al. 2007).
44 The Bryde's whale is the only mysticete species occurring regularly in the GOM. As discussed
45 in Southall et al. (2007), the expected frequencies of best hearing sensitivity in mysticetes and
46 maximal air gun output at source may overlap. Given that no direct audiograms of mysticetes

1 have been obtained, it is impossible to define what level of sound above hearing threshold may
2 cause behavioral effects, which would be expected to be variable, complicated, and dependent
3 upon more than just the received sound level. For this reason, observations at sea have
4 concentrated on relating received sound levels to observed behavioral changes
5 (Malme et al. 1983, 1984, 1985, 1986, 1988; Reeves et al. 1984; Richardson et al. 1986;
6 Ljungblad et al. 1988; McDonald et al. 1993; Richardson and Malme 1993; Richardson 1998;
7 McCauley et al. 2000a, b).

8
9 Auditory thresholds of adult sperm whales have not been obtained. Ridgeway and Carder
10 (2001) studied the vocalizations of a neonate sperm whale which led them to believe that they
11 are sensitive to a wide range of frequencies. This was also hypothesized by Bowles et al. (1994).
12 Sperm whales are a highly vocal species under natural conditions (i.e., they click almost
13 continuously during dives). Jochens et al. 2008 synthesized the findings of the Sperm Whale
14 Seismic Study (SWSS) in the GOM. They stated that it does not appear that sperm whales in the
15 SWSS study area showed any horizontal avoidance to controlled exposure of seismic air gun sounds.
16 The data analysis suggested that, for at least some individuals, it is more likely that some decrease in
17 foraging effort may occur during exposure to full-array air gun firing as compared to the post-
18 exposure condition. Sperm whales are most likely acoustically aware of their environment and
19 can exhibit behavioral reactions in a number of ways, including interruption of vocal activity and
20 foraging. However, there are insufficient data to assign thresholds for acoustic disturbance to
21 sperm whales. Sperm whales are also deep divers, spending relatively little time at the surface
22 while feeding. Therefore, they may be less likely to receive any surface shielding afforded by
23 refractive effects caused by near surface hydrographic conditions, which can sometimes occur.
24 As air gun arrays are generally configured to produce a maximum, low frequency energy lobe
25 directly downwards toward the seabed, sperm whales may enter a region of increased
26 ensonification.

27
28 Dwarf and pygmy sperm whales are also deep-diving and use echolocation clicks in the
29 sonic and low ultrasonic frequency range (Willis and Baird 1998). Few audiograms have been
30 obtained for pygmy sperm whales, dwarf sperm whales, or beaked whales (Cook et al. 2006;
31 Finneran et al. 2009; Ridgeway and Carder 2001), so there still are insufficient data to determine
32 avoidance thresholds. Like sperm whales, they may be sensitive to a wide range of sound
33 frequencies, including those produced by air gun arrays. Similarly, beaked whales are also deep
34 divers, use echolocation clicks to find their prey, and have been shown to be susceptible to
35 acoustic disturbance (Frantzis 1998; Balcomb and Claridge 2001). Since they have similar
36 deep-diving habits and relatively widespread distributions in the GOM, this may warrant concern
37 for dwarf and pygmy sperm whales and beaked whales.

38
39 Delphinids include dolphins, killer whales, and pilot whales. Several studies have been
40 conducted documenting the effects of seismic operations on delphinid species. Finneran et al.
41 (2000a) discuss a behavioral response study measuring masked underwater hearing thresholds in
42 bottlenose dolphin and beluga whale, before and after exposure to seismic pulses from a
43 watergun. Ridgeway et al. (1997) showed that captive delphinids produced behavioral reactions
44 at levels at least 10 dB below those that induced TTS. Soto et al. (2006) and Van Parijs and
45 Corkeron (2001) showed vessel presence is sufficient to change behavior in some species and
46 situations.

1 Dolphin species are generally mid- to high-frequency hearing specialists
2 (Southall et al. 2007). While air guns are primarily low frequency (<200 Hz), they are
3 considered broadband and therefore there is energy at higher frequencies. These energies
4 encompass the entire audio frequency range of 20 Hz to 20 kHz (Goold and Fish 1998), and
5 extend well into the ultrasonic range up to 50 kHz (Sodal 1999). This high-frequency energy
6 must be taken into account when considering seismic interactions with Delphinids. The high-
7 frequency components of air gun emissions are of sufficient level to exceed the dolphin auditory
8 threshold curve at these low frequencies, even after spreading loss (Goold and Fish 1998).

9
10 Some studies, such as Wakefield (2001), have shown that vocal behaviors of common
11 dolphins may be altered by air guns. Stone (1996, 1997a, b, 1998) reported that common
12 dolphins, white beaked dolphins, and white sided dolphins were sighted in the vicinity of seismic
13 surveys less often when the guns were firing than when they were not firing. However, some
14 marine mammals are known to continue calling in the presence of seismic pulses. Their calls
15 can be heard between the seismic pulses (e.g., Richardson et al. 1986; McDonald et al. 1995;
16 Greene et al. 1999; Nieu Kirk et al. 2004; Smultea et al. 2004). Although Delphinids specialize in
17 hearing ranges generally outside of the majority of seismic survey impulse sounds, there is still
18 the potential for sounds from these surveys to fall within the acoustic sensitivity of toothed
19 whales and for behavioral responses to seismic noise to occur.

20
21 *Masking.* Auditory masking occurs when a sound signal that is of importance to a marine
22 mammal (e.g., communication calls, echolocation, environmental sound cues) is rendered
23 undetectable due to the high noise-to-signal ratio in a frequency band relevant to a marine
24 mammal's hearing range. In other words, noise can cause the masking of sounds that marine
25 mammals need to hear to in order to function effectively (Erbe et al. 1999). If sounds used by
26 the marine mammals are masked to the point where they cannot provide the individual with
27 needed information, critical natural behaviors could be disrupted and harm could result (Erbe and
28 Farmer 1998).

29
30 In the case of seismic surveys, where potential masking noise takes a pulsed form with a
31 low duty cycle (~10%, or 1 s of active sound for every 10 s of ambient noise) (MMS 2004), the
32 effect of masking is likely to be low relative to continuous sounds such as ship noise. Some
33 marine mammals are known to continue calling in the presence of seismic pulses. Their calls
34 can be heard between the seismic pulses (e.g., Richardson et al. 1986; McDonald et al. 1995;
35 Greene et al. 1999; Nieu Kirk et al. 2004; Smultea et al. 2004). Bowles et al. (1994) reported that
36 sperm whales ceased calling when exposed to pulses from a very distant seismic ship, while
37 other studies reported that sperm whales continued calling in the presence of seismic pulses
38 (Madsen et al. 2002; Tyack et al. 2003; Smultea et al. 2004; Holst et al. 2006;
39 Jochens et al. 2006).

40
41 Some marine mammals are known to increase the source levels of their calls in the
42 presence of elevated sound levels, or to shift their peak frequencies in response to strong sound
43 signals (Dahlheim 1987; Au 1993; review in Richardson et al. 1995; Lesage et al. 1999; Terhune
44 1999; Nieu Kirk et al. 2005; Parks et al. 2007). However, these studies tested other anthropogenic
45 sounds, not seismic pulses, and it is not known if air guns would elicit this same response. If so,
46 these adaptations would all reduce the importance of masking.

1 Construction of Offshore Facilities and Pipelines. Figure 4.4.7-2 presents a conceptual
2 model for potential effects of infrastructure construction on marine mammals. Construction and
3 trenching activities may affect habitat use for the short or long-term. Marine mammals are
4 mobile and able to avoid areas where construction or trenching is occurring so they are less
5 likely to be injured or killed but their behavior may be altered. Noise and human activity
6 associated with the construction of offshore facilities and pipelines (e.g., pile driving, vessel
7 presence) could disturb marine mammals that may be present in the vicinity of the construction
8 activity. Construction activities could disturb normal behaviors (e.g., feeding, social
9 interactions), mask calls from conspecifics, disrupt echolocation capabilities, temporarily affect
10 localized air/water quality and mask sounds generated by predators. Depending on the size of
11 the project, at any single location, offshore construction and trenching activities would be of
12 relatively short duration since the majority of construction activities would occur on land. The
13 length of time necessary for offshore construction depends on what is being constructed, the
14 water depth, procurement activities, the climatic conditions to install the platform could be
15 considered. It also depends on if the construction project is a fixed platform, semi-submersible
16 platform, or jack-up drilling platform and each one could take approximately 1 to 2 months to set
17 up, depending on the contractor. In addition, running a pipeline likely would not take more than
18 2–3 weeks.

19
20 Animals may leave the vicinity of a constructions area. Some known locations for the
21 endangered sperm whale includes, but is not limited to, the continental slope waters off the
22 Mississippi River Delta in the Central Planning Area (Jochens 2007; Davis et al. 2000;
23 MMS 2004a). Portions of the GOM that would be disturbed by the construction of new wells
24 and pipelines would be largely limited to the immediate footprint of the new structure and its
25 surroundings. Animals would be expected to locate to other suitable habitat nearby. Some
26 permanent displacement may occur, but would be largely limited to the local environment
27 surrounding individual wells or areas with well aggregations, and thus would not be expected to
28 affect overall habitat availability or cetacean access.

29
30 Currently in the northern GOM, the West Indian manatee is the only marine mammal that
31 has a federally designated critical habitat, and this habitat is limited to specific coastal and inland
32 marine and freshwater areas in peninsular Florida (west, southeast, and northeast Florida). As
33 pipeline landfalls and land-based facilities associated with the proposed action would not be
34 located in Florida, no impacts to West Indian manatee critical habitat would occur.

35
36 Under the proposed action, only a few individuals or small groups of marine mammals
37 would be temporarily disturbed behaviorally by routine construction of offshore facilities, and
38 disturbance of these individuals, given their localized nature, would not be expected to result in
39 population-level effects. Any impacts on marine mammals incurred from structure placement or
40 trenching would be short term and localized to the construction area and immediate
41 surroundings, and therefore unlikely to cause more than minor impacts to marine mammals.
42 Onshore construction and operation activities are unlikely to impact cetacean and sirenian
43 populations. Overall, the impacts associated with construction of offshore facilities and pipelines
44 are unlikely to have significant adverse effects on the size and recovery of any marine mammals
45 species or population in the GOM. It is assumed that BOEM will continue to implement GOM

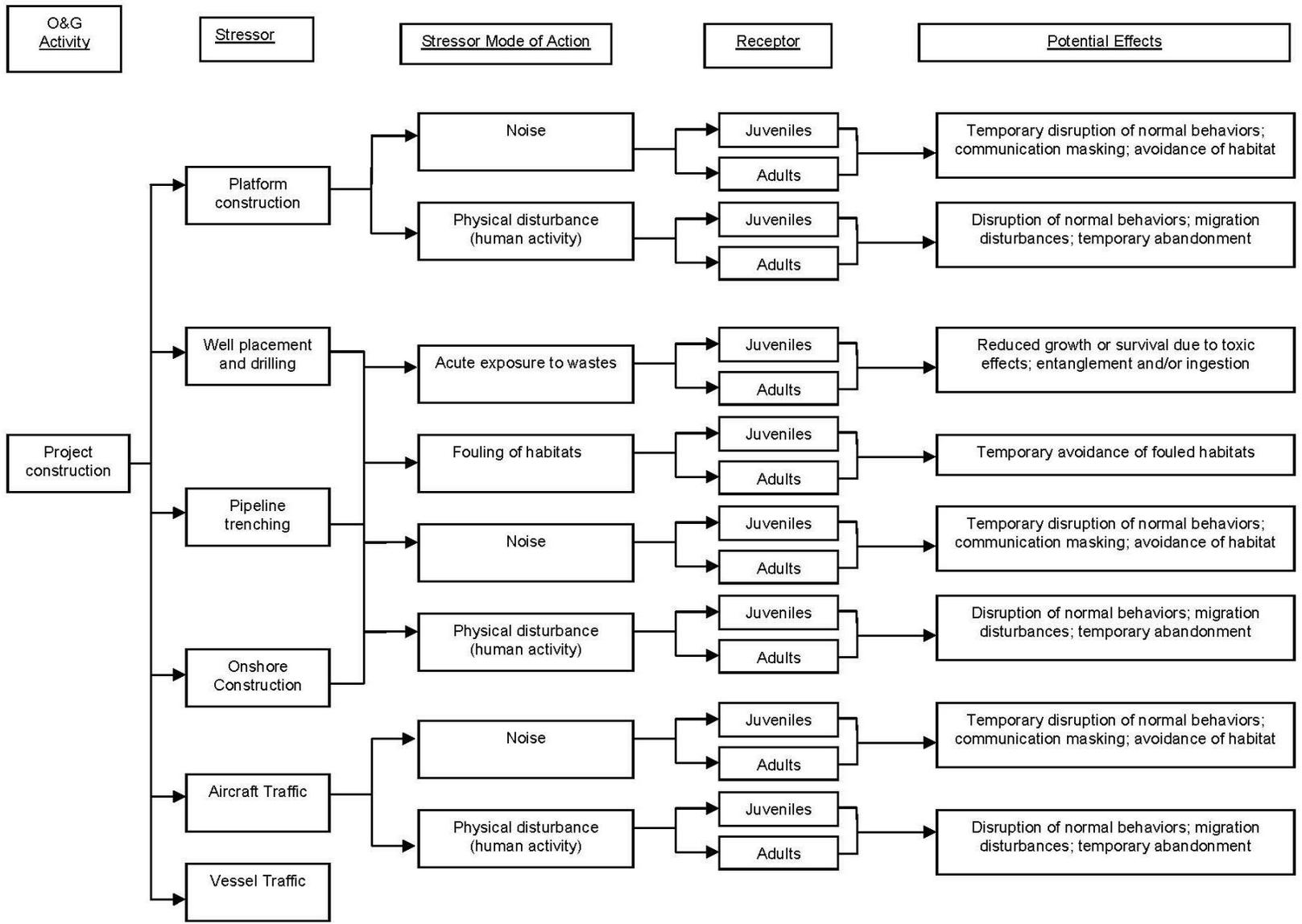


FIGURE 4.4.7-2 Conceptual Model for Potential Effects of Infrastructure Construction on Marine Mammals

1 guidelines currently in place to reduce impacts to marine mammals such as vessel strike
2 avoidance measures and marine debris awareness.

3
4 Operations of Offshore Facilities and Drilling Rigs. Noise from drilling could be
5 intermittent, sudden, and at times could be high intensity as operations take place. Sound from a
6 fixed, ongoing source like an operating drillship is continuous. However, the distinction between
7 transient and continuous sounds is not absolute on a drillship, as generators and pumps operate
8 essentially continuously; however, there are occasional transient bangs and clangs from various
9 impacts during operations (Richardson et al. 1995). Estimated frequencies from drilling by
10 semisubmersible vessels are broadband from 80 to 4,000 Hz, with an estimated source level of
11 154 dB re 1 μ Pa at 1 m. Tones of 60 Hz had source levels of 149 dB, 181 Hz was 137 dB, and
12 301 Hz was 136 dB (Greene 1986). The potential effects that water-transmitted noise have on
13 marine mammals include disturbance (subtle changes in behavior, interruption of previous
14 activities, or short- or long-term displacement), masking of sounds (calls from conspecifics,
15 reverberations from own calls, and other natural sounds such as surf or predators), physiological
16 stress, and hearing impairment. Individual marine mammals exposed to recurring disturbance
17 could be negatively affected. Malme et al. (1986) observed the behavior of feeding gray whales
18 in the Bering Sea during four experimental playbacks of drilling sounds (50–315 Hz; 21-minute
19 overall duration and 10% duty cycle; source levels of 156–162 dB re: 1 μ Pa-m). In two cases for
20 received levels 100–110 dB re: 1 μ Pa, there was no observed behavioral reaction. Avoidance
21 behavior was observed in two cases where received levels were 110–120 dB re: 1 μ Pa. These
22 source levels are all below NMFS's current 160-dB level B harassment threshold under the
23 MMPA.

24
25 The source levels from drilling are relatively low (154 dB and below, as cited by Greene
26 [1986] in Richardson et al. [1995]), below the level B (behavioral) harassment threshold of
27 160 dB (set by NMFS). According to Southall et al. (2007), for behavioral responses to
28 nonpulses (such as drill noise), data indicate considerable variability in received levels associated
29 with behavioral responses. Contextual variables (such as novelty of the sound to the marine
30 mammal and operation features of the sound source) appear to have been at least as important as
31 exposure level in predicting response type and magnitude. While there is some data from the
32 Arctic on baleen whales, there is little data on the behavioral responses of marine mammals in
33 the GOM from the sound of drilling. Southall et al. (2007) summarized the existing research,
34 stating that the probability of avoidance and other behavioral effects increases when received
35 levels increase from 120 to 160 dB. Marine mammals may exhibit some avoidance behaviors,
36 but their behavioral or physiological responses to noise associated with the proposed action,
37 however, are unlikely to have population-level impacts to marine mammals in the northern
38 GOM.

39
40 Discharges and Waste Generation. Table 4.4.1-1 presents information on drilling fluids,
41 drill cuttings, and produced waters discharged offshore as a result of the proposed action.
42 Produced water, drilling muds, and drill cuttings are discharged into offshore marine waters in
43 compliance with applicable regulations and permits. Compliance with regulations and permits
44 will limit the exposure of marine mammals to waste discharges. The discharge or disposal of
45 solid debris into offshore waters from OCS structures and vessels is prohibited by the BOEM

1 (30 CFR 250.40) and the USCG (International Convention for the Prevention of Pollution from
2 Ships [MARPOL], Annex V, P.L. 100-220 [101 Statute 1458]).
3

4 Most operational discharges are diluted and dispersed when released in offshore areas
5 and are considered to have sublethal effects (NRC 1983; API 1989; Kennicutt 1995;
6 Kennicutt et al. 1996). Any potential impacts from drilling fluids would be indirect, either as a
7 result of impacts to prey species or possibly through ingestion via the food chain
8 (Neff et al. 1989). However, marine mammals are generally not considered good
9 bioaccumulators of petroleum compounds from eating contaminated prey due to rapid
10 metabolism and excretion rates (Neff 1990). As such, impacts from discharges related to the
11 proposed action would not be expected to result in long term impacts to marine mammals
12 because these compounds would not assimilated.
13

14 Many types of plastic materials end up as solid waste during drilling and production
15 operations. Some of this material is accidentally lost overboard where cetaceans could consume
16 it or become entangled in it. The incidental ingestion of marine debris and entanglement could
17 adversely affect marine mammals. Industry has made good progress in debris management on
18 vessels and offshore structures in the last several years. It is assumed that BOEM will continue
19 to require implementation of current trash and debris elimination guidelines that appreciably
20 reduce the likelihood of marine mammals encountering marine debris from the proposed action.
21 Thus, impacts to marine mammals from entanglement in or ingestion of OCS-related trash and
22 debris under the proposed action would be negligible to minor.
23

24 Service Vessel and Helicopter Traffic. There may be 300 to 600 vessel and 2,000 to
25 5,500 helicopter trips per week under the proposed action (Table 4.4.1-1). Figure 4.4.7-3
26 presents a conceptual model for the potential effect of vessel traffic on marine mammals. Vessel
27 traffic could occur during seismic exploration, drilling and platform construction, platform
28 operation, and platform decommissioning.
29

30 Ship strikes are a concern for marine mammals. There have been documented reports of
31 cetaceans being struck by ships in the oceans throughout the world (Laist et al. 2001; Jensen and
32 Silber 2004; Glass et al. 2008), although none to date in the GOM as a result of offshore oil/gas
33 operations. Analyses by Vanderlaan and Taggart (2007) provides evidence that as vessel speeds
34 fall below 15 knots (27.75 km/hr or 17.25 mph), there is a substantial decrease in the probability
35 of a vessel strike to prove lethal to a large whale. Collisions with vessels greater than 80 m
36 (260 ft) in length are usually either lethal or result in severe injuries (Laist et al. 2001). In
37 addition, a majority of ship strikes seemed to occur over or near the continental shelf. Collisions
38 with vessels can cause major wounds on marine mammals and/or be fatal. Debilitating injuries
39 may have negative effects on a population through impairment of reproductive output
40 (MMS 2003e). Cetaceans are more likely to be struck by vessels if they are young or sick, slow
41 swimmers, distracted by feeding or mating activities, habituated to vessels, or congregated in an
42 area for feeding or breeding (Dolman et al. 2006). Vessel strikes in inland waterways are a
43 major cause of death in the manatee population. Because this species is rare in these planning
44 areas, encounters with OCS-related vessels in these areas would be unlikely.
45

1 Deep-diving whales, such as the sperm whale, may be more vulnerable to vessel strikes
2 given the longer surface period required to recover from extended deep dives. NMFS has
3 determined that vessel strikes are a “discountable” concern for sperm whales when vessel
4 avoidance measures are implemented (USDOC, NMFS 2007b); it is assumed for the purpose of
5 this analysis that BOEM will continue to requirement operator implementation of such avoidance
6 criteria and speed limitations.

7
8 It is possible that noise produced from vessels and, to a lesser extent helicopters, can
9 cause disturbance, masking of sounds, and physiological stress. The dominant source of noise
10 from vessels is from the propeller operation, and the intensity of this noise is largely related to
11 ship size and speed. Vessel noise from activities resulting from the proposed action will produce
12 low levels of noise, generally in the 150- to 170-dB re 1 μ Pa-m at frequencies below 1,000 Hz.
13 Vessel noise is transitory and generally does not propagate at great distances from the vessel.

14
15 The noise and the shadow from helicopter overflights, take-offs, and landings can cause a
16 startle response and can interrupt whales and dolphins while resting, feeding, breeding, or
17 migrating (Richardson et al. 1995). The Federal Aviation Administration’s Advisory
18 Circular 91-36D (September 17, 2004) encourages pilots to maintain higher than minimum
19 altitudes over noise-sensitive areas. Guidelines and regulations put in place by NOAA Fisheries
20 under the authority of the Marine Mammal Protection Act include provisions specifying that
21 helicopter pilots maintain an altitude of 305 m (1,000 ft) within 91 m (300 ft) of marine
22 mammals. Helicopter occurrences would be temporary and pass within seconds. Marine
23 mammals are not expected to be adversely affected by routine helicopter traffic operating at
24 prescribed altitudes.

25
26 Decommissioning. Under the proposed action, 150 to 275 platforms may be removed
27 with explosives from the northern GOM. Figure 4.4.7-4 presents a conceptual model for
28 potential impacts of decommissioning on marine mammals.

29
30 BOEM published a programmatic EA on decommissioning operations (MMS 2005) that,
31 in part, addresses the potential impacts of explosive- and nonexplosive-severance activities on
32 OCS resources, particularly upon marine mammals and sea turtles. Pursuant to 30 CFR 250
33 Subpart Q, operators must obtain a permit from BOEM before beginning any platform removal
34 or well-severance activities. The NMFS has issued regulations (50 CFR Part 216) under the
35 MMPA for “Taking Marine Mammals Incidental to the Explosive Removal of Offshore
36 Structures in the Gulf of Mexico,” and operators are required to obtain a Letter of Authorization
37 from NMFS in accordance with these regulatory conditions. This analysis assumes the
38 continued implementation of current BOEM guidelines on decommissioning which specify
39 limits on the type and size of explosives that can be used and the times when detonations can
40 occur; require explosives to be placed at a minimum depth of 15 m (49 ft) below the sediment
41 surface; and require a monitoring plan that uses qualified observers to monitor the detonation
42 area for protected species, including all marine mammals, prior to and after each detonation. The
43 detection of a marine mammal (or other applicable biota) within the blast zone would, without
44 exception, would delay explosive detonation. Thus, explosive platform removals conducted
45 under the proposed action and complying with BOEM guidelines would not be expected to
46 adversely affect marine mammals in the GOM.

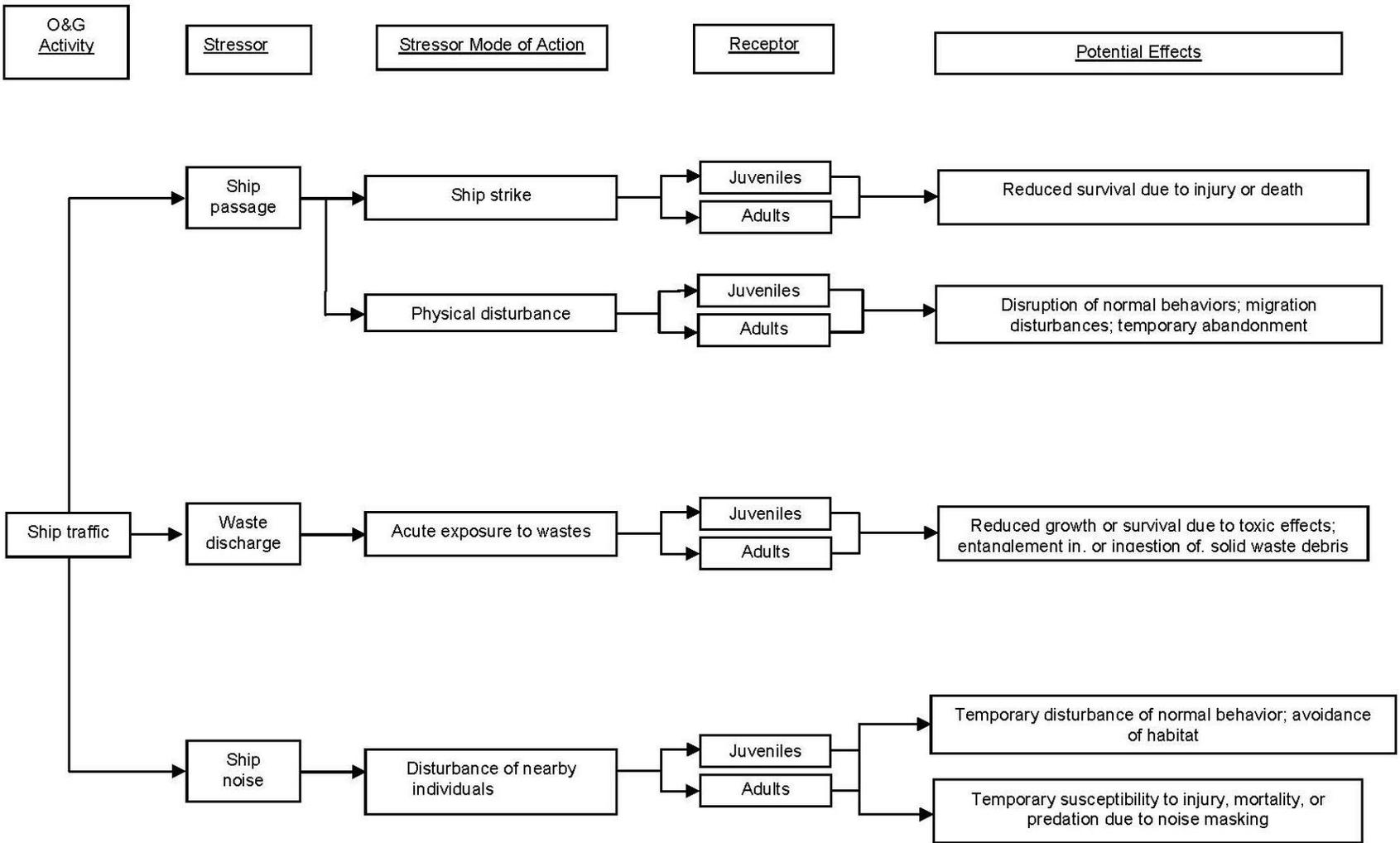


FIGURE 4.4.7-3 Conceptual Model for Potential Effects of Vessel Traffic on Marine Mammals

1
 2
 3
 4

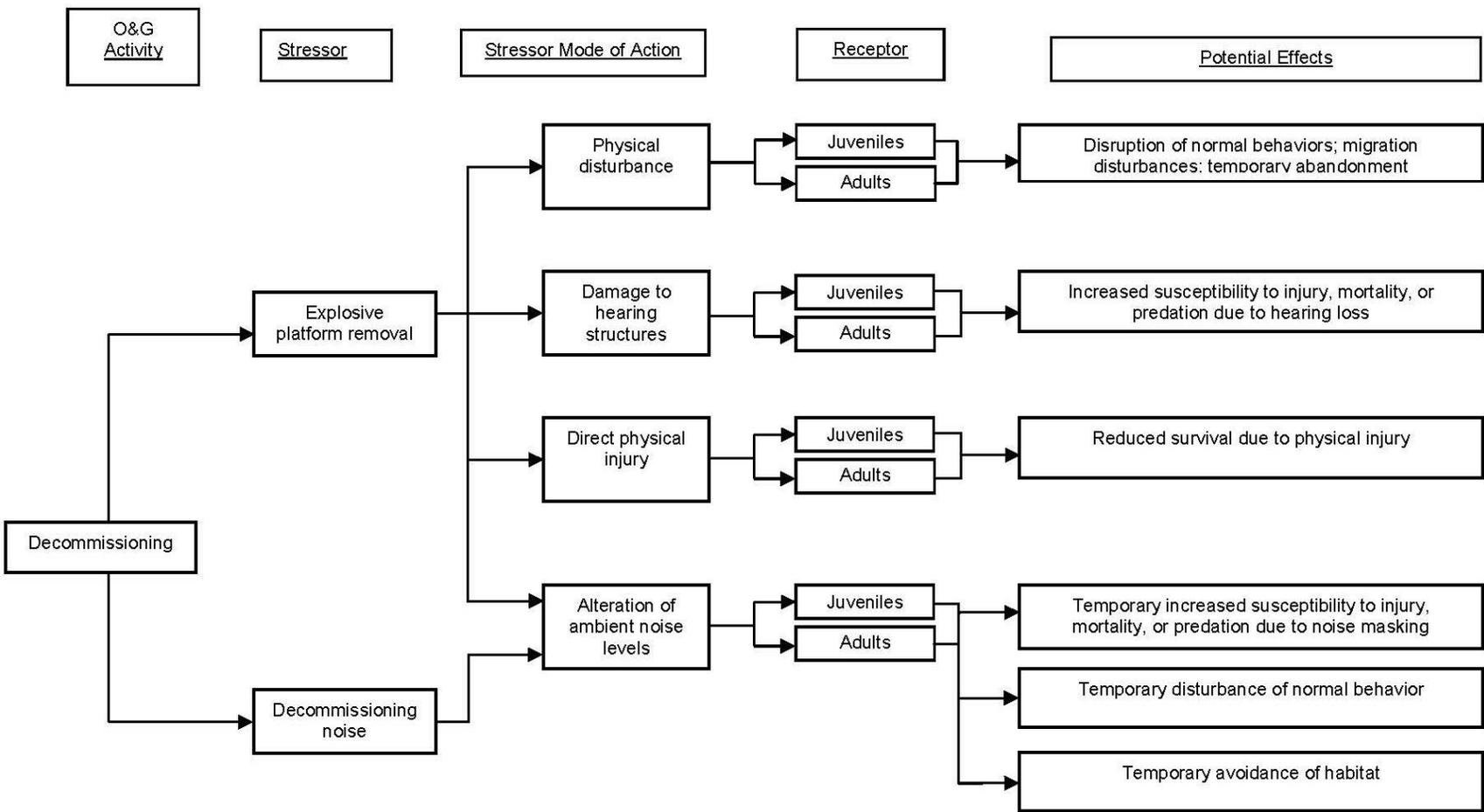


FIGURE 4.4.7-4 Conceptual Model for Potential Effects of Decommissioning on Marine Mammals

1
 2
 3

1 **Accidents.** Potential effects on marine mammal species may occur from accidental
2 activities associated with the proposed action and may be direct or indirect. Accidental oil spills
3 could occur in the GOM under the proposed action (Section 4.4.2.1). Tables 4.4.2-1 and 4.4.2-2
4 presents the oil spill assumptions for the purpose of analyzing the proposed action, while
5 Figure 4.4.7-5 presents a conceptual model for potential effects of oil spills on marine mammals.
6

7 The major potential impact-producing factors include accidental blowouts, platform and
8 pipeline oil spills, and spill-response activities. Impacts (i.e., acute vs. chronic impacts) depend
9 on the magnitude, frequency, location, and date of accidents; characteristics of spilled oil; spill-
10 response capabilities and timing; and various meteorological and hydrological factors. Impacts
11 could include decreased health, reproductive fitness, and longevity; and increased vulnerability
12 to disease). Spilled oil can cause soft tissue irritation, fouling of baleen plates, respiratory stress
13 from inhalation of toxic fumes, food reduction or contamination, direct ingestion of oil and/or
14 tar, and temporary displacement from preferred habitats (St. Aubin and Lounsbury 1990; Geraci
15 and St. Aubin 1990). The long-term impacts to marine mammal populations are poorly
16 understood but could include decreased survival and lowered reproductive success. Impacts
17 from dispersants are unknown but may be irritants to tissues and sensitive membranes
18 (NRC 2005). Chronic or acute exposure may result in harassment, harm, or mortality to marine
19 mammals. In some cases, marine mammals made no apparent attempt to avoid spilled oil in
20 some cases (Smultea and Würsig 1995); however, marine mammals have been observed
21 apparently detecting and avoiding slicks in other reports (Geraci and St. Aubin 1990).
22

23 Impacts on marine mammals from smaller accidental events may adversely affect
24 individual marine mammals in the spill area, but are unlikely to rise to the level of population
25 effects (or significance) given the size and scope of such spills. Assuming that all small spills
26 would not occur at the same time and place, water quality would rapidly recover and therefore
27 would not have significant effects on marine mammals or their prey species. The potential
28 effects associated with a large spill may be more adverse than a smaller accidental spill and
29 could potentially contribute to longer-lasting effects. The long-term impacts to marine mammal
30 populations could include decreased survival and lowered reproductive success. For example,
31 the oil from an oil spill can adversely affect cetaceans by causing soft tissue irritation, fouling of
32 baleen plates, respiratory stress from inhalation of toxic fumes, food reduction or contamination,
33 direct ingestion of oil and/or tar, and temporary displacement from preferred habitats. However,
34 the range of toxicity and degree of sensitivity to oil hydrocarbons and the effects of cleanup
35 activities on cetaceans are not fully understood. Similarly, impacts to marine mammals from
36 dispersants are not fully understood, but may be irritants to tissues and sensitive membranes
37 (NRC 2005). One assumption concerning the use of dispersants is that the chemical dispersion
38 of oil will considerably reduce the impacts to marine mammals, primarily by reducing their
39 exposure to petroleum hydrocarbons (French-McCay 2004; NRC 2005). However, the impacts
40 to marine mammals from chemical dispersants could include nonlethal injury (e.g., tissue
41 irritation, inhalation), long-term exposure through bioaccumulation, and potential shifts in
42 distribution from some habitats.
43

44 **Catastrophic Discharge Event.** The PEIS analyzes a CDE up to 7.2 million bbl
45 (Table 4.4.2-2). If a CDE occurs, there is greater potential for more severe effects compared to
46 the risk of effects from a large oil spill. A CDE would result in sustained degradation of water

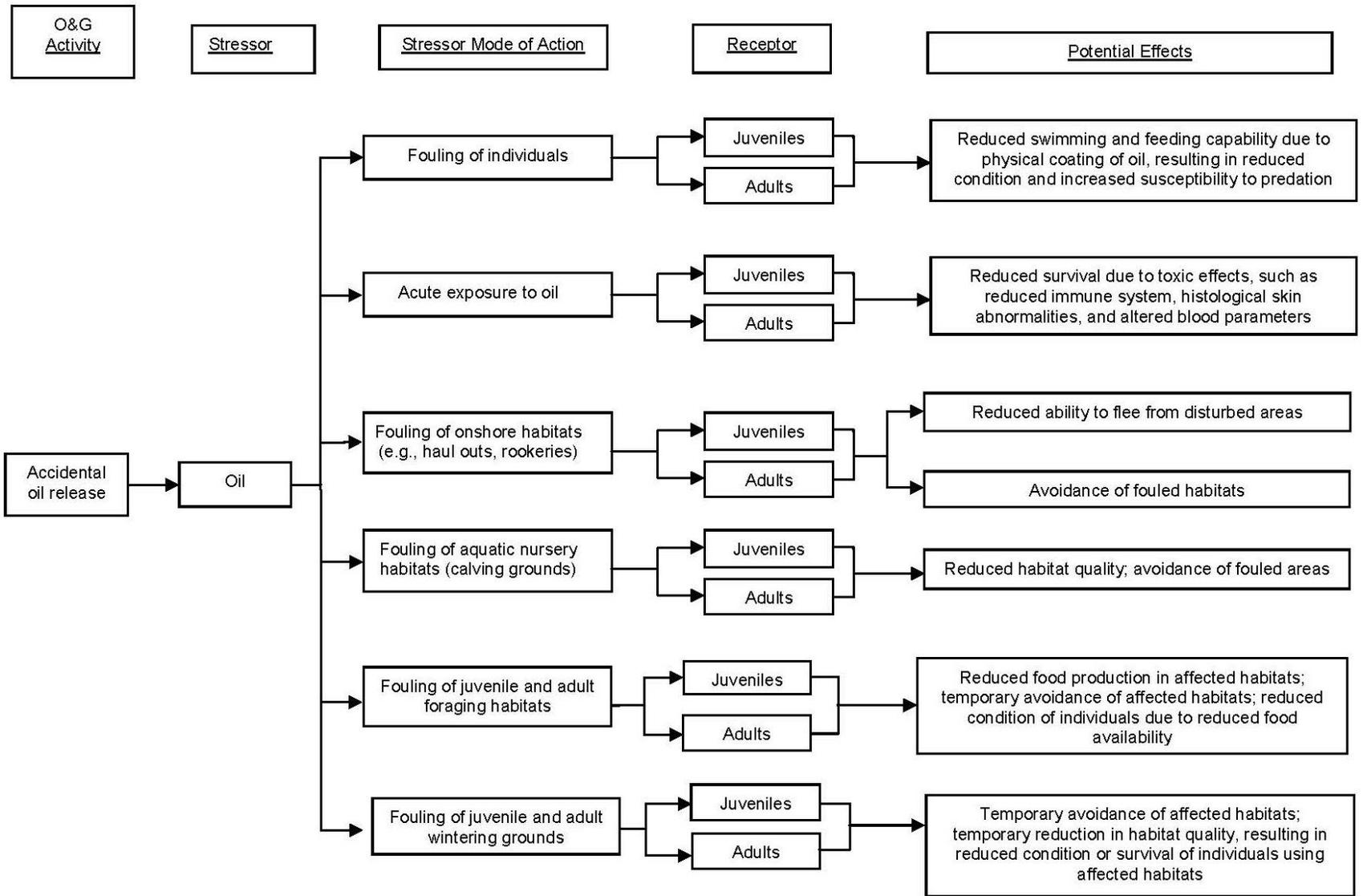


FIGURE 4.4.7-5 Conceptual Model for Potential Effects of Oil Spills on Marine Mammals

1 quality and, to a lesser extent, air quality that would impact marine mammals from direct contact,
2 inhalation, and ingestion (either directly or indirectly through the consumption of oiled forage or
3 prey species). These effects would be significant, causing a multitude of acute and chronic
4 effects. Additional effects on marine mammals would occur from water and air quality
5 degradation associated with response and cleanup vessels, *in situ* burning of oil, dispersant use,
6 discharges and seafloor disturbances from relief well drilling, and activities on shorelines
7 associated with cleanup, booming, beach cleaning, and monitoring. A CDE has the potential to
8 increase the area and duration of an oil spill, thereby increasing the potential for population-level
9 effects, or at a minimum, an increase in the number of individuals killed. For example,
10 following the DWH event, dead marine mammals collected from April 30, 2010, through
11 April 12, 2011, included 142 bottlenose dolphins, 3 spinner dolphins, and 2 each of *Kogia* spp.,
12 melon-headed whales, and sperm whales (NMFS 2011b).

13
14 **Terrestrial Mammals.** The terrestrial mammals considered in this section are those
15 species listed as endangered under the ESA that may be affected by routine OCS operations or
16 accidents under the proposed action. These include the Alabama, Choctawhatchee, Perdido Key,
17 and St. Andrew beach mice (subspecies of the old-field mouse) and the Florida salt marsh vole
18 (Section 3.8.1.1.2).

19
20 **Routine Operations.** The endangered beach mice subspecies inhabit mature coastal
21 barrier sand dunes on the Alabama and northwest Florida coasts; the Florida salt marsh vole
22 inhabits salt marsh habitats and is known from two locations (Waccasassa Bay in Levy County,
23 Florida, and the Lower Suwannee National Wildlife Refuge), in southeastern Dixie and
24 northwestern Levy Counties, Florida; Figure 3.8.1-1). Under the proposed action, no new OCS-
25 related facilities or activities would occur in close proximity to the known habitats for these
26 species; therefore, routine operations would not affect any of the species.

27
28 **Accidents.** Three types of oil residues on or near beach environments are particularly
29 challenging or potentially damaging to the environment if removed (OSAT 2011):

- 30
31
- 32 • Supratidal buried oil — oil residue typically buried below the 15-cm (6-in.)
33 surface cleaning depth near sensitive habitats, removal of which would
34 damage these sensitive habitats and affect protected species;
 - 35 • Small surface residual balls — oil residue left behind after beaches are
36 cleaned (removal would involve sieving sand so finely that it could remove
37 material used for habitat by organisms, thus altering the natural condition of
38 the beach; and
 - 39 • Surf zone submerged oil mats — submerged oil mats in nearshore surf zone in
40 troughs between sand bars.
- 41
42

43 In the event of an accidental offshore or coastal oil spill, the four beach mice subspecies
44 and the vole species could be affected by oil washing up on their beach habitats, and by
45 subsequent spill containment and cleanup activities. Individuals coming in direct contact with
46 spilled oil may experience skin, ear, eye, throat, and mucous membrane irritations. Oiling of fur

1 may affect thermoregulation. Individuals inhaling petroleum vapors may aggravate linings of
2 the respiratory system and in extreme cases may result in asphyxiation. Oil may be ingested
3 through contaminated food or during cleaning of oiled fur. Exposure to oil via inhalation or
4 ingestion may lead to a variety of lethal and sublethal effects, including lung, liver, and kidney
5 damage. Beach mice could be exposed to small surface residual balls via ingestion of residual
6 oil in soil and by exposure in their burrows (OSAT 2011).
7

8 In addition to affecting individuals, an oil spill may also affect the habitats of these small
9 mammals. Oil contacting their habitats could result in a reduced food supply (oiled vegetation),
10 reduced physical habitat quality (oiled sands), and fouling of nests and burrows. The fouling of
11 nests and burrows may also lead to a temporary displacement from or permanent abandonment
12 of these habitats. Depending on the persistence of the oil in these habitats and the effectiveness
13 of spill cleanup, long-term reductions in overall habitat quality and quantity may be possible.
14

15 An accidental spill fairly close to shore would have the potential to contact beaches
16 adjacent to beach mouse habitat, particularly if a spill were to occur nearshore or within inshore
17 waterways. However, beach mice are generally restricted to interior dune habitats, which would
18 not be expected to come in contact with spilled oil unless the accident occurred during a period
19 of high storm surge. In contrast, habitats of the Florida salt marsh vole may be more vulnerable
20 to an oil spill because of their being connected to coastal waters. However, the location of this
21 species and its habitat on the western Florida coast are far removed from those portions of the
22 GOM OCS where exploration and development might occur under the proposed action.
23

24 If an oil spill occurs and contacts a coastal area associated with these species, oil spill
25 response activities, including beach cleanup activities and vehicular and pedestrian traffic, could
26 result in habitat degradation. However, cleanup activities would be designed and conducted in
27 consultation with the USFWS and other appropriate stakeholders so that the potential for impacts
28 on these species and their habitats would be minimized or avoided.
29

30 Large-scale oiling of beach mice or vole habitats could result in extinctions, and if not
31 properly regulated, oil spill-response and cleanup activities could have a significant impact on
32 the species and their habitats. Vehicle traffic and activity associated with oil spill cleanup can
33 trample or bury nests and burrows or cause displacement from preferred habitat (MMS 2008b).
34 If disturbance results in the temporary abandonment of young by adults, survival of young may
35 be reduced (MMS 2007d).
36

37 The probabilities of large oil spills ($\geq 1,000$ bbl) resulting from the proposed action
38 occurring and contacting beach mouse or Florida salt marsh vole habitat within 3 to 30 days from
39 a spill in various locations in the WPA, CPA, and far western EPA is $\leq 5\%$. In most instances,
40 the probabilities were 0% to 1% (MMS 2004a). Direct contact with spilled oil that has washed
41 ashore can cause skin and eye irritation, asphyxiation from inhalation of fumes, oil ingestion, and
42 reduction or contamination of food sources. A slick cannot wash over the fore dunes unless
43 carried by a heavy storm swell. High seas would be necessary to cause a spill slick to landfall
44 and affect beach mice, Florida salt marsh voles, or their habitats. However, erosion with high
45 seas during storms is likely to do more damage to rodent habitat than oiling.
46

1 Protective measures required under the ESA should prevent any oil spill-response and
2 cleanup activities from having more than minor impacts on beach mice, the Florida salt marsh
3 vole, and their habitats (MMS 2003e).
4

5 ***Catastrophic Discharge Event.*** The PEIS analyzes a CDE up to 7.2 million bbl
6 (Table 4.4.2-2). If a CDE occurs, there is greater potential for more severe effects compared to
7 the risk of effects from a large oil spill. A CDE would potentially result in sustained degradation
8 of water quality, shoreline terrestrial habitats, and, to a lesser extent, air quality that could impact
9 terrestrial mammals from direct contact, inhalation, and ingestion (either directly or indirectly
10 through the consumption of oiled forage or prey species). These effects could be significant,
11 causing a multitude of acute and chronic effects. Additional effects on terrestrial mammals
12 would occur from land and air quality degradation associated with response and cleanup vessels,
13 *in situ* burning of oil, dispersant use, and activities on shorelines associated with cleanup,
14 booming, beach cleaning, and monitoring. A CDE has the potential to alter terrestrial mammal
15 habitats and populations, and, could foreseeably contribute to population-level effects on one or
16 more of the beach mice subspecies and/or the Florida salt marsh vole. The potential for these
17 impacts would be more probable if the catastrophic discharge event occurs coincident with a
18 severe storm event (e.g., a hurricane).
19
20

21 **4.4.7.1.2 Alaska – Cook Inlet.**

22
23 **Marine Mammals.** There are 18 species of marine mammals that occur in south
24 Alaskan waters and that may either occur in or near (such as the Gulf of Alaska, Kenai
25 Peninsula, and Kodiak Archipelago) the Cook Inlet Planning Area (Section 3.8.1.2.1;
26 Table 3.8.1-2). Nine of these species or species stocks are threatened or endangered under the
27 ESA. These species include the North Pacific right, sei, blue, fin, humpback, sperm, and beluga
28 whales; the Steller sea lion; and the sea otter. The non-listed species commonly occur in
29 portions in or near the Cook Inlet Planning Area (MMS 2003e). Marine mammals may be
30 exposed to OCS-related oil and gas exploration, development, and operations that could occur
31 under the proposed action.
32

33 ***Routine Operations.*** As part of the proposed action, a maximum of 4 to 12 exploration
34 and delineation wells and 42 to 114 development and production wells will be drilled and 1 to
35 3 new platforms are projected to be used. Additional activities planned as part of the proposed
36 action include 40 to 241 km (25 to 150 mi) of new offshore pipeline. No onshore facilities or
37 pipelines are proposed under the proposed action (Section 4.4.1.2). Table 4.4.7-1
38 (Section 4.4.7.1) illustrates how each of the impacting factors associated with OCS oil and gas
39 development may affect marine mammals and their habitats, while Figure 4.4.7-1
40 (Section 4.4.7.1) presents a conceptual model of potential impacting factors for marine mammals
41 from oil- and gas-related activities (including accidental oil spills). The following text presents
42 an overview of potential impacts to marine mammals in and near Cook Inlet from the following
43 routine operations (seismic surveys, construction of offshore facilities and pipelines, operations
44 of offshore facilities and drilling rigs, discharges and waste generation, service vessel and
45 helicopter traffic, and decommissioning) and from accidents.
46

1 Seismic Surveys. Section 4.4.7.1 provides a detailed discussion of the issues surrounding
2 anthropogenic noise. In Cook Inlet, noise generated by seismic surveys may have physical
3 and/or behavioral effects on marine mammals, such as (1) permanent or temporary hearing loss,
4 discomfort, and injury; (2) masking of important sound signals; and (3) behavioral responses
5 such as fright, avoidance, and changes in physical or vocal behavior (Richardson et al. 1995;
6 R.A. Davis et al. 1998b; Gordon et al. 1998; Nowacek et al. 2004, 2007). Seismic surveys may
7 also indirectly impact marine mammals by altering prey availability (Gordon et al. 2003, 2004).
8

9 *Non-Auditory Injury.* Direct acoustic impact on tissue, indirect acoustic impact on tissue
10 surrounding a structure, and acoustically mediated bubble growth within tissues from
11 supersaturated dissolved nitrogen gas (if source intense and animals within short distance to
12 source: Nowacek et al. 2007; Zimmer and Tyack 2007); resonance (although not anticipated
13 given resonance frequencies of marine mammal lungs are generally below that of the G&G
14 seismic survey source signal).
15

16 *Auditory Injury (Temporary or Permanent Hearing Loss).* The hearing of marine
17 mammals varies based on individuals, absolute threshold of the species, masking, localization,
18 frequency discrimination, and the motivation to be sensitive to a sound (Richardson et al. 1995).
19 As stated previously, Southall et al. (2007) described the frequency sensitivity in five functional
20 hearing. Similarly, the previous discussion in Section 4.4.7.1 on permanent and temporary loss
21 of hearing in a marine mammal (i.e., PTS, TTS) is incorporated.
22

23 *Masking.* In the case of seismic surveys in Cook Inlet, , the effect of masking is likely to
24 be low relative to continuous sounds such as ship noise. In addition, a few cetaceans are known
25 to increase the source levels of their calls in the presence of elevated sound levels, or to shift
26 their peak frequencies in response to strong sound signals (Dahlheim 1987; Au 1993; review in
27 Richardson et al. 1995; Lesage et al. 1999; Terhune 1999; Nieu Kirk et al. 2005;
28 Parks et al. 2007). These studies involved exposure to other types of anthropogenic sounds, not
29 seismic pulses, and it is not known whether these types of responses ever occur upon exposure to
30 seismic sounds. If so, these adaptations, along with directional hearing and preadaptation to
31 tolerate some masking by natural sounds (Richardson et al. 1995), would all reduce the
32 importance of masking.
33

34 *Behavioral Change.* As described in Section 4.4.7.1, a number of studies have
35 documented behavioral effects in response to seismic surveys, primarily for mysticetes
36 (Richardson et al. 1995), given their possible overlap between the expected frequencies of best
37 hearing sensitivity (low threshold) in mysticetes and maximal air gun output at source. Given
38 that no direct audiograms of mysticetes have been obtained, it is impossible to define what level
39 of sound above hearing threshold may cause behavioral effects, which could be expected to be
40 variable, complicated and dependent upon more than just the received sound level. For this
41 reason, observations at sea have concentrated on relating received sound levels to observed
42 behavioral changes.
43

44 Beluga whales are mid-frequency hearing specialists. The Southall et al. (2007) data
45 review discussed the Finneran et al. (2002b) experiment using a seismic watergun which
46 produced a single acoustic pulse. They conducted this test on one beluga and one bottlenose

1 dolphin. Based on Finneran et al. (2002), for belugas exposed to a single pulse, TTS-onset
2 occurred with unweighted peak levels of 224 dB re: 1 μ Pa (peak) and 186 dB re: 1 μ Pa²-s. The
3 latter is equivalent to a weighted (M- weighting for mid-frequency marine mammals) SEL
4 exposure of 183 dB re: 1 μ Pa²-s as some of the energy in the pulse was at low frequencies to
5 which the beluga is less sensitive. Adding 6 dB to the former (224 dB) values, Southall et al.
6 (2007) estimates the pressure criterion for injury for mid-frequency cetaceans is 230 dB re: 1 μ Pa
7 (peak).

8
9 Southall et al. (2007) also went on to discuss pinnipeds, which include 16 species and
10 subspecies of sea lions and fur seals (otariids), 23 species and subspecies of true seals (phocids),
11 and two subspecies of walrus (odobenids). They produce a variety of social signals, most
12 occurring at relatively low frequencies but lack the highly specialized active biosonar systems of
13 toothed cetaceans. Because of they are active both in and out of water, pinnipeds communicate
14 acoustically in air and water, have significantly different hearing capabilities in the air versus
15 water, and may be subject to both aerial and underwater noise exposure (Schusterman 1981;
16 Kastak & Schusterman 1998, 1999 in Southall et al. 2007). Therefore, pinnipeds have two
17 different hearing criteria. However, since seismic surveys are less likely to affect pinnipeds,
18 such as Steller sea lions, in air, the in-water criteria is discussed here. It is also acknowledged
19 that there are “among species differences in the exposure conditions that elicited TTS under
20 water” (Southall et al. 2007). Steller sea lion hearing has not specifically been studied but for the
21 purposes of this analysis, it is assumed that their hearing is comparable to that of California sea
22 lions. Comparative analyses of the combined underwater pinniped data (Kastak et al. 2005)
23 indicated that, in the harbor seal, a TTS of *ca.* 6 dB occurred with 25-min exposure to 2.5 kHz
24 OBN with SPL of 152 dB re: 1 μ Pa (SEL: 183 dB re: 1 μ Pa²-s). Under the same test conditions,
25 a California sea lion showed TTS-onset at 174 dB re: 1 μ Pa (SEL: 206 dB re: 1 μ Pa²-s), and a
26 northern elephant seal experienced TTS-onset at 172 dB re: 1 μ Pa (SEL: 204 dB re: 1 μ Pa²-s).
27 Data on underwater TTS-onset in pinnipeds exposed to pulses are limited to a single study.
28 Finneran et al. (2003) exposed two California sea lions to single underwater pulses from an arc-
29 gap transducer. They found no measurable TTS following exposures up to 183 dB re: 1 μ Pa
30 (peak-to-peak) (SEL: 163 dB re: 1 μ Pa²-s).

31
32 The Southall et al. (2007) criteria do not cover sea otter due to a lack of key hearing data.
33 Further, there is little information on the effects of noise associated with oil and gas exploration
34 on sea otters. Their production and use of sound underwater has not been studied. Airborne
35 sounds are diverse and include high-pitched screams, whines, whistles, deep-throated growls,
36 cooing, chuckles, and snarls (Kenyon 1981). Mothers and their pups communicate by calling,
37 and both call to one another if separated. Most of the sounds in these mother-pup
38 communications are 3-5 Hertz, but there are higher harmonics. Sandegren, Chu, and Vandervere
39 (1973) recorded these calls from a distance of 50 meters in air. It is not known how far sea otters
40 can hear these sounds. Available data do not indicate that sea otters are likely to be seriously
41 impacted by seismic exploration. Riedman (1983, 1984) reported no evident disturbance
42 reactions by sea otters in California coastal waters in response to noise from a full-scale array of
43 air guns (67 L) and a single air gun. No disturbance was noted either when the operating seismic
44 ship passed as close as 1.85 and 0.9 kilometers to sea otters. Sea otters continued to feed, groom,
45 interact with pups, rest, and to engage in other normal behaviors. Riedman (1983, 1984)
46 reported there was also no apparent reaction to the single air gun. Riedman (1983) cautioned

1 that there are no data for the reactions of sea otters more than 400 meters offshore. Riedman
2 (1983, 1984) reported no evidence of changes in behavior of sea otters during underwater
3 playbacks of drillship, semisubmersible, and production platform sound. Most of the animals
4 studied were 400 or more meters from the source of the sound. Foraging otters continued to dive
5 and feed.

6
7 Whales and other marine mammals sometimes continue with important behaviors even in
8 the presence of noise. Some marine mammals may be motivated by feeding opportunities to the
9 extent that they subject themselves to increased noise levels. For example, Native hunters
10 reported to Huntington (2000) that beluga whales often ignore the approach of hunters when
11 feeding, but at other times will attempt to avoid boats of hunters. There is a potential for effects
12 from geophysical survey operations on marine mammals found in Cook Inlet from non-auditory
13 or auditory effects, including PTS, but this is expected to be negligible. Local effects could
14 result to endangered species near noise and other disturbance caused by exploration. For
15 example, in specific areas, particularly near the Barren Islands, these disturbances could affect
16 the haulouts and behavior of Steller sea lions; cause local, short-term effects on the feeding of
17 mysticetes; and locally affect some Cook Inlet beluga whales. Behavior of sea otters could be
18 affected and some displacement of sea otters could occur near areas of activity. Although small
19 numbers of individuals could be affected, regional population or migrant populations of
20 non-endangered marine mammals would experience a negligible effect from disturbance and
21 habitat alteration. The potential for injury is greatly lessened through effective implementation
22 of assumed mitigation. Mitigation that is often implemented to reduce impacts includes use of
23 marine mammal observers, survey vessel speed reductions, and establishment of exclusion
24 zones.

25
26 Construction and Operation of Offshore Platforms and Pipelines. Figure 4.4.7-2
27 (Section 4.4.7.1.1) presents a conceptual model for potential effects of infrastructure construction
28 on marine mammals. Under the proposed action, up to 1 to 3 offshore platforms and 40 to
29 241 km (25 to 150 mi) of offshore pipeline could be constructed in the Cook Inlet Planning Area
30 (Table 4.4.1-3).

31
32 If exploration leads to development and production, impacts likely could occur from the
33 following:

- 34
35 • Noise from construction of pipelines and production facilities;
36
37 • Routine and recurring traffic associated with crew and supply activities;
38
39 • Domestic wastewaters generated at the offshore facility (the scenario assumes
40 on-platform disposal wells will reinject drilling fluids, muds, cuttings, and
41 produced waters generated from production wells. Discharges and Wastes are
42 described further below.);
43
44 • Trash and debris from production activities;
45

- 1 • Gaseous emissions from production facilities, both onshore and offshore, and
- 2 from transportation vessels and aircraft; and
- 3
- 4 • Physical placement, presence, and removal of offshore production facilities,
- 5 including platforms and pipelines to onshore common carrier pipelines.
- 6

7 Noise generated by industrial activities can come from a variety of sources, such as
8 transportation, general machinery use, construction, and human activity. Noise, whether carried
9 through the air or under water, may cause some species to alter their feeding routines, movement,
10 and reproductive cycles. For cetaceans, effects from noise and disturbance associated with
11 development would be much the same as discussed for exploration. The most likely impacts
12 could be the disturbance of sea otters and Steller sea lions that are hauled out and the
13 displacement of females and pups that occur near regions of focused activity. These effects are
14 expected to be extremely local and have no population-level impacts on sea otters or Steller sea
15 lions.

16
17 Construction may also cause an alteration in habitat and water quality for marine
18 mammals. However, the activities associated with construction are not likely to significantly
19 affect water quality. Construction activities would increase the turbidity in the water column
20 along segments of the 40-km (25-mi) corridors for up to a few months, but no significant water
21 quality degradation could occur. Further, construction activities could affect benthic organisms
22 and fish (prey species) in the immediate vicinity. Organisms in soft substrates (bivalves and
23 polychaetes) could be adversely affected; however, platforms would add a hard substrate to the
24 marine environment, providing additional habitat for marine plants and animals (for example,
25 kelp and mussels) that require a hard substrate. Therefore, the overall effect of platform and
26 pipeline installation could be to alter species diversity in a small area. Construction activities
27 may disturb pelagic and demersal finfishes and shellfishes, potentially displacing them from
28 preferred habitat, as turbidity, vibrations, and noise from construction increases. Positive effects
29 may accrue because following construction, offshore structures provide refugia to some species
30 and their prey. Any disturbance or displacement should be localized and short term (hours to
31 days to months), limited to only the time of construction and shortly thereafter. Effects are
32 expected to be limited to negligible numbers of individuals in the immediate vicinity of
33 construction activities.

34
35 The landfall of a pipeline would avoid sensitive aquatic habitat. The route for the
36 pipeline would be sited inland from shorelines and beaches, and pipeline crossings of
37 anadromous fish streams would be minimized and consolidated with other utility and road
38 crossings of such streams. Pipelines would be buried wherever possible and sited in existing
39 rights-of-way for other utilities or transportation systems wherever possible, such as that
40 provided by the Sterling Highway. The pipelines would be designed, constructed, and
41 maintained to minimize risk to fish habitats from a spill, pipeline break, or other construction
42 activity. Habitat alteration due to pipeline laying and platform construction are expected to be
43 localized and should not cause significant impacts to mobile species.

44
45 The immediate response of disturbed individuals or groups could be to leave or avoid the
46 construction areas. This displacement or avoidance could be short or long term in duration,

1 depending on the duration of the construction activity. Because relatively few individuals would
2 be expected to be affected by the limited amount of construction and few new facilities that
3 would be operating, the construction and operation of new offshore facilities would not be
4 expected to result in population-level effects to affected marine mammals.

5
6 Facilities to be constructed and operated under the proposed action may occur in or near
7 beluga whale critical habitat area 2 (76 FR 20180). Construction and operation of offshore
8 platforms and pipelines are expected to have negligible impact to beluga habitat and would not
9 be expected to affect movement of belugas within Cook Inlet. However, if activities were to
10 occur in or near the beluga whale critical habitat, ESA consultation would occur to ensure the
11 protection of the species and their habitat.

12
13 Critical habitat designation for the Steller sea lion (50 CFR 226.202) includes a 0.9-km
14 (3,000-ft) radius no-entry zone around designated rookeries within the Cook Inlet Planning Area,
15 as well as a 37-km (20-NM or 23-mi) aquatic avoidance zone around all major rookeries and
16 haulouts. Additional restrictions (50 CFR 223.202) associated with Steller sea lion critical
17 habitat include a 5.5-km (3-NM or 3.4-mi) radius vessel approach zone around listed rookeries,
18 and 1.9-km a (1-NM or 1.2-mi) minimum distance for vessel passing near rookery sites
19 (50 CFR 223.202). Compliance with these critical habitat designations, restrictions, and buffer
20 zones could greatly reduce the likelihood of exposure of Steller sea lion rookeries and haulouts
21 to OCS activities that could occur in the Cook Inlet Planning Area.

22
23 Discharges and Wastes. Table 4.4.1-3 presents information on drilling fluids, drill
24 cuttings, and produced waters discharged offshore as a result of the proposed action.
25 Figure 4.4.7-3 (Section 4.4.7.1.1) presents a conceptual model for potential effects of operational
26 waste discharges on marine mammals. Produced water, drilling muds, and drill cuttings are
27 discharged into offshore marine waters in compliance with applicable regulations and permits.
28 Compliance with regulations and permits will limit the exposure of marine mammals to waste
29 discharges.

30
31 Up to 500 bbl of drill fluids and 600 tons of drill cuttings will be discharged at each
32 exploration and delineation well (Table 4.4.1-3). Heavier components of these muds and
33 cuttings (such as rock) would settle to the bottom, while lighter components could increase
34 turbidity around the drill site. While this increased turbidity could cause marine mammals to
35 avoid the area, any increase in suspended solids associated with the discharge of drilling wastes
36 would be rapidly diluted and dispersed, and thus not be expected to adversely affect marine
37 mammals in the area. Drilling fluids and cuttings associated with development and production
38 wells would be treated and disposed of in the wells; therefore, negligible impacts to marine
39 mammals from these wastes are expected.

40
41 The OCS-related vessels supporting exploration activities and the construction and
42 operation of offshore platforms and pipelines will generate waste fluids (such as bilge water)
43 which may be discharged to the surface water. Such discharges, if allowed, would be regulated
44 under applicable NPDES permits. Sanitary and domestic wastes would be processed through
45 shipboard waste treatment facilities before being discharged overboard, and deck drainage would
46 also be processed aboard ship to remove oil before being discharged. Because of the low level of

1 expected vessel traffic, relatively small volumes of operational wastes would be discharged, and
2 these would be rapidly diluted and dispersed. Thus, permitted waste discharges from OCS
3 construction and service vessels are expected to have negligible impacts on marine mammals.
4

5 Solid debris can adversely impact marine mammals through ingestion or entanglement
6 (Marine Mammal Commission 2003). Mammals that ingest debris, such as plastics, may
7 experience intestinal blockage, which in turn may lead to starvation, while toxic substances
8 present in the ingested materials (especially in plastics) could lead to a variety of lethal and
9 sublethal toxic effects. Entanglement in plastic debris can result in reduced mobility, starvation,
10 exhaustion, drowning, and constriction of, and subsequent damage to, limbs caused by tightening
11 of the entangling material. The discharge or disposal of solid debris into offshore waters from
12 OCS structures and vessels is prohibited by the BOEM (30 CFR 250.40) and the USCG
13 (International Convention for the Prevention of Pollution from Ships [MARPOL], Annex V,
14 P.L. 100-220 [101 Statute 1458]). Thus, impacts to marine mammals from entanglement in or
15 ingestion of OCS-related trash and debris under the proposed action are expected to be negligible
16 to minor.
17

18 Drilling fluids and produced waters are not anticipated to be discharged during
19 production. The hydrodynamic processes in the Cook Inlet suggest the water column generally
20 is well mixed, and dilution would reduce the concentration of the substances in the discharges.
21 Degradation processes also act to continuously reduce the concentrations of many substances
22 deliberately or accidentally released into the environment. We do not expect the discharge of
23 drilling muds and cuttings and other discharges associated with exploration drilling to have any
24 effect on the overall quality of Cook Inlet water. Within a distance of between 100 and 200 m
25 (328 and 656 ft) from the discharge point, the turbidity caused by suspended-particulate matter in
26 the discharged muds and cuttings would dilute to levels that are less than the chronic criteria
27 (100–1,000 parts per million) and within the range associated with the variability of naturally
28 occurring suspended particulate matter concentrations. Mixing in the water column would
29 reduce the toxicity of the drilling muds that already fall into the “practically nontoxic” category
30 to levels that would not be harmful to organisms in the water column. In general, the amounts of
31 additives in the other discharges are likely to be relatively small (from 4 to 400 or
32 800 liters/month and diluted with seawater several hundred to several thousand times before
33 being discharged into the receiving waters. The potential effects in any of the areas where there
34 are permitted discharges would last for about 3–4 months for each exploration well drilled.
35

36 Vessel and Aircraft Traffic. There may be up to 9 surface vessels and 9 helicopter trips
37 per week under the proposed action (Table 4.4.1-3). Figure 4.4.7-4 (Section 4.4.7.4) presents a
38 conceptual model for potential effect of vessel traffic on marine mammals. Vessel traffic could
39 occur during seismic exploration, drilling and platform construction, platform operation, and
40 platform decommissioning. Generally, marine mammals may be affected by direct collisions
41 with vessels or by visual and noise disturbances.
42

43 In addition to possible collision-related injuries and/or mortalities, cetaceans and
44 pinnipeds in the vicinity of an OCS-related vessel may be disturbed by the presence of vessels
45 and helicopters and the noise they generate. Noises emitted by shipping vessels are expected to
46 range between 140 dB re 1 μ Pa for smaller vessels to 198 dB re 1 μ Pa for larger tankers and

1 cargo ships (Heathershaw et al. 2001; Erbe 2002; Hildebrand 2004). Helicopters flying at 150 m
2 (492 ft) altitude are expected to emit noises received at ground level of approximately 80 to
3 86 dB re 20 μ Pa (Born et al. 1999). Reactions of cetaceans, including both odontocetes and
4 mysticetes, may include apparent indifference, cessation of vocalizations or feeding activity,
5 increases in vocal behavior, and evasive behavior (e.g., turns, diving, etc.)
6 (Richardson et al. 1995; Nowacek and Wells 2001; Buckstaff 2004; Doyle et al. 2008). Noise
7 from service vessels may also mask cetacean sound reception (MMS 2003e). Disturbed
8 individuals would be expected to cease their normal behaviors and likely move away from the
9 vessel. Following passage of the vessel, affected individuals may return and resume normal
10 behaviors.

11
12 Cetaceans, such as humpback whales, near the Barren Islands and the southern portions
13 of the Cook Inlet also could be negatively affected by vessel transport and construction activities.
14 However, this area has a high volume of fishing- and tourism-related vessel traffic in the summer
15 months when the whales are present. The incremental addition of noise from two vessels per day
16 associated with the proposed action is unlikely to add significantly to this existing noise.

17
18 Based on their distributions, humpbacks are more vulnerable to aircraft noise than fin
19 whales. Shallenberger (1978) reported that some humpbacks were disturbed by overflights at
20 305 m (1,000 ft), whereas others showed no response at 152 m (500 ft). As with the response to
21 air gun noise, pods varied in their response. Humpbacks in large groups showed little or no
22 response but some adult-only groups exhibited avoidance (Herman et al. 1980). Other authors
23 report no response (for example, Friedl and Thompson, 1981). Due to concerns about the
24 impacts of helicopters in Hawaiian waters, helicopters are prohibited from approaching within a
25 slant range of 1,000 ft, or 305 m, from humpbacks (National Marine Fisheries Service 1987).

26
27 Belugas could be disturbed by noise and disturbance from exploration and development-
28 related aircraft, especially helicopters. Belugas reacted to aircraft flying at 150–200 m
29 (492–656 ft) by diving for longer periods, reducing surfacing time and sometimes swam away
30 (see references cited in Richardson et al. 1995). They did not respond to aircraft at 500 m
31 (1,640 ft). Richardson et al. (1991) found variable reactions to turbine helicopters and fixed
32 wing aircraft in offshore waters near Alaska. Some individuals exhibited no discernible response
33 even when the aircraft was within 100–200 m (328–656 ft), whereas other individuals dove
34 abruptly, looked upward, or turned sharply in response to aircraft at altitudes up to 460 m
35 (1,510 ft). In shallow summering areas, belugas sometimes respond to aircraft by diving or
36 swimming away (Finley et al. 1982; Gales 1982; Caron and Smith 1990).

37
38 Vessel traffic may disturb pinnipeds and sea otters (which are discussed further below) in
39 the water and hauled out on ice or terrestrial habitats. For example, when approached too closely
40 or disturbed too often, harbor seals are known to abandon their favorite haul-out sites or their
41 pups (Kinkhart et al. 2008). Hauled out pinnipeds may exhibit behavioral reactions to the
42 physical disturbance of an approaching vessel or aircraft by exhibiting startle reactions, slipping
43 into the water. In recognition of their vulnerability to loud and startling noises, Steller sea lion
44 critical habitat has been defined to include a terrestrial zone that extends 914 m (3,000 ft)
45 landward from the baseline or base point of each Steller sea lion major rookery or major haulout
46 and an air zone that extends 914 m (3,000 ft) above the terrestrial zone, as measured at sea level

1 around them. Assuming aircraft flying to any platforms maintain sufficient distances from these
2 rookeries, based on recognition of this critical habitat, it not likely this form of disturbance
3 would have a major impact on Steller sea lions. However, given observations by Withrow et al.
4 (1985) cited above, it is possible that sea lions could be negatively affected by oil- and gas-
5 activity-related helicopters (and possibly by other noise) operating at further distances. Under
6 the proposed scenario, one to two helicopter trips per day would be made to oil and gas
7 operations from Kenai or other sites along the western Kenai Peninsula shore. In most of the
8 proposed Cook Inlet multiple-sale area, these flights would not require transit over any terrestrial
9 components of Steller sea lion critical habitat and adverse effects could easily be avoided. The
10 greatest potential for such disturbance could come from helicopters transiting to blocks on the far
11 side of the Barren Islands if flights originated on the Kenai Peninsula and stayed, as geography
12 permits, near land until crossing of the entrances of Cook Inlet was required to reach drill (or
13 production) sites on the far sides of the Barren Islands.

14
15 Major rookeries in and near the Cook Inlet include Outer Island, Sugarloaf Island,
16 Marmot Island, Chirikof Island, and Chowiet Island. There are several major haulouts in and
17 near the Cook Inlet, 20-NM aquatic zones, and an aquatic foraging area in Shelikof Strait. All of
18 these are part of Steller sea lion critical habitat. Support-vessel traffic would be unlikely to
19 adversely affect these habitats as long as operators avoided transiting near to the rookeries or
20 haulouts or deliberately approaching sea lions in the water. Critical habitat of Steller sea lions is
21 unlikely to be impacted by exploration activities. As noted above, terrestrial zones are legally
22 protected from activities degrading them by disturbance. Shelikof Strait was designated as
23 critical habitat because of its proximity to major rookeries and important haulouts, its use by
24 foraging sea lions and its value as an area of high forage-fish production. Any adverse impacts
25 of oil and gas development that adversely affect the production and availability of prey to Steller
26 sea lions in this and other critical habitat could adversely modify the habitat. Aircraft restrictions
27 associated with Steller sea lion critical habitat protection (50 CFR 223.202; 50 CFR 226.202)
28 could further reduce the likelihood of helicopter flights impacting designated rookery sites for
29 this listed species. Careful planning of flight paths to avoid rookeries and haulouts of other
30 pinnipeds could further reduce or eliminate the potential for disturbing animals in these habitats.

31
32 Boat traffic associated with OCS oil and gas exploration activity could disturb sea otters
33 in specific areas. In summer, these impacts are likely to be insignificant compared to the
34 quantity of fishing, tourism, shipping, and other boat traffic in the region. In winter, boat traffic
35 in a remote region could have local impacts on distribution of females and pups. While male sea
36 otters sometimes habituate to heavy boat traffic, female sea otters, particularly those with pups,
37 are sensitive to disturbance. Garshelis and Garshelis (1984) reported that sea otters in Prince
38 William Sound avoided waters with frequent boat traffic but reoccupy these areas when boats are
39 less frequent. Rotterman and Monnett (2002) concluded that disturbance after the *Exxon Valdez*
40 oil spill was sufficient to keep sea otters from feeding habitat in certain bays in oiled areas of
41 Prince William Sound. Udevitz et al. (1995) reported that about 15% of sea otters along boat
42 survey transects are not detected because they move away from the approaching boat. Boat
43 traffic could disturb resting patterns of sea otters. Sea otters in Alaska haul out regularly. Sea
44 otters that are hauled out will often move into the water with the approach of a boat. Garrott,
45 Eberhardt, and Burn (1993) reported that sea otters on shore would move into the water with
46 approach of a single small motorboat moving parallel to and 100 m (328 ft) from shore.

1 As previously discussed, the FAA Advisory Circular 91-36D (FAA 2004) encourages
2 pilots to maintain higher than minimum altitudes over noise-sensitive areas. Also, guidelines
3 and regulations issued by NMFS under the authority of the MMPA include provisions specifying
4 helicopter pilots to maintain an altitude of 305 m (1,000 ft) within 91 m (300 ft) of marine
5 mammals (MMS 2007d). Helicopter operations would only be expected to occur below
6 specified minimums during inclement weather. In MMS (2007d), it was concluded that this
7 could occur for about 10% of helicopter operations. Because of the low level of vessel and
8 aircraft traffic that could occur under the proposed action, potential impacts to marine mammals
9 from this traffic would likely be limited to a few individuals, be largely short-term in nature, and
10 not result in population-level effects.

11
12 Decommissioning. Under the proposed action, no platforms will be removed with
13 explosives from the Cook Inlet Planning Area. Therefore, potential impacts of decommissioning
14 on marine mammals, as summarized in Figure 4.4.7-4 (Section 4.4.7.1.1), will not occur.

15
16 **Accidents.** Accidental oil spills could occur in Cook Inlet under the proposed action
17 (Section 4.4.2). Table 4.4.2-1 presents the oil spill assumptions for the proposed action, while
18 Figure 4.4.7-5 (Section 4.4.7.1.1) presents a conceptual model for potential effects of oil spills on
19 marine mammals. Small oil spills ($\leq 1,000$ bbl) break-up and dissipate within hours to a day
20 (MMS 2009a). Larger spills, particularly those that continue to flow fresh hydrocarbons into
21 waters for extended periods (i.e., days, weeks, or months), pose an increased likelihood of
22 impacting marine mammal populations (MMS 2008b). While the numbers have been steadily
23 decreasing since the 1970s, operational discharges such as tank washing with seawater, oil
24 content in ballast water, and fuel oil sludge are among the sources of small oil spills from tankers
25 (Jernelöv 2010). Large oil spills from tankers have decreased significantly in recent years
26 (modern tankers have double hulls and are sectioned to prevent losing the ship's entire cargo and
27 sea lanes have been established) while spills from ageing, ill-maintained or sabotaged pipelines
28 have increased.

29
30 Characteristics of impacts (i.e., acute vs. chronic impacts) depend on the magnitude,
31 frequency, location, and date of accidents; characteristics of spilled oil; spill-response
32 capabilities and timing; and various meteorological and hydrological factors. Chronic or acute
33 exposure may result in harassment, harm, or mortality to marine mammals. Studies have shown
34 varying results. Marine mammals made no apparent attempt to avoid spilled oil in some cases
35 (Smultea and Würsig 1995); however, marine mammals have been observed apparently detecting
36 and avoiding slicks in other reports (Geraci and St. Aubin 1990). Since there are reports of oiled
37 marine mammals exposure to hydrocarbons persisting in the sea following the dispersal of an oil
38 slick may result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity;
39 and increased vulnerability to disease) to marine mammals.

40
41 Small and large spills occurring in the Cook Inlet Planning Area are not expected to
42 affect the listed blue, sei, sperm, or North Pacific right whales, as these species occur only
43 infrequently, if at all, within the area (MMS 2003e). However, it is important to note that any
44 impacts to individuals of species already in decline (listed species) that affect their survival or
45 reproductive capacity could result in population-level impacts. The endangered fin and
46 humpback whales, as well as the minke and killer whales, which do occur within the planning

1 area, could be affected by accidental spills occurring in or reaching the Shelikof Strait. Gray
2 whales migrating past Cook Inlet could be exposed to accidental spills occurring near the
3 Kennedy and Stevenson entrances to Cook Inlet. Accidental spills in the Cook Inlet Planning
4 Area could also expose smaller cetacean species (such as Dall's porpoise) and pinnipeds
5 foraging in open marine waters. Because of the small number and mostly small size of potential
6 spills that could occur under the proposed action, exposures of these species to spilled oil would
7 be temporary and likely affect only a few individuals (MMS 2003e).
8

9 Oil spills could have serious impacts on pinnipeds during periods when they are
10 concentrated at rookeries (typically, late spring, summer, and early fall). At such times, spills
11 and/or spill response operations have the potential to disturb hundreds of pinnipeds. If a spill
12 contaminates a rookery, a significant population decline could occur (Calkins et al. 1994). Sea
13 otters, sea lions, and harbor seals had elevated hydrocarbon levels in areas contaminated by the
14 *Exxon Valdez* oil spill, but only sea otters and harbor seals showed population declines
15 associated with the spill (Loughlin et al. 1996).
16

17 Spills occurring in or reaching coastal areas, especially sheltered coastal habitats such as
18 bays and estuaries, pose the greatest risk to marine mammals. These spills may be more likely to
19 affect species such as the sea otter and the Steller sea lion that use coastal habitats for pupping,
20 foraging, and resting. A large spill contacting an active pinniped rookery site could result in
21 population-level effects for some species, while spills in nearshore areas could result in the direct
22 oiling of large numbers of pinnipeds and sea otters, and adversely affect local populations of
23 some of these species (primarily the sea otter and fur seals), while sublethal effects may be
24 incurred by all individuals ingesting or inhaling spilled oil.
25

26 An estimated 3,905 sea otters were killed by the *Exxon Valdez* oil spill (EVOS), and sea
27 otter abundance in some oiled areas remains under pre-spill estimates, suggesting that sea otters
28 have not fully recovered (USFWS 2008). Oiling and ingestion of oil-contaminated shellfish may
29 have affected reproduction and caused a variety of long-term sublethal effects (Fair and
30 Becker 2000). The recovery of sea otters may be constrained by residual spill effects resulting
31 from elevated mortality and emigration (Bodkin et al. 2002). According to Frost and Lowry
32 (1994), initially following the *Exxon Valdez* oil spill in Prince William Sound, Alaska
33 (Frost et al. 1994a, b; Lowry et al. 1994; Spraker et al. 1994), it was claimed an estimated
34 300+ harbor seals died as a result of crude oil exposure. Subsequent investigations revealed that
35 there were no significant quantities of oil in the tissues (liver, blubber, kidney and skeletal
36 muscles) of harbor seals exposed to the *Exxon Valdez* spill (Bence and Burns 1995), and that the
37 cause of the decreasing trend in harbor seal numbers since the spill (4.6% per year) is
38 complicated because seal populations were declining prior to the spill (Frost et al. 1999). A
39 further analysis of harbor seal population trends and movements in Prince William Sound
40 concluded harbor seals moved away from some oiled haul-outs during the *Exxon Valdez* spill
41 (Hoover-Miller et al. 2001) and that the original estimate of 300 or more harbor seal mortalities
42 may have been overstated. St. Aubin (1990) found that the greatest effect of a spill was on
43 young seals in cold water and that no mortalities were reported after a well blowout near Sable
44 Island in 1984.
45

1 As discussed in Section 4.4.7.1.1, oil spill response activities may affect marine
2 mammals through exposure to spill response chemicals (e.g., dispersants or coagulants) and
3 through behavioral disturbance during cleanup and restoration operations. The chemicals used
4 during a spill response are toxic, but are considered much less so than the constituents of spilled
5 oil (Wells 1989), although there is little information regarding their potential effects on marine
6 mammals. The presence of, and noise generated by, oil spill response equipment and support
7 vessels could temporarily disturb marine mammals in the vicinity of the response action, with
8 affected individuals likely leaving the area. While such displacement may affect only a small
9 number of animals, cleanup operations disturbing adults in pup-rearing areas may decrease pup
10 survival and result in population-level effects. While some smaller animals can be collected and
11 examined closely, impacts on whales from oil spills are difficult to assess because large numbers
12 of most of the species cannot be easily captured, examined, weighed, sampled, or monitored
13 closely for extended periods of time. Some authors have attempted to link beached carcasses
14 with spill effects, particularly gray whales. Large numbers of gray whale carcasses were
15 discovered previously in other parts of the range (see examples in Loughlin 1994). During the
16 oil spill off Santa Barbara in 1969, an estimated 80,000 bbl of oil may have entered the marine
17 environment. Gray whales were beginning their annual migration north during the spill. Whales
18 were observed migrating northward through the slick. Several dead whales were observed and
19 carcasses recovered, including six gray whales. Brownell (1971, as reported by Geraci 1990)
20 acknowledged that these whales totaled more than the usual number of gray whales and dolphins
21 stranding annually on California shores, and concluded that increased survey efforts had led to
22 the higher counts. Several of the whales examined were thought to have died from natural
23 causes, and one may have been harpooned. No evidence of oil contamination was found on any
24 of the whales examined. The Battelle Memorial Institute concluded the whales were either able
25 to avoid the oil, or were unaffected when in contact with it. Similarly, extensive beached carcass
26 surveys made after the EVOS revealed a number of gray whales. The number of carcasses found
27 was the result of such an atypical survey effort and were comparable to gray whale strandings
28 along the Pacific coast, well south of the EVOS area.

29
30 ***Catastrophic Discharge Event.*** If a catastrophic discharge event occurs, there is greater
31 potential for more severe effects compared to the risk of effects from a large oil spill. A
32 catastrophic discharge event would result in sustained degradation of water quality and, to a
33 lesser extent, air quality that would impact marine mammals from direct contact, inhalation, and
34 ingestion (either directly or indirectly through the consumption of oiled forage or prey species).
35 These effects would be significant, causing a multitude of acute and chronic effects. Additional
36 effects on marine mammals would occur from water and air quality degradation associated with
37 response and cleanup vessels, *in situ* burning of oil, dispersant use, discharges and seafloor
38 disturbances from relief well drilling, and activities on shorelines associated with cleanup,
39 booming, beach cleaning, and monitoring. A catastrophic discharge event has the potential to
40 increase the area and duration of an oil spill, thereby increasing the potential for population-level
41 effects, or at a minimum, an increase in the number of individuals killed. A catastrophic
42 discharge event in Cook Inlet would potentially impact marine mammals throughout much of
43 south central Alaska and has the potential to increase the area and duration of an oil spill, thereby
44 increasing the potential for population-level effects, or at a minimum, an increase in the number
45 of individuals killed. For example, one resident killer whale pod (AB Pod) and one transient
46 killer whale population (AT1 Group) suffered losses of 33 and 41%, respectively, in the year

1 following the *Exxon Valdez* oil spill. Sixteen years after the spill, the resident pod had not
2 returned to pre-spill numbers, while the transient population lost nine members following the
3 spill and continued to decline to the point that it is listed as depleted under the MMPA
4 (Matkin et al. 2008). Additionally, sea otters and harbor seals showed population declines
5 associated with the spill (Loughlin et al. 1996). An estimated 3,905 sea otters were killed by the
6 *Exxon Valdez* oil spill and sea otter abundance in some oiled areas remains under pre-spill
7 estimates, suggesting that sea otters have not fully recovered (USFWS 2008). An estimated
8 302 harbor seals were killed by the *Exxon Valdez* oil spill, probably due to the inhalation of toxic
9 fumes (Frost and Lowry 1994). Contraction of the Cook Inlet beluga whale population
10 northward into the upper portions of the inlet makes the population more vulnerable to a
11 catastrophic discharge event (NMFS 2008).

12

13 **Terrestrial Mammals.** There are approximately 40 species of terrestrial mammal that
14 occur in southern Alaska. Among these, 10 species may regularly use mainland and island
15 habitats adjacent to or near the Cook Inlet Planning Area (Section 3.8.1.2.2), and thus could be
16 affected by OCS-related activities.

17

18 **Routine Operations.** Under the proposed action, up to 80 km (50 mi) of new onshore
19 pipeline would be installed along Cook Inlet, which could result in up to 364 ha (900 ac) of soil
20 disturbance. The area disturbed represents an extremely small portion of terrestrial wildlife
21 habitat that occurs inshore of the Cook Inlet Planning Area. Wildlife are expected to avoid the
22 area where construction of new pipeline is occurring. Few additional impacts, other than those
23 that might occur from helicopter overflights, would occur on terrestrial mammals. Helicopter
24 traffic could disturb wildlife near the existing onshore facilities and pipelines or along the
25 overland portions of flight paths between the existing onshore facilities and new offshore
26 platforms. The aircraft effects on wildlife vary by species, habitat type, and the wildlife activity
27 occurring at the time of the overflight. During overflights, some wildlife will cease their normal
28 behaviors until the aircraft has passed and then resume their normal activity; others may flee the
29 area, while some species may become habituated and experience no disturbance (Harting 1987).
30 Aircraft overflights would be relatively infrequent (no more than three flights per week per
31 offshore platform). Thus, no long-term, population-level effects are expected from aircraft
32 overflights associated with routine operations.

33

34 **Accidents.** An offshore oil spill that contaminates beaches and shorelines could affect
35 terrestrial mammals, such as the Sitka black-tailed deer, brown bear, and river otter, that forage
36 in intertidal habitats (*Exxon Valdez* Oil Spill Trustees 1992). An onshore oil spill could similarly
37 affect terrestrial animals, such as American black bear or moose that may forage in the area of
38 the onshore pipeline. Spills contacting high-use areas, such as coastal habitats along Shelikof
39 Strait heavily used by brown bears, could locally affect a relatively large number of animals
40 (MMS 2003e). The impacts on wildlife from an oil spill would depend on such factors as the
41 time of year and volume of the spill, type and extent of habitat affected, and home range or
42 density of the wildlife species. The potential effects on wildlife from oil spills could occur from
43 direct contamination of individual animals, contamination of habitats, and contamination of food
44 resources (ADNR 1999). Acute (short-term) effects usually occur from direct oiling of animals,
45 while chronic (long-term) effects generally result from such factors as accumulation of
46 contaminants from food items and environmental media (e.g., sediments).

1 Terrestrial mammals directly contaminated by an accidental release could inhale volatile
2 organics and/or ingest oil while grooming contaminated fur (MMS 1996b). Exposure may also
3 occur through the consumption of contaminated foods. The moose and opportunistic omnivores,
4 such as brown and American black bears, may experience a greater potential of exposure than
5 many other wildlife species.
6

7 Staging and support activities for a large spill cleanup could temporarily displace
8 terrestrial mammals not only from the contaminated habitats but also from nearby
9 uncontaminated habitats. Depending on the effectiveness of the cleanup activities, chronic oil
10 exposure may continue for years in some habitats.
11

12 **Catastrophic Discharge Event.** The PEIS analyzes a CDE of 75 to 125 thousand bbl
13 (Table 4.4.2-2). If a CDE occurs, there is greater potential for more severe effects compared to
14 the risk of effects from a large oil spill. A catastrophic discharge event would result in sustained
15 degradation of water quality, shoreline terrestrial habitats, and, to a lesser extent, air quality that
16 could impact terrestrial mammals from direct contact, inhalation, and ingestion (either directly or
17 indirectly through the consumption of oiled forage or prey species). These effects could be
18 significant, causing a multitude of acute and chronic effects. Additional effects on terrestrial
19 mammals would occur from land and air quality degradation associated with response and
20 cleanup vessels, *in situ* burning of oil, dispersant use, and activities on shorelines associated with
21 cleanup, booming, beach cleaning, and monitoring. A CDE has the potential to alter terrestrial
22 mammal habitats and populations. However, only minor impacts to terrestrial mammals were
23 observed from the *Exxon Valdez* oil spill. No Sitka black-tailed deer were found whose death
24 could be attributed to the *Exxon Valdez* oil spill. However, some deer that fed on kelp in the
25 intertidal areas had slightly elevated concentrations of petroleum hydrocarbons in their tissues
26 (*Exxon Valdez* Oil Spill Trustees 1992). Several river otter carcasses were found following the
27 *Exxon Valdez* oil spill. Analysis showed that they accumulated petroleum hydrocarbons. Also,
28 home ranges in oiled areas were twice that of unoiled areas, suggesting that increased foraging
29 was required to find sufficient food resources. Body lengths, weights, and dietary diversity were
30 also lower in oiled areas (*Exxon Valdez* Oil Spill Trustees 1992). Lewis et al. (1991) examined
31 the impacts of the *Exxon Valdez* oil spill on Katmai National Park coastal brown bears. Of the
32 27 bears captured, 4 had been exposed to crude oil. Bears were also observed with oil on their
33 fur, consuming oiled carcasses, and presumably feeding on razor clams in the intertidal area.
34 One yearling bear was found dead with high concentrations of aromatic hydrocarbons in its bile.
35 Crude oil elements were also found in the fecal samples of the bear's mother. However, no
36 population-level impacts on the bears of Katmai were indicated.
37
38

39 **4.4.7.1.3 Alaska – Arctic.** 40

41 **Marine Mammals.** There are 14 resident or seasonal species of marine mammals in the
42 Arctic region, including 8 species of cetaceans, 5 species of pinnipeds, and 1 fissiped species
43 (Table 3.8.1-4; Section 3.8.1.3.1). All of the species occur in the Chukchi Sea; the Pacific
44 walrus and the bearded and ribbon seals also occur in the western portions of the Beaufort Sea,
45 while the ringed and spotted seals, bowhead and beluga whales, and polar bear occur throughout
46 both seas (Section 3.8.1.3.1). The endangered fin and humpback whales are only occasional

1 transients in the southern portion of the Chukchi Sea during summer. The endangered bowhead
2 whale migrates through the Chukchi and Beaufort Seas between its wintering grounds in the
3 Bering Sea and its summering grounds primarily in the Canadian portion of the Beaufort Sea
4 (Figure 3.8.1-4; Section 3.8.1.3.1). However, some individuals remain in the Alaska portion of
5 the Beaufort Sea and in the Chukchi Sea during summer. Thus, the bowhead whale has the
6 greatest potential of the endangered whale species to occur in areas where OCS-related activities
7 are occurring and be affected by normal operations or oil spills. The potential for this would be
8 most probable during the bowhead whale's spring and fall migrations that generally occur from
9 March through June and September through November, respectively (Hill and DeMaster 1998).

10
11 There are at least 9 species of seasonal or resident cetaceans- bowhead, fin, humpback,
12 minke, gray, beluga, and killer whales; harbor porpoise (Suydam and George, 1992) occur with
13 rare or observational accounts of narwhals. Bearded seals occur throughout the Beaufort Sea and
14 into the Canadian High Arctic and Greenland. There are more seasonal residents (3,150) than
15 year-long resident bearded seals, but some seals remain in the Beaufort year-round. Spotted
16 seals have small haul-outs east to the Colville River Delta and historically to Prudhoe Bay.
17 Spotted seals are rare past Harrison Bay and are not known to occur throughout the Beaufort Sea.
18 Gray whales occur primarily nearshore and are occasionally found as far east as the Canadian
19 Beaufort Sea. The continental shelf in the Beaufort is much narrower than in the Chukchi, and
20 therefore it can support fewer gray whales. Humpback whales have been observed nearshore in
21 the Chukchi Sea and as far east as the Western Beaufort Sea. Observations of fin whales have
22 occurred in the southern and east central Chukchi Sea. Observations of a few individuals have
23 been more consistent over the last five years during the open water period.

24
25 ***Routine Operations.*** Table 4.4.7-1 (Section 4.4.7.1) illustrates how each of the
26 impacting factors associated with OCS oil and gas development may affect marine mammals and
27 their habitats, while Figure 4.4.7-1 (Section 4.4.7.1) presents a conceptual model of potential
28 impacting factors for marine mammals from oil and gas-related activities (including accidental
29 oil spills). The following text presents an overview of potential impacts to marine mammals in
30 and near the Beaufort and Chukchi Sea Planning Areas from the following routine operations
31 (seismic surveys, construction of offshore facilities and pipelines, operations of offshore
32 facilities and drilling rigs, discharges and waste generation, service vessel and helicopter traffic,
33 and decommissioning) and from accidents.

34
35 **Seismic Surveys.** During offshore exploration, seismic surveys conducted in offshore
36 areas and in lagoon systems could affect marine mammals. Seismic surveys generally occur
37 during the ice-free periods, normally from July to October (NMFS 2001b). In the Beaufort Sea,
38 there are also on-ice seismic surveys, which may impact ice seals and polar bear. Noise
39 generated by seismic surveys may have physical and/or behavioral effects on marine mammals,
40 such as hearing loss, discomfort, and injury; masking of important natural sound signals,
41 including communications among individual whales; behavioral responses such as flight,
42 avoidance, displacement of migration route, and changes in physical or vocal behavior
43 (Richardson et al. 1995; Davis et al. 1998; Gordon et al. 1998; MMS 2003e). It has not been
44 possible to predict the type or magnitude of responses to such surveys (and other oil and gas
45 activities) nor to evaluate the potential effects on populations (NRC 2003a). However, there is
46 no evidence to suggest that routine seismic surveys may result in population-level effects for any

1 of the marine mammal species. There have been no documented instances of deaths, physical
2 injuries, or physiological effects on marine mammals from seismic surveys (MMS 2004c).

3
4 Cudahy and Ellison (2002) indicated that tissue damage from exposure to underwater low
5 frequency sound will occur at a damage threshold on the order of 180 to 190 dB or higher. The
6 onset of level A harassment impacts per the MMPA (i.e., the potential to injure a marine
7 mammals or marine mammal stock) for cetaceans and walrus is 180 dB re 1 μ Pa (rms) RL and
8 for pinnipeds and polar bears is 190 dB re 1 μ Pa (rms) RL, while the onset of level B harassment
9 impacts per the MMPA (i.e., the potential to disturb a marine mammal or marine mammal stock
10 by causing disruption of behavioral patterns, including, but not limited to, migration, breathing,
11 nursing, breeding, feeding, or sheltering) for marine mammals is 160 dB re 1 μ Pa (rms) RL.

12
13 Noise from air guns and survey vessels could disturb nearby marine mammals that may
14 be foraging in open waters or using floe ice for resting, birthing, and the rearing of young. These
15 disturbances would be largely limited to the immediate area of the survey vessel, although
16 animals within a few kilometers of seismic operations may be affected (Richardson et al. 1986).
17 Because cetaceans and pinnipeds are highly mobile species, they may leave an area when a
18 seismic survey is initiated, thereby greatly reducing their exposure to maximal sound levels and,
19 to a lesser extent, masking frequencies. However, if they surveys occur during the winter or
20 spring when areas of open water are restricted or isolated, young ringed or bearded seals may
21 have some difficulty avoiding the on-ice seismic surveying, and if there are ice breakers, some
22 ringed seal pups could be crushed inside of their lairs. If an animal is able to relocate, would
23 likely resume its normal behavioral patterns. During the open water season, displaced or
24 disturbed individuals may return to the area and/or resume normal behavioral patterns after the
25 survey activities have ceased, but this is not necessarily also true for individuals displaced from
26 on-ice seismic surveys.

27
28 Among cetaceans, the odontocetes generally demonstrate relatively poor low-frequency
29 hearing sensitivity, and thus might not be expected to experience hearing loss from seismic
30 surveys (unless they are in close proximity to air gun arrays) (MMS 2004a). The odontocetes in
31 the Arctic region (beluga and killer whales and the less frequently encountered harbor porpoise
32 and rare narwhal) may respond behaviorally to seismic surveys by leaving the areas where
33 seismic surveys are being conducted. Unless the surveyed area is further developed, such
34 displacement would be temporary and not expected to result in long-term impacts to either
35 individual animals or populations of these species.

36
37 The mysticetes, which include the endangered bowhead, fin, humpback whales, as well
38 as gray and minke whales, are considered to possess good hearing sensitivity at low frequencies
39 down to approximately 10 Hz, and many of their vocalizations occur in the low tens to a few
40 hundred Hz (Richardson et al. 1995; Crane and Lashkari 1996; Ketten 1998;
41 Stafford et al. 1998). Seismic survey air gun arrays output maximal energy in the region of a few
42 tens of Hz, which overlaps with the expected lower end of the hearing sensitivity of mysticetes.
43 Thus, the mysticetes that occur regularly in the Chukchi and Beaufort Seas may be affected by
44 seismic surveys. Exposure of these whales to maximal air gun output during a seismic survey
45 may result in behavioral changes such as area avoidance or short-term or long-term hearing loss,
46 while less than maximal exposure could result in masking effects (Ljungblad et al. 1988b;

1 Malme et al. 1989). It may also alter or deter migration paths and displacement may then result
2 in fewer feeding opportunities where prey are aggregated.

3
4 Bowhead whales can detect sounds produced by seismic pulses from 10 to 100 km (6 to
5 62 mi) away from the source (MMS 2002a). Bowheads have been rarely observed within 20 km
6 (12 mi) of where air guns are operating. However, occurrences of bowheads within 20 km
7 (12 mi) are similar to those outside this radius about 12 to 24 hours after seismic operations
8 cease (MMS 2002a). At seismic pulses as high as 248 dB re 1 μ Pa-m, bowhead whales
9 respond by orienting away from the seismic vessels at distances up to 7.5 km (4.7 mi)
10 (Richardson et al. 1986). While high-frequency seismic noises have the potential to permanently
11 harm cetaceans, there is evidence that some cetaceans may habituate to lower-level seismic
12 noises. For example, Richardson et al. (1986) found that bowhead whales initially responded to
13 moderate underwater noise frequencies (110 to 115 dB re 1 μ Pa-m) by avoiding areas in which
14 seismic exploration activities were occurring, but later became tolerant to prolonged noise
15 exposure. Migrating bowhead whales have also been shown to exhibit avoidance of a 20-km
16 (12-mi) area around seismic surveying where received levels were estimated to be approximately
17 120 to 130 dB re 1 μ Pa at 1 m (Richardson et al. 1999). Given their mobility and avoidance
18 reactions to approaching seismic vessels, it is unlikely that whales would occur close to injurious
19 noise levels (MMS 2003e). Some bowhead whales may tolerate noise levels that may reach
20 injury levels when they are engaged or highly motivated during behaviors such as feeding, while
21 others may exhibit more sensitivity, such as females with calves.

22
23 Todd et al. (1996) found that humpback whales exhibited little behavioral reaction to
24 underwater anthropogenic noises as high as 153 dB re 1 μ Pa. However, Richardson et al. (1990)
25 observed that bowhead whales in close proximity to underwater anthropogenic noise sources
26 (<1 km [0.6 mi]) reacted to sound levels as low as 122 dB re 1 μ Pa by ceasing their feeding
27 behaviors and moving away from the noise source. Watkins and Scheville (1975) observed
28 sperm whales cease vocalization behaviors in the presence of underwater anthropogenic sounds
29 at frequencies between 6 and 13 kHz. Anthropogenic underwater noises as low as 180 dB re
30 1 μ Pa can elicit startle reactions and avoidance behaviors in sperm whales and gray whales
31 (Malme et al. 1984; Andre et al. 1997). Malme et al. (1984) also observed behavioral reactions
32 (avoidance) in gray whales in response to received levels of around 164 dB re 1 μ Pa at 1 m
33 (3 ft); and Richardson et al. (1995) reported that individual gray whales that reacted to noise
34 generally slowed, turned away from the noise source, and increased their respiration rates.
35 Humpback whales off the western coast of Australia changed course at 3 to 6 km (1.9 to 3.7 mi)
36 from an operating seismic survey vessel, with most animals maintaining a distance of 3 to 4 km
37 (1.9 to 2.5 mi) from the vessel. Humpback whale groups containing females involved in resting
38 behavior were more sensitive than migrating animals and showed an avoidance response
39 estimated at 7 to 12 km (4.3 to 7.5 mi) from a large seismic source (McCauley et al. 2000).

40
41 As discussed for the GOM (Section 4.4.7.1.1), it is assumed that BOEM will continue to
42 require ramp-up of seismic activities coupled with visual monitoring and clearance within an
43 exclusion zone around a seismic array. These actions would reduce the potential for cetaceans to
44 be exposed to sound levels that could affect hearing or behavior. The avoidance reactions of
45 whales to approaching seismic vessels would normally prevent exposure to potentially injurious
46 noise pulses (NMFS 2001b). The geographic scale of any potential noise effect is probably

1 relatively small compared to the total habitat used by whales in the Chukchi and Beaufort Seas
2 (MMS 2004c). For example, in the Chukchi Sea, fall migrating bowhead whales are commonly
3 seen from the coast to about 150 km (93 mi) offshore (MMS 2004c), while fall migration in the
4 Beaufort Sea occurs over a 100 km (62 mi) wide corridor (Malme et al. 1989).

5
6 Pinnipeds in close proximity to sources of seismic noise may experience intense sound
7 pressure levels that could cause temporary hearing loss by masking ambient noise levels, causing
8 damage to hearing structures and body tissues (Richardson et al. 1995). Generally seals move
9 away from seismic vessels, although some are observed swimming in the bubbles generated by
10 large seismic air gun arrays (MMS 2003e).

11
12 Walrus hearing has been reviewed in the Pacific Walrus Status Review (Garlich
13 Miller et al. 2011). If exposed to seismic surveys, some walrus may be temporarily displaced
14 or may even experience temporary threshold shifts in hearing. Seismic surveys occur in open
15 water where walrus may be feeding or passing through but are less likely to be present in large
16 numbers (USFWS 2008; BOEMRE 2010e).

17
18 Noises associated with seismic surveys are less likely to harm fissipeds than cetaceans
19 (MMS 2007d). It is unlikely that polar bears are affected by seismic noise in water, as they swim
20 with their heads above water, reducing the risk of hearing damage. In contrast, on-ice seismic
21 work during the winter is more apt to disturb polar bears. Females with cubs will abandon den
22 sites when a seismic crew is operating nearby (Amstrup 1993; Linnell et al. 2000). Premature
23 den abandonment could lead to an increase in cub mortality. Polar bears may not be very
24 sensitive to noise (Richardson 1995 in Richardson et al. 1995), but bears in the vicinity of a
25 seismic survey may leave the area. Female bears excavate dens in snow on drifting pack ice and
26 on land. Pregnant females and females with newborn cubs in maternity dens are sensitive to
27 noise and may be disturbed by seismic exploration, and have been reported to abandon den sites
28 when seismic crews are operating nearby (Amstrup 1993). Such abandonment of a maternity
29 den, even if short-term, could reduce cub survival. In addition, polar bears encountered along
30 seismic survey lines may be killed in defense of life and property, although regulatory agencies
31 and the oil and gas industry have made serious efforts to minimize interactions with polar bears
32 (NRC 2003a). However, companies are required to search for dens prior to the onset of work
33 and are also required to maintain a 1-mile buffer around the dens, which, so far, appears to be an
34 effective mitigation measure.

35
36 For more information on potential effects to marine mammals from seismic exploration,
37 see the MMS Programmatic Environmental Assessment for Arctic Ocean Outer Continental
38 Shelf Seismic Surveys (MMS 2006c). In summary, seismic noise can alter ambient noise levels,
39 damage marine mammal hearing structures, and cause direct physical injury to marine mammals.
40 Potential effects caused by these stressors include:

- 41
42
- 43 • Temporary increased susceptibility to injury, mortality, or predation due to
44 noise masking (e.g., communication, predator avoidance);
 - 45 • Temporary disturbance of normal behavior;
- 46

- 1 • Temporary avoidance of habitat;
- 2
- 3 • Increased susceptibility to injury, mortality, or predation due to hearing loss;
- 4 and
- 5
- 6 • Reduced survival due to physical injury.
- 7

8 Construction of Offshore Platforms and Pipelines. As part of the proposed action, 6 to
9 16 exploration wells and 40 to 120 production wells will be drilled in the Beaufort Sea, while
10 1 to 20 exploration wells and 60 to 280 production wells will be drilled in the Chukchi Sea.
11 There will also be 1 to 4 platforms in the Beaufort Sea and 1 to 5 platforms in the Chukchi Sea.
12 Additional offshore activities planned as part of the proposed action include 10 subsea
13 production wells and 48 to 217 km (30 to 135 mi) of new offshore pipeline in the Beaufort Sea,
14 and between 18 and 82 subsea production wells and 40 to 402 km (25 to 250 mi) of new offshore
15 pipeline in the Chukchi Sea (Table 4.4.1-4).
16

17 Noise and human activity associated with construction of offshore facilities and pipelines
18 could disturb marine mammals that may be present in the vicinity of the construction site.
19 Construction activities could disturb normal behaviors (e.g., feeding, social interactions), mask
20 calls from conspecifics, disrupt echolocation capabilities, and mask sounds generated by
21 predators or prey. Generally, the immediate response of disturbed individuals is to leave or
22 avoid the construction area. From a behavioral perspective, increased anthropogenic noise could
23 interfere with communication among cetaceans, such as gray, minke, beluga, and killer whales
24 and harbor porpoise, mask important natural and conspecific sounds, or alter natural behaviors
25 (i.e., displacement from migration routes or feeding areas, disruption of feeding or nursing).
26 Behavioral impacts appear to be affected by the animal's sex and reproductive status, age,
27 accumulated hearing damage, type of activity engaged in at the time, group size, and/or whether
28 the animal has heard the sound previously (e.g., Olesiuk et al. 1995; Richardson et al. 1995a;
29 Kraus et al. 1997; National Research Council 2003a, 2005a). Toothed whales can be particularly
30 sensitive to high-frequency sounds given their use of high-frequency sound pulses in
31 echolocation, and moderately high-frequency calls for communication. Baleen whales, a group
32 including gray and minke whales, are similarly sensitive to the low frequency noise that is often
33 characteristic of construction, machinery operation, vessel noise, and aircraft noise. Bowhead
34 whales stop feeding and move from within 0.8 km (0.5 mi) of experimental dredge sounds to
35 more than 2 km (1.2 mi) away (MMS 2002a). In addition, some individuals may habituate to
36 dredging and other construction activities (MMS 2002a). Because some marine mammal species
37 exhibit seasonal changes in distribution and are absent or infrequent in the Beaufort and Chukchi
38 Sea Planning Areas in winter, winter construction of offshore platforms would affect relatively
39 few animals. In spring and summer, species present in construction area would be expected to
40 leave the area to other habitats. Displacement could be of short- or long-term duration and could
41 affect survival of young if adults abandon young or are displaced from important foraging areas
42 as well as adults if they are kept from their feeding areas for a long period of time. The
43 construction of new infrastructure in polar bear habitat has the potential to adversely impact
44 these animals through disturbance and displacement.
45

1 To date, documented impacts to polar bears in Alaska by oil and gas development
2 activities are few. The potential for adverse impacts is largely associated with increases in
3 industrial activity or expansion of industrial footprints, as well as related increases in
4 human/polar bear interactions. Minimal impacts could result from the potential increase in
5 human/polar bear interactions associated with expanding the onshore facility, installing the
6 offshore and onshore pipelines, and extending the production timeframe within the action area.
7 The FWS and USGS have predicted that polar bears may be extirpated throughout much of their
8 range within the next 40 to 75 yr if current trends in sea ice reduction continue (73 FR 28212
9 [15 May 2008]). Nonetheless, impacts to bears as a direct result of routine, OCS-related oil and
10 gas activities appear to be minimal.

11
12 Any activity causing noise reaching 160 re 1 μ Pa would risk level B harassment take of
13 whales, and require a take authorization under the MMPA. Additional mitigation measures
14 required to avoid significant adverse impacts would be required by later BOEM and NMFS
15 review processes. Detailed analysis of potential Exploration Plans and Development &
16 Production Plans, along with mitigation measures incorporated into any necessary Incidental
17 Take Authorizations (ITA), would further reduce the potential for any significant adverse
18 impacts. Overall, while development activities may impact whales through masking and
19 avoidance, significant impacts are not expected. Such effects would likely be limited to
20 individuals or small groups, be limited in duration to the construction period, and be sublethal.

21
22 Pipeline trenching may also disrupt mammal species (e.g., Pacific walrus, gray whale,
23 bowhead whale). Despite the long, linear nature of pipelines, their construction is a slow-
24 moving, relatively stationary operation. Thus, pipeline construction represents a temporary and
25 avoidable source of disturbance. The extent to which benthic food sources are affected and the
26 subsequent impact to marine mammals depend on the type and amount of benthic habitat that
27 would be permanently disturbed by trenching, the importance of the specific habitats in
28 providing food resources to marine mammals, and the marine mammal species and numbers of
29 individuals that could be affected.

30
31 Pipeline construction could cross barrier island and nearshore coastal habitats. Polar
32 bears may be temporarily displaced, or their behavior modified (e.g., by changing direction or
33 speed of travel), by construction activities. As explained in a recent biological opinion,
34 “disturbance from stationary activities could elicit several different responses in polar bears.
35 Noise may act as a deterrent to bears entering the area, or conversely, it could attract bears.
36 Bears attracted to development facilities may result in human–bear encounters, leading to
37 unintentional harassment, or intentional hazing of the bear” (USFWS 2009). Mitigation
38 measures (such as implementation of a human–bear conflict management plan) generally
39 required under MMPA Incidental Take Authorizations (typically a Letter of Authorization)
40 would reduce the potential for these impacts. Any adverse impacts would be localized and
41 negligible.

42
43 Because no more than 13.5 ha (33.4 ac) of bottom area would be disturbed by platform
44 construction and no more than 567 ha (1,401 ac) of bottom area would be disturbed by pipeline
45 construction under the proposed action (Table 4.4.1-4), relatively little benthic habitat would be
46 disturbed compared to that present in the Beaufort and Chukchi Sea Planning Areas. Natural

1 recovery of the disturbed benthic habitats would occur within 3 to 10 yr of initial disturbance
2 (Section 4.4.6.2.3). Pipeline trenching is expected to have a limited effect on the overall
3 availability of food sources for marine mammals. Impacts to marine mammal food sources
4 would be localized and would not result in population-level impacts. To avoid or minimize
5 adverse impacts, relevant organizations (i.e., project proponents, BOEMRE, NMFS) will need to
6 develop timing guidelines and operational protocols to govern the specifics of this project. This
7 review would take place at a later stage of review, when more site-specific information would be
8 known.

9
10 Construction of Onshore Pipelines. Under the proposed action, 16 to 129 km (10 to
11 80 mi) of new pipelines onshore of the Beaufort Sea will occur, causing up to 584 ha (1,443 ac)
12 of soil disturbance (Table 4.4.1-4). No other onshore construction will occur under the proposed
13 action (Section 4.4.1.3). Onshore construction activities would not affect most of the marine
14 mammals in the Arctic region because these species typically occur in offshore open-water
15 habitats and ice floes and along pack ice away from coastal areas where construction might
16 occur. Individuals that might be present in nearshore waters adjacent to a construction area
17 would leave the area. Onshore pipeline construction has the potential to directly affect pinnipeds
18 and fissipeds and their habitats through impacts associated with direct contact with construction
19 equipment or infrastructure, as well as indirect impacts associated with perceived habitat loss.
20 Most pinnipeds and fissipeds are alert and mobile enough to be able to avoid areas where
21 construction is occurring. Juveniles are smaller and less mobile than adults; therefore, human
22 disturbances associated with construction activities may have a greater effect on younger
23 pinniped and fissiped individuals.

24
25 The activities associated with onshore construction may also indirectly affect pinniped
26 and fissiped species by reducing habitat quality, and thereby affecting the distribution of the
27 species. Pinnipeds and fissipeds may avoid certain areas of human disturbance. Polar bears may
28 be affected by oil and gas development by abandoning dens in close proximity to onshore
29 disturbances, which may lead to range conflicts with other polar bears or greater cub mortality
30 (Amstrup 1993; Linnell 2000). However, there is evidence that some species or individuals of
31 pinnipeds and fissipeds may be capable of habituating to moderate levels of oil and gas
32 exploration and development activities (Moulton et al. 2003; Blackwell et al. 2004;
33 Smith et al. 2007).

34
35 The spotted seal, Pacific walrus, and polar bear are the three species of marine mammals
36 in the Beaufort and Chukchi Sea Planning Areas likely to occur in coastal habitats, and therefore
37 to be affected by onshore construction. The spotted seal uses coastal habitats such as beaches
38 and river delta sandbars for sunning and resting, while the polar bear forages along shore ice
39 locations, and may have onshore maternity dens located as much as 8 to 10 km (5 to 6 mi) inland
40 of the coast (Section 3.6.4.2.1). Walrus also haul out in large numbers along the Chukchi Sea
41 Coast and beluga use the near shore areas, such as Kaseguluk Lagoon, in the spring. Foraging
42 bears and resting seals would probably leave or avoid areas where onshore construction is
43 occurring. If an active maternity den is present at or near the construction site, construction may
44 cause the female to abandon the den and her cubs, potentially decreasing cub survival
45 (Linnell et al. 2000); however, there is evidence that denning polar bears can become tolerant of
46 low levels of human activity (Amstrup 1993). This was also recently seen (2011) when a sow

1 with cubs denned on Spy Island next to an offshore facility. As only a small number of
2 individuals of either species might be disturbed, no population-level effects are expected.

3
4 Given the small amount of onshore construction that could occur under the proposed
5 action, it is unlikely that onshore construction would have long-term impacts to pinniped and
6 fissiped populations. Onshore construction activities would be sited to avoid areas of known
7 sensitive habitats (e.g., polar bear dens), minimizing the potential for affecting pinniped and
8 fissiped populations.

9
10 Operations of Offshore and Onshore Facilities. Noise associated with OCS
11 drilling and production is of relatively low frequency, typically between 4.5 and 30 Hz
12 (Richardson et al. 1995). Potential effects on marine mammals may include disturbance
13 (e.g., changes in behavior, short- or long-term displacement) and masking of calls from
14 conspecifics or other natural sounds (e.g., surf, predators).

15
16 Because odontocetes use sounds at frequencies that are generally higher than the
17 dominant sounds generated by offshore drilling and production activities, they may not be
18 sensitive to or affected by these sounds. In contrast, mysticetes (the minke, gray, humpback, fin
19 and bowhead whales) are considered to have good low-frequency hearing and exhibit
20 vocalizations at low frequencies, and thus may be affected by drilling and production noise.
21 Effects would be similar to those identified for exploration and construction activities, namely,
22 behavioral disruption and avoidance of or displacement from the immediate vicinity of the
23 operating facility. For example, bowhead whales have been observed to deflect from their
24 migratory path by 20 km (12 mi) or more in response to drilling noises (MMS 2002a). However,
25 bowhead whales tolerate high levels of continuous drilling noise when necessary to continue
26 with migration (MMS 2002a).

27
28 Avoidance or displacement can be of short- or long-term duration, depending on whether
29 or not affected individuals may become acclimated to the operational activities. Because
30 affected individuals would most likely leave the area for other appropriate habitats, neither
31 behavioral disturbance nor the displacement of individuals by normal operations would be
32 expected to result in long-term effects to either individuals or populations. The presence of an
33 operating onshore facility could reduce the suitability of some areas for use by denning female
34 polar bears, while normal operations of offshore facilities could decrease the suitability of
35 offshore areas as pinniped foraging or pup-rearing habitats. Exposure events that elicit a
36 response also may induce stress and further energy expenditure. The frequency that an
37 individual is exposed and reacts to noise levels throughout a given season or lifetime can reach
38 thresholds whereby individual health or reproductive performance could be adversely affected.

39
40 Under the Final Rule designating critical habitat for polar bears, terrestrial denning
41 habitat (Critical Habitat Unit 2) was not designated along the U.S. Chukchi Sea coastline
42 (75 FR 76086 [Dec. 7, 2010]). In the Bering and Chukchi Seas, the majority of dens that have
43 been documented occur on Wrangel and Herald islands, and on the Chukotka Peninsula in
44 Russia. In recent years, sea ice formation along the coastline is occurring later in winter, which
45 may preclude access to coastal denning areas along the U.S. Chukchi Sea coastline. While the
46 USFWS has determined that the coastlines of the Chukchi and Bering Seas are not critical

1 habitat, some dens may occur along the coast. Disturbance at den sites from construction or
2 other human activities could result in a female with cubs abandoning the den site, resulting in
3 death from hypothermia or predation to the cubs. Should construction activities be proposed
4 near an active den, mitigation measures (such as den detection and avoidance) generally required
5 under the Letter of Authorization would reduce the potential for these impacts. The raised
6 onshore pipeline would not pose a physical barrier to polar bear movement, and once away from
7 the coast, would not be in polar bear habitat.

8
9 Discharges and Wastes. Table 4.4.1-4 presents information on drilling fluids, drill
10 cuttings, and produced waters discharged offshore as a result of the proposed action in the
11 Beaufort and Chukchi Seas. Figure 4.4.7-4 (Section 4.4.7.1.1) presents a conceptual model for
12 potential effects of operational waste discharges on marine mammals. Produced water, drilling
13 muds, and drill cuttings will be discharged into offshore marine waters in compliance with
14 applicable regulations and permits. Compliance with regulations and permits will limit the
15 exposure of marine mammals to waste discharges. In some cases, drilling muds may be recycled
16 and not discharged and cuttings may be transported offsite.

17
18 Up to 500 bbl of drill fluids and 600 tons of drill cuttings will be discharged at each
19 exploration and delineation well (Table 4.4.1-4). Heavier components of these muds and
20 cuttings (such as rock) would settle to the bottom, while lighter components could increase
21 turbidity around the drill site. While this increased turbidity could cause marine mammals to
22 avoid the area, any increase in suspended solids associated with the discharge of drilling wastes
23 would be rapidly diluted and dispersed, and thus not be expected to adversely affect marine
24 mammals in the area. Drilling fluids and cuttings associated with development and production
25 wells would be treated and disposed of in the wells; therefore, negligible impacts to marine
26 mammals from these wastes are expected.

27
28 Some marine mammals may be exposed to waste fluids (such as bilge water) generated
29 by and discharged from OCS vessels. Discharges of such wastes from OCS service and
30 construction vessels, if allowed, would be regulated under applicable NPDES permits and would
31 also be rapidly diluted and dispersed. Sanitary and domestic wastes would be processed through
32 shipboard waste treatment facilities before being discharged overboard, and deck drainage would
33 also be processed shipboard to remove oil before being discharged. Thus, permitted waste
34 discharges from OCS service and construction vessels would not affect marine mammals.

35
36 Ingestion or entanglement with solid debris can adversely impact marine mammals
37 (Marine Mammal Commission 2004). Mammals that have ingested debris, such as plastic, may
38 experience intestinal blockage which, in turn, may lead to starvation, while toxic substances
39 present in the ingested materials (especially in plastics) could lead to a variety of lethal and
40 sublethal toxic effects. Entanglement in plastic debris can result in reduced mobility, starvation,
41 exhaustion, drowning, and constriction of, and subsequent damage to, limbs caused by tightening
42 of the entangling material. The discharge or disposal of solid debris into offshore waters from
43 OCS structures and vessels is prohibited by the BOEM (30 CFR 250.40) and the USCG
44 (MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]). Thus, entanglement in or
45 ingestion of OCS-related trash and debris by marine mammals would not be expected under the
46 proposed action during normal operations.

1 Vessel and Aircraft Traffic. There would be up to 12 surface vessels and 12 helicopter
2 trips per week in the Beaufort Sea and up to 15 surface vessels and 15 helicopter trips per week
3 in the Chukchi Sea under the proposed action (Table 4.4.1-4). The majority of vessel traffic in
4 the Beaufort and Chukchi Seas primarily occurs during summer, at which time it could
5 contribute to ambient noise and potential disturbance to marine mammals (MMS 2002a). Which
6 species could be affected by vessel and aircraft traffic, the nature of their response, and the
7 potential consequences of the disturbance, will be a function of a variety of factors, including the
8 specific routes, the number of trips per day, the altitude of the aircraft overflights, the seasonal
9 habitats along the routes, the species using the habitats and the level of their use, and the
10 sensitivity of the mammals to vessel and aircraft traffic. Traffic over heavily used feeding or
11 calving habitats could result in population-level effects for some species, while impacts from
12 traffic over other areas with less sensitive species would likely be limited to a few individuals
13 and not result in population-level effects.

14
15 Marine mammals may be affected by this traffic either by disturbance from passing
16 vessels or helicopters or by direct collisions with vessels. Among the cetaceans, the beluga,
17 gray, and bowhead whales are the most abundant in the Beaufort and Chukchi Sea Planning
18 Areas. Thus, these species have the potential to encounter OCS-related vessels. The other
19 cetaceans are present in relatively low numbers (e.g., less than 2,000 throughout the entire
20 planning area), and thus are less likely to encounter OCS-related vessels. During their spring
21 migration (April through June), bowhead whales would likely encounter few, if any, vessels
22 along their migration route, as NMFS (in their IHAs) and FWS (in their LOAs) restrict access to
23 the Chukchi Sea to protect animals in the spring lead system.

24
25 Bowheads react to the approach of vessels at greater distances than they react to most
26 other industrial activities. According to Richardson and Malme (1993), most bowheads begin to
27 swim rapidly away when vessels approach rapidly and directly. This avoidance may be related
28 to the historic commercial and continuing subsistence hunting. Avoidance usually begins when a
29 rapidly approaching vessel is 1–4 km (0.62–2.5 mi) away. A few whales may react at distances
30 from 5–7 km (3–4 mi), and a few whales may not react until the vessel is <1 km (<0.62 mi)
31 away. Received noise levels as low as 84 dB re 1 μ Pa (decibels relative to one micropascal) or
32 6 dB above ambient may result in strong avoidance of an approaching vessel at a distance of
33 4 km (2.5 mi) (Richardson and Malme 1993). Vessel disturbance has been known to disrupt
34 activities and social groups. Fleeing from a vessel generally stopped within minutes after the
35 vessel passed, but scattering may persist for a longer period. Parks et al. (2011) note for North
36 Atlantic right whales (a species similar to bowhead whales) and Holt and Noren (2008) note for
37 killer whales that individuals modified calls in response to increased background and vessel
38 noise, respectively, by increasing the amplitude of their calls. McDonald, Hildebrand, and
39 Mesnick (2009), however, noted the decline in blue whale song tonal frequencies was not fully
40 explained by the hypothesis of increasing ocean noise. But these authors suggest that post
41 whaling population increase is altering sexually selected trade-offs for singing males between
42 song intensity (ability to be heard at a greater distance) and song frequency (ability to produce
43 songs of lower pitch).

44
45 Where vessels approach slowly or indirectly, bowheads are much more tolerant, and
46 reactions are generally less dramatic. The encounter rate of bowhead, humpback, and fin whales

1 with vessels associated with natural gas development would depend on the location of the
2 platform in relation to both shipping routes and areas of heavy use. During their spring
3 migration (April through June), bowheads likely would encounter few, if any, vessels along their
4 migration route, because ice at this time of year typically would be too thick for supply vessels to
5 operate in. Bowheads, as with other “right whales” (family Balaenidae), are among the slowest
6 moving of whales, which may make them particularly susceptible to ship strikes. Despite their
7 likely greatest susceptibility to vessel strikes, records of strikes on bowheads are rare compared
8 with records of strikes on some other large whales (Laist et al. 2001). About 1% of the bowhead
9 whales taken by Alaskan Iñupiat bore scars from ship strikes (George et al. 1994). Until
10 recently, few large ships have passed through most of the Western Arctic bowhead’s range but
11 this situation is changing and the potential for increasing opportunity for vessel strikes may be
12 increasing as northern sea routes become more navigable with the decline in sea ice. At present,
13 bowheads, humpback, and fin whales probably would adjust their individual swimming paths to
14 avoid approaching within several kilometers of vessels attending the production platform, and
15 would also move away from vessels that approached them within a few kilometers
16 (Richardson et al. 1995).

17
18 Worldwide, at least 11 species of cetaceans have been documented as being hit by ships
19 (Laist et al. 2001; Jensen and Silber 2003). In most cases, the whales are not seen beforehand or
20 are seen too late to avoid collision. Most lethal or severe injuries involve ships traveling
21 ≥ 14 knots (26 km/hr or 16 mph) or faster, and collisions with vessels greater than 80 m (262 ft)
22 in length are usually either lethal or result in severe injuries (Laist et al. 2001). Most seismic
23 vessels typically operate around 4–5 knots. Gray whale use of shallow coastal habitat during
24 migration makes ship strikes a potential source of mortality. Only one ship strike mortality has
25 been reported in Alaska when a killer whale hit the prop during a groundfish trawl in the Bering
26 Sea (MMS 2008b; Allen and Angliss 2011), however, to-date, there have been no vessel strikes
27 reported in the Arctic. Although, harvested bowhead whales have had scarring, indicating they
28 had been hit by the prop of a ship (Rosa 2008). Pinnipeds may also be struck by vessels. There
29 is a possible, but unlikely, potential for polar bears to be struck by vessels (MMS 2009a).

30
31 In addition to possible collision-related injuries, cetaceans may be disturbed by the
32 observation of the vessel and the noise it generates. Disturbed individuals would be expected to
33 cease their normal behaviors and likely move away from the vessel. Following passage of the
34 vessel, affected individuals may return and resume normal behaviors. However, if vessel traffic
35 occurs along a consistent route, some species may permanently leave the area. If the abandoned
36 areas represent important feeding or calving areas, physical condition and reproductive success
37 may be adversely affected. Of 236 bowhead whales examined between 1976 and 1992, only
38 three ship-strike injuries were documented, indicating that they do not often encounter vessels,
39 avoid interactions with vessels, or that interactions usually result in the death of the animals
40 (Shelden and Rugh 1995; Rosa 2008). Current rates of vessel strikes of bowheads are low, and
41 there are no known fin or humpback strikes in the Alaskan Arctic (BOEMRE 2010e). Bowhead
42 whales do not seem to react to aircraft overflights at altitudes above 300 m (984 ft). Most
43 bowheads do not deflect more than a few kilometers from a single noise disturbance, and
44 behavioral responses last only a few minutes. Most reactions include a change in migration
45 speed and swimming direction to avoid the sound source (Richardson et al. 1991). Bowhead
46 whales typically avoid vessels at distances ranging from 1 to 4 km (0.6 to 2.5 mi); drilling noise

1 may deflect individuals 20 km (12.4 mi) or more from their migratory paths. Schick and Urban
2 (2000) suggest that the spatial pattern of bowhead distribution is highly correlated with distance
3 from drilling rigs, and the presence of drilling rigs results in a temporary loss of available habitat.
4 Miles et al. (1987) suggest icebreakers pushing ice would cause half of the bowheads within
5 4.6 to 20 km (2.9 to 12.4 mi) of the source to demonstrate an avoidance behavior. Beluga whales
6 are also known to avoid ice breakers by long distances (Erbe 1997, 2000; Cosens 2003).

7
8 Fixed wing aircraft may serve as whale spotters during pipeline route surveys or pipeline
9 installation activities in the nearshore areas. The use of spotter aircraft could be an important
10 mitigation technique that would reduce the overall potential for gas development to cause
11 adverse impacts to whales. Helicopters are likely to be used to transport crews and supplies in
12 support of modification of the production platform for gas development. Aircraft noise may
13 elicit a response, such as a turn or hasty dive, from a whale or group of whales. But given the
14 altitude at which these aircraft are expected to fly, the potential for adverse reactions is small.
15 Any impacts that did occur would be temporary and minor. To avoid potential disturbance
16 effects on marine mammals, aircraft maintain minimum flight altitudes — human safety will take
17 precedence at all times over this recommendation.

18
19 Construction- and operation-related noises that have the greatest potential to impact
20 pinnipeds, including those generated from vessel and aircraft traffic. Noises emitted by shipping
21 vessels range between 140 dB re 1 μ Pa for smaller vessels to 198 dB re 1 μ Pa for larger tankers
22 and cargo ships (Heathershaw et al. 2001; Erbe 2002; Hildebrand 2004). Helicopters flying at
23 150 m (492 ft) altitude are expected to emit noises received at ground level of approximately
24 80 to 86 dB re 20 μ Pa (Born et al. 1999). These noises may impact nearby pinniped species,
25 which typically have in-air hearing thresholds between 20 to 80 dB and underwater hearing
26 thresholds between 60 to 120 dB (Kastak and Schusterman 1998; NRC 2005). Noises associated
27 with approaching vessels and helicopters may cause hauled out pinnipeds to flee to aquatic
28 habitats. Fay et al. (1984) observed Pacific walrus diving into the water from pack ice when
29 approached by a helicopter within 400 to 600 m (1,300 to 1,968 ft) upwind and 1,000 to 1,800 m
30 (3,280 to 5,905 ft) downwind. Ringed, spotted, and bearded seals have also been known to
31 avoid approaching vessels by fleeing from haul out sites into the water (Frost et al. 1993;
32 Born et al. 1999; Burns and Frost 1999; COSEWIC 2003). During pinniped flight reactions,
33 young pups could be trampled or become isolated from their mothers, leading to injury or
34 making them more susceptible to predators. Despite this, there is evidence that pinnipeds may
35 habituate to moderate levels of human activity (Moulton et al. 2003; Blackwell et al. 2004);
36 therefore, the impacts to pinnipeds from operational noises are expected to be either negligible
37 or minor depending on the species affected.

38
39 Vessel traffic may disturb pinnipeds in the water and hauled out on ice or terrestrial
40 habitats. Hauled out pinnipeds may exhibit behavioral reactions to the physical disturbance of an
41 approaching vessel or aircraft (sometimes >1 km [0.6 mi] away) by exhibiting startle reactions,
42 escaping the immediate area into the water. Project aircraft has the greatest potential to
43 adversely affect pinnipeds haul out and rookery sites (Frost et al. 1993), where disturbed adults
44 may temporarily cease normal behaviors (such as feeding of young), leave the rookery site, and
45 thereby increase predation risks of unattended pups, or risk of trampling while adults are fleeing.
46 However, pinnipeds may habituate to the presence of project vessels (Moulton et al. 2003;

1 Blackwell et al. 2004), and the escape reactions of hauled out pinnipeds may be minimized over
2 time. At times, many of these species, such as seals, are attracted to moving vessels. Pinnipeds
3 could be injured or killed by ship collisions.
4

5 Vessel traffic associated with icebreaking activities in the Alaskan OCS may alter the
6 behaviors of walrus at greater distances (sometimes >2 km [1.2 mi] away) than ordinary ship
7 traffic (Fay et al. 1984). In response to icebreaking vessels, female and young walrus typically
8 react more than males do. Hauled out females and young typically responded to approaching
9 icebreaking vessels by fleeing into the water at distances of 0.5 to 1 km (0.3 to 0.6 mi); males
10 responded by entering the water at distances of 0.1 to 0.3 km (0.06 to 0.2 mi)
11 (Brueggeman et al. 1991; Johnson et al. 1988).
12

13 Vessel and aircraft traffic may disturb fissipeds in aquatic and terrestrial habitats. It is
14 unlikely for polar bears to be directly impacted by vessel collisions; instead, impacts to polar
15 bears from vessel and aircraft traffic may occur from the physical disturbance associated with
16 such activities. Fissipeds are generally considered to be more tolerant than other marine
17 mammals to noises associated with the construction of offshore oil and gas platforms
18 (MMS 2007d). However, construction-related noises may still affect fissiped populations.
19 Vessel, terrestrial vehicle, and aircraft activities can affect polar bear behavior. Vessel traffic
20 associated with natural gas development activity is not expected to cause impacts to polar bears,
21 because they show little reaction to vessels and generally do not linger in open water where
22 vessels are more likely to travel. As explained in a Biological Opinion (USFWS 2009), “During
23 the open-water season, most polar bears remain offshore on the pack ice. Barges and vessels
24 transporting materials for construction and on-going operations of facilities usually travel in
25 open-water and avoid large ice floes. Therefore, there is some spatial separation between vessels
26 and polar bears.” If there is an encounter between a vessel and a bear, it would most likely result
27 in short-term behavioral disturbance only. Polar bear responses to vessels are brief, and
28 generally include walking toward, stopping and watching, and walking/swimming away from the
29 vessel.
30

31 Polar bears typically flee from low flying aircraft that are at an altitude of <200 m
32 (656 ft) and a lateral distance of <400 m (1,312 ft) (Shideler 1993). Extensive or repeated
33 overflights by helicopters travelling to and from offshore facilities could disturb polar bears.
34 Polar bears have been known to run from other sources of noise and the sight of aircraft,
35 especially helicopters. According to a Biological Opinion (USFWS 2009), “Behavioral reactions
36 of polar bears would likely be limited to short-term changes in behavior and have no long-term
37 impact on individuals. In addition, [BOEMRE] requires these types of flights to operate at an
38 altitude of >1,500 ft AGL where possible, which would significantly reduce disturbance.” It is
39 expected that flight altitude requirements will minimize disturbances and that adverse impacts
40 from this activity will be temporary and minimal.
41

42 The effects of air traffic on pinnipeds in the action area are expected to be localized and
43 transient. Some seals may be disturbed on the ice or at haulouts on land and enter the water,
44 although their responses may be highly variable and brief in nature (Born et al. 1999;
45 Boveng et al. 2008, 2009; Burns and Harbo 1972; Cameron et al. 2010; Kelly et al. 2010).
46 Mitigation measures prohibiting aircraft overflights below 457 m (1,500 ft) will lessen aircraft

1 impacts to these pinnipeds. Results from studies of an existing facility (specifically, the
2 Northstar development) are roughly analogous to what is contemplated under the present natural
3 gas development scenario and suggest that any adverse impacts to phocids would be minor,
4 short-term, and localized, with no measurable consequences to seal populations.
5

6 Pacific walrus are particularly vulnerable to disturbance events given their tendency to
7 aggregate in large groups. Reactions to disturbances when on ice are highly variable
8 (Richardson et al. 1995a). Reactions at group haulouts (on land) are more consistent; walrus will
9 flee haulout locations in response to disturbance from aircraft and ship traffic, though walrus in
10 the water are thought to be more tolerant. Females with dependent young are considered the
11 least tolerant of disturbances. Walrus are particularly sensitive to helicopters and changes in
12 engine noise, and are more likely to stampede when aircraft turn or bank overhead. Disturbances
13 caused by vessel and air traffic may cause walrus groups to abandon land or ice haulouts. Severe
14 disturbance events could result in trampling injuries or cow-calf separations, both of which are
15 potentially fatal. But while adverse impacts can be severe, they are also to a large extent
16 avoidable. The USFWS has concluded that a minimum altitude of 1000 ft ASL is sufficient in
17 sea ice habitats (see p. 24 of the USFWS Chukchi Sea EA, 2008) with a 0.5-mi (80-m) horizontal
18 buffer. BOEMRE has taken the more precautionary approach of a 1-mi horizontal buffer and
19 1500-ft AGL or ASL based in part on industry data and on unpublished ADFG and USFWS
20 haulout monitoring data. While BOEMRE does not regulate air space within the project area,
21 direct overflights of terrestrial or sea ice walrus haulouts by industry are strongly discouraged.
22 Typical mitigation measures include flight corridors, a minimum of 1 to 2 mi inland and directly
23 from shore to the exploration site, while maintaining a minimum of 1 horizontal mi from groups
24 of walrus hauled out on ice or land. Overall, the potential for adverse impacts to individuals or
25 groups of walrus do exist, but the probability is minimal in light of mitigation techniques, such as
26 minimum altitude requirements for aircraft. Impacts to walrus are expected to be minor.
27

28 Decommissioning. Under the proposed action, no platforms will be removed with
29 explosives from the Beaufort and Chukchi Sea Planning Areas. Therefore, potential impacts of
30 decommissioning on marine mammals, as summarized in Figure 4.4.7-4 (Section 4.4.7.1.1), will
31 not occur.
32

33 **Accidents.** Accidental oil spills could occur in the Beaufort and Chukchi Sea Planning
34 Areas under the proposed action (Section 4.4.2). Table 4.4.2-1 presents the oil spill assumptions
35 for the proposed action; while Figure 4.4.7-5 (Section 4.4.7.1.1) presents a conceptual model for
36 potential effects of oil spills on marine mammals. Small oil spills ($\leq 1,000$ bbl) break up and
37 dissipate within hours to a day (MMS 2009a). Large spills, particularly those that continue to
38 flow for extended periods (i.e., days, weeks, or months), pose an increased likelihood of
39 impacting marine mammal populations (MMS 2008b). Operational discharges such as tank
40 washing with seawater, oil content in ballast water, and fuel oil sludge are among the sources of
41 small oil spills from tankers (Jernelöv 2010). Large oil spills from tankers have decreased
42 significantly in recent years while spills from ageing, ill-maintained, or sabotaged pipelines have
43 increased.
44

45 Oil spills could affect marine mammals in a number of ways, and the magnitude and
46 severity of potential impacts would depend on the location and size of the spill, the type of

1 product spilled, weather conditions, the water quality and environmental conditions at the time of
2 the spill, and the species and habitats exposed to the spill. Marine mammals may be exposed to
3 spilled oil by direct contact, inhalation, and ingestion (directly, or indirectly through the
4 consumption of contaminated prey species). Such exposures may result in a variety of lethal and
5 sublethal effects (Geraci 1990).
6

7 Fresh crude oil releases toxic vapors that when inhaled may irritate or damage respiratory
8 membranes, congest lungs, and cause pneumonia. Following inhalation, volatile hydrocarbons
9 may be absorbed into the bloodstream and accumulate in the brain and liver, leading to
10 neurological disorders and liver damage (Geraci and St. Aubin 1982; Geraci 1990). Toxic vapor
11 concentrations may occur just above the surface of a fresh oil spill, and thus be available for
12 inhalation by surfacing cetaceans. Inhalation would be a threat only during the first few hours
13 after a spill (Hayes et al. 1992; ADNR 1999). Prolonged exposure to freshly spilled oil could
14 kill some whales (including bowheads, pinnipeds, and polar bear), but the numbers would be
15 small due to a low chance of such contact. This would most likely occur if oil spilled into a lead
16 that bowhead whales could not escape (MMS 2001).
17

18 Direct contact of oil may irritate, inflame, or damage skin and sensitive tissues (such as
19 eyes and other mucous membranes) (Geraci and St. Aubin 1982). Prolonged contact to
20 petroleum products may reduce food intake; foul baleen on mysticete whales, elicit agitated
21 behavior; alter blood parameters, respiration rates, and gas exchange; and depress nervous
22 functions (Lukina et al. 1996). Under less extreme exposures (lower concentrations or shorter
23 durations), oil does not appear to readily adhere to or be absorbed through cetacean skin, which,
24 due to a thick fat layer, may provide a barrier to the uptake of oil-related aromatic hydrocarbons
25 through the body surface (Geraci and St. Aubin 1982, 1985; Harvey and Dahlheim 1994).
26

27 Effects of oil spills would depend on how many whales contacted oil, the duration of
28 contact, and the age/degree of weathering of the spilled oil. The number of whales contacting
29 spilled oil would depend on the size, timing, and duration of the spill; how many whales were
30 near the spill; the whales' inclination or ability to avoid contact; and the effectiveness of cleanup
31 activities (MMS 2001, 2004c). Some displacement of bowhead whales may occur in the
32 event of a large oil spill, and avoidance of the contaminated area may last for several years
33 (MMS 2001; NMFS 2001b). This indicates that bowhead whales may have some ability to
34 detect an oil spill and would avoid surfacing in the oil by detouring away from the spill area
35 (NMFS 2001b). Modeling efforts have indicated that only up to 2% of the Beaufort Sea
36 bowhead whale population would be affected by a large oil spill (NMFS 2001b).
37

38 An oil spill into ice leads or polynyas in the spring could have devastating effects,
39 trapping bowhead whales where they may encounter fresh crude oil. Calves would be more
40 vulnerable than adults because they need to surface more often to breathe. Feeding bowhead
41 whales are also sometimes observed aggregating in large numbers during the summer open-water
42 season, when they could also be vulnerable to a spill. Beluga whales, that also use the spring
43 lead system to migrate, would be susceptible to a spill that concentrates in these leads (Nuka
44 Research and Planning Group, LLC and Pearson Consulting, LLC 2010).
45

1 Pinnipeds and fissipeds may be exposed while coming ashore onto oiled beaches. In
2 addition, adults and juveniles may also be indirectly affected if an accidental spill reduces the
3 quality or quantity of foraging or breeding habitats. Impacts to calving grounds could result in
4 population-level effects. Fouling of fur of some species (e.g., ringed seal pups, polar bear cubs)
5 could affect thermoregulation and reduce survival of the affected young. Ice seals tend to be
6 solitary and would most likely be exposed to oil at sea or on ice. Walrus and spotted seals would
7 most likely be exposed at sea, on ice, or at coastal haulouts. Polar bears would most likely come
8 into contact with spilled oil at sea, on ice, or on shore.

9
10 Oil would affect pinnipeds if it were to directly contact individuals, haulouts, or major
11 prey species. For example, bearded seals and walrus are vulnerable to spilled oil from direct
12 exposure and from the indirect effects through the benthic organisms on which they feed
13 (Cameron and Boveng 2009). Although some adult pinnipeds (e.g., walruses) have thick skin
14 that would protect them from absorption of oil, direct contact with oil would affect sensitive
15 tissue areas, causing irritation to eyes, nasal passages, and lungs. Inhalation of hydrocarbon
16 vapors may damage or irritate lung tissue. These injuries may affect already stressed adults and
17 could lead to some fatalities. While adult ice seals depend on a thick fat layer for insulation, seal
18 pups rely on a dense layer of underfur until they are several weeks old. The fouling of this
19 underfur in young pups could reduce its insulating properties, increasing the potential for
20 hypothermia and increasing pup mortality. While there is no conclusive evidence of past oil
21 spills causing a decline in prey species sufficient to result in a decline in any marine mammal
22 population, there is still the possibility of such an effect occurring. Because pinniped species in
23 the Arctic do not congregate in rookeries, the overall effects of accidental oil spills on pinnipeds
24 will be species-specific.

25
26 An oil spill that contacts an aggregation of walruses or displaces them from their haulouts
27 may have a severe impact on the population. Walruses could also be impacted by consuming
28 contaminated molluscs and being exposed to oil residues in sediments. As they have a long life
29 span, they could suffer severe effects from the bioaccumulation of oil-derived contaminants
30 (Nuka Research and Planning Group, LLC and Pearson Consulting, LLC 2010). According to
31 Geraci and St. Aubin (1990), ice seals have the ability to metabolize oil if ingested in low
32 amounts and some researchers believe walrus may share this ability (GarlichMiller,
33 Pers. Comm.).

34
35 Accidental oil spills could potentially affect polar bears through contamination of prey or
36 reduction of prey availability, fouling of fur, and oiling of ice. Polar bears are very sensitive to
37 oil contact (Engelhardt 1981). Fouling of fur greatly reduces its ability to insulate, and can result
38 in hypothermia and death. Direct contact with oil or secondary contact with contaminated ice
39 could be fatal. However, in most areas, polar bears occur at low densities; therefore, small
40 numbers of bears would be affected by a single spill. Multiple spills or spills along the ice edge
41 where bear density is greater would potentially increase mortality rate. Ringed seals are the
42 primary prey of polar bears and are, therefore, directly linked to their survival. If seal density is
43 affected by oil spills or cleanup operations, polar bears could experience increased stress and
44 possibly lower survivorship.

1 Marine mammals may incidentally ingest floating or submerged oil or tar, and may
2 consume oil-contaminated prey (Geraci 1990). Spilled oil may also foul the baleen fibers of
3 mysticete whales, temporarily impairing food-gathering efficiency or resulting in the ingestion of
4 oil or oil-contaminated prey (Geraci and St. Aubin 1987). Ingested oil can remain within the
5 gastrointestinal tract and be absorbed into the bloodstream, thus irritating and/or destroying
6 epithelial cells in the stomach and intestine. Oil ingested during grooming of fouled fur has been
7 reported to result in liver and kidney damage in polar bears and ringed seals (NRC 2003a;
8 Oritsland et al. 1981). It should be noted that ringed seals and likely other ice seals can detoxify
9 their bodies by renal and biliary pathways. Further, seals do not typically orally groom
10 themselves and are therefore less likely to ingest toxins in that way (Kooyman et al. 1976; Geraci
11 and Smith 1976).

12
13 An accidental oil spill may result in the localized reduction, extirpation, or contamination
14 of prey species. Invertebrate and vertebrate species (such as zooplankton, crustaceans, mollusks,
15 and fishes) may become contaminated and subsequently expose marine mammals that feed on
16 these species.

17
18 Depending on their habitat preferences, feeding styles, and migration patterns, some
19 species may be more vulnerable to exposure than other species. Spills occurring in spring may
20 affect a greater number of individuals due to animals congregating during migration. Spills
21 occurring in or reaching coastal areas, especially sheltered coastal habitats such as bays and
22 estuaries, would be more likely to affect species such as the beluga whale and spotted seal that
23 use coastal habitats for calving and resting. Bowheads are most sensitive to oil contamination
24 during the spring migration when calves are present and their movements are restricted to open
25 leads in the ice (MMS 2002a).

26
27 Polar bears may be directly affected by an oil spill, since they spend the majority of their
28 time on ice, through oiling of fur, ingestion of oil from grooming, or by feeding on oiled prey or
29 carcasses. Large oil spills could have a significant impact on polar bear habitat and can result in
30 food chain effects. Spills associated with onshore facilities (and especially any onshore
31 pipelines) would potentially affect polar bears. While it is unlikely that a bear would be directly
32 exposed to an accidental pipeline release, bears could be affected by feeding on contaminated
33 prey. However, because of the relatively low density of bears in the Arctic region, no more than
34 a few individuals would be expected to be affected by an onshore release. Onshore spills that
35 enter a stream system may be carried to coastal areas, where other marine mammals may be
36 exposed.

37
38 Because benthic organisms (such as crustaceans and mollusks) accumulate oil
39 compounds more readily and to higher levels than pelagic biota, the potential for ingesting oil-
40 contaminated prey is highest for benthic feeding species, such as the gray whale, less so for
41 zooplankton-feeding cetaceans, and least for fish-eating cetaceans (Würsig 1990). Similar
42 differences in exposure via food ingestion may be expected among benthic and fish-eating
43 pinnipeds (i.e., Pacific walrus, spotted seals). Species with a dependence on or preference for
44 offshore areas or habitats for feeding, shelter, or reproduction would be more likely to be
45 affected by a spill than would other marine mammals (Würsig 1990).

46

1 Spills occurring in winter may accumulate and may be incorporated into the ice matrix
2 and move with the ice pack. In spring, this oil may be released into ice leads that are used by
3 migrating whales (such as beluga and bowhead whales) and by pinnipeds that use these areas,
4 resulting in the exposure of relatively large numbers of individuals. Spills under ice or
5 associated with leads may affect haulout sites, causing either abandonment or repeated exposure
6 through use of the contaminated haulout. Because some species are relatively restricted to open-
7 water areas associated with ice, individuals may not be able to disperse from spills in these areas,
8 and thus may incur increased exposures. Because polar bears are closely associated with ice
9 edges, spills accumulating along these areas may expose the greatest number of bears to an
10 offshore spill. An oil spill in areas where polar bears congregate (e.g., leads or polynyas and
11 beachcast marine mammal carcasses) could have negative population effects.

12
13 Marine mammals that frequently groom, such as polar bears, would be most likely to
14 ingest oil. Feeding on contaminated prey or carcasses also causes ingestion of oil (Fair and
15 Becker 2000). With the exception of bearded seals who may enter the water within hours of
16 being born, newborn seals are more sensitive to oil than adult seals, as they have little fat and
17 rely on a dense layer of fur (lanugo). Loss of this waterproofing by oil could cause hypothermia
18 and death (Fair and Becker 2000).

19
20 The magnitude and extent of any adverse effects will also depend on how quickly a spill
21 is contained and how quickly and effectively cleanup is accomplished (USFWS 2004). Arctic
22 conditions (i.e., sea ice, wind, temperature, limited visibility, and sea state) can potentially
23 impact oil spill responses. Other than high sea state (choppy waves), which can enhance the
24 effectiveness of chemical dispersants, most extremes in arctic conditions hinder spill response
25 activities (Nuka Research and Planning Group 2007). Lessees are required to have contingency
26 plans to prevent, address, and clean up oil spills (ADNR 1999). Spill cleanup operations could
27 result in short-term disturbance of marine mammals in the vicinity of the cleanup activity, while
28 a collision with a cleanup vessel could injure or kill marine mammals. Disturbance of adults
29 with young during cleanup could reduce survival of the young animals. For example, vessel and
30 human activities associated with cleanup efforts may cause pinnipeds to abandon coastal haulout
31 areas and/or rookeries for an extended period of time. Cleanup operations, including helicopter
32 overflights and vessel traffic, could also potentially increase pup mortality if operations were to
33 occur near rookeries. Aircraft readily disturb pinnipeds and walruses, which can cause adults to
34 stampede into the water, trampling pups in the process. Any increased mortality in a pinniped
35 population could impact the population as a whole, especially for sensitive or declining
36 populations (e.g., Pacific walruses).

37
38 An approved oil spill response plan would be required for all exploration and production
39 activities. Oil-containment and cleanup activities would be initiated a short time following an oil
40 spill (MMS 2003e). Oil spill response activities may affect marine mammals through exposure
41 to spill response chemicals (e.g., dispersants or coagulants) or through behavioral disturbance by
42 cleanup operations or habitat disturbance. The chemicals used during a spill response are toxic,
43 but are considered much less so than the constituents of spilled oil (Wells 1989), although there
44 is little information regarding their potential effects on marine mammals. The presence of, and
45 noise generated by, oil spill response equipment and support vessels could temporarily disturb
46 marine mammals in the vicinity of the response action, with affected individuals likely leaving

1 the area. While such displacement may affect only a small number of animals and not result in
2 population-level effects, cleanup operations disturbing adults in pup-rearing areas may decrease
3 pup survival. Oil spill response support vessels may also increase the risk of collisions between
4 these vessels and marine mammals in the vicinity of the spill response. During oil spill cleanup
5 activities, interactions with humans could cause polar bear disturbance, injury, or death. For
6 example, cleanup operations that disturb a den could result in the death of cubs through
7 abandonment and perhaps death of the mother.
8

9 ***Catastrophic Discharge Event.*** The PEIS analyzes a CDE of 1.4 to 2.2 million bbl for
10 the Chukchi Sea and 1.7 to 3.9 million bbl for the Beaufort Sea (Table 4.4.2-2). If a CDE
11 occurs, there is greater potential for more severe effects compared to the risk of effects from a
12 large oil spill. A CDE would result in sustained degradation of water quality and, to a lesser
13 extent, air quality that would impact marine mammals from direct contact, inhalation, and
14 ingestion (either directly or indirectly through the consumption of oiled forage or prey species).
15 These effects would be significant, causing a multitude of acute and chronic effects. Additional
16 effects on marine mammals would occur from water and air quality degradation associated with
17 response and cleanup vessels, *in situ* burning of oil, dispersant use, discharges and seafloor
18 disturbances from relief well drilling, and activities on shorelines associated with cleanup,
19 booming, beach cleaning, and monitoring. A CDE has the potential to increase the area and
20 duration of an oil spill, thereby increasing the potential for population-level effects, or at a
21 minimum, an increase in the number of individuals killed. For example, a catastrophic
22 discharge event contaminating ice leads or polynyas in the spring could have devastating effects,
23 trapping bowhead whales where they may encounter fresh crude oil. Beluga whales that also use
24 the spring lead system to migrate would also be susceptible to a spill that concentrates in these
25 leads.
26

27 ***Terrestrial Mammals.*** The terrestrial mammal communities present within the Beaufort
28 and Chukchi Sea Planning Areas include a variety of small mammals (e.g., rodents), big game,
29 and furbearer species. Species of particular concern are the caribou, muskoxen, grizzly bear, and
30 arctic fox. Section 3.6.4.2.1 provides an overview of these species.
31

32 ***Routine Operations.*** Under routine operations for the proposed action, terrestrial
33 mammals could be affected by the construction and operation of new onshore pipelines and from
34 vehicle traffic and helicopter overflights.
35

36 **Construction and Operation of Onshore Pipelines.** Under the proposed action, 16 to
37 129 km (10 to 80 mi) of new onshore pipeline would be installed along the Beaufort Sea, which
38 could result in 73 to 584 ha (180 to 1,443 ac) of soil disturbance (Table 4.4.1-4). The areas
39 disturbed represent an extremely small portion of terrestrial wildlife habitat that occurs inshore
40 of the Beaufort and Chukchi Sea Planning Areas.
41

42 ***Caribou.*** In general, caribou use coastal areas of the North Slope largely in June, July,
43 and August, although a portion of the Western Arctic Herd may overwinter in coastal habitats
44 bordering the Chukchi Sea, and in some years, the Teshekpuk Lake Herd may remain on the
45 Arctic Coastal Plain throughout the winter. Because onshore pipeline construction would likely
46 occur in winter to minimize impacts on the ground surface and vegetation, construction activities

1 would not affect caribou calving or foraging in summer. Construction could, however, disturb
2 caribou in overwintering areas, causing them to vacate preferred overwintering areas and move
3 into less suitable habitats. Such displacement could affect individuals or local populations as a
4 result of increased energy expenditure associated with movement to, and use of, suboptimal
5 habitat, with subsequent mortality and reduced productivity (NRC 2003a).
6

7 If construction were to occur in late spring and summer, calving caribou, females with
8 newborn calves, and older foraging calves could be disturbed. Affected individuals would likely
9 leave or avoid habitats in the vicinity of the construction activities and move into potentially less
10 suitable habitats. During the calving season from late May until late June, which includes the
11 actual calving dates and the following 2 to 3 weeks, cows with calves are particularly susceptible
12 to disturbance by human activities, and such displacement could result in population-level effects
13 if calving success and calf survival are reduced (NRC 2003a).
14

15 Overall, caribou may be disturbed during construction or affected by the presence of new
16 onshore pipeline. The response of caribou may include the avoidance or abandonment of
17 preferred habitats in the vicinity of the new pipeline, with subsequent displacement to other
18 potentially suboptimal areas. The magnitude of any such effects would be a function of the
19 specific location of the new pipeline relative to preferred habitats (such as calving and foraging
20 grounds and insect-avoidance areas), the location and length of the pipeline, and the number of
21 individuals affected — the greater the length and distance of the new pipeline from existing
22 pipelines (particularly TAPS), the greater the potential for affecting caribou and the greater the
23 number of caribou and caribou herds that could be affected.
24

25 While pipelines built lower than 1.5 m (4.9 ft) above the ground surface may act as
26 physical barriers to movement (NRC 2003a), a pipeline constructed to current clearance
27 standards (with a minimum clearance of 1.5 m [4.9 ft]) would not be expected to physically
28 hinder caribou crossings (Curatolo and Murphy 1986). Caribou have been shown to be reluctant
29 in approaching pipelines and to exhibit reduced crossing success of pipelines located in close
30 proximity to roadways with traffic. Thus, the presence of a new pipeline may affect daily or
31 seasonal movements of some individuals and herds.
32

33 *Muskoxen.* Muskoxen are expected to avoid the area where construction of new pipeline
34 is occurring. It is not known how construction disturbance or the presence of a completed
35 pipeline would affect muskoxen habitat use and reproductive success. However, muskoxen may
36 be particularly vulnerable to disturbance in winter because of limited habitat, the length of the
37 arctic winter, the need to conserve energy throughout the winter, and, for females, the need to
38 maintain good body condition throughout winter and spring for calving (Reynolds et al. 2002).
39 However, because of the small population size of muskoxen, disturbance from pipeline
40 construction could result in population-level effects, especially if this species is disturbed during
41 winter. The limited distribution and small population size of muskoxen in the coastal and inland
42 areas adjacent to the Beaufort and Chukchi Sea Planning Areas would greatly reduce the
43 likelihood for disturbance of this species.
44

45 The presence of a completed pipeline may hinder movement by muskoxen if there is
46 insufficient pipeline clearance for this species. However, muskoxen do not exhibit as extensive

1 seasonal or daily movements as caribou. If undisturbed, muskoxen remain in relatively small
2 areas throughout the winter, while in summer they exhibit longer movements that track the
3 emergence of high-quality forage plants (Reynolds et al. 2002). In summer, most daily
4 movements of radio-tracked individuals in the Arctic National Wildlife Refuge (ANWR) were
5 reported to be less than 5 km (3 mi) in length, and many were typically less than 1 km (0.6 mi) in
6 length (Reynolds et al. 2002). Existing pipelines associated with the North Slope oil fields and
7 TAPS do not appear to have hindered the westward expansion of muskoxen from ANWR. For
8 muskoxen to have expanded their range from ANWR to the Colville River, some individuals had
9 to cross the TAPS ROW or travel through the oil fields on the North Slope (BLM 2002). Thus,
10 the presence of a new pipeline is not expected to adversely affect muskoxen populations in
11 onshore areas adjacent to the Beaufort and Chukchi Sea Planning Areas.

12
13 *Brown Bear.* The brown bear uses the coastal environments and/or terrestrial oil
14 transportation routes onshore of the entire Beaufort and Chukchi Sea Planning Areas. Winter
15 construction of onshore pipeline could disrupt individual bear dens. In summer, some
16 individuals may temporarily leave habitats in the vicinity of active construction. However,
17 because bears often habituate to human activities and facilities (Follmann and Hechtel 1990), the
18 presence of new pipeline is not expected to directly adversely affect the grizzly bear.

19
20 *Arctic Fox.* Arctic foxes occur throughout the Beaufort and Chukchi Sea Planning Areas,
21 using the coastal and shore-fast ice habitats. The arctic fox would not be adversely affected by
22 the construction or operation of new pipeline. Individuals would likely abandon habitats
23 temporarily in the vicinity of construction activities. Because the completed pipeline could
24 provide increased shelter and den habitat, populations of arctic fox could increase along the
25 pipeline corridor. An increase in fox abundance could lead to increased outbreak of disease
26 (rabies, canine distemper) among foxes living along the pipeline corridor, as well as increased
27 predation pressures on populations of prey species.

28
29 Foxes are highly mobile, and in late autumn and winter, they disperse out onto the sea ice
30 in search of food. Because of this mobility, foxes may visit new offshore facilities (e.g., drilling
31 platforms, ice roads, exploratory seismic trains) in search of food when sea ice is present. Arctic
32 foxes were regularly observed near Seal Island in the Northstar development during the ice-
33 covered season (MMS 2002a). Thus, depending on their number and distance from shore, new
34 offshore platforms may provide additional winter food supplies and increase winter survival of
35 some individuals.

36
37 Vehicle Traffic and Helicopter Overflights. Vehicle traffic associated with operations of
38 a pipeline (e.g., pipeline monitoring) could affect wildlife along the new pipeline and any
39 associated access roads. In addition, new access roads may also increase the incidence of
40 vehicles associated with recreation, subsistence hunting, and other activities. Vehicle traffic
41 could disturb wildlife foraging along roadways, causing affected wildlife to temporarily stop
42 normal activities (e.g., foraging, resting) or leave the area. Collision with vehicles could result in
43 mortality, especially in areas with concentrations of wildlife or along migration corridors.
44 Vehicle traffic along any access road associated with the proposed action would likely be light.
45 Thus, the incidence of such collisions would be very low and not expected to result in
46 population-level impacts on wildlife.

1 Helicopter overflights associated with pipeline monitoring and transport of personnel
2 and supplies may disturb wildlife. The effects of helicopters on wildlife vary by species,
3 populations, habitat type, and environmental variables. Some species may become habituated
4 and experience no adverse effects (e.g., see Harting 1987). Routine overflights by surveillance
5 helicopters would result in a short-term disturbance to animals along the pipeline route, causing
6 them to temporarily alter behaviors, and would not be expected to result in long-term population-
7 level effects.

8
9 *Caribou.* Responses to vehicle and helicopter traffic by caribou can vary from no
10 response to panic behavior. Cow and calf groups appear to be most sensitive (Valkenburg and
11 Davis 1984; MMS 1998). Because caribou tend to avoid transportation corridors (Dau and
12 Cameron 1986; Griffith et al. 2002; Cameron et al. 2002; NRC 2003a), disturbance of caribou by
13 vehicle traffic associated with normal operations of an onshore pipeline would be infrequent.
14 Single passes by helicopters may result in short-term disturbances that should not adversely
15 affect caribou (MMS 1998). Low-flying helicopters are more likely to produce negative
16 responses from caribou than are light, fixed-wing aircraft (Maier et al. 1998). McKechnie and
17 Gladwin (1993) evaluated altitude tolerance thresholds below which aircraft overflights elicit
18 panic and escape responses and determined that the tolerance threshold for a fixed-wing aircraft
19 was 61 m (200 ft), with few or no response reactions observed above 153 m (500 ft). In contrast,
20 the tolerance threshold for helicopters was determined to be 306 m (1,000 ft) in altitude (Miller
21 and Gunn 1979).

22
23 *Muskoxen.* Vehicle traffic along a pipeline access road would likely result in temporary
24 disturbance of muskoxen in the immediate vicinity of the roadway. The response of muskoxen
25 to aircraft overflights has been reported to range from calm to excitable, and the nature of the
26 response depends in part on the altitude of the overflight, terrain, climate, sex, group size,
27 number of calves present in a group, and habituation (Miller and Gunn 1979, 1980). Helicopter
28 and low-flying aircraft overflights can cause muskoxen to stampede and abandon their calves
29 (NRC 2003a). While responses of muskoxen to vehicle traffic and aircraft overflights associated
30 with the proposed action are not expected to adversely affect muskoxen populations, energetic
31 costs associated with forced movements (especially if frequent) in winter could adversely affect
32 spring calving and could result in population-level effects.

33
34 *Brown Bear.* Some brown bears may be injured or killed by collisions with vehicles
35 along access roads, while bears in the vicinity of vehicle traffic may be disturbed and temporarily
36 cease normal behavior or leave the area until the vehicle has passed. Aircraft overflights have
37 been reported to elicit a variety of responses in brown bears, including escape behavior and
38 hiding (Larkin 1996). While vehicle traffic and aircraft overflights associated with the proposed
39 action may on occasion temporarily disturb individual bears, long-term population-level effects
40 would not be expected from normal operations.

41
42 *Arctic Fox.* The Arctic fox may experience temporary disturbance from vehicle traffic
43 and aircraft overflights, resulting in hiding, departure from the immediate area, or cessation of
44 normal behaviors. Some individuals crossing or traveling along access roads may be injured or
45 killed by vehicle traffic. Relatively few individuals are expected to be affected, and population-
46 level impacts would not be expected under normal operations.

1 **Accidents.** Accidents under the proposed action that could affect terrestrial wildlife
2 would be largely limited to an oil spill from a new pipeline. The impacts on wildlife from an oil
3 spill would depend on such factors as the time of year and volume of the spill, type and extent of
4 habitat affected, and home range or density of the wildlife species. The potential effects on
5 wildlife from oil spills could occur from direct contamination of individual animals,
6 contamination of habitats, and contamination of food resources. Acute (short-term) effects
7 usually occur from direct oiling of animals (e.g., exposure to toxic hydrocarbons via inhalation
8 and/or by ingestion of oil while grooming contaminated fur), while chronic (long-term) effects
9 generally result from such factors as accumulation of contaminants from food items and
10 environmental media (e.g., water).

11
12 Up to two large pipeline spills are expected to occur over the lifetime of the proposed
13 action (Table 4.4.2-1). For the most part, expected spills would occur at offshore facilities rather
14 than from the onshore pipeline. Wildlife may be exposed to spilled oil by eating a variety of
15 oiled vegetation, wildlife, and/or contaminated carrion. In addition, animals occurring within a
16 spill area may also be exposed via inhalation of aromatic hydrocarbons. Such exposure would
17 likely result in sublethal or lethal effects. The magnitude of the effect will depend on the level of
18 exposure, the life stage of the exposed bear (i.e., adult, cub), and the condition of the exposed
19 animal (i.e., healthy, injured).

20
21 Oil spills could potentially affect arctic foxes through contamination of prey, reduction of
22 prey availability, and fouling of fur, causing loss of its insulating capacity. Arctic foxes would
23 be vulnerable to oil ingestion from grooming their fur (Nuka Research and Planning Group, LLC
24 and Pearson Consulting, LLC 2010). Although arctic foxes are abundant predators on the North
25 Slope, their mobility allows them to disperse from oiled areas, if necessary. Because arctic foxes
26 are opportunistic carnivores, they may prey on oiled birds and small mammals and consume
27 oiled carcasses, thereby increasing their potential for incurring lethal and sublethal exposure to
28 the spilled oil and its breakdown products. While some loss of arctic foxes may occur as a result
29 of this exposure, this loss would be limited to animals in the vicinity of the spill. While a local
30 population-level effect may result, recruitment from other areas would likely quickly replace the
31 lost individuals.

32
33 Staging and support activities for cleanup of a large offshore spill could temporarily
34 displace terrestrial mammals. Oil spill cleanup activities on land may displace these animals
35 from not only contaminated habitats but also nearby uncontaminated habitats. This displacement
36 could reduce energy reserves (especially in winter), which in turn could affect body condition
37 and calving success.

38
39 **Catastrophic Discharge Event.** The PEIS analyzes a CDE of 1.4–2.2 million bbl in the
40 Chukchi Sea and 1.7-3.9 million bbl in the Beaufort Sea (Table 4.4.2-2). If a CDE occurs, there
41 is greater potential for more severe effects compared to the risk of effects from a large oil spill.
42 A CDE would result in sustained degradation of water quality, shoreline terrestrial habitats, and,
43 to a lesser extent, air quality that could impact terrestrial mammals from direct contact,
44 inhalation, and ingestion (either directly or indirectly through the consumption of oiled forage or
45 prey species). These effects could be severe where persistent, heavy oil makes contact with
46 important habitat and prey base, causing a multitude of acute and chronic effects. Additional

1 effects on terrestrial mammals would occur from land and air quality degradation associated with
2 response and cleanup vessels, *in situ* burning of oil, dispersant use, and activities on shorelines
3 associated with cleanup, booming, beach cleaning, and monitoring. A CDE has the potential to
4 alter terrestrial mammal habitats and populations. The potential for a population-level impact
5 would occur in the unlikely event that a spill occurred in an area where a large number of
6 individual animals are concentrated. For instance, population-level effects to caribou would be
7 most likely from spills occurring in calving areas and along migration corridors. For the
8 muskoxen, the potential for population-level effects would be greatest for a spill occurring in
9 winter when this species remains in small areas, restricted by the availability of forage
10 (Reynolds et al. 2002).

11 12 13 **4.4.7.1.4 Conclusion.**

14 **Routine Operations.**

15 ***Marine Mammals.***

16
17
18
19 Under the proposed action, routine operations could affect marine mammals in the
20 northern GOM. The levels of impacts to marine mammals for each of the planning areas are:

- 21
22 • GOM: Impacts on cetaceans could range from negligible to moderate, while
23 impacts on the West Indian manatee would be negligible. Rare or extralimital
24 species are not likely to be affected by routine operations.
- 25
26 • Cook Inlet: Impacts to marine mammals could range from negligible to
27 moderate. Many of the listed cetacean species occur infrequently, if at all,
28 within the Cook Inlet Planning Area and thus would not be expected to be
29 affected by normal operations. Cook Inlet belugas primarily occur in the
30 upper portion of Cook Inlet that is not in the Cook Inlet Planning Area.
- 31
32 • Arctic: Impacts to marine mammals could range from negligible to moderate.

33
34 Noise generated during seismic surveys, exploration and production activities, platform
35 removal, and by OCS-related vessels and helicopters may temporarily disturb some individuals.
36 Contaminants in waste discharges and drilling muds might indirectly affect marine mammals
37 through food-chain biomagnification, although the scope of effects and their magnitude are not
38 known. However, this information is not essential to the determination of a reasoned choice
39 among alternatives. Small numbers of marine mammals could be killed or injured by chance
40 collision with service vessels and by eating indigestible debris, particularly plastic items, lost
41 from service vessels, drilling rigs, and platforms (including FPSO facilities for the GOM).
42 While vessels may collide with marine mammals, the most likely impact on marine mammals
43 would be changes in behavior (e.g., avoidance responses). Normal behavior is expected to return
44 once a vessel or helicopter has passed. It is expected that structure removal would cause only
45 minor behavioral changes and non-injurious physiological effects on cetaceans as a result of the

1 implementation of BOEM guidelines and the NOAA Fisheries Observer Program for explosive
2 removals.

3
4 ***Terrestrial Mammals.***

5
6 Gulf of Mexico. The four federally endangered GOM coast beach mice subspecies and
7 the federally endangered Florida salt marsh vole and their habitats would not be affected by
8 normal operations under the proposed action.

9
10 Cook Inlet. Overall, routine activities associated with the proposed action will have
11 negligible to minor impacts on the size and productivity of terrestrial mammal species along the
12 shorelines of Cook Inlet. Up to 120 km (75 mi) of onshore pipeline would be constructed and
13 operated as part of the proposed project; thus, impacts to terrestrial mammals would include a
14 minor loss or modification of habitat and behavioral responses associated with occasional
15 helicopter traffic to and from new platforms. Loss or modification of habitat for the pipeline
16 would affect a very minor amount of wildlife habitat within the Cook Inlet area. The disturbance
17 of wildlife by helicopter flights would be short-term in nature and not expected to result in
18 population-level effects.

19
20 Arctic. Impacts to terrestrial mammals could range from negligible to moderate. The
21 construction and normal operations of up to 129 km (80 mi) of new pipeline could result in a
22 variety of short-term and long-term impacts to terrestrial mammals. Short-term impacts would
23 largely be behavioral in nature, with affected animals avoiding or vacating the construction
24 areas. Similarly, vehicle and aircraft traffic associated with the proposed action could
25 temporarily disturb mammals near access roads or under flight paths. While the disturbance of
26 these animals would be short-term in nature, the energetic costs incurred by some of the
27 disturbed biota (especially overwintering muskoxen and pre-calving female caribou) could affect
28 reproductive success. Therefore, disturbances could result in longer term impacts to animal
29 populations. The presence of a new onshore pipeline may result in the displacement from
30 preferred habitats to less suitable habitats for overwintering muskoxen, calving female caribou,
31 and female caribou and their calves. Such displacement may reduce overwinter conditioning or
32 survival as well as calving success. While population-level effects may not be likely for caribou,
33 local population-level effects may occur for muskoxen because of the small population size in
34 Alaska. While vehicle traffic and aircraft overflights associated with the proposed action may on
35 occasion temporarily disturb brown bears and arctic foxes, long-term population-level effects
36 would not be expected from normal operations. Overall, routine activities associated with the
37 proposed action are not expected to have long-term major impacts on the size and productivity of
38 terrestrial mammal species of the North Slope of Alaska.

39
40 ***Accidents.***

41
42 ***Marine Mammals.*** Any of the oil spill scenarios developed for the proposed action
43 (Section 4.4.2) may expose marine mammals to oil or its weathering products. Overall, oil spills
44 are expected to have small to medium impacts to marine mammals, while impacts from oil spill
45 response activities are expected to be small. In the case of a low probability CDE, there is
46 greater potential for more severe and population-level effects compared to a large oil spill. The

1 magnitude of effects from accidental spills would depend on the location, timing, and volume of
2 the spills; the environmental settings of the spills (e.g., restricted coastal waterway, deepwater
3 pelagic location); and the species (and its ecology) exposed to the spills. Spill cleanup
4 operations could result in short-term disturbance of marine mammals in the vicinity of the
5 cleanup activity, while a collision with a cleanup vessel could injure or kill the affected
6 individual. In general, oil spill impacts on species that are extralimital to rare are expected to be
7 small, but could be larger depending on the number of individuals contacted by a spill.

8 9 *Terrestrial Mammals.*

10
11 GOM. Because of their locations on inner dunes, the habitats of the beach mice are
12 unlikely to be affected by an accidental offshore oil spill. While the habitat of the Florida salt
13 marsh vole could be affected by an oil spill, this species and its habitat are located far from areas
14 where oil leasing and development may occur under the proposed action. Thus, it is highly
15 unlikely that this habitat would be contacted by an accidental oil spill from OCS oil and gas
16 activities. Potential impacts of accidents on terrestrial mammals are not expected.

17
18 Cook Inlet and Arctic. Overall, oil spills are expected to have minimal to small impacts
19 to terrestrial mammals, while impacts from oil spill response activities are expected to be very
20 small. In the event of an accidental spill, terrestrial mammals may be exposed via ingestion of
21 contaminated food, inhalation of airborne oil droplets, and direct ingestion of oil during
22 grooming, which may result in a variety of lethal and sublethal effects. However, because most
23 spills would be relatively small ($\leq 1,000$ bbl), relatively few individuals would likely be exposed.
24 While some individuals may incur lethal effects, population-level impacts would not be expected
25 for most species. Cleanup activities could temporarily disturb terrestrial mammals in the vicinity
26 of the cleanup operation, causing those animals to move from preferred to less optimal habitats,
27 which, in turn, could affect overall condition. Such displacement would be limited to those
28 relatively few animals in the vicinity of the cleanup activity, and thus would not be expected to
29 result in population-level effects.

30 31 32 **4.4.7.2 Marine and Coastal Birds**

33
34 Each of the four phases of OCS oil and gas development have associated impact-
35 producing factors (Table 4.1.1-1), some of which may affect marine and coastal birds in the
36 Planning Areas included in the proposed action. Oil and gas development activities that may
37 occur following lease sales under the proposed action and that may affect marine and coastal
38 birds include (1) offshore structure placement and pipeline trenching; (2) offshore structure
39 removal; (3) operational discharges and wastes; (4) OCS vessel and aircraft traffic;
40 (5) construction and operation of onshore infrastructure (including new pipeline landfalls); and
41 (6) noise. Table 4.4.7-2 identifies the impacting factors associated with routine operations that
42 could affect birds and the aspects of marine and coastal birds that could be affected by those
43 factors.

44
45 In general, routine operations associated with oil and gas development are not expected to
46 result in population-level effects on marine and coastal birds. Most impacts from routine

1 **TABLE 4.4.7-2 Impacting Factors and the Marine and Coastal Bird Resource**
2 **Components That Could Be Affected with Oil and Gas Development under the**
3 **Proposed Action**

Development Phase and Impacting Factors That May Affect Marine and Coastal Birds	Resource Component Potentially Affected								
	Habitat ^a			Life Stage ^b			Behavior		
	Nesting	Foraging	Overwintering	Nestlings	Juveniles	Adults	Foraging	Courtship/ Nesting	Migration/ Staging
<i>Impacting Factors Common to All Phases</i>									
Helicopter noise	- ^c	-	-	+	+	+	+	+	-
Helicopter traffic	-	-	-	+	+	+	+	+	-
Ship noise	-	-	-	-	-	-	-	-	-
Ship traffic	-	-	-	+	+	+	+	+	+
Hazardous materials	-	-	-	+	+	+	-	-	-
Solid wastes	-	-	-	+	+	+	-	-	-
Offshore lighting	-	-	-	-	+	+	-	-	+
Offshore air emissions	-	-	-	-	-	-	-	-	-
<i>Exploration – Exploratory Drilling</i>									
Seismic noise	-	-	-	-	+	+	+	-	-
Drilling noise	-	-	-	-	+	+	-	-	-
Drilling mud/debris	-	-	-	-	+	+	-	-	-
<i>Offshore Development</i>									
Drilling noise	-	-	-	-	+	+	+	-	-
Trenching noise	-	-	-	+	+	+	+	+	-
Drilling mud/debris	-	-	-	-	+	+	+	-	-
Pipeline trenching	-	+	+	+	+	+	+	-	-
Wellhead and platform placement	-	-	-	-	+	+	+	-	-
<i>Onshore Development</i>									
Site clearing	++	++	-	++	+	+	++	++	+
Construction activity	-	-	-	+	+	+	+	+	+
Construction noise	-	-	-	+	+	+	+	+	+
<i>Production</i>									
Platform collisions	-	-	-	-	+	+	-	-	-
Production noise	-	-	-	-	+	+	-	-	-
Produced water	-	-	-	-	+	+	-	-	-
Drill mud/debris	-	-	-	-	-	-	-	-	-
<i>Decommissioning</i>									
Explosive platform removal	-	-	-	-	+	+	+	-	-
Non-explosive platform removal	-	-	-	-	+	+	+	-	-

^a Reflects only direct loss or physical degradation of the habitat and not habitat use.

^b Reflects only injury or mortality of affected life stage.

^c A dash (-) indicates no or negligible effect anticipated; “+” indicates potentially minor impacts, “++” indicates potentially moderate impacts, and “+++” indicates possible major impacts and possible population-level effects. See Section 4.1.4 for impact level definitions.

1 operations would be localized to the site of the project infrastructure or along support vehicle
2 routes, would for most operations be short term or transient, and would likely affect relatively
3 few individuals or habitats. The greatest potential for longer term and possibly population-level
4 impacts would be associated with very large accidental oil spills. In most areas, small spills
5 would likely affect relatively small numbers of birds and habitats. In contrast, very large spills
6 could affect habitats along extensive areas of coastline and large numbers of birds and important
7 habitats (such as nesting colonies or wintering grounds). Depending on the timing, duration,
8 size, and location of a very large spill, population-level impacts could be incurred by some
9 species.

10 11 12 **4.4.7.2.1 Gulf of Mexico.**

13
14 **Routine Operations.** Routine activities associated with the proposed action that may
15 affect marine and coastal birds in the northern GOM include (1) offshore structure placement and
16 pipeline trenching, (2) offshore structure removal, (3) operational discharges and wastes,
17 (4) OCS vessel and aircraft traffic, (5) construction and operation of onshore infrastructure
18 (including new pipeline landfalls), and (6) noise. Potential impacts associated with these
19 activities may include injury or mortality of birds from collisions with platforms, vessels, and
20 aircraft; exposure to operational discharges; ingestion of trash or debris; loss or degradation of
21 habitat due to construction; and behavioral disturbance due to the presence of, and noise
22 generated by, equipment and human activity (Russell 2005). The nature and magnitude of
23 effects on birds will depend on the specific location of an activity or completed structure
24 (e.g., with greater impacts if a pipeline landfall construction would occur adjacent to a heron
25 rookery), the timing of the activity (e.g., construction that occurs during nesting), and the nature
26 and magnitude of the activity (e.g., the number of miles of trenching through nearshore coastal
27 habitats, the quantity and concentrations of the production water discharges).

28
29 **Offshore Structure Placement and Pipeline Trenching.** The construction of new
30 offshore infrastructure is not expected to adversely affect marine and coastal birds. Pipeline
31 trenching may affect birds in nearshore coastal areas if trenching occurs in or near foraging or
32 nesting areas. For many species, the effects would be primarily behavioral, namely, the short-
33 term avoidance or abandonment of habitats in the immediate area of trenching. Pipeline
34 trenching near nesting colonies (such as heron rookeries) may disturb adults that are incubating
35 eggs or feeding young, potentially affecting nesting success. Because trenching could result in
36 some long-term loss of coastal habitat (see Section 4.4.6.1.1), habitat loss for some species may
37 also occur. Such impacts could be avoided or minimized by locating pipeline corridors away
38 from nesting aggregations and/or by scheduling trenching activities to avoid the nesting period.

39
40 Seabirds such as the brown pelican often use offshore oil and gas production platforms as
41 rest areas or as temporary shelters during inclement weather. In addition, offshore platforms are
42 also used in spring and fall for resting and feeding stopovers by birds migrating to and from
43 more southern wintering areas (Baust et al. 1981; Russell 2005). For example, in the fall, many
44 migratory species (including waterfowl, shorebirds, and passerines) arrive at the GOM coast and
45 then fly several hundred miles across the open GOM waters directly for to Central and South
46 America (Lincoln et al. 1998). This route appears to be preferred over the safer but more

1 circuitous land or island routes by way of Texas or Florida. The use of offshore platforms may
2 increase the survivability of individuals using these structures to rest or as shelter during bad
3 weather conditions in the open waters of the GOM (Russell 2005).
4

5 Migrating birds may collide with offshore platforms. Annual bird mortality from
6 collisions with offshore platforms has been estimated at 200,000 birds in the northern GOM,
7 with an average of 50 collision deaths per platform per year (Russell 2005). This is probably an
8 underestimate of actual collision mortality incurred by migrating birds, because it is based only
9 on birds recovered from the platforms; birds falling into the water are not reflected in these
10 mortality estimates (Russell 2005). Applying the 50 collision deaths per platform per year
11 estimate, new platforms that could be constructed following lease sales held under the proposed
12 action may result in a total incremental increase of about 10,000 to 22,500 bird collision
13 mortalities. By comparison, hundreds of millions of birds are killed each year colliding with
14 communication towers, windows, electric transmission lines, and other structures (e.g., see
15 Klem 1989, 1990; Dunn 1993). Migrating birds may also be drawn to a lighted platform and
16 circle the platform before moving on or stopping on the platform (Russell 2005). Such circling
17 behavior could increase the potential for a platform collision and use up valuable energy reserves
18 needed for completing the trans-GOM migration.
19

20 ***Offshore Structure Removal.*** Under the proposed action, up to 275 existing platforms
21 could be removed from the GOM planning areas. Because many marine birds, as well as
22 migratory birds, are attracted to platforms, there is a potential for some individuals to be affected
23 if they are present during platform removal activities. Typical platform decommissioning
24 involves dismantling many of the above-platform structures, followed by the use of underwater
25 explosives to collapse the platform proper. Birds using a platform undergoing decommissioning
26 would likely leave the platform during dismantling activities. Any remaining birds would be
27 startled by the underwater detonations and quickly leave the collapsing structure. Thus, only
28 negligible minor impacts on relatively few individual birds would be expected from
29 decommissioning activities under the proposed action.
30

31 The explosive removal of offshore structures is not expected to affect any of the birds
32 listed under the ESA that occur in the three planning areas. Only two species, the roseate tern
33 and the red knot (a candidate species), are likely to visit offshore platforms either during
34 migration (red knot) or during normal foraging activities (roseate tern). The NMFS has
35 previously evaluated the explosive removal of offshore platforms in the GOM and issued a
36 Biological Opinion that concluded that such structure removal would not jeopardize birds listed
37 under the ESA (NMFS 1988). In addition, the BOEMRE has established guidelines for
38 explosive platform removals (30 CFR 250). These guidelines require structure removal-specific
39 plans to protect marine life and the environment and specify procedures and mitigation measures
40 to be taken to minimize potential impacts. BOEMRE conducts detailed technical and
41 environmental reviews of proposed removal projects to ensure that listed species would not be
42 affected; these reviews include consultation with NMFS and USFWS. Thus, compliance with
43 the BOEMRE guidelines should further reduce the likelihood that offshore structure removal
44 would affect either the red knot or the roseate tern.
45

1 **Operational Discharges and Wastes.** Normal operational wastes may include produced
2 water, drilling muds, and drill cuttings discharged from offshore platforms, waste fluids
3 produced on OCS vessels, and trash and debris generated on platforms and vessels. A number of
4 normal operational discharges and wastes have the potential to affect marine and coastal birds.
5

6 The discharge of production wastes into open water is prohibited in coastal waters but
7 permitted in marine waters under the NPDES program (see Section 4.4.3.1). Produced water,
8 drilling muds, and drill cuttings are routinely discharged from production platforms in the GOM
9 into offshore marine waters in compliance with applicable regulations and permits, and would
10 continue to be so discharged with any development following lease sales under the proposed
11 action. The discharged materials may contain a variety of constituents (e.g., trace metals,
12 hydrocarbons) that may be toxic to birds. In marine waters, birds could be exposed to these
13 materials by direct contact or through the ingestion of contaminated food items. Birds most
14 likely to be present at offshore production locations where operational discharges are occurring
15 are those that forage on fish in offshore waters and may frequent offshore facilities; these include
16 pelicans, frigatebirds, gannets, and terns.
17

18 Upon discharge in accordance with permit specifications, production wastes would be
19 rapidly diluted in the water column (i.e., to ambient levels within several thousand meters of
20 discharge [see Section 4.4.3.1.1]) and dispersed by currents, thus greatly reducing the magnitude
21 of exposure that a bird might incur. If constituents of the discharged materials bioaccumulate or
22 biomagnify, there is a potential that some birds may be exposed through their food. Field studies
23 have shown that the concentrations of trace metals, hydrocarbons, or NORM in the tissues of
24 fishes collected around production platforms are within background levels (Neff 1997a). Thus,
25 food chain uptake is likely not a major exposure pathway for fish-eating birds at offshore
26 facilities.
27

28 Among the threatened and endangered species present in the northern GOM planning
29 areas (see Section 3.8.2.1.2), only the roseate tern and the candidate red knot may be expected at
30 offshore platforms. The roseate tern, which is known to occur in oceanic waters, occurs within
31 the Florida Keys and southeastern Florida (USFWS 1999; FFWCC 2003). Because these areas
32 are hundreds of kilometers away from the portion of the EPA where oil and gas leasing and
33 development might occur under the proposed action, the roseate tern would not be expected to be
34 exposed to production wastes generated at offshore facilities. The red knot is a shorebird that
35 would occur only at a platform during spring and fall migrations, and then only if stopping to rest
36 on a platform while crossing the GOM. As this species is not an open-water feeder or swimmer,
37 no exposure to operational discharges would be expected for the red knot.
38

39 Some bird species may also be affected indirectly if the discharges reduce the abundance
40 of prey species (NRC 1983; API 1989; Kennicutt 1995). However, because of the rapid dilution
41 that would occur, potential impacts on prey populations inhabiting the water column (e.g., fish,
42 plankton) would likely be limited in extent and not be expected to significantly affect overall
43 prey abundance (see Sections 4.4.7.3.1 and 4.4.7.5.1). While some production-related
44 contaminants may reach sediments and reduce macroinfaunal abundance (Rabalais et al. 1998),
45 the potentially affected macroinvertebrate biota would be at depths beyond the diving limits of
46 birds. Sediment impacts can last for years after the discharge period has ended (Rye et al. 2008)

1 and can cause an overall impoverishment of the benthic community (Daan and Mulder 1996).
2 These sediment changes may affect benthic larval or juvenile stages of species which would
3 eventually become prey for seabirds.
4

5 Many species of marine birds (especially gulls) often follow ships and forage in their
6 wake on fish and other prey injured or disoriented by the passing vessel. In doing so, these birds
7 may be affected by discharges of waste fluids (such as bilge water) generated by OCS vessels.
8 Discharges of such wastes from OCS service and construction vessels, when allowed, would be
9 regulated under applicable NPDES permits (see Section 4.4.3.1); any discharged wastes would
10 be quickly diluted and dispersed and thus not be expected to affect marine birds.
11

12 Marine and coastal birds may become entangled in or ingest floating, submerged, and
13 beached debris (Heneman and the Center for Environmental Education 1988; Ryan 1987, 1990).
14 Entanglement may result in strangulation, the injury or loss of limbs, entrapment, or the
15 prevention or hindrance of the ability to fly or swim, and all these effects may be considered
16 lethal. Ingestion of debris may irritate, block, or perforate the digestive tract, suppress appetite,
17 impair digestion of food, reduce growth, or release toxic chemicals (Fry et al. 1985; Dickerman
18 and Goelet 1987; Ryan 1988; Derraik 2002). Because the discharge or disposal of solid debris
19 into offshore waters from OCS structures and vessels is prohibited by the BOEMRE
20 (30 CFR 250.40) and the USCG (MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]),
21 entanglement in or ingestion of OCS-related trash and debris by marine and coastal birds would
22 not be expected under normal operations.
23

24 ***Vessel and Aircraft Traffic.*** Under the proposed action, up to 600 vessel and
25 5,500 helicopter trips may take place weekly within the northern GOM planning areas. Birds
26 may be affected in the following ways by this traffic: (1) they may be induced by vehicle noise
27 to cease a particular activity (such as nesting or feeding) and leave the area, (2) they may incur
28 injury or mortality through collision with a ship or helicopter, or (3) nests may be disturbed by
29 excessive boat wakes.
30

31 Disturbance from noise is addressed later in this section. Birds disturbed by the presence
32 of an OCS vessel may flee an area. Displaced birds would move to other habitats and may or
33 may not return. In most cases, such displacement would be short term and transient and would
34 not be expected to result in any lasting effects. However, if the displaced birds were occupying
35 active nests, incubating eggs, or feeding and protecting hatchlings, even a short-term absence of
36 the adult birds could increase predation of eggs or unfledged young, or reduce hatching success.
37 However, because of the heavy commercial and recreational boat traffic in the northern GOM,
38 most birds of the area are likely habituated to ship traffic and may only minimally react to
39 passing OCS support vessels. In addition, OCS vessel traffic would likely occur within
40 designated traffic lanes and not in waterways where birds may be nesting on beaches or other
41 shoreline habitats. For this same reason, wakes from OCS-related vessels are also not expected
42 to affect coastal birds and their nests. In addition, low-wake or wake-free vessel speeds are
43 required while transiting across waterways that have sensitive shoreline resources (such as
44 shorebird nesting colonies). Thus, compliance with such requirements would further minimize
45 potential wake-induced impacts on birds.
46

1 A number of studies have examined the responses of birds to low-flying aircraft and
2 atypical noise (see *Noise* discussion below). The results of many of these studies have indicated
3 that although habituation may vary among species (Conomy et al. 1998), many species of birds
4 will habituate to low-flying aircraft and noise and exhibit no effects on reproductive success
5 (Black et al. 1984; Andersen et al. 1989; Delaney et al. 1999).
6

7 FAA guidelines for helicopter operations in the GOM request that pilots maintain a
8 minimum altitude of 213 m (600 ft) while in transit offshore, 305 m (1,000 ft) over unpopulated
9 areas or across coastlines, and 610 m (2,000 ft) over populated areas and sensitive habitats such
10 as wildlife refuges and park properties (FAA 2010). Compliance with these guidelines regarding
11 service altitudes for OCS helicopters would minimize disturbance of nesting or roosting birds
12 within coastal areas.
13

14 ***Construction and Operation of Onshore Infrastructure.*** Loss or alteration of preferred
15 habitat due to new OCS pipeline landfalls could result in the displacement of individuals or
16 groups of birds from the affected area(s), including a possible decrease in nesting activities.
17 Some pipelines in the central and western GOM have been brought to shore using a directional
18 drilling process (MMS 2006a, 2008a) in which pipelines pass beneath coastal habitats to emerge
19 inland at an onshore receiving facility, away from coastal habitats. Where used, this process
20 could greatly reduce or avoid impacts on coastal habitats that are important to listed and non-
21 listed marine and coastal birds.
22

23 Under the proposed action, up to 12 landfalls would be expected in the Western and
24 Central GOM Planning Areas, with none occurring in the EPA. The location and small number
25 of landfalls that could occur with development associated with the proposed action would greatly
26 limit the amount of coastal bird habitat that might be disturbed. In addition, siting of pipeline
27 landfalls would consider the presence of sensitive habitats and areas, and avoid such areas to the
28 maximum extent possible, further reducing the likelihood of affecting coastal bird habitats and
29 the magnitude and extent of impacts on such habitats.
30

31 ***Noise.*** Noise generated during facility and pipeline construction, production operations,
32 and platform removal activities, and by OCS ships and helicopters, may affect birds in a variety
33 of ways. Unexpected noise can startle birds and potentially affect feeding, resting, or nesting
34 behavior, and often causes flocks of birds to abandon the immediate area.
35

36 Much of the wildlife-related noise effects research has shown that noise may affect
37 territory selection, territorial defense, dispersal, foraging success, fledging success, and song
38 learning (e.g., Anderson et al. 1986; Gladwin et al. 1988; Larkin 1996). In many cases, the
39 effects are temporary, with the birds becoming habituated to the noise. For example, weapons
40 testing noise has been reported to have no significant effect on bald eagle activity or reproductive
41 success, suggesting habituation of the birds to the noise (e.g., Brown et al. 1999). Studies of
42 birds exposed to frequent low-level military jet aircraft overflights and simulated (with mortars,
43 shotguns, and propane cannons) mid- to high-altitude sonic booms have shown aircraft and
44 detonation noise to elicit some short-term behavioral responses but to have little effect on
45 reproductive success (Ellis et al. 1991). Birds of prey have been reported to habituate to low-
46 level helicopter flights and exhibit no effects on their reproductive success (Delaney et al. 1999);

1 Andersen et al. 1989), and low-level (<500 ft AGL) military training flights have been shown to
2 have no effects on the establishment, size, and reproductive success of wading bird colonies in
3 Florida (Black et al. 1984). On the basis of these studies, noise generated during normal
4 operations is expected to have only short-term and transient effects on birds, and would not be
5 expected to result in long-term disturbance or population-level effects.
6

7 **Accidents.** The accidental oil spill scenario for the GOM under the proposed action
8 identifies as many as 8 large ($\geq 1,000$ bbl) and as many as 470 small (<1,000 bbl) oil spills
9 potentially occurring with development that could result through the lease sales of the proposed
10 action (Table 4.4.2-1). In the event of an accidental oil spill, birds may be adversely affected
11 through direct contact with the spilled oil, by the fouling of their habitats and contamination of
12 their food by the oil, and as a result of oil spill-response activities. Exposure of eggs, young, and
13 adult birds to oil may result in a variety of lethal and sublethal effects. Fouling of habitats can
14 reduce habitat quality, while contamination of foods may lead to a variety of lethal and sublethal
15 toxic and physiological effects. Finally, oil spill-response activities may disturb birds in nearby
16 habitats that are unaffected by an oil spill.
17

18 Adult and young birds may come in direct contact with oil on the water's surface or on
19 oiled beaches, mudflats, and other shore features. Oil may also be physically transferred by
20 nesting adults to eggs or young. Direct contact with oil by young and adult birds may result in
21 the fouling or matting of feathers, which would affect flight and/or diving capabilities, affecting
22 such activities as foraging and fleeing predators. Birds that have been fouled by oil also
23 experience a loss in the insulating properties of their feathers, making them susceptible to
24 hypothermia during cold weather periods. Oil making contact with skin, eyes, or other sensitive
25 tissues may result in an irritation or inflammation of skin or sensitive tissues (Fry and
26 Lowenstine 1985), while oiled eggs would incur reduced gas exchange.
27

28 Birds may ingest oil incidentally while foraging and while preening oiled feathers.
29 Ingested oil may depress egg-laying activity or may result in the death or deformities of young
30 (Fry et al. 1985; Leighton 1990). Direct effects of oil contact may be amplified under conditions
31 of environmental stress such as low temperatures, migration movements, and molting. Indirect
32 effects of oil contact include toxic effects from the consumption of contaminated food or
33 starvation from the reduction of food resources (Lee and Socci 1989). The latter effects may
34 hinder the recovery of impacted bird populations after a spill (Hartung 1995; Piatt and
35 Anderson 1996; Piatt and Ford 1996).
36

37 Certain species of marine and coastal birds may be more susceptible to contact with
38 spilled oil than others, based on their life histories. For example, diving birds and underwater
39 swimmers such as loons, cormorants, and diving ducks may be the most susceptible to spilled oil
40 because of their relatively long exposure time within the water and at the sea surface
41 (Camphuysen 2007; Williams et al. 1995). Shorebirds and wetland birds may also be susceptible
42 to direct oiling if a spill were to reach the beach intertidal zone or inshore wetland habitats,
43 respectively, where these species forage and raise young (King and Sanger 1979). Oiled birds
44 collected during response actions to the DWH event included seabirds, shorebirds, wetland birds,
45 waterfowl, passerines, and raptors, with the majority of oiled birds being seabirds (see
46 Section 3.8.2.1.5 and Table 3.8.2-6).

1 The magnitude of the impact would depend on the size, location, and timing of the spill;
2 the species and life stage when exposed; and the size of the local bird population.
3

4 Spills in deep water are not likely to affect the listed and candidate bird species identified
5 for the northern GOM (Table 3.8.2-3). Only the roseate tern and the red knot would be expected
6 in areas of the outer inner continental shelf where deepwater spills could occur, and these
7 occurrences would be transient and not expected to result in direct exposure to spilled oil. In
8 contrast, all the listed and candidate species with the exception of the roseate tern could be
9 exposed if a deepwater spill were to move into coastal waters and reach coastal habitats utilized
10 by these species. Even if a deepwater spill were to reach coastal habitats, because of the great
11 distance from shore at which a deepwater spill would originate, the oil would be greatly
12 weathered, and therefore reduced in toxicity, by the time it reached the shore (see
13 Section 4.4.3.1.2).
14

15 In contrast, a number of non-listed seabird species (e.g., terns, gulls, shearwaters,
16 boobies, frigatebirds) could be exposed to deepwater spills. Some of these species are found
17 only in pelagic areas of the GOM, while others inhabit waters of the continental shelf (see
18 Section 3.1.2.3.2) (Duncan and Havard 1980; Davis et al. 2000). A number of these species
19 forage in deepwater areas, are attracted to offshore platforms, and often follow vessels. These
20 birds may be directly exposed while feeding or resting in spills originating from deepwater
21 platforms or transport tankers and could incur lethal or sublethal effects. Depending on its size,
22 location, and timing, a deepwater spill may affect only a few individuals or, as in the case of
23 aggregations of overwintering gannets, a relatively large number of birds.
24

25 A shallow water spill in an offshore or nearshore area has the potential to affect a greater
26 number of bird species than a deepwater spill of comparable size. Most threatened or
27 endangered avian species are not likely to be affected by a spill unless a hurricane were to occur
28 and spread oil inland to freshwater and terrestrial habitats. The piping plover and red knot could
29 be exposed if their beach habitats become fouled by a spill. Because shorebirds tend to be
30 flocking species, spills reaching habitats used by these species could result in the exposure of a
31 relatively large number of individuals. While the sandhill crane, wood stork, and whooping
32 crane could be exposed if a spill were to foul their coastal wetland habitats. Because of the very
33 specific and limited winter habitat that supports the majority of whooping cranes, a spill
34 affecting this habitat could result in a major impact on this species. Audubon's crested caracara,
35 while reported to use coastal dune habitats, is generally more of a terrestrial species and would
36 not be expected to occur along beach and wetland habitats. The roseate tern breeds in scattered
37 colonies along the Florida Keys (see Section 3.8.2.1.2) and could be exposed if a spill were to
38 occur in the extreme southeastern portion of the EPA. Under the proposed action, however,
39 lease sales would be limited to the extreme western portion of this planning area, hundreds of
40 miles from the nearest nesting colony of this tern. Thus, this species would not be expected to be
41 exposed to any accidental spills that might occur in association with a lease sale under the
42 proposed action.
43

44 Accidental spills in shallow water could affect a wide variety of non-listed species. In
45 offshore locations, shallow water spills could expose any of a large number of ducks,
46 cormorants, terns, grebes, and gulls. Spills reaching shoreline habitats such as beaches,

1 mudflats, and wetlands could affect shorebirds (e.g., sandpipers, plovers), wading birds
2 (e.g., herons, bitterns), wetland birds (e.g., rails, coots, blackbirds), and a wide variety of
3 migratory birds. Spills occurring during the fall or spring migrations have the potential to expose
4 large numbers of birds in both nearshore coastal waters and in coastal habitats such as beaches,
5 flats, and wetlands. The magnitude of impacts that could result from an accidental spill in
6 shallow water would depend on the timing, duration, location, and size of the spill; the habitats
7 that came in contact with the spill; and the species and numbers of birds exposed to the spill.
8

9 Besides being affected by the spill itself, marine and coastal birds may be affected during
10 spill containment and cleanup activities. During cleanup, some oiled birds could be successfully
11 cleaned, and cleanup of the affected habitat could be necessary to avoid chronic exposure.
12 Nesting or roosting birds in nearby habitats unaffected by the spill could be disturbed by cleanup
13 of contaminated habitats. Coastal cleanup and remediation activities in coastal habitats may
14 impact local populations of coastal birds, resulting in their temporary displacement from these
15 areas. If the abandoned area is an important nesting habitat (especially during the breeding
16 season), local population-level impacts may be incurred. The application of dispersant chemicals
17 to spilled surface oil could also affect birds. While dispersant chemicals contain constituents that
18 are considered to have low levels of toxicity when compared to toxic constituents of spilled oil
19 (Wells 1989), the effects of these dispersants on seabirds are poorly understood. Because the use
20 of these chemicals and spill cleanup activities would be localized and infrequent, potential
21 impacts from spill response activities would largely be short term (e.g., avoidance of the cleanup
22 area).
23

24 The specific nature and magnitude of effects of an oil spill on marine and coastal birds of
25 the GOM will depend on the size, location, timing, and duration of the spill and the birds and
26 habitats exposed to the spill. Small spills may be expected to affect relatively small numbers of
27 birds and habitats and would not be expected to cause population-level impacts.
28

29 **Catastrophic Discharge Event.** The PEIS analyzes a CDE with a volume ranging from
30 900,000 to 7,200,000 bbl (Table 4.4.2-2). A low probability CDE would have similar impacts on
31 bird populations as spills of other magnitudes; however, the area affected would increase and the
32 degree of impact would be more severe. A much greater number of birds and habitats could be
33 affected, and population-level impacts for some species could be incurred as CDEs can affect
34 extensive areas of shoreline. For example, the Gulf Coast Least Tern Colony (see
35 Section 3.8.2.1.4) on the Mississippi coast has one of the world's largest colonies of least tern. A
36 catastrophic discharge event reaching this colony site during the nesting season could foul
37 several thousand nests and result in the loss of an entire reproductive season, the effects of which
38 may cause long-term population effects.
39

40 **4.4.7.2.2 Alaska – Cook Inlet.**

41 **Routine Operations.** Oil and gas development that could occur in the Cook Inlet
42 Planning Area following a lease sale under the proposed action would include (1) offshore
43 exploration; (2) construction of offshore platforms and pipelines; (3) construction of onshore
44 pipeline landfalls and pipelines; (4) operations of offshore and onshore facilities; and (5) OCS-
45
46

1 related vessel and aircraft traffic (Table 4.4.1-3). While activities supporting this development
2 may be expected to affect marine and coastal birds in the vicinity of the development activities,
3 these impacts would largely be short term, generally affect only a relatively small number of
4 birds at any one time, and not be expected to result in population-level impacts on any species.
5

6 ***Offshore Exploration.*** Under the proposed action, oil and gas exploration could include
7 the placement of up to 12 exploration and development wells in the Cook Inlet Planning Area.
8 Seismic surveys and placement and operation of the wells could affect some birds. Disturbance
9 of birds during seismic surveys would be limited to the immediate area around survey vessels, be
10 short term, and be largely behavioral (MMS 2005e). For example, noise from air guns and
11 disturbance from survey vessel traffic could displace foraging seabirds in offshore waters,
12 especially if exploration were to occur in areas with high seabird density (such as the open
13 waters adjacent to the Stevenson and Kennedy Entrances to Cook Inlet and off the northwestern
14 coast of Kodiak Island [see Section 3.8.2.2.4]) where seabirds are likely to be encountered. If
15 disturbed, affected birds would likely cease foraging activities and leave the vicinity to feed in
16 other areas. Because the lease sale would occur no closer than 3 NM from shore, offshore
17 exploration activities (including the placement of exploration and development wells) would not
18 be expected to disturb marine or coastal birds or their habitats (such as seabird colonies or
19 wintering grounds) in coastal areas. Thus, normal offshore exploration activities are expected to
20 have negligible or minor effects on marine and coastal birds, and are not expected to result in any
21 population-level effects for local bird populations.
22

23 ***Construction of Offshore Platforms and Pipelines.*** Under this proposed action, up to
24 three offshore platforms could be constructed in the Cook Inlet Planning Area. These platforms
25 would likely be constructed outside of the planning area and towed to their final location, and
26 marine and coastal birds could be temporarily disturbed during the transportation and placement
27 of the platforms. Disturbance would likely result in affected birds leaving the immediate area of
28 activity (either the platform location or the transportation route). Because of the small number of
29 platforms, the transient nature of their transport and construction, and their offshore locations
30 being well away from coastal habitats and seabird colonies, any impacts on marine and coastal
31 birds may be expected to be short term, affect relatively few birds, and not result in long-term
32 population-level effects for any species.
33

34 In addition to the new platforms, up to 241 km (150 mi) of new offshore pipeline could
35 be constructed following leasing under the proposed action. Pipeline trenching could affect birds
36 in nearshore coastal habitats if trenching occurs in or near foraging, overwintering, or staging
37 areas or near seabird colonies. Trenching may also disturb marine species foraging in offshore
38 waters. For many species, disturbance from pipeline trenching would result primarily in a
39 behavioral response, namely, the short-term abandonment or avoidance of habitats in the
40 immediate area of trenching. Pipeline trenching near seabird colonies could cause adults to
41 abandon nests (at least temporarily) and cease incubating eggs or feeding young, and thereby
42 potentially affecting nesting success. If nests are permanently abandoned, some population-level
43 effects may be incurred by the affected species. Potential impacts could be avoided or
44 minimized by locating pipeline corridors and the landfall away from nesting aggregations
45 (seabird colonies), and by scheduling trenching activities to avoid staging, overwintering, and
46 nesting periods.

1 Construction of up to 241 km (150 mi) of new offshore pipeline could affect as much as
2 210 ha (519 ac) of benthic habitat within the Cook Inlet Planning Area and locally affect the
3 availability of foraging habitat for some marine and coastal birds. Because portions of the new
4 pipelines would be in water depths potentially unavailable for most marine and coastal birds,
5 pipeline construction may be expected to have limited effect on the overall availability of
6 foraging habitat for marine and coastal birds. Any impacts on food sources would be localized
7 to the pipeline footprint and are expected to have negligible or minor impacts on local marine
8 and coastal bird populations.
9

10 **Construction of Onshore Pipelines and Landfalls.** Under the proposed action, up to
11 169 km (105 mi) of new pipeline and possibly one new pipeline landfall could be constructed in
12 onshore areas adjacent to the Cook Inlet Planning Area. Construction of new pipelines would
13 likely be located in the general vicinity of existing oil and gas infrastructure, delivering oil to
14 existing refineries in Nikiski and natural gas to existing transmission facilities in the Kenai area
15 (Table 4.4.1-3). Depending on the proximity of the new onshore pipelines or a new pipeline
16 landfall to existing roads, one or more new access roads could be needed to bring in construction
17 equipment and supplies to the construction areas. The construction of new pipelines would
18 permanently eliminate a relatively small amount of habitat (about 4.9 ha [12 ac], assuming a
19 30.5-m [100-ft] construction ROW) along the pipeline routes, while construction camps to
20 support onshore construction activities would affect an additional very small amount of
21 terrestrial habitat. Siting new pipelines and facilities away from coastal areas would reduce the
22 amount of marine or coastal bird habitat that could be affected. Potential habitat impacts could
23 be reduced by locating the new pipelines within existing utility or transportation ROWs.
24 Because there are relatively few nesting colonies along the Kenai Peninsula north of Anchor
25 Point (USGS undated), only a few seabird colonies could be affected by onshore construction
26 activities. The disturbance of birds in these colonies could be reduced or avoided by siting any
27 new onshore infrastructure away from colony sites and by scheduling construction activities to
28 avoid nesting periods. Overall, onshore construction activities are expected to affect only a
29 relatively small number of birds and not to result in population-level effects for any affected
30 species.
31

32 **Operations of Offshore Facilities.** During normal operations, birds may be affected by
33 noise and human activities at onshore and offshore facilities and by the presence of the facilities
34 themselves. Noise and human activities (such as normal maintenance) could affect birds moving
35 through Cook Inlet during spring and fall migration, as well as birds moving into nesting, fall
36 molting, or overwintering habitats in the planning area. Affected birds would likely avoid the
37 platforms and nearby habitats. Although operational noise and human activity may cause birds
38 to avoid areas where platforms are located, affected birds would likely select other suitable areas
39 of the planning area. Because of the small number of new platforms (no more than three), the
40 disturbance of birds in offshore waters by operational noise and human activity would be limited
41 to only a few areas around the platforms and is not expected to adversely affect marine or coastal
42 bird populations.
43

44 Offshore platforms may pose a collision hazard to birds, especially during migration
45 and/or periods of low visibility. No information is available regarding bird collisions with
46 platforms and other structures in Cook Inlet or elsewhere in Alaskan waters. However, a

1 reasoned estimate of the potential number of such collisions can be made from information
2 available about potential collisions in the GOM. Annual bird mortality in the northern GOM (a
3 major migratory area with several hundred million migrants estimated to pass through annually)
4 from collisions with offshore platforms has been estimated to average 50 collision deaths per
5 platform per year (Russell 2005). Applying a similar collision mortality rate to development that
6 could occur under the proposed action, about 150 bird collision mortalities might be expected
7 annually for the three new platforms.

8
9 ***Operational Discharges and Wastes.*** Oil and gas development occurring following a
10 lease sale under the proposed action would result in the generation of drilling fluids and debris
11 (Table 4.4.1-3). Produced water, drilling muds, and drill cuttings generated by development and
12 production wells would be disposed of through down-hole injection. Thus, no impacts on marine
13 and coastal birds from these wastes would be expected under normal operations. In contrast,
14 produced water, drilling muds, and drill cuttings generated by exploration and delineation wells
15 would be discharged at the well sites in compliance with applicable regulations and permits. The
16 discharged materials may contain a variety of constituents (e.g., trace metals, hydrocarbons) that
17 may be toxic to birds. In marine waters, birds could be exposed to these materials by direct
18 contact or through the ingestion of contaminated food items. Birds most likely to be present at
19 well sites are those that forage on invertebrates and fish in offshore waters; these include
20 seabirds such as the alcids (such as the common murre, pigeon guillemot, and ancient murrelet),
21 gulls and terns (such as the mew gull and Arctic tern), and others.

22
23 Upon discharge in accordance with permit specifications, production wastes would be
24 rapidly diluted in the water column (i.e., to ambient levels within several thousand meters of
25 discharge [see Section 4.4.3.2.1]) and dispersed by currents, thus greatly reducing the potential
26 for, and the magnitude of, exposure. If constituents of the discharged materials bioaccumulate or
27 biomagnify, there is a potential for some birds to be exposed through their food. Field studies
28 have shown that the concentrations of trace metals, hydrocarbons, or NORM in the tissues of
29 fishes collected around production platforms are within background levels (Neff 1997a).

30
31 Normal operations may be expected to generate a variety of operational wastes, such as
32 waste oils, bilge water on support ships, and sanitary wastes. Hazardous waste materials such as
33 lubricating oils, paint, and industrial cleaners would be controlled and disposed of at licensed
34 onshore facilities. Domestic wastewater and sanitary wastes generated on platforms or support
35 vessels would be treated and then discharged to surrounding waters, where they would be
36 quickly diluted (Section 4.4.3.2.1). Many species of marine birds (such as gulls) often follow
37 ships and forage in their wake on fish and other prey injured or disoriented by the passing vessel.
38 Because there would be up to 3 platforms and no more than three weekly vessel trips, only a
39 relatively small volume of operational wastes would be discharged. Any such discharges would
40 be quickly diluted and dispersed and thus not expected to affect marine or coastal birds that
41 could be following the vessels or visiting waters immediately around the production platform.

42
43 Marine and coastal birds may become entangled in or ingest floating, submerged, and
44 beached debris (Ryan 1987, 1990). Because the discharge or disposal of solid debris into
45 offshore waters from OCS structures and vessels is prohibited by the BOEMRE (30 CFR 250.40)
46 and the USCG (MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]), entanglement in

1 or ingestion of OCS-related trash and debris by marine and coastal birds would not be expected
2 under normal operations.
3

4 ***Vessel and Helicopter Traffic.*** There could be up to three helicopter trips and three
5 vessel trips each week supporting up to three offshore platforms that could be installed following
6 leasing under the proposed action. Vessel and helicopter traffic could disturb birds in foraging,
7 molting, and staging area habitats as well as in nesting areas (such as seabird colonies) that may
8 occur along the traffic routes. Birds may also be injured as a result of collisions with aircraft.
9 Birds responding to approaching support vessels may be expected to cease normal behaviors and
10 move away from the oncoming vessel; this would have little overall impact on affected birds.
11

12 In contrast to ship traffic, helicopter overflights likely have a greater potential for
13 disturbing birds. Both the relatively sudden appearance (compared to an approaching ship) and
14 the noise of helicopter overflights may startle birds, causing them to cease their normal behaviors
15 and flee. The reactions of birds to aircraft overflights will depend on a variety of factors,
16 including the species present, the altitude of the flights, and the frequency of the flights (e.g., see
17 Gladwin et al. 1988; Ellis et al. 1991; Derksen et al. 1992; Miller et al. 1994; Larkin 1996;
18 Delany et al. 1999). Helicopter overflights of open water may startle birds that are resting or
19 foraging on the water surface, causing them to cease normal behavior and possibly try to flee the
20 area. Should birds be disturbed while nesting, nesting success may be affected, especially if the
21 disturbance results in nest abandonment and/or increased nest predation. Alternately, some birds
22 may become habituated to aircraft disturbance. For example, no significant decrease in
23 reproductive success was reported in a thick-billed murre colony located near an airport
24 compared to other thick-billed murrees that nested away from the airport (Curry and
25 Murphy 1995). FAA guidelines for helicopter oceanic operations request that pilots maintain a
26 minimum altitude of 213 m (600 ft) while in transit offshore, 305 m (1,000 ft) over unpopulated
27 areas or across coastlines, and 610 m (2,000 ft) over populated areas and sensitive habitats such
28 as wildlife refuges and park properties (FAA 2010).
29

30 It is assumed that helicopter support for the new platform would originate from the
31 municipal airport in the Kenai-Nikiski area, north of the Cook Inlet Planning Area, and potential
32 for disturbance of marine and coastal birds would be greatest along the east coast of Cook Inlet
33 in this area and southward into the planning area. This area has several areas that provide
34 important habitat for migrating shorebirds and waterfowl in spring, and some of which provide
35 important overwintering habitat for Steller's eider (Table 3.8.2-2). Although there are no large
36 seabird colonies in this area, small numbers of nesting seabirds could be affected by the
37 overflights. Because of the low amount and transient nature of daily support traffic that might
38 occur under the proposed action, relatively few birds may be expected to be affected by vessel or
39 aircraft traffic, with negligible or minor impacts on affected birds. While disturbance of nesting
40 birds has the potential for moderate impacts, the number of affected birds would likely be very
41 limited, and if seabird colonies are present, the disturbance of nesting birds could be avoided by
42 using flight paths and vessel routes that avoid the colonies.
43

44 ***Potential Effects on ESA-listed Species in the Cook Inlet Planning Area.*** Normal
45 operations may affect listed bird species in the same manner as non-listed species (i.e., primarily
46 behavioral disturbance). Compliance with ESA regulations and coordination with the NMFS

1 and USFWS would ensure that lease-specific operations would be conducted in a manner that
2 avoids or greatly minimizes the potential for affecting these species.

3
4 The endangered short-tailed albatross, the threatened Steller's eider, and the candidate
5 Kittlitz's murrelet occur in or near the Cook Inlet Planning Area and thus could be affected by
6 oil and gas development in the area. The short-tailed albatross does not breed in or near the
7 Cook Inlet Planning Area, occurring only as an occasional visitor that forages on the continental
8 shelf edge beyond the southern boundary of the planning area (see Section 3.8.2.2.2). The
9 Steller's eider also does not nest in the Cook Inlet Planning Area, but does overwinter in lower
10 Cook Inlet and in the Shelikof Strait. Thus, normal operations would not be expected to affect
11 nesting habitats or reproductive success of either of these species.

12
13 Because of its uncommon occurrence in marine waters in and around the Cook Inlet
14 Planning Area, relatively few short-tailed albatross would be expected to be present in areas
15 where seismic exploration, offshore platform and pipeline construction, or OCS vessel and
16 aircraft traffic is occurring. If present, disturbed individuals would likely move to areas away
17 from the OCS activity and not be adversely affected. While it is possible for a bird to collide
18 with an OCS-related aircraft, the combination of the very low number of short-tailed albatrosses
19 that could be present around platforms or along associated flight lines with the very small
20 amount of aircraft traffic supporting only new platforms means that few, if any, birds would be
21 expected to incur collisions with support aircraft or with a platform. While such collisions would
22 likely result in the mortality of the affected individual, population-level effects would not be
23 expected to result from such collisions.

24
25 Overwintering flocks of Steller's eider could be temporarily disturbed by seismic
26 exploration and by the construction of offshore platforms and pipelines, if those activities were
27 to occur in or near areas where the birds are overwintering. Overwintering birds may also be
28 disturbed by OCS-related vessel and aircraft traffic. If affected, birds would be expected to
29 move away from oncoming vessels and would not be adversely affected. Overwintering birds
30 may be startled by helicopter overflights and may or may not take flight and flee the immediate
31 vicinity. Some birds could be killed or injured as a result of collisions with platforms or OCS-
32 related aircraft. Because there would only be no more than three new platforms and three flights
33 per week to the platforms by support aircraft, such collisions are not expected, few if any
34 individuals would be affected, and no population-level effects would be expected.

35
36 While Kittlitz's murrelet can be found in the Cook Inlet Planning Area, it is present in a
37 very patchy and clumped distribution, preferring areas of heavy glaciation, high turbidity, and
38 partial ice cover (Day et al. 2000b; Van Pelt and Piatt 2003). This species has been reported to
39 be sensitive to excessive noise and human activity (Day and Nigro 1999). Offshore platform or
40 pipeline construction activities occurring near concentrations of this species could result in the
41 short- or long-term displacement of birds from the construction areas. Construction of onshore
42 pipelines and facilities could disturb nesting birds and affect nest sites, although it is unlikely that
43 more than a few individuals would be affected. This species nests on cliffs and scree slopes, in a
44 terrain typically avoided when pipelines are being sited. Long-term platform operations and
45 daily vessel and aircraft traffic may also result in the long-term displacement of birds from
46 platform locations and along frequently used flight line locations. In addition, some individuals

1 could collide with OCS-related aircraft. Because of the disjunct distribution of this species,
2 exposure to routine operations would be expected to be infrequent and localized.
3

4 **Accidents.** Under the proposed action, no more than one large spill (between 1,700 and
5 5,000 bbl from either a platform or a pipeline), and as many as 18 small spills (<1,000 bbl) may
6 be expected over the lifetime of the lease. The magnitude and extent of impacts on marine and
7 coastal birds from such spills will be a function of a variety of factors, including (1) the time of
8 year of the spill, (2) the volume of the spill, (3) the habitats exposed to the spill, and (4) the
9 species exposed to the spill or that utilize the impacted habitats. Oil spills from onshore
10 pipelines may affect terrestrial habitats and birds. Because of the lower number of birds that
11 would be present in winter, as well as their more limited winter distribution, a greater number of
12 birds may be expected to be affected by an accidental oil spill in summer than in winter. Birds in
13 areas near habitats that have been affected by oil may also be disturbed during spill cleanup
14 operations. Spill cleanup activities may displace birds from nearby habitats, which, depending
15 on the nature of those habitats (e.g., nesting, molting, staging), could result in reduced
16 reproductive success or survival. In addition, the duration of cleanup activities may preclude
17 birds from using the area for quite some time.
18

19 Exposure of eggs and young and adult birds to oil may result in a variety of lethal and
20 sublethal effects, while oil may foul habitats, reducing habitat quality and contaminating foods;
21 these potential effects apply to both non-listed and listed bird species of the Cook Inlet Planning
22 Area. The short-tailed albatross, Steller's eider, and Kittlitz's murrelet may be directly affected
23 by an accidental oil release in the same manner as described for non-listed birds, namely, via
24 direct contact and through the ingestion of contaminated foods. These three species may also be
25 indirectly affected as a result of spill-related impacts on their habitats, which may also be
26 affected during oil spill cleanup activities. Direct exposure of birds or their habitats could result
27 in a variety of lethal and nonlethal effects that may affect survival and reproductive success,
28 potentially resulting in population-level effects on the exposed species (e.g., see Hartung 1995;
29 Piatt and Anderson 1996; Day et al. 1997; Esler et al. 2000; Lance et al. 2001; Golet et al. 2002;
30 Esler et al. 2002). The types of effects that exposed birds could incur are discussed in
31 Section 4.4.7.1.
32

33 During ice-free conditions (i.e., summer), accidental spills (especially small ones) may be
34 expected to be quickly diluted (see Section 4.4.3.2.2). In contrast, spills occurring under ice may
35 persist for a longer period of time and be transported by currents to areas much more distant
36 from the site of the accidental spill. Previous modeling of similar size oil spills in Cook Inlet
37 indicate that land segments with the highest chance of contact with an offshore platform or
38 pipeline spill are generally along the western shore of lower Cook Inlet in Kamishak Bay and
39 Shelikof Strait (MMS 2003a). Several areas that provide important habitat to migrating and
40 overwintering birds (see Figure 3.8.2-8 and Table 3.8.2-8), as well as a number of seabird
41 colonies, occur in these areas (USGS undated).
42

43 Offshore spills that reach coastal areas may expose species that forage or nest in coastal
44 habitats along Cook Inlet and Shelikof Strait. As discussed in Section 3.8.2.2, these areas
45 support thousands of migrating shorebirds and waterfowl, provide important wintering habitat
46 for Steller's eider, and include numerous seabird colonies. Spills reaching these areas could

1 directly or indirectly expose adults, eggs, young, and food resources. Because of the large
2 number of Steller's eider that overwinter in coastal areas of Cook Inlet (in the vicinity of Homer
3 Spit and Kamishak Bay) (Larned 2005), an accidental spill reaching wintering areas could
4 expose a large number of birds. This species concentrates in shallow, vegetated nearshore
5 habitats, and spills contacting such areas could locally reduce foraging habitat and food resources
6 and contaminate potential prey. The number of birds affected would depend on the size and
7 location of the spill, the number of birds directly exposed to the spill, and the amount of habitat
8 affected.

9
10 Offshore spills in marine waters may also expose migrating seabirds and waterfowl, as
11 well as pelagic seabirds that forage in areas such as the offshore marine waters of Cook Inlet
12 near the Barren Islands (Figure 3.8.2.2-1). The short-tailed albatross is considered to be highly
13 vulnerable to the impacts of oil pollution (King and Sanger 1979). Because this species does not
14 breed in the planning area, accidental spills would not be expected to affect nesting colonies.
15 Because this species is widely dispersed and is only a regular visitor to the marine waters of the
16 planning area, few individuals would be expected to be exposed to an accidental spill, and few
17 individuals would be expected to be disturbed during spill cleanup activities. The exposure of a
18 very small number of short-tailed albatross would not be expected to result in population-level
19 impacts on the species. This species forages in open marine waters, and no specific foraging
20 habitat type or location has been identified as being of prime importance for this species. In the
21 event of an accidental spill, members of this species would likely relocate their foraging
22 activities, with no resulting significant impacts expected. Thus, accidental spills would not be
23 expected to adversely affect foraging habitats and associated prey items available to the short-
24 tailed albatross in the Cook Inlet Planning Area.

25
26 Spills may also indirectly affect bird populations by reducing food resources and prey
27 availability in affected habitats. These indirect effects could reduce foraging success and energy
28 assimilation, which may affect growth, survival, and reproductive success. Depending on the
29 species affected, these effects could result in population-level effects. Because of the small
30 number and size of spills assumed for development that might occur under the proposed action
31 (Table 4.4.2-1), widespread exposure and impacts such as those observed for the *Exxon Valdez*
32 oil spill in Prince William Sound are not expected for this alternative.

33
34 Because of the preference of Kittlitz's murrelet for glacially influenced habitats and its
35 patchy and disjunct distribution among coastal areas, accidental oil spills would generally not be
36 expected to affect more than a few individuals. A moderate to large spill in a high-use area
37 could, however, result in the oiling of a relatively large number of birds. While the chronic
38 effects of long-term exposure of this species are not known, studies on the effects of the *Exxon*
39 *Valdez* oil spill on marine birds indicate that while murrelets as a whole are especially vulnerable
40 to and adversely affected by large oil spills, this group recovers within a relatively short time
41 following the initial spill and exposure (Day et al. 1997a,b; Murphy et al. 1997). The greatest
42 potential for population-level impacts would be associated with offshore spills occurring in
43 spring and summer and affecting breeding adults. Because this species nests in terrestrial
44 habitats up to 129 km (80 mi) inland (see Section 3.8.2.2.2), nest sites would not be expected to
45 be affected by offshore spills but could be affected by spills from onshore pipelines. However,
46 because this species nests in habitats such as coastal cliffs, scree slopes, and talus above

1 timberline, which are typically considered unsuitable and thus are avoided when a pipeline is
2 being sited, nest sites are unlikely to be affected by an onshore oil spill.

3
4 **Catastrophic Discharge Event.** The PEIS analyzes a CDE with a volume ranging from
5 75,000 to 125,000 bbl (Table 4.4.2-2). A low-probability CDE would have similar impacts on
6 bird populations as spills of other magnitudes; however, the area affected would increase and the
7 degree of impact would be more severe. A much greater number of birds and habitats could be
8 affected, and population-level impacts for some species could be incurred as CDEs can affect
9 extensive areas of shoreline. Such a spill contacting important migratory staging areas for
10 waterfowl and shorebirds could have major adverse effects on a variety of species. Similarly, a
11 catastrophic discharge event reaching wintering areas for waterfowl could have serious
12 population-level effects, especially with the increased difficulty in addressing spills under winter
13 conditions.

14 15 16 **4.4.7.2.3 Alaska – Arctic.**

17
18 **Routine Operations.** Under the proposed action, a number of facilities could be
19 constructed and operated in offshore and onshore portions of the Beaufort Sea and Chukchi Sea
20 Planning Areas (Table 4.4.1-4). Under the exploration and development scenarios for these two
21 planning areas, it is assumed that development would be limited to the shelf areas of both
22 planning areas and to water depths less than 91 m (300 ft). Because the shelf is relatively narrow
23 in the Beaufort Sea, ranging from 90 km (about 60 mi) in the west to 50 km (30 mi) in the east,
24 oil and gas activities would occur within 200 km (100 mi) of shore. In contrast, the Chukchi Sea
25 Planning Area has a very wide shelf area with water depths less than 91 m (300 ft), and oil and
26 gas activities may occur in areas 200 km (120 mi) or more from shore. Figure 4.4.1-2 shows the
27 locations of historic lease sales in the Beaufort Sea and Chukchi Sea Planning Areas; future lease
28 sales and development may be expected to occur in similar areas. Thus, coastal birds are more
29 likely to be affected by development in the Beaufort Sea Planning Area than in the Chukchi Sea
30 Planning Area following lease sales under the proposed action. Marine and coastal birds could
31 be affected during routine operations at these locations by (1) offshore exploration,
32 (2) construction of offshore platforms and pipelines, (3) construction of onshore pipelines,
33 (4) operation of offshore platforms, (5) operational discharges and wastes, and (6) vessel and
34 aircraft traffic.

35
36 **Offshore Exploration.** During offshore exploration, seismic surveys conducted in
37 offshore areas could affect primarily seabirds, because these are the species most likely to be
38 foraging or otherwise using pelagic open waters areas of the two planning areas. Potentially
39 affected birds may include puffins, murres, auklets, gulls and terns. Noise from air guns and
40 disturbance from survey vessel traffic could displace birds from nearby habitats. These
41 disturbances would be limited to the immediate area around survey vessels, would be short term,
42 and would not be expected to result in adverse impacts on local bird populations.

43
44 **Construction of Offshore Platforms and Pipelines.** Under the proposed action, one to
45 four offshore platforms could be constructed in the Beaufort Sea Planning Area, and one to five
46 in the Chukchi Sea Planning Area (Table 4.4.1-4). Construction of offshore platforms would

1 likely involve the construction of gravel islands to support drilling operations, and seabirds and
2 waterfowl that utilize offshore waters could be affected by construction of these islands.
3 However, construction of these offshore islands would occur in winter when most species are
4 absent. Thus, construction of offshore platforms would not be expected to affect seabirds or
5 waterfowl.
6

7 The exploration and development scenario for the proposed action identifies the
8 construction of many miles of new offshore pipeline in the two planning areas: 48 to 2,422 km
9 (30 to 1,505 mi) for the Beaufort Sea and 40 to 402 km (25 to 250 mi) for the Chukchi Sea.
10 Because pipeline construction would also occur in winter when most species have left the area,
11 few birds would be affected by this construction.
12

13 Construction of the offshore gravel islands to support drilling operations would likely use
14 gravel mined from the vicinity of the offshore islands. On the North Slope, gravel is generally
15 extracted from the floodplains of large rivers (Pamplin 1979; BLM 2002). Because the mining
16 of gravel would occur in winter along with other construction activities, gravel mining would not
17 be expected to disturb seabirds, waterfowl, or shorebirds, because these would normally be
18 absent during that time. The winter excavation of gravel could result in the conversion of some
19 riverine floodplain habitats into open water habitats, potentially affecting the distribution and
20 availability of nesting and foraging habitats for some species arriving the following spring after
21 gravel excavation has occurred.
22

23 A variety of waterfowl and shorebird species nest in floodplain habitats along the Arctic
24 coast. The extent to which some of these species could be affected by gravel excavation will
25 depend on the specific habitats excavated, the extent of habitat disturbance, and the level of
26 nesting use that the affected habitat typically supported. Because gravel excavation would occur
27 in winter, active nests would not be disturbed. Instead, birds arriving in spring searching for
28 suitable nesting habitat would simply search for other nesting locations. Because the relatively
29 small number of offshore facilities that could be constructed under the proposed action (no more
30 than nine platforms total for the two planning areas) would require a relatively limited amount of
31 gravel, excavation activities (and associated habitat impacts) would likely be limited to a few
32 locations.
33

34 Although pipeline trenching would also be carried out in winter when most seabird and
35 waterfowl species are not present, seafloor trenching could locally disrupt benthic invertebrate
36 communities that may serve as food sources for waterfowl during other seasons. The extent to
37 which benthic food sources could be affected and the subsequent impact on waterfowl will
38 depend on the type and amount of benthic habitat that would be permanently disturbed by
39 trenching, the importance of the specific habitats in providing food resources to waterfowl, and
40 the number of waterfowl that could be affected.
41

42 Pipeline trenching could disturb as much as 13.5 ha (33 ac) and 567 ha (1,400 ac) of
43 benthic habitat in the Beaufort Sea and Chukchi Sea Planning Areas, respectively. Much of this
44 disturbance would occur in water depths of 30 m (100 ft) or more and thus affect benthic habitats
45 that are largely inaccessible by seabirds and diving ducks. Trenching could, however, affect the
46 egg or larval survival/development (through direct mortality and increased turbidity) of fish

1 species that will eventually become prey for seabirds (SAFMC 2005). The environmental
2 changes caused by trenching would be temporary and would only affect more sensitive prey
3 species. Thus, pipeline trenching is expected to have limited effects on the overall availability of
4 waterfowl food sources, and any impacts on food sources would be very localized and would not
5 be expected to result in population-level impacts on local seabird and waterfowl populations.
6

7 The winter construction would also utilize ice roads to build and access gravel island
8 construction sites during the winter. Ice roads may be constructed over both tundra habitats and
9 frozen ocean habitats. During the construction of ice roads, water from local rivers and lakes
10 would be pumped onto the desired area to build up a rigid surface. Ice roads over frozen ocean
11 habitats would have little effect on most bird species because few species would be present in
12 this season. However, species that do overwinter (such as ptarmigan and snowy owl) may
13 temporarily leave the construction area and move to similar habitats in nearby locations.
14

15 **Construction of Onshore Pipelines.** Under the proposed action, up to 129 km (80 mi) of
16 new onshore pipeline could be constructed in onshore areas adjacent to the Beaufort Sea
17 Planning Area; no onshore pipelines would be constructed in support of new development in the
18 Chukchi Sea Planning Area (Table 4.4.1-4). The construction and operation of up to 129 km
19 (80 mi) of new overland pipelines could disturb coastal and tundra species; it could degrade or
20 eliminate as much as 390 ha (970 acres; assumes 30.5-m [100-ft] pipeline ROW) of potential
21 nesting or post-molting habitat that would be permanently lost within the footprint of the new
22 pipelines, causing birds to select habitats in other locations. Construction camps to support
23 onshore construction activities would temporarily disturb some areas and limit use by birds; this
24 disturbance would be short or long term, depending on the nature and effectiveness of camp
25 abandonment and restoration activities following completion of construction activities. The
26 impacts on potential habitat would be temporary and localized, and birds would likely respond
27 by selecting other areas for nesting or post-molting. Regardless of the duration of the effect, the
28 amount of habitat that would be disturbed would be relatively small and not be expected to affect
29 more than a few birds. Careful pipeline ROW siting to avoid important nesting or post-molting
30 habitats, and avoiding construction during post-molting and staging periods near such habitats,
31 would further reduce the magnitude of any potential effects on local bird populations.
32

33 **Operations of Offshore Platforms.** During normal operations, birds may be affected by
34 noise and human activities at the platforms, as well as by the presence of the platforms
35 themselves. Noise generated during drilling and production activities could affect the use of
36 surrounding waters by birds arriving during spring migration, foraging in surrounding waters
37 during nesting season, and later in the year during fall molting and staging periods. Some
38 species may react by avoiding areas immediately in the vicinity of the platforms, other species
39 may show little avoidance or become acclimated, and still others may be attracted to the offshore
40 platforms. Because of the small number of offshore platforms (no more than nine for both
41 planning areas), the disturbance of birds by operational noise and activity would likely be limited
42 to relatively few individuals and would not be expected to result in population-level effects for
43 any species.
44

45 Operational platforms may pose collision threats to migrating and nesting birds alike.
46 Many coastal nesting species travel out to open waters of the shelf to forage, while many species

1 of waterfowl and seabirds migrate along the shelf in spring and summer (Section 3.8.2.3). While
2 little information is available regarding bird collisions with platforms in the Arctic, annual bird
3 mortality from collisions with offshore platforms in the northern GOM has been estimated to
4 average 50 collision deaths per platform per year (Russell 2005). By applying a similar collision
5 mortality rate to the platforms that would be developed in the Beaufort Sea and Chukchi Sea
6 Planning Areas, a total of 200 annual bird collision mortalities might be expected for the four
7 new platforms in the Beaufort Sea Planning Area, and 250 total annual collision mortalities for
8 the five new platforms in the Chukchi Sea Planning Area. The incidence of bird collisions in the
9 GOM may be much greater than the incidence that could occur in the two Arctic planning areas
10 because of the much greater number of migrants in the GOM. However, some Arctic species
11 such as the murre and puffins are present in very large numbers (Section 3.8.2.3.1) in some
12 locations along the Arctic coast and exhibit daily migrations between coastal nesting areas and
13 foraging areas as far as 80 km (50 mi) or more offshore, which could increase the potential for
14 encountering offshore platforms.

15
16 **Operational Discharges and Wastes.** Produced water, drilling muds, and drill cuttings
17 generated by development and production wells would be disposed of through down-hole
18 injection. Thus, no impacts on marine and coastal birds from these wastes would be expected
19 under routine operations. In contrast, produced water, drilling muds, and drill cuttings generated
20 by exploration and delineation wells would be discharged at the well sites in compliance with
21 applicable regulations and permits. In marine waters, birds could be exposed to these materials
22 by direct contact or through the ingestion of contaminated food items. Birds most likely to be
23 present at well sites are those that forage on invertebrates and fish in offshore waters; these
24 include seabirds such as the murre and puffins, gulls, and jaegers.

25
26 Many species of marine birds (especially gulls) often follow ships and forage in their
27 wake on fish and other prey injured or disoriented by the passing vessel. In doing so, these birds
28 may be affected by discharges of waste fluids (such as bilge water) generated by OCS vessels.
29 The discharge of such wastes from OCS service and construction vessels, if allowed, would be
30 regulated under applicable NPDES permits, and any discharged wastes would be quickly diluted
31 and dispersed and thus not be expected to affect marine birds.

32
33 Marine and coastal birds may become entangled in or ingest floating, submerged, and
34 beached debris (Heneman and the Center for Environmental Education 1988; Ryan 1987, 1990).
35 Entanglement may result in strangulation, the injury or loss of limbs, entrapment, or the
36 prevention or hindrance of the ability to fly or swim, and all these effects may be considered
37 lethal. Ingestion of debris may irritate, block, or perforate the digestive tract, suppress appetite,
38 impair digestion of food, reduce growth, or release toxic chemicals (Fry et al. 1985; Dickerman
39 and Goelet 1987; Ryan 1988; Derraik 2002). Because the discharge or disposal of solid debris
40 into offshore waters from OCS structures and vessels is prohibited by the BOEMRE
41 (30 CFR 250.40) and the USCG (MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]),
42 entanglement in or ingestion of OCS-related trash and debris by marine and coastal birds would
43 not be expected under routine operations.

44
45 **Vessel and Aircraft Traffic.** Development occurring under the proposed action could
46 include up to 12 weekly vessel and helicopter trips in the Beaufort Sea Planning Area and as

1 many as 15 weekly helicopter and vessel trips in the Chukchi Sea Planning Area. The presence
2 of ships and helicopters, as well as noise associated with their passage, can disturb birds and
3 potentially affect feeding, resting, or nesting behavior, and may cause affected birds to abandon
4 the immediate area. Which birds could be affected, the nature of their response, and the potential
5 consequences of the disturbance will be a function of a variety of factors, including the specific
6 routes, the number of trips per day, the altitude of the flights, the seasonal habitats along the
7 routes, the species using the habitats and the level of their use, and the sensitivity of the birds to
8 vessel and aircraft traffic. Traffic near or over heavily utilized feeding or nesting habitats of
9 sensitive species could result in population-level effects, while impacts from traffic in other areas
10 with less sensitive species would largely be limited to a few individuals and would not result in
11 population-level effects. The use of shipping lanes and aircraft routes avoiding sensitive bird
12 areas would greatly reduce or eliminate the potential for vessel and aircraft traffic to cause
13 population-level effects in marine and coastal birds.

14
15 Helicopter overflights are generally conducted at low altitudes and have the potential for
16 disturbing birds in onshore and offshore locations (Ward and Stein 1989; Ward et al. 1994;
17 Miller 1994; Miller et al. 1994). FAA guidelines for helicopter oceanic operations request that
18 pilots maintain a minimum altitude of 213 m (600 ft) while in transit offshore, 305 m (1,000 ft)
19 over unpopulated areas or across coastlines, and 610 m (2,000 ft) over populated areas and
20 sensitive habitats such as wildlife refuges and park properties (FAA 2010). The type of response
21 elicited from the birds and the potential effect on the birds will depend in large part on the time
22 of year for the overflights and the species disturbed. Helicopter overflights during spring
23 breakup of pack ice may disturb marine species feeding in open water leads and waterfowl in
24 open coastal waters, causing birds to leave the area. Similarly, overflights in summer could
25 displace waterfowl and seabirds from preferred foraging areas and from coastal nesting or brood-
26 rearing areas such as seabird colonies and the lagoon systems of the Beaufort and Chukchi Seas.
27 Molting and staging waterfowl may temporarily leave an area experiencing helicopter overflights
28 (Derksen et al. 1992), while geese have been reported to exhibit alert behavior and flight in
29 response to helicopter overflights (Ward and Stein 1989; Ward et al. 1994).

30
31 While bird strikes are possible, any such events would affect only an occasional
32 individual and not result in any population-level effects. However, the increased energy demand
33 associated with birds leaving foraging or staging areas for other, potentially less favorable areas
34 could result in a lowered fitness of the affected birds. While birds disturbed from nesting or
35 brood-rearing habitats by occasional overflights would be expected to return, birds experiencing
36 frequent overflights may permanently relocate to less favorable habitats (MMS 2002b). In
37 addition, the temporary absence of adult birds may increase the potential for predation of
38 unguarded nests and young (NRC 2003a).

39
40 **Accidents.** Marine and coastal birds could be affected by accidental oil spills from
41 offshore platforms and pipelines, as well as from onshore processing facilities and pipelines.
42 The magnitude and extent of impacts will be a function of a variety of factors, including (1) the
43 time of year of the spill, (2) the volume of the spill, (3) the habitats exposed to the spill, and
44 (4) the species exposed to the spill or that utilize the exposed habitats. Exposure of eggs and
45 young and adult birds to oil may result in a variety of lethal and sublethal effects. Oil moving
46 into coastal and inshore areas may foul habitats, reducing habitat quality and contaminating

1 vegetation and invertebrate foods. Ingestion of contaminated foods may lead to a variety of
2 lethal and sublethal toxic and physiological effects. Finally, oil spill-response activities may
3 disturb birds in nearby habitats that are unaffected by an oil spill.
4

5 Certain species of marine and coastal birds may be more susceptible to contact with
6 spilled oil than others, based on their life histories. For example, diving seabirds and underwater
7 swimmers such as loons and diving ducks may be the most susceptible to offshore spills because
8 of their extensive use of such areas and their relatively long exposure time on the sea surface. In
9 contrast, shorebirds and waterfowl may be most susceptible to spills that reach the beach
10 intertidal zone, coastal lagoons, or inshore wetland habitats where these species forage and raise
11 young. The magnitude of the impact will depend on the size of the spill, the species and life
12 stage when exposed, and the size of the local bird population.
13

14 Offshore spills in spring that reach coastal barrier islands and mainland coastal wetland
15 areas may expose common eiders, gulls, and other birds that nest in these habitats along the
16 Beaufort and Chukchi Seas. Some of these areas support large nesting colonies, and direct and
17 indirect exposure of adults, eggs, young, and food resources may adversely affect reproductive
18 success and result in population-level effects on some species.
19

20 Offshore spills in spring may also expose migrating seabirds and waterfowl. Exposed
21 individuals may experience lethal or sublethal effects from the exposure. Depending on the
22 species, mortality or subsequent impacts on reproduction could result in population-level impacts
23 on some species. Species with naturally low reproductive rates, such as the long-tailed duck and
24 red-throated loon, may be especially vulnerable to population-level impacts. Because these
25 species have a low reproductive rate that limits natural population growth, the loss of
26 comparatively few individuals could result in more substantive population impacts.
27

28 Spring spills contacting shoreline areas have the potential to expose thousands of
29 migrating shorebirds, as well as contaminating nesting and foraging habitats and oiling nests and
30 eggs. Exposure of individuals could result in lethal or sublethal effects, while oiling of nests
31 and/or eggs would reduce reproductive success.
32

33 Spills occurring in late summer through autumn and that enter coastal lagoons and delta
34 areas could expose large numbers of waterfowl (loons, tundra swans, king eiders, long-tailed
35 duck) that use these habitats for molting and staging, and potentially result in adverse
36 population-level effects. For example, mortality estimates of long-tailed ducks in the central
37 Beaufort Sea from a hypothetical spill ranged as high as 35%, depending on the amount of oil
38 spilled and the number of birds present (MMS 2003a). A winter spill under the ice could
39 contaminate ice leads that develop during spring breakup, exposing eiders and other waterfowl
40 that use these features while migrating.
41

42 Oil spills from onshore pipelines would likely be limited to a much smaller area than
43 would a spill in an offshore location. Those birds exposed could incur a variety of lethal or
44 sublethal effects; however, because relatively few individuals or nests would be expected to be
45 exposed, no population-level impacts would be expected. However, an oil spill from an onshore
46 pipeline that reaches an aquatic habitat such as a stream, wetland, or lake on the Arctic coastal

1 plain may have greater impacts on shorebirds and waterfowl. Many such aquatic habitats are
2 used by a variety of waterfowl and shorebirds for brood rearing, molting, and staging. Thus, a
3 terrestrial spill reaching such habitats could expose a much larger number of birds than a spill
4 restricted to a terrestrial environment.

5
6 Spill cleanup activities may disturb and displace birds from nearby habitats. Depending
7 on the use of those habitats (e.g., nesting, molting, staging), displaced birds could incur reduced
8 reproductive success or survival. In addition, the duration of cleanup activities may not only
9 displace birds currently present but also preclude birds using the area for quite some time. For
10 example, cleanup activities associated with a large spill may involve hundreds of workers and
11 numerous boats, aircraft, and onshore vehicles, operating in the affected area for a year or more.
12 During this time, migrating birds arriving in spring would be expected to bypass habitats that are
13 near areas undergoing active cleanup operations.

14
15 **Catastrophic Discharge Event.** The PEIS analyzes CDEs for the Chukchi Sea and
16 Beaufort Sea Planning Areas with volumes ranging from 1,400,000 to 2,200,000 bbl and
17 1,700,000 to 3,900,000 bbl, respectively (Table 4.4.2-2). A low-probability CDE would have
18 similar impacts on bird populations as spills of other magnitudes; however, the area affected
19 would increase and the degree of impact would be more severe. A much greater number of birds
20 and habitats could be affected, and population-level impacts for some species could be incurred
21 as impacts of CDEs in this region are prolonged by the cold water and cold air temperatures.

22
23
24 **4.4.7.2.4 Conclusion.** Routine operations may be expected to affect some birds in each
25 of the planning areas included in the proposed action. The nature and magnitude of effects on
26 birds would depend on the specific location, the timing, and the nature and magnitude of the
27 operation, as well as the species that would be exposed to the operation. For routine Program
28 activities, the primary effects would be the disturbance of birds (and their normal behaviors) by
29 noise, construction and development equipment, and human activity, and habitat loss in areas of
30 infrastructure construction. Birds may also incur injury or mortality as a result of collisions with
31 infrastructure and support vessels. Impacts to birds from routine operations associated with the
32 Program are expected to range from negligible to moderate.

33
34 Because birds tend to habituate to human activities and noise, potential impacts for many
35 species associated with such disturbance would be short term and would not be expected to result
36 in population-level effects. This could be especially true in the GOM planning areas, where
37 local bird populations are regularly exposed to noise, construction, and vessel traffic associated
38 with commercial and recreational activities. However, depending on the time of year,
39 construction activities near coastal habitats could disrupt breeding and nesting activities of
40 colonial nesting birds, potentially affecting local populations. In most cases, the disturbance of
41 birds would be short term or transient, and would not be expected to result in population-level
42 effects on affected species.

43
44 Construction of pipelines, landfalls, and offshore gravel islands (to support Arctic drilling
45 platforms) would result in the permanent disturbance of habitat within the immediate footprint of
46 the new facilities and gravel excavation areas. Because of the relatively small amount of habitat

1 that could be disturbed, as well as the limited use of some of the affected habitats (such as deep
2 water benthic habitat), habitat disturbance or loss is expected to have only minor impacts on
3 marine and coastal birds. However, the level of impact that could be incurred by any species
4 will depend on the type of habitats affected and the importance of those habitats to local bird
5 populations. Loss of nesting, molting, or staging habitats (especially in the Alaska Planning
6 Areas) has the potential to affect reproductive success, foraging success, and survival of some
7 species, and may result in population-level impacts on affected species. Careful siting of
8 infrastructure to avoid sensitive and important habitats would greatly reduce or eliminate the
9 potential for population-level effects.

10
11 Some mortality may be expected for birds colliding with offshore platforms and, to a
12 lesser extent, with helicopters providing support services to offshore platforms. Impacts from
13 such collisions are anticipated to affect relatively few birds and result in only minor impacts on
14 bird populations, with no population-level effects. Because the discharge of production wastes
15 and other materials generated at offshore platforms and OCS-related vessels is regulated and
16 because permitted production wastes discharged into marine waters would be quickly diluted and
17 dispersed, relatively few birds would be exposed to these waste materials and impacts from such
18 discharges would likely be negligible.

19
20 While normal operations could affect listed bird species in the same manner as non-listed
21 species (primarily behavioral disturbance), compliance with ESA regulations and coordination
22 with the USFWS would ensure that lease-specific operations would be conducted in a manner
23 that avoids or greatly minimizes impacts on these species.

24
25 Accidental oil spills (and especially those associated with a CDE) pose the greatest threat
26 to marine, coastal, and migratory birds, and could affect both birds and their habitats. Exposed
27 birds may experience a variety of lethal or sublethal effects, including reduced reproductive
28 success. The magnitude and ecological importance of any effects would depend upon the size of
29 the spill, the species and life stages that are exposed, and the size of the local bird population. A
30 spill associated with a CDE would affect the greatest number of species, individuals, and
31 habitats, and have the potential to cause population-level impacts to affected species. Exposure
32 to spills in deep water would be largely limited to pelagic birds, while shallow-water spills could
33 affect the greatest variety and number of birds, including shorebirds, waterfowl, wading birds,
34 gulls and terns. Birds that become heavily oiled by direct contact with a spill would likely
35 perish, while lightly oiled birds may experience a variety of lethal or sublethal effects. Oil
36 washing ashore may contaminate eggs and nest sites, as well as fowl foraging areas and food
37 resources.

38
39 In the GOM, spills in deep water are not likely to affect listed marine and coastal birds
40 because, with the exception of the roseate tern, none of the seven listed species would be
41 expected offshore where deepwater spills could occur. The roseate tern does not normally
42 frequent waters in close proximity to the Western, Central, and Eastern GOM Planning Area
43 where lease sales and subsequent oil and gas activities may occur under the proposed action. In
44 the Alaskan Planning Areas, only the short-tailed albatross would be expected with any
45 regularity in OCS areas more than 200 km (124 mi) from shore. For the GOM and Alaskan OCS
46 Planning Areas, most of the listed and candidate species could be exposed to shallow-water spills

1 or to large deepwater spills (especially large or CDE-level spills) that have moved into coastal
2 waters. In coastal areas, most of the listed species could be directly exposed while foraging in
3 oiled flats, beaches, and coastal wetlands. Because all of the wild populations of the endangered
4 whooping crane use limited habitats on the GOM coast (in Texas, Florida, and Louisiana), the
5 entire population of this species may be especially vulnerable to a spill that reaches these
6 locations. In Alaska, the threatened spectacled eider congregates in specific habitats during
7 molting and when staging for fall migration, this listed species may also be particularly
8 vulnerable to population-level effects should a spill contact molting or staging habitats with large
9 numbers of individuals. Similarly, the threatened Steller's eider overwinters in Cook Inlet and a
10 large spill could locally affect a relatively large number of birds. Spills occurring in glacially
11 influenced coastal habitats could expose relatively large numbers of Kittlitz's murrelet, a
12 candidate species for listing under the ESA. This species has been reported to be particularly
13 vulnerable to oil exposure. Because neither the albatross nor the eider breeds in the Cook Inlet
14 Planning Area, accidental spills would not be expected to affect nest sites of these species.
15 While Kittlitz's murrelet breeds in Cook Inlet, it nests on cliffs, scree slopes, and other areas
16 where its nests would not be expected to come in contact with accidental oil spills.

19 **4.4.7.3 Fish**

22 **4.4.7.3.1 Gulf of Mexico.**

24 **Fish Resources.**

26 ***Routine Operations.*** See individual habitat sections for detailed discussions of the
27 impacts of oil and gas activities on fish habitat in the GOM. Potential OCS oil and gas
28 development impacting factors for fish in the GOM are shown by phase in Table 4.4.7-3.
29 Impacting factors common to all phases include platform lighting, increased ship traffic, vessel
30 discharges (bilge and ballast water), and miscellaneous discharges (deck washing, sanitary
31 waste). Impacts from waste discharges would be localized and temporary and are expected to
32 have negligible impacts on fish populations. Many of these waste streams are disposed of on
33 land, and all vessel and platform wastes that are discharged into surface waters must meet
34 USEPA and/or USCG regulatory requirements. Studies conducted in the northern GOM suggest
35 that platform lighting could alter predator-prey dynamics by enhancing phytoplankton
36 productivity around the platform, potentially improving food availability and the visual foraging
37 environment for fishes (Keenan et al. 2007). Potential impacts from platform lighting would be
38 localized but long term and are expected to have minimal impacts on fish populations.

40 **Exploration and Site Development.** During the OCS oil and gas exploration and
41 development phase, fish could be affected by noise from seismic surveys and noise and bottom
42 disturbance from drilling, platform placement, and pipeline trenching and placement activities.
43 Releases of drilling muds and cuttings could also affect fish by contaminating food resources in
44 sediments and surrounding surface waters (Table 4.4.7-3).

1
2

TABLE 4.4.7-3 Impacting Factors on Fish and Their Habitat in the GOM Planning Areas

Development Phase and Impacting Factor	Life Stage Affected ^a		
	Eggs	Larvae	Adults
<i>Impacting Factors Common to All Phases</i>			
Vessel noise	X	X	X
Vessel traffic	X	X	X
Hazardous materials	X	X	X
Solid wastes	X	X	X
Offshore lighting	X	X	X
Aircraft noise			
Offshore air emissions			
Onshore air emissions			
Aircraft traffic			
Miscellaneous platform discharges	X	X	X
Vessel discharges	X	X	X
Bottom disturbance from vessel anchors	X	X	X
<i>Exploration and Development</i>			
Seismic noise	X	X	X
Noise from drilling and construction	X	X	X
Bottom disturbance from platform placement, drilling, and pipeline placement and trenching	X	X	X
Discharge of drilling muds and cuttings	X	X	X
<i>Production</i>			
Production noise	X	X	X
Produced water discharge	X	X	X
Artificial reef	X	X	X
<i>Decommissioning</i>			
Platform removal (non-explosive)	X	X	X
Platform removal (explosive)	X	X	X

^a Colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

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13

All fish species in the GOM are presumed to be able to hear with varying degrees of sensitivity and within the frequency range of sound produced by exploration site development activities. Noises generated during platform and pipeline placement, vessel traffic, and seismic surveys are all potential sources of disturbance to fish communities. Noise could kill or injure fish, induce behavioral alterations, produce generalized stress, and interfere with communication (Smith et al. 2004; Vasconcelos et. al. 2007; see Popper and Hastings 2009 for a recent review). A primary source of noise during exploration and site development would be air guns used during seismic surveys. There is some experimental evidence that noise generated by seismic surveys could kill or injure organisms typically within a few meters of the noise source, but other

1 studies found no injury or mortality even for sensitive, early life stages (Dalen and
2 Knutsen 1986; Holliday et al. 1987; reviewed in NSF and USGS 2010). Several researchers
3 have also documented startle responses or temporary avoidance of areas exposed air gun noise,
4 but these effects are not found consistently (Turnpenny and Nedwell 1994; reviewed in Popper
5 and Hastings 2009 and NSF and USGS 2010). Continuous long-term exposure to high-pressure
6 sound waves has been shown to cause damage to the hair cells of the ears of some fishes under
7 some circumstances (Popper 2003). Several studies have found that species with gas bladders,
8 which includes many of the pelagic and demersal fish species in the GOM, are more vulnerable
9 to injury or mortality from explosions than species without gas bladders such as flatfish
10 (MMS 2004a). For adult fishes, continuous exposures would not exist under natural
11 circumstances as fish could move from the area. However, fish larvae may suffer greater
12 mortality because of their small size and relative lack of mobility. The severity and duration of
13 noise impacts would vary with site and development scenario, but overall the impacts would be
14 temporary, localized, and minor. A recent review of seismic survey noise on marine fish
15 concluded that although data were limited, there would be no significant impacts on marine fish
16 populations from seismic surveys (BOEMRE 2010c; NSF and USGS 2010).

17
18 Bottom-disturbing activities such as coring and drilling, platform placement and mooring,
19 and pipeline trenching and placement would displace fish in the vicinity of the activities. Bottom
20 disturbance would result in temporary sedimentation and increased turbidity, which could
21 damage fish gills and bury benthic invertebrate prey resources within some distance of the
22 disturbance. Fish mortality may also be greater if bottom disturbance occurs in areas of high
23 larval and juvenile fish density such as estuaries and nearshore areas. In addition, the physical
24 changes to benthic habitat resulting from drilling could affect food resources for benthic fishes
25 by altering benthic invertebrate community composition. Soft sediment fishes, particularly in
26 shallow water, are subject to frequent bottom disturbance from human activities such as trawling
27 and natural occurrences such as storms and are presumably well adapted to such conditions.

28
29 The discharge of drilling muds and cuttings (including synthetic drilling fluids adhering
30 to the cuttings) can affect fish in several ways. Impacts from turbidity would be similar to those
31 described above and could damage respiratory structures, cause fish to temporarily move from
32 the area, and disrupt food acquisition. Drilling muds and cuttings released near the sediment
33 surface or in shallow water would bury benthic food resources in the release area although
34 conditions would eventually recover. Trace metal and hydrocarbon constituents in drilling fluids
35 can be toxic to all life stages of fishes if exposed to high enough concentrations. Planktonic eggs
36 and larvae that contact the mixing zone would be at greatest risk (e.g., Kingsford 1996), while
37 juveniles and adults passing through a discharge are not likely to be adversely affected. The
38 disturbance would be short, and based on the assumption of a relatively widespread distribution
39 of eggs, larvae, and prey, only a very small proportion of the population of a given fish species is
40 likely to be affected. In addition, all discharges must comply with NPDES permit requirements
41 regarding the discharge amount, rate, and toxicity, which would greatly reduce the impact on fish
42 communities. BOEM-sponsored research on the biological effects of drilling fluids on marine
43 communities in the GOM (Continental Shelf Associates, Inc. 2004, 2006) found that fish
44 densities were elevated near the platforms compared to control locations and certain classes of
45 benthic invertebrate food sources were also more abundant within 300 m (984 ft) of the well
46 compared to control areas (Continental Shelf Associates, Inc. 2006).

1 There are several protective measures in place to protect sensitive fish habitat from oil
2 and gas activities. Impacts on hard-bottom areas from bottom-disturbing activities would be
3 minimized by the Topographic Features Stipulation that establishes No Activity Zones, where no
4 operations, anchoring, or structures are allowed. There is also a lease stipulation that requires
5 avoidance of low-relief live-bottom and pinnacle features. In deep water, there are stipulations
6 requiring the avoidance of chemosynthetic communities and deepwater corals.
7

8 Based on the discussion above, the site development and exploration represent a minor
9 disturbance, primarily affecting demersal fishes, with the severity of the impacts generally
10 decreasing dramatically with distance from bottom-disturbing activities.
11

12 Production. Production activities that could affect soft sediment habitat include
13 operational noise, bottom disturbance, and the release of process water. In addition, the platform
14 would replace existing featureless soft sediments and serve as an artificial reef (Table 4.4.7-3).
15

16 Chronic bottom disturbance could result from the movement of anchors and chains
17 associated with support vessels and floating platform moorings. Bottom disturbance would
18 affect fish and their food resources in a manner similar to that described above for the
19 exploration and site development phase. Some of the disturbance could be episodic and
20 temporary, but others would last for the lifetime of the platform.
21

22 Sessile epifaunal invertebrates requiring hard substrate (i.e., barnacles and corals) as well
23 as small motile invertebrates (amphipods and worms) would colonize fixed or floating platform
24 structures, creating an artificial reef. Pipelines not buried would also provide hard substrate for
25 sessile and structure-oriented fish species. Reef fish and epipelagic fishes such as tunas, dolphin
26 fish, and jacks would be attracted to these platforms in concentrations greater than those of
27 surrounding soft sediments and even natural reefs (Wilson et al. 2003). The platforms could
28 possibly enhance feeding of predators by attracting and concentrating smaller prey species.
29 However, concerns have been expressed that highly migratory species could be diverted from
30 normal migratory routes and consequently from normal spawning or feeding areas because of
31 attraction to structures such as oil platforms (Carney 1997). Similarly, platforms may attract reef
32 fish from natural hard-bottom areas. Thus platforms may simply attract fish rather than
33 increasing fish production and at the same time make them easier to harvest by commercial and
34 recreational fisheries (Brickhill et al. 2005). Because of the wide distribution of reef and
35 epipelagic species and the great number and spatial extent of production platforms, such effects
36 could extend to the regional scale. Ultimately, the benefit or detriment of artificial reefs as
37 habitat depends on how fisheries are managed on the reef and the individual life histories and
38 habitat requirements of the species present (Bohnsack 1989; Macreadie et al. 2011).
39

40 Produced water contains several toxic elements (Neff 1997a), and direct and continuous
41 exposure to produced waters can be lethal to all life stages of fishes. Because more chemicals
42 are required to maintain adequate flow in deep waterwells, produced water from deepwater wells
43 is expected to contain more chemical contaminants than wells in shallow water. Direct exposure
44 would occur only in the water column near the discharge point; thus pelagic adults and
45 planktonic eggs and larvae would be most susceptible. Higher impacts would be realized if eggs
46 and larvae were unusually concentrated. Thus, local circulation patterns greatly influence the

1 degree of potential impact. Nevertheless, population-level effects on fishes are not likely, as
2 contaminants are not expected to reach toxic levels in the sediment and water column because of
3 dilution and NPDES permitting requirements regarding discharge rate, contaminant
4 concentration, and toxicity. In studies of the potential long-term ecological effect of oil and gas
5 development, no significant bioaccumulations of hydrocarbons or metals were observed in fish
6 collected near platforms, and histopathological evaluations of fish found no damage to liver
7 tissue (Peterson et al. 1996). In addition, benthic invertebrate food sources collected in
8 sediments near platforms do not appear to bioaccumulate the common contaminants in produced
9 water, and their tissues did not exceed USEPA-specified concentrations considered harmful
10 (Continental Shelf Associates, Inc. 1997). Organisms attached to oil platforms have not been
11 found to accumulate metals, although they have been found to bioaccumulate organic
12 contaminants (Continental Shelf Associates, Inc. 1997). Produced water discharge has also not
13 been found to contribute significantly to hypoxia in the GOM (Rabalais 2005;
14 Bierman et al. 2007). Thus, production activities are expected to result in minor impacts on fish
15 communities.

16
17 Decommissioning. Platform removal in general would temporarily affect fish by
18 displacing resident fishes, disturbing sediments, and increasing noise and turbidity for some
19 length of the water column. In addition, it is assumed that up to 275 platforms would be
20 removed using explosives, which could kill or cause sublethal injury to many of the fishes
21 associated with the structures. Small fish and fish with swimbladders are most susceptible to
22 injury and mortality from underwater blasts. In a study of 792 explosive platform removals in
23 the GOM, an average of 567 dead fish were observed floating at the surface, although the actual
24 number dead is likely to be higher (Continental Shelf Associates, Inc. 2004b). Mark and
25 recapture studies conducted at platform removal sites in the central and western GOM
26 (Gitschlag 2000) estimated that between 2,000 and 5,000 fishes greater than 8 cm (3 in.) in
27 length and more than 6,200 fish less than 8 cm (3 in.) were killed during explosive removals in
28 water depths ranging from 14 to 32 m (46 to 105 ft). Sheepshead, spadefish, red snapper, and
29 blue runner accounted for 89% of the mortality estimated by these studies. Mortality estimates
30 of red snapper associated with the platform ranged from 57 to 90%. Assuming 275 explosive
31 removals, a large number of fish could potentially be killed during the Program. Displaced fish
32 would repopulate the area over a short period of time, although the species composition would
33 likely shift to soft sediment species and away from reef and migratory pelagic species of fish.
34 Overall, decommissioning activities are expected to result in up to moderate effects on fish
35 communities.

36
37 If fixed platforms are toppled and left in place, the platform would continue to serve as an
38 artificial reef, although the density and composition of fish may change. For example, the high
39 vertical relief of the platform is important in attracting fish; thus fish density may decline once
40 the platform is toppled (Wilson et al. 2003). Pipelines not buried, in both shallow and deepwater
41 would provide hard substrate and habitat for structure-oriented fishes. As discussed above, the
42 ability of artificial reefs to enhance fish production is controversial. In addition, artificial reefs
43 may allow the spread of non-native fish species across the GOM, especially as waters warm due
44 to climate change (Hickerson et al. 2008). For example, lionfish (*Pterois volitans*) have spread
45 from the reefs of the West Florida shelf to the central and western GOM, where they are often

1 found associated with oil platforms (<http://www.lsu.edu/seagrantfish/biological/invasive/redlionfish.htm>). In the future, other species could become established through range expansion
2 or human introductions. Ultimately, the benefit or detriment of artificial reefs as habitat depends
3 on how fisheries are managed on the reef and the individual life histories and habitat
4 requirements of the species present (Bohnsack 1989; Macreadie et al. 2011).
5
6

7 **Accidents.** Impacts of most accidental hydrocarbon releases on fish and their habitat are
8 expected to be relatively minor, as most spills would be small and hydrocarbons would be
9 diluted and broken down by natural processes. The location of the spill, habitat preference of the
10 fish, and the season in which the spill occurred would be important determinants of the impact
11 magnitude of the spill.
12

13 Toxic fractions of PAHs in spilled oil can cause death or illness in adult fishes. Less is
14 known about the impacts of natural gas on fish, but natural gas could have lethal or sublethal
15 impacts as well, depending on concentration. Impacts of hydrocarbons differ among various life
16 stages of fishes. For example, pelagic eggs and larval stages of fish, whose movements are
17 largely controlled by water currents, could be killed if they came into contact with surface oil
18 spills (Patin 1999). Conversely, oil and gas would typically rise above the seafloor, which would
19 limit direct contact with demersal fishes. Evidence also indicates that the majority of adult
20 pelagic fish can likely detect and avoid heavily oiled waters in the open sea, thereby avoiding
21 acute effects (Patin 1999; Roth and Baltz 2000). However, adult fish could still be exposed to
22 sublethal hydrocarbon concentrations through direct contact with gills or through ingestion of
23 spilled oil. In addition, oil could ultimately enter the benthic food web as oil-contaminated
24 pelagic organic matter and biota settled to the seafloor.
25

26 **Catastrophic Discharge Event.** The PEIS analyzes a CDE up to 7.2 million bbl could
27 result from pipeline ruptures, a loss of well control, and from tanker spills associated with an
28 FPSO system (Table 4.4.2-2). At the population level, hydrocarbon spills could affect fish by
29 causing high mortality of eggs, larvae, juveniles, or adults; triggering abnormal development;
30 impeding the access of migratory fishes to spawning habitat; displacing individuals from
31 preferred habitat; reducing or eliminating prey populations available for consumption; impairing
32 feeding, growth, or reproduction; causing adverse physiological responses; increasing
33 susceptibility to predation, parasitism, diseases, or other environmental perturbations; and
34 increasing or introducing genetic abnormalities. Most of the fishes inhabiting shelf or oceanic
35 waters of the GOM have planktonic eggs and larvae (Ditty 1986; Ditty et al. 1988;
36 Richards et al. 1993). Catastrophic spills occurring during recruitment periods or spills that
37 affect areas with high larval fish concentrations such as estuaries could result in population-level
38 impacts. Because of the wide dispersal of early life history stages of most fishes in the GOM, it
39 is anticipated that only a relatively small proportion of early life stages present at a given time
40 would be affected by a particular oil spill event, and this would limit the potential for population-
41 level effects. For example, an evaluation of the response of coastal fishes to the DWH event
42 suggests that large-scale losses of 2010 cohorts were largely avoided and that there were no
43 discernible shifts in species composition following the spill (Fodrie et al. 2011). However, the
44 impact magnitude would also depend on the temporal and spatial scope of the oil spill. Since
45 some species of fish spawn in a limited geographic area(s) during a small temporal window, a
46 spill could have population-level impacts if the spill coincided in time and space with spawning

1 activity. In addition, fish species such as tuna, swordfish, and other billfish that currently have
2 depressed populations and critical spawning grounds in the GOM could experience major
3 impacts if high numbers of early life stages were killed by a spill.

4
5 **Protected Species: Gulf Sturgeon.**

6
7 ***Routine Operations.***

8
9 Exploration and Site Development. No information is available on the hearing or
10 acoustic biology of Gulf sturgeon from which to assess effects. The only noise sources strong
11 enough to produce impacts other than behavioral disruption are seismic surveys. Since the
12 seismic sources (air guns) are fired in the upper water column, Gulf sturgeon are unlikely to be
13 injured, but the noise could have behavioral effects such as disruption of feeding and movement
14 behaviors. Adult Gulf sturgeon wintering in shelf waters of the GOM may be affected by sounds
15 emanating from working platforms and their attendant operations. However, the most likely
16 effects would be short-term behavioral disruption or avoidance of certain areas.

17
18 The placement of bottom-founded structures during the exploratory drilling phase may
19 affect adult Gulf sturgeon and their designated critical habitat (50 CFR 226.214) directly and
20 indirectly. As with all fish, the drilling platform and pipeline placement could injure or displace
21 Gulf sturgeon and reduce or eliminate their benthic food resources. These disturbances could
22 affect adult Gulf sturgeon during cooler months, which is their primary feeding period of the
23 year when they move from coastal rivers into inner shelf waters of the eastern and central GOM
24 (Huff 1975; Mason and Clugston 1993). However, most new oil and gas production activities
25 would not occur in the shallow coastal waters less than 10 m (33 ft) in depth (67 FR 39106–
26 39199) preferred by Gulf sturgeon. Consequently, only a small proportion of the areas of bottom
27 disturbance would potentially be used by Gulf sturgeon.

28
29 Drilling muds and cuttings can be released at or near the sea surface or the seafloor.
30 Muds and cuttings are diluted and dispersed rapidly in the ocean; therefore, cuttings released at
31 the surface are unlikely to have measurable impacts on Gulf sturgeon. However, food resources
32 for Gulf sturgeon may be buried by muds and cuttings released near the seafloor or settling in
33 thick accumulations in shallow water. Gulf sturgeon are known not to have an affinity for
34 structured habitat, and they occur in water shallower than that typically used for drill sites. Thus,
35 accumulations of drilling muds and cuttings are not likely to affect Gulf sturgeon or their habitat.

36
37 Production. Produced water discharges dilute rapidly in the open ocean, and direct
38 exposure would occur only in the water column near the discharge point where adult sturgeon
39 are not likely to be located. Vulnerable early life stages of Gulf sturgeon exist only in rivers far
40 removed from produced water discharges, making exposure unlikely. The discharge of produced
41 water is not thought to contribute to significantly increasing the size or severity of the hypoxic
42 zone in the GOM (Rabalais 2005). Consequently, it is believed that discharges resulting from
43 the proposed action will not affect dissolved oxygen levels in areas used by Gulf sturgeon.

44
45 Decommissioning. Under the proposed action, it is assumed that explosives would be
46 used to remove up to 275 platforms in the entire GOM. Explosive blasts can be lethal to fishes

1 that may be present near the structure (Gitschlag 2000). However, the Gulf sturgeon are known
2 not to have an affinity for offshore structures; thus, they are not likely to be affected.

3
4 ***Accidents.*** Hydrocarbons could affect adult sturgeon by direct contact with gills or via
5 direct ingestion. Adult and juvenile fishes would likely avoid oil from a spill. Eggs and larvae
6 of fishes could die or become deformed if exposed to certain toxic fractions of spilled oil
7 (Longwell 1977; Collier et al. 1996; Kingsford 1996). However, contact with early life stages of
8 Gulf sturgeon is unlikely because floating oil is not likely to penetrate to the middle reaches of
9 most rivers where eggs are deposited and because oil would float on the freshwater outflow and
10 never reach or settle directly on demersal eggs (Sulak and Clugston 1998; Fox et al. 2000).

11
12 **Protected Species: Smalltooth Sawfish.**

13
14 ***Routine Operations.***

15
16 Exploration and Site Development. Smalltooth sawfish are considered rare from Texas
17 to the Florida panhandle (NMFS 2009) and are not likely to be present in the Central and
18 Western Planning Areas where exploration and site development, production, and
19 decommissioning activities occur. In addition, smalltooth sawfish are livebearers; therefore
20 sensitive egg and larval life stages are not present in the water column, which makes them less
21 susceptible to impacts from exploration and production activities.

22
23 Noise from underwater construction and seismic surveys could produce impacts ranging
24 from lethal to sublethal and behavioral (Popper and Hastings 2009). Since the seismic sources
25 (air guns) are fired in the upper water column, smalltooth sawfish are unlikely to be affected.
26 Juvenile smalltooth sawfish occupy shallow estuaries and nearshore areas away from noise-
27 generating oil and gas exploration and development activities. Adult smalltooth sawfish are
28 found in waters up to 122 m (400 ft) or deeper and could be affected by exploration and
29 production noises. However, the most likely effects would be short-term behavioral disruption
30 or avoidance of certain areas.

31
32 The placement of bottom-founded structures during the exploratory drilling phase may
33 affect adult smalltooth sawfish and their designated critical habitat (50 CFR 226.214) directly
34 and indirectly. As with all fish, the drilling platform and pipeline placement could injure or
35 displace smalltooth sawfish and reduce or eliminate their benthic food resources. Small
36 juveniles typically occupy shallow estuarine waters and would not be located in the vicinity of
37 most bottom disturbance. However, most new platform and drilling activity would occur at the
38 depth range occupied by large juveniles and adults. Given their size, most adults would likely be
39 able to swim away from bottom-disturbing activities, thereby avoiding injuries. However,
40 foraging habitat would be temporarily eliminated and food resources in the disturbed area may
41 be reduced.

42
43 Drilling muds and cuttings can be released at or near the sea surface or the seafloor.
44 Muds and cuttings are diluted and dispersed rapidly in the ocean; therefore, cuttings released at
45 the surface are unlikely to have measurable impacts on smalltooth sawfish. However, food
46 resources for smalltooth sawfish may be buried by muds and cuttings released near the seafloor

1 or settling in thick accumulations in shallow water. Small juvenile smalltooth sawfish occur in
2 water shallower than that typically used for drill sites and are not likely to be affected.
3

4 Production. Vulnerable early life stages of smalltooth sawfish exist only in shallow
5 estuarine areas far removed from produced water discharges, making exposure unlikely. Adults
6 and larger juveniles do occupy coastal waters where produced water discharge would occur.
7 Produced water discharges dilute rapidly in the open ocean, and direct exposure would occur
8 only in the water column near the discharge point where adult sawfish are not likely to be
9 located. The discharge of produced water is not thought to contribute to significantly increasing
10 the size or severity of the hypoxic zone in the GOM (Rabalais 2005). Consequently, it is
11 believed that discharges resulting from the proposed action will not affect dissolved oxygen
12 levels in areas used by smalltooth sawfish.
13

14 Decommissioning. Under the proposed action, it is assumed that explosives would be
15 used to remove up to 700 platforms in the entire GOM. Explosive blasts can be lethal to fishes
16 that may be present near the structure (Gitschlag 2000). However, smalltooth sawfish are known
17 not to have an affinity for offshore structures; thus, they are not likely to be affected.
18

19 **Accidents.** Smalltooth sawfish are considered rare from Texas to the Florida panhandle
20 and are not likely to be present in the Central and Western Planning Areas where accidental oil
21 spills would occur. Adult and juvenile fishes would likely avoid oil from a spill, although they
22 could be exposed to sublethal concentrations through aqueous or dietary routes. Smalltooth
23 sawfish are livebearers and the exposure of eggs to hydrocarbons would occur only by adult
24 exposure. Contact with early small juvenile smalltooth sawfish is unlikely unless oil penetrates
25 shallow estuarine areas. However, actively reproducing populations are thought to exist only in
26 south Florida, and therefore small juveniles are not likely to be exposed to oil spills
27 (NMFS 2009).
28
29

30 **4.4.7.3.2 Alaska – Cook Inlet.**

31
32 **Routine Operations.** Potential OCS oil and gas development impacting factors for fish
33 in the Cook Inlet Planning Area are shown by phase in Table 4.4.7-4. Impacting factors
34 common to all phases include vessel traffic, platform lighting, vessel discharges (bilge and
35 ballast water), and miscellaneous discharges (deck washing, sanitary waste). Impacts from waste
36 discharges would be localized and temporary and are expected to have negligible impacts on fish
37 populations. Many of these waste streams are disposed of on land, and those that are discharged
38 must meet USEPA and/or USCG regulatory requirements that minimize environmental impacts.
39 Studies of platform lighting suggest the lights could alter predator-prey dynamics by enhancing
40 phytoplankton productivity around the platform, potentially improving food availability and the
41 visual foraging environment for fishes (Keenan et al. 2007). Potential impacts from platform
42 lighting would be localized but long term and expected to have minimal impacts on fish
43 populations.
44

45 **Exploration and Site Development.** During the OCS oil and gas exploration and
46 development phase, fish could be affected by noise from seismic surveys and noise and bottom

1
2

TABLE 4.4.7-4 Impacting Factors on Fish and Their Habitat in the Cook Inlet Planning Area

Development Phase and Impacting Factor	Life Stage Affected ^a		
	Eggs	Larvae	Adults
<i>Impacting Factors Common to All Phases</i>			
Vessel noise	X	X	X
Vessel traffic	X	X	X
Hazardous materials	X	X	X
Solid wastes	X	X	X
Offshore lighting	X	X	X
Aircraft noise			
Offshore air emissions			
Onshore air emissions			
Aircraft traffic			
Miscellaneous platform discharges	X	X	X
Vessel discharges	X	X	X
Bottom disturbance from vessel anchors	X	X	X
<i>Exploration and Development</i>			
Seismic noise	X	X	X
Noise from drilling and construction	X	X	X
Bottom disturbance from platform placement, drilling, and pipeline placement and trenching	X	X	X
Discharge of drilling muds and cuttings	X	X	X
<i>Production</i>			
Production noise	X	X	X
Produced water discharge	X	X	X
Artificial reef	X	X	X
<i>Decommissioning</i>			
Platform removal (non-explosive)	X	X	X

^a Colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

3
4
5
6
7

disturbance from drilling, platform placement, and pipeline trenching and placement activities (Table 4.4.7-4).

Noise disturbance from drilling, construction, and seismic surveys could potentially kill, injure, or displace fish depending on the magnitude of the noise, fish size, and distance from the noise source. Seismic survey data are usually collected by discharging compressed air from arrays of air guns towed behind ships. All fish species in Cook Inlet are presumed to be able to hear, with varying degrees of sensitivity, within the frequency range of sound produced by exploration and site development activities. The effects of air gun discharges on fishes depend on the fish life history stage and biology, distance to and type of the sound source, and the

1 magnitude of the explosion. Noise generated by seismic surveys could kill or injure organisms
2 typically within 1 to 5 m (3 to 16 ft) of the air gun or cause some species to temporarily avoid the
3 area (Turnpenny and Nedwell 1994; Popper and Hastings 2009). Noise might also produce
4 generalized stress (Smith et al. 2004) and interfere with communication (Vasconcelos et al.
5 2007). Several studies have found that species with gas bladders (e.g., salmonids, coregonids,
6 and gadids) are more vulnerable to injury or mortality from explosions than species without gas
7 bladders such as flatfish (MMS 2004a). The juvenile and adult fish in Cook Inlet likely to be
8 affected by the noise generated from seismic surveys include salmon, cod, whitefishes, and
9 herring. Continuous, long-term exposure to high-pressure sound waves has also been shown to
10 cause damage to the hair cells of the ears of some fishes under some circumstances (Popper and
11 Hastings 2009). For adult fishes, continuous exposures would not exist under natural
12 circumstances, as fish could move from the area. However, fish larvae may suffer greater
13 mortality because of their small size and relative lack of mobility. In a confined area such as
14 Cook Inlet, noise from seismic surveys can also alter fish behavior. For example, disruption of
15 normal behaviors during critical spawning and feeding periods in spring and summer has the
16 potential to adversely affect survival and reproduction. The severity and duration of noise
17 impacts would vary with site and development scenario, but overall the impacts would be
18 temporary. Recent reviews of seismic survey noise on marine fish concluded that although data
19 were limited, significant impacts on marine fish populations from seismic surveys were not
20 likely (BOEMRE 2010c; National Science Foundation and USGS 2010).

21
22 Bottom-disturbing activities such as coring and drilling, platform placement and mooring,
23 and pipeline trenching and placement would displace fish in the vicinity of the activities and
24 result in temporary sedimentation and turbidity, which could damage fish gills and bury benthic
25 invertebrate prey resources within some distance of the disturbance. Fish mortality may be
26 greater if bottom disturbance occurred in areas of high larval and juvenile fish density such as
27 estuaries and nearshore areas. The migrations of anadromous species common in Cook Inlet
28 such as Pacific salmon and eulachon could also be disrupted. Soft sediments in Cook Inlet are
29 subject to frequent bottom disturbance from high discharge and storms and Cook Inlet waters are
30 naturally high in suspended sediments. Thus, fish communities in Cook Inlet are presumably
31 well adapted to such conditions.

32
33 It is assumed that drilling muds and cuttings would be discharged into Cook Inlet for
34 exploration wells only, while drilling wastes from development and production wells would be
35 reinjected into the wells. The discharge of drilling muds and cuttings (including synthetic
36 drilling fluids adhering to the cuttings) can adversely affect fish in several ways. Impacts from
37 turbidity associated with drilling waste discharge would be similar to those described above and
38 could damage respiratory structures, cause fish to temporarily move from the area, and disrupt
39 food acquisition. Drilling wastes released near the sediment surface or in shallow water would
40 bury benthic food resources in the release area, although conditions would eventually recover.
41 Trace metal and hydrocarbon constituents in drilling fluids can be toxic to fish at all life stages if
42 they are exposed to high enough concentrations. Impacts would be greatest for planktonic eggs
43 and larvae that contact the mixing zone, while juveniles and adults passing through a discharge
44 are not likely to be adversely affected. Based on the assumption of a relatively widespread
45 distribution of eggs, larvae, and prey in Cook Inlet, drilling waste discharge is not likely to alter
46 the population dynamics of fisheries resources in Cook Inlet or the Gulf of Alaska. In addition,

1 drilling discharges must comply with NPDES permit requirements regarding the discharge
2 amount, rate, and toxicity, which would greatly reduce the impact on fish communities.
3

4 While an exact route cannot be determined at this time, any onshore pipeline route would
5 be required to comply with various Alaska Coastal Management Program policies. As a
6 consequence, construction activities in sensitive aquatic habitat would be minimized.
7 Specifically, the route for onshore pipeline facilities would be sited inland from shorelines and
8 beaches, and crossings of anadromous fish streams would be minimized and consolidated with
9 other utility and road crossings of such streams. In addition, onshore pipelines would be
10 designed, constructed, and maintained to minimize risk to fish habitats from a spill, pipeline
11 break, or construction activities.
12

13 Overall, site development and exploration activities represent a minor and temporary
14 disturbance primarily affecting demersal fishes, with the severity of the impacts generally
15 decreasing dramatically with distance from the disturbance.
16

17 **Production.** Production activities that could affect fish communities in Cook Inlet
18 include operational noise, bottom disturbance from anchors and the release of process water. In
19 addition, the platform would replace existing featureless soft sediments and serve as an artificial
20 reef (Table 4.4.7-4).
21

22 Chronic disturbance to demersal fish communities could result from the movement of
23 pipelines and anchors and chains associated with support vessels. Bottom disturbance would
24 affect fish in a manner similar to that described above for the exploration and site development
25 phase. The disturbance would be episodic and temporary, but would last for the lifetime of the
26 platform.
27

28 Produced water contains metals, hydrocarbons, salts, and radionuclides, and their
29 discharge could contaminate habitat, resulting in lethal and sublethal effects on fish, particularly
30 early life stages. However, NPDES permitting requirements regarding discharge rate,
31 contaminant concentration, and toxicity would greatly reduce the potential for impacts on fish. It
32 is assumed that all produced water would be disposed of by injection into permitted disposal
33 wells. Therefore, the effects of produced water discharges on fish are expected to be minimal.
34

35 Platforms would add a hard substrate to the marine environment, providing additional
36 habitat for marine plants and animals (e.g., kelp and mussels) that require a hard substrate. Fish
37 species in Cook Inlet that prefer hard substrate, such as rockfish, may be attracted to platforms.
38 The platform would likely increase shell material and organic matter in the sediments
39 surrounding the platform, potentially resulting in a shift in benthic invertebrate food sources.
40

41 A two-year (1997–1998) study of contaminant levels in the sediments of the Shelikof
42 Strait and Cook Inlet provide information on potential effects of oil and gas development in the
43 Cook Inlet Planning Area (MMS 2001a). Samples of sediment from depositional areas (where
44 sediment contamination is expected to be greatest) suggested that metals and PAHs in sediments
45 derived primarily from natural sources rather than past oil and gas developments (MMS 2001a).
46 In addition, sediment concentrations of metals and organic contaminants in outermost Cook Inlet

1 and Shelikof Strait (1) have not increased significantly since offshore oil exploration and
2 production began in Cook Inlet (circa 1963) and (2) posed only minor risks to benthic biota or
3 fish (MMS 2001a). Consequently, it is expected that production activities would have negligible
4 effects on fish communities in Cook Inlet.

5
6 **Decommissioning.** No explosive platform removals are anticipated under the proposed
7 action. Nonexplosive removals (e.g., abrasive, mechanical, or diver cutters) would have
8 negligible long-term impacts to fish populations, although individuals associated with the
9 platform would experience a loss of habitat. Pipelines installed and anchored on the seafloor
10 would be capped and left in place, although there is the potential for chronic sediment
11 disturbance from pipeline movement. If fixed platforms are left in place, the changes to fish
12 communities resulting from the initial platform installation would be permanent. Overall,
13 impacts on fish populations associated with decommissioning activities are expected to be
14 negligible.

15
16 **Accidents.** Accidental hydrocarbon releases in Alaska may have greater ecological
17 consequences than in temperate areas because oil is likely to persist in the environment due to
18 the colder temperatures. Hydrocarbons can have a range of effects on fish depending on the
19 concentration, the length of exposure, and the life history stage of the fish involved
20 (Starr et al. 1981; C.I. Hamilton et al. 1979; Malins 1977; Neff and Stubblefield 1995).
21 Prolonged exposure to elevated levels of petroleum hydrocarbons can result in lethal or sublethal
22 (reproduction, recruitment, physiology, growth, development, and behavior) impacts at the level
23 of the individual, while catastrophic oil spills could result in population-level effects in some
24 cases (Peterson et al. 2003). Fishes most likely to be affected by an oil spill would be those that
25 migrate extensively (e.g., arctic cisco and salmon), those with high fidelity to natal streams
26 (e.g., Dolly Varden), and those confined to nearshore environments (e.g., broad whitefish and
27 rainbow smelt). Gas and particularly oil releases in Cook Inlet could affect fish populations by
28 causing mortality of eggs, larvae, juveniles, or adults; triggering abnormal development;
29 impeding the access of migratory fishes (e.g., salmon and herring) to spawning habitat; altering
30 behaviors; displacing individuals from preferred habitat; reducing or eliminating prey
31 populations available for consumption; impairing feeding, growth, or reproduction; causing
32 adverse physiological responses; increasing susceptibility to predation, parasitism, diseases or
33 other environmental perturbations; and increasing or introducing genetic abnormalities. It is
34 anticipated that pelagic eggs and larval stages of fish, whose movements are largely controlled
35 by water currents, would be killed if they came into contact with surface oil spills (Patin 1999).
36 Conversely, evidence indicates that the majority of adult pelagic fish can likely detect and avoid
37 heavily oiled waters in the open sea, thereby avoiding acute effects (Patin 1999). Adult salmon
38 are able to return to natal streams and hatcheries even under very large oil spill conditions
39 (Brannon et al. 1986; Nakatani and Nevissi 1991), as evidenced by the return of pink and
40 sockeye salmon to Prince William Sound and sockeye salmon to Cook Inlet during and after the
41 *Exxon Valdez* oil spill.

42
43 Impacts from spills would be greatest if a large spill occurred during a reproductive
44 period or contacted a location important for spawning or growth such as intertidal and nearshore
45 subtidal habitats. However, it is anticipated that only a small amount of shoreline would be
46 affected by these smaller oil spills and would not, therefore, present a substantial risk to fish

1 populations. Most small hydrocarbon releases would be rapidly diluted and are expected to
2 primarily affect fish in the water column, as most oil and gas would float above the sediment
3 surface. Because pelagic species of fishes in Cook Inlet are relatively abundant and widely
4 distributed in waters across much of the central Gulf of Alaska, even a large oil spill (up to
5 4,600 bbl) is not likely to cause population-level impacts on most fish populations inhabiting the
6 central Gulf of Alaska (i.e., South Alaskan Peninsula, Kodiak Archipelago, Shelikof Strait, Cook
7 Inlet, and Prince William Sound).

8
9 **Catastrophic Discharge Event.** The PEIS analyzes a CDE of 75 to 125 thousand bbl in
10 the Cook Inlet Planning Area. The likelihood of oil from a CDE (Table 4.4.2-2) contacting part
11 of the shoreline is relatively high because the Cook Inlet Planning Area is located within a
12 relatively confined estuary. Spilled oil affecting nearshore and intertidal areas would likely
13 result in the greatest impacts on fisheries resources. Oil may persist for years in intertidal areas
14 and could represent a persistent source of exposure for fish such as herrings that generally spawn
15 near shorelines. Oil spills in intertidal areas also have the potential to contaminate or alter the
16 composition and abundance of benthic food resources. For example, evidence from the *Exxon*
17 *Valdez* oil spill suggests stress-tolerant invertebrates such as polychaetes and snails would not
18 suffer long-term population declines in oiled areas, but clams and mussels could be contaminated
19 and reduced in abundance for several years (*Exxon Valdez* Oil Spill Trustee Council 2010c). A
20 catastrophic oil spill and/or multiple smaller spills could result in a decline in local abundances
21 of fish stocks or subpopulations, with recovery potentially requiring multiple generations. Some
22 stocks are already in decline due to non-OCS anthropogenic and natural impact-producing
23 factors (e.g., commercial fisheries, climatic shifts).

24
25 Some of the potential effects that catastrophic oil spills in Cook Inlet could have on fish
26 resources can be inferred based upon the impacts of the 1989 *Exxon Valdez* oil spill, which
27 released approximately 257,000 bbl of oil into nearby Prince William Sound. The potential
28 effects of the Valdez spill are best known for salmon and Pacific herring. Population-level
29 effects on salmon were primarily through exposure of eggs and larvae to oil in sediments.
30 Because of their long incubation period in intertidal gravel and because salmon embryos have a
31 large lipid-rich yolk that can accumulate hydrocarbons from low-level exposures, salmon
32 embryos are vulnerable to contamination from oil spills that reach intertidal areas
33 (Peterson et al. 2003). For example, pink salmon embryos in oiled intertidal streams of Prince
34 William Sound continued to show higher mortality than those in non-oiled streams until 1993
35 (Bue et al. 1998), and from 1989 to 1990, the growth rates of cutthroat trout and Dolly Varden in
36 oiled streams were lower than those in clean streams (Hepler et al. 1993). However, salmonid
37 populations appeared to recover within 15 years. Pink and sockeye salmon populations were
38 considered to have recovered in 1999 and 2002, respectively (*Exxon Valdez* Oil Spill Trustee
39 Council 2010c). Dolly Varden char were considered recovered in 2002, and cutthroat trout are
40 considered to have very likely recovered (*Exxon Valdez* Oil Spill Trustee Council 2010c).

41
42 Although the *Exxon Valdez* oil spill occurred a few weeks before Pacific herring spawned
43 in Prince William Sound, adult herring appeared to be relatively unaffected by the spill. About
44 half of the herring egg biomass was deposited within the oil trajectory, and toxicity tests
45 suggested egg-larval mortality in the oiled areas was twice as great as in the non-oiled areas and
46 that larval growth rates in oiled areas were depressed compared to those in areas unaffected by

1 the spill (Brown et al. 1996; McGurk and Brown 1996). After a record harvest in 1992
2 (following the *Exxon Valdez* spill), the Pacific herring population in Prince William Sound
3 collapsed and has remained depressed, with reduced or no commercial harvest allowed. The
4 Pacific herring stock of Prince William Sound is still classified as “not recovered” from the
5 *Exxon Valdez* oil spill (*Exxon Valdez* Oil Spill Trustee Council 2010c). However, because of
6 natural variability in population and confounding environmental factors, there has not been full
7 consensus among researchers that the currently low herring numbers are fully attributable to the
8 effects of spilled oil. Pathogens, rather than lingering effects of the Valdez spill, may be
9 primarily responsible for the lack of recovery (*Exxon Valdez* Oil Spill Trustee Council 2010c).

10
11 Although the effects of the spill on rockfish, a common demersal fish in Cook Inlet, were
12 never well understood, their populations and habitat are considered recovered from the *Exxon*
13 *Valdez* spill (*Exxon Valdez* Oil Spill Trustee Council 2010c). In general, adult demersal fishes
14 are believed to avoid oil slicks, although individuals in coastal shallow waters with slow water
15 exchange could be exposed to sublethal hydrocarbon concentrations (Patin 1999). A large or
16 catastrophic spill could adversely affect hundreds of millions of eggs and juvenile stages,
17 especially spills that reach nearshore areas, which are important to many species of demersal
18 fishes as juveniles (Moles and Norcross 1998). Adult demersal and benthic-pelagic fish,
19 including pollock, sablefish, Pacific cod, eulachon, and Pacific sand lance, would probably not
20 be harmed by spilled oil at the surface. However, many demersal fishes such as walleye pollock,
21 halibut, and cod all have buoyant eggs and larvae that float near the surface where they could be
22 exposed to spilled oil (NPFMC 2010).

23 24 25 **4.4.7.3.3 Alaska – Arctic.**

26
27 **Routine Operations.** Potential OCS oil and gas development impacting factors for fish
28 are shown by phase in Table 4.4.7-5. Impacting factors common to all phases include vessel
29 traffic, platform lighting, vessel discharges (bilge and ballast water), and miscellaneous
30 discharges (deck washing, sanitary waste). Impacts from waste discharges would be localized
31 and temporary and would be expected to have negligible impacts on fish populations. Many of
32 these waste streams are disposed of on land, and any discharges into surface waters must meet
33 USEPA and/or USCG regulatory requirements before discharge. Studies of platform lighting
34 suggest that the lights could alter predator-prey dynamics by enhancing phytoplankton
35 productivity around the platform, potentially improving food availability and the visual foraging
36 environment for fishes (Keenan et al. 2007). Potential impacts from platform lighting would be
37 localized but long term and are expected to have minimal impacts on fish populations.

38
39 **Exploration and Site Development.** During the OCS oil and gas exploration and
40 development phase, fish could be affected by noise from seismic surveys and noise and bottom
41 disturbance from drilling, subsea well, gravel island, and platform placement, and pipeline
42 trenching and placement activities (Table 4.4.7-5). The effects of these activities on fish
43 communities are described in detail in Section 4.4.7.3.2.

44
45 Fish in the Beaufort Sea and Chukchi Sea Planning Areas most likely to be affected by
46 the noise generated from drilling, vessel traffic, and seismic surveys include salmon, cod,

1
2

TABLE 4.4.7-5 Impacting Factors on Fish and Their Habitat in the Beaufort Sea and Chukchi Sea Planning Areas

Development Phase and Impacting Factor	Life Stage Affected ^a		
	Eggs	Larvae	Adults
<i>Impacting Factors Common to All Phases</i>			
Vessel noise	X	X	X
Vessel traffic	X	X	X
Hazardous materials	X	X	X
Solid wastes	X	X	X
Offshore lighting	X	X	X
Aircraft noise			
Offshore air emissions			
Onshore air emissions			
Aircraft traffic			
Miscellaneous platform discharges	X	X	X
Vessel discharges	X	X	X
Bottom disturbance from vessel anchors	X	X	X
<i>Exploration and Development</i>			
Seismic noise	X	X	X
Noise from drilling and construction	X	X	X
Bottom disturbance from drilling and placement of subsea wells, platforms, and pipelines	X	X	X
Discharge of drilling muds and cuttings	X	X	X
<i>Production</i>			
Production noise	X	X	X
Produced water discharge	X	X	X
Artificial reef	X	X	X
<i>Decommissioning</i>			
Platform removal (non-explosive)	X	X	X

^a Colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

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whitefishes, and herring. The effect on the overall fish population would be negligible since fishes are distributed over wide geographic areas and air gun operations are localized (Section 4.4.7.3.2). While it is anticipated that there would be no permanent population-level effects on managed species from seismic surveys, individual fish, especially egg and larval life stages in close proximity (1 to 5 m [3 to 16 ft]) to air gun arrays (Dalen and Knutsen 1986; Holliday et al. 1987; Turnpenney and Nedwell 1994), could suffer mortality or injury, and adult fishes more distant from the noise could exhibit short-term avoidance and behavioral alteration. A recent review of seismic survey noise on marine fish concluded that although data were limited, there would be no significant impacts on marine fish populations from seismic surveys (BOEMRE 2010c; National Science Foundation and USGS 2010).

1 Development and construction activities that could affect fish in the Beaufort and
2 Chukchi Sea Planning Areas include drilling, installation of pipelines and construction of subsea
3 wells, platforms, artificial islands, and ice roads. Bottom disturbance would result in temporary
4 sedimentation and turbidity, which could damage fish gills and bury benthic invertebrate prey
5 resources within some distance of the disturbance. Individual fish would likely temporarily
6 move away from affected areas (Section 4.4.7.3.2). The total area affected by seafloor
7 disturbance under the proposed action would be relatively small compared to the availability of
8 similar seafloor habitat in surrounding areas.

9
10 Onshore, up to 129 km (80 mi) of oil pipeline could be constructed. While an exact route
11 cannot be determined at this time, the pipeline route would be required to comply with various
12 Alaska Coastal Management Program policies. As a consequence, construction activities in
13 sensitive aquatic habitats would be minimized. Specifically, the route for onshore pipeline
14 facilities would be sited inland from shorelines and beaches, and crossings of anadromous fish
15 streams would be minimized and consolidated with other utility and road crossings of such
16 streams. In addition, onshore pipelines would be designed, constructed, and maintained to
17 minimize risk to fish habitats from a spill, pipeline break, or construction activities.

18
19 It is assumed that drilling muds and cuttings would be discharged into the Beaufort and
20 Chukchi Sea Planning Areas for exploration wells only and that drilling wastes from
21 development and production wells would be reinjected into the wells. The discharge of drilling
22 muds and cuttings (including synthetic drilling fluids adhering to the cuttings) can adversely
23 affect fish in several ways. Impacts from turbidity associated with drilling waste discharge
24 would be similar to those described above and could damage respiratory structures, cause fish to
25 temporarily move from the area, and disrupt food acquisition. Drilling wastes released near the
26 sediment surface or in shallow water would bury benthic food resources in the release area,
27 although conditions would eventually recover. Trace metal and hydrocarbon constituents in
28 drilling fluids can be toxic to fish at all life stages if they are exposed to high enough
29 concentrations. Impacts would be greatest for planktonic eggs and larvae that contact the mixing
30 zone, while juveniles and adults passing through a discharge are not likely to be adversely
31 affected. Assuming a relatively widespread distribution of eggs, larvae, and prey in the Beaufort
32 and Chukchi Seas, drilling waste discharge is not likely to alter the population dynamics of
33 fisheries resources. In addition, drilling discharges must comply with NPDES permit
34 requirements regarding the discharge amount, rate, and toxicity, which would greatly reduce the
35 impact on fish communities.

36
37 Overall, site development and exploration activities represent a minor and temporary
38 disturbance primarily affecting demersal fishes, with the severity of the impacts generally
39 decreasing dramatically with distance from the disturbance.

40
41 **Production.** Production activities that could affect fish communities in the Beaufort and
42 Chukchi Seas include operational noise, bottom disturbance from anchors and the release of
43 process water. In addition, the platform would replace existing featureless soft sediments and
44 serve as an artificial reef (Table 4.4.7-5). Chronic disturbance to demersal fish communities
45 would result from the movement of anchors and chains associated with support vessels.
46 Pipelines not buried would be anchored in place which would minimize their movement and

1 potential to disturb fish habitat. Bottom disturbance would affect similar to that described above
2 for the exploration and site development phase. The disturbance would be episodic and
3 temporary, but would last for the lifetime of the platform.
4

5 Artificial islands would increase the diversity of habitat available on an otherwise
6 homogeneous ocean. Specifically, such construction would introduce an artificial hard substrate
7 that opportunistic benthic species, especially those that prefer gravel substrate, could colonize.
8 Fishes may be attracted to the newly formed habitat complex, and fish population numbers in the
9 immediate vicinity of the platforms are likely to be higher than in surrounding waters away from
10 the structures. The overall change in habitat could result in changes in local community
11 assemblage and diversity (Howarth 1991). The number of platforms projected for the Beaufort
12 and Chucki Sea Planning Areas under the proposed action (up to nine) would create a small
13 amount of hard substrate habitat and would likely have little effect on overall fish populations.
14

15 Produced water contains metals, hydrocarbons, salts, and radionuclides, and their
16 discharge could contaminate habitat, resulting in lethal and sublethal effects on fish, particularly
17 early life stages. It is assumed that all produced water would be disposed of by injection into
18 permitted disposal wells. Therefore, the effects of miscellaneous and produced water discharges
19 on fish communities are expected to be minimal.
20

21 The results of the Arctic Nearshore Impacts Monitoring in the Development Area study
22 funded by BOEM provide a good summary of the long-term changes to benthic communities
23 resulting from oil and gas development in the Arctic. Hydrocarbons are primarily derived from
24 river inputs rather than oil and gas development (Brown 2005; Neff and Associates LLC 2010).
25 Tissue hydrocarbon and metals concentrations in fish and their invertebrate food sources
26 sampled near the Northstar development and Liberty prospect area were similar to or lower than
27 invertebrate tissue levels found elsewhere in the world. No increase in hydrocarbons and metals
28 in fish or invertebrate tissues was attributable to oil and gas production (Neff and Associates
29 LLC 2010).
30

31 Overall, production activities would result in negligible and temporary effects on fish
32 communities in the Beaufort and Chukchi Sea Planning Areas.
33

34 **Decommissioning.** No explosive platform removals are anticipated under the proposed
35 action. Nonexplosive removals (e.g., abrasive, mechanical, or diver cutters) would have
36 negligible long-term impacts to fish populations, although fish associated with the platform
37 would experience a loss of habitat. Pipelines installed and anchored on the seafloor would be
38 capped and left in place, although there is the potential for chronic sediment disturbance from
39 pipeline movement. Overall, impacts on fish populations associated with decommissioning
40 activities are expected to be negligible.
41

42 **Accidents.** Most accidental hydrocarbon releases would be small and rapidly diluted and
43 are expected to primarily affect fish in the water column, as most oil and gas would float above
44 the sediment surface. Impacts from spills would be greatest if a large spill occurred during a
45 reproductive period or contacted a location important for spawning or growth such as intertidal
46 and nearshore subtidal habitats. However, it is anticipated that in most cases only a small

1 amount of shoreline would be affected by these smaller oil spills and would not, therefore,
2 present a substantial risk to fish populations. Most small hydrocarbon releases would be rapidly
3 diluted and are expected to primarily affect fish in the water column, as most oil and gas would
4 float above the sediment surface. Because pelagic species of fishes in the Beaufort and Chukchi
5 Sea Planning Areas are widely distributed, even a large oil spill (up to 4,600 bbl) is not likely to
6 cause population-level impacts on most fish populations.

7
8 **Catastrophic Discharge Event.** The PEIS analyzes a CDE of 1.4 to 2.2 million bbl in
9 the Chukchi Sea and 1.7 to 3.9 million bbl in the Beaufort Sea (Table 4.4.2-2). A CDE
10 (Table 4.4.2-2) has the potential to affect multiple species in the Arctic Planning Areas. Such
11 spills can have a range of effects on fish depending on the concentration, the length of exposure,
12 and the life history stage of the fish involved (Starr et al. 1981; Hamilton et al. 1979;
13 Malins 1977; Neff and Stubblefield 1995). During the spill, adult and juvenile fish may be
14 temporarily displaced, which could interfere with movements to feeding, overwintering, or
15 spawning areas. Fish eggs, larvae, and juveniles are the most sensitive life history stages
16 (Section 4.4.7.3.2). Spilled petroleum hydrocarbons may persist for years (Howarth 1991;
17 Wiedmer et al. 1996), especially in sediments of cold waters, making it likely that some fish
18 species would be exposed to low levels of hydrocarbons for an extended time after an oil spill.
19 Similarly, petroleum hydrocarbons could remain available for uptake and bioaccumulation by
20 benthic food sources for years following a spill (Howarth 1991).

21
22 Among the most abundant marine fish in the Beaufort and Chukchi Sea Planning Areas
23 are arctic cod, sculpin, eelpout, pricklebacks, and flatfish. Of these, the arctic cod may be the
24 most susceptible to lethal hydrocarbon effects because the larvae are pelagic and most likely to
25 come into contact with oil and gas, which tend to float on the surface. Arctic cod are also
26 susceptible because they are dependent on algal production in open water and under sea ice,
27 which could be affected by oil and gas exposure. Among the most abundant anadromous species
28 are the arctic and least cisco, broad whitefish, Dolly Varden, and rainbow smelt. Fishes most
29 likely to be affected by an oil spill would be those that migrate extensively (e.g., Arctic cisco),
30 those with high fidelity to natal streams (e.g., Dolly Varden), and those confined to nearshore
31 environments (e.g., broad whitefish and rainbow smelt). Some pelagic species (e.g., Pacific
32 herring; capelin) spawn in intertidal zones where their eggs may be susceptible to oil
33 (Rice et al. 1984). Herring generally spawn near shorelines over 3–4 week periods, and oil
34 driven onshore could contact spawning adults and developing eggs (MMS 1996a). Larval
35 herring are also susceptible after moving into deeper water because they rise diurnally to feed on
36 plankton and could be exposed to surface oil repeatedly if a spill occurs. Demersal fishes such as
37 walleye pollock, halibut, and cod all have buoyant eggs and larvae that float near the surface
38 where they could be exposed to spilled oil (MMS 1996a).

39
40 A CDE spill could have population-level consequences if vital habitat areas were affected
41 or if it occurred in spawning areas or juvenile feeding grounds when fish populations are highly
42 concentrated (e.g., the Arctic cisco population concentrated near the Colville River). In such
43 cases, catastrophic spills could cause substantial reductions in population levels for one or more
44 years. However, no permanent impacts on fish populations are expected. See Section 4.4.7.3.2
45 for a detailed discussion of oil spills on fish following the catastrophic *Exxon Valdez* spill.

1 **4.4.7.3.4 Conclusion.** The primary potential impacts on fish communities from Program
2 activities could result from seismic surveys and bottom-disturbing activities such as drilling,
3 platform placement and mooring, and pipeline trenching and placement, which could displace,
4 injure, or kill fish in the vicinity of the activity. Fixed platforms, particularly the large number
5 projected for the GOM, would also serve as artificial reefs that would attract substantial numbers
6 of fish. Oil and gas activities would be temporary, and no permanent or population-level impacts
7 on fish are expected. Displaced fish and invertebrate food sources would repopulate the area
8 over a short period of time in the GOM, but fish habitat recovery may be long term in Alaskan
9 waters. The effects of drilling muds and produced water discharge on fish would be localized,
10 and no population-level effects are expected. Drilling waste and produced water discharge
11 would be far less in Alaska because fewer wells would be drilled in Alaska and because it is
12 assumed that drilling muds and cuttings from production wells and all produced water would be
13 reinjected into the wells. Overall, impacts to fish from routine Program activities are expected to
14 range from negligible to minor, and no impacts on threatened or endangered fish species are
15 expected.

16
17 Small spills would be localized and are unlikely to affect a substantial number of fish
18 before dilution and weathering would reduce concentrations of toxic fractions to nontoxic levels.
19 Large and especially CDE-level spills would affect a wider area, with the magnitude of the
20 impacts depending on the location, timing, and volume of spills, distribution and ecology of
21 affected fish species, and other environmental factors. Most adult fish are highly mobile and
22 would likely avoid lethal hydrocarbon exposures, although they may be subjected to sublethal
23 concentrations. Smaller species and egg and larval life stages are more likely to suffer lethal or
24 sublethal exposures from oil contact because of their relative lack of mobility. Under most
25 circumstances, any single large or CDE spill would affect only a small proportion of a given fish
26 population; therefore, overall population levels may not be affected. However, fish species that
27 currently have depressed populations or have critical spawning grounds present in the affected
28 area could experience population-level impacts. Oil contacting shoreline areas used for
29 spawning or providing habitat for early life stages of fish could result in large-scale lethal and
30 long-term sublethal effects on fish. In Alaskan waters, where oil may be slow to break down,
31 coastal oiling could measurably depress some fish populations for several years especially if the
32 spill were very large (such as a CDE spill). However, no permanent impacts on fish populations
33 are expected.

34 35 36 **4.4.7.4 Reptiles**

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38
39 **4.4.7.4.1 Routine Operations.** The discussion of impacts to reptile species from OCS oil
40 and gas development is primarily focused on sea turtles that may occur throughout the GOM.
41 There is the potential for other reptile species to be affected from a small number of impacting
42 factors related to OCS oil and gas development. Additional reptile species (e.g., American
43 crocodile) will be identified as impacting factors are discussed in this PEIS.

44
45 There are five species of sea turtle that may be encountered in the GOM OCS Planning
46 Areas: green, hawksbill, Kemp's ridley, leatherback, and loggerhead. All of these species have

1 the potential to occur throughout the planning areas as hatchlings, juveniles, and adults. All but
2 the hawksbill have been reported to nest on beaches within the GOM Planning Areas, and the
3 number and distribution of nests differ dramatically among these species across bordering States
4 (Section 3.8.3; Figure 3.8.3-1). Sea turtles may be affected in all phases of OCS oil and gas
5 development. Under the proposed action, one or more of the sea turtle life stages could be
6 affected under routine operations due to (1) airborne and underwater noise, (2) offshore structure
7 placement and pipeline trenching, (3) removal of offshore structures, (4) OCS vessel traffic,
8 (5) construction and operation of onshore infrastructure, and (6) exposure to operational
9 discharges and wastes. In addition, reptiles may be affected by unexpected and accidental spills
10 of oil and other contaminants. Table 4.4.7-6 illustrates how each of the various impact factors
11 associated with OCS oil and gas development may affect sea turtles and their habitats in the
12 GOM. Many of these impacting factors could occur during multiple project phases. Conceptual
13 models illustrated in Figures 4.4.7-6 through 4.4.7-10 show how various activities associated
14 with seismic surveys, onshore and offshore construction, normal O&G operations,
15 decommissioning, and accidental oil releases may impact sea turtles. While OCS O&G projects
16 have the potential to affect sea turtles of all life stages, it has been determined that impacts to
17 later life stages (large juveniles and adults) result in greater population-level impacts
18 (Crouse et al. 1987).

19
20 As discussed in Section 3.3.1, climate change in the GOM is expected to affect coastal
21 systems through processes such as warming temperatures, changes in precipitation, sea level rise,
22 and more frequent intense storms. Rising water temperatures, increased sea levels, and intense
23 storms may affect the availability and suitability of foraging and nesting habitats for coastal and
24 marine reptiles (Hawkes et al. 2009). For reptiles that rely on temperature to determine the
25 gender of offspring in incubating eggs (referred to as temperature-dependent sex determination),
26 including sea turtles and crocodylians, subtle increases in atmospheric temperatures could skew
27 sex ratios of hatchlings, which could have future population implications (Walther et al. 2002).
28 It is also predicted that global warming and increased precipitation rates associated with climate
29 change will cause sea levels to rise (Church et al. 2001). This phenomenon could alter sea turtle
30 coastal habitat in many areas (Hawkes et al. 2009). For example, a study in Hawaii predicted
31 that as much as 40% of green sea turtle nesting habitat could be affected with a 0.9 m (2.7 ft) sea
32 level rise (Baker et al. 2006).

33
34 **Noise.** Hearing sensitivity includes the hearing threshold (the minimum sound level that
35 an animal can perceive in the absence of significant background noise) and the hearing
36 bandwidth (the range of frequencies that an animal can hear). There is very little published data
37 on sea turtle hearing sensitivities, but the little available data suggests that sea turtle species
38 exhibit best hearing at low frequencies 200–700 Hz (BOEMRE 2010c), with an upper hearing
39 limit of 1,600 Hz (Dow et al. 2008). Reported hearing thresholds are also of low frequency,
40 estimated to be between 50 and 1,000 Hz (Tech Environmental, Inc. 2006). Threshold detection
41 levels for these species over this frequency range are relatively high (>100 dB referenced to
42 1 micropascal within 1 meter of the source [dB re 1 μ Pa-m]) (Tech Environmental, Inc. 2006).

43
44 Potential responses to noises generated during normal operations may be expected to be
45 behavioral and may include avoidance of the noise source, disorientation, and disturbance of
46 normal behaviors such as feeding. Evidence suggests that sea turtles may be affected by seismic

TABLE 4.4.7-6 Potential OCS Oil and Gas Development Impacting Factors for Reptiles in the GOM

Resource Receptor Category Potentially Affected	O&G Impacting Factor								
	Noise		Collisions with OCS Vessels	Presence of OCS Vessels	Construction and Decommissioning of Onshore and Offshore Infrastructure	Offshore and Onshore Lighting	Produced Water, Drill Cuttings and Mud, Liquid Wastes, Hazardous Materials	Solid Wastes and Debris	Accidental Oil Spills
	Seismic Exploration	Construction, Operation, and Decommissioning							
Sea turtle nest sites – individual nests and nesting beaches	–	–	–	–	Destruction of nests; degradation or loss of nesting beaches	–	–	–	Physical disturbance and reduced quality from fouling
Sea turtle hatchlings	Injury; disruption of normal behavior	Disruption of normal behavior (feeding, nesting)	Injury of mortality from ship strikes	Disruption of normal behavior (feeding, nesting)	Injury; disruption of normal behavior	Attraction of reproductive adults to low quality nesting habitats	Toxicity	Ingestion and/or entanglement	Fouling, toxicity
Sea turtle juveniles	(feeding, nesting)				Injury; disruption of normal behavior	Attraction of reproductive adults to low quality nesting habitats			Fouling, toxicity
Sea turtle adults					Injury; disruption of normal behavior	Attraction of reproductive adults to low quality nesting habitats			Fouling, toxicity
Sea turtle migration	Displacement or impediment	Displacement or impediment	–	Displacement or impediment	Displacement or impediment	Attraction of reproductive adults to low quality nesting habitats	–	–	Displacement or impediment
Sea turtle juvenile foraging habitats	–	–	–	–	Temporary habitat disturbance during construction; possible long-term increase in habitat	Attraction of reproductive adults to low quality nesting habitats	Reduced habitat quality	–	Physical disturbance; reduced habitat quality
Sea turtle adult foraging habitats	–	–	–	–	Temporary habitat disturbance during construction; possible long-term increase in habitat	Attraction of reproductive adults to low quality nesting habitats	Reduced habitat quality	–	Physical disturbance; reduced habitat quality

TABLE 4.4.7-6 (Cont.)

Resource Receptor Category Potentially Affected	O&G Impacting Factor								
	Noise				Construction and Decommissioning of Onshore and Offshore Infrastructure	Offshore and Onshore Lighting	Produced Water, Drill Cuttings and Mud, Liquid Wastes, Hazardous Materials	Solid Wastes and Debris	Accidental Oil Spills
	Seismic Exploration	Construction, Operation, and Decommissioning	Collisions with OCS Vessels	Presence of OCS Vessels					
Sea turtle wintering grounds	-	-	-	-	Temporary habitat disturbance; possible long-term increase in habitat	Attraction of reproductive adults to low quality nesting habitats	Reduced quality	-	Physical disturbance; reduced quality
American crocodile nest sites, adults, juveniles, hatchlings, and their habitat	-	-	-	-	-	-	-	-	Fouling, toxicity; physical disturbance; reduced habitat quality

^a - = No impact anticipated.

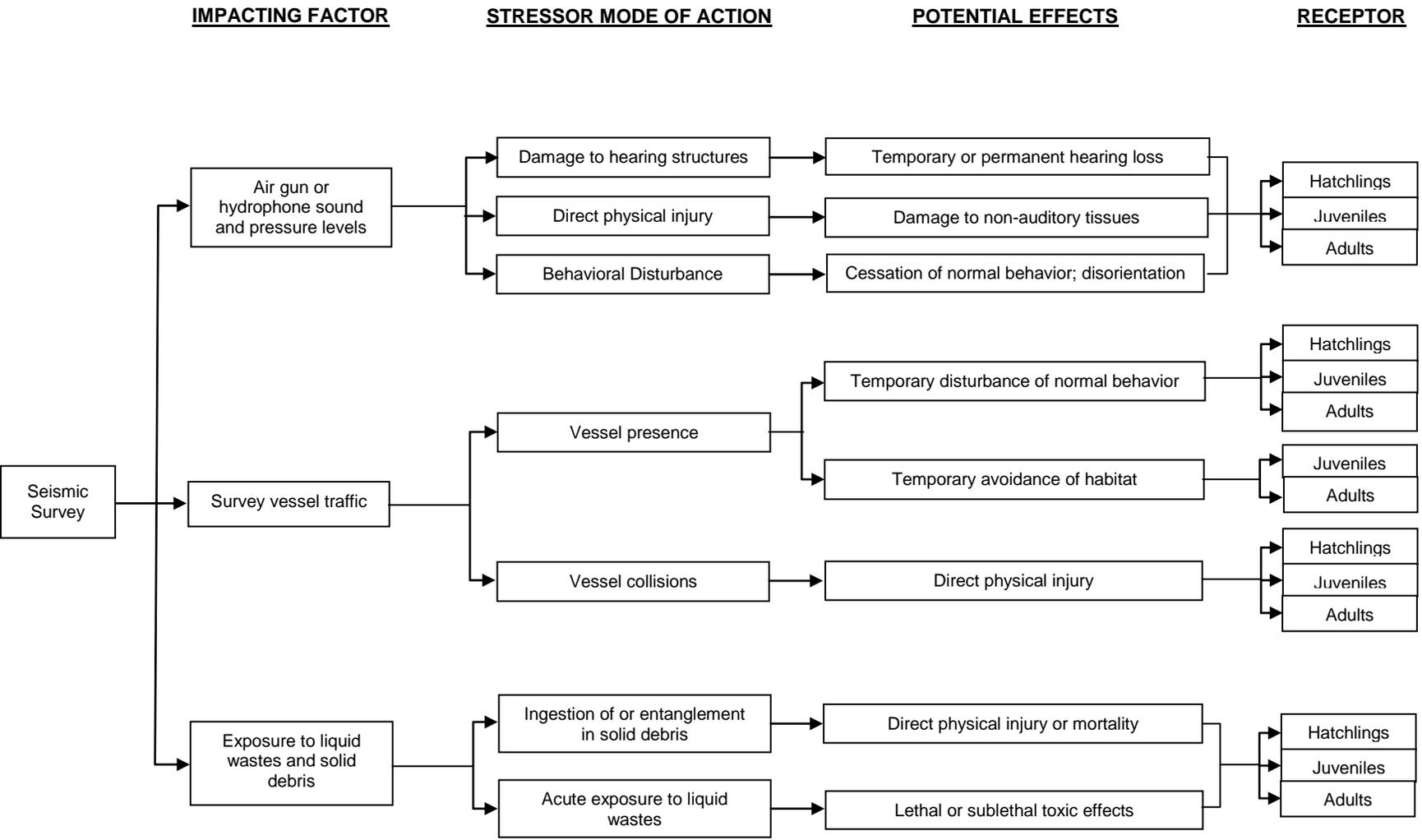


FIGURE 4.4.7-6 Conceptual Model for Potential Effects of Seismic Survey Activities on Turtles in the GOM

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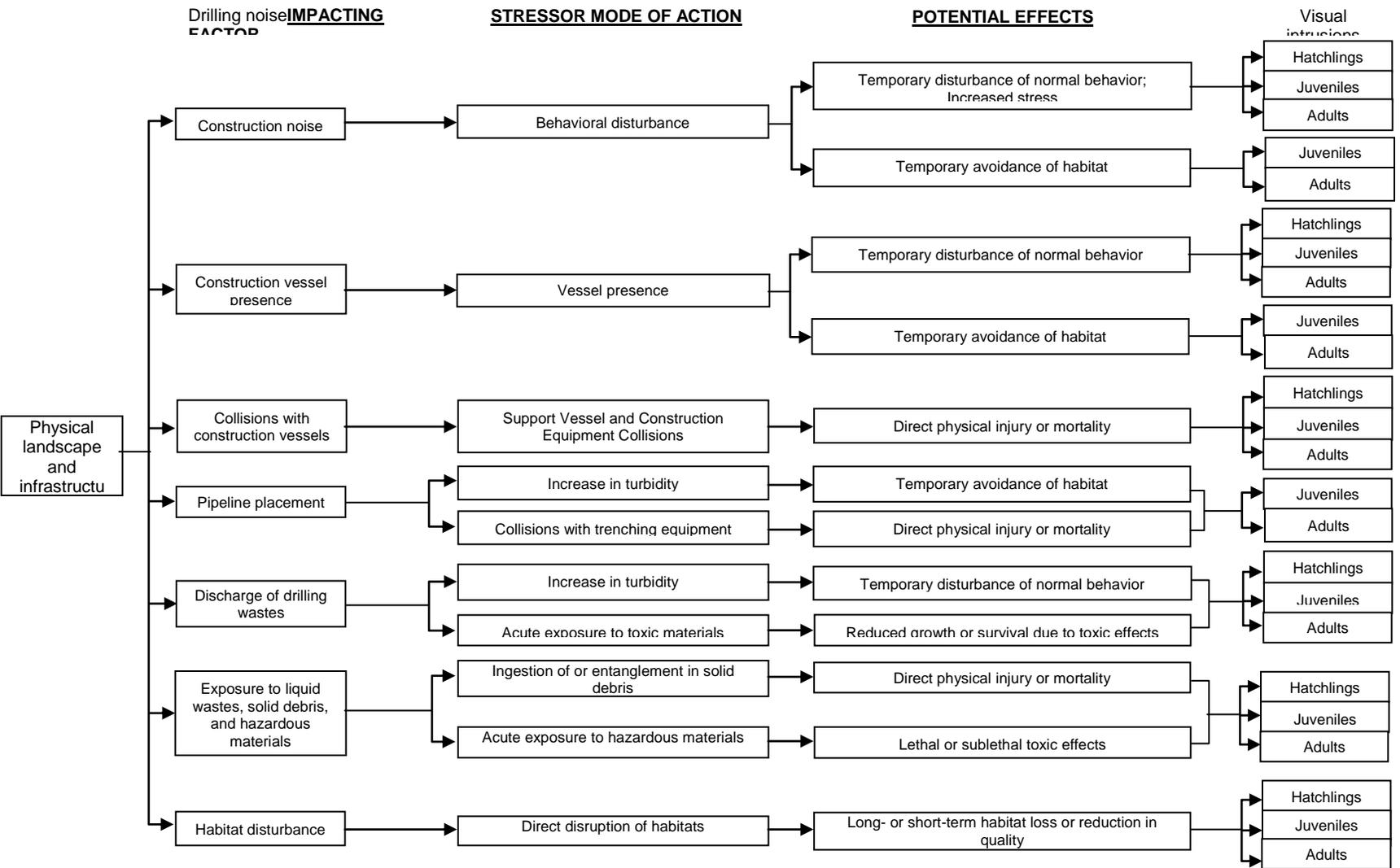
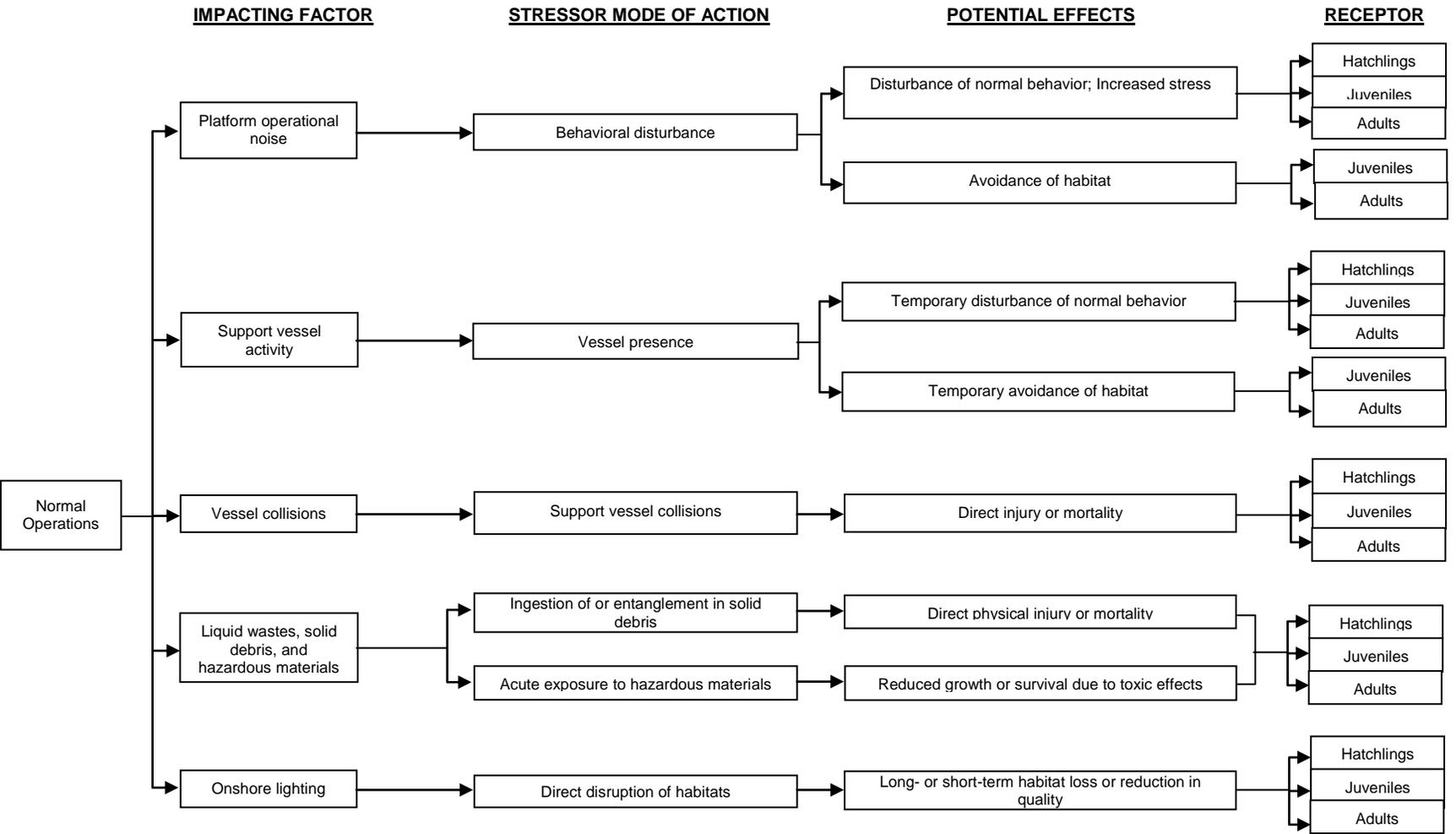


FIGURE 4.4.7-7 Conceptual Model for Potential Effects of OCS-Related Construction Activities on Turtles in the GOM



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2
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FIGURE 4.4.7-8 Conceptual Model for Potential Effects of OCS Operation on Turtles in the GOM

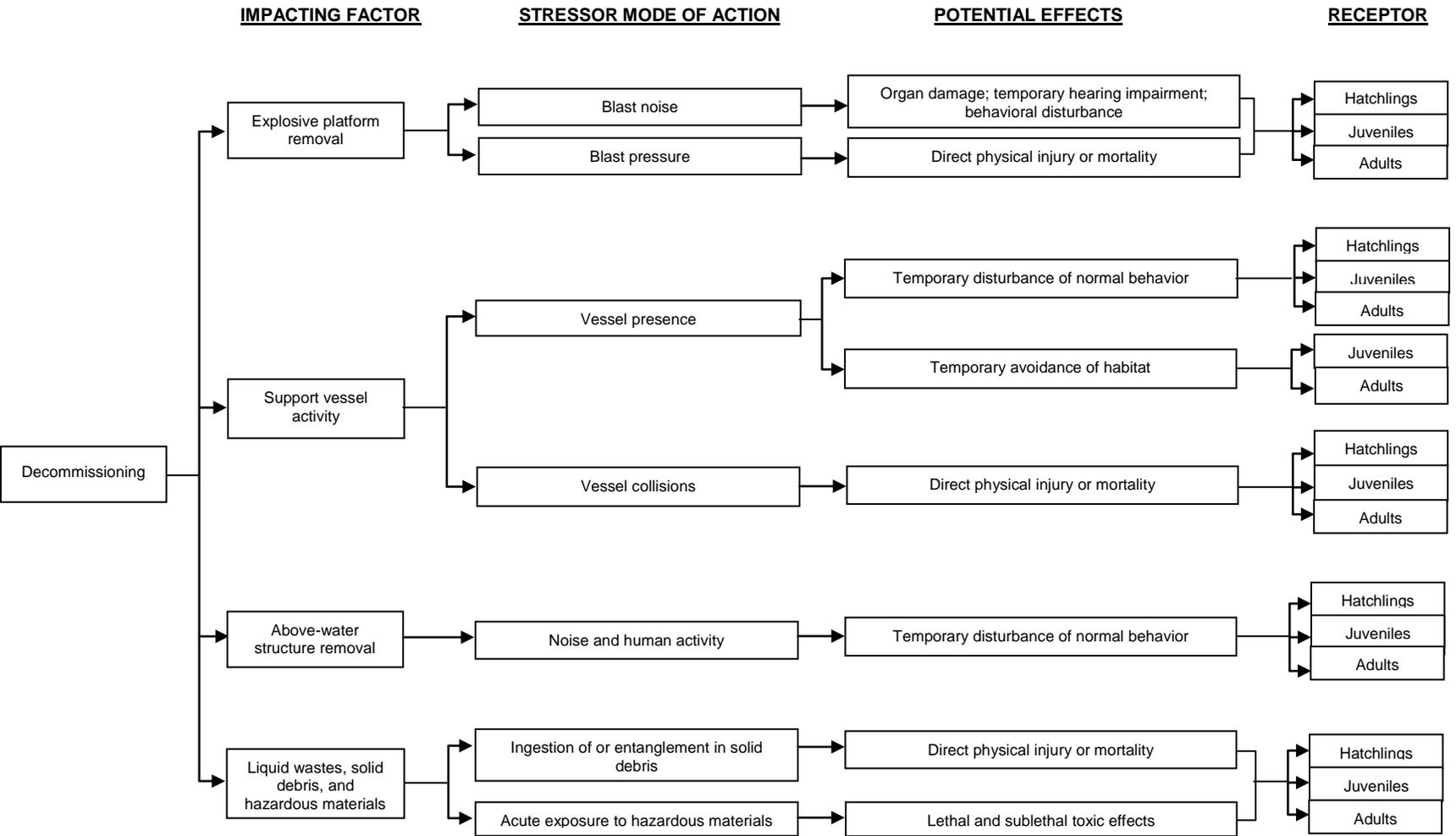


FIGURE 4.4.7-9 Conceptual Model for Potential Effects of Platform Decommissioning on Turtles in the GOM

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2
3

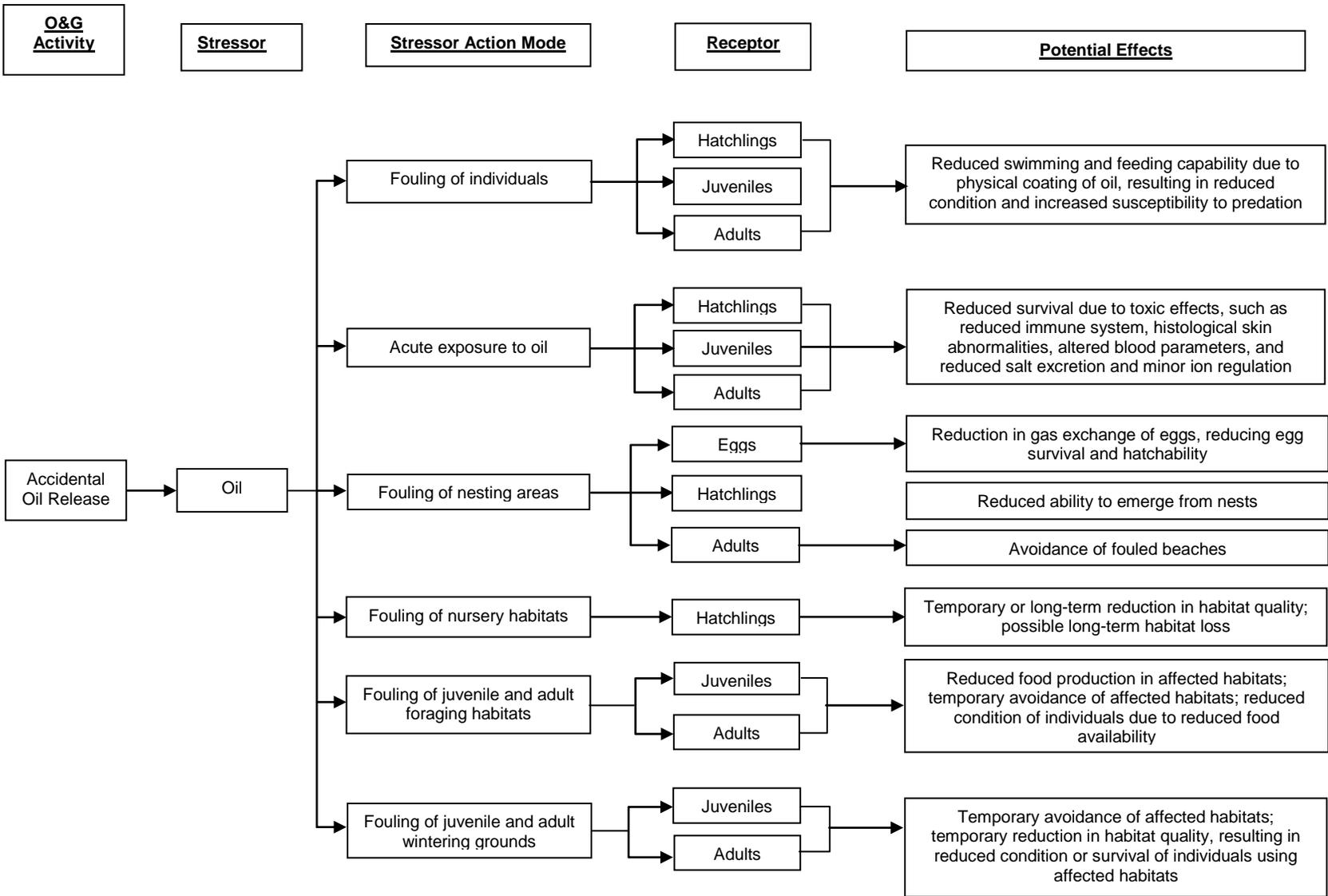


FIGURE 4.4.7-10 Conceptual Model for Potential Effects of Oil Spill on Reptiles in the GOM

1

2

1 noises (McCauley et al. 2000; BOEMRE 2010c; NSF and USGS 2010), but it is largely
2 unknown how sea turtles may respond to and be affected by noise generated during structure
3 placement, drilling and production, pipeline trenching, vessel traffic, and explosive structure
4 removal (Geraci and St. Aubin 1987). Because some sea turtles, such as the loggerhead, may be
5 attracted to OCS structures, these may be more susceptible to sounds produced during routine
6 operations.

7
8 Noise generated by seismic surveys may affect sea turtles (Figure 4.4.7-6). Seismic
9 surveys generate both high-frequency and low-frequency noise at levels up to 250 dB re 1 μ Pa-
10 m, with emitted energy levels in the low-frequency range of 10–120 Hz (IACMST 2006). These
11 survey noises are expected to be detected by sea turtles. Table 4.4.7-7 provides a general
12 summary of available information on the effects of exposure to seismic noises (e.g., sonar) on
13 sea turtles. It has been suggested that sound levels above 175 dB re 1 μ Pa-m induce behavioral
14 reactions in sea turtles. Air guns and pingers typically used in seismic surveys have nominal
15 source outputs ranging from 192 to 265 dB re 1 μ Pa-m. Therefore, depending on the species of
16 turtle, its age class, and proximity to the acoustic source, there is potential for air gun blasts to
17 affect sea turtle behavior. Currently, the effects of seismic noise on sea turtle physiology are
18 unknown (BOEMRE 2010c; NSF and USGS 2010; Table 4.4.7-7).

19
20 Offshore drilling and production structures produce a broad array of sounds at
21 frequencies and levels that may be detected by sea turtles within the area of the installation
22 (Geraci and St. Aubin 1987). These sounds are generally of relatively low frequencies, typically
23 4.5–30 Hz, and may be generated at sound levels up to 190 dB re 1 μ Pa-m. Helicopters and
24 service and construction vessels may affect sea turtles due to machinery noise and/or visual
25 disturbances (NRC 1990). The effects of noise generated from construction and operations are
26 illustrated in Figures 4.4.7-7 and 4.4.7-8.

27
28 Underwater explosions associated with the explosive removal of offshore facilities may
29 generate noises that disturb sea turtles (Figure 4.4.7-9; MMS 2005d). Underwater explosions
30 associated with the explosive removal of offshore facilities may generate sound levels in excess
31 of 267 dB re 1 μ Pa-m. Exposure criteria developed by the U.S. Navy (as cited in Frankel and
32 Ellison 2005) to evaluate the potential for impacts of impulsive sounds (i.e., underwater
33 detonations) on marine biota include a sound level of 182 dB re 1 μ Pa-m. Using this criterion, a
34 sea turtle may be affected if exposed to a sound level that exceeds 182 dB re 1 μ Pa-m.
35 Depending on the size of the charges used in an explosive detonation, the surrounding water
36 depth, and the distance to the nearest sea turtles, individual turtles in the vicinity of the facility
37 undergoing explosive removal may be exposed to sound at or above this level. Based on
38 responses reported for marine mammals, sea turtles exposed to explosive noise may experience
39 temporary hearing loss as well as behavioral changes (NRC 2003c, 2005). Behavioral responses
40 may include avoidance of the noise source, disorientation, and disturbance of normal behaviors
41 such as resting or feeding. Turtles may also sustain organ or tissue damage when exposed to
42 explosive noise (Klima et al. 1988).

43
44 In advance of explosive severance activities, BOEMRE and NOAA fisheries have
45 implemented protocols to detect the presence of sea turtles within a 1,000-yard radius around
46 decommissioning sites through observer programs operated by vessels, platforms, and

TABLE 4.4.7-7 Summary of Known and Anticipated Effects of Seismic Noise on Sea Turtles in the GOM

Species	Masking	Disturbance	Temporary Hearing Impairment	Injury	Other Physiological Effects	Comments
Green	Unknown	Possible – Short-term	Possible if close to high-energy acoustic source	Unknown	Unknown	Potential for limited adverse effects due to frequency overlap between seismic source and green sea turtle hearing, based on airborne sounds not measured behaviorally (Ridgway et al. 1969; Bartol and Ketten 2006; Dow et al. 2008)
Hawksbill	Unknown	Possible – Short-term	Possible if close to high-energy acoustic source	Unknown	Unknown	No studies available
Kemp’s ridley	Unknown	Possible – Short-term	Possible if close to high-energy acoustic source	Unknown	Unknown	Potential for limited adverse effects due to frequency overlap between seismic source and juvenile Kemp’s ridley sea turtle hearing (Bartol and Ketten 2006)
Leatherback	Unknown	Possible – Short-term	Possible if close to high-energy acoustic source	Unknown	Unknown	Potential for limited adverse effects due to frequency overlap between seismic source and leatherback vocalizations (Mrosovksy 1972)
Loggerhead	Unknown	Possible – Short-term	Possible if close to high-energy acoustic source	Unknown	Unknown	Potential for limited adverse effects due to frequency of seismic source and a study indicating that loggerheads avoided low-frequency sound (O’Hara and Wilcox 1990)

Source: 2010 Marine Seismic Research PEIS (NSF and USGS 2010, Table 3.4-5).

1 helicopters. Since 1987, these observer programs have documented takes of four sea turtles (all
2 loggerheads) in the GOM as a result of explosive severance. Of these four takes, one animal was
3 killed, one stunned, and two injured (MMS 2005d). BOEMRE continues to require these
4 mitigation measures (see Appendix F of MMS 2005d) and, with compliance, expects these
5 requirements to reduce the potential for negative impacts to sea turtles from explosive removals.
6

7 Noise related to exploration, construction vessel passage, and facility removal may be
8 expected to be transient, while noise generated during production may be more long-term. The
9 dominant source of noise from vessels is propeller operation, and the intensity of this noise is
10 largely related to ship size and speed. Vessel noise resulting from O&G activities in the GOM is
11 expected to occur at low levels, generally 150 to 170 dB re 1 μ Pa-m at frequencies below
12 1,000 Hz. Vessel noise is transitory and generally does not propagate at great distances from the
13 vessel. Also, available information suggests that sea turtles are not thought to rely on acoustics;
14 the effects to sea turtles from vessel noise are discountable (NMFS 2007).
15

16 As few studies on sea turtle hearing sensitivities or noise-induced stress exist, a full
17 understanding of physical and behavioral impacts from sounds generated during exploration,
18 normal operations, and explosive facility removal is not available. Experiments using air guns to
19 try to repel turtles to avoid hopper dredges have been inconclusive (O'Hara and Wilcox 1990;
20 Moein et al. 1995), while sea turtles exposed to an operating seismic source of 166 dB re 1 μ Pa-m
21 were shown to increase their swimming speed in response to the sound (McCauley et al. 2000).
22 In addition, BOEM has implemented mitigation measures for seismic surveys in the GOM
23 requiring ramp-up, protected species observer training, visual monitoring, and reporting for all
24 surveys potentially affecting marine mammals and sea turtles (MMS 2004b). These measures
25 were developed in consultation with NOAA fisheries, and with operator compliance, they are
26 expected to reduce the potential for impacts to sea turtles.
27

28 **Offshore Structure Placement and Pipeline Trenching.** The placement of offshore
29 structures and pipeline trenching may affect hatchling, juvenile, and adult sea turtles in two ways
30 (Figure 4.4.7-7). Individuals coming in contact with construction or trenching equipment may be
31 injured or killed; construction and trenching activities may also temporarily affect habitat use as
32 habitats may experience short-term and long-term changes in abundance and quality.
33

34 During placement, pipelines are placed on or in the seafloor to connect offshore platforms
35 with onshore facilities (MMS 2001b). Burial of pipelines using equipment such as jetting sleds
36 physically digs a trench in the bottom sediment and results in a temporary, localized increase in
37 turbidity. This increased turbidity may temporarily affect habitat use by sea turtles, with sea
38 turtles avoiding such areas. Increases in turbidity from trenching at any particular location may
39 be expected to be short-lived, as jet sleds can lay pipe at an average of 1.6 km/day (1 mi/day)
40 (MMS 2001b). While some turtles may alter their use of habitats in the vicinity of a pipeline,
41 affected turtles would likely return to these areas following a return to more normal turbidity
42 levels and experience little adverse affect from any temporary avoidance of the area.
43

44 Because hatchlings are not strong swimmers and undergo passive transport by ocean
45 currents, it is unlikely that they would be able to avoid or leave areas where pipeline trenching or
46 structure placement is occurring, and, if present during offshore construction or trenching, they

1 could be injured or killed. In contrast, juvenile and adult sea turtles are active swimmers, and
2 thus may be able to avoid areas where construction or trenching is occurring. Sea turtles have
3 been known to be killed or injured during dredging operations (Dickerson 1990;
4 Dickerson et al. 1992), and thus may also be affected during trenching activities. Juveniles or
5 adults may also be affected if the placement of new structures occurs in foraging or
6 developmental habitats or offshore of nesting beaches (see Section 3.6.4.1 for a discussion of
7 these habitats and areas). Following several years out in open water as growing hatchlings,
8 juvenile sea turtles move into nearshore habitats for further growth and maturation. Adults also
9 utilize nearshore habitats for feeding and may mate in nearshore habitats directly off nesting
10 beaches. In addition, females may become residents in the vicinity of nesting beaches. Offshore
11 construction and trenching may reduce the quality or availability of foraging habitat for juveniles
12 and adults, and may affect adult nesting behavior or access to nest sites. It is assumed that
13 habitats such as seagrass beds and live-bottom areas commonly used by turtles for feeding or
14 resting would be avoided during facility siting and pipeline routing, and that some soft-bottom
15 areas affected by construction or trenching would recover (see Section 4.4.6.2.1).

16
17 Based on exploration and development (E&D) scenario estimates (Section 4.4.1.1), up to
18 2,100 exploration wells and 2,600 production wells may be constructed and up to 12,000 km
19 (7,500 mi) of new pipeline may be installed among the GOM planning areas under the proposed
20 action. At any single location, construction and trenching activities would be of relatively short
21 duration (only until the offshore structure or pipeline is in place). Thus, any impacts incurred
22 from structure placement or trenching would be short-term and localized to the construction area
23 and immediate surroundings and, therefore, would likely affect relatively few juveniles or adults.
24 Because they are passively aggregated by currents, a greater number of hatchlings may be
25 affected if present in a construction or trenching area. However, these effects are not expected to
26 result in population-level impacts.

27
28 **Removal of Offshore Structures.** Sea turtles are known to be attracted to offshore
29 platforms (Lohofener et al. 1990); therefore, they may be killed or injured during explosive
30 platform removal (Klima et al. 1988; Gitschlag and Herczeg 1994). Even if turtles are not
31 capable of hearing the acoustic properties of an explosion, physiological or behavioral responses
32 (startle) to detonations may still result (MMS 2007b). The effects of blast pressure on sea turtles
33 during explosive platform removal activities are illustrated in Figure 4.4.7-9. Exposure to
34 explosion pressure could result in internal injuries, such as lung hemorrhaging, and individuals
35 may be rendered unconscious by the force of the blasts (Duronslet et al. 1986; Klima et al. 1988).
36 However, evidence of sea turtle mortality or injury from blast pressure is sparse, probably due to
37 the difficulty in observing submerged turtles and because affected turtles may remain submerged
38 rather than float to the surface (NRC 1990). Despite this, the relative importance of oil platform
39 removal to overall sea turtle mortality (from human activities) is considered to be low
40 (NRC 1990; NOAA 2003). Under the proposed action, approximately 150 to 275 existing
41 platforms could be removed from the planning areas using explosives.

42
43 Mitigation measures in the form of guidelines for explosive platform removals have been
44 established by BOEMRE with the cooperation of the National Marine Fisheries Service (NMFS).
45 These guidelines require a mitigation plan that uses qualified observers to monitor the detonation
46 area for protected species prior to and after each detonation. The detection of sea turtles within a

1 predetermined radius from the structure prior to detonation would, without exception, delay
2 structure removal. As long as operators comply with these mitigating measures, it is expected
3 that impacts other than short-term behavioral disturbance would be avoided or greatly reduced,
4 and no population-level effects would occur.

5
6 **OCS Vessel Traffic.** Sea turtles could be disturbed by the presence of OCS project
7 vessels traveling from port locations to the construction area, as well as ships supporting pipeline
8 trenching activities. It is unknown whether or how the presence of passing project vessels might
9 affect nearby sea turtles. Sea turtles exposed to a passing vessel could exhibit short-term
10 cessation of normal behaviors and possibly exhibit behavioral responses such as fleeing
11 (Hazel et al. 2007). Construction vessel traffic would be expected in both offshore and coastal
12 areas, and thus could affect sea turtles in coastal nest staging, foraging, and wintering habitats, as
13 well as in offshore foraging areas and along migration routes. Several studies have reported sea
14 turtles to exhibit strong fidelity to migration corridors, habitat foraging grounds, and nesting
15 areas (e.g., see Morreale et al. 1996; Morreale and Standora 1998, Avens et al. 2003; and
16 Casale et al. 2007). Many important coastal habitats for sea turtles are in areas with high levels
17 of commercial and recreational boat traffic (e.g., see USDOT 2008). In such areas, construction
18 vessel traffic would likely result in only a very small incremental increase in overall vessel
19 traffic in many locations.

20
21 Boat collisions are reported to be a major cause of injury and mortality in sea turtles
22 (Lutcavage et al. 1997; TEWG 2007). While juvenile and adult sea turtles may avoid areas with
23 heavy vessel traffic, most species generally exhibit considerable tolerance to ships. Because of
24 their limited swimming abilities, hatchlings would likely not be able to avoid oncoming vessels,
25 and thus may be more susceptible to vessel collisions, especially if aggregated in areas of current
26 convergence or in mats of floating *Sargassum*. To date, there is no direct evidence of OCS
27 vessel collisions with sea turtles (of any life stage) in the GOM from oil and gas activities.

28
29 The likelihood of such a collision would vary depending upon species and life stage
30 present, the location of the vessel, its speed, and its visibility. Hatchling turtles, including those
31 aggregated in convergence zones or patches of *Sargassum*, would be difficult to spot from a
32 moving vessel because of their small size and generally cryptic coloration patterns, which blend
33 in with the color and patterns of the *Sargassum*. While adult and juvenile turtles are generally
34 visible at the surface during periods of daylight and clear visibility, they may also be very
35 difficult to spot from a moving vessel when resting below the water surface and during nighttime
36 and periods of inclement weather.

37
38 While sea turtles are distributed within nearshore waters and waters of the continental
39 shelf throughout the GOM, they appear to occur in greatest abundance east of Mobile, Alabama,
40 in the Eastern Planning Area (Davis et al. 2000). Only a small portion of the Eastern GOM
41 located greater than 160 km (100 mi) from the Florida coast (Figure 1-2) is being considered for
42 the Program. Service vessels that would go to this area are assumed to originate from bases
43 located in coastal areas adjacent to the Central Planning Area; thus the potential for sea turtle
44 collisions with OCS project boats may be very low for the Eastern Planning Area. In contrast,
45 there may be a greater potential for turtle-vessel collisions in the Western and Central Planning
46 Areas, due to the large number of vessel trips in these areas. Under the proposed action, it is

1 estimated that between 300 and 600 vessel trips would occur per week; most of this activity
2 would occur in the Central and Western Planning Areas. However, BOEMRE has implemented
3 measures for all oil and gas operators in the GOM that require actions to minimize the risk of
4 vessel strikes to protected species, including sea turtles and reporting observations of injured or
5 dead animals (see NTL 2003-G10 [MMS 2003b]). In lieu of a formal observer program, this
6 Notice to Lessees and Operators (NTL) also provides specific guidelines for operators to follow
7 to avoid injury to marine mammals and sea turtles. With compliance, the BOEM expects these
8 measures to reduce the potential for negative impacts to sea turtles from vessel collisions.
9

10 **Construction and Operation of Onshore Infrastructure.** Unless existing onshore
11 facilities are available, new platforms and pipelines will require the construction of new onshore
12 infrastructure such as pipeline landfalls. Onshore construction activities may disturb nesting
13 adults, hatchlings, and nest sites along the northern GOM coastline.
14

15 If present in a construction area, nests containing eggs or emerging hatchlings could be
16 destroyed by site clearing and grading activities. Females ready to nest may avoid disturbed
17 historic nesting beaches or may dig nests in poor quality locations where hatchling success may
18 be greatly reduced. Lighting from construction areas may disorient hatchlings emerging from
19 nearby nests, which could increase exposure to predators, cause entanglement in vegetation, or
20 lead hatchlings away from the surf (NRC 1990; Witherington and Martin 1996; Lorne and
21 Salmon 2007). Onshore lighting may also draw hatchlings back out of the surf, as well as
22 disorient adult females seeking to nest on nearby beaches.
23

24 Although disturbed beaches may undergo restoration activities, such as placement of new
25 sand in disturbed areas, the effectiveness of such actions to restore nesting activity is unknown.
26 Constructed beaches often differ physically from natural beaches and depending on the type of
27 sand used may exhibit sand temperatures quite different from the original pre-disturbed beaches
28 (NMFS and USFWS 2008). Loggerhead nesting activity on restored beaches was found to be
29 reduced the first season following restoration, but much less reduced by the second season,
30 suggesting that nesting activity may return to pre-disturbance levels within a few years
31 (Rumbold et al. 2001). Because nest temperatures affect the sex of hatchlings, restored beach
32 sites with cooler temperatures may skew sex ratios toward males (Milton et al. 1997). Similar
33 impacts could be incurred to more inland reptile species that may occur in brackish environments
34 that are listed as species of concern by the USFWS (e.g., diamondback terrapin [*Malaclemys*
35 *terrapin*], gulf salt marsh snake [*Nerodia clarkia*]).
36

37 Given the small amount of onshore construction that could occur with a pipeline landfall,
38 it is unlikely that onshore construction would impact more than a few nests. The implementation
39 of all mitigation measures required by statutes, regulations, and/or lease stipulations that have
40 applied in past lease sales would also greatly limit the potential for impacts to nests and
41 emerging hatchlings. Applicable mitigation measures may include preconstruction surveys for
42 nest sites and delay of construction activities until hatchlings have emerged and moved into open
43 water. In addition, onshore facilities could be located such that known nesting beaches would
44 not be affected by construction and operation of such facilities.
45

1 **Operational Discharges and Wastes.** Normal operations generate a variety of wastes
2 such as produced water, drilling muds and cuttings, sanitary and other waste fluids, and
3 miscellaneous trash and debris. Hatchling, juvenile, and adult sea turtles may be exposed to
4 these wastes by permitted and accidental discharges from onshore and offshore facilities and
5 OCS service and construction vessels. Produced water and drilling muds may contain a variety
6 of constituents, such as trace metals, hydrocarbons, and NORM (Neff 1997b), which may be
7 toxic to fish and wildlife, including sea turtles. Exposure to these wastes may occur through
8 direct contact with the wastes in the ocean water and through the ingestion of food contaminated
9 by one or more of the waste constituents. Because produced water and other liquid wastes would
10 be rapidly diluted in the open ocean (i.e., to ambient levels within several thousand meters of the
11 discharge), sea turtles would be expected to experience only very low levels of exposure from
12 the water column. Species such as loggerheads and Kemp's ridleys that feed at the top of the
13 food chain have been found to have higher tissue levels of bioaccumulative compounds than
14 species feeding at lower trophic levels (Pugh and Becker 2001).

15
16 While there is limited information regarding the levels of some contaminants (such as
17 polychlorinated biphenyls [PCBs] and metals) in sea turtle tissues, little is known about what
18 concentrations are within normal ranges of a particular species or what tissue levels may result in
19 acute or chronic effects (Pugh and Becker 2001; NOAA 2003). In loggerhead turtles, chlordane
20 concentrations have been negatively correlated with blood parameters indicative of anemia, and
21 several classes of organic contaminants have been correlated with hepatocellular damage and
22 possible alterations of protein and ion regulation (Keller et al. 2004).

23
24 Ingestion of, or entanglement with, discarded solid debris can adversely impact sea
25 turtles. Ingestion of plastic and other nonbiodegradable debris has been reported for almost all
26 sea turtle species and life stages (NOAA 2003). Ingestion of waste debris can result in gut
27 strangulation, reduced nutrient uptake, and increased absorbance of various chemicals in plastics
28 and other debris (NOAA 2003). Sublethal quantities of ingested plastic debris can result in
29 various effects including positive buoyancy, making them more susceptible to collisions with
30 vessels, increasing predation risk, or reducing feeding efficiency (Lutcavage et al. 1997). Some
31 species of adult sea turtles, such as loggerheads, appear to readily ingest appropriately sized
32 plastic debris. In oceanic waters, floating or subsurface translucent plastic material and sheeting
33 may be mistaken for gelatinous prey items such as jellyfish. Entanglement in debris (such as
34 rope and discarded fishing line) can result in reduced mobility, drowning, and constriction of and
35 subsequent damage to limbs (Lutcavage et al. 1997). However, the discharge or disposal of solid
36 debris into offshore waters from OCS structures and vessels is prohibited by BOEMRE
37 (30 CFR 250.40) and the USCG (MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]).
38 Assuming compliance with these regulations and laws and only accidental releases occur, very
39 little exposure of sea turtles to solid debris generated during normal operations is expected.

40
41 Produced waters, drilling muds, and drill cuttings are routinely discharged into offshore
42 marine waters and regulated by USEPA NPDES permits and USCG regulations. Compliance
43 with these permits and regulations will greatly limit the exposure of sea turtles to produced water
44 and other wastes generated at offshore facilities and on OCS vessels. Most operational
45 discharges, as regulated, are diluted and dispersed when released in offshore areas and are
46 considered to have sublethal effects (API 1989; Kennicut 1995). Any potential for impact on sea

1 turtles from drilling fluids would be indirect, either by impact on prey items or through ingestion
2 via the food chain (API 1989). Contaminants in drilling muds or waste discharge may
3 biomagnify and bioaccumulate in the food web, which may kill or debilitate prey species or
4 species lower in the food web. Sea turtles may bioaccumulate chemicals (Sis et al. 1993), which
5 may ultimately reduce fitness characteristics, such as reproductive output.
6
7

8 **4.4.7.4.2 Accidents.** All sea turtle life stages, as well as nest sites and eggs, may be
9 exposed to accidental oil releases in the GOM planning areas. In extreme catastrophic oil spills,
10 all life stages of the American crocodile and their habitats may also be exposed to oil
11 (Table 4.4.7-6). The American crocodile inhabits brackish and freshwater environments and is
12 primarily known to occur in coastal mangrove swamps in southern Florida. Depending on
13 location and magnitude, catastrophic oil spills in the GOM have the potential to affect coastal
14 mangrove and beach habitats in southern Florida for the American crocodile.
15

16 The effects of accidental oil spills on reptiles are illustrated in Figure 4.4.7-10. Nests
17 may be exposed by oil washing ashore and soaking through overlying soils onto buried eggs,
18 while hatchlings may be exposed as they emerge from nests. Hatchlings, juveniles, and adults
19 may be exposed while swimming through oil on the water surface, through inhalation of
20 petroleum vapors, and through ingestion of contaminated foods and floating tar. Nesting adults
21 (females) may also be exposed while coming ashore on oiled beaches. In addition to direct
22 adverse effects from such exposures, adults and juveniles may also be indirectly affected if an
23 accidental spill reduces the quality or quantity of foraging or nesting habitats. Impacts to nesting
24 habitats could result in population-level effects. Similar impacts could be incurred to more
25 inland reptile species that may occur in brackish environments that are listed as species of
26 concern by the USFWS (e.g., diamondback terrapin [*Malaclemys terrapin*], gulf salt marsh snake
27 [*Nerodia clarkia*]).
28

29 Sea turtle behavior may put the turtles at greater risk of oil exposure in the event of an
30 accidental spill. Sea turtles are air breathers and must surface frequently to breathe. Many
31 turtles surface at convergence areas, highly productive areas where ocean currents converge and
32 where spilled oil could be pushed by the ocean currents. These convergence areas also provide
33 food, shelter, and habitat for sea turtles, especially young individuals. Therefore, the
34 accumulation of oil in GOM convergence areas increases the risk of sea turtle exposure to oil
35 (NOAA 2010a).
36

37 Sea turtles accidentally exposed to oil or tarballs have been reported to incur a variety of
38 conditions, including inflammatory dermatitis, breathing disturbance, salt gland dysfunction or
39 failure, hematological disturbances, impaired immune responses, and digestive disorders or
40 blockages (Vargo et al. 1986; Lutz and Lutcavage 1989).
41

42 Sea turtle nest sites and emerging hatchlings may be exposed to and subsequently
43 affected by oil spills that wash up on nesting beaches and contaminate active nests. Oil may
44 interfere with gas exchange within an oiled nest, may alter hydric conditions of the sand so that it
45 is too wet or too dry for optimal nesting, or may alter nest temperatures by changing the color or

1 thermal conductivity of the overlying sand (NOAA 2003). Adult females may refuse to use oiled
2 beaches (NOAA 2003).

3
4 Eggs exposed to freshly oiled sands may incur a significant decrease in hatching success
5 and an increase in developmental abnormalities in hatchlings (Fritts and McGehee 1982). In
6 contrast, eggs exposed to weathered oil did not produce measurable impacts on hatchling
7 survival or development, suggesting that impacts to nest sites would be greatest if the accidental
8 spill occurred during the nesting season. Because most sea turtles nest above the high-tide line
9 and oil washing ashore would be deposited at and just above the high-tide line, oiling of actual
10 nests is unlikely except possibly in the event of exceptionally high tides or storms.

11
12 Hatchlings may become oiled while traveling from the nest to water, and a heavy oil
13 layer or tar deposits on the beach may prevent the hatchlings from reaching water. Oiled
14 hatchlings may have difficulty crawling and swimming, increasing the potential for predation.
15 Open-water convergence zones where hatchlings may aggregate are also areas where oil slicks
16 may aggregate. For example, the Sargasso Sea has been estimated to annually entrap
17 70,000 metric tons of tar (NOAA 2003). Because hatchlings spend more time at the sea surface,
18 they will be more likely to be exposed to surface oil slicks than adults or juveniles. Post-
19 hatchling sea turtles have been collected from convergence zones off Florida with tar in their
20 mouths, esophagi, and stomachs, and tar caking their jaws (Loehfener et al. 1989; Witherington
21 1994). Ingested tar may result in starvation from gut blockage and decreased food adsorption
22 efficiency, absorption of toxins, local necrosis or ulceration associated with gut blockage,
23 interference with fat metabolism, and buoyancy problems (NOAA 2003).

24
25 Sea turtles surfacing and diving in an oil spill may inhale petroleum vapors and aspirate
26 small quantities of oil. While no information is available about the effects of petroleum vapors
27 or aspirated oil on sea turtles, inhalations by mammals of small amounts of oil or petroleum
28 vapors have been shown to result in acute fatal pneumonia, absorption of hydrocarbons in organs
29 and other tissues, and damage to the brain and central nervous system.

30
31 Ingested oil, particularly the lighter fractions, could be toxic to sea turtles. Ingested oil
32 may remain within the gastrointestinal tract, irritate and/or destroy epithelial cells in the stomach
33 and intestine, and subsequently be absorbed into the bloodstream (NOAA 2003). Certain
34 constituents of oil, such as aromatic hydrocarbons and PAHs, include some well-known
35 carcinogens. These substances, however, do not show significant biomagnification in food
36 chains and are readily metabolized by many organisms. Hatchling and juvenile turtles feed
37 opportunistically at or near the surface in oceanic waters and may be especially vulnerable and
38 sensitive to spilled oil and oil residues such as floating tar (Lutz and Lutcavage 1989;
39 Lutcavage et al. 1995). Tar found in the mouths of turtles may have been selectively eaten or
40 ingested accidentally while feeding on organisms or vegetation bound by tar (Geraci and
41 St. Aubin 1987; Geraci 1990).

42
43 Certain species of sea turtles may be at greater risk of exposure to spilled oil based on
44 their distributions and habitat preferences and also on the timing of a spill. For example,
45 loggerhead and Kemp's ridley sea turtles frequent current-restricted areas such as bays and
46 estuaries. Because oil entering these areas may remain for longer periods of time due to reduced

1 weathering rates and natural dispersion, sea turtles using habitats in these areas may incur longer
2 exposure periods. Spills occurring in coastal waters of the Western Planning Area may affect
3 greater numbers of green, hawksbill, loggerhead, and leatherback sea turtles during summer
4 months when nearshore densities are greater than offshore densities.
5

6 Oil spill response activities that may adversely affect sea turtles include artificial lighting
7 at night, machine and human activity and related noise, sand removal and cleaning, and the use
8 of dispersant or coagulant chemicals. Lights used to support nighttime cleanup activities may
9 attract sea turtles to the spill location or disorient hatchlings emerging from nearby nests.
10 Machine and human activity may cause a temporary avoidance of nearby habitats (including nest
11 sites) by sea turtles, produce noise that may disturb sea turtles, and also increase the potential for
12 sea turtle collisions with vessels and onshore vehicles. Onshore activities may also crush
13 existing nests and result in beach compaction, reducing the suitability of existing nest sites for
14 future use. Sand removal may also directly impact nest site habitat quality. While oil
15 dispersants or coagulants contain constituents that are considered to be low in toxicity when
16 compared to many of the constituents of spilled oil (Wells 1989), there are little available data
17 regarding the effects of these chemicals on sea turtles (Tucker and Associates, Inc. 1990).
18

19 The magnitude and severity of impacts that could result from such exposures would
20 depend on the location of the spill, spill size, type of product spilled, weather conditions, the
21 water quality and environmental conditions at the time of the spill, and the species and life stage
22 of the sea turtle exposed to the spill. The magnitude and extent of any adverse effects would also
23 depend on how quickly a spill is contained and how quickly and effectively cleanup is
24 accomplished. Based upon spill scenario estimates provided in Section 4.4.2, between 200 and
25 400 spills of <50 bbl of oil and up to 70 spills of ≥ 50 bbl of oil could be expected in the GOM
26 under the proposed action.
27

28 **Catastrophic Discharge Event.** The PEIS analyzes a CDE up to 7.2 million bbl
29 (Table 4.4.2-2). The recent oil spill associated with the DWH oil rig explosion, which occurred
30 in April 2010 approximately 66 km (41 mi) off the Louisiana coast, may have had detrimental
31 consequences to sea turtles that had direct contact with spilled oil. A total of 1,146 sea turtles
32 were recovered from the GOM that had come in contact with or were in the vicinity of spilled
33 oil. The recovered turtles included adults or free-swimming juveniles of four species: green,
34 hawksbill, Kemp's ridley, and loggerhead. However, some recovered sea turtle species could
35 not be identified (Table 4.4.7-7). Of the total number of turtles recovered, 608 (53%) were found
36 dead and 537 (47%) were found alive. Most of the recovered sea turtles (dead or alive) were
37 Kemp's ridley sea turtles (Table 4.4.7-7). Approximately 85% of the live turtles recovered were
38 visibly oiled; approximately 3% of the dead turtles recovered were visibly oiled (Restore the
39 Gulf 2010a). While in the case of the DWH event, the cause of death of the deceased turtles
40 remains unclear, it is possible for turtles to ingest or inhale oil during a CDE that could be
41 potentially fatal without any noticeable external indications.
42

43 A CDE spill also has the potential to affect sea turtle populations by fouling habitats such
44 as seagrass beds and nesting beaches. In the case of the DWH event, preliminary reports on the
45 DWH event from the NOAA Natural Resource Damage Assessment Team have indicated that
46 about 1,600 km (1,000 mi) of shoreline along the GOM has tested positive for oil, including salt

1 marshes, beaches, mudflats, and mangroves (NOAA 2010b). The presence of oil in these areas
2 likely affected foraging and nesting habitats for sea turtles, although the true ecological
3 consequences of these effects are not known.
4

5 **4.4.7.4.3 Conclusion.** Under the proposed action, some routine operations could affect
6 individual sea turtles, but population-level impacts are not expected. Noise generated during
7 exploration and production activities and platform removal may result in the temporary
8 disturbance of some sea turtles, while some turtles may be injured or killed during the use of
9 underwater explosives for platform removal. Sea turtles could be directly affected by
10 construction of offshore and onshore facilities and pipeline trenching, and also indirectly by
11 short-term and long-term impacts to habitats. The construction and operation of new onshore
12 facilities may impact nest sites, possibly result in eggs being crushed, and disturb hatchling
13 movement from the nest sites to the water. Sea turtles may also be injured or killed by collisions
14 with OCS vessels. Sea turtles may also be exposed to a variety of waste materials which have
15 the potential to cause a variety of lethal and sublethal effects. Accidental spills have the
16 potential to foul habitats and injure or kill exposed sea turtles. Depending on magnitude and
17 location, catastrophic accidental oil spills have the potential to affect American crocodile habitats
18 and exposed individuals. Many of these impacts would be of relatively short duration and
19 localized and would likely affect relatively few individuals in the immediate project area.
20 Existing permit requirements, regulatory stipulations, and BOEM guidelines and mitigation
21 measures, if applied, target many of the routine operations and could limit the potential effects.
22 Impacts to reptiles from routine operations associated with the Program are expected to range
23 from minor to moderate.
24

25 Any of the oil-spill scenarios developed for the proposed action (Section 4.4.2) may
26 result in the exposure of one or more life stages of reptiles to oil or its weathered products. Oil
27 may reduce egg hatching and hatchling survival and may inhibit hatchling access to water.
28 Hatchlings, juveniles, and adults may inhale or ingest oil and oil vapors and may incur any of a
29 variety of physiological impacts. The presence of oil slicks or oiled beaches may alter habitat
30 use and affect nest site access and use. Small spills that may occur under the proposed action are
31 unlikely to affect a large number of sea turtles or their habitats and are not expected to have long-
32 term effects on sea turtle populations in the GOM. A large spill could affect many more
33 individuals and habitats, including nesting beaches, and, in the case of a CDE, potentially may
34 incur population-level effects. The magnitude of effects from accidental spills would depend on
35 the location, timing, and volume of the spills; the environmental settings of the spills; and the
36 species and life stages of sea turtle exposed to the spills. Because 93% of the new oil production
37 that is expected to occur during the Program is assumed to occur far from the coast in deep water
38 (>200 m [656 ft] deep), the likelihood of a large spill occurring close enough to the coastline to
39 affect turtle nesting beaches is expected to be small. However, a CDE occurring in deep water
40 has a greater likelihood of reaching coastal areas, although this will depend on the specific
41 location of the spill and the prevailing currents in that area. The rapid deployment of spill-
42 response teams and implementation of cleanup activities could limit the magnitude of impacts
43 incurred by sea turtles in the event of an accidental spill; however, cleanup operations
44 themselves could also impact sea turtle habitats.
45
46

1 **4.4.7.5 Invertebrates and Lower Trophic Levels**

2 3 4 **4.4.7.5.1 Gulf of Mexico.**

5
6 **Routine Operations.** Impacting factors common to all phases include vessel discharges
7 (bilge and ballast water), miscellaneous discharges (deck washing, sanitary waste), and offshore
8 lighting. Many of these waste streams are disposed of on land, and all vessel and platform waste
9 streams must meet USEPA and/or USCG regulatory requirements before discharge into surface
10 waters. Impacts from waste discharges would be localized and temporary and are expected to
11 have negligible impacts on invertebrate populations. Studies conducted in the northern GOM
12 suggest that platform lighting could alter predator-prey dynamics by enhancing phytoplankton
13 productivity around the platform, attracting phototaxic pelagic invertebrates, and potentially
14 improving the visual foraging environment for fishes (Keenan et al. 2007). Consequently,
15 increased predation of invertebrates may occur in the vicinity of the platform. Potential impacts
16 from platform lighting would be localized but long-term and are expected to have minimal
17 impacts on invertebrate populations.

18
19 **Exploration and Site Development.** During the OCS oil and gas exploration and
20 development phase, invertebrates could be affected by noise from seismic surveys and noise and
21 bottom disturbance from drilling, platform placement, and pipeline trenching and placement
22 activities. Releases of drilling muds and cuttings could also affect invertebrates by
23 contaminating sediments and surrounding surface waters (Table 4.4.7-8).

24
25 Noise from vessel traffic, construction, seismic surveys, and drilling could kill or injure
26 invertebrates close enough to the noise source, as well as reducing habitat suitability, as some
27 species would avoid the area. For example, decapods and cephalopods, two numerically
28 abundant and commercially important groups of invertebrates, are known to detect vibrations
29 from underwater noise and may be sensitive to noise from vessel traffic, seismic surveys, and
30 drilling (DFO 2004; National Science Foundation and USGS 2010). Recent reviews of the
31 impacts of anthropogenic noise on invertebrates indicates that invertebrates exposed to noise
32 could exhibit pathological effects (i.e., injury and mortality), physiological changes (i.e., changes
33 in hormone, protein, and enzyme levels), and/or behavioral changes (such as a startle response)
34 and change swimming and movement patterns (DFO 2004; National Science Foundation and
35 USGS 2010). Although data is limited, zooplankton and larvae stages may be injured because of
36 their small size and relative lack of mobility, while noise is often found to have negligible effects
37 on adult invertebrates (reviewed in DFO 2004 and National Science Foundation and
38 USGS 2010). The studies typically suggested that injury was limited to within 10 m (33 ft) of
39 the noise source. The numbers of invertebrates that could be affected by noise during the
40 exploration and site development phase make it unlikely that noise impacts would have
41 appreciable effects on invertebrate populations in the Western and Central Planning Areas. A
42 recent review of the effects of seismic survey activities on marine invertebrates concluded that
43 although data were limited, mortality and injury of invertebrates would be limited to organisms
44 located within a few meters of the air gun, and that there would be no significant impacts on
45 marine invertebrate populations from air gun and sonar sounds (National Science Foundation and
46 USGS 2010). The severity and duration of noise impacts would vary with site and development

1 **TABLE 4.4.7-8 Impacting Factors Potentially Affecting Invertebrates and Their**
2 **Habitat in the GOM Planning Areas**

Development Phase and Impacting Factor	Life Stage Affected ^a		
	Eggs	Larvae	Adults
<i>Impacting Factors Common to All Phases</i>			
Vessel noise	X	X	X
Vessel traffic	X	X	X
Hazardous materials	X	X	X
Solid wastes	X	X	X
Offshore lighting	X	X	X
Aircraft noise			
Offshore air emissions			
Onshore air emissions			
Aircraft traffic			
Miscellaneous platform discharges	X	X	X
Vessel discharges	X	X	X
Bottom disturbance from vessel anchors	X	X	X
<i>Exploration and Development</i>			
Seismic noise	X	X	X
Noise from drilling and construction	X	X	X
Bottom disturbance from platform placement, drilling, and pipeline placement and trenching	X	X	X
Discharge of drilling muds and cuttings	X	X	X
<i>Production</i>			
Production noise	X	X	X
Produced water discharge	X	X	X
Artificial reef	X	X	X
<i>Decommissioning</i>			
Platform removal (non-explosive)	X	X	X
Platform removal (explosive)	X	X	X

^a colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

3
4
5 scenario, but given the temporary and localized nature of the noise generating activities, impacts
6 on invertebrates are expected to be negligible.

7
8 Bottom-disturbing activities such as coring and drilling, platform placement and mooring,
9 and pipeline trenching and placement would displace, injure, or kill invertebrates in the vicinity
10 of the activities. The estimated bottom habitat that may be directly disturbed by new pipeline
11 and platform installation ranges from 2,150 to 14,000 ha (5,313 to 34,594 ac) over the entire
12 GOM. In the initial drilling phase before a riser is installed, drilling muds would accumulate
13 around the well and bury benthic invertebrates as well as create a turbidity plume that could

1 impact pelagic invertebrates located near the bottom. Drilling is also expected to increase the
2 amount of sand in sediments surrounding the well for at least 300 m (984 ft) (Continental Shelf
3 Associates, Inc. 2006). This change in grain size could alter community composition and
4 prevent the settlement of some species. In addition, bottom disturbance during platform and
5 pipeline placement would result in sedimentation and turbidity, which could bury benthic
6 infauna and damage the gills of water-column and benthic invertebrates present within some
7 distance of the disturbance. These disturbances would be localized and temporary. Species most
8 likely to be affected are sessile benthic organisms and small zooplankton, which lack the
9 mobility to avoid the direct disturbance and the associated turbidity plumes. An FPSO system
10 may be employed for deepwater wells. Under the FPSO system, oil would be transported from
11 the well to a surface vessel and ultimately to shore. By eliminating the need for pipelines, an
12 FPSO system would greatly reduce bottom disturbance and the chance for disturbing benthic and
13 near-bottom invertebrates and their habitat. Most disturbed areas would be recolonized quickly,
14 but, if grain size is significantly altered, the benthic community may take several years to return
15 to its pre-disturbance composition (Bolam and Rees 2003 and references therein).

16
17 The effects of drilling muds and cuttings (including drilling fluids adhering to the
18 cuttings) on invertebrates can be chemical such as toxicity or physical such as gill abrasion,
19 burial, or displacement from turbidity and sedimentation. Impacts from turbidity and
20 sedimentation would be similar to those described above and could damage respiratory structures
21 and disrupt food acquisition at all trophic levels. Drilling wastes released near the sediment
22 surface or in shallow water would bury benthic organisms in the release area. Muds released in
23 deeper water or near the water's surface would be spread over a greater area in a thinner layer
24 and may not result in high mortality, although impacts to water-column invertebrates may be
25 greater under this scenario. The disturbance would be short in duration, with repopulation of the
26 affected area occurring by larval recruitment. In addition, drilling discharges must comply with
27 NPDES permit requirements regarding the discharge amount, rate, and toxicity, which would
28 greatly reduce the impact to invertebrate communities.

29
30 The USEPA and BOEM have sponsored research on the biological effects of drilling
31 fluids on benthic invertebrates. In studies conducted on the GOM continental shelf and slope,
32 synthetic drilling fluids in sediments were elevated within 500 m (1,640 ft) of the well
33 (Continental Shelf Associates, Inc. 2004, 2006). Meiofaunal and macroinvertebrate abundance
34 were typically highest near the well, and were often found to increase with the concentration of
35 drilling fluids in the sediment (Continental Shelf Associates, Inc. 2006). However, the effects of
36 drilling muds appears to be species-dependent. Amphipod, ophiuroid, and ostrocod densities
37 were depressed within 300 m (984 ft) of the well compared to control areas, while copepods,
38 nematodes, and several classes of dominant infauna including worms, clams, and snails were
39 more abundant within 300 m (984 ft) of the well (Continental Shelf Associates, Inc. 2006).
40 Sediments collected near the well were found to be toxic to amphipods, which explains their
41 depressed abundance (Continental Shelf Associates, Inc. 2004, 2006). The elevated abundance
42 of most infauna may have been due to the high organic matter content of the drilling fluids
43 adhering to the muds and cuttings. Some sites showed particularly high abundance of species
44 tolerant of organic enrichment (Continental Shelf Associates, Inc. 2006). However, the high
45 organic matter content also created anoxic patches along the seafloor that contained very few
46 infauna. The recovery time for benthic communities will depend on impact magnitude and

1 species present, and existing data suggest recovery will begin rapidly but may take years for
2 recovery to pre-disturbance communities (Continental Shelf Associates, Inc. 2004, 2006).

3
4 Overall, the site development and exploration represent a moderate disturbance primarily
5 affecting benthic invertebrates, with the severity of the impacts generally decreasing dramatically
6 with distance from bottom-disturbing activities. Recovery of invertebrate communities could
7 range from short-term to long-term.

8
9 **Production.** Production activities that could affect soft sediment habitat include
10 operational noise, bottom disturbance from the movement of mooring anchors, chains, and
11 cables, and the release of process water. In addition, the platform would replace existing
12 featureless soft sediments and potentially serve as an artificial reef (Table 4.4.7-8).

13
14 Chronic bottom disturbance would result from the movement of anchors and chains
15 associated with support vessels and floating platform moorings. Bottom disturbance would
16 impact invertebrates in a manner similar that described above for the exploration and site
17 development phase. The disturbance would be episodic and temporary, but would last for the
18 lifetime of the platform.

19
20 Sessile epifaunal invertebrates requiring hard substrate (i.e., barnacles and corals) as well
21 as small motile invertebrates (amphipods and worms) would be able to colonize the structure of
22 the platform, resulting in an artificial reef. Unburied pipelines would also provide hard substrate
23 for sessile and structure-oriented invertebrates. Although densities of some zooplankton species
24 were elevated near the platforms in the northern GOM, the effect was not consistent (Keenan and
25 Benfield 2003). The platform would likely increase shell material and organic matter in the
26 surrounding sediments, potentially resulting in a shift in benthic invertebrate community
27 composition. The replacement of soft sediment with artificial reef would only exist during the
28 production phase, unless the platform was permitted to remain in place after decommissioning.
29 Because platforms are spread across a large area of the GOM, they could provide habitat for non-
30 native invertebrate species that prefer hard substrate. Such species could be introduced by a
31 number of mechanisms both natural and anthropogenic (commercial shipping and human
32 introduction). In the deep sea, floating production platforms are used that could create a floating
33 reef habitat at the surface. In deep sea soft sediment, communities may form on mooring
34 structures, but colonization would likely be slow and mooring structures would be completely
35 removed during decommissioning, so impacts, if any, would be temporary.

36
37 Produced water contains metals, hydrocarbons, salts, and radionuclides, and its discharge
38 could contaminate habitat resulting in lethal and sublethal effects on invertebrates. Organisms
39 attached to oil platforms have not been found to accumulate metals, although they have been
40 found to bioaccumulate organic contaminants (Neff 2005; Trefry et al. 1995). Produced water
41 from deepwater wells is expected to contain more chemical contaminants to maintain adequate
42 flow. Contaminants from produced water discharges are not expected to reach toxic levels in the
43 sediment and water column due to dilution and NPDES permitting requirements regarding
44 discharge rate, contaminant concentration, and toxicity. Invertebrates collected in sediments
45 near platforms in the GOM do not appear to bioaccumulate the common contaminants in
46 produced water, such as radionuclides, metals, and hydrocarbons, and in most cases, the

1 concentration of these contaminants in their tissues did not exceed USEPA-specified
2 concentrations considered harmful (Continental Shelf Associates, Inc. 1997). Produced water is
3 also not expected to contribute significantly to the creation of hypoxic bottom water conditions
4 (Rabalais 2005; Bierman et al. 2007). Consequently, impacts to water-column and benthic
5 invertebrates should be minor.
6

7 The results of the GOM Offshore Monitoring Experiment, funded by BOEM, provide a
8 good summary of the long-term sublethal impacts of oil and gas development on invertebrates at
9 the individual, population, and community level (Kennicutt et al. 1995). Stations surrounding
10 petroleum wells were sampled in a radial pattern with stations at 30–50, 100, 200, 500, and
11 3,000 m distances (98–164, 328, 656, 1,640, and 9,842 ft). Elevated sediment concentrations of
12 sand, organic matter, hydrocarbons, and metals were generally restricted to sediments within
13 200 m (656 ft) of the platforms. Overall, there was no evidence of sublethal physiological stress
14 or change in distribution of epifaunal invertebrates attributable to the presence of the platform.
15 Oil and gas development activities resulted in altered infaunal communities within 100 m
16 (328 ft) of the platform, with reduced density and diversity of crustaceans (primarily amphipods
17 and copepods) near the platform and enhanced density of polychaetes and deposit-feeding
18 nematodes. The patterns in invertebrate density were often attributable to changes in a few
19 species. Differences in abundance between near- and far-field stations were the product of toxic
20 response of sensitive crustacean species and sediment organic enrichment, which increased the
21 density of worms (Kennicutt et al. 1995). Toxicity tests indicated copepod survival,
22 reproduction, and genetic diversity were lower near the platforms due to metal concentrations
23 (Kennicutt 1996; Montagna and Harper 1996) or the reef effect of the platform
24 (Montagna et al. 2002). Thus, production activities are expected to result in minor impacts to
25 invertebrates.
26

27 **Decommissioning.** Platform removal (potentially using explosives) would temporarily
28 affect benthic and pelagic invertebrates, as described above, by disturbing sediments and
29 increasing noise and turbidity for some length of the water column. Deposition of suspended
30 sediments could bury, smother, or kill some benthic organisms in the vicinity of work sites.
31 Mortality to epifauna should be limited to within a few meters of the blast (O’Keeffe and
32 Young 1984). In addition, the explosive charges typically would be set at 5 m (16 ft) below the
33 seafloor surface, which would significantly attenuate the shock wave as it moved through the
34 seabed. Displaced invertebrate communities would repopulate the area over a short period of
35 time, although a return to the pre-disturbance community may take longer. No permanent
36 change in benthic communities would result from floating platform removal. However, if fixed
37 platforms are toppled and left in place, the changes to invertebrate communities resulting from
38 the initial platform installation would be permanent. Pipelines installed and anchored on the
39 seafloor would be capped and left in place, although there is the potential for chronic sediment
40 disturbance from pipeline movement. Pipelines not buried would also continue to serve as hard
41 substrate for sessile invertebrates and structure oriented invertebrates. Overall, impacts to
42 invertebrates associated with decommissioning activities are expected to be minor.
43

44 **Accidents.** Accidental hydrocarbon spills can occur at the surface or at the seafloor,
45 potentially affecting pelagic and benthic invertebrates. Exposure to hydrocarbons can result in
46 lethal or sublethal (reproduction, recruitment, physiology, growth, development, and behavior)

1 impacts at the level of the individual, while catastrophic oil spills could result in population-level
2 effects and complex indirect effects on species interactions (i.e., competition and predation) in
3 some cases. Invertebrates differ in their sensitivity to hydrocarbon pollution both by organism
4 class and life stage (Laws 1992). For example, crustaceans appear to be among the taxa most
5 sensitive to oil pollution, while certain species of worms, such as Capitellid polychaetes, appear to
6 be tolerant of oil pollution (Blumer et al. 1971; Laws 1992; NRC 2003b). Among meiofauna,
7 nematodes may be less sensitive to oil than copepods.
8

9 Most oil and gas spills would be small and rapidly be diluted and are expected to
10 primarily affect invertebrates in the water column, as most hydrocarbons would float above the
11 sediment surface. However, even a small spill (<999 bbl) could affect intertidal and subtidal
12 invertebrates. After the spill of 600 bbl of crude oil in Barataria Bay, Louisiana, Roth and Baltz
13 (2009) found a reduction in total number of decapod crustaceans as well as reduction in grass
14 shrimp (*Palaeomonetes pugio*) 3 weeks after the spill occurred. The impact magnitude of these
15 small oil spills on invertebrates is primarily a function of the invertebrate species and habitat
16 affected. Impacts from spills would be greatest if a large spill occurred during a reproductive
17 period or contacted a location important for spawning or growth such as intertidal and nearshore
18 subtidal habitats. However, it is anticipated that only a small amount of shoreline would be
19 affected by these smaller oil spills and would not, therefore, present a substantial risk to
20 invertebrate populations. Impacts from small and large spills are expected to be temporary as oil
21 is diluted and broken down by natural chemical and microbial processes.
22

23 **Catastrophic Discharge Event.** The PEIS analyzes a CDE up to 7.2 million bbl
24 (Table 4.4.2-2). Spilled oil has been found to affect pelagic and sediment-dwelling invertebrates
25 (Laws 1992; reviewed in NRC 2003b). Pelagic invertebrates are concentrated in the upper water
26 column so oil and gas reaching the surface from a surface or subsurface CDE spill have the
27 potential to affect the greatest number of invertebrates. Hydrocarbon releases at the seafloor
28 would typically rise in the water column, which would limit direct contact with benthic
29 invertebrates. However, benthic invertebrates could be affected directly by oil reaching intertidal
30 or shallow subtidal habitats or natural deposition of oil contaminated pelagic organic matter and
31 biota, which could ultimately enter the benthic invertebrate food web. The location of the CDE
32 and the season in which the CDE occurred would be important determinants of the impact
33 magnitude of the spill. For example, catastrophic spills occurring during recruitment periods or
34 spills that affect areas with high larval invertebrate concentrations (i.e., estuaries) would have the
35 greatest impact. In addition, the magnitude of a spill's impacts on invertebrates and their habitat
36 would likely increase with the degree of shoreline oiling, as estuaries have high biological
37 productivity and serve as critical habitat for invertebrates. Oil would persist longer in the
38 environment than gas and oil could be transported to the shoreline where it could reduce local
39 populations of shallow subtidal and intertidal coastal habitat for an extended period of time.
40 However, a spill of this kind is unlikely to occur, and invertebrates typically have short
41 generation times and should recover from even a catastrophic spill. Therefore, no permanent
42 impacts to invertebrate communities are expected to result from an accidental oil spill.
43

44 Prior studies provide insight into the potential long-term effects of an oil spill on
45 invertebrate populations in the GOM. A large oil spill in Panama affected intertidal and subtidal
46 infauna and epifauna, with the impact magnitude and recovery time varying with the habitat,

1 organism, and degree of oiling (Jackson et al. 1989; Keller and Jackson 1993). Oysters and
2 mussels within mangroves, as well as amphipods, tanaids, and ophiurods in seagrass habitats,
3 displayed long-term (>9 months) reduction in abundance compared to unoiled areas. Corals and
4 associated biota were also affected by the spill, especially at the reef edge that received the
5 heaviest oiling. Although many species recovered within a few months to 2 years, certain
6 crustaceans and oysters had not recovered within 5 years (Keller and Jackson 1993).
7 Guzman et al. (1993) estimated a total recovery time of 10 to 20 years. The 1979 Ixtoc I spill in
8 the Bay of Campeche was not well studied; therefore it is difficult to assess the extent of impacts
9 on invertebrates (ERCO/Energy Resources Co. Inc 1982). Most studies of the Ixtoc spill
10 occurred in south Texas far from the spill site. In these studies, sediment contamination was not
11 detected and no strong links between Ixtoc oil and changes in invertebrate communities could be
12 found (ERCO/Energy Resources Co. Inc 1982; Laws 1993). In a study of upper Galveston Bay,
13 a site of heavy oil and gas activity with a history of spills, Rozas et al. (2000) found no consistent
14 significant relationships between sediment oil concentration and invertebrate densities, despite
15 testing multiple species. Although sediment contamination did not appear to affect habitat use,
16 sublethal exposure impacts could have been possible.

17 18 19 **4.4.7.5.2 Alaska– Cook Inlet.**

20
21 **Routine Operations.** Potential OCS oil and gas development impacting factors relevant
22 to invertebrates are shown by phase in Table 4.4.7-9. Impacting factors common to all phases
23 include vessel noise and discharges (bilge and ballast water), miscellaneous discharges (deck
24 washing, sanitary waste), and offshore lighting. Impacts from these activities would be localized
25 and temporary and would range from short-term to long-term. Overall, vessel and miscellaneous
26 discharges are not expected to impact invertebrate communities in the sediment or water column,
27 because many of these waste streams are disposed of on land or must meet USEPA and/or USCG
28 regulatory requirements before being discharged into surface waters. Studies of platform
29 lighting suggest the lights would alter predator-prey dynamics by enhancing phytoplankton
30 productivity around the platform, attracting phototaxic invertebrates and potentially improving
31 the visual foraging environment for fishes (Keenan et al. 2007).

32
33 **Exploration and Site Development.** During the OCS oil and gas exploration and
34 development phase, invertebrates could be affected by noise from seismic surveys and noise and
35 bottom disturbance from drilling, platform placement, and pipeline trenching and placement
36 activities.

37
38 Noise from vessel traffic, construction, seismic surveys, and drilling could kill or injure
39 invertebrates close enough to the noise source, as well as reducing habitat suitability, as some
40 species would avoid the area. For example, decapods and cephalopods, two numerically
41 abundant and commercially important groups of invertebrates, are known to detect vibrations
42 from underwater noise and may be sensitive to noise from vessel traffic, seismic surveys, and
43 drilling (DFO 2004; National Science Foundation and USGS 2010). Recent reviews of the
44 impacts of anthropogenic noise on invertebrates indicates that invertebrates exposed to noise
45 could exhibit pathological effects (i.e., injury and mortality), physiological changes (i.e., changes
46 in hormone, protein, and enzyme levels), and/or behavioral changes (such as a startle response)

1 **TABLE 4.4.7-9 Impacting Factors Potentially Affecting Invertebrates and Their**
2 **Habitat in the Cook Inlet Planning Area**

Development Phase and Impacting Factor	Life Stage Affected ^a		
	Eggs	Larvae	Adults
<i>Impacting Factors Common to All Phases</i>			
Vessel noise	X	X	X
Vessel traffic	X	X	X
Hazardous materials	X	X	X
Solid wastes	X	X	X
Offshore lighting	X	X	X
Aircraft noise			
Offshore air emissions			
Onshore air emissions			
Aircraft traffic			
Miscellaneous platform discharges	X	X	X
Vessel discharges	X	X	X
Bottom disturbance from vessel anchors	X	X	X
<i>Exploration and Development</i>			
Seismic noise	X	X	X
Noise from drilling and construction	X	X	X
Bottom disturbance from platform placement, drilling, and pipeline placement and trenching	X	X	X
Discharge of drilling muds and cuttings	X	X	X
<i>Production</i>			
Production Noise	X	X	X
Produced water discharge	X	X	X
Artificial reef	X	X	X
<i>Decommissioning</i>			
Platform removal (non-explosive)	X	X	X

^a Colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

3
4
5 and change swimming and movement patterns (DFO 2004; National Science Foundation and
6 USGS 2010). Although data is limited, zooplankton and larvae stages may be injured because of
7 their small size and relative lack of mobility, while noise is often found to have negligible effects
8 on adult invertebrates (reviewed in DFO 2004 and National Science Foundation and
9 USGS 2010). The studies typically suggested that injury was limited to within 10 m (33 ft) of
10 the noise source. The numbers of invertebrates that could be affected by noise during the
11 exploration and site development phase make it unlikely that noise impacts would have
12 appreciable effects on invertebrate populations in the overall Cook Inlet Planning Area. A recent
13 review of the effects of seismic survey activities on marine invertebrates concluded that although
14 data were limited, mortality and injury to invertebrates would be limited to organisms located

1 within a few meters of the air gun, and that there would be no significant impacts on marine
2 invertebrate populations from air gun and sonar sounds (National Science Foundation and
3 USGS 2010). The severity and duration of noise impacts would vary with site and development
4 scenario, but given the temporary and localized nature of the noise generating activities, impacts
5 on invertebrates are expected to be negligible.
6

7 Bottom-disturbing activities such as coring and drilling, platform placement and mooring,
8 and pipeline trenching and placement would displace, injure, or kill invertebrates in the vicinity
9 of the activities. Exploration would involve semisubmersible or floating drilling rigs, jack-up
10 rigs, and bottom-founded rigs depending on water depth. Production rigs would most likely be
11 fixed platforms. In the initial drilling phase before a riser is installed, drilling muds and cuttings
12 would accumulate around the well and bury benthic invertebrates as well as create a turbidity
13 plume that could adversely impact pelagic invertebrates located near the bottom. This change in
14 grain size could alter community composition and prevent the settlement of some species. In
15 addition, bottom disturbance during platform and pipeline placement would result in sediment
16 resuspension and turbidity, which could bury benthic infauna and damage the gills of water-
17 column and benthic invertebrates present within some distance of the disturbance. Platforms and
18 pipeline placement would disturb 1.5 to 4.5 ha (4 to 11 ac) and 35 to 210 ha (86 to 519 ac) of
19 bottom habitat, respectively. In addition, up to one pipeline landfill may result from the
20 proposed action. Species most likely to be affected by bottom-disturbing activities are sessile
21 and infaunal benthic organisms and small zooplankton that lack the mobility to avoid the direct
22 disturbance and the associated turbidity plumes. Pipelines would be installed and anchored on
23 the surface or buried. Pipelines could crush, injure, or displace invertebrates, as well as shift
24 invertebrate community composition to those species preferring hard substrate. Soft-sediment
25 invertebrates, particularly in shallow water, are subject to frequent bottom disturbance and
26 sediment resuspension due to human activities such as trawling and natural occurrences such as
27 storms. Thus, disturbed areas would likely be recolonized quickly, but, if grain size is greatly
28 altered and slow to recover, the benthic community may take from a few months to several years
29 to return to its pre-disturbance composition (Bolam and Rees 2003 and references therein).
30

31 The discharge of drilling muds and cuttings (including synthetic drilling fluids adhering
32 to the cuttings) can adversely affect invertebrates in several ways. The effects of drilling muds
33 and cuttings (including drilling fluids adhering to the cuttings) on invertebrates can be chemical
34 such as toxicity or physical such as gill abrasion, burial, or displacement from turbidity and
35 sedimentation. Impacts from turbidity and sedimentation would be similar to those described
36 above and could damage respiratory structures and disrupt food acquisition at all trophic levels.
37 Drilling wastes released near the sediment surface or in shallow water would bury benthic
38 organisms in the release area. Muds released in deeper water or near the water's surface would
39 be spread over a greater area in a thinner layer and may not result in high mortality, although
40 impacts to water column invertebrates may be greater under this scenario. The disturbance
41 would be short in duration, with repopulation of the affected area occurring by larval
42 recruitment. In addition, drilling discharges must comply with NPDES permit requirements
43 regarding the discharge amount, rate, and toxicity, which would greatly reduce the impact to
44 invertebrate communities.
45

1 Overall, site development and exploration activities would result in moderate and
2 temporary effects on primarily benthic invertebrates, with the severity of the impacts generally
3 decreasing dramatically with distance from the disturbance. Recovery of benthic habitat could
4 range from short-term to long-term.

5
6 **Production.** Production activities that could affect invertebrates in Cook Inlet include
7 operational noise, bottom disturbance from anchors and the release of process water. In addition,
8 the platform would replace existing featureless soft sediments and serve as an artificial reef
9 (Table 4.4.7-9).

10
11 Chronic disturbance to benthic invertebrates would result from the movement of
12 pipelines and anchors and chains associated with support vessels. Pipelines not buried would be
13 anchored in place which would minimize their movement and potential to disturb benthic
14 invertebrate communities. Bottom disturbance would impact invertebrates in a manner similar
15 that described above for the exploration and site development phase. The disturbance would be
16 episodic and temporary, but would last for the lifetime of the platform.

17
18 Produced water contains metals, hydrocarbons, salts, and radionuclides, and their
19 discharge could contaminate habitat resulting in lethal and sublethal effects on invertebrates,
20 particularly non-mobile benthic infauna. However, NPDES permitting requirements regarding
21 discharge rate, contaminant concentration, and toxicity would greatly reduce the potential for
22 impacts to invertebrates. In addition, it is assumed that all produced water would be disposed of
23 by injection into permitted disposal wells. Therefore, the effects of produced water discharges
24 on invertebrates are expected to be minimal.

25
26 Platforms would add a hard substrate to the marine environment, providing additional
27 habitat for marine plants and animals (e.g., kelp and mussels) that require a hard substrate. The
28 platform would likely increase shell material and organic matter in the sediments surrounding the
29 platform, potentially resulting in a shift in benthic invertebrate community composition.

30
31 A two-year (1997–1998) study of contaminant levels in the sediments of the Shelikof
32 Strait and Cook Inlet provide information on the overall, long-term potential effects of oil and
33 gas development in the Cook Inlet Planning Area (MMS 2001a). Samples of sediment from
34 depositional areas (where sediment contamination is expected to be greatest) suggested that
35 metals and PAHs in sediments derived primarily from natural sources rather than past oil and gas
36 developments (MMS 2001a). In addition, sediment concentrations of metals and organic
37 contaminants in outermost Cook Inlet and Shelikof Strait (1) have not increased significantly
38 since offshore oil exploration and production began in Cook Inlet (circa 1963) and (2) posed
39 only minor risks to benthic biota or fish (MMS 2001a). Consequently, it is expected that
40 production activities would have negligible effects on invertebrate communities in Cook Inlet.

41
42 **Decommissioning.** No explosive platform removals are anticipated under the proposed
43 action. Nonexplosive removals (e.g., abrasive, mechanical, or diver cutters) would have
44 negligible long-term impacts to invertebrates, although individuals associated with the platform
45 would experience, injury, mortality, or loss of habitat. Most sediments will recover their normal
46 physical characteristics, ecological functions, and biological communities. Pipelines installed

1 and anchored on the seafloor would be capped and left in place, although there is the potential
2 for chronic sediment disturbance from pipeline movement. If fixed platforms are left in place,
3 the changes to invertebrate communities resulting from the initial platform installation would be
4 permanent. Overall, impacts associated with decommissioning activities are expected to be
5 negligible.

6
7 **Accidents.** Accidental hydrocarbon releases can occur at the surface or at the seafloor,
8 potentially affecting pelagic and benthic invertebrates. Exposure to hydrocarbons can result in
9 lethal or sublethal (reproduction, recruitment, physiology, growth, development, and behavior)
10 impacts. Most small hydrocarbon releases would rapidly be diluted and are expected to
11 primarily affect invertebrates in the water column as most oil and gas would float above the
12 sediment surface. The impact magnitude of these oil spills on invertebrates is primarily a
13 function of the invertebrate species and habitat affected. Impacts from spills would be greatest if
14 a large spill occurred during a reproductive period or contacted a location important for
15 spawning or growth such as intertidal and nearshore subtidal habitats. However, it is anticipated
16 that only a small amount of shoreline would be affected by these smaller spills and they would
17 not, therefore, present a substantial risk to invertebrate populations.

18
19 **Catastrophic Discharge Event.** The PEIS analyzes a CDE of 75 to 125 thousand bbl in
20 the Cook Inlet Planning Area (Table 4.4.2-2). Because the Cook Inlet Planning Area is located
21 within a relatively confined estuary, the likelihood of oil from a catastrophic spill contacting part
22 of the shoreline is relatively high and is a function of assumed spill location. Site-specific
23 evaluations would have to be conducted to fully evaluate potential spill trajectories from future
24 lease sales. Benthic invertebrates in intertidal and shallow subtidal areas are likely to be
25 contacted by an oil spill. In addition, some oil spill-response activities could adversely affect
26 lower trophic-level organisms. For example, dispersants could increase oil toxicity, and cleanup
27 techniques, the presence of large numbers of people, or the use of heavy equipment on shorelines
28 could kill some coastal organisms during cleanup responses.

29
30 The toxicity of released hydrocarbons would probably decrease rapidly because of
31 evaporation, dispersion, and dilution. Thus, it is concluded that planktonic organisms within the
32 area of lethal hydrocarbon concentration could be killed during the first few days of a
33 hydrocarbon spill; after that, the primary effects would be sublethal responses such as reduction
34 in growth or reproductive rates except at the surface boundary of an oil slick. Large-scale
35 changes in overall plankton populations in Cook Inlet are considered unlikely. However,
36 intertidal invertebrates could experience long-term exposures, as oil could persist in intertidal
37 sediments for decades. Thus invertebrate populations could be depressed for a decade or more
38 (Highsmith et al. 2001; Exxon Valdez Oil Spill Trustee Council 2009a).

39
40 Studies following the *Exxon Valdez* spill give insight into the impacts of a catastrophic oil
41 spill on vertebrate communities and their subsequent recovery. Amphipods, sea stars, and
42 certain crabs were less abundant in oiled sites compared to areas not affected by the spill (*Exxon*
43 *Valdez* Oil Spill Trustee Council 2010c). Studies of mussels indicated hydrocarbons
44 accumulated in their tissue in the decade after the spill at sites where oil did not break down.
45 However, by 1999, contaminant levels in mussels from the most heavily oiled beds in Prince
46 William Sound were similar to background levels even though sediment contamination was still

1 present (*Exxon Valdez* Oil Spill Trustee Council 2010c). Stress-tolerant invertebrates like
2 polychaetes and snails did not appear to suffer long-term population declines in oiled areas. As
3 late as 2002, studies of clams indicated differences in population structure between areas affected
4 by the spill and clean areas (*Exxon Valdez* Oil Spill Trustee Council 2010c). However, much of
5 the long-term reduction in clam densities may have been due to the high-pressure beach washing
6 that occurred after the spill (*Exxon Valdez* Oil Spill Trustee Council 2009a). In intertidal areas,
7 the *Exxon Valdez* spill created large density fluctuations in kelp communities that serve as
8 habitat for benthic invertebrates. Intertidal experimental studies have demonstrated that rocky
9 intertidal communities are particularly slow to recover (+10 years) following disturbance
10 (Highsmith et al. 2001). As of 2009, clams, mussels, and intertidal communities are still listed as
11 recovering (*Exxon Valdez* Oil Spill Trustee Council 2009a).

12
13

14 **4.4.7.5.3 Alaska – Arctic.** Impacting factors common to all phases include vessel
15 discharges (bilge and ballast water), miscellaneous discharges (deck washing, sanitary waste),
16 and offshore lighting. Impacts from these activities would be localized and temporary and would
17 range from short-term to long-term. These discharges are expected to have no or negligible
18 impacts on invertebrate communities in the sediment and water column because many of these
19 waste streams are disposed of on land or must meet USEPA and/or USCG regulatory
20 requirements before being discharged into surface waters. Studies of platform lighting suggest
21 the lights would alter predator-prey dynamics by enhancing phytoplankton productivity around
22 the platform, attracting phototactic invertebrates, and potentially improving the visual foraging
23 environment for fishes (Keenan et al. 2007).

24

25 **Routine Operations.**

26

27 ***Exploration and Site Development.*** During the OCS oil and gas exploration and
28 development phase, invertebrates could be affected by noise from seismic surveys and noise and
29 bottom disturbance from drilling, subsea well, gravel island, and platform placement, and
30 pipeline trenching and placement activities. See Section 4.4.7.5.2 for a complete discussion of
31 the effects of exploration and site development activities on invertebrates.

32

33 Noise from seismic surveys and drilling could kill or injure invertebrates close enough
34 to the noise source and reduce habitat suitability as some species would avoid the area. Noise is
35 expected to have negligible effects on invertebrate populations in the overall Beaufort and
36 Chukchi Planning Areas (see Section 4.4.7.5.2).

37

38 Bottom-disturbing activities such as drilling, subsea well and platform placement, and
39 pipeline trenching and placement would displace, injure, or kill invertebrates in the vicinity of
40 the activities, as described in Section 4.4.7.5.2. In addition to burying and displacing benthic
41 communities, the construction of artificial islands would permanently alter sediment composition
42 and shift benthic invertebrate communities to species adapted to coarse gravel substrate.
43 Platform and pipeline placements in the Beaufort and Chukchi Planning Areas would disturb 3 to
44 13.5 ha (7 to 33 ac) and 77 to 567 ha (190 to 1,401 ac) of bottom habitat, respectively. Pipelines
45 would be installed and anchored on the surface or buried in waters less than 50 m (156 ft) to
46 prevent damage from ice gouges. Pipelines could crush, injure, or displace invertebrates, as well

1 as shift invertebrate community composition to those species preferring hard substrate. Benthic
2 habitats such as the Steffanson Boulder Patch and kelpbeds would be protected by stipulations
3 that require surveys for and avoidance of sensitive biological habitat. Although pipeline and
4 platform placement would disturb a large area of the seafloor, it is not expected to have a
5 measurable effect on regional populations. The benthic community in these areas experiences
6 similar naturally occurring disturbances from ice gouging, strudel scour, and severe storms. In
7 the Arctic, recolonization by benthic invertebrates can be slow to begin, and the benthic
8 community may take several years to return to its pre-disturbance composition following bottom-
9 disturbance activities (Conlan and Kvitek 2005). Overall, moderate but temporary impacts to
10 invertebrates are expected to result from platform and pipeline placement.

11
12 The discharge of drilling muds and cuttings from exploration wells could adversely affect
13 pelagic and benthic invertebrates (Section 4.4.7.5.2). However, drilling discharges must comply
14 with NPDES permit requirements regarding the discharge amount, rate, and toxicity, which
15 would greatly reduce the impact to invertebrate communities.

16
17 Overall, site development and exploration activities represent a moderate and temporary
18 disturbance that would primarily affect benthic invertebrates. The severity of the impacts would
19 generally decrease dramatically with distance from bottom-disturbing activities. Recovery of
20 benthic habitat could range from short-term to long-term.

21
22 **Production.** Production activities that could affect invertebrates include operational
23 noise, bottom disturbance from the movement of mooring anchors, chains, and cables, and the
24 release of process water. In addition, the platform and gravel islands would replace existing
25 featureless soft sediments and serve as artificial reefs (Table 4.4.7-10).

26
27 Chronic disturbance to benthic invertebrates would result from the movement of anchors
28 and chains associated with support vessels. Bottom disturbance would impact invertebrates in a
29 manner similar to that described above for the exploration and site development phase. The
30 disturbance would be episodic and temporary, but would last for the lifetime of the platform.

31
32 Produced water contains metals, hydrocarbons, salts, and radionuclides, and its discharge
33 could contaminate habitat resulting in lethal and sublethal effects on invertebrates, particularly
34 nonmobile benthic infauna. However, it is assumed that produced water would be reinjected into
35 the well rather than discharged into the ocean. In addition, produced water discharges must
36 comply with NPDES permit requirements regarding the discharge amount, rate, and toxicity,
37 which would greatly reduce the impact to invertebrate communities (Section 4.4.7.5.2).

38
39 The presence of platforms or artificial islands would favor invertebrates requiring or
40 preferring hard substrates, thus shifting community composition in some areas. The platform
41 would likely increase shell material and organic matter in the sediments surrounding the
42 platform, potentially resulting in a shift in benthic invertebrate community composition.

43
44 The results of the study Arctic Nearshore Impacts Monitoring in the Development Area
45 funded by BOEM provide a good summary of the long-term changes to benthic communities
46 resulting from oil and gas development in the Arctic. Boehm (2001) determined that

1 **TABLE 4.4.7-10 Impacting Factors Potentially Affecting Invertebrates and Their**
2 **Habitat in the Beaufort and Chukchi Planning Areas**

Development Phase and Impacting Factor	Life Stage Affected ^a		
	Eggs	Larvae	Adults
<i>Impacting Factors Common to All Phases</i>			
Vessel noise	X	X	X
Vessel traffic	X	X	X
Hazardous materials	X	X	X
Solid wastes	X	X	X
Offshore lighting	X	X	X
Aircraft noise			
Offshore air emissions			
Onshore air emissions			
Aircraft traffic			
Miscellaneous platform discharges	X	X	X
Vessel discharges	X	X	X
Bottom disturbance from vessel anchors	X	X	X
<i>Exploration and Development</i>			
Seismic noise	X	X	X
Noise from drilling and construction	X	X	X
Bottom disturbance from drilling and placement of platforms, subsea wells, artificial islands, and pipelines	X	X	X
Discharge of drilling muds and cuttings	X	X	X
<i>Production</i>			
Production noise	X	X	X
Produced water discharge	X	X	X
Artificial reef	X	X	X
<i>Decommissioning</i>			
Platform removal (nonexplosive)	X	X	X

^a Colors indicate impact level: white = negligible; blue = minor; yellow = moderate; red = major.

3
4
5 hydrocarbons in sediments (largely attributable to natural sources) were not readily bioavailable
6 to marine filter feeders and deposit-feeders, and concluded that small incremental contaminant
7 additions from future development activities are unlikely to cause immediate ecological harm to
8 organisms in the Beaufort Sea study area. After reviewing tissue samples between 2000 and
9 2006, hydrocarbon and metals concentrations in invertebrates sampled near the Northstar
10 development and Liberty Prospect area were found to be similar to or lower than invertebrate
11 tissue levels found elsewhere in the world (Neff and Associates LLC 2010). No increase in
12 hydrocarbons and metals in marine invertebrate tissues was attributable to oil and gas
13 production, even for benthic infauna such as amphipods and clams. Concentrations of metals

1 and hydrocarbons in benthic invertebrates collected in the Boulder Patch were similar to
2 concentrations in invertebrates collected elsewhere in the development area.

3
4 Overall, the effects of production activities on invertebrates are expected to be negligible.

5
6 **Decommissioning.** No explosive platform removals are anticipated under the proposed
7 action. Nonexplosive removals (e.g., abrasive, mechanical, or diver cutters) would have
8 negligible long-term impacts on invertebrates, although individuals associated with the platform
9 would experience injury, mortality, and loss of habitat. Pipelines installed and anchored on the
10 seafloor would be capped and left in place, although there is the potential for chronic sediment
11 disturbance from pipeline movement. The changes to invertebrate communities resulting from
12 the construction of artificial gravel islands would be permanent. Overall, impacts associated
13 with decommissioning activities are expected to be negligible.

14
15 **Accidents.** See Section 4.4.6 for a general discussion of hydrocarbon spills in marine
16 habitat and Section 4.4.7.5.2 for a discussion of their impacts on invertebrates. Hydrocarbons
17 can cause both lethal and sublethal effects to marine invertebrates. Sublethal effects occur at
18 lower concentrations and include reduced growth and/or fecundity, increased physiological
19 stress, and behavioral changes that may reduce fitness and population size.

20
21 Accidental hydrocarbon releases can occur at the surface or at the seafloor, potentially
22 affecting pelagic and benthic invertebrates. Most hydrocarbon releases would be rapidly diluted
23 and are expected to primarily affect plankton, as most oil and gas would float above the sediment
24 surface. Most accidental releases would be small, and any impacts would be sublethal except in
25 the immediate vicinity of the spill where lethal concentrations of oil may be present. The impact
26 magnitude of these oil spills on invertebrates is primarily a function of the invertebrate species
27 and habitat affected. Impacts from spills would be greatest if a large spill occurred during a
28 reproductive period or contacted a location important for spawning or growth such as intertidal
29 and nearshore subtidal habitats. However, it is anticipated that only a small amount of shoreline
30 would be affected by these smaller oil spills and would not, therefore, present a substantial risk
31 to invertebrate populations. Impacts from small and large spills are expected to be temporary as
32 oil is diluted and broken down by natural chemical and microbial processes.

33
34 **Catastrophic Discharge Event.** The PEIS analyzes a CDE of 1.4 to 2.2 million bbl in
35 the Chukchi Sea and 1.7 to 3.9 million bbl in the Beaufort Sea (Table 4.4.2-2). A CDE oil spill
36 could contaminate sediments and the water column for some distance around the leak or rupture.
37 Most released oil and gas would float above the seafloor, so direct contact with benthic
38 communities in deeper water should be relatively low. If large quantities of oil from a
39 catastrophic oil spill were to reach intertidal sediments or shallow subtidal sediment, benthic
40 invertebrates in the affected areas could experience high levels of contamination and mortality,
41 and, given the slow rate of oil breakdown in the Arctic, benthic invertebrate populations could be
42 depressed for many years. See Section 4.4.7.5.2 for a detailed discussion of oil spills on
43 invertebrates following the catastrophic Exxon Valdez spill.

44
45 Hydrocarbon releases contacting the Stefansson Sound Boulder Patch community could
46 have direct impacts on organisms inhabiting the area. The magnitude of impacts to the Boulder

1 Patch would depend on the location and severity of the spill. Studies show that the Boulder
2 Patch communities are slow to recolonize (Konar 2007 and references therein). Kelp associated
3 benthic animal communities have also been shown to have major shifts in species composition
4 following exposure to oil (Dean and Jewett 2001). Impacts to kelp habitat from an oil spill could
5 be long-term, but are not expected to be permanent. *Laminaria* beds oiled by the *Exxon Valdez*
6 spill recovered within 10 years (Dean and Jewett 2001). Planning and permitting procedures
7 requiring no impacts to sensitive biological communities will also minimize spill impacts to the
8 Boulder Patch area.

9
10 Oil from a CDE occurring under ice is more difficult to locate and clean than surface
11 spills. Since weathering would be greatly reduced by ice cover, pelagic invertebrates could
12 continue to be harmed or killed as they drift into the trapped oil. In addition, invertebrates living
13 beneath the ice are a crucial food source in the Arctic food web that could be degraded or lost by
14 contact with oil spills.

15
16
17 **4.4.7.5.4 Conclusion.** The primary impacts of oil and gas activities on invertebrates in
18 the GOM and Alaska Planning Areas would be from drilling waste discharges and from bottom-
19 disturbing activities during the exploration and site development phase, which could displace,
20 bury, injure, or kill invertebrates in the vicinity of the activities. Displaced invertebrate
21 communities would generally repopulate the area over a short-period of time, although a return
22 to the pre-disturbance community may take longer, particularly in the Arctic. Where floating
23 platforms are used, scour from the movement of mooring structures represents a chronic
24 disturbance to benthic invertebrates lasting the life of the production phase. If discharged into
25 open water, the effects of drilling wastes and produced water on invertebrates would be localized
26 and no population-level effects are expected. Changes in benthic invertebrate community
27 structure and function should be restricted to the vicinity of the platform. Overall, activities
28 conducted during exploration and site development, production, and decommissioning phases
29 could result in moderate impacts to benthic and pelagic invertebrates. Bottom-disturbing
30 activities would be temporary and recovery could be short-term to long-term. No permanent or
31 population-level impacts to invertebrates are expected. Overall impacts from routine Program
32 activities would range from negligible to moderate.

33
34 Small surface or subsurface hydrocarbon spills would be rapidly diluted and would likely
35 result in only small localized, sublethal impacts to invertebrates. Large or CDE-level spills could
36 affect a large number of benthic and pelagic invertebrates and their habitats. The location of the
37 spill and the season in which the spill occurred would be important determinants of the impact
38 magnitude of the spills. A large or CDE spill would likely contact shoreline areas, and benthic
39 invertebrates in sensitive intertidal and shallow subtidal habitats could experience large-scale
40 lethal and long-term sublethal effects. In Alaska, local populations of intertidal organisms
41 affected by such large spills could be measurably depressed for several years and oil could
42 persist in shoreline sediments for decades (especially in the case of a CDE spill). However, large
43 or CDE spills are unlikely to occur, and invertebrates typically have short generation times and
44 should recover.

1 **4.4.8 Potential Impacts to Areas of Special Concern**

2
3
4 **4.4.8.1 Gulf of Mexico**

5
6
7 **4.4.8.1.1 Routine Operations.**

8
9 **Marine Protected Areas (MPAs).** National System MPAs in the Western and Central
10 Planning Areas consist of the FGBNMS, Jean Lafitte National Historical Park and Preserve,
11 Barataria Preserve, and a number of National Wildlife Refuges (NWRs) (Table 3.9.1-1). MPAs
12 would primarily be affected by pipeline landfalls and potentially by accidental oil spills
13 occurring nearshore as well as large offshore oil spills. Impacts on the FGBNMS and NWRs are
14 described below. *De facto* MPAs are primarily military use areas and are also discussed below.
15

16 **National Marine Sanctuaries of Texas and Louisiana in the Western Gulf of Mexico**
17 **Planning Area (Figure 3.9.1-1).** Potential impacts on the FGBNMS resulting from site
18 exploration and development activities are discussed in detail in (Section 4.4.6.2.1). Direct
19 impacts on the FGBNMS from bottom disturbance would be prevented by the Topographic
20 Features Stipulation, which prohibits exploration and development activities and the deposition
21 of drilling muds and cuttings in the vicinity of the FGBNMS. During the production phase,
22 produced water discharges are not likely to impact the FGBNMS because of the Topographic
23 Features Stipulation requiring large buffers between the FGBNMS and oil and gas development
24 activities (Section 4.4.6.2.1).
25

26 New oil and gas production platforms could act as artificial reef habitat and potentially
27 act as stepping stones allowing the establishment of invasive species in the FGBNMS
28 (Section 4.4.6.2.1). However, there is no conclusive evidence this has occurred historically, and
29 it is more likely that invasive species would establish at the FGBNMS even without the
30 platforms, although the platforms may speed the process.
31

32 **National Parks, National Seashores, Reserves, and Refuges.** See Section 4.4.6.1.1 for
33 a discussion of the potential impacts of the Program on coastal habitats. It is assumed that
34 pipeline landfalls, shore bases, and waste facilities would not be located in National Parks,
35 NWR, or National Estuarine Research Reserves because of their special status and protections.
36 Consequently, impacts to these areas from oil and gas exploration and production activities are
37 not expected to occur.
38

39 It is possible that shore bases and waste facilities may be located in one or more estuaries
40 in the Western or Central GOM Planning Area. It is assumed that new shore bases and waste
41 facilities would be constructed in existing developed or upland areas and would not be sited in
42 coastal habitats such as barrier beaches or wetlands. Therefore, impacts on parks, seashores,
43 refuges, and reserves are not likely to occur.
44

45 Trash and debris from various sources, including OCS operations, frequently wash up on
46 beaches, which could affect Gulf Shores or Padre Island National Seashore. The discharge or

1 disposal of solid debris from OCS structures and vessels is prohibited, and assuming that
2 operators comply with regulations, most potential impacts would be avoided, although some
3 accidental loss of materials is inevitable.

4
5 NPS lands, wildlife refuges, and research reserves could potentially be affected by
6 increased boat and aircraft traffic associated with OCS oil and gas activities. Existing mitigation
7 measures limit vessel speeds in inland waterways and aircraft altitudes over Areas of Special
8 Concern. With these measures in place, most impacts on these Areas of Special Concern due to
9 vessel and aircraft traffic would be avoided.

10
11 **Military Uses.** The Military Areas Stipulation applies to all blocks leased in military
12 areas and requires lessees to coordinate their activities with the relevant military authorities and
13 also states that the U.S. Government is not responsible for any accidents involving military
14 operations. The Military Areas Stipulation reduces use conflicts and improves safety but does
15 not reduce or eliminate the actual physical presence of oil and gas operations. Accidents and use
16 conflicts involving oil and gas and military operations would be minimized or eliminated by
17 adherence to the Military Areas Stipulation. Currently, both activities coexist in the GOM, and
18 there has never been an accident involving the military and oil and gas lessees.

19
20
21 **4.4.8.1.2 Accidents.** It is assumed that up to 8 large spills (between 1,700 and
22 5,300 bbl), up to 70 spills between 50 and 999 bbl, and up to 400 smaller spills between 1 and
23 50 bbl could occur during the lease period under the proposed action. Small spills at the seafloor
24 would rise in the water column but are not likely to contact the FGBNMS at concentrations toxic
25 to marine life (see Section 4.4.6.2.1). Small platform spills and tanker spills at the ocean surface
26 could penetrate the water column to documented depths of 20 m (66 ft) or more, which is within
27 the depth range of the crests of some coral reefs and topographic features including the
28 FGBNMS. However, at these depths, the contaminant concentrations are typically several orders
29 of magnitude lower than those demonstrated to have an effect on marine organisms
30 (MMS 2008a). Therefore, it is likely that only small concentrations of oil from surface spills
31 would reach the FGBNMS (MMS 2008a).

32
33 An oil spill reaching sensitive coastal habitats could impact National Parks, NWRs,
34 National Estuarine Research Reserves, or National Estuary Program sites. Impacts could result
35 from both oiling of the shoreline and mechanical damage during the cleanup process. Small or
36 large spills (>1,000 bbl) would be rapidly diluted and degraded by natural processes and, given
37 the small size of most spills, impacts to a significant area of the shoreline are unlikely.

38
39 **Catastrophic Discharge Event.** This PEIS analyzes a CDE up to 7.2 million bbl in the
40 GOM. It is possible that such a spill originating from outside the No Activity Zones established
41 by the Topographic Features Stipulations could reach the vicinity of the FGBNMS. However,
42 because of the tendency for oil components to rise toward the surface and to be diluted as they
43 are transported by water currents, any impacts associated with a large or catastrophic spill
44 reaching sensitive corals would most likely be sublethal. Hydrocarbons have been shown to
45 have lethal and sublethal (reproduction, larval settlement, photosynthesis, and feeding) effects on
46 corals, although no effects on corals following oil spills are also frequently reported (Loya and

1 Rinkevich 1980; Bak 1987; Guzman et al. 1991; Dodge et al. 1995; Haapkyla et al. 2007).
2 Corals have the capacity to recover quickly from hydrocarbon exposure. For example,
3 Knap et al. (1985) found that when *Diploria strigosa*, a common massive brain coral at the
4 Flower Garden Banks, was dosed with oil, it rapidly exhibited sublethal effects but also
5 recovered quickly. However, larval stages of coral are far more sensitive than adults. Therefore,
6 the impact magnitude of a spill is partly dependent on whether the spill occurs during a period of
7 coral spawning. For lethal exposures, the community would likely recover once the area had
8 been cleared of oil, although full recovery could take many years (Haapkvla et al. 2007).
9 Consequently, it is anticipated that impacts of lethal concentrations of oil reaching coral reef or
10 hard-bottom habitat would be long-term but temporary.

11
12 A CDE taking place near shore or in deeper water could affect coastal parks, reserves,
13 and refuges if the oil was transported to these areas by currents. Impacts on parks, preserves, and
14 refuges would depend on the size and specific location of the oil spill and the effectiveness of
15 cleanup procedures. If a large volume of heavy oil were to reach these areas, that situation could
16 result in park closure and reduced visitation. In general, oil spills affecting parks, refuges, and
17 reserves would diminish their function by reducing habitat value for wildlife and aquatic biota
18 and interrupting monitoring and research activities.

19
20 The impacts of oil spills on parks, preserves, and refuges could include death of wetland
21 vegetation and associated wildlife, oil saturation and trapping by vegetation and sediments (thus
22 causing it to become a chronic source of pollution), and mechanical destruction of the wetland
23 area during cleanup. Spills that damage wetland vegetation protecting canal and waterway banks
24 could accelerate erosion of those banks (see Section 4.4.6.1.1). Some areas may recover
25 completely if proper remedial action was taken. Others may not recover completely. Oil could
26 remain in some coastal substrates for decades, depending on the type of oil spilled, the amount
27 present, sand grain size, the degree of penetration into the subsurface, the exposure to the
28 weathering action of waves, and sand movement onto and off the shore. See Section 4.4.6.1.1
29 for a discussion of the potential impacts of oil spills on coastal habitats.

30 31 32 **4.4.8.2 Alaska – Cook Inlet**

33 34 35 **4.4.8.2.1 Routine Operations.**

36
37 **Marine Protected Areas (MPAs).** The Alaska Peninsula unit and Gulf of Alaska unit of
38 the Alaska Maritime NWR are the only Federal MPAs in the vicinity of the Cook Inlet Planning
39 Area. NWRs could primarily be affected by pipeline landfalls and potentially by accidental oil
40 spills, as described below.

41
42 **National Parks, National Forests, National Seashores, Reserves, and Refuges.**
43 Impacts on National Parks, Forests, Reserves, and Refuges could result from facilities developed
44 to support offshore oil drilling and production, and could include effects from pipeline landfall;
45 dredging and construction; and the construction of roads, processing and waste facilities, and
46 onshore pipelines. In addition, subsistence hunting and fishing, which are permitted on all

1 refuges in Alaska, could be affected by oil and gas operations. It is assumed that pipeline
2 landfalls, shore bases, and waste facilities would not be located in National Parks, National
3 Forests, NWRs, or National Estuarine Research Reserves because of the special status and
4 protections afforded these areas. See Section 4.4.6.1.2 for a discussion of the potential impacts
5 of OCS oil and gas activities on coastal habitats.
6

7 National Park Service (NPS) lands are potentially susceptible to impacts from activities
8 related to OCS oil and gas development as a consequence of the Program in Cook Inlet. The
9 potentially affected lands include the Lake Clark National Park and Preserve, the Katmai
10 National Park and Preserve, and Aniakchak National Monument. Kenai Fjords National Park is
11 east of Cook Inlet on the GOA, but it could be affected by an oil spill associated with OCS
12 activities in Cook Inlet.
13

14 Impacts from routine OCS operations could come from facilities developed to support oil
15 drilling and production, and could include effects from pipeline landfalls, dredging, air pollution,
16 and the construction of roads and new facilities. Onshore oil facilities are permissible only on
17 private acreage within each national park land. All of these national parks, monuments, and
18 preserves contain privately held acreage, and development of onshore oil support facilities is
19 possible in these areas. Because of the more confined nature of Cook Inlet, OCS construction of
20 facilities within the Cook Inlet Planning Area could have some negative effects on scenic values
21 for some users of the Lake Clark and Katmai National Parks and Preserves, if the facilities were
22 visible from shore or the air during flightseeing.
23

24 Noise and vessel traffic associated with construction activities in offshore areas adjacent
25 to park and refuge boundaries could temporarily disturb some wildlife and could negatively
26 affect recreational values for park users. It is anticipated that noise generated by offshore
27 construction activities would be at low levels, intermittent, and would not occur for more than a
28 few months. Scenic values for some park users could be negatively affected in the long term by
29 the presence of platforms visible from park areas.
30

31 National Wildlife Refuges (NWRs) in the vicinity of Cook Inlet are identified in
32 Section 3.9.2.2. NWRs potentially affected by OCS activities in the Cook Inlet Planning Area
33 include the Alaska Peninsula NWR, Becharof NWR, Kodiak NWR, Kenai NWR, and Izembek
34 NWR. Section 22(g) of the Alaska Native Claims Settlement Act of 1971 (ANCSA) requires
35 that new development on National Wildlife Refuge lands must be in accordance with the purpose
36 for which the refuge was formed. Therefore, although development of onshore oil and gas
37 support facilities is technically possible, such projects would be subject to intensive review. The
38 potential effects of routine operations and accidental events on these NWRs are essentially the
39 same as those discussed above for the NPS lands. Noise and vessel traffic associated with
40 construction activities in offshore areas adjacent to park and refuge boundaries could temporarily
41 disturb some wildlife and could negatively affect recreational values for park users. It is
42 anticipated that noise generated by offshore construction activities would be at low levels,
43 intermittent, and would not occur for more than a few months. Scenic values for some park
44 users could be negatively affected in the long term by the presence of platforms visible from park
45 areas. In addition, subsistence hunting and fishing are permitted on all refuges in Alaska and

1 could, therefore, be affected by accidents and routine operations in the immediate vicinity of
2 refuge properties.

3
4 The only national forest within the vicinity of the Cook Inlet Planning Area is the
5 Chugach National Forest, which is located mainly on the eastern side of the Kenai Peninsula
6 (Figure 3.9.2-1). Because there would be no OCS-related development, such as pipelines or
7 other onshore facilities, within the Chugach National Forest, it would not be affected by routine
8 OCS activities associated with lease sales in the Cook Inlet Planning Area. The Chugach
9 National Forest also borders Prince William Sound and is close to Valdez. The Chugach
10 National Forest is, therefore, potentially susceptible to effects of routine oil-related operations
11 from transport and tanker loading of oil produced (OCS and non-OCS) in other regions (e.g., the
12 Beaufort Sea Planning Area) and transported by pipeline to the Port of Valdez. Potential effects
13 include increased noise and air pollution from tanker traffic.

14
15 **Other Areas of Special Concern.** There are multiple State parks and State recreation
16 areas near the Cook Inlet Planning Area, many of which border Cook Inlet or are located in areas
17 that could be contacted by accidental oil spills. Such areas include Captain Cook State
18 Recreation Area, Clam Gulch State Recreation Area, Chugach State Park, Kachemak Bay State
19 Park and State Wilderness Park, and Ninilchik State Recreation Area. In addition, the Kachemak
20 Bay National Estuarine Research Reserve is located in Cook Inlet on the southern end of the
21 Kenai Peninsula. Impacts from OCS activities would be similar to those described above for
22 National Parks and Refuges. Existing protections and restrictions on uses should limit the direct
23 terrestrial impacts from OCS activities on these areas. It is assumed that pipeline landfalls, shore
24 bases, and waste facilities would not be located in the State parks and recreation areas. It is
25 anticipated that noise generated by OCS offshore construction activities would be at low levels,
26 intermittent, and would not persist for more than a few months at any one time. It is considered
27 unlikely that these additional activities would noticeably affect wildlife or park user values
28 compared to current (non-OCS) activities within the considered planning areas. There are no
29 Military Use Areas in the Cook Inlet Planning Area; therefore, no conflicts between OCS
30 activities and the military are expected to occur.

31
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33 **4.4.8.2.2 Accidents.** Accidental oil spills could occur from land-based pipelines and
34 facilities, vessels, and offshore platforms and pipelines. It is assumed that 2 small spills between
35 50 and 999 bbl and 10 smaller spills between 1 and 50 bbl could occur under the proposed
36 action. It is assumed that one large spill between 1,500 and 7,800 bbl could occur in Cook Inlet.

37
38 Spills on land are not likely to affect National Parks, Refuges, or National Forests
39 because pipelines and other oil and gas infrastructure would not likely be permitted in these
40 areas. However, there are several NWRs and National Parks along the shorelines of the Cook
41 Inlet Planning Area, as well as one National Estuarine Research Reserve, and coastal areas of all
42 could be significantly affected by large or catastrophic spills. A section of the Chugach National
43 Forest borders Turnagain Arm and could be affected by spills originating in Cook Inlet as well as
44 tanker spills associated with the Port of Valdez. The Lake Clark National Park and Preserve has
45 approximately 50 km (31 mi) of shoreline along Cook Inlet, including shoreline areas in Tuxedni
46 and Chinitna Bays that are considered to contain sensitive habitats. Katmai National Park and

1 Preserve also contains extensive shoreline in proximity to the Cook Inlet Planning Area and the
2 Shelikof Strait, and it is also adjacent to Katmai Bay, which is considered a sensitive resource
3 area. If a large amount of oil were to contact a National Park, visitation would be likely to
4 decrease or be temporarily prohibited. The several NWRs located in and around Cook Inlet,
5 such as the Kodiak NWR and the Alaska Maritime NWR, could also experience a loss of habitat
6 value if they experienced heavy oiling from offshore spills. Site-specific evaluations would be
7 conducted to fully evaluate potential spill trajectories and spill probabilities in a lease sale EIS.
8

9 Several State parks and recreational areas border Cook Inlet and could be affected by
10 accidental releases of oil spilled from onshore facilities and offshore drilling rigs. An oil spill
11 contacting shoreline habitats could affect subsistence harvests in those parks in which recreation
12 and subsistence hunting and fishing are allowed and could affect the number of park visitors.
13 Impacts would depend primarily on the spill location, size, and time of year.
14

15 **Catastrophic Discharge Event.** The PEIS analyzes the impacts of a CDE up to
16 125,000 bbl in the Cook Inlet Planning Area. If a large volume of oil were to reach the shoreline
17 following a catastrophic spill, NWRs could suffer a reduction in their primary function, which is
18 to support wildlife and aquatic biota. Given the cold temperatures in Alaska, oil could
19 contaminate nearshore refuge habitats for several years to decades and result in lethal and long-
20 term sublethal impacts to refuge biota. Impacts would depend primarily on spill location, spill
21 size, and timing of the spill. In general, directly affected coastal fauna would include marine
22 mammals; fishes that reproduce in, inhabit, or migrate through coastal areas; terrestrial mammals
23 that forage on fish; and marsh and seabirds that use these habitats for nesting and/or foraging.
24 Spilled oil could also affect subsistence harvests in those parks in which subsistence hunting and
25 fishing are allowed. See Sections 4.4.6.1.2 and 4.4.6.1.3 for a description of potential impacts of
26 catastrophic oil spills on coastal areas and biota. Oil could contaminate nearshore habitats for
27 several years to decades and result in lethal and long-term sublethal impacts on refuge biota
28 (Short et al. 2007; Taylor and Reimer 2008; *Exxon Valdez* Oil Spill Trustee Council 2010c). The
29 degree of effects and length of recovery depend on a number of factors such as the type of oil,
30 extent of biota exposure, substrate type, degree of sediment contamination, time of year, and
31 species sensitivity (NOAA 1998; Hayse et al. 1992; Hoff 1995). Sheltered intertidal areas are
32 particularly slow to recover. More than 20 years after the *Exxon Valdez* oil spill, intertidal
33 communities were considered to be recovering, but had not yet fully recovered from the effects
34 of the spill (*Exxon Valdez* Oil Spill Trustee Council 2010a).
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37 **4.4.8.3 Alaska – Arctic**

38 **4.4.8.3.1 Routine Operations.**

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42 **Marine Protected Areas (MPAs).** The Arctic National Wildlife Refuge (ANWR) and
43 the Chukchi Sea unit of the Alaska Maritime National Wildlife Refuge are the two Federal
44 system MPAs in or adjacent to the Beaufort and Chukchi Planning Areas, and are described in
45 Section 3.6.5.1. NWRs could primarily be affected by pipeline landfalls and potentially by
46 accidental oil spills, as described below.

1 **National Forests, Parks and Refuges.** There are no National Forests in the vicinity of
2 the Beaufort and Chukchi Sea Planning Area; therefore, no impacts on U.S. Forest Service lands
3 are expected. Impacts on NWRs could result from facilities developed to support offshore oil
4 drilling and production, and could include effects from onshore pipelines and pipeline landfalls,
5 dredging and construction, air pollution and the construction of roads, and processing and waste
6 facilities. In addition, subsistence hunting and fishing, which are permitted on all NWRs in
7 Alaska, could be affected by OCS activities. See Section 4.4.6.1.3 for a discussion of the
8 potential impacts of the Program on coastal habitats. Oil facility development currently is
9 prohibited on the ANWR and is discretionary on all other NWRs within Alaska. Although
10 numerous refuge lands have been conveyed to private ownership and Native corporations,
11 Section 22(g) of ANCSA requires that new development on these lands must be in accordance
12 with the purpose for which the refuge was formed. Therefore, development of onshore oil and
13 gas support facilities, though technically possible, would be subject to an exhaustive
14 environmental review process. Therefore, it is currently considered unlikely that onshore oil and
15 gas activities would be developed on refuge lands. Indirect impacts resulting from OCS
16 activities, such as noise pollution or emissions associated with transportation of oil from adjacent
17 planning areas, could occur but would be unlikely to have substantial effects on resources within
18 refuge boundaries.

19
20 The Iñupiat Heritage Center, located in Barrow, Alaska, is the only NPS-managed area
21 along the coast of the Beaufort and Chukchi Planning Areas. The area is already urbanized and
22 would not be adversely affected by OCS activities. Although not an NPS land, the National
23 Petroleum Reserve is managed by BLM and has a large shoreline component that borders the
24 Chukchi Sea. Cape Krusenstern National Monument and the Bering Land Bridge National
25 Preserve are south of the Chukchi Planning Area. Although oil transport through the Cape
26 Krusenstern National Monument is permitted under the ANCSA and an existing road is present
27 that could be used to access or create support facilities, such development is considered unlikely
28 under the proposed action. Onshore oil and gas development within the boundaries of the Bering
29 Land Bridge National Preserve is also considered to be unrealistic. Consequently, there are
30 likely to be no effects in either of these National Parks from the proposed action.

31
32 **4.4.8.3.2 Accidents.** It is assumed that up to 3 large oil spills between 1,700 and
34 5,100 bbl, up to 35 small spills (50 to 999 bbl) and up to 190 smaller spills (>1 and <50 bbl)
35 could occur during the lease period under the proposed action. Oil spills can occur from offshore
36 drilling platforms, from vessels, or from pipelines located onshore and offshore. OCS
37 infrastructure and activities are not likely to be permitted in NPS lands or in NWRs. Therefore,
38 impacts to these areas from onshore pipeline spills are not likely. While small oil spills would
39 likely only have limited influence on potentially affected resources within these refuges, a large
40 spill could result in more drastic effects on coastal habitats and fauna.

41
42 **Catastrophic Discharge Event.** This PEIS analyzes the impacts of a CDE up to
43 2.2 million bbl in the Chukchi Sea Planning Area and 3.9 million bbl in the Beaufort Sea
44 Planning Area (Table 4.4.2-2). Large catastrophic oil spills from offshore pipelines or platforms
45 could potentially contact shoreline habitats and communities in NWRs and NPS lands.
46 However, Cape Krusenstern National Monument and the Bering Land Bridge National Preserve

1 are located more than 322 km (200 mi) south of the Chukchi Sea Planning Area and are therefore
2 unlikely to be adversely affected by accidental spills occurring offshore in the Beaufort and
3 Chukchi Seas. The Arctic NWR and the Chukchi Sea unit of the Alaska Maritime NWR would
4 be susceptible to oil spilled from subsea pipelines or drilling platforms.
5

6 If a large volume of heavy oil were to reach the shoreline following a catastrophic spill,
7 NWRs could suffer a reduction in their primary function which is to support wildlife and aquatic
8 biota. Given the cold temperatures in Alaska, oil could contaminate nearshore refuge habitats for
9 several years to decades and result in lethal and long-term sublethal impacts to refuge biota.
10 Impacts would depend primarily on spill location, spill size, and timing of the spill. In general,
11 directly affected coastal fauna would include marine mammals; fishes that reproduce in, inhabit,
12 or migrate through coastal areas; terrestrial mammals that forage on fish; and marsh and seabirds
13 that use these habitats for nesting and/or foraging. Spilled oil could also affect subsistence
14 harvests in those parks in which subsistence hunting and fishing are allowed. See
15 Section 4.4.6.1.3 for a description of potential impacts of catastrophic oil spills on coastal areas
16 and biota.
17
18

19 **4.4.8.4 Conclusion**

20
21 Overall, impacts on areas of special concern resulting from routine Program activities are
22 expected to be negligible to moderate because of the existing protections and use restrictions
23 applicable to these areas. However, increased vessel and aircraft traffic and the construction of
24 pipelines and platforms could have temporary and localized effects on wildlife and reduce the
25 scenic value of National Parks and NWRs for some visitors.
26

27 Impacts on areas of special concern from hydrocarbon spills are unlikely because most
28 spills would be small. Should oil from large or CDE-level spills reach an area of special
29 concern, the impacts would depend on the location and size of the spill, the type of product
30 spilled, weather conditions, the type of area affected, the effectiveness of cleanup operations, and
31 other environmental conditions at the time of the spill. Although unlikely, if oil from a large or
32 CDE spill were to reach an area of special concern, coastal habitats and fauna, as well as
33 subsistence use, commercial or recreational fisheries, and tourism, could be negatively affected
34 (especially in the case of a CDE spill). In Alaska, oil in some coastal habitats would likely
35 persist for multiple years.
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38 **4.4.9 Potential Impacts on Population, Employment, and Income**

39 **4.4.9.1 Gulf of Mexico**

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44 **4.4.9.1.1 Routine Operations.** Under the proposed action alternative, between 200 and
45 400 new platforms would be located in the GOM over the 40-year planning period. Using
46 impact estimates provided by the MAG-PLAN Model (MMS 2006b), Table 4.4.9-1 shows total

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**TABLE 4.4.9-1 Average Annual
Impacts of the Proposed Action
(Alternative 1) on Regional
Employment and Income^a**

Area	Employment	Income
Alabama		
Low	350	15
High	800	35
Florida		
Low	950	45
High	2,150	95
Louisiana		
Low	7,500	350
High	16,500	765
Mississippi		
Low	225	10
High	525	25
Texas		
Low	10,900	630
High	22,000	1,270
Total GOM region		
Low	20,000	1,050
High	41,825	2,180

^a Totals may not add due to rounding. All estimates are totals of direct, indirect, and induced impacts. Employment estimates are in employee years; personal income estimates are in millions of 2010 dollars.

Source: BOEMRE 2011.

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(direct, indirect, and induced) employment and regional income for the Labor Market Areas (LMAs) in each State in the GOM coast region (see Section 3.10). Average annual impacts of the proposed action in the GOM coast region would be between 20,000 and 41,825 jobs, which would amount to less than 1% of total GOM coast regional employment. Between \$1,050 million and \$2,180 million in income would be produced. The largest employment impacts would be in Texas, ranging from 10,900 to 22,000, with smaller impacts in Louisiana, where the employment created would range from 7,500 to 16,500 jobs. Income impacts in these States would range between \$630 million and \$1,270 million in Texas and between \$350 million and \$765 million in Louisiana. Employment impacts are lower in the other GOM coast States; the total number of jobs created would be between 950 and 2,150 in Florida, between 350 and

1 800 in Alabama, and between 225 and 525 in Mississippi. Although only a small amount of
2 OCS oil and gas activity is proposed for the Eastern Planning Area, economic impacts would
3 occur in Florida associated with expenditures on material and equipment supplied by sectors
4 located in Florida, and the and use of ports and infrastructure for the associated transportation.
5

6 The additional jobs would create small but noticeable increases in the population of these
7 regions. Using a historically observed ratio of 2.59 persons per new job (MMS 2006b),
8 population increases of between 28,231 and 56,980 would be expected in Texas on average in
9 each year of the proposed action, with increases of between 19,425 and 42,735 occurring in
10 Louisiana. Smaller increases in population of between 2,461 and 5,569 per new job would occur
11 in Florida, with increases of between 907 and 2,072 in Alabama, and between 583 and 1,360 in
12 Mississippi.
13

14 Installation and operation of new offshore oil and gas platforms have the potential to
15 impact property values in coastal areas within viewing distances of offshore activities. However,
16 although the extent of the impact of any given platform would vary according to distance to
17 shore, location within a maximum viewing range, and regional visibility conditions, the impact
18 of additional platforms on coastal property values in areas where there is substantial existing
19 offshore oil and gas is likely to be relatively small. There are currently 3,679 offshore platforms
20 in the Western and Central Planning Areas in Federal waters in the GOM. Under the proposed
21 action alternative, between 200 and 450 platforms would be added over the 40-year planning
22 period, an average of between five and ten platforms per year. It is also anticipated that between
23 150 and 275 platforms would be removed over the same period. Although the location of
24 additional offshore platforms is not known, with some new platforms conceivably located in
25 areas of the GOM with relatively little existing oil and gas development, the majority of new
26 platforms are likely to be located in areas already hosting existing platforms. Given these
27 considerations, it is likely that the impacts of oil and gas development under the proposed action
28 would only have a minor impact on property values in coastal areas in the GOM.
29
30

31 **4.4.9.1.2 Accidents.** Up to 8 large spills greater than 1,000 bbl, between 35 and 70 spills
32 between 50 and 1,000 bbl, and up to 400 small spills less than 50 bbl could occur in the GOM
33 from the proposed action. It is expected that many of these spills will occur in deepwater areas
34 located away from the coast, based on the established trend for greater oil production activity to
35 move into deepwater located for the most part at a substantial distance from the coast.
36

37 In previous oil spill analyses, there is a less than 0.5% probability that an oil spill greater
38 than or equal to 1,000 bbl would reach the shores of the majority of coastal counties and parishes
39 in Texas and Louisiana within 10 days of a spill occurring over the 40-yr leasing period in the
40 Western and Central Planning Areas (BOEMRE 2005). Six counties in Texas and one parish in
41 Louisiana have a 1–5% chance of an OCS offshore oil spill greater than or equal to 1,000 bbl
42 reaching their shoreline within 10 days. BOEM also estimates that between 5 and 15 chemical
43 spills associated with the OCS program are anticipated each year, with a small percentage of
44 these associated with the proposed action. The majority of spills are expected to be less than
45 50 bbl in size; a chemical spill of greater than or equal to 1,000 bbl as a result of the proposed
46 action is very unlikely.

1 The immediate socioeconomic impact of a larger oil spill would include the loss of
2 employment, income, and property value; increased traffic congestion; increased cost of public
3 service provision, and possible shortages of commodities or services. In the short term, the
4 impacts of a spill are expected to be modest, measured in terms of projected cleanup
5 expenditures and the number of people employed in cleanup and remediation activities. Longer-
6 term impacts may be more substantial if fishing, shrimping, oystering, and/or tourism were to
7 suffer due to the real or perceived impacts of the spill, or if there were substantial changes to the
8 energy industries in the region as a result of the spill.

9
10 The employment and regional income impact from an oil spill would likely be greatest in
11 Texas and Florida, with the highest concentration of tourism-related employment occurring in
12 Florida, particularly in the Miami and Tampa-St. Petersburg areas and the Houston-Galveston
13 areas. In the Central GOM Planning Area, the New Orleans area would also be affected due to
14 their high concentration of tourism-related employment. Net employment impacts from a spill
15 are not expected to exceed 1% of baseline employment for any LMA in any given year, even if
16 they are included with employment associated with routine oil and gas development activities
17 associated with the proposed action.

18
19 **Catastrophic Discharge Event.** The PEIS analyzes a CDE up to 7.2 million bbl
20 (Table 4.4.2-2). The socioeconomic impact of a CDE would include the loss of employment,
21 income, and possible shortages of commodities or services in both coastal and inland areas. In
22 coastal areas, losses of property value and increased traffic congestion could also occur, with
23 increases in the cost of public service provision also possible. In the short term, impacts of a
24 CDE, measured in terms of projected cleanup expenditures and the number of people employed
25 in cleanup and remediation activities, would be expected to be large. Longer-term impacts may
26 also be substantial if fishing activities and tourism were to suffer as a result of the real or
27 perceived impacts of the event, or if there were substantial changes to energy industries in the
28 region as a result of the event.

31 4.4.9.2 Alaska – Cook Inlet

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34 **4.4.9.2.1 Routine Operations.** Under the proposed action alternative, between 1 and
35 3 new platforms would be located in Cook Inlet over the 40-year planning period. Table 4.4.9-2
36 shows total (direct, indirect, and induced) employment and regional income in Alaska and the
37 rest of the United States. Average annual impacts of the proposed action in the Alaska region
38 would be between 302 and 575 jobs, which would amount to less than 5% of total Alaska
39 employment. An additional 567 to 1,431 jobs would be created in the rest of the United States.
40 Personal income would increase by between \$25.4 million and \$52.9 million annually in Alaska,
41 and by between \$27.0 million and \$69.1 million in the rest of the United States.

42
43 Based on current trends, it is assumed that most of the workers directly associated with
44 OCS oil and gas activity will work offshore or onshore in worker enclaves separated from local
45 communities, and that most OCS workers will likely commute to work sites from Alaska's larger
46 population centers or from outside the immediate area. It is also assumed that OCS jobs would

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TABLE 4.4.9-2 Average Annual Impacts of the Proposed Action (Alternative 1) on Regional Employment and Income^a

Area	Employment	Income
Cook Inlet		
Low	302	25.4
High	575	52.9
Rest of United States		
Low	567	27.0
High	1,431	69.1

^a All estimates are totals of direct, indirect, and induced impacts. Employment estimates are in employee years; labor income estimates are in millions of 2010 dollars.

be available to the local populations in all areas, but that rural Alaskan employment in the petroleum industry, especially among Alaska Natives, will remain relatively low.

Many workers on oil rigs in the Cook Inlet Planning Area (and onshore oil and gas facilities on the Kenai Peninsula and the North Slope) currently live in Anchorage or on the Kenai Peninsula. The larger populations and more diverse economies of south central Alaska compared to other Alaskan communities will tend to lessen the potential effect of proposed leasing on their economies. As a result, employment generated by OCS activity in the Cook Inlet Planning Area at its peak is only expected to account for less than 5% of total Alaska employment.

Installation and operation of new offshore oil and gas platforms have the potential to impact property values in coastal areas within viewing distances of offshore activities. However, although the extent of the impact of any given platform would vary according to distance from shore, location within a maximum viewing range, and regional visibility conditions, the impact of additional platforms on coastal property values in areas where there is substantial existing offshore oil and gas is likely to be relatively small. Under the proposed action alternative, between one and three platforms would be added over the 40-yr planning period. It is also anticipated that between one and three platforms would be removed over the same period. Although the location of additional offshore platforms is not known, with some new platforms conceivably being located in areas of the Cook Inlet area, the majority of new platforms are likely to be located in the vicinity of areas already hosting existing platforms. Given these considerations, it is likely that the impacts of oil and gas development under the proposed action would only have a minor impact on property values in coastal areas in the Cook Inlet area.

1 **4.4.9.2.2 Accidents.** One large spill greater than 1,000 bbl, up to 3 spills between 50 bbl
2 and 1,000 bbl, and up to 15 small spills less than 50 bbl could occur in the Cook Inlet Planning
3 Area under the proposed action. Although an oil spill could occur anywhere in the lease sale
4 area, cleanup-related employment would likely occur in the area directly affected, generally in
5 locations remote from communities. The hiring of cleanup workers will likely draw from labor
6 markets in both the region and the rest of Alaska. Oil spills will generate only temporary
7 employment (and population) increases during cleanup operations, because such operations are
8 expected to be of short duration. Employment generated by spills will be a function of the size
9 and frequency of spills.

10
11 **Catastrophic Discharge Event.** The PEIS analyzes a CDE of 75 to 125 thousand bbl
12 (Table 4.4.2-2). The socioeconomic impact of a CDE would include the loss of employment,
13 income, and possible shortages of commodities or services in both coastal and inland areas. In
14 coastal areas, losses of property value and increased traffic congestion could also occur, with
15 increases in the cost of public service provision also possible. In the short term, impacts of a
16 CDE, measured in terms of projected cleanup expenditures and the number of people employed
17 in cleanup and remediation activities, would be expected to be large. Longer-term impacts may
18 also be substantial if fishing activities and tourism were to suffer as a result of the real or
19 perceived impacts of the event, or if there were substantial changes to energy industries in the
20 region as a result of the event.

21 22 23 **4.4.9.3 Alaska – Arctic**

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26 **4.4.9.3.1 Routine Operations.** Under the proposed action alternative, between one and
27 five new platforms would be located in the Chukchi Sea and one and four platforms in the
28 Beaufort Sea over the 50-yr planning period. Table 4.4.9-3 shows the potential effects of the
29 proposed action alternative in the Arctic region and the rest of the United States. Average annual
30 impacts of the proposed action in the Arctic region would be between 1,466 to 3,646 jobs, which
31 would amount to less than 1% of total Alaska employment. An additional 3,759 to 10,083 jobs
32 would be created in the remainder of the United States. Personal income would increase by
33 between \$136.1 million and \$329.8 million annually in the Arctic region and between
34 \$156.6 million and \$398.2 million in the rest of the United States.

35
36 Most of the workers directly associated with OCS oil and gas activity will work offshore
37 or onshore in worker enclaves separated from local communities, and most workers will likely
38 commute to work sites from Alaska's larger population centers, including Anchorage and
39 Fairbanks, or from outside Alaska (MMS 2006b). While OCS jobs would be available to the
40 local populations in all areas, rural Alaskan employment in the petroleum industry, especially
41 among Alaska Natives, would likely remain relatively low.

42
43 Employment in the North Slope oil and gas industry has little direct impact on the
44 communities of the North Slope Borough. While actively working, most North Slope oil and gas
45 workers stay in enclave housing separate from local communities, permanently residing in south
46 central Alaska (Anchorage, the Kenai Peninsula Borough, and the Matanuska-Susitna Borough),

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TABLE 4.4.9-3 Average Annual Impacts of the Proposed Action (Alternative 1) on Regional and National Employment and Income^a

Area	Employment	Income
Beaufort Sea		
Low	800	72.0
High	2,052	192.1
Chukchi Sea		
Low	667	64.1
High	1,594	137.7
Rest of United States		
Low	3,759	156.6
High	10,083	398.2

^a All estimates are totals of direct, indirect, and induced impacts. Employment estimates are in employee years; labor income estimates are in millions of 2007 dollars.

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or the Fairbanks area, and commute to their homes (or other locations) when not working. As population, employment, and income impacts affect the regional economies in which employees permanently reside, BOEM has not included these impacts in the discussion of impacts of the proposed action in the Arctic region.

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The most important benefit of oil and gas development in the Arctic region is revenue from taxation of oil industry facilities. Although jurisdictions in the North Slope Borough and Northwest Arctic Borough are unable to tax offshore OCS facilities, the borough collects property tax revenue from new onshore pipelines and other facilities. The borough also receives indirect benefits from Alaska Native corporation investments in petroleum service companies. The effects of the proposed action on employment and income in Arctic region communities are likely to be significant, especially when combined with the continued decline in Prudhoe Bay and other North Slope production areas, and continued OCS production would allow jurisdictions in the Arctic region to maintain revenue collection from onshore facilities associated with continued offshore production.

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4.4.9.3.2 Accidents. Up to 3 large spills greater than 1,000 bbl, 10 and 35 spills between 50 and 1,000 bbl, and up to 190 small spills of less than 50 bbl could occur in the Beaufort and Chukchi Sea area from the proposed action. Although an oil spill could occur anywhere in the lease sale area, cleanup-related employment would likely occur in the area directly affected, generally in locations remote from communities. The hiring of cleanup workers would have a regional and State of Alaska emphasis. Oil spills will generate only temporary employment (and

1 population) increases during cleanup operations, because such operations are expected to be of
2 short duration. Employment generated by spills will be a function of the size and frequency of
3 spills. Large spills of over 1,000 bbl would generate 60 to 90 jobs for up to 6 months and would
4 generate moderate local effects (BOEMRE 2008).

5
6 **Catastrophic Discharge Event.** The PEIS analyzes a CDE of 1.4 to 2.2 million bbl in
7 the Chukchi Sea and 1.7 to 3.9 million bbl in the Beaufort Sea (Table 4.4.2-2). The
8 socioeconomic impact of a CDE would include the loss of employment, income, and possible
9 shortages of commodities or services in both coastal and inland areas. Losses of property value
10 could also occur in coastal communities, with increased cost of local public service provision
11 also possible. In the short term, impacts of a CDE, measured in terms of projected cleanup
12 expenditures and the number of people employed in cleanup and remediation activities, would be
13 expected to be large. Longer-term impacts would likely be small, unless recreational activities
14 and tourism suffered as a result of the real or perceived impacts of the event, or if there were
15 substantial changes to energy production in the region as a result of the event.

16 17 18 **4.4.9.4 Conclusions**

19
20 Routine Program activities would result in negligible impacts in the GOM from small
21 increases in population, employment, and income, and in minor impacts in the Alaska Planning
22 Areas. In the GOM, increases in population, employment, and income would increase by less
23 than 1% of baseline levels, and by less than 5% in Alaska.

24
25 Small accidental oil spills would have little socioeconomic impact. In contrast, large and
26 especially CDE-level spills could result in the loss of employment, income, and possible
27 shortages of commodities or services in both coastal and inland areas affected by the spill.
28 Losses of property value could also occur in coastal communities, with increased cost of local
29 public service provision also possible. In the short term, impacts of a CDE, measured in terms of
30 projected cleanup expenditures and the number of people employed in cleanup and remediation
31 activities, would be expected to be large. Longer-term impacts would likely be small, unless
32 recreational activities and tourism suffered as a result of the real or perceived impacts of the
33 event, or if there were substantial changes to energy production in the region as a result of the
34 accidental spill; this would be more likely in the event of a CDE spill.

35 36 37 **4.4.10 Potential Impacts to Land Use and Infrastructure**

38
39 The development of oil and gas facilities within the GOM, the Cook Inlet, and the Arctic
40 would have both direct and indirect impacts on existing and future land use, development
41 patterns, and infrastructure. Impacts of routine activities of the Proposed Action Alternative are
42 presented below. These routine activities include seismic explorations and exploratory drilling,
43 onshore and offshore construction, normal operations, and decommissioning. Impacts on land
44 use and infrastructure potentially resulting from an accident (an oil spill or release) occurring in
45 the three areas also are presented. In general, the nature and magnitude of these impacts would

1 depend upon the level and location of new construction, the degree to which the area is already
2 developed, and, in the case of accidental spills, the size and location of the spill.

3
4 Table 4.4.10-1 provides a summary of the resource receptors that pertain to routine
5 activities. As shown in this table, potential receptors include the following:

- 6
- 7 • Land use categorization,
- 8
- 9 • Land use plans and initiatives,
- 10
- 11 • Development patterns, and
- 12
- 13 • Onshore infrastructure.
- 14

15 Conceptual models illustrated in Figures 4.4.10-1 through 4.4.10-3 show how various
16 activities associated with seismic surveys, onshore and offshore construction, and normal oil and
17 gas operations may impact land use, development patterns, and infrastructure. These figures are
18 applicable to the GOM, the Cook Inlet, and the Arctic.

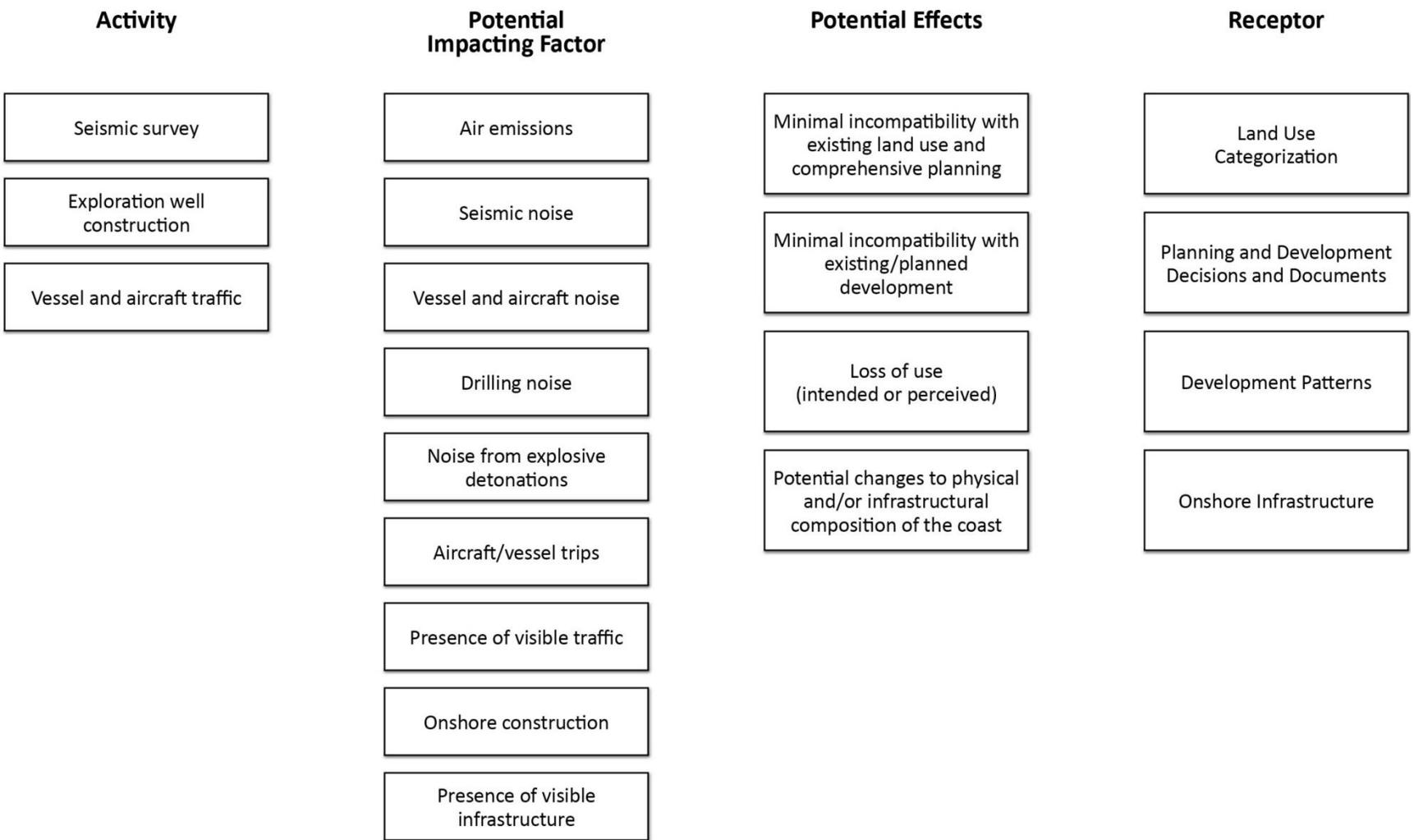
19
20 As shown in these figures, the potential effects of oil and gas activities typically include
21 the following:

- 22
- 23 • Incompatibility with local land use/comprehensive planning patterns,
- 24
- 25 • Incompatibility with existing/planned development,
- 26
- 27 • Loss of use (intended or perceived) to existing landowners or users, and
- 28
- 29

30 **TABLE 4.4.10-1 Impacting Factors Associated with Each Phase of Oil and Gas**
31 **Activities^a**

Resource Receptor Category Potentially Affected	O&G Activities Phase				
	Exploration			Production/ Normal	
	Seismic Survey	Exploratory Wells	Development/ Construction	Operations	Decommissioning
Land use categorization	I	I	X	I	X
Land use plans/initiatives	I	I	X	I	X
Development patterns	I	I	X	I	X
Onshore infrastructure	I	I	X	I	X

^a I = Indirect impacts are anticipated; X = Both direct and indirect impacts are anticipated.



1

2 **FIGURE 4.4.10-1 Conceptual Model for Potential Direct and Indirect Effects of Seismic Survey Activities on Land Use, Development**
3 **Patterns, and Infrastructure**

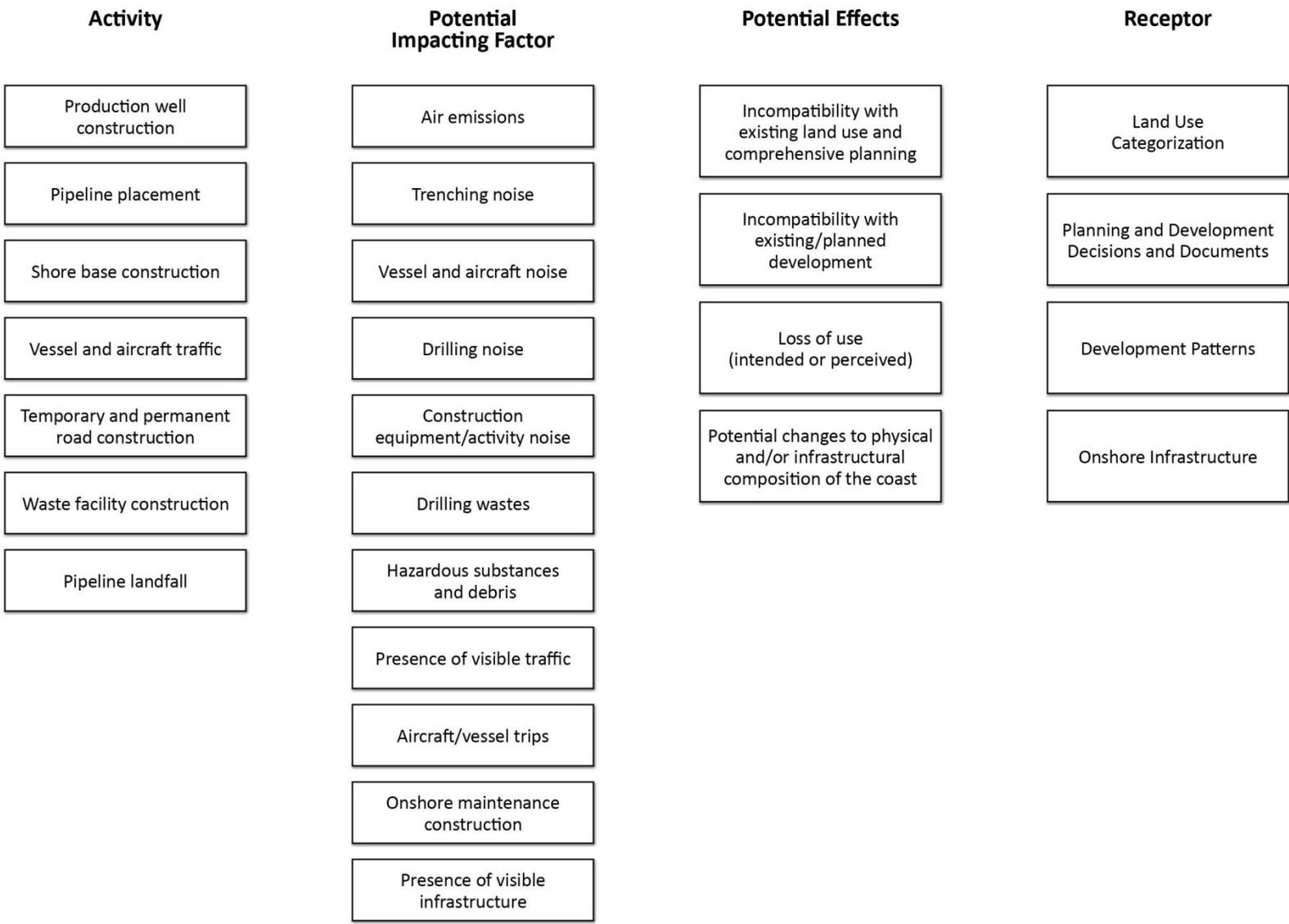


FIGURE 4.4.10-2 Conceptual Model for Potential Direct and Indirect Effects of Onshore/Offshore Construction Activities on Land Use, Development Patterns, and Infrastructure

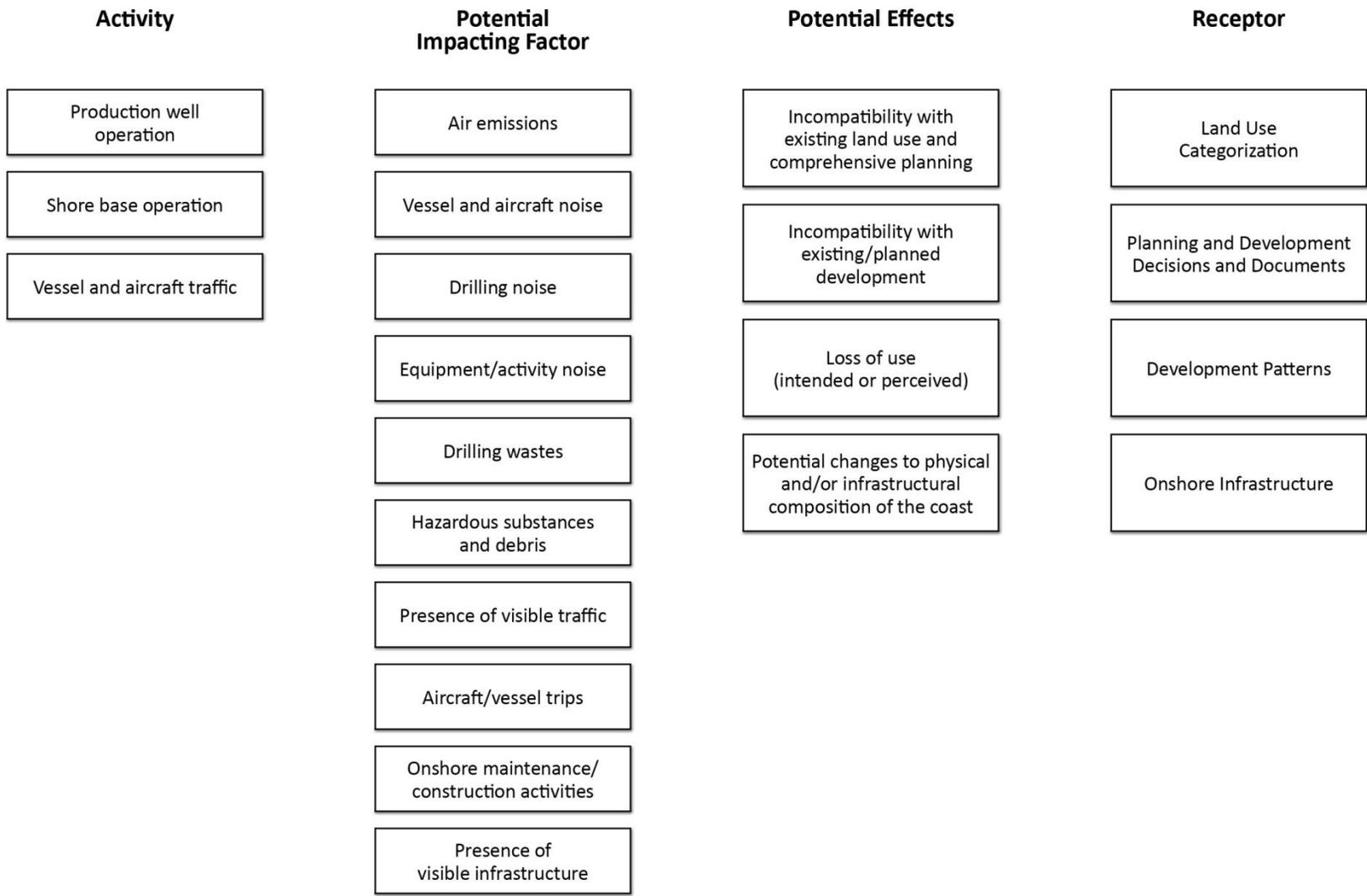


FIGURE 4.4.10-3 Conceptual Model for Potential Direct and Indirect Effects of Normal Operations on Land Use, Development Patterns, and Infrastructure

- 1 • Potential changes to the physical and/or infrastructural composition of the
2 coast.

3
4 Each of these impacts is discussed in the context of seismic explorations, construction of
5 onshore and offshore facilities, normal operations, and decommissioning. A more general
6 discussion of impacts is provided for accidental releases or spills.

7
8 For the purpose of this discussion, land use refers to the activity that occurs on a specific
9 area of land and within the structures that occupy it, whereas zoning regulations include such
10 things as requirements for building size, bulk, and density. General land use is assumed to be the
11 primary factor in determining existing and future development decisions. Specific zoning
12 regulations were not evaluated for areas located within the GOM, the Cook Inlet, or the Arctic
13 due to the large scale of the planning areas. Individual environmental assessments generally
14 would account for localized regulations.

15
16 In addition, for the purposes of this discussion, intended land use is that prescribed by
17 regulations or formalized land use plans. For instance, if a parcel of land is dedicated as
18 agricultural land, the intended activities likely would include farming, animal husbandry, or a
19 combination of rural activities. The actual use, however, may differ. For the purpose of this
20 evaluation, “actual use” is the manner in which people physically use the land that may or may
21 not be regulated or prescribed by laws or formal plans. Instead, the use may involve traditional
22 practices or activities occurring for long periods of time.

23 24 25 **4.4.10.1 Gulf of Mexico**

26
27 As indicated in Table 4.4.1-1, potentially available oil includes a range of 2.7 to
28 5.4 billion barrels (Bbbl) within the GOM, along with 12–24 trillion cubic feet (tcf) of natural
29 gas. In order to provide for production of these resources, a number of routine activities are
30 necessary. As previously indicated, these activities have the potential to impact existing and
31 future land use, development patterns, and infrastructure.

32
33 The following analysis provides a description of those impacts that would occur on land
34 use within the Western and Central Planning Areas. No additional or new development is
35 anticipated to occur within the Eastern Planning Area.

36
37
38 **4.4.10.1.1 Routine Operations.** Impacts from routine activities including exploration,
39 development, production, and decommissioning are presented below.

40
41 **Seismic Explorations and Exploratory Drilling.** Activities associated with exploration
42 typically include a seismic survey, exploratory well construction, and aircraft and vessel traffic
43 (see Figure 4.4.10-1).

44
45 **Local Land Use/Comprehensive Planning and Development Patterns.** Seismic
46 explorations and exploratory drilling would not impact land use, development patterns, and

1 infrastructure directly, as a majority of the activities would be located offshore. In general,
2 existing and future land use categorizations would remain unchanged, along with current
3 development patterns. Existing and planned activities associated with local planning initiatives
4 and plans likely would not be hindered, as the jurisdiction of these plans typically would not
5 extend to the offshore activities. State and Federal planning initiatives, such as the National
6 Coastal Zone Management (CZM) Program, would generally be consistent with seismic surveys
7 and exploratory drilling due to the need for prioritizing coastal-dependent uses (see
8 Section 3.11.1 for more information on this program).

9
10 ***Loss of Use to Existing Landowners or Users.*** Seismic explorations and exploratory
11 drilling activities would not impact access or use of a particular land area. Some safety-related
12 temporary restrictions on access may be necessary both onshore and offshore; however, these
13 restrictions likely would be temporary, lasting only as long as the exploration activities, with
14 access restrictions lifted afterwards.

15
16 In addition, the use of individual properties may be affected indirectly if excessive noise
17 and air emissions generated by survey equipment/vessels and onshore/offshore vehicular and air
18 traffic (e.g., helicopters and automobiles) were to occur, or if a small increase in the amount of
19 trash and debris washing ashore were to result from exploration. These occurrences may cause a
20 temporary disturbance or annoyance among particular landholders or users and thereby interfere
21 with their intended or actual use of the land. These impacts would be temporary in nature due to
22 the short time frame of these activities. The level of impact would depend on the specific
23 location of the exploration activities within the GOM, but generally would be anticipated to be
24 minimal.

25
26 ***Physical and/or Infrastructural Composition.*** While additional infrastructure, such as
27 machinery and staging area improvements, may be needed to accommodate equipment and
28 workers associated with the exploration activities, the increase likely would be negligible at this
29 stage of oil and gas development. In general, existing infrastructure within the GOM would
30 likely be able to accommodate activities associated with exploration (see Section 3.11.1 for
31 further information regarding existing GOM infrastructure).

32
33 ***Onshore and Offshore Construction.*** Impacts on land use, development patterns, and
34 infrastructure associated with onshore and offshore construction are presented below. As
35 indicated in Figure 4.4.10-2, activities associated with this phase include production well
36 placement, pipeline placement, onshore construction, and aircraft and vessel traffic. Similar to
37 the exploration phase, these activities have the potential to impact local land use and
38 comprehensive planning and existing and planned development; access and use of particular
39 properties; and the physical and infrastructural makeup of the GOM as pertaining to emissions,
40 waste, noise, and traffic; each is discussed below.

41
42 ***Local Land Use/Comprehensive Planning and Development Patterns.*** As indicated in
43 Section 3.11.1, a number of onshore and offshore facilities are associated with the development
44 of offshore oil and gas. Among these are ports, ship and shipbuilding yards, support and
45 transport, pipelines, pipe coating yards, natural gas processing and storage, refineries,
46 petrochemical plants, and waste management facilities. Current BOEM data suggests that more

1 than 3,900 offshore production facilities are located within the GOM within Federal waters.
2 Most of these facilities are located within the Western and Central Planning Areas.
3

4 According to previous government documents, a steady pace of offshore leasing has
5 persisted in the GOM for nearly six decades with the first Federal lease sale in 1954
6 (MMS undated). Consequently, land use categorizations in the Western and Central Planning
7 Areas often would be able to accommodate this type of industry. Therefore, negligible impacts
8 on land use categorizations (i.e., receptor) are predicted by the continuation of leasing and
9 subsequent exploration and development activities in the Western and Central GOM Planning
10 Areas. In addition, the development of oil and gas facilities likely would be compatible with
11 existing local land use, zoning, and comprehensive planning in these areas. Land use likely
12 would evolve over time, with most changes occurring as a result of general regional growth
13 rather than specific activities associated with the production of oil and gas (BOEMRE 2011).
14

15 As a result of the DWH event, the overall climate for development of oil and gas has
16 been altered in response to a recent suspension and changes in Federal requirements for drilling
17 safety in the whole of the GOM (BOEMRE 2011a). In some areas of the GOM, for instance,
18 local planning initiatives have been drafted in response to the recent event that could impact the
19 construction of new and/or infill facilities. Some of these initiatives focus on the economic
20 diversification of the GOM coast, rather than upon oil and gas activities, while other strategies
21 focus on the investment of monies for necessary human services (Restore the Gulf 2010b). In
22 this manner, perceptions about the spill may influence future decisions regarding the need for oil
23 and gas investments, improvements to existing infrastructure, and the construction of new oil and
24 gas facilities.
25

26 Likewise, individual businesses and organizations have adapted to the altered, post-DWH
27 environment. For instance, some companies have removed a portion of their equipment, and a
28 substantial decrease in helicopter flights and servicing of rigs has occurred. Companies have
29 trimmed budgets by cutting hours and salaries of workers; associated support services, such as
30 chemical suppliers and welders, also have been affected by the DWH event.
31

32 The effects of this decreased demand have rippled through the various infrastructure
33 categories (e.g., fabrication yards, shipyards, port facilities, pipecoating facilities, gas processing
34 facilities, and waste management facilities) and have affected the oil and gas support sector
35 businesses (e.g., drilling contractors, offshore support vessels, helicopter hubs, and mud/drilling
36 fluid/lubricant suppliers) (BOEMRE 2011a). Land use has been impacted indirectly through
37 various economic incentives, compliance with permitting requirements, and the lack of use of
38 existing facilities. As indicated in a 2011 lease sale, some locations offered a 30% reduction in
39 rental rates in order to keep businesses (BOEMRE 2011a). Actions of this nature influence the
40 overall development pattern. As a consequence, BOEM anticipates monitoring the overall oil
41 and gas development climate as it pertains to the DWH event (BOEMRE 2011a).
42

43 If new infrastructure is needed onshore, some developments may be subject to local,
44 State, and/or other Federal permitting and regulations. Within the Western and Central Planning
45 Areas, infill development likely would occur in areas already established for oil and gas

1 development. Specific timelines and requirements would vary by location, as the BOEM
2 typically is not the permitting or regulating agency for development activities that occur onshore.
3

4 ***Loss of Use to Existing Landowners or Users.*** In addition to receiving proper permitting
5 and approvals, onshore and offshore construction generally would not interfere with or prevent
6 use by existing owners or users within areas of immediate development. During construction
7 activities, a temporary loss of access to some areas may be required for safety reasons, with
8 access restored upon completion of the activities. Some users of surrounding land may be
9 inconvenienced by closure or restrictions on access routes, as well. Permanent loss of use is not
10 anticipated. If new land were necessary in order to construct onshore facilities, the acquisition
11 would follow all pertinent local, State, and Federal requirements.
12

13 In addition, the use of individual properties in the vicinity of the construction activities
14 may be affected indirectly if excessive noise and air emissions generated by the construction
15 equipment and onshore/offshore vehicular and air traffic (e.g., helicopters and automobiles) were
16 to occur, or if a small increase in the amount of trash and debris washing ashore were to result
17 from the activities. These occurrences may cause a temporary disturbance or annoyance among
18 particular landholders or users, thereby inhibiting the intended or actual use of a property. The
19 level of impact would depend on the specific location within the GOM, but generally would be
20 anticipated to be minimal.
21

22 ***Physical and/or Infrastructural Composition.*** Physical land disturbance also would
23 occur in locations where new facilities are needed. As indicated in Table 4.4.1-1, the Western
24 and Central Planning Areas may require up to 12 new pipeline landfalls, four to six new pipe
25 yards, and the potential for up to 12 new natural gas processing facilities. Approximately
26 3,862–12,070 km (2,400–7,500 mi) of new pipeline could be needed, as well.
27

28 The creation of pipeline landfalls could involve such activities as clearing land, preparing
29 a ROW, and digging and backfilling trenches. These activities could alter the physical
30 composition of the landscape, thus potentially limiting the intended use of a parcel unless located
31 in existing utility ROWs. Likewise, the construction of new shore bases and waste facilities
32 could involve, but would not be limited to, the preparation of a site through grading and clearing,
33 excavations, and foundation building. As with a pipeline, these types of activities would alter the
34 existing landscape and, depending on the scale and location, could alter the intended use of a
35 parcel. While these changes would be necessary in some locations within the GOM, the
36 activities associated with the oil and gas construction would not likely cause an extensive change
37 to existing development patterns; as such, the impacts would be anticipated to be minimal.
38

39 The construction of more permanent facilities could be a positive impact or a negative
40 impact depending on the specific location within the GOM. For instance, where new roads
41 would provide additional routes and capacity for coastline travel, they may be perceived as a
42 positive impact by some stakeholders. However, if the same roadways added large traffic
43 volumes to existing roadways that already were over capacity, the construction could be seen as
44 a negative impact.
45

1 Additional indirect impacts include those associated with climate change. Siting of new
2 facilities may account for potential changes resulting from rises in sea level, increased storm
3 frequency and intensity, and temperature changes. Figure 4.4.10-4 provides an illustration of the
4 potential sea rise levels in the GOM. Potential solutions to account for these changes include
5 facility relocation, the construction of seawalls and storm surge barriers, dune reinforcement, and
6 land acquisitions to create buffer areas (IPCC 2007).

7
8 Consequently, indirect impacts on land use, development patterns, and infrastructure
9 could include locating facilities further inland and/or strengthening the foundations or building
10 materials of existing facilities. These actions potentially could increase costs associated with
11 development or lead to the construction of new facilities rather than the reuse or expansion of
12 existing properties associated with oil and gas production. These decisions may be influenced by
13 the potential for increased flooding and/or erosion.

14
15 **Routine Operations.** Routine operation activities would consist of production well
16 operation, onshore facility operation, and vessel and aircraft traffic, and would also include the
17 transport of oil from offshore to onshore locations using ships or pipelines (see Figure 4.4.10-3).
18 Potential impacts associated with these activities would range in extent from negligible to
19 minimal.

20
21 **Local Land Use/Comprehensive Planning and Development Patterns.** Once in
22 operation, negligible to minimal impacts are anticipated to result on land use, development
23 patterns, and infrastructure, because a majority of the activities would be located offshore. As
24 previously indicated, land use likely would evolve over time, with most changes occurring as a
25 result of general regional growth rather than through activities associated with oil and gas
26 production (BOEMRE 2011a). Some regions within the GOM may be impacted to a greater
27 extent than others depending on the site-specific conditions.

28
29 **Loss of Use to Existing Landowners or Users.** Once the new offshore oil and gas
30 facilities were in operation, temporary or permanent loss of use is not anticipated. As indicated
31 in Section 3.11.1, many facilities already are located within the GOM to support oil and gas
32 development. At times, some access to particular areas may be restricted within surrounding
33 lands to accommodate a brief alteration in normal operations, such as an emergency response.
34 These impacts would be limited and temporary.

35
36 Similar to construction, the use of individual properties in the vicinity of the operating
37 platforms may be affected indirectly if excessive noise and air emissions were generated from
38 equipment and onshore/offshore vehicular and air traffic (e.g., helicopters and automobiles), or if
39 a small increase in the amount of trash and debris washing ashore were to result from the
40 activities. These occurrences may cause disturbances or annoyance among particular
41 landholders or users, thereby inhibiting the intended or actual use of a property. The level and
42 extent of impact would depend on the specific location within the GOM, but generally would be
43 anticipated to be minimal.

44
45 **Physical and/or Infrastructural Composition.** To the extent possible, existing facilities
46 would be used to support activities under new leases, and new facilities would be built only

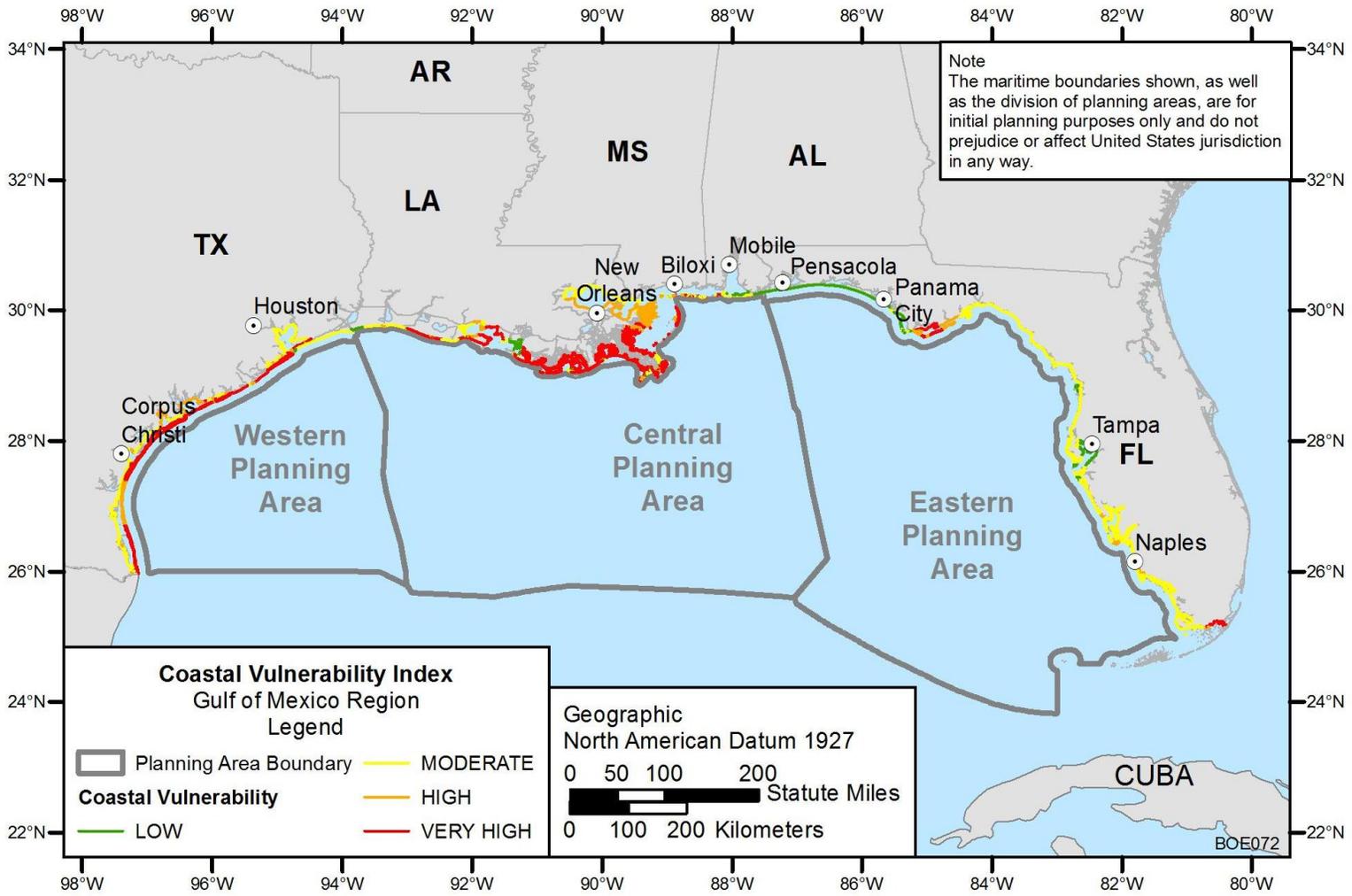


FIGURE 4.4.10-4 Coastal Vulnerability Index

1
2

1 where necessary, which would tend to limit the potential to create lasting changes to the physical
2 and/or infrastructural makeup of the GOM during operations.
3

4 **Decommissioning.** Typical activities during the decommissioning/reclamation phase
5 could include, but are not limited to, the closure of all wells, removal of access roads (not
6 maintained or intended for other uses) and associated facility sites, and revegetation. These
7 activities have the potential to directly impact land use, development patterns, and infrastructure.
8

9 Impacts associated with decommissioning, however, generally would be site-specific. In
10 some cases, return to pre-exploration and preconstruction conditions may not be feasible.
11

12 **Local Land Use/Comprehensive Planning and Development Patterns.** Depending on
13 the location of the production wells and associated infrastructure, decommissioning activities
14 onshore may be regulated by local land use, zoning, and comprehensive planning initiatives or
15 requirements. The continued use of the facilities after production could impact planned
16 development in a positive manner, either by providing an opportunity for reuse of facilities or
17 allowing for the potential for additional or future oil and gas development.
18

19 **Loss of Use to Existing Landowners or Users.** No permanent loss of use is anticipated
20 to occur during the decommissioning/reclamation phase. Some temporary loss may occur if road
21 or area closures are necessary to accommodate equipment, workers, or specific activities
22 associated with this type of process. Access typically would be restored to its preconstruction or
23 operations state.
24

25 In addition, the use of individual properties in the vicinity of the activities may be
26 affected indirectly if excessive noise and air emissions generated by the decommissioning
27 equipment, activities, and onshore/offshore vehicular and air traffic (e.g., helicopters and
28 automobiles) were to occur, or if a small increase in the amount of trash and debris washing
29 ashore were to result from the activities. These occurrences may cause a temporary disturbance
30 or annoyance among particular landholders or users, thereby inhibiting the intended or actual use
31 of a property. The level of impact would depend on the specific location within the GOM, but
32 generally would be anticipated to be minimal.
33

34 **Physical and/or Infrastructural Composition.** In addition, potential changes to the
35 physical and infrastructural makeup of the GOM coast could occur. Any equipment added may
36 be removed; defunct equipment also could be removed. These alterations would be site-specific
37 and the extent of their impact likely could range from negligible to minimal with regard to the
38 existing composition of land use and infrastructure.
39

40
41 **4.4.10.1.2 Accidents.** Oil spills are the principal accidental impact-causing event. If oil
42 spills were to occur and were to contact the coast, overall impacts on land use and existing
43 infrastructure typically would be minor. Approximately 8 large spills, 35–70 medium-sized
44 spills, and 200–400 small spills are anticipated to occur in the GOM as a result of new

1 development (see Table 4.4.2-1).¹⁴ Oil spilled in offshore areas usually is localized and has a
2 low probability of contacting coastal areas, because much of the oil volatilizes or is dispersed by
3 currents (MMS 2008a). In most cases, coastal or nearshore spills would have short-term adverse
4 effects on coastal infrastructure requiring cleanup of any oil or chemicals spilled (MMS 2006a).
5

6 Potential impacts on land use and existing infrastructure would likely include “stresses of
7 the spill response on existing infrastructure, direct land-use impact (such as impacts of oil
8 contamination to a recreational area or to agricultural land), and restrictions of access to a
9 particular area, while the cleanup is being conducted” (MMS 2007c). These impacts generally
10 would be temporary and localized. However, as shown by recent events in the GOM (i.e., the
11 Deepwater Horizon event), the degree of impact is influenced by many factors including, but not
12 limited to, spill location, spill size, type of material spilled, prevailing wind and current
13 conditions, the vulnerability and sensitivity of the land use and infrastructure, and response
14 capability.
15

16 **Catastrophic Discharge Event.** In addition to small and large releases, the PEIS
17 analyzes the impacts of a CDE of 0.9 to 7.2 million bbl in size (Table 4.4.2-2). While no direct
18 major land use impacts would be expected following a CDE, post-spill habitat restoration efforts
19 could result in enhanced barrier islands and wetlands. A number of indirect effects may result,
20 including adaptations in commercial industries, such as fishing and tourism, fluctuating
21 economic patterns, and changes in demographic distributions; all of these impacts could affect
22 land use or development patterns by altering spending patterns of consumers and developers.
23 Following the DWH event, perceptions regarding emergency planning have created a need for
24 future planning and accounting for potential events of greater magnitude than typically
25 anticipated. Trickle-down effects of the DWH event may include more stringent safety protocols
26 in the operation and construction of infrastructure, which may include onshore facilities as well
27 as offshore facilities. Similar types of effects would be anticipated if a catastrophic discharge
28 event were to occur during the life of the Program.
29
30

31 **4.4.10.2 Alaska – Cook Inlet** 32

33 New oil and gas production is anticipated in the Cook Inlet, an area previously used for
34 offshore production. As indicated in Table 4.4.1-3, oil production is anticipated to include a
35 range of 0.1 to 0.2 Bbbl within south central Alaska; currently no active Federal leases are
36 located within the Inlet. However, 16 active offshore producing platforms are located within the
37 Cook Inlet in State submerged land. These platforms are served by more than 320 km (200 mi)
38 of undersea gas and oil pipelines, as well as onshore facilities (see Section 3.11.2).
39

40 A number of routine activities would be necessary to provide for additional production;
41 these activities have the potential to impact existing and future land use, development patterns,
42 and infrastructure. This analysis of impacts, therefore, focuses solely on new production within
43 the Cook Inlet.

¹⁴ As indicated in Section 4.4.2.1, large spills are categorized as those that result in over 1,000 barrels of oil being released; medium-sized are those between 50 and 1,000 barrels, and small spills are those under 50 barrels.

1 **4.4.10.2.1 Routine Operations.**

2
3 **Seismic Explorations and Exploratory Drilling.** As previously noted, activities
4 associated with exploration typically include a seismic survey, exploratory well construction, and
5 aircraft and vessel traffic (Figure 4.4.10-1). The impacts resulting from these activities are
6 discussed below.

7
8 **Local Land Use/Comprehensive Planning and Development Patterns.** Seismic
9 explorations and exploratory drilling would not directly impact land use, development patterns,
10 and infrastructure within the Cook Inlet, because a majority of the activities would be located
11 offshore. During this phase, existing and future land use categorizations would remain largely
12 unchanged, along with current development patterns.

13
14 In general, activities to support exploration would be located onshore within existing
15 developments in order to act as staging areas for the seismic surveys and exploratory wells.
16 Temporary onshore service bases could be needed to support offshore exploratory drilling
17 operations. These bases would transfer materials between land and the offshore drilling rigs. In
18 addition, supply vessels and helicopters would be used to shuttle personnel, equipment, and
19 supplies. Existing facilities generally would be used within the Cook Inlet, if they were available
20 in the selected location for exploration; if necessary, new facilities would be built, or
21 prefabricated modules could be moved to the base of the exploration activities (Kenai Peninsula
22 Borough 2008).

23
24 **Loss of Use to Existing Landowners or Users.** Activities associated with seismic
25 explorations and exploratory drilling could impact access or use of a particular land area,
26 although to a minimal extent. Some temporary onshore and offshore access restrictions could be
27 necessary for safety reasons; however, these restrictions likely would be temporary, lasting only
28 as long as the exploration activities.

29
30 The perception of loss of land or use, however, might increase among tribal
31 communities,¹⁵ local inhabitants, and visitors within the Cook Inlet. As offshore exploration
32 includes the temporary siting of large drilling rigs and discharges of drilling muds and cuttings,
33 some people using the coastal area for subsistence hunting and gathering or for recreation and
34 tourism might perceive the effects of the drilling as a disruption to their regular activities
35 (see Sections 4.4.13 and 4.4.14 for a further discussion of subsistence activities, Section 4.4.12
36 for a discussion of recreation and tourism, and Section 4.4.3.2 for a discussion of water quality).
37 If the perceived disruption or “nuisance” becomes too intense, users may relocate to other parts
38 of the Inlet in order to conduct their regular activities in anticipation of the new oil and gas
39 activities. Thus, the actual use of the land may be impacted, even if the intended land use
40 designation or categorization is not altered. Within the Cook Inlet, this impact would be
41 anticipated to be minimal, due to the presence of the existing oil and gas industry.

¹⁵ Approximately 8.9% of all land within the Kenai Peninsula Borough is owned by Native Village and Regional Corporations. Large tracts of this type of land surround Nanwalek, Port Graham, Tyonek, Ninilchik, Seldovia, and Kenai. Some of the parcels have been used for logging, oil and gas extraction, and mining (Kenai Peninsula Borough 2005).

1 In addition, the use of individual properties in the vicinity of the exploration activities
2 may be affected indirectly if excessive noise and air emissions generated by the exploratory
3 equipment, activities, and onshore/offshore vehicular and air traffic (e.g., helicopters and
4 automobiles) were to occur, or if a small increase in the amount of trash and debris washing
5 ashore were to result from the activities. These occurrences may cause a temporary disturbance
6 or annoyance among particular landholders or users, thereby inhibiting the intended or actual use
7 of a property. The level of impact would depend on the specific location within the Cook Inlet,
8 but generally would be anticipated to be minimal.

9
10 ***Physical and/or Infrastructural Composition.*** As noted in Table 4.4.1.2-1,
11 approximately 4–12 exploration wells would be drilled within south central Alaska. Due to the
12 existing oil and gas infrastructure already present, a minimal amount of additional machinery and
13 staging area improvements would be needed in order to accommodate equipment and workers
14 associated with exploration activities.

15
16 ***Onshore and Offshore Construction.*** Onshore and offshore construction could impact
17 local land use and comprehensive planning and existing and planned development; access and
18 use of particular properties; the physical and infrastructural composition of the Cook Inlet; and
19 existing conditions as they pertain to emissions, waste, noise, and traffic (see Figure 4.4.10-2).

20
21 As indicated in Section 4.1.1-2, construction activities often include production well
22 placement, pipeline placement, onshore construction, and aircraft and vessel traffic. Per the
23 proposed development scenario within south central Alaska, construction of approximately one
24 to three new platforms is anticipated, along with 40–241 km (25–150 mi) of new offshore
25 pipeline and 80–169 km (50–105 mi) of onshore pipeline. Up to one new pipeline landfall also
26 may be needed, as indicated in Table 4.4.1.1-3. Potential impacts of these activities are
27 presented below.

28
29 ***Local Land Use/Comprehensive Planning and Development Patterns.*** Due to a long
30 history of oil and gas development, existing land use categorizations in Cook Inlet often would
31 be able to accommodate new leases for the proposed development scenario. As indicated in
32 Section 4.4.1.2, existing infrastructure would be used to the extent possible, limiting the need for
33 the acquisition of new sites for development. Therefore, negligible to minor impacts on land use
34 categorizations (i.e., receptors) are predicted by the addition of new leases and subsequent
35 construction activities.

36
37 ***Loss of Use to Existing Landowners or Users.*** Onshore and offshore construction
38 generally would not interfere with or prevent use by existing owners or users within areas
39 already used for oil and gas. As previously indicated, the use of existing facilities generally
40 would be preferred over new construction. However, during construction activities, a temporary
41 loss of access for some users may occur, even within an existing oil and gas development area.
42 Restrictions on access may be put in place for safety reasons or to allow certain activities to
43 occur. Depending on the location of the activities, the restrictions would be lifted after the
44 completion of construction.

1 Likewise, some users of surrounding land may be inconvenienced by closure or
2 restrictions on access routes or within areas used for subsistence activities. For example, within
3 the Cook Inlet, as in other parts of Alaska, air carriers generally provide a large share of the
4 cargo and passenger service to and within the State. Water transport, especially for large and
5 heavy materials, also is an important component of the transportation network. Activities related
6 to the construction may impact Alaska's air routes, air-terminal facilities, and barge-cargo
7 services, causing delays or changes in scheduling or service (MMS 2002a). Consequently, the
8 perceived impact associated with these restrictions or closures to access routes or land areas may
9 weigh more heavily on permanent communities using surrounding lands or routes for subsistence
10 activities or for daily employment than on temporary visitors or tourists.

11
12 While plans for oil and gas development generally would limit the amount of permanent
13 loss of use, especially during construction, some users may be subject to this type of impact
14 dependent on the specific location chosen. A permanent loss of use generally would be
15 associated with land parcels in which land use categorizations were amended to allow for oil and
16 gas construction activities. If new land were necessary in order to construct onshore facilities,
17 such as a new pipeline or landfall, the acquisition process would need to follow all pertinent
18 local, State, and Federal requirements.

19
20 In addition, the use of individual properties in the vicinity of the construction activities
21 may be affected indirectly if excessive noise and air emissions generated by the construction
22 equipment and onshore/offshore vehicular and air traffic (e.g., helicopters and automobiles) were
23 to occur, or if a small increase in the amount of trash and debris washing ashore were to result
24 from the activities. These occurrences may cause a temporary disturbance or annoyance among
25 particular landholders or users, thereby inhibiting the intended or actual use of a property. The
26 level of impact would depend on the specific location within the Cook Inlet, but generally would
27 be anticipated to be minimal.

28
29 ***Physical and/or Infrastructural Composition.*** The physical and infrastructural
30 composition of south central Alaska would be altered by the expansion and/or improvement of
31 existing facilities, as well as by new construction. The extent of the impacts associated with
32 these activities ultimately would depend on their specific location within the Cook Inlet. For
33 example, this region has an inland network of oil and gas gathering distribution pipelines; one
34 such community is Nikiski, which has existing oil and gas support facilities to account for
35 current leasing (MMS 2007a). The basic onshore support and processing infrastructure that
36 would be necessary to support the anticipated levels of activity are already in place within the
37 Cook Inlet; these transport, loading, and storage capabilities would require expansion to handle
38 an increased volume of produced crude oil rather than extensive construction of new facilities
39 (MMS 2002a, 2007a).

40
41 While the oil and gas industry within Cook Inlet was one of the largest sources of high
42 paying jobs within the last decade, natural gas production recently has provided a more stable
43 source of employment. As a result, some of the aging infrastructure associated with offshore
44 drilling is in poor repair, and thus would require updates, expansion, and/or other improvements
45 (Fried and Windisch-Cole 2004). In these locations, new construction could be a more
46 appropriate solution to accommodate offshore oil and gas production.

1 If new infrastructure were needed, it would be built either as infill within an existing
2 industrial or port area or within an area recently designated for this type of development.
3 A greater impact on the existing physical landscape would be experienced in those areas not
4 already used for oil and gas production. For instance, the construction of the pipeline landfall
5 could involve clearing land, preparing a ROW, and digging and backfilling trenches. Additional
6 clearance could be necessary in order to accommodate the new on shore pipeline, as well. These
7 types of activities or similar ones could alter the physical composition of the landscape, thus
8 potentially limiting the intended, actual, or future use of a parcel. If needed, this type of
9 construction would have extensive impacts in lands used for subsistence hunting or other similar
10 activities.

11
12 Additional indirect impacts concern those associated with climate change. New facilities
13 may be sited in different locations in response to anticipated rises in sea level, increased storm
14 frequency and intensity, and temperature changes. Other activities that might be undertaken in
15 response to real or potential climate change-induced rises in sea level include facility relocation,
16 the construction of seawalls and storm surge barriers, and land acquisitions to create buffer areas
17 (IPCC 2007).

18
19 Consequently, indirect impacts on land use, development patterns, and infrastructure
20 could include locating further inland and/or strengthening foundations or building materials of
21 existing facilities. These actions potentially could increase costs associated with development or
22 force the construction of new facilities rather than the reuse or expansion of existing properties
23 associated with oil and gas production. These decisions may be influenced by the potential for
24 increased flooding and/or erosion, as well.

25
26 **Routine Operations.** Routine operations would include production well operation,
27 onshore facility operation, and vessel and aircraft traffic, as well as the transport of oil from
28 offshore to onshore locations using pipelines. Potential impacts associated with these activities
29 would range in extent from negligible to minimal (see Figure 4.4.10-3).

30
31 **Local Land Use/Comprehensive Planning and Development Patterns.** Once offshore
32 oil and gas facilities were in operation,¹⁶ negligible to minimal impacts on land use,
33 development patterns, and infrastructure would be expected, because a majority of the activities
34 would be located offshore, with some activity occurring within onshore bases and transportation
35 facilities.

36
37 In addition, as shown in Table 4.4.1-3, no new shore bases, processing facilities, or waste
38 disposal facilities are associated with the proposed action. Since existing infrastructure would be
39 used to the extent possible, the anticipated use of onshore facilities during normal operations
40 would not be expected to generate noticeable changes to the current setting that would impact the
41 overall land use, development patterns, or infrastructure of Cook Inlet.

42

¹⁶ For the purposes of this evaluation, normal operations exclude events leading up to the production of offshore oil and gas.

1 **Loss of Use to Existing Landowners or Users.** Once offshore oil and gas facilities were
2 in operation, a temporary or permanent loss of use would not be anticipated, because a sufficient
3 number of facilities already are located within Cook Inlet to support the increased oil and gas
4 development. At times, some access may be restricted within surrounding lands to accommodate
5 a brief alteration in normal operations (e.g., an emergency response).
6

7 Furthermore, the use of individual properties in the vicinity of the operating platforms
8 may be affected indirectly if excessive noise and air emissions were generated from equipment
9 and onshore/offshore vehicular and air traffic (e.g., helicopters and automobiles), or if a small
10 increase in the amount of trash and debris washing ashore were to result from the activities.
11 These occurrences may cause disturbances or annoyance among particular landholders or users,
12 thereby inhibiting the intended or actual use of a property. The level and extent of impact would
13 depend on the specific location within the Cook Inlet, but generally would be anticipated to be
14 minimal.
15

16 **Physical and/or Infrastructural Composition.** To the extent possible, existing facilities
17 would be used and new facilities would be built only where necessary, once initial construction
18 was completed. Since the anticipated new development is modest, large impacts on the physical
19 and/or infrastructural composition of Cook Inlet during the operation phase would not be
20 expected.
21

22 **Decommissioning.** When activities for oil and gas become uneconomical to continue
23 production operations or when a lease expires, many of the structures built for production would
24 be dismantled, shut down, or converted to other uses. Typical government regulations require
25 that offshore structures be cut off below the mud line and entirely removed, while pipelines often
26 are left in place due to the high cost of removal. Offshore wells would be cemented in, and sea
27 bottom well sites would be dragged to remove obstructions (Kenai Peninsula Borough 2008).
28 Due to the physical nature of these activities, land use, development patterns, and infrastructure
29 might be impacted directly. These impacts generally would be site-specific. In some cases, a
30 return to pre-exploration and preconstruction conditions might not be feasible.
31

32 **Local Land Use/Comprehensive Planning and Development Patterns.** Depending on
33 the location of the production wells and associated infrastructure, decommissioning activities
34 onshore might be regulated by local land use, zoning, and comprehensive planning initiatives or
35 requirements. In turn, local planning initiatives often account for developments of this nature in
36 future planning. For instance, the continued use of the facilities after production could impact
37 planned development in a positive manner, either by providing an opportunity for reuse of
38 facilities or allowing for additional or future oil and gas activities (MMS 2007b).
39

40 **Loss of Use to Existing Landowners or Users.** No permanent loss of use is anticipated
41 to occur during the decommissioning/reclamation phase. Some temporary loss might occur if
42 road or area closures were necessary to accommodate equipment, workers, or specific
43 deconstruction activities. If feasible, access would be restored to its preconstruction or
44 operations state.
45

1 During decommissioning, the use of individual properties in the vicinity of the activities
2 may be affected indirectly if excessive noise and air emissions were generated from equipment
3 and onshore/offshore vehicular and air traffic (e.g., helicopters and automobiles), or if a small
4 increase in the amount of trash and debris washing ashore were to result from the activities.
5 These occurrences may cause temporary disturbances or annoyance among particular
6 landholders or users, thereby inhibiting the intended or actual use of a property. The level and
7 extent of impact would depend on the specific location, but generally would be anticipated to be
8 minimal.

9
10 ***Physical and/or Infrastructural Composition.*** In addition, potential changes to the
11 physical and infrastructural makeup of Cook Inlet could occur. Any equipment added may be
12 removed; other defunct equipment also could be removed. Impacts on land use and
13 infrastructure would be site-specific and could range from negligible to minor. Moreover, if any
14 offshore or onshore infrastructure were deemed a visual intrusion within the landscape for the
15 duration of the project, removal of the structure during decommissioning would remove the
16 feature, and thus help to alleviate the impact (MMS 2003a).

17
18
19 **4.4.10.2.2 Accidents.** The risk of a spill is present whenever crude oil or petroleum
20 products are handled. Oil spills could be associated with the exploration, development,
21 production, storage, and/or transportation processes and might occur from losses of well control
22 or pipeline or tanker accidents. As indicated in Table 4.4.2-1, approximately 1 large spill, 1 to
23 3 medium-sized spills, and 7 to 15 small spills are anticipated to occur as part of new
24 development within Cook Inlet. From 1999 to 2008, 18 crude oil spills of 380 L (100 gal) or
25 more from pipelines, platforms, onshore production facilities, storage facilities, and marine
26 tankers have occurred in Cook Inlet. Six of these were more than 1,900 L (500 gal)
27 (ADNR 2009b).

28
29 Based upon knowledge acquired from previous spills, potential impacts to land use and
30 infrastructure resulting from an oil spill would likely include moderate temporary stresses of the
31 spill response on existing community infrastructure, increased boat and air traffic to respond to
32 the spill and cleanup operations, and restrictions of access to a particular area while the cleanup
33 is conducted (MMS 2007c). These stresses could lead to a temporary loss of use of certain
34 parcels both for their intended and actual uses, but generally no permanent land use
35 categorization changes.

36
37 Within Cook Inlet, a geographic response strategy (GRS) has been formulated to account
38 for 17 sites within the central Cook Inlet, 18 sites for the southwest, 21 sites for Kachemak Bay,
39 and 22 sites for the southeast. Strategies within this plan focus on minimizing the environmental
40 damage, using a small response footprint, and selecting sites for equipment deployment that
41 would not cause further harm (ADNR 2009b).

42
43 **Catastrophic Discharge Event.** The PEIS analyzes the impacts of a CDE that could
44 range in size from 75 to 125 thousand bbl (see Table 4.4.2-2). These events have the potential to
45 impact future development patterns if irreversible changes to the land composition occur within
46 certain areas. For example, one of the largest events of this type occurred in 1989; it consisted of

1 the *Exxon Valdez* discharge. This event led to the closure or disruption of many Cook Inlet
2 businesses, including fisheries (ADNR 2009b).

3
4 However, only one spill of this size is anticipated to occur within this region (see
5 Table 4.4.2-2). It would likely be a result of oil transport from a tanker carrying Arctic and Cook
6 Inlet OCS oil from the Valdez terminal to U.S. ports (see Section 4.4.2.1 for additional
7 information). In most cases, a worst-case oil discharge from an exploration facility, production
8 facility, pipeline, or storage facility would be restricted by the maximum tank or vessel storage
9 capacity or by a well's ability to produce oil.

10
11 Potential impacts to land use and infrastructure resulting from a CDE would likely
12 include moderate to high temporary stresses of the spill response on existing community
13 infrastructure, increased boat and air traffic to respond to the spill and cleanup operations, and
14 restrictions of access to a particular area while the cleanup is conducted (MMS 2007c). Some of
15 these impacts may lead to more permanent changes in the way land is used, such as closure or
16 disruptions of business as occurred for the *Exxon Valdez* event (ADNR 2009b).

17 18 19 **4.4.10.3 Alaska – Arctic**

20
21 Oil and gas production within the Arctic as a whole is not as developed as that in the
22 GOM and Cook Inlet; however, this region includes the Beaufort Sea Planning Area, which has
23 well-developed oil and gas industry infrastructure on adjacent land and in State waters. For
24 instance, the Prudhoe Bay complex is located within the Beaufort Sea Planning Area. This is
25 part of a large oil producing field, which contains extensive infrastructure (MMS 2007c).

26
27 As indicated in Table 4.4.1-4, oil production is anticipated to include 0.2 to 2.1 Bbbl
28 within the Beaufort Sea and the Chukchi Sea. Therefore, a number of routine activities would be
29 necessary to more fully develop this industry in order to provide for additional production within
30 the Beaufort and Chukchi Seas region. As noted for the other areas, these activities have the
31 potential to impact existing and future land use, development patterns, and infrastructure.

32
33
34 **4.4.10.3.1 Routine Operations.** Routine activities include exploration, development,
35 production, and decommissioning. Impacts on land use, development patterns, and infrastructure
36 within the Beaufort and Chukchi Seas regions from each of these activities are presented below.

37
38 **Seismic Explorations and Exploratory Drilling.** Activities associated with exploration
39 typically include a seismic survey, exploratory well construction, and aircraft and vessel traffic.

40
41 **Local Land Use/Comprehensive Planning and Development Patterns.** Seismic
42 explorations and exploratory drilling would not directly impact land use, development patterns,
43 and infrastructure, because a majority of the activities would be located offshore. During this
44 phase, existing and future land use categorizations would remain largely unchanged.

1 **Loss of Use to Existing Landowners or Users.** Activities associated with seismic
2 explorations and exploratory drilling could potentially impact access or use of a particular land
3 area, although to a minimal extent. Some temporary safety-related restrictions on access might
4 be necessary both onshore and offshore; however, these restrictions likely would last only as
5 long as the exploration activities.
6

7 For this area of Alaska, a scattered exploration pattern may be necessary due to the lack
8 of existing oil and gas infrastructure. For this type of exploration pattern, more frequent and
9 longer-duration helicopter and support boat trips would be needed than if a clustered pattern of
10 exploration were utilized. For instance, platforms located beyond the landfast ice zone would
11 require substantial helicopter support, especially during the developmental drilling phase,
12 because they would be unreachable by ice roads. In addition, platforms located in the landfast
13 ice zone could be served by vehicles traveling over ice roads (MMS 2007c). Local access to
14 these transportation modes could be impacted, although to a minimal extent, to account for the
15 additional trips and traffic associated with this type of exploration. This would result in a
16 perceived loss of use for some people either living, visiting, or working within the area.
17

18 Perceived loss of land or use might also increase among tribal communities, local
19 inhabitants, and visitors within the coastal areas of the Beaufort and Chukchi Seas. Since
20 offshore exploration includes the placement of wells and the production of drilling muds and
21 cuttings, which may be discharged into the marine environment, some people using the coastal
22 area may perceive the effects of the drilling as a disruption to their regular activities. If the
23 perceived disruption or “nuisance” becomes too intense, users may relocate to other parts of the
24 coast in order to conduct their regular activities. Thus, the actual use of the land may be
25 impacted, even if the intended land use designation or categorization is not altered.
26

27 For example, as indicated in Section 4.4.13.3, residents of the Chukchi Sea communities
28 have noted a concern over the loss of a subsistence lifestyle and the imposition of additional
29 demands on communities to maintain new infrastructure either directly or indirectly related to
30 oil and gas exploration and eventual production. “Residents of the Chukchi Sea coastal
31 communities have been remarkably consistent in their primary concerns during the more than
32 20 years of public hearings and meetings on State and Federal oil development on the North
33 Slope” (BOEMRE 2010a, 2011k). Sections 4.4.13.3.1 and 4.4.14.3.1 provide additional
34 information on the impacts to subsistence and tribal communities within the Arctic region
35 resulting from oil and gas activities.
36

37 In addition, the use of individual properties in the vicinity of the exploration activities
38 may be affected indirectly if excessive noise and air emissions were generated from equipment
39 and onshore/offshore vehicular and air traffic (e.g., helicopters and automobiles), or if a small
40 increase in the amount of trash and debris washing ashore were to result from the activities.
41 These occurrences may cause disturbances or annoyance among particular landholders or users,
42 thereby inhibiting the intended or actual use of a property. The level and extent of the indirect
43 impacts would depend on the specific location within the Arctic region, but generally would be
44 anticipated to be minimal to moderate (BOEMRE 2011k).
45

1 **Physical and/or Infrastructural Composition.** As noted in Table 4.4.1-4, approximately
2 6–20 exploration and delineation wells and 40–280 development and production wells would be
3 drilled within the Arctic. Machinery and staging area improvements would be needed in order to
4 accommodate equipment and workers associated with these exploration activities. The increase
5 in physical infrastructure likely would be negligible to minimal at this stage of oil and gas
6 development due to the temporary nature of the exploration activities and the anticipated use of
7 existing facilities, where available.
8

9 **Onshore and Offshore Construction.** Similar to the exploration phase, onshore and
10 offshore construction have the potential to impact local land use and comprehensive planning
11 and existing and planned development; access and use of particular properties; and the physical
12 and infrastructural composition of the Beaufort and Chukchi Seas.
13

14 As indicated in Figure 4.4.10-2, activities associated with this phase often include
15 production well placement, pipeline placement, onshore construction, and aircraft and vessel
16 traffic. Per the proposed development scenario within the Arctic region, approximately
17 1–5 platforms are anticipated, along with 16–130 km (10–80 mi) of onshore pipeline. No new
18 pipeline landfalls or shore bases are anticipated. This section provides a discussion of impacts
19 associated with land use as they pertain to onshore and offshore construction.
20

21 **Local Land Use/Comprehensive Planning and Development Patterns.** Due to the
22 minimal level of current oil and gas development within the whole of the Beaufort and Chukchi
23 Seas, existing land use plans and designations may not provide for areas that are able to
24 accommodate new leases. Therefore, minimal to moderate impacts to land use and
25 comprehensive planning decisions, such as a conditional use permit or zoning change, are
26 predicted as a result of the leasing and subsequent development activities, including construction.
27 The need to address existing land use would depend on the specific location selected for onshore
28 construction and on the activity to be conducted (e.g., the construction of onshore pipeline routes
29 or new transportation routes).
30

31 For instance, according to the North Slope Borough (NSB) comprehensive plan, five
32 major zoning districts are present, including the Village, Barrow, Conservation, Resource
33 Development, and Transportation Corridor (MMS 2007a). “All areas within the NSB are in the
34 Conservation District, unless they are specifically designated within the limited boundaries of a
35 village or Barrow, a unitized oil field within the Resource Development District, or within the
36 Trans-Alaska Pipeline System (TAPS) corridor” (MMS 2007a). As indicated by this statement,
37 major land uses generally are divided between subsistence use and petroleum-resource extraction
38 (MMS 2007a).
39

40 Due to the recognition of oil and gas activities, all of the NSB land management
41 regulations address oil and gas leasing activities, including onshore and offshore (MMS 2007a).
42 Therefore, within the NSB, conditional use permits may be requested that would allow for
43 specific, temporary activities; in some cases, the more permanent development associated with
44 production would require that a master plan be prepared describing anticipated activities. In
45 addition, use of non-Federal land within the NSB may require rezoning from the Conservation
46 District to the Resource Development District or Transportation Corridor (MMS 2007a).

1 While not a direct cause and effect relationship, if changes to overall land use
2 categorizations or planning initiatives were needed to begin construction and subsequent
3 development of oil and gas facilities, future development patterns could be impacted. If onshore
4 construction were to occur within the Arctic region, various government agencies and
5 jurisdictions would be involved in the change. Land ownership within the North Slope area
6 consists of overlapping ownership interests, at times vague boundary descriptions, and informal
7 or unrecorded land transfers. Surface and subsurface ownership interests are held by the Federal
8 Government, State government, the borough, villages, regional and village Native corporations,
9 and private individuals, including Native allotments. As in many areas, surface and subsurface
10 owners may differ, particularly in communities and Native allotments (URS Corporation 2005).

11
12 In addition, if new infrastructure would be needed onshore, some facilities and
13 infrastructure would be subject to other local, State, and/or other Federal permitting and
14 regulations, including provisions for the siting of facilities. Specific timelines and requirements
15 would vary by location, as BOEM typically is not the permitting or regulating agency for
16 development activities that occur onshore.

17
18 ***Loss of Use to Existing Landowners or Users.*** Onshore and offshore construction
19 generally has the potential to interfere with or prevent use by existing owners or users within
20 areas not already used for oil and gas activities (see Section 4.4.13.3 and 4.4.14.3 regarding
21 impacts on subsistence activities). While the use of existing facilities generally is preferred over
22 new construction, few of these facilities exist within the whole of the Arctic region as compared
23 to the GOM and Cook Inlet. As previously indicated, the Chukchi Sea Planning Area has
24 relatively little established infrastructure, while well-developed oil and gas facilities are located
25 within the Beaufort Sea Planning Area, such as at the Prudhoe Bay complex. Therefore, during
26 construction, a temporary loss of access to some users may occur. Restrictions on access may be
27 put in place as safety precautions or to allow certain activities to occur. Depending on the
28 location of the activities, these restrictions could be lifted after construction was completed.

29
30 Users of surrounding lands also may be inconvenienced by closure or restrictions on
31 access routes or within areas used for subsistence activities during construction. For instance, if
32 platforms were constructed in part onshore, some marine subsistence hunters may have to avoid
33 or navigate around them when preparing their crafts from an onshore location. Another example
34 would include the construction of temporary roads for exploration drilling or permanent roads
35 that may be constructed as a result of proposed activities. While roads could increase access to
36 previously inaccessible areas, they also could also create community-development, land use-
37 planning, or fish and game-management problems (ADNR 2009). Consequently, the perceived
38 impact associated with these restrictions or closures may weigh more heavily on communities
39 using surrounding lands for subsistence activities than recreational users or tourists
40 (see Sections 4.4.13.3.1 and 4.4.14.3.1 for additional information regarding subsistence
41 activities).

42
43 In addition, the use of individual properties in the vicinity of the construction activities
44 may be affected indirectly if excessive noise and air emissions were generated from equipment
45 and onshore/offshore vehicular and air traffic (e.g., helicopters and automobiles), or if a small
46 increase in the amount of trash and debris washing ashore were to result from the activities.

1 These occurrences may cause disturbances or annoyance among particular landholders or users,
2 thereby inhibiting the intended or actual use of a property. The level and extent of impact would
3 depend on the specific location within the Arctic, but generally would be anticipated to be
4 minimal to moderate.

5
6 ***Physical and/or Infrastructural Composition.*** The physical presence of the shore-based
7 and pipeline infrastructure within the Arctic region would represent an initial industrialization of
8 the area and a long-term and significant change in land use patterns. This would result due to the
9 change from an isolated and often pristine environment to one that supports oil and gas
10 infrastructure. While new technologies and practices tend to be less damaging than those
11 associated with past activities, the addition of these facilities has the potential to permanently
12 alter the land use within the region (AMAP 2010).

13
14 In areas already developed with oil and gas infrastructure, such as in the Beaufort Sea
15 Planning Area, the construction of oil and gas infrastructure would represent a continuation of
16 industrial/commercial activity; however, in areas lacking existing infrastructure, it would account
17 for a more substantial change in the industrial/commercial activity and diversity of individual
18 villages (MMS 2007a). The extent of the impacts associated with these activities ultimately
19 would depend on the specific location within the Arctic and the particular community in which
20 facilities would be placed.

21
22 Impacts on infrastructural composition also would result from the development of
23 onshore pipeline and a permanent road network in locations that do not already have existing oil
24 and gas facilities. Depending on the location of a pipeline landfall, the path of an associated road
25 to the Trans-Alaska Pipeline System (TAPS) might open up areas not previously reached by
26 permanent roads. The positive benefits of this construction would be to aid future ice road and
27 permanent road construction, as well as providing a connection to the North Slope communities
28 (MMS 2007c). Some of the negative impacts of roadway construction would be the interference
29 with subsistence uses and animal movement and the potential for increased traffic (see
30 Sections 4.4.13.3.1 and 4.4.14.3.1 for more information).

31
32 Additional indirect impacts concern those associated with climate change. Siting of new
33 facilities may account for potential changes resulting from rises in sea level, increased storm
34 frequency and intensity, and temperature changes. One of the more noticeable effects would be
35 the thawing of permafrost on land. In the Arctic, facilities often use permafrost as a solid
36 foundation for buildings, pipelines, and roads, and for containing waste materials. Warming may
37 degrade permafrost, which can harm existing facilities and prevent the use of permafrost in the
38 future (AMAP 2007; MMS 2007c).

39
40 Consequently, indirect impacts on land use, development patterns, and infrastructure can
41 include locating further inland and/or strengthening foundations or building materials of existing
42 facilities. These actions potentially can increase costs associated with development or force the
43 construction of new facilities rather than the reuse or expansion of existing properties associated
44 with oil and gas production. These decisions also may be influenced by the potential for
45 increased flooding and/or erosion.

1 **Routine Operations.** Routine operation activities would consist of production well
2 operation, onshore facility operation, and vessel and aircraft traffic. It also would include the
3 transport of oil from offshore to onshore locations using ships or pipelines (see Figure 4.4.10-3).
4 As indicated in Section 4.4.1.3, the PEIS assumes that the most likely locations for the
5 occurrence of activities would be in areas that already have been leased in recent sales. One to
6 15 helicopter trips and 1 to 15 vessel trips would be anticipated. Potential impacts associated
7 with these activities would range in extent from negligible to moderate.

8
9 **Local Land Use/Comprehensive Planning and Development Patterns.** Once in
10 operation,¹⁷ negligible to minimal impacts are anticipated to result on land use, development
11 patterns, and infrastructure, since a majority of the activities would be located offshore, and no
12 additional construction would be anticipated. In general, the production of oil and gas would
13 need to be consistent with Federal, State, and local planning initiatives.

14
15 **Loss of Use to Existing Landowners or Users.** Once in operation, an additional loss of
16 use is not anticipated. At times, some access may be restricted within surrounding lands to
17 accommodate a brief alteration in operations or a peak in normal activities, or to conduct
18 maintenance.

19
20 During operation, the use of individual properties in the vicinity of the operating
21 platforms may be affected indirectly if excessive noise and air emissions were generated from
22 equipment and onshore/offshore vehicular and air traffic (e.g., helicopters and automobiles), or if
23 a small increase in the amount of trash and debris washing ashore were to result from the
24 activities. These occurrences may cause disturbances or annoyance among particular
25 landholders or users, thereby inhibiting the intended or actual use of a property. The level and
26 extent of impact would depend on the specific location within the Arctic, but generally would be
27 anticipated to be minimal to moderate. For instance, in locations where subsistence activities
28 occur, the impacts may be more noticeable and have a larger impact on certain communities as
29 compared to other areas of the Arctic; a discussion of these impacts is provided in
30 Sections 4.4.13.3.1 and 4.4.14.3.1.

31
32 **Physical and/or Infrastructural Composition.** To the extent possible, no new facilities
33 would be built during normal operations. Therefore, the potential to create lasting changes to the
34 physical and/or infrastructural composition of the Arctic region during the operation phase would
35 be limited.

36
37 **Decommissioning.** When activities for oil and gas production operations become
38 uneconomical to continue, or when a lease is expired, many of the structures built for production
39 are dismantled, shut down, or converted to other uses. Decommissioning activities in the Arctic
40 typically involve permanently plugging wells (with cement), removing wellhead equipment, and
41 removing the processing module from the platform. Pipelines also must be decommissioned,
42 which involves cleaning the pipeline, plugging the ends, and leaving it in place, buried within the
43 seabed. Onshore pipelines may be used for other purposes, if not removed (MMS 2008b). All

¹⁷ For the purposes of this evaluation, normal operations are considered exclusive of events leading up to the production of offshore oil and gas.

1 decommissioning activities would abide by Federal regulations. Due to the physical nature of
2 these activities and the length of the leases, land use, development patterns, and infrastructure
3 may be impacted directly. These impacts, however, generally would be site-specific. In some
4 cases, pre-exploration and preconstruction conditions may not be able to be reestablished.

5
6 ***Local Land Use/Comprehensive Planning and Development Patterns.*** Depending on
7 the location of the production wells and associated infrastructure, decommissioning activities
8 onshore may be regulated by local land use, zoning, and comprehensive planning initiatives or
9 requirements.

10
11 In turn, local planning initiatives often account for developments of this nature in future
12 planning due to the length of operation. For instance, the continued use of the facilities after
13 production could impact planned development in a positive manner, either by providing an
14 opportunity for reuse of facilities or by allowing for the potential for additional or future oil and
15 gas development.

16
17 ***Loss of Use to Existing Landowners or Users.*** No permanent loss of use is anticipated
18 to occur during the decommissioning/reclamation phase. Some temporary loss may occur if road
19 or area closures are necessary to accommodate equipment, workers, or specific activities
20 associated with this type of process. Access to and the physical composition of the
21 industrial/port areas typically would be restored to its preconstruction or operations state to the
22 extent possible.

23
24 In addition, the use of individual properties in the vicinity of the decommissioning
25 activities may be affected indirectly if excessive noise and air emissions were generated from
26 equipment and onshore/offshore vehicular and air traffic (e.g., helicopters and automobiles), or if
27 a small increase in the amount of trash and debris washing ashore were to result from the
28 activities. These occurrences may cause disturbances or annoyance among particular
29 landholders or users, thereby inhibiting the intended or actual use of a property. The level and
30 extent of impact would depend on the specific location within the Arctic, but generally would be
31 anticipated to be minimal.

32
33 ***Physical and/or Infrastructural Composition.*** In addition, potential changes to the
34 physical and infrastructural composition of the Beaufort and Chukchi Seas would occur. Any
35 equipment added may be removed; other defunct equipment also could be removed. These
36 alterations would be site-specific and likely could range from negligible to minimal in the extent
37 of their impact with regard to the existing composition of land use and infrastructure. Moreover,
38 if any offshore or onshore infrastructure were deemed a visual intrusion within the landscape for
39 the duration of the project, removal of the structure during decommissioning would remove the
40 feature, and thus alleviate the intrusion (MMS 2003a).

41
42
43 **4.4.10.3.2 Accidents.** One anticipated effect of oil and gas development within the
44 Arctic is to extend infrastructure (e.g., landfalls and platforms) and associated activities
45 westward. As a result of this construction, new areas of Alaska adjacent to the Beaufort and
46 Chukchi Seas would be exposed to the potential effects of crude oil spills. Approximately

1 3 large spills, 10 to 35 medium-sized spills, and 50 to 190 small spills are anticipated to occur
2 with the proposed development of the Arctic Beaufort Sea (see Table 4.4.2-1). Consequently,
3 crude oil spill-response equipment and personnel would be needed in those locations
4 (MMS 2007c).

5
6 As with other areas of Alaska, potential indirect impacts on land use and infrastructure
7 resulting from small, medium, or large spills would likely include moderate temporary stresses
8 from the spill response on existing community infrastructure; oil contamination at a coastal area;
9 increased boat and air traffic to respond to the spill and cleanup operations; and restrictions of
10 access to a particular area while the cleanup is conducted (MMS 2007c). These occurrences
11 could lead to a temporary loss of use of certain parcels for both their intended and actual uses.

12
13 **Catastrophic Discharge Event.** The PEIS analyzes a CDE as large as 1.4 to
14 2.2 million bbl in the Chukchi Sea and 1.7 to 3.9 million bbl in the Beaufort Sea (Table 4.4.2-2).
15 A CDE would have similar types of impacts as spills of other magnitudes; however, the degree
16 of impact would be more severe. For instance, the length of time in which the impacts would be
17 experienced generally would be longer for this type of event (MMS 2007c; BOEMRE 2011k).
18 Likewise, communities that are in close proximity to the event may experience a displacement of
19 existing sociocultural patterns that could affect how they use the land (BOEMRE 2011k). In
20 particular, this type of event would have major effects on communities using land for subsistence
21 activities. These impacts are discussed in detail in Section 4.4.13.3.2.

22 23 24 **4.4.10.4 Conclusion**

25
26 The addition of new oil and gas leases within the GOM Planning Areas would result in
27 negligible to minor impacts on land use, development patterns, and infrastructure. In general, the
28 existing infrastructure would be expected to be sufficient to handle exploration and development
29 associated with potential new leases.

30
31 Additional leases for oil and gas development would have a more noticeable impact on
32 land use, development patterns, and infrastructure within Alaska. While Cook Inlet currently
33 supports some oil and gas production, some minor impacts on land use, development patterns,
34 and infrastructure would be anticipated to occur as a result of new leases. These impacts would
35 vary in intensity dependent on specific location within the Inlet. The existing infrastructure
36 would help to limit the intensity of the impacts as compared to Arctic locations, in which limited
37 infrastructure is present and where communities are much smaller than within Cook Inlet.

38
39 Within the Arctic, minor to moderate impacts would be anticipated to result from the
40 development of new oil and gas leases within the Beaufort and Chukchi Seas. Existing land use
41 and infrastructure likely would be able to accommodate new leases. In general, land use changes
42 would be needed only in locations where new onshore pipeline routes would be constructed, and
43 in areas requiring new transportation networks (MMS 2007a).

44
45 In all three areas, the potential for accidents to occur would be present. These types of
46 events could have both direct and indirect effects on land use, depending on the type, size,

1 location, and duration of the incident. Impacts generally would be more intense in areas with
2 little infrastructure in place to handle accidents and where a greater reliance is placed on coastal
3 activities for subsistence and would be greater in the event of a CDE-level spill.
4
5

6 **4.4.11 Potential Impacts on Commercial and Recreational Fisheries**

7
8

9 **4.4.11.1 Gulf of Mexico**

10
11

12 **4.4.11.1.1 Routine Operations.**

13

14 **Commercial Fisheries.** Routine operations could affect commercial fisheries by causing
15 changes in the distribution or abundance of fishery resources, reducing the catchability of fish or
16 shellfish, precluding fishers from accessing viable fishing areas, or causing losses of or damage
17 to equipment or vessels. Between 200 and 450 new platforms would be established under the
18 proposed action, with up to 2,500 ha (6,177 ac) of seafloor likely to be disturbed by offshore
19 platforms and up to 11,500 ha (28,417 ac) by pipelines. Impacts on commercial fishing activities
20 would vary depending on the nature of a particular structure, the phase of operation, the fishing
21 method or gear, and the target species group. Impacts would be higher for drifting gear such as
22 purse nets, bottom longlines, and pelagic longlines than for trawls and handlines (MMS 2005).
23 Nevertheless, areas in which commercial fishing would be affected are small relative to the
24 entire fishing area available to surface longliners or purse seiners.
25

26 To avoid potential conflicts and to maintain safety at large deepwater structures, a safety
27 zone for vessels longer than 30 m (100 ft) may be established up to 500 m (1,640 ft) around each
28 production platform, which would encompass up to approximately 80 ha (198 ac) of surface area
29 per platform. The Fisherman's Contingency Fund, established under OSCLA, can compensate
30 fisherman for property and economic losses related to obstructions caused by oil and gas
31 development in the OCS. The Fund is composed of assessments paid by offshore oil and gas
32 operations and administered by the NMFS (see [www.nmfs.noaa.gov/mb/financial_services/
33 fcf.htm](http://www.nmfs.noaa.gov/mb/financial_services/fcf.htm)).
34

35 Federal regulations (30 CFR 250.702(I)) require that, during decommissioning, all
36 wellheads, casings, pilings, and other obstructions be removed to a depth of at least 5 m (15 ft)
37 below the mud line or to a depth approved by the District Supervisor; the size of the area left
38 untrawlable due to abandoned components would represent only a fraction of the total area
39 excluded by oil and gas operations. Longlining would still be possible following
40 decommissioning and removal because surface waters would not be affected by the presence of
41 the remaining underwater components.
42

43 The impact of oil and gas structures on commercial fisheries at various depth ranges can
44 be estimated using data in the Offshore Environmental Cost Model (OECM) (BOEMRE 2010d).
45 The model assumes that there will be buffer zones of up to 0.8 km (0.5 mi) around new oil and
46 gas structures, decreasing the area of ocean available for fishing. Although harvesting levels are

1 not affected by offshore structures and pipelines, as these levels are below federally mandated
2 levels, it is assumed that fishing activity will continue in areas still open for fishing, with existing
3 harvesting levels remaining, but that there will be an increase in fishing costs.
4

5 The impacts of oil and gas development on commercial fishing costs would vary
6 considerably by planning region and placement depth (Table 4.4.11-1). In the Western Planning
7 Area, the largest cost increases would occur with structures located in water between 150 and
8 300 m (492 and 984 ft) deep, with an annual increase of \$93 in costs from a single structure; a
9 single structure in each depth range would increase annual costs by \$147. In the Central
10 Planning Area, overall increases in costs would be much larger at \$1,080 per year, with the
11 largest increase coming with a single structure placed in water between 150 and 300 m (492 and
12 984 ft). Cost impacts in the Eastern Planning Area would be minimal, at \$2 per year with a
13 structure in each depth range. In each of the planning areas, single structures would have
14 relatively insignificant impacts compared to fishery revenues in each depth range.
15

16 Under the proposed action alternative, between 44 and 80 platforms would be located in
17 the depth range 0 to 60 m (0 to 197 ft) in the Western Planning Area, with between 122 and
18 257 such platforms in the Central Planning Area. Offshore oil and gas structures placed within
19 this depth range would increase annual commercial fishing costs by between \$1,993 and
20 \$3,819 in the Western Planning Area, while reducing costs by between \$2,507 and \$11,243 in
21 the Central Planning Area. No data is currently available on the placement of offshore platforms
22 in the Eastern Planning Area, and consequently, their impact on commercial fishing costs.
23

24 **Recreational Fisheries.** The level of impacts on recreational fisheries in the GOM due
25 to routine operations under the proposed action would be similar to impacts during the previous
26 lease period. Biological resources that serve as the basis for recreational fisheries in the GOM
27 are expected to be only minimally affected by activities associated with routine operations.
28 Construction activities would primarily affect soft bottom species such as red drum, sand sea
29 trout, and spotted sea trout that are sought by anglers in private or charter/party vessels. Such
30 conflicts would be temporary, however, as fishes would eventually return to disturbed areas.
31 The presence of offshore platforms may have a positive effect on the availability of recreational
32 fishing opportunities. During 1999, for example, approximately 20% of private boat fishing
33 trips, 32% of charter boat fishing trips, and 51% of party boat fishing trips in the western and
34 central GOM (Alabama, Mississippi, Louisiana, and Texas) took recreational fishers within 91 m
35 (300 ft) of oil or gas structures (Hiatt and Milon 2002), as the presence of structures is known to
36 aggregate pelagic (e.g., king mackerels, tunas, and cobia) and reef-associated fish species
37 (e.g., red snapper, gray triggerfish, and amberjack) that are targeted by many recreational fishers.
38

39 **4.4.11.1.2 Accidents.**

40
41
42 **Commercial Fisheries.** Under the proposed action, up to 8 large spills greater than
43 1,000 bbl, between 35 and 70 spills between 50 bbl and 1,000 bbl, and up to 400 small spills less
44 than 50 bbl could occur within the northern GOM. Most of the fish species inhabiting shelf or
45 oceanic waters of the GOM have planktonic eggs and larvae (Ditty 1986; Ditty et al. 1988;
46 Richards and Potthoff 1980; Richards et al. 1993). Certain species, such as triggerfishes, deposit

1 **TABLE 4.4.11-1 Impacts of Single Oil and Gas Structures on Commercial Fisheries, by**
 2 **Placement Depth (\$2010)**

Placement Depth Range	Western Planning Area		Central Planning Area		Eastern Planning Area	
	Fishery Revenue (\$m)	Cost Impact (\$)	Fishery Revenue (\$m)	Cost Impact (\$)	Fishery Revenue (\$m)	Cost Impact (\$)
0 to 60 m	103.4	41.24	153.5	-165.82	64.4	-0.52
60 to 150 m	22.6	16.73	40.4	21.00	17.7	0.24
150 to 300 m	8.3	92.89	26.1	916.09	9.4	-0.92
300 to 1,500 m	74.4	-5.95	180.3	224.17	22.3	2.15
More than 1,500 m	45.4	2.11	402.7	84.91	54.4	0.76
All depths	254.1	147.03	803.1	1,080.40	168.2	1.70

Source: BOEMRE 2010d.

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demersal eggs but have larvae that take up residence in the water column, meaning that these species would also be affected by oil spills. Depending on the location and timing of particular spills, effects would be greater if local water currents retained planktonic larvae and floating oil within the same water mass for extended periods of time. In deepwater areas, adults of highly migratory fish species, including pelagic species such as tunas, sharks, and billfish, would move away from surface oil spills. Pelagic larvae and neuston would not be able to move away from the spilled oil on the surface and would most likely be killed or injured. However, these impacts are not expected to cause population reductions in most commercially exploited species. In coastal areas, moderate and long-term but temporary degradation of estuarine habitat could occur if a large coastal area was oiled following a large or very large oil spill. Although some wetland areas may not recover completely, it is anticipated that spills considered possible as a result of the proposed action are not likely to substantially threaten the overall viability of wetland habitats used by commercially important species. On the basis of the potential level of impacts on coastal habitats including wetlands and submerged seagrass beds under the proposed action, major declines in fish population are not likely to occur.

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In general, the level of effects from accidental spills would depend on the location, timing, and volume of spills in addition to other environmental factors. Small spills would be unlikely to affect a large number of fish or commercial fishing before dilution and weathering reduced concentrations; therefore, they would not have long-term effects on commercial fisheries in the GOM. It is anticipated that any single large spill would affect only a small proportion of a given fish population within the GOM and that fish resources would not be permanently affected. However, localized effects on commercial fishing could result as a consequence of reduced catch, loss of gear, or loss of fishing opportunities during cleanup and recovery periods.

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31
32

Recreational Fisheries. The magnitude of effects from accidental spills would depend on the location, timing, and volume of spills, in addition to other environmental factors. Small spills that may occur under the proposed action are unlikely to affect a large number of fish or

1 have a substantial effect on recreational fishing before dilution and weathering reduced
2 concentrations of oil in the water. Consequently, it is anticipated that small spills would not have
3 substantial or long-term effects on recreational fishing in the GOM. Any single large spill would
4 likely affect only a small proportion of a given fish population within the GOM, and it is unlikely
5 that fish resources would be permanently affected. However, spills could have localized effects
6 on recreational fishing as a consequence of contamination of fish tissues, degradation of aesthetic
7 values that attract fishers, or temporary closure of fishing areas. A CDE, such as occurred
8 following the DWH accident, could have more noticeable impacts on recreational fishing
9 activity, as well as on individuals and firms that depend on angler spending. Spill effects can be
10 mitigated to some extent through financial compensation and through policies of Federal and
11 State fisheries management agencies. On the basis of the number and size of spills assumed for
12 the proposed action, persistent degradation of shorelines and waters are not likely to occur;
13 therefore, impacts on recreational fishing are not expected to be significant. Impacts of spills on
14 subsistence resources are also discussed in Section 4.4.13 and 4.4.14.
15

16 **Catastrophic Discharge Event.** The PEIS analyzes a CDE that ranges in size from
17 0.9 to 7.2 million bbl (Table 4.4.2-2). The magnitude of effects from a CDE would depend on
18 the location, timing, and volume of the oil associated with the event. Oil from a CDE could
19 contact intertidal habitat and subsequently contaminate or reduce the abundance of commercial
20 and recreational species that depend on nearshore habitat. However, it is likely that an event
21 would only affect a small proportion of fish species population, and it is unlikely that fish
22 resources would be permanently affected. In the short term, there would be local or regional
23 effects on commercial fishing that as a result of reduced catch, loss of gear, or loss of fishing
24 opportunities during cleanup and recovery periods, and on recreational fishing as a consequence
25 of contamination of fish tissues, the degradation of aesthetic values that attract fishers, and the
26 likely temporary closure of fishing areas.
27
28

29 **4.4.11.2 Alaska – Cook Inlet**

30 31 **4.4.11.2.1 Routine Operations.**

32
33 **Commercial Fisheries.** With one to three new platforms to be established under the
34 proposed action, up to 4.5 ha (11 ac) of seafloor would be disturbed by offshore platforms, and
35 up to 210 ha (519 ac) by pipelines. Impacts on commercial fishing activities would vary,
36 depending on the nature of a particular structure, the phase of operation, fishing method or gear,
37 and target species group. Routine operations could affect commercial fisheries by causing
38 changes in the distribution or abundance of fishery resources, by reducing the catchability of fish
39 or shellfish, by precluding fishers from accessing viable fishing areas, or by causing losses of or
40 damage to equipment or vessels. It is anticipated that routine operations would not result in
41 detectable effects on overall populations of fishery resources in Cook Inlet. Temporary
42 displacement of fishery resources from localized areas could occur as a consequence of noise and
43 activities associated with construction activities during development; however, these resources
44 would be expected to return once construction disturbances have been terminated. Following
45 platform construction, there could be some highly localized long-term changes in fish densities
46

1 and species diversity in the vicinity of platforms due to attraction of some invertebrate and fish
2 species.

3
4 Some exploration, development, and production activities have a potential to result in
5 space use conflicts with commercial fishing activities. Seismic exploration vessels towing long
6 cables have had a history of conflicts with the commercial fishing industry in Cook Inlet
7 (MMS 2003a), including losses of crab pots, longlines, or other gear. In some cases, commercial
8 fishing vessels could be excluded from normal fishing grounds to avoid the potential for gear
9 loss. Such conflicts can sometimes be avoided by conducting seismic surveys during closed
10 fishing periods or closed seasons. A potential also exists for loss of gear or access to fishing
11 areas when floating drill rigs used for exploration are being moved and during other vessel
12 operations.

13
14 Offshore construction of platforms could infringe on commercial fishing activities by
15 excluding commercial fishing from adjacent areas due to safety considerations. It is assumed
16 that up to three production platforms could be constructed as a consequence of leasing in the
17 Cook Inlet Planning Area. If it is assumed that a safety zone of 500 m (1,640 ft) is maintained
18 by larger vessels around each production platform, commercial fishing could be excluded from
19 up to 160 ha (395 ac) of surface area within the planning area. Drilling discharges associated
20 with exploration activities would likely affect only a small area near a drilling platform, and are
21 not expected to interfere with commercial fishing. During development and production phases,
22 potential effects of such discharges would cease because all muds, cuttings, and produced water
23 would be discharged into wells instead of being released to open waters. Potential effects of
24 platform construction and operation are expected to be highly localized. Because only a very
25 small area of the Cook Inlet would be affected, interference with commercial fisheries is also
26 expected to be small.

27
28 Construction of pipelines can result in entanglement hazards for some types of fishing
29 gear. The presence of an offshore pipeline would not typically interfere with the use of
30 longlines, purse seines, drift nets (MMS 2004a), or beach seines. However, a bottom trawl, such
31 as those employed by the commercial groundfish industry in Cook Inlet, has a potential to
32 become snagged on exposed pipelines. It is estimated that up to 241 km (150 mi) of additional
33 offshore pipeline could result from lease sales in the Cook Inlet Planning Area, thereby
34 increasing the potential for snagging on pipelines by bottom trawling equipment, unless subsea
35 pipelines are buried in trenches.

36
37 It is anticipated that the small increase in vessel activity that could occur as a result of
38 additional lease sales in Cook Inlet under the proposed action (up to six additional trips per
39 week) would not measurably affect commercial fishing opportunities, catchability of fish and
40 shellfish resources, or navigation by commercial fishing vessels.

41
42 The impact of oil and gas structures on commercial fisheries at various depth ranges can
43 be estimated using data from the OECM (BOEMRE 2010d). The model assumes that there will
44 be buffer zones of up to 0.8 km (0.5 mi) around new oil and gas structures, decreasing the area of
45 ocean available for fishing. Although harvesting levels are not affected by offshore structures
46 and pipelines, as these levels are below federally mandated levels, it is assumed that fishing

1 activity will continue in areas still open for fishing, with harvesting levels remaining, but that
2 there will be an increase in fishing costs.

3
4 The impacts of oil and gas development on commercial fishing costs would vary
5 considerably by placement depth (Table 4.4.11-2). In the Kodiak area, the largest cost increases
6 would occur with structures located in water between 300 and 1,500 m (984 and 4,921 ft) deep,
7 with an annual increase of \$34 in costs from a single structure; a single structure in each depth
8 range would increase annual costs by \$44. In the Cook Inlet area, the largest increase would
9 come with a single structure placed in water between 150 and 300 m (492 and 984 ft), with an
10 overall increase in costs of \$57 per year. In each of the areas, single structures would have
11 relatively insignificant impacts compared to fishery revenues in each depth range.

12
13 **Recreational Fisheries.** In general, routine operations associated with exploration,
14 development, or production activities could affect recreational fisheries by causing changes in
15 the distribution or abundance of fishery resources, by reducing the catchability of fish and
16 shellfish, by precluding fishers from accessing viable fishing areas, or by causing losses of or
17 damage to equipment or vessels. It is anticipated that routine operations would not result in
18 detectable effects on overall populations of fishery resources in Cook Inlet. Temporary
19 displacement of fishery resources from localized areas could occur as a consequence of noise and
20 bottom-disturbing activities associated with routine operations. Following platform construction,
21 there could be long-term localized changes in fish densities and species diversity due to the
22 attraction of some invertebrate and fish species to platforms.

23
24 Seismic surveys could temporarily affect the behavior of some targeted species, thereby
25 affecting catch rates in the immediate area of the surveys. Some recreational anglers could
26 decide to avoid areas during seismic surveys due to the potential for loss of fishing gear, due to
27 the increased vessel activity, or because of perceived or actual changes in catchability. It is
28 estimated that new areas in the Cook Inlet Planning Area could be subjected to seismic surveys

29
30
31 **TABLE 4.4.11-2 Impacts of Single Oil and Gas Structures on**
32 **Commercial Fisheries, by Placement Depth (\$2010)**

Placement Depth Range	Kodiak		Cook Inlet	
	Fishery Revenue (\$m)	Cost Impact (\$)	Fishery Revenue (\$m)	Cost Impact (\$)
0 to 60 m	15.6	-3.34	7.3	-0.04
60 to 150 m	43.7	9.87	2.6	3.88
150 to 300 m	22.8	3.32	7.0	53.50
300 to 1,500 m	23.4	34.07	0.1	0.0
More than 1,500 m	1.3	0.26	0.0	0.0
All depths	106.9	44.18	17.0	57.35

Source: BOEMRE 2010d.

1 during the Program. However, given the relatively small proportion of the available Cook Inlet
2 area that would be affected at any particular time, it is not anticipated that seismic surveys would
3 greatly disrupt recreational fishing activities.
4

5 Offshore construction of platforms could infringe on some recreational fishing activities
6 by excluding recreational fishing boats from adjacent areas for safety considerations. It is
7 assumed that up to three production platforms could be constructed as a consequence of lease
8 sales in the Cook Inlet Planning Area. However, the area lost to recreational fishing would be
9 limited to the immediate footprint of the platforms plus a small safety zone surrounding each
10 platform; only a very small proportion of available recreational fishing areas in Cook Inlet would
11 be affected. The presence of such platforms could also benefit anglers by aggregating some
12 pelagic or groundfish species.
13

14 Vessel traffic to provide support to OCS activities could increase by one to three trips per
15 week. This would constitute a very small increase in overall vessel traffic in Cook Inlet. The
16 potential increase in daily helicopter trips in the Cook Inlet area would not be expected to affect
17 recreational fishing activities. Disturbances of recreational fishing opportunities from other
18 activities associated with routine operations (e.g., pipeline construction) are also expected to be
19 relatively minor and temporary.
20

21 22 **4.4.11.2.2 Accidents.** 23

24 **Commercial Fisheries.** Fisheries resources could become exposed to oil as a
25 consequence of accidental oil spills. One large spill greater than 1,000 bbl, up to 3 spills
26 between 50 and 1,000 bbl, and up to 15 small spills less than 50 bbl could occur in the Cook Inlet
27 area from the proposed action.
28

29 Although pelagic fishes would be less likely to be affected than fishes in shallow subtidal
30 or intertidal areas, oil spills could contaminate gear used for commercial fishing, such as purse
31 seines and or drift nets. A large oil spill before or during the season when such fishing gears are
32 in use could result in closures of some short-period, high-value commercial fisheries in order to
33 protect gears or harvests from potential contamination. Lines from longline fisheries for halibut,
34 Pacific cod, black cod, and other fish species could also be affected by oil. Some lines and
35 buoys fouled with small amounts of oil could be unfit for future use. Although it is unlikely that
36 a trawler would be operating in an oiled area, the trawl catches could be contaminated by oil and
37 rendered unfit for consumption if the trawler did pass through such an area.
38

39 The bays and beaches of Cook Inlet have a number of setnet sites where gillnets are
40 anchored to the beach or slightly offshore, and are used to harvest salmon and herring. Oil spills
41 could damage setnet fisheries, as evidenced by the *Exxon Valdez* oil spill in 1989. While only a
42 relatively small volume of weathered oil entered the lower Cook Inlet region as a result of the
43 *Exxon Valdez* spill, the commercial salmon fishery was closed to protect both gear and the
44 harvest from possible contamination.
45

1 Multiple small spills or a single large spill could cause declines in subpopulations of
2 some species inhabiting the Cook Inlet Planning Area, although the level of effects would
3 depend on a variety of factors. It is anticipated that there would be no long-term effects on
4 overall fish populations in the central Gulf of Alaska. However, even localized decreases in
5 stocks of fish could have effects on some commercial fisheries by reducing their catch or
6 increasing the amount of effort or the distances that must be traveled to obtain adequate catches.
7 Even if fish stocks are not reduced as a consequence of a spill, specific fisheries could be closed
8 due to actual or perceived contamination of fish or shellfish tissues. Larger spills in Cook Inlet
9 would probably result in the area being temporarily closed to commercial fishing until cleanup
10 operations or natural processes reduced oil concentrations in fishery areas to levels considered
11 safe. The Cook Inlet commercial shellfish industry is likely to be affected by closures because
12 such a spill would be likely to affect shellfish in nearshore subtidal and intertidal areas. Fisheries
13 for shellfish that occur in deeper waters, where oil residues seldom reach, are less likely to be
14 closed. Shellfish from deeper areas could become commercially unacceptable for market due to
15 actual or perceived contamination and tainting.

16
17 Closure of Cook Inlet to commercial fishing activities could result in considerable loss of
18 income. Based on analyses conducted by MMS for Cook Inlet oil spills of the same sizes
19 assumed for large spills in this analysis and assumptions about the value of commercial fisheries
20 in Cook Inlet, it was estimated that a large oil spill in lower Cook Inlet could result in economic
21 losses to commercial fisheries for up to 2 yr (MMS 2003a), and, depending on the timing and
22 location of a spill, it was also considered possible that the fishery could be closed for a whole
23 season, resulting in a 100% loss for a given year.

24
25 **Recreational Fisheries.** Recreational fishery resources could be exposed to oil as a
26 consequence of accidental oil spills. Up to 1 large spill greater than 1,000 bbl, up to 2 spills
27 between 50 and 1,000 bbl, and up to 10 small spills less than 50 bbl could occur in the Cook Inlet
28 area from the proposed action.

29
30 While it is anticipated that these spills would not affect the overall populations of fishes
31 in the central Gulf of Alaska, some fish stocks in localized areas of Cook Inlet could be affected.
32 Populations of intertidal organisms could be depressed measurably for a year or more in
33 intertidal areas contacted by spilled oil. Oil contacting beaches could affect clam gathering by
34 depressing clam populations or tainting tissues of clams. The magnitude of such effects would
35 depend upon many factors, including the volume of oil spilled, weather conditions, prevailing
36 currents, locations, oil spill response actions, and whether the oil reached sensitive habitats for
37 fishery resources. Declines in localized fish stocks could affect recreational fishing success and
38 businesses associated with providing recreational and sport fishing opportunities.

39
40 An oil spill could result in a closure of ports in an effort to protect the ports and vessels
41 from being oiled. Oil spills could potentially cause economic losses for boat owners and anglers
42 by contaminating vessels and fishing gear. Oiled vessels would need to be cleaned and oiled
43 gear either cleaned or replaced; potential individual costs are expected to be relatively small. It
44 is anticipated that many anglers would choose to fish in alternate areas in the event of port
45 closures. Charter operators could be inclined to temporarily avoid going out of port into Cook
46 Inlet to avoid fouling their gear and vessels with oil. Public perception of oil spill damage could

1 temporarily reduce the number of anglers. If so, anglers would likely target alternate fishing
2 areas until they deemed that the quality of the fishing experience in the oil spill area had returned
3 to previous conditions.
4

5 While charter operators could lose business in the event of a large spill, a report on the
6 July 2, 1987, *Glacier Bay* tanker oil spill found “no measurable impacts” on sportfishing from
7 that spill (Northern Economics 1990). It is estimated that 3,100 bbl of oil were spilled.
8 Although several popular sportfishing runs had already ended when the spill occurred, the
9 busiest season was beginning for the halibut charter boat fishery, and the second-run Kenai
10 salmon sport fishing season was just opening for the year. The study found no evidence of losses
11 in these sportfisheries due to oil-fouled boats or gear, loss of fishing opportunity, or harvest of
12 oil-fouled fish that had to be discarded (with only one exception). In addition, the numbers of
13 fish caught did not appear to be affected, and customers did not cancel reservations because of
14 concerns about the spill. Very large oil spills could have greater impacts, especially if the oil
15 reached large areas of intertidal habitat. Studies following the *Exxon Valdez* oil spill suggest that
16 a very large oil spill could have the potential to reduce or contaminate populations of
17 recreationally popular salmon and shellfish in heavily oiled areas for more than 10 yr. For
18 example, pink salmon had elevated egg mortality for at least 4 yr after the spill
19 (Peterson et al. 2003), and littleneck and butter clam populations were reduced for a decade after
20 the spill, although much of the slow recovery may have resulted from cleanup methods used in
21 intertidal areas (*Exxon Valdez* Oil Spill Trustee Council 2009a). Contamination of shellfish may
22 persist even after populations recover. Species less dependent on intertidal soft sediments, such
23 as rockfish, are less likely to be affected. Impacts of spills on subsistence resources are
24 discussed in Section 4.4.13 and Section 4.4.14.
25

26 **Catastrophic Discharge Event.** The PEIS analyzes a CDE that ranges in size from
27 75 to 125 thousand bbl (Table 4.4.2-2). The magnitude of effects from a CDE would depend on
28 the location, timing, and volume of the oil associated with the event. Oil from a CDE could
29 contact intertidal habitat and subsequently contaminate or reduce the abundance of commercial
30 and recreational species that depend on nearshore habitat. However, it is likely that an event
31 would only affect a small proportion of fish species population, and it is unlikely that fish
32 resources would be permanently affected. In the short term, there would be local or regional
33 effects on commercial fishing that as a result of reduced catch, loss of gear, or loss of fishing
34 opportunities during cleanup and recovery periods, and on recreational fishing as a consequence
35 of contamination of fish tissues, the degradation of aesthetic values that attract fishers, and the
36 likely temporary closure of fishing areas.
37
38

39 4.4.11.3 Alaska – Arctic 40 41

42 **4.4.11.3.1 Routine Operations.** There is a relatively small salmon fishery in Kotzebue
43 Sound in Hope Basin, but there are no commercial fisheries in the Chukchi Sea Planning Area
44 where routine operations would occur (MMS 2006b). Consequently, no impacts from routine
45 operations are anticipated. The single commercial fishery in the Beaufort Sea is for cisco and
46 whitefish on the Colville River during the summer and fall months. The potential for negative

1 effects on this fishery would be related to the timing of exploration and development activities
2 and the proximity of those activities to the mouth of the Colville River. Because exploration and
3 development of this area has already occurred, it is considered unlikely that there would be
4 substantial levels of additional development as a result of the proposed action. In addition,
5 impacts would be limited in scope as a result of adherence to mitigation measures and
6 compliance with Federal, State, and local requirements. Therefore, impacts on this fishery are
7 also anticipated to be limited in scope. Similarly, impacts on recreational fisheries from routine
8 operations are expected to be negligible, as little recreational fishing occurs in the Beaufort and
9 Chukchi Sea Planning Areas (NPFMC 2009).

10
11
12 **4.4.11.3.2 Accidents.** Up to 3 large spills greater than 1,000 bbl, between 10 and
13 35 spills between 50 and 1,000 bbl, and up to 190 small spills of less than 50 bbl could occur in
14 the Beaufort and Chukchi Sea areas from the proposed action.

15
16 Recreational fishing in the Beaufort and Chukchi Sea Planning Areas is very limited and
17 generally occurs only at larger population centers. However, where and when recreational
18 fishing does occur, an oil spill could reduce fishing activity or contaminate fishery resources.
19 Commercial fishing in the Beaufort and Chukchi Sea Planning Areas is restricted to the Colville
20 River. The occurrence of an oil spill near commercial fishing areas during the fishing season
21 could have effects on particular fisheries and the local economies that depend on them. Oil spills
22 typically result in the closure of fishing grounds and reduced or lack of harvest. Even if harvest
23 continues, the perception of a tainted product could reduce the economic value of fish harvested
24 in the vicinity of an oil spill or could even cause fish to be removed from markets.

25
26 Spills could foul fishing gear, result in fish contamination and mortality, and potentially
27 close some fishing grounds or entire fisheries for one or more years. A large spill could also
28 increase competition on alternative fishing areas that remain open, resulting in increased costs
29 and/or reduced harvests for individual fishermen. There is a reduced chance of a spill occurring
30 during pulse fisheries of short duration, such as those for salmon, herring, or whitefish, because
31 of the relatively short period of time that such fisheries are open. However, if a spill were to
32 occur during operation of such a fishery, potential impacts would include a total loss of
33 commercial fishing harvest due to the inability to switch to an alternative fishing time or area.
34 Impacts of spills on subsistence resources are discussed in Section 4.4.13 and Section 4.4.14.

35
36 **Catastrophic Discharge Event.** The PEIS analyzes a CDE that ranges in size from
37 1.4 to 2.2 million bbl in the Chukchi Sea Planning Area and from 1.7 to 3.9 million bbl in the
38 Beaufort Sea Planning Areas (Table 4.4.2-2). The magnitude of effects from a CDE would
39 depend on the location, timing, and volume of the oil associated with the event. Oil from a CDE
40 could contact intertidal habitat and subsequently contaminate or reduce the abundance of
41 commercial and recreational species that depend on nearshore habitat. However, it is likely that
42 an event would only affect a small proportion of fish species population, and it is unlikely that
43 fish resources would be permanently affected. Although commercial and recreational fishing in
44 the Arctic region are of minor economic significance, in the short term, there would be local and
45 regional economic impacts resulting from reduced catch, loss of gear, or loss of fishing
46 opportunities during cleanup and recovery periods, and on recreational fishing as a consequence

1 of contamination of fish tissues, the degradation of aesthetic values that attract fishers, and the
2 likely temporary closure of fishing areas.

3 4 5 **4.4.11.4 Conclusion** 6

7 Routine operations could affect commercial fisheries by causing changes in the
8 distribution or abundance of fishery resources, by reducing the catchability of fish or shellfish,
9 precluding fishers from accessing viable fishing areas, or causing losses of or damage to
10 equipment or vessels. No population-level effects or permanent loss of fishery resources are
11 expected to result from routine operations in the GOM or Cook Inlet. Commercial and
12 recreational fisheries in the Beaufort and Chukchi Sea Planning Areas are relatively small and
13 localized. Impacts on these fisheries are unlikely, since OCS activities would not occur in the
14 immediate area near these fisheries. Impacts to commercial and recreational fisheries from
15 routine Program activities are expected to be minor.

16
17 The magnitude of effects from accidental spills would depend on the location, timing,
18 and volume of spills, in addition to other environmental factors, and would be greatest in the
19 event of a CDE-level spill. Small spills that may occur under the proposed action are unlikely to
20 affect a large number of fish or have a substantial effect on recreational fishing before dilution
21 and weathering reduced concentrations of oil in the water. Consequently, it is anticipated that
22 small spills would have little effect on commercial and recreational fishing. Any single large
23 spill would likely affect only a small proportion of a given fish population within the GOM,
24 Cook Inlet, and Beaufort and Chukchi Seas, and it is unlikely that fish resources would be
25 permanently affected. However, large spills could have localized effects on commercial fishing
26 that could result as a consequence of reduced catch, loss of gear, or loss of fishing opportunities
27 during cleanup and recovery periods, and on recreational fishing as a consequence of
28 contamination of fish tissues, degradation of aesthetic values that attract fishers, or temporary
29 closure of fishing areas. Oil from large or very large spills could contact intertidal habitat and
30 subsequently contaminate or reduce the abundance of commercial and recreational species that
31 depend on nearshore habitat. Impacts from a large spill could be long term, but are not expected
32 to result in permanent loss of fishery resources. In the event of a CDE-level spill, fisheries
33 recoveries could be impacted on a manner similar to that from a large spill. However, a larger
34 proportion of a fish population could be affected, and impacts could be much more long-term on
35 duration.

36 37 38 **4.4.12 Potential Impacts to Tourism and Recreation** 39

40 41 **4.4.12.1 Gulf of Mexico** 42

43
44 **4.4.12.1.1 Routine Operations.** In addition to the continuing use of existing onshore
45 support and processing facilities, between 4 and 6 new pipeyards, less than 12 new pipeline
46 landfalls, and as many as 12 new gas processing facilities are projected to be built as a result of

1 the Program. Additional offshore construction could include increased noise and traffic, air and
2 water pollution, impacts on residential property values, and land use changes. As it is likely that
3 onshore facilities would be placed near other commercial areas zoned for such development,
4 certain coastal areas could also be closed temporarily to accommodate the construction of new
5 facilities, while underground pipeline construction could occur near important recreational areas.
6 Routine operations would have limited effects on recreation and tourism, with potential adverse
7 aesthetic impacts on beach recreation and sightseeing and potential positive impacts on diving
8 and recreational fishing.

9
10 The proposed action is expected to result in 300 to 600 service-vessel trips and 2,000 to
11 5,500 helicopter operations weekly. Although service vessels are assumed to use established
12 nearshore traffic lanes and helicopters are assumed to comply with areal clearance restrictions at
13 least 90% of the time, additional helicopter and vessel traffic would add a low level of noise
14 pollution that could affect beach users. Routine OCS traffic can cause minor disturbances to
15 recreational resources, particularly beaches, through increased levels of noise, debris, and rig
16 visibility. Although the proposed action has the potential to directly and indirectly impact
17 recreational resources along the GOM coast, the small scale of OCS activities relative to the
18 scale of the existing oil and gas industry is such that these potential impacts on recreational
19 resources are likely to be minimal. There may also be minor space-use conflicts with
20 recreational fishermen during the initial phases of the proposed action and low-level
21 environmental degradation of fish habitat, which would negatively impact recreational fishing
22 activity. However, these minor negative effects would likely be outweighed by the beneficial
23 role that oil rigs serve as artificial reefs for fish populations. The degree to which oil platforms
24 will become a part of a particular State's rigs-to-reefs program will be an important determinant
25 of the degree to which the proposed action will impact recreational fishing activity in the long
26 term.

27
28 The broader economic implications of the proposed action would be felt primarily on the
29 GOM coast of Texas. The Texas coastline features an important barrier island system that
30 supports a broad range of beach-related activity, and the visual, debris, and noise related issues
31 could impact beach-related activity at these locations. However, given the expansive oil and gas
32 industry already in place, as well as the distance oil platforms in Texas maintained from shore,
33 beach-related disruptions due to OCS operations are expected to be minimal.

34
35
36 **4.4.12.1.2 Accidents.** Up to 8 large spills greater than 1,000 bbl, between 35 and
37 70 spills between 50 and 1,000 bbl, and up to 400 small spills less than 50 bbl could occur in the
38 GOM from the proposed action. It is reasonable to expect that most of these spills will occur in
39 deepwater areas located away from the coast, based on the established trend for oil and gas
40 activity to move into deep waters located for the most part at a substantial distance from the
41 coast.

42
43 Temporary impacts would occur if an oil spill reached a beach or other recreational use
44 area. The magnitude of these impacts would depend on factors such as the size and location of
45 the spill, and would likely be greatest if the spill occurred during the peak recreational season. A

1 number of studies (see Section 3.1.3) have shown that there could be a one-time seasonal decline
2 in tourist visits of 5 to 15% associated with a major oil spill.

3
4 **Catastrophic Discharge Event.** The PEIS analyzes a CDE that ranges from 0.9 to
5 7.2 million bbl (Table 4.4.2-2). The effects from a catastrophic discharge event would likely
6 include beach and coastal access restrictions, including restrictions on visitation, fishing, or
7 hunting while cleanup is being conducted, and aesthetic impacts associated with the event itself
8 and with cleanup activities. These impacts are expected to be temporary, with the magnitude
9 dependent on the location and size of the event and the effectiveness of cleanup operations.
10 Longer-term impacts may also be substantial if tourism were to suffer as a result of the real or
11 perceived impacts of the event, or if there were substantial changes to tourism and recreation
12 sectors in the region as a result of the event.

13 14 15 **4.4.12.2 Alaska – Cook Inlet**

16
17
18 **4.4.12.2.1 Routine Operations.** Although no new pipe yards, pipeline landfalls, or gas
19 processing facilities would be built as a result of the proposed 5-yr program, additional offshore
20 construction could include increased noise and traffic, air and water pollution, impacts on
21 residential property values, and land use changes. Oil and gas development under the proposed
22 action in the south central Alaska region would occur in the vicinity of previous development.
23 The additional development would not alter the character of the area, because similar
24 infrastructure is already present. Effects on scenic quality would be temporary and localized,
25 and would be most noticeable during heavy periods of industrial activity, such as during drilling
26 or pipelaying. Temporary closure of certain areas to recreation would likely be necessary, but
27 would be limited in size and duration. A small increase in the amount of trash and debris
28 washing ashore may also occur as a result of the development. The frequency of helicopter and
29 vessel traffic to and from the new platforms would be consistent with that of existing platforms,
30 but would contribute marginally to the impact on scenic quality and add to the industrial noise.
31 The magnitude of these impacts would be small and vary with the distance of these activities
32 from existing parks and wildlife refuges, primary recreational use areas, and cruise line paths.
33 During the short period of construction, the increased workforce could impact lodging
34 accommodations for tourists during peak times; however, impacts would depend on the timing
35 and location of the activities and the availability of a local workforce.

36
37
38 **4.4.12.2.2 Accidents.** One large spill greater than 1,000 bbl, up to 3 spills between
39 50 and 1,000 bbl, and up to 15 small spills less than 50 bbl could occur in the Cook Inlet area
40 from the proposed action. These oil spills would be responded to primarily by existing response
41 facilities along the coast and existing shore bases according to spill response protocols. Potential
42 impacts on recreation and tourism resulting from an oil spill would likely include direct land use
43 impacts (e.g., from oil contamination at a coastal area), access restrictions to a particular area
44 (e.g., no fishing or hunting while cleanup is conducted), and aesthetic impacts of the spill itself
45 and cleanup operations. These impacts are expected to be temporary, but could last an entire
46 season. However, because of public perceptions resulting from the *Exxon Valdez* oil spill in

1 Prince William Sound, tourism in the region may respond more strongly than would tourism in
2 other regions. The magnitude of the impacts would depend on the location and size of the spill
3 and the effectiveness of cleanup operations.
4

5 **Catastrophic Discharge Event.** The PEIS analyzes a CDE that ranges in size from 75 to
6 125 thousand bbl (Table 4.4.2-2). The effects from a CDE would likely include beach and
7 coastal access restrictions, including restrictions on visitation, fishing, or hunting while cleanup
8 is being conducted, and aesthetic impacts associated with the event itself and with cleanup
9 activities. These impacts are expected to be temporary, with the magnitude dependent on the
10 location and size of the event and the effectiveness of cleanup operations. Longer-term impacts
11 may also be substantial if tourism were to suffer as a result of the real or perceived impacts of the
12 event, or if there were substantial changes to tourism and recreation sectors in the region as a
13 result of the event.
14

15 **4.4.12.3 Alaska – Arctic** 16 17 18

19 **4.4.12.3.1 Routine Operations.** Although no new pipe yards, pipeline landfalls, or gas
20 processing facilities would be built as a result of the proposed 5-yr program, additional offshore
21 construction could include increased noise and traffic, air and water pollution, impacts on
22 residential property values, and land use changes. Oil and gas development activities could
23 result in minor impacts on recreation and tourism in the Arctic region. The main recreation and
24 tourism activities that could be impacted by routine oil and gas operations would be sightseeing,
25 hiking, and rafting. Fishing in this region is primarily a subsistence activity rather than a
26 recreational activity. Impacts on sightseeing might be viewed as being negative, with adverse
27 aesthetic impacts from offshore platforms and possible increases in construction projects for gas
28 processing facilities and new offshore pipelines to connect to existing onshore pipelines in the
29 Chukchi Sea area. Impacts on these recreational activities would depend on the proximity of the
30 new construction to the recreational use areas (such as whether they are in view of existing parks
31 and refuges).
32

33 The additional development would not alter the character of the area, as similar
34 infrastructure is already present. Effects on scenic quality would be temporary and localized,
35 and would be most noticeable during heavy periods of industrial activity, such as during drilling
36 or pipelaying. Temporary closure of certain areas to recreation would likely be necessary, but
37 would be limited in size and duration. A small increase in the amount of trash and debris
38 washing ashore may also occur as a result of the development. The frequency of helicopter and
39 vessel traffic to and from the new platforms would be consistent with that of existing platforms,
40 but would contribute marginally to the impact on scenic quality and add to the industrial noise.
41 The magnitude of these impacts would be small and vary with the distance of these activities
42 from existing parks and wildlife refuges and primary recreational use areas. During the short
43 period of construction, the increased workforce could impact lodging accommodations for
44 tourists during peak times; however, impacts would depend on the timing and location of the
45 activities and the availability of a local workforce.
46

1 **4.4.12.3.2 Accidents.** Up to 3 large spills greater than 1,000 bbl, up to 35 spills between
2 50 and 1,000 bbl, and up to 190 small spills of less than 50 bbl could occur in the Beaufort and
3 Chukchi Sea area from the proposed action. These spills would be responded to primarily by
4 existing response facilities along the coast and existing shore bases according to spill response
5 protocols. Potential impacts to recreation and tourism resulting from an oil spill would likely
6 include direct land use impacts (e.g., from oil contamination at a coastal area), access restrictions
7 to a particular area (e.g., no fishing or hunting while cleanup is being conducted), and aesthetic
8 impacts (e.g., view of spill and cleanup activities). These impacts are expected to be temporary,
9 and the magnitude of the impacts would depend on the location and size of the spill and the
10 effectiveness of cleanup operations. The greatest potential impacts would occur from large spills
11 in shallow water. The potential for impact would likely decrease with decreasing spill size and
12 increasing water depth.

13
14 **Catastrophic Discharge Event.** The PEIS analyzes a CDE that ranges from 1.9 to
15 2.2 million bbl in the Chukchi Sea Planning Area, and from 1.7 to 3.9 million bbl on the
16 Beaufort Sea Planning Area (Table 4.4.2-2). The effects from a CDE would likely include beach
17 and coastal access restrictions, including restrictions on visitation, fishing, or hunting while
18 cleanup is being conducted, and aesthetic impacts associated with the event itself and with
19 cleanup activities. These impacts are expected to be temporary, with the magnitude dependent
20 on the location and size of the event and the effectiveness of cleanup operations. Longer-term
21 impacts may also be substantial if tourism were to suffer as a result of the real or perceived
22 impacts of the event, or if there were substantial changes to tourism and recreation sectors in the
23 region as a result of the event.

24 25 26 **4.4.12.4 Conclusion**

27
28 Routine operations would have minor, short-term negative effects on recreation and
29 tourism, with potential adverse aesthetic impacts on beach recreation and sightseeing and
30 potential positive impacts on diving and recreational fishing in the GOM coast; sightseeing,
31 boating, fishing, and hiking activities in the Cook Inlet area; and sightseeing, hiking, and rafting
32 activities in the Chukchi Sea and Beaufort Sea Planning Areas.

33
34 Temporary impacts would occur if an oil spill reached a beach or other recreational-use
35 area in the GOM or Cook Inlet. The magnitude of these impacts would depend on factors such
36 as the size and location of the spill, and would likely be greatest if the spill occurred during the
37 peak recreational season. In the event of a CDE-level spill, impacts to tourism and recreation
38 would be long-term and substantial.

1 **4.4.13 Potential Impacts to Sociocultural Systems**

4 **4.4.13.1 Gulf of Mexico**

5
6 As discussed in Section 3.4.1.1, the counties in the GOM coastal commuting zone
7 include a diverse mixture of social classes, cultures, ethnic groups, and communities. They also
8 include a well-established oil and gas industry and support structure focused mainly in Louisiana
9 and Texas. The activities covered under the Program would tend to maintain existing onshore
10 facilities rather than require new ones (MMS 2006a, 2008a). While oil and gas facilities are
11 dispersed along the central and western coast of the GOM, they are not spread evenly.
12 Terrebonne, Plaquemine, and Lafourche parishes in Louisiana are the heart of the oil and gas
13 support industry (MMS 2008a) with Port Fourchon catering to 90% of all GOM deepwater
14 production (BOEMRE 2011a). Sociocultural impacts from routine operations would be small,
15 while impacts from a low-probability catastrophic discharge event could be significant.
16

17
18 **4.4.13.1.1 Routine Operations.** Routine OCS gas and oil operations include
19 exploration, development, operation, and decommissioning. Although tied to the shore by
20 aircraft, supply vessels, and pipelines, these activities occur well offshore and in increasingly
21 deeper water. The global nature of deepwater activities has contributed to cultural heterogeneity
22 with the importation of migrant workers. A recent study reports that industry employers often
23 hire foreign-born Mexican and Laotian workers in upstream support sectors such as ship and
24 fabrication yards (Hemmerling and Colton 2004). The greater distance of deepwater platforms
25 from coastal communities has resulted in workers being drawn from a wider range of locations in
26 the GOM region, making the ties between local subcultural groups and the offshore industry less
27 consistent. The move farther offshore into deep water has also led to longer offshore work shifts
28 and to more “on call” schedules for many workers, including technical experts and mariners
29 (Austin et al. 2002). In the past, development of infrastructure within coastal wetlands has
30 contributed to the shrinking of wetlands and loss of land in Louisiana, resulting in a loss of both
31 subsistence and commercial harvesting areas. However, most new production will be able to tie
32 into the existing pipeline system, so it is unlikely that many new pipeline channels will need to
33 be dredged. Current practice is for pipeline channels to be backfilled, reducing wetland erosion
34 and partitioning of habitat (Hemmerling and Colton 2004).
35

36
37 **4.4.13.1.2 Accidents.** Accidental spills, including oil spills, chemical spills, vessel
38 collisions, and loss of well control, are possible under the Program (MMS 2008a)
39 (see Section 4.4.2). Between 200 and 400 spills of 50 bbl or less, 35 to 70 spills between 50 and
40 1,000 bbl, and 8 large spills greater than 1,000 bbl are posited for the GOM Program. Most
41 accidental spills on this scale are likely to be short term and localized. Those occurring well
42 offshore are likely to be cleaned up or dissipate before reaching shore, and would thus have little
43 effect on onshore communities (MMS 2006a). Those occurring in coastal waterways involving
44 OCS support vessels or pipelines (BOEMRE 2011a) would have localized effects on wild
45 resources harvested either commercially or for subsistence purposes. Intertidal and estuarian
46 habitats, where shellfish are harvested and the juveniles of harvested species develop, are the

1 most vulnerable. Most adult fish species seem to be better able to avoid oiled waters. Impacts
2 from small and moderate coastal spills are likely to have localized and short-lived effects. Large
3 spills (over 1,000 bbl) and especially spills of sufficient size to overwhelm cleanup and booming
4 efforts, could significantly affect communities dependent on harvesting renewable wild resources
5 either commercially or for subsistence purposes.
6

7 **Catastrophic Discharge Event.** The PEIS analyzes a CDE that ranges in size from
8 0.9 to 7.2 million bbl (Table 4.4.2-2). A CDE would have significant sociocultural consequences
9 for populations employed in offshore oil and gas production and in commercial fishing and
10 shrimping, and engaged in subsistence harvesting. A catastrophic discharge event would result
11 in negative and long-lasting social effects (BOEMRE 2011b). Recent studies have shown that
12 major oil releases result in negative and long-lasting social effects. Unlike devastation from
13 hurricanes or other natural disasters that tend to bring communities together to face a common
14 tragedy, oil spills tend to have divisive effects. Technical disasters such as oil spills are deemed
15 as preventable, have a person or organization viewed as primarily responsible, and often can lead
16 to litigation that can last for years (Picou et al. 2009). For example, during the DWH release,
17 large areas of the GOM were closed to all shrimping and fishing (NMFS 2010, 2011). The loss
18 of work placed financial stress on workers in that industry. Some, but not all, shrimpers and
19 fishing boats were employed in the cleanup, creating a division between those who received
20 some financial relief through the cleanup effort and those who did not. The loss of income and
21 potential loss of some subsistence sources create emotional stress stemming from financial
22 stress, often resulting in depression and post-traumatic stress disorder in those who depend on
23 the renewable resources of the sea for their livelihood. An increase in sociological disorders
24 such as domestic violence, substance abuse, and suicide was observed in communities affected
25 by the *Exxon Valdez* spill (Picou and Arata 1997). Similar patterns appear to be emerging
26 among populations that are heavily dependent on fishing along the GOM coast
27 (Picou et al. 1999; Picou 2010), especially among fishing communities already hard hit by
28 Hurricane Katrina (Yeoman 2010). Methods for mitigating social stress by creating a therapeutic
29 community based on a model developed for the *Exxon Valdez* spill are being implemented in the
30 GOM (SAMHSA 2010; MASGC 2011).
31

32 While only a small portion of those who live along the northern coast of the GOM are
33 engaged in subsistence harvesting, if oil from a catastrophic discharge event were to reach the
34 shore, it could affect the barrier islands and wetlands important to the harvesting of subsistence
35 resources, including waterfowl, fish, shrimp, and shellfish. If coastal fisheries were
36 contaminated or closed, it would have a significant effect on subsistence harvesting. As a result
37 of the DWH event, close to 30,000 emergency advance payment claims were filed based on the
38 loss of subsistence resources (BOEMRE 2011a). Loss of subsistence resources has economic,
39 nutritional, and cultural consequences.
40

41 **4.4.13.2 Alaska – Cook Inlet**

42 Finding and developing oil and gas resources on the Cook Inlet OCS has the potential to
43 create adverse effects on sociocultural systems and subsistence. Such effects would range from
44 minor to major depending on the timing, location, and scale of the activity. Many negative
45
46

1 consequences could be minimized through appropriate mitigation procedures. The most central
2 of these is establishing and maintaining communication among Native villages, oil companies,
3 and appropriate Federal agencies, including both government-to-government consultation in
4 compliance with legal requirements and U.S. Department of the Interior (USDOJ) policy
5 (USDOJ 2001) and ongoing dialogue leading to adaptive management of adverse effects.
6

7 The areas surrounding the Cook Inlet Planning Area are demographically diverse,
8 including isolated subsistence-based Native villages, towns that rely primarily on commercial
9 fishing, and ethnically and economically diverse cities partly dependent on the oil industry.
10 There have been oil and gas operations in Cook Inlet since the late 1950s, and the surrounding
11 area is home to a well-established gas and oil infrastructure that could accommodate much of
12 any newly developed resource. As discussed in Section 4.4.1.2, under the proposed action, no
13 new shore bases would be constructed, and one new pipeline landfall and possibly one new
14 natural gas processing facility would be built.
15

16 Rural communities in the area benefit from oil and gas development throughout the State.
17 However, currently the Federal Government does not share revenues from oil and gas leasing on
18 the OCS with the States, although Alaska has received Federal Coastal Impact Assistance
19 Program (CIAP) funding, because it is an OCS State (Hess 2011; BOEMRE 2011m). Benefits
20 from revenue sharing would only occur if Congress authorizes the sharing of OCS revenues with
21 the OCS States. If such sharing were to occur, OCS activities could be expected to have effects
22 on Alaskan rural communities, through various State programs, proportionate to the percentage
23 of the State budget that relies on revenues from OCS oil and gas production and that is allocated
24 to the affected communities. For the period of the Program, the allocated revenues from OCS oil
25 and gas production would be relatively small.
26

27
28 **4.4.13.2.1 Routine Operations.** Routine operations under the Program would include
29 exploration for oil and gas resources, development of the resources including infrastructure,
30 operation of the facilities, and decommissioning of the facilities. Each of these phases is
31 characterized by different levels of activity, different extent, and different timing. Because the
32 region as a whole has already undergone oil and gas development, each of these phases can take
33 advantage of and tie into existing infrastructure and can draw on an existing pool of experienced
34 workers (MMS 2003a). The Cook Inlet area has already experienced the impacts of oil and gas
35 development, and would also experience both the positive and negative effects of increased
36 population and employment from the proposed OCS activities. Most area communities are
37 ethnically diverse, with Caucasian majority populations. Native communities tend to be more
38 remote and more difficult to access than non-Native communities, and would be somewhat
39 buffered from the impacts of the proposed action. Overall, impacts of routine operations on
40 sociocultural systems are expected to be minor.
41

42 Exploration activities include seismic surveys and the drilling of test wells, activities that
43 are typically conducted from self-contained vessels. Exploration crews would be drawn from an
44 existing pool of trained oil and gas workers in the Cook Inlet area. In-migration for these jobs is
45 expected to be minimal and to have little effect on the current ethnic composition or social
46 structure of the area (MMS 2003a). Exploration activities would likely be supported from

1 existing air and marine facilities on the Kenai Peninsula. No additional facilities would be
2 required. Industrial activities associated with exploration would not be new to the area, but
3 would continue existing operations. There would be very little in-migration for exploration jobs
4 because of the existing trained labor pool and the fact that exploration rig crews are normally
5 contracted with the vessel. Exploration activities are not expected to result in measurable
6 changes in the availability or accessibility of subsistence resources.

7
8 Exploration activities could have temporary effects on subsistence harvesting, but are not
9 expected to result in measurable changes in the availability or accessibility of subsistence
10 resources. Cook Inlet personal use and subsistence fisheries are important to all residents of
11 South Central Alaska. Since the Cook Inlet Planning Area lies outside of the Anchorage-Mat-
12 Su-Kenai Peninsula Nonsubsistence Use Area, effects on personal use fishing are not expected.
13 Most of upper Cook Inlet north of Ninilchik is included in the Anchorage-Mat-Su-Kenai
14 Peninsula Nonsubsistence Use Area. While subsistence fishing is not authorized by the Alaska
15 Board of Fisheries in this area, personal use fisheries, open to all Alaska residents who have
16 lived in the state for at least a year, do exist on the Kenai and Kasilof Rivers and Fish Creek that
17 provide an important food source for many families in the Mat-Su-Anchorage-Kenai area
18 (SCADA 2011). More remote subsistence fisheries are accessible to rural communities where
19 customary and traditional uses of fish and wildlife are a principal characteristic of the economy,
20 culture, and way of life. These include Alaska Native communities (ADFG 2011), such as the
21 community of Tyonek, on the west shore of Cook Inlet, and Port Graham and Nanwalek, located
22 on the southern Kenai Peninsula and the Alaska Native communities along the northwestern
23 shore of Kodiak Island.

24
25 The effects of exploration on subsistence fishing would be similar to the effects discussed
26 for recreational and commercial fishing in Section 4.4.11.2. Seismic exploration vessels tow
27 long lines that could be entangled with seines, gillnets, long lines, and other gear used by
28 subsistence fishers (MMS 2003a), who may choose to avoid seismic vessels to prevent the loss
29 of gear and thus be kept from their normal fishing grounds. Fishers may also choose to avoid
30 floating exploratory drilling rigs being moved from one location to another for safety reasons and
31 to prevent the loss of gear. Seismic surveys could temporarily affect the behavior of some
32 targeted species, thereby temporarily affecting catch rates in the immediate area of the surveys.
33 Some subsistence fishers could decide to avoid areas during seismic because of perceived or
34 actual changes in catchability. New areas in the Cook Inlet Planning Area could be subjected to
35 seismic surveys during the Program. However, given the relatively small proportion of the
36 available Cook Inlet area that would be affected at any particular time, it is not anticipated that
37 seismic surveys would greatly disrupt subsistence fishing activities. Platform installation
38 activities associated with exploration could temporarily displace seals and possibly some whales
39 from installation sites and because of the noise and movement of aircraft. It is estimated that
40 displaced animals would return to normal behavior and distribution once the operation is
41 complete (MMS 2003a). Effects on subsistence harvesting would vary with the size and
42 duration of the operation.

43
44 There would be some direct effects on the subsistence harvest from noise and drilling
45 discharges. Under Federal authority, limited sea mammal harvest and subsistence halibut (and
46 some other non-salmon species) fishing can take place in Cook Inlet. Alaska Natives can hunt

1 marine mammals under the MMPA. Traditionally, beluga whales have been one of the most
2 important marine mammal subsistence resources taken from Cook Inlet at Tyonek. However,
3 this population has experienced a sharp decline and is now endangered. Under current
4 co-management agreements, subsistence harvesting has been suspended to allow the population
5 to recover (Allen and Angliss 2011). After recovery, belugas would once again be available for
6 the village of Tyonek to hunt. Proposed actions should have negligible effects upon this
7 potential harvest. While belugas occasionally inhabit areas where exploration noise and
8 disturbance could occur, in recent years their use of such areas appears to be low. In summer,
9 belugas tend to be concentrated in the extreme upper inlet outside the planning area.

10
11 The drilling of exploratory wells would have minimal impact on fish species (see
12 Section 4.4.7.3.2) and subsistence fishers. The estimated volume of drilling discharges from
13 exploration wells would have no effect on fish other than bottom dwellers in the immediate area
14 (within 100 m [328 ft]) of the well at the time of discharge (see Section 4.4.7.1). Drilling muds
15 and cuttings may temporarily limit subsistence fishers to portions of traditional fishing grounds,
16 since the fishers would be required to remain at least 500 m (1,640 ft) away from the drilling
17 platform for safety reasons. Only a very small portion of the available subsistence fishing areas
18 in Cook Inlet would be taken up.

19
20 Impacts on marine and coastal birds from exploration activities would be limited to the
21 effects of helicopter flights on nesting or roosting individuals directly or in close proximity to
22 regular flight paths. Effects could include abandonment of roosting or foraging areas, nest
23 abandonment, and lower reproductive success. These effects could last from 1 to 2 years if birds
24 adapt and for the life of the project if they fail to do so (MMS 2003a). Cook Inlet is an important
25 seabird breeding area. All Alaska Native communities surrounding the Cook Inlet Planning Area
26 report the harvesting of seabird eggs and marine and coastal birds including migratory waterfowl
27 (Table 3.14.2-2). This localized, probably temporary displacement of bird populations from
28 traditional subsistence harvest areas would affect subsistence bird and egg harvesters by reducing
29 the availability of the resource and/or requiring harvesters to extend their harvesting range. It is
30 not expected that any resource would become unavailable or that there would be an overall
31 population decrease (MMS 2003a).

32
33 Sociocultural effects could result from development and production phases, if the
34 resulting employment were to cause an in-migration into the area that is beyond the capacity of
35 existing sociocultural systems to absorb, or if subsistence harvest patterns were changed.
36 Although new development is likely to create jobs, many of these jobs could be filled from the
37 reservoir of skilled petroleum industry workers in the Cook Inlet area (particularly on the Kenai
38 Peninsula) or filled by others who would commute from outside the area and return home at the
39 end of their shifts or contracted work assignments (MMS 2003a). The effect of job creation on
40 population growth is thus likely to be small. The characteristics of any new population segment
41 are likely to be compatible with the towns and cities in which they choose to reside. It is not
42 likely that they will choose to reside in isolated Native villages, unless they are of Native
43 heritage. Any in-migration should do little to change existing sociocultural patterns.

44
45 Because oil and gas industry infrastructure already exists in and around Cook Inlet, new
46 construction would be limited to tying new production wells to the existing system. This could

1 entail the construction of new offshore platforms, offshore and onshore pipelines, and a new
2 landfall. Increased turbidity from the construction of platforms and pipelines could disturb
3 pelagic fish important to subsistence fishers and commercial fishers alike, and displacing the fish
4 from their preferred habitat and decreasing their catchability by subsistence fishers. However,
5 disturbance or displacement should be short term — limited to the time of construction and a few
6 hours or days thereafter. The drilling structures themselves may result in changes in species
7 distribution as offshore structures attract and protect some species (MMS 2003a). Cuttings and
8 fluids from production wells would be treated and disposed of in the well. Longlines and hand-
9 held trolls used for bottom fishing and gear such as beach and purse seines could snag on
10 submerged pipelines, causing some loss of gear for subsistence fishers.

11
12 A small increase in vessel activity to support platforms (up to six additional trips per
13 week) is anticipated. This small increase should not measurably affect subsistence harvesting
14 opportunities, catchability of fish and shellfish resources, or navigation by subsistence fishers.

15
16 Noise associated with drilling rig and support vessel traffic, helicopter flights, platform
17 construction and operation, pipeline construction, and vessel traffic to and from drilling
18 platforms could temporarily disturb belugas, particularly in the winter when they are more often
19 in the lower inlet. While the beluga population in the inlet is in decline and the Cook Inlet stock
20 is endangered, routine industry activities have not been found to contribute significantly to this
21 decline (MMS 2003a). The effects of increased routine industry activity on beluga populations
22 are assessed in Section 4.4.7.1.1.

23
24 Effects on marine and coastal birds important to subsistence harvesters would result from
25 helicopter flights and would be similar to those described above for exploration activities.

26
27 Airborne and underwater noise would be the main sources of disturbance for marine
28 mammals harvested by Native communities. Noise and disturbance would come from flights
29 and vessel traffic to platforms, offshore pipelaying, platform installation, and very local costal
30 habitat modification at the pipeline landfall. There would also be brief displacement of
31 terrestrial mammals harvested by some communities (see Table 3.14.2-2) (e.g., brown bears,
32 moose) on the Kenai Peninsula from helicopter flights and supply vessel traffic between
33 platforms and onshore facilities.

34
35 Effects from well abandonment and decommissioning on wildlife important to
36 subsistence harvesters would be similar to those from construction.

37
38
39 **4.4.13.2.2 Accidents.** The activities associated with the proposed action are susceptible
40 to oil spills and natural gas releases. While developers are required to submit oil spill response
41 plans, the *Exxon Valdez* oil spill has shown that a catastrophic discharge event can overwhelm
42 existing plans and cause damage to resources important to subsistence harvesters, affect fish
43 populations important to commercial fishers, and have sociological impacts in affected
44 communities.

1 It is assumed that as many as 15 very small oil spills (50 bbl or less), 3 small oil spills
2 between 50 and 1,000 bbl, and 1 large spill greater than 1,000 bbl and one catastrophic discharge
3 event (250,000 bbl) could occur under the Program (see Section 4.4.2). While most small spills
4 are likely to be contained, small spills may have effects on subsistence resources. Because small
5 amounts of oil spread out rapidly over the ocean surface, forming a thin sheen, and tend to break
6 up into small patches and streamers, an oil spill has to be at least several barrels, perhaps as
7 many as 50, before birds important to subsistence hunters would be at risk. A limited number of
8 birds would be lost. Small oil spills are estimated to have minor effects on mammals sought by
9 subsistence hunters, such as harbor seals, other marine mammals, and terrestrial mammals, with
10 perhaps the loss of a few individuals to oiling and some minor, transient, and local
11 contamination. Subsistence harvesters would consider animals from an oiled context to be
12 tainted and would be less likely to harvest them. Recovery from small spills would probably
13 require no more than a year (MMS 2003a).

14
15 One large spill (over 1,000 bbl) is assumed here. Effects of a large spill are likely to be
16 greatest in parts of the Cook Inlet Planning Area that are relatively confined, since oil is more
17 likely to reach the shore and affect important intertidal zones that support the young of many fish
18 species as well as shellfish that form a part of the subsistence harvest. Fishes most likely to be
19 affected by large spills include many that are important to subsistence fishers. They include
20 those that migrate extensively, such as the arctic cisco; those with strong ties to the streams
21 where they were spawned, such as the Dolly Varden; and those tied to nearshore environments
22 (see Section 4.4.7.2.3).

23
24 As the ongoing experience with the results of the *Exxon Valdez* oil spill and subsequent
25 cleanup efforts has shown, a major oil spill in the waters of southern Alaska can have significant
26 consequences for sociocultural systems (Fall 2009). Such effects could reduce the availability
27 and/or accessibility of subsistence resources. Typically, this would last for a single season or
28 less, but potentially for longer periods. Resources subject to such impacts include those that are
29 most significant for the area — fish and shellfish — as well as marine mammals and, to some
30 extent, terrestrial mammals. Birds and marine plants (seaweed) would also be at-risk resources
31 that are used locally. A pipeline or platform spill in Cook Inlet could affect subsistence activities
32 on the Kenai Peninsula, Kodiak Island, and the Alaska Peninsula. Lesser spills would have more
33 confined and more limited impacts.

34
35 A large spill and cleanup effort can have long-lasting social and psychological
36 repercussions. The sociocultural impacts of oil spills are of at least two types. The first is the
37 result of direct effects upon resources that are used in some way by local residents
38 (i.e., subsistence, tourism, recreation, and elements of quality of life). This includes economic
39 losses for commercial fishers and support businesses.

40
41 The second is the impact of spill cleanup efforts in terms of short-term increases in
42 population and economic opportunities, as well as increased demand on community services and
43 increased stress to local communities. In communities based on commercial fishing, the
44 increased demand on community services coincides with a decrease in tax revenues as income
45 from commercial fishing declines. Competition for employment in the cleanup process creates
46 division within communities (Picou et al. 2009).

1 As is evident from the *Exxon Valdez* event, cleanup efforts can be quite disruptive
2 socially, psychologically, and economically for an extended period of time. While the
3 magnitude of impacts declines rapidly in the first year or two after a large spill, long-term effects
4 continue to be evident. Technological disasters, such as oil spills, have been shown to have more
5 divisive community effects than those of natural disasters (Picou et al. 2009). Such effects can
6 be reduced by the early implementation of coping and mitigation measures (Picou et al. 1999).
7 One important coping measure is the establishment of, and local participation in, an effective
8 spill-response effort that has been formulated into an explicit spill-response plan. Such local
9 programs do have a number of benefits. They provide local employment, a sense of local
10 empowerment, and a means for local resident/oil industry communication. Another coping
11 measure is the establishment of intervention programs such as peer listening programs based on
12 community participation (MMS 2003a; Picou et al. 1999, 2009; Picou 2010).

13
14 Oil spills have the potential for significant and long-lasting effects on subsistence-based
15 Native villages and communities. However, Native communities have proven to be flexible and
16 adaptive, mitigating to some extent immediate losses to subsistence harvest resources. Of major
17 concern to Native wild food harvesters relating to oil spills is the contamination of the natural
18 environment. After the *Exxon Valdez* spill, Alaska Natives were fearful that marine and near
19 shore resources had been tainted, placing more trust in traditional environmental knowledge than
20 government agencies. Harvesting of traditional resources dropped off and Alaska Natives relied
21 on stored foods from previous seasons augmented by relief supplies of traditional foods supplied
22 by unaffected villages with whom they had traditional ties and exchange relationships.
23 Nonetheless, over time, social ties appear to have weakened. In the years following the spill,
24 harvesting slowly rebounded, but the composition of the harvest changed, attributed both to
25 long-term loss of resources and continuing fears of tainting (Fall 2009). Nanwalek Native Tom
26 Evans reported in 2003 that “our resources have not recovered” (MMS 2003c). Other
27 sociocultural effects included changes in wild food preferences, changes in traditional roles and
28 status in the communities, disruption of the instruction of children in traditional subsistence
29 knowledge and practices and thus the disruption of the transmission of Native culture, and
30 conflicts with outsiders (MMS 2003a).

31
32 Cleanup efforts would also affect subsistence resources. While cleanup strategies would
33 reduce the amount of spilled oil in the environment, thus mitigating negative effects to some
34 extent, disturbance and displacement of subsistence resources would increase from cleanup
35 activities such as offshore skimmers, workboats, barges, aircraft overflights, and *in situ* burning.
36 Deflection of resources resulting from the combination of a large oil spill and cleanup efforts
37 could persist beyond one season, perhaps lasting several years. The result could be a major
38 effect on subsistence harvests and subsistence users, who would suffer nutritional and cultural
39 impacts (MMS 2003a). In addition to effects on subsistence, during the *Exxon Valdez* cleanup,
40 culturally important archaeological resources were damaged or stolen (Picou et al. 2009).

41
42 If a natural gas loss of well control occurred, with possible explosion and fire, subsistence
43 resources such as fish, birds, and beluga whales in the immediate vicinity of the loss of well
44 control could be killed, if the loss of well control occurred below or on the water surface.
45 Natural gas and gas condensates that did not burn would be hazardous to any organism exposed
46 to high natural gas and gas condensate concentrations. Natural gas vapors and condensates

1 disperse rapidly and would not affect subsistence resources beyond the immediate area. High
2 concentrations would not occur if the loss of well control occurred on the top of a platform
3 where they would disperse more rapidly. Effects from losses of well control are likely to be
4 short term and local, lasting a year or less and extending for about 1.6 km (1 mi) (MMS 2003a).
5

6 **Catastrophic Discharge Event.** The PEIS analyzes a CDE that ranges from 75 to
7 125 thousand bbl (Table 4.4.2-2). It is likely that a CDE would cause significant damage to
8 resources important to subsistence harvesters, affect fish populations important to commercial
9 fishers, and have sociological impacts in affected communities. Alaska Native subsistence
10 harvesters would consider marine mammals from an oiled context to be tainted and would be
11 less likely to harvest them. Since the waters of the Cook Inlet Planning Area are relatively
12 confined, oil from a catastrophic discharge is likely to reach the shore and affect important
13 intertidal zones that support the young of many fish species as well as shellfish that form a part
14 of the subsistence harvest. Fishes most likely to be affected by large spills include many that are
15 important to subsistence fishers. They include those that migrate extensively, such as the arctic
16 cisco; those with strong ties to the streams where they were spawned, such as the Dolly Varden;
17 and those tied to nearshore environments.
18

19 A CDE in the waters of south central Alaska and the resulting cleanup are likely to have
20 significant consequences for sociocultural systems and can have long-lasting social and
21 psychological repercussions. The sociocultural impacts would include effects upon resources
22 that are used in some way by local residents (i.e., subsistence, tourism, recreation, and elements
23 of quality of life), and economic losses for commercial fishers and support businesses. In past
24 catastrophic discharge events, the loss of livelihood for both commercial and subsistence fishers
25 can result in depression and an increase in suicide and other pathological behavior, as can
26 participation in protracted litigation resulting from the spill (Picou et al. 2009, Fall et al. 2009).
27

28 Cleanup efforts resulting from a CDE would result in short-term increases in population
29 and economic opportunities, as well as increased demand on community services and increased
30 stress to smaller local communities. In communities based on commercial fishing, the increased
31 demand on community services coincides with a decrease in tax revenues as income from
32 commercial fishing declines. Competition for employment in the cleanup process creates
33 division within communities (Picou et al. 2009).
34

35 Disturbance and displacement of subsistence resources would increase from cleanup
36 activities such as offshore skimmers, workboats, barges, aircraft overflights, and *in situ* burning.
37 Deflection of resources resulting from the combination of a large oil spill and cleanup efforts
38 could persist beyond one season, perhaps lasting several years. The result could be a major
39 effect on subsistence harvests and subsistence users, who would suffer nutritional and cultural
40 impacts (MMS 2003a).
41

42 43 **4.4.13.3 Alaska – Arctic** 44

45 As was the case for Cook Inlet, finding and developing oil and gas resources on the arctic
46 OCS has the potential for creating adverse effects on sociocultural systems and subsistence.

1 Such effects would range from minor to major depending on the timing, location, and scale of
2 the activity. Many negative consequences could be minimized through appropriate mitigation
3 procedures. The most central of these would be establishing and maintaining communication
4 among Native villages, oil companies, and appropriate Federal agencies, including both
5 government-to-government consultation in compliance with legal requirements and USDOJ
6 policy (USDOJ 2001) and ongoing dialogue leading to adaptive management of adverse effects.
7

8 As discussed in Section 3.14.3.1, the northern and northwestern coasts of Alaska are the
9 home of indigenous Iñupiat communities confronted with increasing industrialization tied to
10 mineral extraction. While it is clear that industrialization in northern Alaska has had significant
11 economic and social effects, until now, the industrial workforce building and operating the
12 expanding oil and gas extraction facilities has been largely non-local and transient, residing in
13 self-sufficient enclaves far removed from Native villages and, for the most part, placing little
14 strain on village government resources. However, as expressed by Alaska Natives in scoping
15 meetings (BOEMRE 2011c–f), as oil and gas production infrastructure expands both onshore
16 and into the Arctic Ocean, the indigenous villagers feel their traditional subsistence-based
17 lifeway is being constrained and their cultural values threatened.
18

19 As expressed by Carla Sims Kayotuk in the 2011 Kaktovik scoping meetings: “I do not
20 want to see that [sociocultural] change for our community. It has changed some, but I don’t
21 want to see any more negative changes happen. And I strongly believe that if offshore
22 development, even onshore development [continues], that’s going to happen and our community
23 will never be the same again. And I know change happens. Culture changes, traditions change,
24 but I think it’s going to be a very negative impact on us” (BOEMRE 2011c).
25

26 The Iñupiat are closely tied to the land and the sea. Subsistence harvesting and the
27 distribution of the subsistence harvest through kin and social networks based on cultural ideals of
28 community and sharing are core values of Iñupiat culture. To the extent that oil and gas
29 activities in or close to Native villages adversely affect the subsistence harvest or limit cultural
30 continuity, they have a negative impact on Iñupiat sociocultural systems. In addition, new
31 development may result in an influx of outsiders who do not share Iñupiat values and mores,
32 resulting in stress on indigenous sociocultural systems. For example, all Iñupiat villages on the
33 North Slope are “dry,” and in some of them the importation of alcohol is illegal. These values
34 may not be shared by oil workers coming from outside Iñupiat communities.
35

36 The Iñupiat harvest a wide range of wild animal and plant resources including bowhead
37 and beluga whales, seals, walrus, polar bears, fish, waterfowl, and caribou (see Section 3.14.3.1).
38 For coastal communities, the most iconic harvests are the bowhead and beluga whale hunts.
39 These lie at the heart of Iñupiat social system and sense of cultural identity.
40

41 “If you ever see this young kid as a young man [become] a whaler, it’s like an individual
42 that lives in [the city], has a dream of becoming a pilot or [having] a career of some sort. But
43 when you are a Native, it’s always been being a provider to the community, be a hunter. That’s
44 the culture of Iñupiat. Pass on the traditions that’s been passed on to us for thousands of years,”
45 said Isaac Nukapigak from the village of Nuiqsut (BOEMRE 2011d).
46

1 Native Alaskans often refer to the Chukchi and Beaufort Seas as the Iñupiat garden or
2 Garden of Eden and are extremely concerned about loss of resources from oil spills and
3 pollution, and from changes in patterns of wildlife migration resulting from industrial activities.
4 In the words of Raymond Aguvluk, a local resident, at the 2011 Wainwright scoping meeting for
5 this PEIS “We eat from out there, you know. And [are] you guys going to send us chicken or
6 steak? No way. We love our garden out there” (BOEMRE 2011e)
7

8 Marine mammals and fish are the resources of most concern, as they constitute a major
9 part of the subsistence harvest and typically are the resources most likely to be directly affected
10 by oil and gas activities on the OCS. Land mammals, particularly caribou, are also important
11 subsistence resources, but would be affected more by transportation pipelines and other support
12 infrastructure tied to OCS development than directly by oil and gas activities on the OCS. Oil
13 spills that have occurred elsewhere in Alaska have resulted in negative consequences for
14 subsistence resources and activities, but routine exploration, development, and operation could
15 also potentially result in negative effects.
16
17

18 **4.4.13.3.1 Routine Operations.** Routine oil and gas operations may be divided into four
19 categories or phases: exploration, development, operations, and decommissioning. Exploration
20 on the OCS, whether using seismic surveys or test wells, is done from largely self-contained
21 ocean-going vessels, and in the past has had little direct impact on the infrastructure of local
22 communities (MMS 2007a, 2008b). Exploration ships do require onshore support facilities.
23 Exploration in the Beaufort Sea using existing facilities at Prudhoe Bay/Deadhorse and Barrow
24 would result in little new impact. Conversely, exploration plans filed for the Chukchi Sea
25 include development of an onshore base in Wainwright that would use some village
26 infrastructure and services. With a staff of 22 to 64 individuals, it would include a helipad, fuel
27 storage, lift and hoist facilities near existing boat ramps, and temporary housing for vessel crews
28 weathered in while being changed (Shell 2009a,b). The local village corporation has built its
29 crew quarters (Burwell 2011; Anchorage Daily News 2010). Having the shore base in the
30 village would likely increase interaction between transient workers and Wainwright Native
31 Alaskans, with the potential for changing cultural dynamics, including conflicts arising from
32 differing behavioral norms and the adoption of Western cultural traits by indigenous
33 communities. The presence of the onshore base would also provide some employment
34 opportunities for Native Alaskans (Shell 2009b). Cultural conflicts may be minimized through
35 cultural awareness orientation stipulated in lease contracts so in-migrant workers are made aware
36 of Native Alaskan cultural values including the importance of the subsistence harvest to local
37 communities. Lease stipulations would require developers to submit plans that orient new
38 in-migrant workers to the local Alaska Native culture, including subsistence, in advance
39 (MMS 2007a).
40

41 Of great concern to local populations is the noise created by seismic survey air guns and
42 test drilling rigs during exploration and their potential for disturbing or driving away the
43 migratory sea mammals upon which subsistence communities depend. Iñupiat whalers generally
44 agree that whales and other marine mammals are more sensitive to noise than Western scientific
45 studies suggest and will avoid noise sources, and that they have been disturbed from their normal
46 patterns of behavior by past seismic and drilling activities. According to Kaktovik whaling

1 captain George Kaleak, Sr., “The sound can go over 50 miles, and whales can hear it”
2 (BOEMRE 2011c). Noise and other associated activities can make whales less predictable and
3 more dangerous to those who hunt them. They can be deflected from their usual migration
4 routes into deeper, more dangerous waters, where they are more difficult to take and bring home
5 successfully. Whalers from Barrow, Nuiqsut, and Kaktovik have been especially vocal on this
6 issue, as they are most likely to be directly affected by such activities during the fall open water
7 season.
8

9 Isaac Nukapigak, a Nuiqsut whaling captain explained at scoping meetings held in 2011:
10 “At one point, I remember us being out there for 7 weeks and didn’t meet our quota because of
11 [oil and gas exploration] activities and weather prediction where our subsistence hunt and the
12 whales were disrupted because of this heavy activity going on in the Beaufort. We had to go
13 30 miles north. That’s where we finally were able to see whales because there was so much
14 activity east of Cross Island. And that time we had no choice because a whale was got 35 miles
15 north of Cross Island because of ... safety [in] these small boats that we go out in to harvest,
16 weather prediction got bad on us. We had no choice but to let go of the whale even though we
17 didn’t want to. And that year was so harsh because we didn’t meet our quota. It was very
18 noticeable in this community. There was no whale meat stored in our cellars. People were
19 hurting” (BOEMRE 2011d).
20

21 According to Tom Albert, a former non-Iñupiat senior scientist for the North Slope
22 Borough (NSB) Department of Wildlife Management, “When a captain came in to talk to me, I
23 knew he was going to say that the whales are displaced [by noise] farther than you scientists
24 think they are. But some of them would also talk about ‘spookiness,’ when the whales were
25 displaced out there and when the whaler would get near them, they were harder to approach and
26 harder to catch” (MMS 1997a).
27

28 That marine mammals are sensitive to noise disturbance is clear, although thresholds in
29 terms of signal characteristics and distance for each species have not been established.
30 Generally, such effects would be confined to the vicinity of the seismic vessel and to the actual
31 time of operation. Seismic surveys would occur after July 1 in the open water season, and would
32 thus not affect the spring whale hunt. Deferral of leasing from a corridor along the coast
33 provides a sea mammal migration corridor in the Chukchi Sea. Villagers along the Beaufort
34 coast have requested a similar deferral corridor (BOEMRE 2011d,f). Without mitigation in
35 place, seismic surveys could affect the more important fall hunt and cause subsistence resources
36 to be unavailable and have a major effect on subsistence harvesting. Lease stipulations for
37 whaler-oil industry conflict avoidance agreements (CAAs) and other “non-disturbance”
38 agreements have minimized such problems in the recent past so that noise and disturbance
39 effects of single actions have been, and are expected to be, effectively mitigated. However, such
40 agreements become more difficult to implement if multiple vessels are surveying at the same
41 time. It is expected that required adaptive mitigation and management plans (AMMPs), the
42 requirements of National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service
43 (USFWS) incidental take authorizations, and required consultation with local communities
44 would ensure that impacts on marine mammals would be minimal. Typical requirements include
45 monitoring for the presence of sea mammals and ensuring that supply aircraft routinely fly above
46 elevations that would disturb sea mammals (MMS 2007a, 2008b).

1 Development would involve the construction of onshore and offshore infrastructure
2 including gravel drilling pads, onshore and offshore pipelines, landfalls, pumping stations, roads,
3 and additional facilities to house an influx of construction workers. While construction has the
4 potential of providing additional local employment, the noise and human presence associated
5 with construction activities are likely to have temporary and localized effects on some
6 subsistence resources and, depending on the location of construction worker enclaves, place
7 stress on the infrastructure of local communities. Operation of the facilities may require fewer
8 workers than construction, many of whom are likely to be transient shift-workers based in other
9 parts of Alaska. The sociocultural impact of these transient workers would depend on the
10 location of new shore-based facilities, and associated enclaves. With a shore-based facility for
11 Chukchi Sea exploration and development is established at Wainwright, it is likely to expand
12 beyond that required for exploration, further increasing the interaction between transient workers
13 and the previously relatively isolated Alaska Native population.
14

15 The potential direct and indirect effects of development in the Arctic would result from
16 noise, visual, and traffic disturbances from the construction of pipelines and other offshore and
17 shore-based facilities. Construction activities, including the delivery of fuel and supplies, are
18 limited in time and space and can be scheduled to minimize impacts to subsistence resources. In
19 the past, they have been effectively limited in specified areas during critical periods on
20 subsistence use through industry/subsistence user cooperation (MMS 2008b). The need to install
21 additional platforms in the Arctic could increase the areas and times where either industry or
22 subsistence activities are restricted. This would increase the possibility for significant harvest
23 disruption. Disruption would be made worse if construction and production activities were
24 concentrated in critical subsistence-use areas, which may include cabins and camps. Potential
25 cumulative effects of multiple projects are discussed in Section 4.6.5.3.
26

27 Onshore pipeline effects on subsistence would occur during the 1- or 2-year construction
28 period. The major onshore pipeline to be constructed for the proposed action would connect
29 Chukchi Sea oil production with the TAPS or to a possible deepwater port at Kotzebue.
30 Offshore pipeline effects on subsistence would generally be confined to the period of
31 construction and could be mitigated through lease stipulations that would restrict industry
32 activities during critical subsistence-use periods.
33

34 The potential disturbance effects of production operations may be more difficult to
35 mitigate, because such activities would be longer term and operate year round. As with
36 construction, the potential direct and indirect effects of routine OCS operations in the Arctic
37 regions derive from noise, visual, and traffic disturbances from the operation of pipelines and
38 other shore-based facilities.
39

40 Even when construction is complete, new infrastructure such as roads and pipelines could
41 serve to restrict the movement of land mammals and the access by indigenous populations to
42 onshore subsistence resources such as caribou herds. For example, a pipeline connecting the
43 Chukchi Sea Planning Area with the TAPS would cross a large area that is currently
44 undeveloped except for isolated and relatively small airstrips. This could restrict access by
45 Nuiqsut subsistence hunters, who already could be restricted by oil and gas development in the
46 Coleville River delta the westward expansion of the Prudhoe Bay facilities, and the potential for

1 development to their west in the National Petroleum Reserve in Alaska (BOEMRE 2011d). The
2 potential impact of the pipeline on subsistence resource-use patterns, while unavoidable, can be
3 at least partially mitigated and minimized with proper pipeline design, location, and routing.
4 Potential effects of a pipeline on subsistence users (perceptions of areas they wish to avoid or
5 that are difficult for them to access for hunting) can be addressed with design considerations (for
6 instance, by elevating or burying segments of the pipeline) and by including subsistence users
7 early in the consultation process. The most difficult potential onshore pipeline effects to mitigate
8 would be those related to pipeline servicing and access. If a service road is constructed for this
9 purpose, it would greatly increase impacts on caribou movement and access to subsistence
10 resources on the western part of the North Slope (MMS 2007a). This effect would be greater if
11 such a road were eventually opened to public access, on the model of the Dalton Highway.
12 Roads are also reported to impose substantial maintenance costs on subsistence equipment (snow
13 machines and sleds) and to present some safety issues (Impact Assessment, Inc. 1990). Current
14 practices aim to minimize the construction of new roads. If pipeline servicing was conducted
15 using aircraft, and perhaps ice roads or other ground transport in winter, such potential access
16 effects would be minimized. Increased aircraft traffic in the summer could have a moderate
17 effect on subsistence uses, but such impacts could be reduced through coordination with
18 subsistence users.

19
20 The potential effect of pipelines on subsistence resources themselves (in terms of
21 population and behavior) are discussed in Section 4.4.7.13. With regard to caribou, onshore
22 facilities and activities associated with the proposed offshore development program in northern
23 Alaska should have temporary impacts on individual caribou but negligible effects on caribou
24 herds, although development may change their migration patterns and make them less accessible
25 or less desirable. Caribou habituation to gravel pads and oil field infrastructure alters the value
26 of the caribou to subsistence users, who view these habituated caribou as contaminated and not
27 behaving correctly. Frank Long, Jr., stated in the Nuiqsut Alpine Satellite Development Project
28 scoping meeting: “We will have the same problem we did in the Prudhoe Bay and the Kuparuk
29 area with our caribou. Right now, I call our caribou that are existing around here that don’t go
30 nowhere our ‘industrial dope addict caribou.’ They are already sick and nobody’s doing anything
31 about them” (MMS 2007a).

32
33 Fish are another important subsistence resource. Most petroleum industry activities
34 would occur far from the freshwater or nearshore locations where subsistence harvests are
35 concentrated. However, the construction of gravel causeways has the potential to affect fish
36 migration routes. This can be mitigated by including culverts that allow the fish to pass through.
37 Other effects would include potential reductions in fish populations (or health effects), which
38 have been evaluated in Section 4.4.7.3.3.

39
40 Many Iñupiat villagers take the long view of their presence on the North Slope. The
41 Iñupiat lived as subsistence hunters for centuries before the arrival of oil development and expect
42 to remain after the oil and gas reserves have been depleted. They are concerned with
43 decommissioning. The impacts of decommissioning are expected to be similar to those of the
44 construction process. Likewise short-lived and spatially restricted, impacts of noise and traffic
45 on subsistence resources can be mitigated through consultation and scheduling.

46

1 The principal sociocultural systems impacts of the proposed action in the Arctic would be
2 due to developing a Shore Base within an Alaska Native community. Additional significant
3 effects would be in the area of subsistence harvesting, with implications for health, population,
4 and the economy. All of these topics, except for health, are discussed in other sections
5 (see Sections 4.4.9, 4.4.10, and 4.4.14). Potential OCS activity would support these established
6 trends. Activity under the proposed program could exert sociocultural effects at the Statewide,
7 regional, and local levels. Income related to OCS development could be expected to support
8 many of the preexisting State programs. At a regional level, OCS activity would constitute one
9 component of continued economic development — primarily onshore and related to the Prudhoe
10 Bay “oil patch” — which has become the prime source of support for most of the infrastructure
11 and local economic development. At a local level, communities might experience adverse
12 sociocultural impacts if development leads to the establishment of shore based facilities, new
13 onshore access routes into the communities, an influx of oil industry personnel into local
14 communities, or local economic benefits from increased local employment opportunities.
15

16 Social systems and cultures are seldom, if ever, static. Many changes viewed as
17 sociocultural concerns could also be seen as adaptive change. What is often perceived as the
18 “erosion of cultural values” may only be a transformation or change in the behavioral expression
19 of those values (modes of sharing, expressions of respect). On the other hand, some behavioral
20 changes are more important indicators of cultural and value change than others. That is perhaps
21 why public testimony on the impacts of petroleum development in Arctic Alaska — especially
22 that of Native Elders — has focused on subsistence resources and practices, the relationship of
23 people to the land and its resources, health, increased social pathologies, and the use (and loss) of
24 Native languages. While OCS activity from the proposed action would only contribute
25 incrementally to these effects, it should be recognized that these activities would occur within
26 this context.
27

28 Some of the vectors of sociocultural change that have been commonly noted in studies of
29 Arctic Alaska, lease sale documents, or testimony during the lease sale process can be briefly
30 summarized as follows (see MMS 2008b, p. 4-327, and reference therein):
31

- 32 • Changes in community and family organization (availability of wage-labor
33 opportunities locally or regionally, ethnic composition, factionalism,
34 household size);
- 35
- 36 • Institutional dislocation and continuity (introduction of new institutions,
37 “loss” or de-emphasis of older or more traditional ones, and adaptation of new
38 forms to old content or values, and vice versa);
- 39
- 40 • Changes in the patterns of overall subsistence activities (time allocation,
41 access, effort, equipment, and monetary needs) and the potential disruption of
42 subsistence harvest activities by industrial development;
- 43
- 44 • Changes in health measures (a combination of increased access to health care,
45 changes in diet, increased exposure to disease, substance use and abuse,

- 1 concern over possible exposure to contaminants of various sorts, and other
2 factors);
3
4 • Perceived erosion of cultural values and accompanying behaviors (increased
5 social pathologies such as substance abuse, suicide, and crime/delinquency in
6 general; decreased fluency in Native languages; decreased respect for elders;
7 less sharing); and
8
9 • Cultural “revitalization” efforts such as dance groups, Native language
10 programs, and official and regular traditional celebrations (such as the
11 reestablishment of *Kivgiq* [the Messenger Feast], for example, in the NSB and
12 the NWAB).
13

14 While these are all in some sense generalizations and “analytical constructs,” all are also
15 supported by specific testimony of Native residents of the region. These dynamics are not
16 generally viewed as specific to oil and gas development (let alone OCS), but rather as the overall
17 context within which Iñupiat culture must continue to exist (MMS 2008b).
18
19

20 **4.4.13.3.2 Accidents.** The high degree of dependence of Arctic Native communities on
21 the Beaufort and Chukchi Seas for their subsistence is reflected in the frequency and urgency
22 with which they expressed their concerns over oil spills in the Arctic at public meetings. They
23 are aware of the long-lasting consequences of the *Exxon Valdez* oil spill and of the scale of the
24 effort that was required to cap and clean up after the DWH event in the GOM.
25

26 Oil spills have the most potential for adverse effects attributable to the proposed action.
27 Negative effects on specific subsistence species, as well as on the more general patterns of
28 subsistence resource use, persisted in Prince William Sound for years after the *Exxon Valdez* oil
29 spill and the subsequent cleanup effort (Fall 2009).
30

31 The impacts of both large and small oil spills are expected to be significant in the Arctic,
32 where oil is more likely to persist in the environment due to colder temperatures. An oil spill of
33 more than 1,000 bbl could, depending on the time and location of the spill event, affect the
34 subsistence use of marine mammals in the region where it occurs. In 1978, Thomas P. Bower,
35 Sr., a whaler from Barrow, reported the results of a 1944 oil spill when a Liberty Ship, the
36 *S.S. Jonathan Harrington*, ran aground southeast of Barrow and dumped fuel oil into the sea to
37 lighten the ship:
38

39 According to Bower, about 25,000 gallons of oil were deliberately spilled into the
40 Beaufort Sea in this operation. In the cold, arctic water, the oil formed a mass several inches
41 thick on top of the water. Both sides of the barrier islands in that area — the Plover Islands —
42 became covered with oil. “That first year ... I observed how seals and birds who swam in the
43 water would be blinded and suffocated by contact with the oil. It took approximately 4 years for
44 the oil to finally disappear.... I observed that for 4 years after that oil spill, the whales made a
45 wide detour out to sea from these islands” (MMS 2007a).
46

1 Although this episode shows that a species can recover after 4 years without cleanup,
2 those years are remembered by subsistence harvesters as a time when subsistence harvest was
3 severely reduced.
4

5 It is assumed that as many as 190 very small oil spills (50 bbl or less) and between 35 and
6 70 small oil spills (more than 50 bbl but no greater than 1,000 bbl) would be associated with the
7 Program in the Arctic (see Section 4.4.2). While most small spills are likely to be contained,
8 small spills may have effects on subsistence resources. Because small amounts of oil spread out
9 rapidly over the ocean surface, forming a thin sheen, and tend to break up into small patches and
10 streamers, an oil spill has to be at least several barrels, perhaps as many as 50, before birds
11 important to subsistence hunters would be at risk. A limited number of birds would be lost.
12 Small oil spills are estimated to have minor effects on mammals sought by subsistence hunters,
13 such as harbor seals, other marine mammals, and terrestrial mammals, with perhaps the loss of a
14 few individuals to oiling and some minor, transient, and local contamination. Subsistence
15 harvesters would consider animals from an oiled context to be tainted and would be less likely to
16 harvest them. Recovery from small spills would probably require no more than a year
17 (MMS 2003a). The effects of prolonged exposure to elevated levels of petroleum hydrocarbons
18 on fish are discussed in Section 4.4.7.3.3. The effects can be lethal or sublethal and have the
19 greatest effect on eggs, larvae, and juveniles, particularly in intertidal zones.
20

21 As many as three large spills (over 1,000 bbl) could occur in the Beaufort Sea and
22 Chukchi Sea Planning Areas under the proposed action. As the result of a large spill, the
23 bowhead whale hunt could be disrupted, as could the beluga harvest and the more general and
24 longer hunt for walrus west of Barrow. Animals could be directly oiled, or oil could contaminate
25 the ice floes or onshore haulouts they use on their northern migration. Such animals could be
26 more difficult to hunt because of the physical conditions. Animals could be “spooked” and/or
27 wary, either because of the spill itself or because of the “hazing” of marine mammals, which is a
28 standard spill-response technique in order to encourage them to leave the area affected by a spill.
29 Oiled animals are likely to be considered tainted by subsistence hunters and would not be
30 harvested, as occurred after the *Exxon Valdez* spill. This would also apply to terrestrial animals,
31 such as bears that scavenge oiled birds and animals along the shore, or caribous that seasonally
32 spend time along the shore or on barrier islands seeking relief from insects.
33

34 Although developers must submit oil spill response plans and have spill response vessels
35 available, there has been little experience with under-ice or broken-ice oil spills. While the
36 concern is most typically phrased in terms of the potential effects of oil spills on whales and
37 whaling, it can be generalized to a concern for marine mammals and ocean resources in general.
38 Fishes most likely to be affected by large spills include many that are important to subsistence
39 fishers. They include those that migrate extensively, such as the arctic cisco; those with strong
40 ties to the streams where they were spawned, such as the Dolly Varden; and those tied to
41 nearshore environments, such as broad whitefish (see Section 4.4.7.3.3). Marine mammals and
42 fish typically comprise 60% of a coastal community’s diet. Pipeline and platform spills could
43 also impact migrating anadromous fish in the river deltas, as well as species that use oiled coastal
44 and nearshore habitat, such as nesting birds, breeding caribou, and the like. Overall, the impacts
45 of oil spills on subsistence practices and resources are variable, ranging from minor to major,
46 depending on the size, location, and timing of the spill. As shown by the results of the *Exxon*

1 *Valdez* spill, subsistence harvesters in unaffected areas are likely to share resources with
2 impacted villages through established social networks. While local ties are regularly
3 strengthened through mutual exchange, they can weaken when there is less to exchange
4 (Picou et al. 2009).

5
6 Cleaning up a major spill is likely to have negative consequences as well. Cleanup
7 activities and increased human presence could displace subsistence species from their usual
8 harvesting locations. There are relatively few vessels on the northern coast that could participate
9 in the cleanup of a major spill. It is likely that whaling boats and their crews would be diverted
10 for this purpose. Depending on the timing of the spill, this would make them unavailable for the
11 whale hunt. While local villagers would be employed in the cleanup, it is likely that many
12 additional workers would be necessary, placing stress on village facilities. An influx of outsiders
13 is likely to result in some cultural conflict, stressing the local sociocultural systems.

14
15 As is evident from the *Exxon Valdez* oil spill event, such cleanup efforts can be disruptive
16 socially, psychologically, and economically for an extended period of time. While the
17 magnitude of impacts declines rapidly in the first year or two after a large spill, long-term effects
18 continue to be evident (Picou et al. 2009). Such effects can be reduced by the early
19 implementation of coping and mitigation measures (Picou et al. 1999). One important coping
20 measure is the establishment of, and local participation in, an effective spill-response effort that
21 has been formulated into an explicit spill-response plan. Such local programs do have a number
22 of benefits. They provide local employment, a sense of local empowerment, and a means for
23 local resident–oil industry communication. Another possible coping measure would be the
24 establishment of intervention programs, such as peer listening programs based on community
25 participation (MMS 2003a; Picou et al. 1999, 2009; Picou 2010).

26
27 **Catastrophic Discharge Event.** The PEIS analyzes a CDE that ranges in size from
28 1.4 to 2.2 million bbl in the Chukchi Sea Planning Area, and for 1.7 to 3.9 million bbl in the
29 Beaufort Sea Planning Area (Table 4.4.2-2). Local Alaska Natives have grave concerns over the
30 possibility of a CDE. They are concerned that oil from such an event would spread quickly in
31 the shallow Arctic waters, that oil companies lack the technology to clean up a spill in ice and
32 lack an understanding of how dispersants would act in Arctic waters, and that there is not enough
33 equipment nearby and insufficient infrastructure such as harbors and airports to handle a major
34 spill. They are particularly concerned about the effects of a spill in the whale migration path and
35 the resulting loss and/or contamination of a major food source. In the words of Waska Williams
36 at the 2011 Barrow scoping meetings, “In the event that a major spill happens, our way of life is
37 in jeopardy” (BOEMRE 2011f).

38
39 Depending on the time and place it occurred, a CDE could have significant effects on the
40 marine mammals, fishes, migratory birds, and terrestrial mammals upon which Alaska Native
41 subsistence harvesters depend. Oil is more likely to persist in the Arctic environment due to the
42 colder temperatures prolonging the effects of such an event. As the result of a catastrophic
43 discharge event, the economically, socially, and culturally important bowhead whale hunt could
44 be disrupted, as could the beluga harvest and the more general and longer hunt for walrus west of
45 Barrow. Animals could be directly oiled, or oil could contaminate the ice floes or onshore
46 haulouts they use on their northern migration. Such animals could be more difficult to hunt

1 because of the physical conditions. Animals could be “spooked” and/or wary, either because of
2 the spill itself or because of the “hazing” of marine mammals, which is a standard spill-response
3 technique in order to encourage them to leave the area affected by a spill. Oiled animals are
4 likely to be considered tainted by subsistence hunters and would not be harvested, as occurred
5 after the *Exxon Valdez* spill. This would also apply to terrestrial animals, such as bears that
6 scavenge oiled birds and animals along the shore, or caribous that seasonally spend time along
7 the shore or on barrier islands seeking relief from insects. The loss of subsistence harvest
8 resources, particularly marine mammals, would have significant effects on Alaska native culture
9 and society. As shown by the results of the *Exxon Valdez* spill (Picou et al. 2009), subsistence
10 harvesters in unaffected areas are likely to share resources with impacted villages through
11 established social networks. While local ties are regularly strengthened through mutual
12 exchange, they can weaken when there is less to exchange.

13
14 Cleaning up a CDE would have negative consequences as well. Cleanup activities and
15 increased human presence could displace subsistence species from their usual harvesting
16 locations. There are relatively few vessels on the northern coast that could participate in the
17 cleanup of a major spill. It is likely that whaling boats and their crews would be diverted for this
18 purpose. Depending on the timing of the spill, this would make them unavailable for the whale
19 hunt. While local villagers would be employed in the cleanup, it is likely that many additional
20 workers would be necessary, placing stress on village facilities. An influx of outsiders is likely
21 to result in some cultural conflict, stressing the local sociocultural systems. As is evident from
22 the *Exxon Valdez* oil spill event, such cleanup efforts can be disruptive socially, psychologically,
23 and economically for an extended period of time.

24 25 26 **4.4.13.4 Conclusion**

27
28
29 **4.4.13.4.1 Gulf of Mexico.** Few impacts on GOM sociocultural systems are anticipated
30 from the proposed action. The oil and gas industry is well developed along the coast, and the
31 proposed action is more likely to support the existing industry than to create industry growth.
32 Any expansion of deepwater activities will result in jobs that require longer, unbroken periods of
33 work offshore, specialized skills, and potential in-migration of part of the workforce. Such
34 changes can affect workers, their families, and the communities in which they reside. Impacts to
35 sociocultural systems from routine Program activities in the GOM planning areas are expected to
36 be minor.

37
38 Impacts from small spills are likely to have small, localized, and short-lived effects. In
39 the unlikely event of a CDE, there will be economic repercussions for the oil and gas industry,
40 commercial fishers, and subsistence harvesters. These could result in social and cultural stress,
41 leading to possible social pathologies.

42
43
44 **4.4.13.4.2 Cook Inlet.** Oil and gas exploration, development, and production activities
45 are a continuation of long-time economic characteristics of the area. The proposed action would
46 not introduce new kinds of activities to the area that would alter existing socioeconomic systems.

1 The relatively small number of new residents that would come into the area because of the
2 proposed action should likewise not alter existing sociocultural systems. These activities are not
3 likely to affect commercial fishing (see Section 4.4.11.2); however, they may periodically result
4 in temporary and localized displacement of subsistence resources or limit subsistence access,
5 making the subsistence harvest by Native Alaskans more difficult, but no resource would
6 experience an overall decrease in population, and no harvest would be curtailed for part of the
7 harvest season. Impacts to sociocultural systems from routine Program activities in the Cook
8 Inlet Planning Area are expected to be minor.

9
10 A large oil spill could contact environmental resource areas where important subsistence
11 resources are present. Some harvest areas and resources in these locations would be too
12 contaminated to harvest. Some subsistence resource populations could suffer losses and, as a
13 result of tainting, an even larger array of resources could be rendered unavailable for use.
14 Tainting concerns in communities nearest the spill could seriously curtail traditional practices for
15 harvesting, sharing, and processing resources and threaten pivotal practices of traditional Alaska
16 Native culture. Harvesting, sharing, and processing of subsistence resources would continue but
17 would be hampered to the degree these resources were contaminated. In the case of
18 contamination, harvests would cease until such time as local subsistence hunters perceived
19 resources as safe. In the event of a CDE-level spill, similar impacts would be incurred, although
20 the extent, duration, and magnitude of impacts would be greater. Oil spill cleanup would
21 increase overall effects by displacing subsistence species, altering or reducing subsistence hunter
22 access, and altering or extending the normal period of the subsistence hunt (MMS 2003).

23
24
25 **4.4.13.4.3 Arctic.** Finding and developing oil and gas resources on the arctic OCS has
26 the potential to create adverse effects on sociocultural systems and subsistence in the Arctic
27 Planning Areas. Such effects would range from minor to major for the routine Program
28 activities, depending on the nature, timing, location, and scale of the activity. Many potential
29 effects are expected to be limited or mitigable. Of greatest concern to the Alaska Natives who
30 inhabit the area are threats to their subsistence base and way of life. Not only does subsistence
31 harvesting provide them with a substantial portion of their food supply, but subsistence-related
32 activities are central to their cultural identity. For many, the most iconic subsistence activity is
33 the whale hunt.

34
35 Lease sales on the Arctic OCS are likely to result in the search for and development of oil
36 and gas resources. These activities could have direct and indirect effects on Alaska Native
37 culture. Noise from seismic surveys and exploratory drilling has the potential to deflect whales
38 and other marine mammals from their accustomed migration routes, making them more difficult
39 to harvest. The effects can be reduced through cooperative scheduling and exploration design
40 based on dialogue among the villages, oil companies, and Federal and State agencies. The noise
41 and increased human presence resulting from the construction and operation of drilling pads,
42 pipelines, and shore base facilities has the potential to disturb subsistence species. The increased
43 presence of non-Natives in and around previously isolated villages increases the chance of cross-
44 cultural misunderstanding and could result in financial and cultural stress on Native
45 communities. Lease stipulations requiring conflict avoidance agreements between oil developers
46 and Native villages, along with training of in-migrating work force, will reduce negative impacts.

1 Impacts on freshwater fish and terrestrial subsistence species such as caribou from onshore
2 pipelines can be ameliorated by cooperative planning efforts that take subsistence needs into
3 account. Effects are likely to be compounded by concern over cumulative effects, which are
4 discussed in Section 4.6.5.3. Of greatest concern to the villagers are the effects of any oil spill.
5 Potential impacts on sociocultural systems from accidents under the proposed action could vary
6 greatly, depending on the size, location, and timing of a spill with greatest impacts occurring
7 with a CDE-level spill. A catastrophic discharge event could prove challenging for existing
8 response capacity and capability, especially if the spill were under ice or in broken ice.

11 **4.4.14 Potential Impacts on Environmental Justice**

14 **4.4.14.1 Gulf of Mexico**

17 **4.4.14.1.1 Routine Operations.** In addition to the continuing use of existing onshore
18 support and processing facilities, between 4 and 6 new pipe yards, up to 12 new pipeline
19 landfalls, and as many as 12 new gas processing facilities are projected to be built as a result of
20 the proposed 5-yr program. Impacts of new onshore construction impacts could include
21 increased noise and traffic, air and water pollution, impacts on residential property values, and
22 land use changes. Air emissions from onshore facilities and helicopter and vessel traffic
23 traversing coastal areas will be highest in the areas containing the greatest amounts of
24 infrastructure, which again will be Texas and Louisiana. Lesser amounts will occur in
25 Mississippi and Alabama. No onshore infrastructure supporting OCS operations currently exists
26 in Florida, and none will be built as a result of the proposed program.

28 It is assumed that 75% of the activity from the proposed 5-yr program will occur in deep
29 and ultra-deep waters, with offshore air emissions greatest in the coastal areas of Texas and
30 Louisiana, the areas with the greatest amounts of oil and gas activity, and lesser amounts in
31 occurring in Mississippi and Alabama. The coastal areas of Florida are located so far from OCS
32 activities that no environmental justice issues from offshore air emissions are expected to impact
33 the coastal parts of the State.

35 The effects of the OCS program on air quality have been analyzed in Section 4.4.4. This
36 analysis concluded that routine operations associated with the proposed 5-yr program would
37 result in NO₂, SO₂, PM₁₀, and CO levels that are well within the National Ambient Air Quality
38 Standards (NAAQS). Coastal effects from offshore activities are expected to be small, based on
39 the established and increasing trend toward movement of oil and gas activities into deeper waters
40 of the GOM.

42 The proposed 5-yr program will result in levels of infrastructure use and construction
43 similar to that which has occurred in the GOM coast region during previous programs. These
44 activities are not expected to expose residents to notably higher risks than currently occur. While
45 the distribution of offshore-related activities and infrastructure indicates that some places and
46 populations in the GOM region will continue to be of environmental justice concern, the

1 incremental contribution of the proposed OCS program is not expected to affect those places and
2 populations.
3
4

5 **4.4.14.1.2 Accidents.** Up to 8 large spills greater than 1,000 bbl, between 35 and
6 70 spills between 50 and 1,000 bbl, and between 200 and 400 small spills less than 50 bbl could
7 occur in the GOM from the proposed action. It is reasonable to expect that most of these spills
8 will occur in deepwater areas located away from the coast, based on the established trend for oil
9 and gas activity to move into deep waters located for the most part at a substantial distance from
10 the coast. However, according to MMS (2002b), the probability of an offshore oil spill occurring
11 and impacting coastal populations is low. While the location of possible oil spills cannot be
12 determined and while low-income and minority populations reside in some areas of the coast, in
13 general the coasts are home to more affluent groups. Low-income and minority groups are not
14 more likely to bear more negative impacts than other groups.
15

16 Chemical and drilling-fluid spills may be associated with exploration, production, or
17 transportation activities that result from the proposed action. Low-income and minority
18 populations might be more sensitive to oil spills in coastal waters than is the general population
19 because of their dietary reliance on wild coastal resources, their reliance on these resources for
20 other subsistence purposes such as sharing and bartering, their limited flexibility in substituting
21 wild resources with those purchased, and their likelihood of participating in cleanup efforts and
22 other mitigating activities. With the exception of a catastrophic accidental event, such as that
23 which occurred following the DWH accident, the impacts of oil spills, vessel collisions, and
24 chemical/drilling fluid spills are not likely to be of sufficient duration to have adverse and
25 disproportionate long-term effects for low-income and minority communities in the analysis
26 area.
27

28 A CDE could have adverse and disproportionate effects for low-income and minority
29 communities in the analysis area. Many of the long-term impacts of the DWH accident on low-
30 income and minority communities are unknown. While economic impacts have been partially
31 mitigated by employers retaining employees for delayed maintenance or through the Gulf Coast
32 Claims Facility (GCCF) program's emergency funds, the physical and mental health effects on
33 both children and adults within these communities could potentially unfold for many years. As
34 studies of past oil spills have highlighted, different cultural groups can possess varying capacities
35 to cope with these types of events (Palinkas et al. 1992). Likewise, some low-income and/or
36 minority groups may be more reliant on natural resources and/or less equipped to substitute
37 contaminated or inaccessible natural resources with private market offerings. Because lower
38 income and/or minority communities may live near and be directly involved with spill cleanup
39 efforts, the vectors of exposure can be higher for them than for the general population, increasing
40 the potential risks of long-term health effects. To date, there have been no longitudinal
41 epidemiological studies of possible long-term health effects for oil spill cleanup workers.
42

43 **Catastrophic Discharge Event.** The PEIS analyzes a CDE that ranges in size from
44 0.9 to 7.2 million bbl (Table 4.4.2-2). Although the magnitude of impacts of a CDE would partly
45 depend on the location, size, and timing of the event, many of the long-term impacts of a CDE
46 on low-income and minority communities are unknown. A spill as large as that which occurred

1 following the DWH accident could have adverse and disproportionate effects for low-income
2 and minority communities in coastal and inland areas. Different cultural groups would likely
3 possess varying capacities to cope with catastrophic events, with some low-income and/or
4 minority groups more reliant on subsistence resources and/or less equipped to substitute
5 contaminated or inaccessible subsistence resources with those purchased in the marketplace.
6 Because lower income and/or minority communities may live near and be directly involved with
7 CDE cleanup efforts, the vectors of exposure can be higher for them than for the general
8 population, increasing the potential risks of long-term health effects.
9

10 **4.4.14.2 Alaska – Cook Inlet**

11
12
13
14 **4.4.14.2.1 Routine Operations.** Although only one pipeline landfall and no new pipe
15 yards or gas processing facilities would be built as a result of the Program, additional offshore
16 construction could include increased noise and traffic, air and water pollution, impacts on
17 residential property values, and land use changes. Much of the Alaska Native population resides
18 in the coastal areas of Alaska. New offshore infrastructure resulting from this program could be
19 located near areas where subsistence hunting occurs. The Program will result in levels of
20 infrastructure use and construction similar to that which has occurred in the south central Alaska
21 region during previous programs, and, in many of the same locations. These activities are not
22 expected to expose residents to notably higher risks than those that currently occur.
23

24 Any adverse environmental impacts on fish and mammal subsistence resources from
25 installation of infrastructure and routine operations of these facilities could have
26 disproportionately higher health or environmental impacts on Alaska Native populations,
27 particularly with regard to air quality impacts and impacts on animal species used for subsistence
28 purposes.
29

30 Air emissions from onshore facilities and helicopter and vessel traffic traversing coastal
31 areas will be highest in areas containing the greatest amounts of infrastructure. It is assumed that
32 the majority of the activity from the Program will occur in deep and ultra-deep waters, with
33 offshore air emissions greatest in the coastal areas with the greatest amounts of oil and gas
34 activity, and lesser amounts occurring elsewhere. The effects of the OCS program on air quality
35 have been analyzed in Section 4.4.4. This analysis concluded that routine operations associated
36 with the proposed 5-yr program would result in NO₂, SO₂, PM₁₀, and CO levels that are well
37 within the NAAQS. Coastal effects from offshore activities are expected to be small, based on
38 the established and increasing trend toward movement of oil and gas activities into deeper
39 waters.
40

41 Critical subsistence species that are most likely to be disturbed by noise-producing
42 activities include bowhead and beluga whales, seals, fish, caribou, and birds. Noise disturbance
43 would be associated with aircraft and vessel support of modifications to platform facilities,
44 installation of oil and gas pipelines from platforms to shore, and the expansion of shore facilities.
45 While OCS oil and gas activities are not expected to appreciably reduce any populations of
46 subsistence species, it is possible that disturbance caused by these activities could alter the local

1 availability of these resources to harvesters. These impacts would be considered short term and
2 localized, and would not rise to the level of significant adverse effects.
3
4

5 **4.4.14.2.2 Accidents.** One large spill greater than 1,000 bbl, between 1 and 3 spills
6 between 50 and 1,000 bbl, and up to 15 small spills less than 50 bbl could occur in the Cook Inlet
7 area from the proposed action. It is reasonable to expect that most of these spills will occur in
8 deepwater areas located away from the coast, based on the established trend for oil and gas
9 activity to move into deep waters located for the most part at a substantial distance from the
10 coast. The magnitude of impacts from such spills cannot be predicted, should they contact the
11 coast, and depends on their location, size, and timing. However, according to MMS (2002b), the
12 probability of an offshore oil spill occurring and impacting coastal populations is low. While the
13 location of possible oil spills cannot be determined and while low-income and minority
14 populations are resident in some areas of the coast, in general the coasts are home to more
15 affluent groups. Low-income and minority groups are not more likely to bear more negative
16 impacts than are other groups.
17

18 Subsistence activities of Alaska Native communities could be affected by accidental oil
19 spills, with the potential health effects of oil spill contamination on subsistence foods being the
20 main concern. After the 1989 *Exxon Valdez* spill, testing of subsistence foods for hydrocarbon
21 contamination between 1989 and 1994 revealed very low concentrations of petroleum
22 hydrocarbons in most subsistence foods, and the U.S. Food and Drug Administration concluded
23 that eating food with such low levels of hydrocarbons posed no significant risk to human health
24 (Hom et al. 1999). Human health risks can be reduced through timely warnings about spills,
25 forecasts about which areas may be affected, and even evacuating people and avoiding marine
26 and terrestrial foods that may be affected. Avoidance of shellfish, which accumulate
27 hydrocarbons, would be recommended, and Federal and State agencies with health care
28 responsibilities would have to sample the food sources and test for possible contamination.
29

30 Whether subsistence users will use potentially tainted foods would depend on the cultural
31 “confidence” in the purity of these foods. Based on surveys and findings in studies of the *Exxon*
32 *Valdez* spill, Natives in affected communities largely avoided subsistence foods as long as the oil
33 remained in the environment. Perceptions of food tainting and avoiding use lingered in Native
34 communities after the *Exxon Valdez* spill, even when agency testing maintained that
35 consumption posed no risk to human health (MMS 2006b).
36

37 The assessment and communication of the contamination risks of consuming subsistence
38 resources following an oil spill is a continuing challenge to health and natural resource
39 managers. After the *Exxon Valdez* spill, analytical testing and rigorous reporting procedures
40 failed to convince many subsistence consumers because test results were often inconsistent with
41 Native perceptions about environmental health. Any effective discussion of subsistence resource
42 contamination must understand the conflicting scientific paradigms of Western science and
43 traditional knowledge in addition to the vocabulary of the social sciences in reference to
44 observations throughout the collection, evaluation, and reporting processes. True restoration of
45 environmental damage, according to Picou and Gill (1996), “must include the re-establishment
46 of a social equilibrium between the bio-physical environment and the human community”

1 (Field et al. 1999; Nighswander and Peacock 1999; Fall et al. 1999). Since 1995, subsistence
2 restoration resulting from the *Exxon Valdez* oil spill has improved by taking a more
3 comprehensive approach by partnering with local communities and by linking scientific
4 methodologies with traditional knowledge (Fall et al. 1999; Fall and Utermohle 1999).

5
6 **Catastrophic Discharge Event.** The PEIS analyzes a CDE that ranges in size from 75 to
7 125 thousand bbl (Table 4.4.2-20). Although the magnitude of impacts of a CDE would partly
8 depend on the location, size, and timing of the event, many of the long-term impacts of a CDE
9 on low-income and minority communities are unknown. A spill as large as that which occurred
10 following the DWH accident could have adverse and disproportionate effects for low-income
11 and minority communities in coastal and inland areas. Different cultural groups would likely
12 possess varying capacities to cope with catastrophic events, with some low-income and/or
13 minority groups more reliant on subsistence resources and/or less equipped to substitute
14 contaminated or inaccessible subsistence resources with those purchased in the marketplace.
15 Because lower income and/or minority communities may live near and be directly involved with
16 catastrophic discharge event cleanup efforts, the vectors of exposure can be higher for them than
17 for the general population, increasing the potential risks of long-term health effects.

18 19 20 **4.4.14.3 Alaska – Arctic**

21
22
23 **4.4.14.3.1 Routine Operations.** Although only one pipeline landfall and no new pipe
24 yards or gas processing facilities would be built as a result of the Program, additional offshore
25 construction could include increased noise and traffic, air and water pollution, impacts on
26 residential property values, and land use changes. Much of the Alaska Native population resides
27 in the coastal areas of Alaska. Any new onshore and offshore infrastructure resulting from this
28 program could be located near these populations or near areas where subsistence hunting occurs.
29 The Program will result in levels of infrastructure use and construction similar to what has
30 occurred in the Arctic region during previous programs. These activities are not expected to
31 expose residents to notably higher risks than currently occur.

32
33 Air emissions from onshore facilities and helicopter and vessel traffic traversing coastal
34 areas will be highest in the areas containing the greatest amount of infrastructure. It is assumed
35 that the majority of the activity from the Program will occur in deep and ultra-deep waters, with
36 offshore air emissions greatest in the coastal areas with the greatest amounts of oil and gas
37 activity, and lesser amounts in occurring elsewhere. The effects of the OCS program on air
38 quality have been analyzed in Section 4.4.4. This analysis concluded that routine operations
39 associated with the Program would result in NO₂, SO₂, PM₁₀, and CO levels that are well within
40 the NAAQS.

41
42 Any adverse environmental impacts on fish and mammal subsistence resources from
43 installation of infrastructure and routine operations of these facilities could have
44 disproportionately higher health or environmental impacts on Alaska Native populations,
45 particularly with regard to air quality impacts and impacts on animal species used for subsistence
46 purposes.

1 The NSB Municipal Code defines subsistence as “an activity performed in support of the
2 basic beliefs and nutritional needs of the residents of the borough and includes hunting, whaling,
3 fishing, trapping, camping, food gathering, and other traditional and cultural activities”
4 (ADNR 1997). While this is, at best, a partial view of the significance of these activities to the
5 Iñupiat (and more generally to Alaskan Natives) as individuals, culturally it stresses subsistence
6 as a primary cultural and nutritional set of activities upon which Alaskan Natives depend.
7

8 Critical subsistence species that are most likely to be disturbed by noise-producing
9 activities include bowhead and beluga whales, seals, fish, caribou, and birds. Noise disturbance
10 would be associated with aircraft and vessel support of modifications to platform facilities,
11 installation of oil and gas pipelines from platforms to shore, and the expansion of shore facilities.
12 While natural gas development and production are not expected to appreciably reduce any
13 populations of subsistence species, it is possible that disturbance caused by these activities could
14 alter the local availability of these resources to harvesters. These impacts would be considered
15 short term and localized, and would not rise to the level of significant adverse effects.
16
17

18 **4.4.14.3.2 Accidents.** Up to 3 large spills greater than 1,000 bbl, between 10 and
19 35 spills between 50 and 1,000 bbl, and up to 190 small spills of less than 50 bbl could occur in
20 the Beaufort and Chukchi Sea area from the proposed action. The magnitude of impacts from
21 such spills cannot be predicted, should they contact the coast, and depends on their location, size,
22 and timing. However, according to MMS (2002b), the probability of an offshore oil spill
23 occurring and impacting coastal populations is low. While the location of possible oil spills
24 cannot be determined, and while low-income and minority populations are resident in some areas
25 of the coast, low-income and minority groups are not more likely to bear more negative impacts
26 than are other groups.
27

28 Subsistence activities of Native communities could be affected by accidental oil spills,
29 with the potential health effects of oil spill contamination of subsistence foods being the main
30 concern. After the 1989 *Exxon Valdez* spill, testing of subsistence foods for hydrocarbon
31 contamination between 1989 and 1994 revealed very low concentrations of petroleum
32 hydrocarbons in most subsistence foods, and the U.S. Food and Drug Administration concluded
33 that eating food with such low levels of hydrocarbons posed no significant risk to human health
34 (Hom et al. 1999). Human health risks can be reduced through timely warnings about spills,
35 forecasts about which areas may be affected, and even evacuating people and avoiding marine
36 and terrestrial foods that may be affected. Avoidance of shellfish, which accumulate
37 hydrocarbons, would be recommended, and Federal and State agencies with health care
38 responsibilities would have to sample the food sources and test for possible contamination.
39

40 Whether subsistence users will use potentially tainted foods would depend on the cultural
41 “confidence” in the purity of these foods. Based on surveys and findings in studies of the *Exxon*
42 *Valdez* spill, Natives in affected communities largely avoided subsistence foods as long as the oil
43 remained in the environment. Perceptions of food tainting and avoiding use lingered in Native
44 communities after the *Exxon Valdez* spill, even when agency testing maintained that
45 consumption posed no risk to human health (MMS 2006b).
46

1 The assessment and communication of the contamination risks of consuming subsistence
2 resources following an oil spill is a continuing challenge to health and natural resource
3 managers. After the *Exxon Valdez* spill, analytical testing and rigorous reporting procedures
4 failed to convince many subsistence consumers, because test results were often inconsistent with
5 Native perceptions about environmental health. Any effective discussion of subsistence resource
6 contamination must understand the conflicting scientific paradigms of Western science and
7 traditional knowledge in addition to the vocabulary of the social sciences in reference to
8 observations throughout the collection, evaluation, and reporting processes. True restoration of
9 environmental damage, according to Picou and Gill (1996), “must include the re-establishment
10 of a social equilibrium between the bio-physical environment and the human community”
11 (Field et al. 1999; Nighswander and Peacock 1999; Fall et al. 1999). Since 1995, subsistence
12 restoration resulting from the *Exxon Valdez* oil spill has improved by taking a more
13 comprehensive approach by partnering with local communities and by linking scientific
14 methodologies with traditional knowledge (Fall et al. 1999; Fall and Utermohle 1999).

15
16 **Catastrophic Discharge Event.** The PEIS analyzes a CDE that ranges from 1.4 to
17 2.2 million bbl in the Chukchi Sea Planning Area and from 1.7 to 3.9 million bbl in the Beaufort
18 Sea Planning Area (Table 4.4.2-2). Although the magnitude of impacts of a CDE would partly
19 depend on the location, size, and timing of the event, many of the long-term impacts of a CDE
20 on low-income and minority communities are unknown. A spill as large as that which occurred
21 following the DWH accident could have adverse and disproportionate effects for low-income
22 and minority communities in coastal and inland areas. Different cultural groups would likely
23 possess varying capacities to cope with catastrophic events, with some low-income and/or
24 minority groups more reliant on subsistence resources and/or less equipped to substitute
25 contaminated or inaccessible subsistence resources with those purchased in the marketplace.
26 Because lower income and/or minority communities may live near and be directly involved with
27 catastrophic discharge event cleanup efforts, the vectors of exposure can be higher for them than
28 for the general population, increasing the potential risks of long-term health effects.

31 **4.4.14.4 Conclusion**

32
33 The Program would result in levels of infrastructure use and construction similar to those
34 that have already occurred along the GOM coast during previous programs. Routine Program
35 operations are not expected to expose residents to notably higher risks than currently occur.
36 While the distribution of offshore Program activities and infrastructure indicates that some places
37 and populations in the GOM region will continue to be of environmental justice concern, the
38 incremental contribution of the Program is not expected to affect those places and populations.
39 Air emissions from the proposed program are not expected to result in air quality impacts on
40 minority or low-income populations, with emissions from the proposed program not being
41 expected to exceed the NAAQS in any affected area. Impacts to environmental justice from
42 routine Program activities in the GOM Planning Areas are expected to be negligible. No
43 environmental justice impacts from accidental oil spills are expected in the GOM because of the
44 movement of oil and gas activities farther away from coastal areas and the demographic pattern
45 of more affluent groups living in coastal areas.

1 In Alaska, much of the Alaska Native population resides in the coastal areas. Any new
2 onshore and offshore infrastructure occurring under the Program could be located near these
3 populations or near areas where subsistence hunting occurs. Any adverse environmental impacts
4 on fish and mammal subsistence resources from Program infrastructure and routine operations
5 could result in health or environmental justice impacts on Alaska Native populations although
6 impacts are expected to be minor. A large oil spill, and especially a CDE-level spill, that
7 contacts subsistence resources could also have disproportionately high impacts on the Alaska
8 Native population, particularly if the subsistence resources were diminished or tainted as a result
9 of the spill. In the event of a CDE, long-term impacts to subsistence resources may be expected,
10 and these may lead to longer and greater environmental justice impacts. Mitigation measures,
11 cooperative agreements between Native and industry groups, and government-to-government
12 consultations are designed to limit the effects from oil spills and routine operations.
13
14

15 **4.4.15 Potential Impacts to Archeological and Historic Resources**

16 **4.4.15.1 Gulf of Mexico**

17
18
19
20 Archaeological resources in the GOM region that may be impacted by the proposed
21 action include historic shipwrecks and inundated prehistoric sites offshore as well as historic and
22 prehistoric sites onshore. Historic shipwrecks tend to concentrate in the shallow, nearshore
23 waters of the GOM (CEI 1977; Garrison et al. 1989; Pearson et al. 2003); however, numerous
24 recent discoveries of well-preserved historic shipwrecks in deepwater areas of the GOM have
25 increased understanding of shipwreck potential on the OCS (Atauz et al. 2006; Church and
26 Warren 2008; Church et al. 2004; Ford et al. 2008). BOEM has expanded its archaeological
27 survey requirements to ensure the detection of these deepwater shipwrecks prior to approving
28 bottom-disturbing activities in areas where it has reason to believe that archaeological resources
29 might exist. Inundated prehistoric sites may exist on the continental shelf shoreward of about the
30 50-m (164-ft) isobath. The depth may increase as our understanding of the timing for the
31 peopling of North America is pushed ever earlier.
32

33 Onshore historic properties include sites, structures, and objects such as historic
34 buildings, forts, lighthouses, homesteads, cemeteries, and battlefields. Onshore prehistoric
35 archaeological resources include sites, structures, and objects such as shell middens, earth
36 middens, campsites, kill sites, tool manufacturing areas, ceremonial complexes, and earthworks.
37 Adverse effects on historic properties require mitigation. The appropriate mitigation would be
38 developed through consultation among BOEM, the appropriate SHPO, and any Native American
39 tribes who have an interest in the resources.
40

41 All archaeological sites identified through surveys conducted for BOEM permitting
42 activities require avoidance or evaluation for listing on the NRHP. Only archaeological and
43 historic resources that are determined eligible for listing on the NRHP require consideration
44 during Federal undertakings (36 CFR Part 800).
45
46

1 **4.4.15.1.1 Routine Operations.** Routine operations associated with offshore oil and gas
2 fall into four stages: exploration, development, operations, and decontamination and
3 decommissioning. Impacts can occur on archaeological and historic resources during any stage
4 but would be most likely during the exploration and development stages when the seafloor is
5 first altered by an activity. It is assumed that operations and decontamination and
6 decommissioning would affect seafloor that had been previously altered by the earlier activities.
7 The potential for impacting a cultural resource is dependent upon the specific activity and
8 whether a cultural resource is present within the area of potential effect for that activity.
9

10 Routine activities associated with exploration and development that are likely to affect
11 archaeological and historic resources include drilling wells, platform installation, and pipeline
12 installation and anchoring, as well as onshore facility and pipeline construction projects. While
13 the source of potential impacts will vary with the specific location and nature of the routine
14 operation, the goal of archaeological resource management remains the protection and/or
15 retrieval of unique information contained in intact archaeological deposits.
16

17 Direct impacts occur when permitted activities physically alter significant archaeological
18 or historic resources. The result of direct impacts on shipwrecks would be the loss of
19 archaeological data on ship construction, cargo, and the social organization of the vessel's crew,
20 as well as loss of information on maritime cultures for the time period from which the ship dates.
21 Other indirect impacts can result from the visual intrusion resulting from oil and gas
22 development on the OCS and its effect on onshore historic properties. An indirect effect of oil
23 and gas development on archaeological and historic resources is that metal debris from a
24 permitted activity could settle near a shipwreck and could mask magnetic signatures of
25 significant historic archaeological resources, making them more difficult to detect with
26 magnetometers. Direct impacts from a routine activity on a prehistoric archaeological site could
27 include destruction of artifacts or site features, as well as disturbance of the stratigraphic context
28 of the site. This would result in the loss of archaeological data on prehistoric migrations,
29 settlement patterns, subsistence strategies, and archaeological contacts for North America,
30 Central America, South America, and the Caribbean.
31

32 Regulations in 30 CFR 250.194 allow the BOEM Regional Director to require that an
33 archaeological report based on geophysical data be prepared, if there are indications that a
34 significant archaeological resource may exist within a lease area. For historic resources, this
35 decision can be based on whether a lease block falls within an area assessed as having a high
36 potential for shipwreck occurrence, such as the entrances to historic ports and harbors, or on the
37 Regional Director's determination that a survey is warranted. For prehistoric resources, a survey
38 is required if there is the potential for landforms to be present that could contain prehistoric
39 material. If the survey finds evidence of a possible archaeological resource within the lease area,
40 the lessee must either move the proposed activity to avoid the possible resource or conduct
41 further investigations to determine whether an archaeological resource actually exists at the
42 location. If an archaeological resource is present at the location of proposed activity and cannot
43 be avoided, BOEM procedures require consultation with the State Historic Preservation Office to
44 develop mitigating measures prior to any exploration or development.
45

1 BOEM has used predictive models based on various parameters to determine when and
2 where archaeological surveys should be required. Studies conducted between 2006 and 2008
3 suggest that the models used in the past are not adequate (Church and Warren 2008;
4 Ford et al. 2008; Atauz et al. 2006). These studies document significant effects on shipwrecks
5 resulting from routine activities that occurred in areas where wrecks were not anticipated. As a
6 result of these discoveries, BOEM may require surveys in all areas outside those already
7 identified as having the potential for archaeology that could be affected by a project.
8

9 Federal, State, and local laws and ordinances, including the National Historic
10 Preservation Act provide a process to facilitate the consideration of known sites and as-yet-
11 unidentified archaeological resources in the planning phases of a proposed project. Where there
12 is reason to believe that an archaeological resource might exist in a lease area, regulations require
13 archaeological surveys to be conducted prior to permitting any activity that might disturb a
14 significant archaeological site. When required, these archaeological surveys have been found to
15 be effective in locating most archaeological resources prior to any construction on the OCS;
16 however, even with surveys, there is the potential that a shipwreck or an inundated terrestrial site
17 could be missed due to sedimentation on the wreck or other factors, resulting in a routine activity
18 contacting a shipwreck or site. Such an event could result in the disturbance or destruction of
19 unique or significant historic archaeological information.
20

21
22 **4.4.15.1.2 Accidents.** Impacts on archaeological and historical resources from an
23 accidental oil spill can result from either direct contact of crude oil with archaeological material
24 or from effects caused by cleanup workers and their equipment (i.e., anchor drags, dredging of
25 contaminated soils, or unauthorized collecting by cleanup workers). The following are
26 discussions of the potential effects from an accidental oil spill on various resource types based on
27 location and water depth.
28

29 Shipwrecks in shallow waters and coastal historic and prehistoric archeological sites
30 could be impacted by an accidental oil spill. Archaeological resource protection during an oil
31 spill requires specific knowledge of the resource's location, condition, nature, and extent prior to
32 impact; however, the GOM coastline has not been systematically surveyed for archaeological
33 sites. Existing information indicates that, in coastal areas of the GOM, prehistoric sites occur
34 frequently along the barrier islands and mainland coast and the margins of bays and bayous.
35 Thus, any spill that contacted the land would involve a potential impact on a prehistoric site.
36

37 Shipwrecks can be affected by contact with crude oil. Shallow water shipwrecks often
38 serve as artificial reefs when they are covered by corals and other organisms. The organisms that
39 attach to the wreck protect the wood from deterioration. An oil spill could destabilize a balanced
40 ecosystem covering the wreck, thus potentially increasing deterioration of the wreck until the
41 wreck comes into equilibrium with its new environment. Some terrestrial studies have suggested
42 that, while oil contamination of wood initially restricts deterioration, it can later increase
43 deterioration (Ejechi 2003). It is not known how this situation would be altered in a marine
44 environment. It is also not known whether dispersants used to break up concentrations of oil
45 have any effect on shipwrecks or the vegetation that forms on the wrecks (BOEMRE 2011a).
46

1 Should an oil spill contact a coastal historic site, such as a fort or a lighthouse, the major
2 impact would be visual due to oil contamination of the site and its environment. Any effects
3 from contact with oil to historic materials could be mitigated through cleaning of the historic
4 material. The visual impact would most likely be temporary, lasting up to several weeks
5 depending on the time required for cleanup. Gross crude oil contamination of shorelines is a
6 potential direct impact that may affect archaeological site recognition. Heavy oiling conditions
7 (Whitney 1994) could conceal intertidal sites that may not be recognized until they are
8 inadvertently damaged during cleanup. Crude oil may also contaminate organic material used in
9 ¹⁴C dating, and, although there are methods for cleaning contaminated ¹⁴C samples, greater
10 expense is incurred (Dekin et al. 1993). An Alaskan study examining the effects of the 1989
11 *Exxon Valdez* oil spill on archaeological deposits revealed that oil in the intertidal zone had not
12 penetrated the subsoil, apparently due to hydrostatic pressure (Dekin et al. 1993); however,
13 because of the different environments, these results should not be translated into the GOM
14 coastal environment without further study.

15
16 **Spill Response and Cleanup.** Cleanup activities have the potential to alter
17 archaeological sites and shipwrecks. Inadvertent damage from anchors can greatly impact
18 archaeological sites and shipwrecks (Church and Warren 2008). The potential amount of
19 damage depends on several factors including the presence and density of shipwrecks and
20 archaeological material in the area of activity, the number of vessels being employed in the
21 cleanup activities, and whether offshore decontamination stations were needed and where these
22 facilities were established. These types of impacts could be avoided or minimized if wreck
23 locations are known. In 2007, 2,100 shipwrecks were reported to have been lost in the GOM;
24 however, specific location information is known for only 233 of these wrecks
25 (BOEMRE 2011a). This issue makes avoiding wrecks difficult.

26
27 Another source of potential impact from oil spills is the harm that could result from
28 unmonitored shoreline cleanup activities. Unmonitored booming, cleanup activities involving
29 vehicle and foot traffic, mechanized cleanup involving heavy equipment, and high-pressure
30 washing on or near archaeological sites pose risks to the resources. Unauthorized collecting of
31 artifacts by cleanup crew members is also a concern, albeit one that can be mitigated with
32 effective training and supervision. As Bittner (1996) described in her summary of the *Exxon*
33 *Valdez* oil spill, “Damage assessment revealed no contamination of the sites by oil, but
34 considerable damage resulted from vandalism associated with cleanup activities and lesser
35 amounts were caused by the cleanup process itself.”

36
37 The National Response Team’s *Programmatic Agreement on Protection of Historic*
38 *Properties during Emergency Response under the National Oil and Hazardous Substances*
39 *Pollution Contingency Plan* clarifies interagency and regulatory aspects of archaeological site
40 protection during oil spill response. The agreement was followed during the DWH event and it
41 is assumed that the agreement was effective; however, no reports on the utility of the agreement
42 for that event are currently available.

43
44 **Catastrophic Discharge Event.** The PEIS analyzes a CDE that ranges in size from
45 0.9 to 7.2 million bbl (Table 4.4.2-2). A CDE could result in extensive impacts on a large
46 number of archaeological and historic resources. Due to the large area affected by a catastrophic

1 event, some resources such as coastal historic sites that are sensitive to prolonged contact with
2 oil could be more heavily impacted. Cleanup crews would be needed in a greater number of
3 locations. This could allow oil to be in contact with resources for a significant amount of time
4 before cleanup efforts could be applied, which could result in impacts to these resources. A
5 greater threat to archaeological and historic resources during a catastrophic discharge event
6 would result from the larger number of response crews being employed. Historically most
7 impacts to archaeological and historic resources during a spill response were the result of
8 vandalism or physical damage from spill response activities (Bittner 1996). A catastrophic
9 discharge event would result in major impacts to numerous archaeological and historic resources
10 from response activities.

11
12 *The Programmatic Agreement on Protection of Historic Properties during Emergency*
13 *Response under the National Oil and Hazardous Substances Pollution Contingency Plan* would
14 be followed during the response to a CDE. As mentioned above, it is assumed that the process
15 identified in the agreement would be effective; however, no assessments of the agreement's
16 application during the DWH event are available.

17 18 19 **4.4.15.2 Alaska – Cook Inlet**

20
21 Archaeological and historic resources in the Alaska region include historic shipwrecks,
22 submerged aircraft, inundated prehistoric sites offshore, and historic and prehistoric sites
23 onshore. These resources have the potential to be affected by the proposed action. The locations
24 of most of the cultural resources in Cook Inlet are currently unknown, but if any are discovered
25 during OCS oil and gas activities, they would be subject to archaeological surveys, and other
26 activities and mitigations required by applicable laws and BOEM policies. There is currently no
27 archaeological baseline study for Alaska on which to base decisions concerning where cultural
28 resources should be present. An archaeological baseline study was done for Alaska in the mid-
29 1980s (Dixon et al. 1986); however, this research was never updated and should be assessed for
30 its validity when compared with current research and scientific findings. Some research
31 attempting to identify landforms that may contain archaeological remains has been done in the
32 Beaufort and Chukchi Seas, but no new studies have been conducted in Cook Inlet. Research on
33 historic shipwrecks has identified 108 shipwrecks in Cook Inlet (Tornfelt and Burwell 1992). As
34 discussed in Section 3.16.2, portions of Cook Inlet are subject to high-energy tidal movements
35 (MMS 2003a). This high-energy environment may have destroyed some of the archaeological
36 evidence that once existed in Cook Inlet, but this can only be verified through science-based
37 methods of inquiry.

38
39
40 **4.4.15.2.1 Routine Operations.** Routine activities associated with the proposed action
41 that could affect cultural resources include well drilling, platform installation, pipeline
42 installation, and onshore facility and pipeline construction projects that involve ground
43 disturbance. Effects on cultural resources can be determined only on a case-by-case basis. Only
44 through project-specific surveys can cultural resources be identified. The determination that a
45 survey is required depends on several factors including the potential for landforms to exist that

1 may contain archaeological sites (i.e., submerged coastlines) or archival records suggesting that
2 shipwrecks could be present.
3

4 As previously discussed, regulations at 30 CFR 250.194 allow the BOEM Regional
5 Director to require that an archaeological report based on geophysical data be prepared, if there
6 are indications that a significant archaeological resource may exist within a lease area. For
7 historic resources, this decision is based on whether a historic shipwreck is reported to exist
8 within or adjacent to a lease area. For prehistoric resources, an analysis is completed prior to
9 each lease sale to consider the relative sea level history, the depth of burial of the late
10 Wisconsinan land surface (i.e., lands that could contain archaeological sites), the type and
11 thickness of sediments burying the old land surface, and the severity of ice gouging at the present
12 seafloor. Lease areas that are shown by this analysis to have the potential for prehistoric
13 archaeological resources are required to have an archaeological survey prior to initiating
14 exploration and development activities. If the survey finds evidence of a possible archaeological
15 resource within the lease area, the lessee must either move the proposed activity to avoid the
16 possible resource or conduct further investigations to determine whether an archaeological
17 resource actually exists at the location. If an archaeological resource is present at the location of
18 proposed activity and cannot be avoided, BOEM procedures require consultation with the State
19 Historic Preservation Office to develop mitigation measures prior to any exploration or
20 development.
21

22 Federal, State, and local laws and ordinances, including the National Historic
23 Preservation Act and the Alaska Historic Preservation Act, provide a process to facilitate the
24 consideration of known sites and as-yet-unidentified archaeological resources both onshore and
25 offshore. Where there is reason to believe that an archaeological resource might exist in a lease
26 area, regulations require archaeological surveys to be conducted prior to permitting any activity
27 that might disturb a significant archaeological site. When required, these surveys have been
28 found to be effective in locating most archaeological resources prior to any construction or
29 offshore bottom-disturbing activity on the OCS. However, even with surveys there is the
30 potential that a shipwreck or an inundated terrestrial site could be missed due to sedimentation
31 on the wreck or other factors, resulting in a routine activity contacting a shipwreck or site. Such
32 an event could result in the disturbance or destruction of unique or significant historic
33 archaeological information. However, regulations in 30 CFR 250.194(c) require that if any
34 archaeological resource is discovered, operations must be immediately halted in the area of the
35 discovery and a report of the discovery must be made so that further investigation may determine
36 the significance of the resource.
37
38

39 **4.4.15.2.2 Accidents.** Oil spills and their subsequent cleanup could impact the
40 archaeological resources of the Alaska region directly and/or indirectly. The geologic history of
41 specific shorelines generally affects the presence or absence, condition, and age of
42 archaeological sites on or near Alaska region shorelines. However, some types of archaeological
43 resources are present on or adjacent to nearly all Alaska region shorelines. Existing data indicate
44 that archaeological resources are particularly abundant along Gulf of Alaska shorelines
45 (Mobley et al. 1990).
46

1 Archaeological resource protection during an oil spill requires specific knowledge of the
2 resource's location, condition, nature, and extent prior to impact. However, large portions of the
3 Cook Inlet coastline have not been systematically surveyed for archaeological sites. While some
4 response groups have compiled known archaeological site data in a form useful for mitigation
5 during an emergency response (Wooley et al. 1997), these data have not been compiled for all
6 areas of the Alaska region.

7
8 Gross crude oil contamination of shorelines is a potential direct impact that may affect
9 archaeological site recognition. Heavy oiling conditions (Whitney 1994) could conceal intertidal
10 sites that may not be recognized until they are inadvertently damaged during cleanup. Crude oil
11 may also contaminate organic material used in ^{14}C dating, and, although there are methods for
12 cleaning contaminated ^{14}C samples, greater expense is incurred (Dekin et al. 1993). However,
13 many other anthropogenic sources of hydrocarbons and other possible contaminants also exist,
14 so caution should always be taken when analyzing radiocarbon samples from coastal Alaska
15 (see Reger et al. 1992). A study examining the effects of the 1989 *Exxon Valdez* oil spill on
16 archaeological deposits revealed that oil in the intertidal zone had not penetrated the subsoil,
17 apparently due to hydrostatic pressure (Dekin et al. 1993).

18
19 **Spill Response and Cleanup.** The major source of potential impact from oil spills
20 resulting from the proposed action is the harm that could result from unmonitored shoreline
21 cleanup activities. Cleanup activities could impact beached shipwrecks, or shipwrecks in
22 shallow waters, as well as coastal historic and prehistoric archaeological sites. Unmonitored
23 booming, cleanup activities involving vehicle and foot traffic, mechanized cleanup involving
24 heavy equipment, and high-pressure washing on or near archaeological sites pose risks to the
25 resources. Inadvertent damage from anchors can greatly alter archaeological sites and
26 shipwrecks (Church and Warren 2008). The potential amount of damage depends on several
27 factors including the presence and density of shipwrecks and archaeological material in the area
28 of activity, the number of vessels being employed in the cleanup activities, and whether offshore
29 decontamination stations were needed and where these facilities were established. These types
30 of impacts could be avoided or minimized if wreck locations are known. Unauthorized
31 collecting of artifacts by cleanup crew members is also a concern, albeit one that can be
32 mitigated with effective training and supervision. As Bittner (1996) described in her summary of
33 the 1989 *Exxon Valdez* oil spill, "Damage assessment revealed no contamination of the sites by
34 oil, but considerable damage resulted from vandalism associated with cleanup activities, and
35 lesser amounts were caused by the cleanup process itself."

36
37 The National Response Team's *Programmatic Agreement on Protection of Historic*
38 *Properties during Emergency Response under the National Oil and Hazardous Substances*
39 *Pollution Contingency Plan* clarifies interagency and regulatory aspects of archaeological site
40 protection during oil spill response. The agreement also outlines the Federal On-Scene
41 Coordinator's role in protecting archaeological resources, the type of expertise needed for site
42 protection, and the appropriate process for identifying and protecting archaeological sites during
43 an emergency response. The agreement was followed during the DWH event, and it is assumed
44 that the agreement was effective; however, no reports on the utility of the agreement for that
45 event are currently available.

1 **Catastrophic Discharge Event.** The PEIS analyzes a CDE that ranges from 75 to
2 125 thousand bbl (Table 4.4.2-2). A CDE could result in extensive impacts on a large number of
3 archaeological and historic resources. Due to the large area affected by a catastrophic event
4 some resources such as coastal historic sites that are sensitive to prolonged contact with oil could
5 be more heavily impacted. Cleanup crews would be needed in a greater number of locations.
6 This could allow oil to be in contact with resources for a significant amount of time before
7 cleanup efforts could be applied, which could result in impacts to these resources. A greater
8 threat to archaeological and historic resources during a catastrophic discharge event would result
9 from the larger number of response crews being employed. Historically most impacts to
10 archaeological and historic resources during a spill response were the result of vandalism or
11 physical damage from spill response activities (Bittner 1996). A catastrophic discharge event
12 would result in major impacts to numerous archaeological and historic resources from response
13 activities.

14
15 The *Programmatic Agreement on Protection of Historic Properties during Emergency*
16 *Response under the National Oil and Hazardous Substances Pollution Contingency Plan* would
17 be followed during the response to a CDE. As mentioned above, it is assumed that the process
18 identified in the agreement would be effective; however, no assessments of the agreement's
19 application during the DWH event are available.

20 21 22 **4.4.15.3 Alaska – Arctic**

23
24 Archaeological and historic resources in the Alaska region include historic shipwrecks,
25 submerged aircraft, inundated prehistoric sites offshore, and historic and prehistoric sites
26 onshore. These resources have the potential to be affected by the proposed action. Several
27 factors must be considered when assessing any potential impacts on offshore resources in
28 Alaska. First, the locations of most of the cultural resources in the Arctic are currently unknown;
29 this is especially true of submerged cultural resources. If any are discovered during OCS oil and
30 gas activities, they would be subject to archaeological surveys and other activities and
31 mitigations required by applicable laws and BOEM policies. The goal of much of the
32 archaeological research being done in the Arctic is to identify locations and landforms that have
33 the potential to contain archaeological and historic resources. The focus on submerged
34 prehistoric resources in Alaska is due to the theory that North America was first populated by
35 nomadic hunters following game across the submerged land mass known as Beringia that once
36 linked Asia with North America (Hoffecker and Elias 2003). A second factor is that, unlike the
37 GOM region, there is no current archaeological baseline study for Alaska on which to base
38 decisions concerning where cultural resources should be present. A third factor is that sea levels
39 have risen over the last 13,000 years. Human activity tends to concentrate on coasts. Regions
40 that were once coastal are now submerged. The coastline that existed 13,000 years ago is now
41 found at roughly the 50-m (164-ft) bathymetry line (Darigo et al. 2007). It is thought that people
42 first came to North America approximately 13,000 years ago. A fourth factor is that natural
43 processes such as ice gouging may have modified much of the ocean bottom to the extent that
44 many cultural resources no longer exist. Studies conducted in 2007 suggest some nearshore
45 locations may remain intact due to shorefast ice, which kept the ice which normally would scrape

1 the sea floor away from the coast. Other factors such as the amount of sediment that has
2 collected on a location may improve the potential for some resources to remain intact.
3
4

5 **4.4.15.3.1 Routine Operations.** Routine activities associated with the proposal that
6 could affect cultural resources include well drilling, platform installation, pipeline installation,
7 and onshore facility and pipeline construction projects that involve ground disturbance. Effects
8 on cultural resources can be determined only on a case-by-case basis. Only through project-
9 specific surveys can cultural resources be identified. The determination that a survey is required
10 depends on several factors, including the potential for landforms to exist that may contain
11 archaeological sites (i.e., submerged coastlines) or archival records suggesting that shipwrecks
12 could be present.
13

14 Regulations at 30 CFR 250.194 allow the BOEM Regional Director to require that an
15 archaeological report based on geophysical data be prepared if there are indications that a
16 significant archaeological resource may exist within a lease area. For historic resources, this
17 decision is based on whether an historic shipwreck is reported to exist within or adjacent to a
18 lease area. For prehistoric resources, an analysis is completed prior to each lease sale to consider
19 the relative sea level history, the depth of burial of the late Wisconsinan land surface (i.e., lands
20 that could contain archaeological sites), the type and thickness of sediments burying the old land
21 surface, and the severity of ice gouging at the present seafloor. Lease areas that are shown by
22 this analysis to have the potential for prehistoric archaeological resources are required to have an
23 archaeological survey prior to initiating exploration and development activities. If the survey
24 finds evidence of a possible archaeological resource within the lease area, the lessee must either
25 move the proposed activity to avoid the possible resource or conduct further investigations to
26 determine whether an archaeological resource actually exists at the location. If an archaeological
27 resource is present at the location of proposed activity and cannot be avoided, BOEM procedures
28 require consultation with the State Historic Preservation Office to develop mitigation measures
29 prior to any exploration or development.
30

31 Federal, State, and local laws and ordinances, including the National Historic
32 Preservation Act and the Alaska Historic Preservation Act provide a process to facilitate the
33 consideration of known sites and as-yet-unidentified archaeological resources both onshore and
34 offshore. Where there is reason to believe that an archaeological resource might exist in a lease
35 area, existing regulations require archaeological surveys to be conducted prior to permitting any
36 activity that might disturb a significant archaeological site. When required, these archaeological
37 surveys have been found to be effective in locating most archaeological resources prior to any
38 onshore construction project or offshore bottom-disturbing activity; however, even with surveys
39 there is the potential that a shipwreck or an inundated terrestrial site could be missed due to
40 sedimentation on the wreck or other factors, resulting in a routine activity contacting a shipwreck
41 or site. Such an event could result in the disturbance or destruction of unique or significant
42 historic archaeological information.
43
44

45 **4.4.15.3.2 Accidents.** Oil spills and their subsequent cleanup could impact the
46 archaeological resources of the Alaska region directly and/or indirectly. The geologic history of

1 specific shorelines generally affects the presence or absence, condition, and age of
2 archaeological sites on or near Alaska region shorelines; however, some type of archaeological
3 resource is present on or adjacent to nearly all Alaska region shorelines. Existing data indicate
4 that archaeological resources are particularly abundant along Gulf of Alaska shorelines
5 (Mobley et al. 1990).
6

7 Archaeological resource protection during an oil spill requires specific knowledge of the
8 resource's location, condition, nature, and extent prior to impact; however, large portions of the
9 Alaska region coastline have not been systematically surveyed for archaeological sites. While
10 some response groups have compiled known archaeological site data in a form useful for
11 mitigation during an emergency response (Wooley et al. 1997), these data have not been
12 compiled for all areas of the Alaska region.
13

14 Gross crude oil contamination of shorelines is a potential direct impact that may affect
15 archaeological site recognition. Heavy oiling conditions (Whitney 1994) could conceal intertidal
16 sites that may not be recognized until they are inadvertently damaged during cleanup. Crude oil
17 may also contaminate organic material used in ^{14}C dating, and, although there are methods for
18 cleaning contaminated ^{14}C samples, greater expense is incurred (Dekin et al. 1993). Many other
19 anthropogenic sources of hydrocarbons and other possible contaminants also exist, so caution
20 should always be taken when analyzing radiocarbon samples from coastal Alaska
21 (see Reger et al. 1992). A study examining the effects of the 1989 *Exxon Valdez* oil spill on
22 archaeological deposits revealed that oil in the intertidal zone had not penetrated the subsoil,
23 apparently due to hydrostatic pressure (Dekin et al. 1993).
24

25 **Spill Response and Cleanup.** The major source of potential impact from oil spills
26 resulting from the proposed action is the harm that could result from unmonitored shoreline
27 cleanup activities. Cleanup activities could impact beached shipwrecks, or shipwrecks in
28 shallow waters, as well as coastal historic and prehistoric archaeological sites. Unmonitored
29 booming, cleanup activities involving vehicle and foot traffic, mechanized cleanup involving
30 heavy equipment, and high-pressure washing on or near archaeological sites pose risks to the
31 resource. Inadvertent damage from anchors can greatly alter archaeological sites and shipwrecks
32 (Church and Warren 2008). The potential amount of damage depends on several factors,
33 including the presence and density of shipwrecks and archaeological material in the area of
34 activity, the number of vessels being employed in the cleanup activities, and whether offshore
35 decontamination stations were needed and where these facilities were established. These types
36 of impacts could be avoided or minimized if wreck locations are known. Unauthorized
37 collecting of artifacts by cleanup crew members is also a concern, albeit one that can be
38 mitigated with effective training and supervision. As Bittner (1996) described in her summary of
39 the 1989 *Exxon Valdez* oil spill, "Damage assessment revealed no contamination of the sites by
40 oil, but considerable damage resulted from vandalism associated with cleanup activities, and
41 lesser amounts were caused by the cleanup process itself."
42

43 The National Response Team's *Programmatic Agreement on Protection of Historic*
44 *Properties during Emergency Response under the National Oil and Hazardous Substances*
45 *Pollution Contingency Plan* clarifies interagency and regulatory aspects of archaeological site
46 protection during oil spill response. The agreement also outlines the Federal On-Scene

1 Coordinator's role in protecting archaeological resources, the type of expertise needed for site
2 protection, and the appropriate process for identifying and protecting archaeological sites during
3 an emergency response. The agreement was followed during the DWH event, and it is assumed
4 the agreement was effective; however, no reports on the utility of the agreement for that event
5 are currently available.
6

7 **Catastrophic Discharge Event.** The PEIS analyzes a CDE that ranges from 1.4 to
8 2.2 million bbl in the Chukchi Sea Planning Area and from 1.7 to 3.9 million bbl in the Beaufort
9 Sea Planning Area (Table 4.4.2-2). A CDE could result in extensive impacts on a large number
10 of archaeological and historic resources. Due to the large area affected by a catastrophic event
11 some resources such as coastal historic sites that are sensitive to prolonged contact with oil could
12 be more heavily impacted. Cleanup crews would be needed in a greater number of locations.
13 This could allow oil to be in contact with resources for a significant amount of time before
14 cleanup efforts could be applied, which could result in impacts to these resources. A greater
15 threat to archaeological and historic resources during a catastrophic discharge event would result
16 from the larger number of response crews being employed. Historically most impacts to
17 archaeological and historic resources during a spill response were the result of vandalism or
18 physical damage from spill response activities (Bittner 1996). A catastrophic discharge event
19 would result in large impacts to numerous archaeological and historic resources from response
20 activities.
21

22 *The Programmatic Agreement on Protection of Historic Properties during Emergency*
23 *Response under the National Oil and Hazardous Substances Pollution Contingency Plan* would
24 be followed during the response to a CDE. As mentioned above, it is assumed that the process
25 identified in the agreement would be effective; however, no assessments of the agreement's
26 application during the DWH event are available.
27
28

29 **4.4.15.4 Conclusion** 30

31 Assuming compliance with existing Federal, State, and local archaeological regulations
32 and policies, most impacts on archaeological resources resulting from routine activities under the
33 proposed action should be avoided. BOEM may alter its requirements for archaeological surveys
34 because currently BOEM does not require the submission of archaeological reports based on
35 high-resolution geophysical survey data in all lease sale areas. Without the data analysis
36 included in the archaeological reports, it is impossible to assess whether a proposed activity may
37 impact an unknown cultural resource in the area of potential effect. When required,
38 archaeological reports based on high-resolution geophysical data are believed to provide the
39 information needed by BOEM to develop appropriate avoidance or mitigation strategies to
40 protect cultural resources within the area of potential effect from impacts associated with oil and
41 gas activities on the OCS. Impacts to archeological and historic resources from routine Program
42 activities are expected to range from negligible to major.
43

44 In the case of accidental oil spills, and especially CDE-level spills, some impacts could
45 occur on coastal historic and prehistoric archaeological resources. Although it is not possible to
46 predict the precise numbers or types of sites that would be affected, contact with archaeological

1 sites would probably be unavoidable, and the resulting loss of information would be
2 irretrievable. The magnitude of the impacts would depend on the number of resources affected
3 and on the significance and uniqueness of the information lost. Impacts can result from both
4 direct contact with oil and from cleanup operations. Based on experience gained from the *Exxon*
5 *Valdez* oil spill, no or very limited impacts from direct contact with oil from even a CDE-level
6 spill are expected, but some impacts are expected during cleanup activities. Response actions
7 associated with a CDE-level spill have the greatest potential for adversely impacting
8 archeological and historic resources
9

10 **4.5 OTHER ALTERNATIVES**

11 **4.5.1 Alternative 2 – Defer the Eastern Planning Area for the Duration of the 2012-2017** 12 **Program**

13 **4.5.1.1 Description of Alternative 2**

14 Under Alternative 2, no sales would be held in the Eastern GOM Planning Area under the
15 Program, and there would be no change from the proposed action for the other planning areas.
16 Under Alternative 2, the following would take place:
17

- 18 • Five area-wide lease sales in the Central GOM Planning Area;
- 19 • Five area-wide lease sales in the Western GOM Planning Area;
- 20 • One lease sale with a whaling deferral in the Beaufort Sea Planning Area;
- 21 • One lease sale with a 40-km (25-mi) buffer in the Chukchi Sea Planning Area;
- 22 and
- 23 • One special interest lease sale in Cook Inlet.

24 **4.5.1.2 Summary of Impacts**

25 Excluding the Eastern GOM Planning Area from the Program would reduce the number
26 of potential lease sales in the GOM from 12 to 10, and there would be no offshore and onshore
27 oil and gas development activities in the Eastern GOM Planning Area. As a result, none of the
28 localized impacts (short or long term) on water quality, air quality, marine and coastal biota and
29 habitats, or archeological or historic resources that would be associated with development in the
30 Eastern GOM Planning Area would be expected to occur. However, water and air quality, as
31 well as marine and coastal biota and habitats, in some portions of the Eastern GOM Planning
32 Area could be affected by oil and gas leasing and development in the eastern portions of the
33 Central GOM Planning Area.
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1 Because of the relatively small amount of development that would occur in the Eastern
2 GOM Planning Area under the proposed action (no more than 1 installed platform, no more than
3 17 wells), the population, employment, and income impacts identified for the GOM under the
4 proposed action would be only slightly reduced, and would remain unchanged in the other
5 planning areas.
6

7 Under Alternative 2, potential impacts on natural, physical, and socioeconomic resources
8 in Alaska would be the same as those identified from the proposed action.
9

10 Under Alternative 2, no oil spills from oil and gas development activities under the
11 Program would occur directly in the Eastern GOM Planning Area. However, spills from
12 development in the other planning areas (especially a large or very large spill in the Central
13 Planning Area) could be carried by currents into the Eastern GOM Planning Area and affect
14 marine and coastal resources, tourism and recreation, commercial fisheries, and local economies.
15 The nature and magnitude of any such impacts on those resources (as described in earlier
16 sections of this chapter) will depend on the location, size, and duration of a spill in the other
17 GOM planning areas.
18
19

20 **4.5.2 Alternative 3 – Defer the Western Planning Area for the Duration of the 2012-2017** 21 **Program**

22 **4.5.2.1 Description of Alternative 3**

23
24
25
26 Under Alternative 3, no lease sales would be held in the Western Planning Area under the
27 Program, and there would be no change from the proposed action for the other planning areas.
28 Under Alternative 3, the following would take place:
29

- 30 • Five area-wide lease sales in the Central GOM Planning Area;
- 31
- 32 • One or two lease sales in the extreme western portion of the Eastern GOM
33 Planning Area;
- 34
- 35 • One lease sale with a whaling deferral in the Beaufort Sea Planning Area;
- 36
- 37 • One lease sale with a 40-km (25-mi) buffer in the Chukchi Sea Planning Area;
38 and
- 39 • One special interest lease sale in Cook Inlet.
40
- 41
- 42

43 **4.5.2.2 Summary of Impacts**

44
45 Excluding the Western GOM Planning Area from the Program would reduce the number
46 of potential lease sales in the GOM from 12 to 7. Under the proposed action, there could be as

1 many as 96 platforms and 534 wells (and associated pipelines, landfalls, and onshore processing
2 facilities) developed in the Western GOM Planning Area. Under Alternative 3, this development
3 would not occur, and as a result none of the short- or long-term localized impacts identified for
4 the proposed action on water quality, air quality, marine and coastal biota and habitats,
5 archeological or historic resources, or land use and infrastructure that would be associated with
6 development and operation of this infrastructure and support activities (such as support vessel
7 and helicopter traffic) in the Western GOM Planning Area would be expected to occur.
8 However, water and air quality, as well as marine and coastal biota and habitats, in some
9 portions of the Western GOM Planning Area could still be affected by oil and gas leasing and
10 development in the western portions of the Central GOM Planning Area, especially if that
11 development uses existing commercial infrastructure (such as shipyards, support centers,
12 processing facilities) and shipping lanes in coastal areas of the Western GOM Planning Area.
13

14 Even though a relatively large amount of development would occur in the Western GOM
15 Planning Area under the proposed action, the increases in population, employment, and income
16 identified to occur under the proposed action would be only slightly reduced under Alternative 3,
17 and would remain unchanged in the other planning areas.
18

19 Under Alternative 3, potential impacts on natural, physical, and socioeconomic resources
20 in Alaska would be the same as those identified from the proposed action.
21

22 Under Alternative 3, no oil spills from oil and gas development activities would occur
23 directly in the Western GOM Planning Area under the Program. However, spills that may occur
24 under Alternative 3 from development in the other planning areas (especially large or very large
25 spills in the Central Planning Area) could be carried by currents into the Western GOM Planning
26 Area and affect marine and coastal resources, tourism and recreation, commercial fisheries, and
27 local economies. The nature and magnitude of any such impacts on those resources (as
28 described in earlier sections of this chapter) will depend on the location, size, and duration of any
29 spills in the other GOM Planning Areas.
30
31

32 **4.5.3 Alternative 4 – Defer the Central Planning Area for the Duration of the 2012-2017** 33 **Program**

34 35 36 **4.5.3.1 Description of Alternative 4** 37

38 Under Alternative 4, no lease sales would be held in the Central Planning Area under the
39 Program, and there would be no change from the proposed action for the other planning areas.
40 Under Alternative 4, the following would take place:
41

- 42 • Five area-wide lease sales in the Western GOM Planning Area;
- 43
- 44 • One or two lease sales in the extreme western portion of the Eastern GOM
45 Planning Area;
- 46

- 1 • One lease sale with a whaling deferral in the Beaufort Sea Planning Area;
- 2
- 3 • One lease sale with a 40-km (25-mi) buffer in the Chukchi Sea Planning Area;
- 4 and
- 5
- 6 • One special interest lease sale in Cook Inlet.
- 7
- 8

9 **4.5.3.2 Summary of Impacts**

10
11 Excluding the Central GOM Planning Area from the Program would reduce the number
12 of potential lease sales in the GOM from 12 to 7. Under the proposed action, the greatest amount
13 of oil and gas development in the GOM would occur in the Central GOM Planning Area, with as
14 many as 316 platforms and 749 wells (and associated pipelines, landfalls, and onshore
15 processing facilities). Under Alternative 4, this development would not occur, and as a result
16 none of the localized impacts (short or long term) on water quality, air quality, marine and
17 coastal biota and habitats, archeological or historic resources, or land use and infrastructure that
18 would be associated with development and operation of this infrastructure and support activities
19 (such as support vessel and helicopter traffic) in the Central GOM Planning Area would be
20 expected to occur. However, water and air quality, as well as marine and coastal biota and
21 habitats could still be affected in some portions of the Central Planning Area by oil and gas
22 activities in portions of the Western and Eastern GOM Planning Areas that abut the Central
23 GOM Planning Area, especially if those activities use existing commercial infrastructure (such
24 as shipyards, support centers, processing facilities) that are located in the Central GOM Planning
25 Area.

26
27 Under Alternative 4, potential impacts on natural, physical, and socioeconomic resources
28 in Alaska would be the same as those identified from the proposed action.

29
30 Even with the large amount of development that could occur in the Central GOM
31 Planning Area under the proposed action, under Alternative 4 the increases in population,
32 employment, and income likely to occur under the proposed action would be only slightly
33 reduced, and would remain unchanged in the other planning areas.

34
35 Under Alternative 4, no oil spills from oil and gas development activities associated with
36 the Program would occur directly in the Central GOM Planning Area. However, spills from
37 development in the Western or Eastern GOM Planning Areas could be carried by currents into
38 the Central GOM Planning Area and affect marine and coastal resources, tourism and recreation,
39 commercial fisheries, and local economies. The nature and magnitude of any such impacts on
40 those resources (as described in earlier sections of this chapter) will depend on the location, size,
41 and duration of any spills in the other GOM planning areas.

1 **4.5.4 Alternative 5 – Defer the Beaufort Sea Planning Area for the Duration of the**
2 **2012-2017 Program**

3
4
5 **4.5.4.1 Description of Alternative 5**
6

7 Under Alternative 5, no lease sales would be held in the Beaufort Sea Planning Area
8 under the Program, and there would be no change from the proposed action for the other
9 planning areas. Under Alternative 5, there would be:

- 10
- 11 • Five area-wide lease sales in the Western GOM Planning Area;
 - 12
 - 13 • Five area-wide lease sales in the Central GOM Planning Area;
 - 14
 - 15 • One or two lease sales in the extreme western portion of the Eastern GOM
16 Planning Area;
 - 17
 - 18 • One lease sale with a 40-km (25-mi) buffer in the Chukchi Sea Planning Area;
19 and
 - 20
 - 21 • One special interest lease sale in Cook Inlet.
 - 22
 - 23

24 **4.5.4.2 Summary of Impacts**
25

26 Excluding the Beaufort Sea Planning Area from the Program would reduce the number of
27 potential lease sales in the Arctic from 2 to 1. Under the proposed action, there could be as many
28 as 4 platforms, 136 wells, 249 km (155 mi) of offshore pipeline, and 129 km (80 mi) of onshore
29 pipeline developed in the Beaufort Sea Planning Area and adjacent coastal areas. Under
30 Alternative 5 this development would not occur, and as a result none of the localized impacts
31 (short or long term) on water quality, air quality, marine and coastal biota and habitats,
32 archeological or historic resources, or land use and infrastructure that would be associated with
33 development and operation of this infrastructure and any supporting activities (such as support
34 vessel and helicopter traffic) in the Beaufort Sea Planning Area would be expected to occur.
35 However, water quality, as well as marine and coastal biota and habitats in some portions of the
36 Beaufort Sea Planning Area and adjacent coastal areas, could still be affected by oil and gas
37 leasing and development in the eastern portions of the Chukchi Sea Planning Area.
38

39 Under Alternative 5, the increases in population, employment, and income likely to occur
40 under the proposed action would be only slightly reduced, and would remain unchanged in the
41 other planning areas.
42

43 Under Alternative 5, potential impacts on natural, physical, and socioeconomic resources
44 in the GOM planning areas would be the same as those identified from the proposed action.
45

1 Under Alternative 5, no oil spills from oil and gas development activities associated with
2 the Program would occur directly in the Beaufort Sea Planning Area. However, a spill that may
3 occur under this alternative in the Chukchi Sea Planning Area could be carried by coastal
4 currents into the Beaufort Sea Planning Area and affect marine and coastal resources, subsistence
5 whaling, tourism and recreation, and local economies and communities. The nature and
6 magnitude of any such impacts on those resources (as described in earlier sections of this
7 chapter) will depend on the location, size, and duration of a spill in the Chukchi Sea Planning
8 Area.

11 **4.5.5 Alternative 6 – Defer the Chukchi Sea Planning Area for the Duration of the** 12 **2012-2017 Program**

15 **4.5.5.1 Description of Alternative 6**

17 Under Alternative 6, no lease sales would be held in the Chukchi Sea Planning Area
18 under the Program, and there would be no change from the proposed action for the other
19 planning areas. Under Alternative 6, the following would take place:

- 21 • Five area-wide lease sales in the Western GOM Planning Area;
- 23 • Five area-wide lease sales in the Central GOM Planning Area;
- 25 • One or two lease sales in the extreme western portion of the Eastern GOM
26 Planning Area;
- 28 • One lease sale with a whaling deferral in the Beaufort Sea Planning Area; and
- 30 • One special interest lease sale in Cook Inlet.

33 **4.5.5.2 Summary of Impacts**

35 Excluding the Chukchi Sea Planning Area from the Program would reduce the number of
36 potential lease sales in the Arctic from 2 to 1. Under the proposed action, there could be as many
37 as 5 platforms, 300 wells, and 402 km (250 mi) of offshore pipeline developed in the Chukchi
38 Sea Planning Area. Under Alternative 6, this development would not occur, and as a result none
39 of the localized impacts (short or long term) on water quality, air quality, marine and coastal
40 biota and habitats, archeological or historic resources, or land use and infrastructure that would
41 be associated with development and operation of this infrastructure and any supporting activities
42 (such as support vessel and helicopter traffic) in the Chukchi Sea Planning Area would be
43 expected to occur. However, water quality, as well as marine and coastal biota and habitats, and
44 land use and infrastructure in some portions of the Chukchi Sea Planning Area and adjacent
45 coastal areas, could still be affected by oil and gas leasing and development in the western
46 portions of the Beaufort Sea Planning Area.

1 Under Alternative 6, the increases in population, employment, and income likely to occur
2 under the proposed action would be only slightly reduced, and would remain unchanged in the
3 other planning areas.

4
5 Under Alternative 6, potential impacts on natural, physical, and socioeconomic resources
6 in the GOM planning areas would be the same as those identified from the proposed action.

7
8 Under Alternative 6, no oil spills from oil and gas development activities under the
9 Program would occur directly in the Chukchi Sea Planning Area. However, spills from
10 development in the Beaufort Sea Planning Area could be carried by coastal currents into the
11 Chukchi Sea Planning Area and affect marine and coastal resources, subsistence whaling,
12 tourism and recreation, and local economies and communities. The nature and magnitude of any
13 such impacts on those resources (as described in earlier sections of this chapter) will depend on
14 the location, size, and duration of a spill in the Beaufort Sea Planning Area.

15 16 17 **4.5.6 Alternative 7 – Defer the Cook Inlet Planning Area for the Duration of the** 18 **2012-2017 Program**

19 20 21 **4.5.6.1 Description of Alternative 7**

22
23 Under Alternative 7, no lease sales would be held in the Cook Inlet Planning Area during
24 the Program, and there would be no change from the proposed action for the other planning
25 areas. Under Alternative 7, the following leasing activities could take place:

- 26
27 • Five area-wide lease sales in the Western GOM Planning Area;
- 28
29 • Five area-wide lease sales in the Central GOM Planning Area;
- 30
31 • One or two lease sales in the extreme western portion of the Eastern GOM
32 Planning Area;
- 33
34 • One lease sale with a whaling deferral in the Beaufort Sea Planning Area; and
- 35
36 • One lease sale with a coastal deferral in the Chukchi Sea Planning Area.

37 38 39 **4.5.6.2 Summary of Impacts**

40
41 Excluding the Cook Inlet Planning Area could result in one less potential lease sale in the
42 Alaska Region. All offshore and onshore oil and gas activities and production associated with
43 this sale would not occur. The small amount of oil assumed to be developed under Alternative 1
44 in Cook Inlet would be compensated for by imported oil. It is unlikely that the additional
45 amount of imported oil that could occur under Alternative 7 will measurably affect the number
46 of tanker oil spills that occur in other offshore areas in the United States.

1 The analyses of impacts of Alternative 1, the Proposed Action, in Cook Inlet showed in
2 almost all cases temporary and localized impacts. Any disturbance to existing environmental
3 conditions associated with routine operations or an oil spill would be expected to be ameliorated
4 on a time scale of days to a year or two. Under Alternative 7, these short-term localized impacts
5 would not occur. Under the Proposed Action, no population-level impacts were predicted for
6 biological resources, although several endangered and/or threatened bird species would be
7 vulnerable to mortality from oil spills. A moderate to large oil spill could affect a relatively large
8 number of Steller's eiders, which overwinter in Cook Inlet. However, because the eider does not
9 breed in Cook Inlet, the breeding populations would not be directly affected, although the
10 number of eiders that arrive in the Arctic for breeding could be reduced. The endangered short-
11 tailed albatross occurs uncommonly in Cook Inlet, so large numbers of birds would not be
12 affected by a spill. Furthermore, the albatross breeds outside Cook Inlet, so the breeding
13 population would not be affected. Kittlitz's murrelets, a candidate for listing under the
14 Endangered Species Act, also occur in Cook Inlet and would be expected to come in contact with
15 spilled oil while foraging. Impacts on these species under Alternative 1 would be contained
16 within the Cook Inlet area and would not extend to other planning areas in Alaska where these
17 species also occur during different life stages or seasons. Under Alternative 7, none of these
18 localized impacts on protected species would occur from OCS activity.

19
20 While no long-term population-level impacts on terrestrial mammals in the Cook Inlet
21 area are expected under Alternative 1, increased mortality of brown and black bears could occur
22 if previously remote areas were converted to industrial use, resulting in increased conflict
23 between bears and humans. A large oil spill that affected intertidal areas could lead to
24 significant mortality of eggs and juvenile fish of pelagic species, such as the salmon, leading to
25 reduced adult survival. The overall fish populations in South Alaska, however, would not be
26 affected. A large spill could temporarily affect fisheries in the area that were contacted by the
27 spill. While no long-term impacts on the fish populations are expected, economic impacts on
28 commercial and recreational fisheries could result as a result of loss of gear, closings of affected
29 areas, and unavailability of fishing areas during cleanup operations. These temporary and
30 localized impacts in Cook Inlet, which are unlikely given the small amount of activity expected
31 under Alternative 1, would be precluded under Alternative 3.

32
33 Impacts on air and water quality under Alternative 1 in Cook Inlet are expected to be
34 short-term and localized because of the small amount of activity anticipated and the largely
35 pristine quality of the air and water environments there. Therefore, Alternative 3 will not result
36 in a major difference from Alternative 1 for these resources.

37
38 The analysis of archaeological resources indicated that existing BOEM requirements for
39 archaeological surveys would be expected to eliminate most of the possible impacts on historic
40 and prehistoric resources. Impacts were possible from cleanup operations after an oil spill.
41 Given the small amount of liquid hydrocarbons expected to be produced under Alternative 1 in
42 Cook Inlet, compounded with the requirement that the spill would have to contact areas with
43 historic or prehistoric resources for impacts to occur, Alternative 3 is not expected to result in a
44 significant difference from Alternative 1 with regard to the potential for archaeological resource
45 impacts.

1 The population, employment, and income impacts anticipated under Alternative 1 in the
2 Cook Inlet area would not occur under Alternative 3. Table 4.4.9-2 shows estimates of
3 4,520 jobs and \$152 million in income resulting from Alternative 1 in the Cook Inlet area during
4 the life of the Program.
5
6

7 **4.5.7 Alternative 8 – No Action** 8

9 The National Environmental Policy Act requires consideration of a No Action
10 Alternative to every major Federal action that could result in significant impacts on the
11 environment. In the context of the Program, the No Action Alternative is defined as the scenario
12 in which BOEM holds no OCS oil and gas lease sales during the Program. Under this scenario,
13 none of the potential environmental impacts associated with oil and gas related activities under
14 the proposed action that have been evaluated in Section 4.4 would occur. These precluded
15 impacts would include both the anticipated effects under the proposed action of routine
16 operations and accidental discharges on ecological conditions and the effects of leasing on
17 regional employment, regional income, and sociocultural stability. In addition, the oil and
18 natural gas that would have been produced as a consequence of sales over the 5-yr program
19 period would not be available to consumers, who would therefore need to obtain energy from
20 other sources. The energy substitutes needed to replace the lost OCS production would be
21 associated with their own potential environmental effects that could occur throughout the United
22 States or the world depending on the mix of specific energy substitutes that would be used. The
23 analysis that follows considers these factors to evaluate the overall effects of implementing the
24 No Action Alternative. Information is first presented on the various uses of energy in the
25 economy and on the current and projected uses of oil and gas compared to other fuel or alternate
26 energy sources in each economic sector. Substantial discussions of the current status and
27 projected developments in alternate energy sources for each sector of the economy are provided.
28 A scenario of energy substitutes is then developed that projects the mix of energy substitutes that
29 would be used to replace lost OCS production during the life of the program. This scenario is
30 used to evaluate the anticipated broad effects of implementing the No Action Alternative in each
31 program area as well as in other areas that could be affected by the energy substitutes used to
32 replace lost OCS production.
33
34

35 **4.5.7.1 Oil and Gas Uses and Alternatives** 36

37 The primary energy sources used in the United States are petroleum, coal, natural gas,
38 nuclear energy, and hydroelectric and non-hydroelectric power, the latter of which includes
39 geothermal, wind, and solar power. The U.S. Energy Information Administration's *Annual*
40 *Energy Review for 2009* reports that the largest portion (over 39%) of our energy comes from
41 liquid fuels, primarily petroleum, and natural gas adds another 23% (EIA 2009a).
42
43

44 **4.5.7.1.1 Transportation Sector.** Total energy use in the transportation sector has
45 grown by an average of just over 1% per year over the last 20 yr. As of 2008, the transportation
46 sector accounted for an estimated 28% of all energy consumption in the United States, a

1 proportion that has been slowly rising since the 1960s. The vast majority of this energy has
2 come from oil — nearly three-fourths of all petroleum consumed in the United States in 2008
3 was used for transportation — with natural gas, electricity, and other alternatives playing much
4 smaller roles (EIA 2008a). In this section, we discuss recent trends in the use of oil and gas in
5 the transportation sector and the potential for substitutes for these energy sources within the time
6 frame of the 40- to 50-yr life of the Program.

7 8 **Uses of Oil and Gas in the Transportation Sector.**

9
10 **Ground Travel.** Oil is the dominant energy source for ground travel. Approximately
11 141 billion gal of gasoline and 45 billion gal of diesel fuel were consumed for ground travel in
12 2007. Growth in consumption has been slow but steady in recent years, averaging about 1% per
13 year from 2003 to 2007 (EIA 2007a). However, motor gasoline use fell by about 3% from 2007
14 to 2008, the first time total annual consumption has fallen since 1988–1991. Preliminary data
15 show consumption remaining flat from 2008 to 2009 (EIA 2009b).

16
17 The use of natural gas as a vehicle fuel (in both compressed and liquid forms) has
18 increased significantly in recent years, with an average annual growth rate of 8.5% from 2003 to
19 2007. However, natural gas still represents a small fraction of the total (just over 200 million gal
20 of gasoline-equivalent in 2007, or about 1% of total vehicle fuel). In 2007, approximately
21 117,000 gas-fueled vehicles were in use, many of which were buses and other fleet vehicles
22 (EIA 2007b).

23
24 Ethanol is currently the most used alternative fuel; consumption increased from
25 1.9 million gal of gasoline equivalent in 2003 to 4.7 million gal in 2007 (mostly as an additive in
26 modest proportions to gasoline, although it is sometimes used as the dominant fuel source in an
27 85/15 ethanol-gasoline mix). Biodiesel use rose even more quickly over that period, but remains
28 relatively modest overall at 470,000 gasoline equivalent gallons. Electricity, hydrogen, and other
29 fuels contributed very little; electricity use for vehicle transportation actually declined slightly
30 over this period (EIA 2007b).

31
32 **Air Travel.** Certified U.S. air carriers used 18.9 billion gal of fuel in 2008, which was
33 7.6% of the total consumed by the U.S. transportation sector. Fuel use for air travel has risen
34 much faster than use for ground travel; total consumption rose by 4.6% per year from 2003 to
35 2007 before falling in 2008 (USDOT 2009c), indicating a strong linkage to larger economic
36 factors. Petroleum-derived kerosene-style jet fuel accounts for nearly all of the fuel used for air
37 travel.

38
39 **Marine Travel.** Marine travel accounts for a relatively small proportion of total oil
40 consumption in the transportation sector and, as with air travel, there is no natural gas
41 consumption. Total fuel consumption for marine travel was about 1,367 trillion Btu in 2007,
42 roughly three-fourths the amount used by air travel and 6% of the total for the sector. Marine
43 travel does show greater variation in fuels; residual fuel oil makes up about 70% of oil use,
44 distillate and diesel fuel oil another 20%, with the remainder in gasoline. This mix has remained
45 fairly consistent over time (USDOT 2010).

1 Total oil consumption for marine travel has shown no clear trend over time, with periods
2 of sharp declines following years of growth, and vice versa. After dropping by nearly 30% from
3 2000 to 2003, fuel use increased nearly as dramatically to reach comparable levels by 2007.
4 Consumption decreased in 2008. Taking a longer-term view does little to clarify the situation
5 (USDOT 2010).
6

7 **Rail Travel.** Similar to marine travel, rail travel constitutes a small proportion of total oil
8 consumption and virtually no natural gas consumption. Total oil use was 576 trillion Btu in
9 2007; the overwhelming majority of this was for freight transport, rather than passengers.
10 Distillate and diesel are the fuels used (USDOT 2010).
11

12 Following a low of 414 trillion Btu in 1990, oil consumption for rail transportation grew
13 steadily to 594 trillion Btu in 2006, before falling to 576 trillion in 2007 (USDOT 2010). Thus,
14 it appears that fuel use for rail transportation is in the midst of a long-term increase, although the
15 slide during the 1980s indicates that this is by no means inevitable.
16

17 **Analysis of Energy Substitutes in the Transportation Sector.** In this section we
18 analyze the potential for substitution away from fossil fuels within the time frame of the 40- to
19 50-yr life of the Program. Our focus is primarily on ground transportation, which could
20 demonstrate lower fuel consumption through efficiency improvements, a shift toward greater use
21 of public transportation, or use of alternative fuels. We also discuss the potential for oil
22 substitution in air travel through both efficiency improvements and fuel switching.
23

24 **More Efficient Vehicles.** Automobiles in the United States currently have a lifespan of
25 about 14 years. While some individual vehicles will remain in use for a longer period of time, it
26 seems safe to assume that the Nation's fleet will have turned over nearly in its entirety within
27 20 years. As of 2007, there were 254.4 million registered highway vehicles, of which
28 135.9 million were passenger cars, 7.1 million were motorcycles, and 111.3 million were other
29 vehicles (primarily light- and heavy-duty trucks); population growth is likely to add substantially
30 more vehicles, even if the number of vehicles per capita continues to fall (USDOT 2009d).
31 Thus, there is huge potential for oil reductions through efficiency improvements in the Nation's
32 automobiles. Since natural gas makes up such a small proportion of fuel used for transportation,
33 we do not consider it further.
34

35 In the near term, the efficiency of the Nation's vehicle fleet is likely to be determined
36 more by stricter regulatory requirements than by a demand from consumers for yet-more-
37 efficient vehicles. CAFE standards currently stand at 27.5 mpg for passenger cars and 23.1 mpg
38 for light trucks. Building on requirements in the 2007 Energy Policy Act, however, the Obama
39 Administration has established stricter targets, setting a schedule that steadily raises the
40 requirements to an end point of 35.7 mpg in 2015 for cars and 28.6 mpg for trucks. The new
41 vehicles subject to these limits will replace older, retired vehicles manufactured in the late 1990s
42 and early 2000s, whose fuel efficiency was, on average, about 8 mpg lower. This is equivalent
43 to a 23% savings in fuel use for passenger cars, or a 28% savings for light trucks. If we hold the
44 number of miles driven per vehicle steady at 2007 levels, we can expect a total savings of
45 12.3 billion gal of gasoline per year by 2015 as a result of the stricter vehicle standards.
46

1 **Hybrid Vehicles.** Hybrid vehicles are already fairly well established, with all of the
2 major automakers now mass-producing hybrid models. While hybrids will remain somewhat
3 more expensive than conventional cars in terms of the upfront cost, the premium will likely fall
4 as technology improves and manufacturers continue to scale up production. With sufficiently
5 strong tax incentives or other forms of policy support, hybrids could theoretically entirely replace
6 conventional automobiles.

7
8 Rough calculations of the scale of the impacts that such a shift would entail suggest a
9 large potential for reducing the consumption of gasoline. If population growth continues at its
10 current pace, there will be about 393 million people in the United States in 2035; this will likely
11 translate into roughly 300 million vehicles. Projecting a 30% savings per vehicle (based on the
12 hybrid and traditional Toyota Camry models) would imply a total savings of 49 billion gal of
13 gasoline — more than one-fourth of total current consumption for ground transportation.
14 Clearly, this is a very rough, illustrative figure, but it nonetheless shows that hybrid vehicles
15 have the potential to offset a significant fraction of oil use. While we do not discuss other types
16 of fuel efficiency improvements (such as switching from trucks to cars or using more lightweight
17 materials), the scope for potential gains would be similar.

18
19 **Electric and Plug-in Vehicles.** The impact of plug-in hybrid and electric vehicles is
20 likely to be comparatively modest, even over a fairly long 25-year horizon. Plug-in hybrids use
21 20 to 55% less gasoline than traditional hybrids, depending on the mix of electricity and gasoline
22 used (NRC 2010); electric vehicles, of course, use no oil at all. The existence of 40 million plug-
23 in hybrids, the high estimate from the National Research Council (NRC), would imply a savings
24 of about 12 billion gal of gasoline per year. While the NRC report did not consider all-electric
25 vehicles, a similar number of electric vehicles (a very aggressive assumption) would save about
26 22 billion gal of gasoline per year. The 13 million vehicles considered a more likely figure
27 would produce savings of 4 to 7 billion gal.

28
29 The keys to future rates of adoption of electric vehicles and plug-in hybrids are the
30 batteries used to replace (in whole or in part) the gasoline-powered combustion engine. Both
31 plug-in hybrids and electric vehicles currently use lithium-ion batteries; conventional hybrids use
32 nickel-metal hydride technology, but are expected to switch over to lithium-ion batteries as well
33 (Pike Research 2009). Within the broad characterization of lithium-ion batteries, there are
34 several different subtypes, each of which can be evaluated on six basic criteria: energy storage
35 capacity, power, safety, performance, life span, and cost. Significantly, none of the battery types
36 currently in use performs well across all six criteria. As a result, the Boston Consulting Group
37 concluded that, absent a major breakthrough, fully electric vehicles that are as convenient as
38 conventional cars will likely not be available by 2020 (Boston Consulting Group 2010).

39
40 Similarly, a report from the NRC explored the prospects for plug-in hybrid vehicles by
41 2030. NRC estimates that, under optimistic assumptions, the maximum number of plug-in
42 electric vehicles on the road at that time would be 40 million; cost and convenience factors
43 suggest that 13 million may be more likely. The NRC report did not anticipate significant cost
44 improvements in lithium-ion batteries in the foreseeable future (NRC 2010).

1 **Ethanol Vehicles.** Perhaps the single most important factor driving the long-term
2 adoption of ethanol is the cost of producing cellulosic ethanol. Unlike traditional corn- or sugar-
3 based ethanol, which is derived from starch, cellulosic ethanol uses cellulose as its basis, a
4 structural component of plant cell walls and the most common organic compound on earth. A
5 cost-effective method to produce cellulosic ethanol would allow for the use of a wide variety of
6 feedstocks, including inedible crop residues and plants that grow on marginal agricultural land
7 with little or no active cultivation. This would, in turn, enable far greater use of ethanol as a
8 substitute for petroleum-based fuel.

9
10 At this time, cellulosic ethanol production is too expensive to justify large-scale use, due
11 largely to the cost of producing enzymes to convert cellulose into a useable form. However,
12 many observers expect significant cost reductions in the coming years. For example,
13 Novozymes, the world’s largest manufacturer of industrial enzymes, announced in
14 February 2010 that it was launching a line of enzymes that it expects will lower overall
15 production costs to under \$2 a gallon, which is in line with costs for corn-based ethanol and
16 gasoline (Leber 2010; Motavalli 2010).

17
18 If ethanol production costs fall below those of petroleum, further policy support may be
19 unnecessary, as ethanol will become the preferred transportation fuel. Failing this, however,
20 energy policy could play a major role in determining future levels of ethanol use. As was noted
21 above, the Energy Independence and Security Act requires the use of 36 billion gal of ethanol in
22 2022, of which 16 billion is to be cellulosic ethanol. The U.S. Environmental Protection Agency
23 (USEPA) has not yet established targets for later years (USEPA 2010a).

24
25 Another important consideration is whether there is sufficient agricultural capacity to
26 support substantially greater reliance on biofuels — and to do so without causing an
27 unacceptable rise in the price of basic foods, due to upward pressure on demand for agricultural
28 land. A 2005 U.S. Department of Energy/U.S. Department of Agriculture (USDOE/USDA)
29 report examined the feasibility of displacing 30% of the country’s petroleum consumption with
30 biomass-based energy, which the authors estimated would require a dry biomass potential of
31 about 1 billion tons per year. That report identified the potential for 368 million dry tons
32 biomass potential per year from forestlands and 998 million dry tons biomass potential from
33 agricultural lands, with “relatively modest changes in land use and agricultural and forestry
34 practices.” Agricultural biomass would comprise a mix of crop residues, grains for biofuels,
35 process residues, and dedicated perennial crops. Not all of this would be suitable for conversion
36 to liquid fuels for transportation. Nonetheless, the report makes clear that the United States has
37 the productive capacity to meet a significant portion, but not all, of its transportation fuel demand
38 from biofuels (USDOE and USDA 2005).

39
40 The USDOE/USDA study cited above noted several potential environmental impacts
41 from increased use of forest and agricultural land for biofuel production:

- 42
43 • Increased logging could result in greater soil erosion and elevated levels of
44 sediment in surface waters.

- 1 • Removing crop residues could reduce soil quality, increase erosion, and
2 release carbon from the soil into the atmosphere.
- 3
- 4 • In addition, removing the nutrients embodied in crop residues could lead to
5 increased fertilizer use, leading to increased nutrients in water runoff and
6 greater use of fossil fuels for fertilizer manufacture (USDOE and
7 USDA 2005).
- 8

9 In addition, agriculture is relatively fuel-intensive; reliance on petroleum to power
10 machinery and equipment, and to manufacture fertilizers and other inputs, could offset much of
11 the potential for biofuels to reduce overall petroleum consumption. Cellulosic ethanol is
12 expected to have a more favorable lifecycle profile than corn ethanol, but it will nonetheless be
13 unable to reduce petroleum consumption on a 1-to-1 basis.

14

15 Overall, if cellulosic ethanol becomes cost-competitive with other liquid fuel sources,
16 and/or if it is given sufficiently strong policy support, it will likely displace a significant amount
17 of petroleum in the long term, possibly as much as 30% or more of total consumption. It is
18 unlikely to have any appreciable impact on natural gas consumption.

19

20 **Public Transportation.** In the short term, cities that have established public
21 transportation systems could see increased ridership on their existing routes. To expand the
22 impact of public transportation over the longer term, cities could build new mass transit systems
23 or expand existing systems, thereby allowing residents to reduce their use of gasoline-fueled
24 automobiles. There are no firm rules regarding how much time is needed to develop new
25 systems, but anecdotal information from cities that have recently created or expanded their
26 transit networks suggests that a 10- to 15-yr time horizon should generally be sufficient for large
27 cities to create or expand light rail systems. Bus-based systems could presumably be
28 implemented in much shorter time frames.

29

30 **Hydrogen and Fuel Cell Vehicles.** Hydrogen has been discussed for some time as the
31 “fuel of the future,” touted as being advantageous because of its abundance as an element, its
32 density as an energy carrier, and its lack of harmful emissions. In vehicles, hydrogen fuel can be
33 used in two different ways: burning in an internal combustion engine, or in a chemical reaction
34 in a fuel cell. The focus of this section is on the latter, which has the potential for greater
35 efficiency in the long term. Fuel cells work by separating a chemical fuel, such as hydrogen, into
36 negatively charged electrons and positively charged ions. The electrons are forced through a
37 wire to create an electrical current and power the vehicle. The electrons are then reunited with
38 the ions and oxygen to form pure water. Since there are no moving parts, fuel cells are
39 exceptionally reliable and can last for a very long time.

40

41 While hydrogen is one of the most abundant elements on earth, it occurs only rarely in
42 pure elemental form. Hydrogen for fuel must be gathered from another source. Currently, 95%
43 of the hydrogen used in the United States is produced through steam reforming of natural gas, in
44 which high-pressure steam reacts with methane to produce hydrogen, carbon monoxide, and a
45 small amount of carbon dioxide (EERE 2008). A potentially more environmentally friendly,
46 though more expensive, alternative is to split water molecules into hydrogen and oxygen through

1 the process of hydrolysis. Since hydrolysis is powered by electricity, renewable power sources
2 such as wind or solar power could theoretically be used to produce the hydrogen needed to fuel
3 vehicles.
4

5 All of the technology needed for hydrogen-powered, fuel cell operated cars is already in
6 existence, but not at a stage that would permit cost-effective widespread commercial
7 deployment. Key areas of ongoing research include the materials and manufacturing process for
8 fuel cells and, in particular, a reduction in the amount of platinum used. Another area of ongoing
9 research is to develop a more efficient means of producing hydrogen through hydrolysis or from
10 other non-fossil fuel sources, which would ultimately be more environmentally beneficial than
11 production from natural gas.
12

13 Perhaps a more critical issue is the “chicken-and-egg” problem inherent in deploying
14 hydrogen fuel on a wide scale. Widespread adoption of hydrogen vehicles will necessitate
15 enormous investments in infrastructure, to make the fuel as widely available as gasoline is at
16 present. However, it will be difficult to justify investment on the scale required until there are
17 enough hydrogen-fueled cars on the road to create sufficient demand to support the industry. So
18 long as there is a sufficient supply of petroleum or biofuels that can use existing infrastructure to
19 meet the needs of the Nation’s vehicle fleet, this will pose a serious problem. Sustained policy
20 support will likely be necessary to establish adequate hydrogen fueling infrastructure.
21

22 The California Fuel Cell Partnership estimates that if fuel cell vehicles are introduced
23 into the market on a limited scale over the next decade, as expected, they could be widely
24 available by 2030. Due to the significant lag in vehicle turnover, then, it would likely be another
25 10 to 20 yr before hydrogen could replace oil as the dominant transportation fuel. Ultimately,
26 hydrogen has the potential to replace substantially all of the petroleum used by the transportation
27 sector, but only over a very long time horizon (NREL 2007).
28

29 **Summary.** The review of potential sources of oil and gas savings from the transportation
30 sector showed that the ground transportation sector accounted for about 180 billion gal of
31 gasoline and diesel fuel use in 2008. Air travel consumed roughly 19 billion gal of fuel; marine
32 travel used somewhat less. Natural gas did not play a significant role as a transportation fuel.
33

34 In the near term, major sources of potential fuel savings include more efficient gasoline-
35 powered automobiles and substitution of biofuels for gasoline in automobiles. These two
36 sources could save approximately 17 billion gal of gasoline per year by 2015, or about 10% of
37 the total for ground transportation. Hybrid and electric vehicles and increased use of public
38 transportation could contribute more modest savings.
39

40 The potential for oil savings is greater in the longer term. Cellulosic ethanol could
41 displace as much as 30% of total oil consumption. Hybrid and electric vehicles, increased use of
42 public transportation, and more efficient planes could generate oil savings as well, albeit in more
43 modest amounts (likely on the order of 9 billion to 14 billion gal gasoline-equivalent). Finally, if
44 adopted on a wide scale, hydrogen fuel could replace substantially all of the petroleum used by
45 the transportation sector, but only over a very long time horizon, beyond what is under
46 consideration for the Program.

1 **4.5.7.1.2 Electricity Generation Sector.**

2
3 **Uses of Oil and Gas in the Electricity Generation Sector.** Petroleum plays a very
4 modest role in electricity generation, and the proportion of U.S. electricity generation from oil-
5 fired power plants has been on a steep decline since the late 1970s. For natural gas, the converse
6 is true; gas-fueled electricity generation nearly doubled over the 10 years from 1997 to 2007.
7 The electricity generation sector is second only to industrial use in terms of overall consumption
8 of natural gas. This section analyzes the use of oil and gas for electricity generation. We begin
9 with an examination of recent trends and current use of oil and gas in the sector, and then discuss
10 the near- and long-term potential for substitutes. A particular focus is on the circumstances
11 under which these fuels are used for electricity generation, and how this affects the ability of
12 renewable energy sources to substitute for these fossil fuels.

13
14 Electricity generation consumed 81 million barrels of petroleum in 2008, or about
15 3.4 billion gal; this translates into total primary energy use of about 469 trillion Btu (EIA 2010c).
16 This represents a steep decline from 2005, when electricity production consumed nearly three
17 times as much oil. Prior to that, oil consumption had remained at approximately the same level
18 since the mid-1980s. Oil consumption in the electricity generation sector peaked in 1977 at
19 3,900 trillion Btu, more than eight times the current level (EIA 2009c).

20
21 Within the electricity generation sector, petroleum is used primarily to fuel “peaker”
22 plants — facilities that stand idle most of the time and are used only at times of very high
23 demand. Generally, such plants are relatively cheap to build but expensive to operate, as the
24 per-unit fuel costs are more expensive than other plants; thus, they are only used when all other
25 options have been exhausted. As a result, oil provides the fuel for only a small fraction of
26 electricity generated in the United States. Petroleum was used to produce 46 million megawatt-
27 hours of electricity in 2008, about 1% of the 4,119 million megawatt-hour total. This was far
28 less than the generation provided by coal, natural gas, nuclear, hydroelectric, or even biomass
29 and wind resources (EIA 2010d).

30
31 Since most petroleum-fired plants are used relatively infrequently, these plants contribute
32 a larger proportion of generating capacity to the total than they do actual generation. In 2008,
33 oil-fired plants accounted for 57,445 MW of net summer generating capacity, or 5.7% of total
34 U.S. capacity. This figure has remained fairly steady since 2002, despite the significant drop in
35 petroleum-fueled electricity generation over that time period (during which overall peak
36 electricity demand increased) (EIA 2008c, 2010d). What this indicates is that, for peaker plants
37 in particular, there may not be a strong correlation over the short run between available capacity
38 and actual use. Thus, oil price changes may be reflected to some degree in electricity generation,
39 but it will take a longer time (and a more sustained price change) before total capacity of oil-
40 fired plants is similarly affected.

41
42 The use of oil predominantly as a peak fuel means that most oil-fired plants are relatively
43 small, and that there are a relatively high number of them in use. There were 1,205 oil-fired
44 generating stations in 2008, with an average capacity of less than 50 MW each. By comparison,
45 there were half as many coal-fired plants, with an average generating capacity of more than
46 500 MW.

1 Thermodynamically, the conversion of fossil fuels into electricity is not particularly
2 efficient; that is, a significant amount of usable energy is lost as waste heat in the process. The
3 use of 469 trillion Btu of petroleum products to produce 46 million megawatt-hours translates
4 into an efficiency of about 34% (100% efficiency would require 3,412 Btu per kilowatt-hour).
5 However, due to the nature of the technologies involved, there is relatively little room for
6 efficiency gains using conventional combustion engines.
7

8 Much larger quantities of natural gas are used for electricity generation than petroleum.
9 In 2008, 6,896 billion cubic feet of natural gas, or 7,089 trillion Btu, were consumed in
10 electricity generation — an energy content 15 times greater than that supplied by petroleum.
11 Natural gas use has risen sharply in recent years, growing by an average of 6.3% annually from
12 2003 to 2008. While that rate may seem modest, it was five times greater than the overall
13 increase in electricity generation. Only coal supplied a larger share of the nation’s electricity in
14 2008 (EIA 2010d).
15

16 In terms of generating capacity, natural gas ranks as the largest component of the
17 electricity generation sector, producing 397 million MW in 2008, or 40% of the total. Growth in
18 gas-fired capacity has outpaced overall capacity expansion in recent years (2.2% vs. 1.3% per
19 year), albeit not to the same extent as has generation. Notably, gas generation expanded much
20 more rapidly in the early years of the last decade than in later years, growing more than 16% per
21 year from 1999 to 2003. This was largely in response to the relative flexibility of natural gas
22 power plants, which can be used for baseload, intermediate, or peak generation, and the
23 comparatively favorable environmental profile of such plants compared to coal or nuclear power.
24 As of 2008, there were 1,653 gas-fired power plants in operation in the United States, with an
25 average capacity of about 240 MW (EIA 2010d).
26

27 Electricity generation is somewhat more efficient using gas than oil, with an average
28 42.5% thermodynamic efficiency in 2008. This is partially due to the nature of the combustion
29 engines used for each fuel; since gas engines are more expensive and run more frequently, there
30 is a greater incentive for efficient combustion. However, efficiency has also been rising in recent
31 years as the result of greater use of natural gas combined cycle plants. In a combined cycle
32 plant, the exhaust gases from the gas turbine are used to heat steam which is used to turn a
33 second turbine, thereby capturing the “waste” heat from the first cycle. As these secondary
34 steam turbines are installed in new gas power plants or placed into existing ones, the efficiency
35 of gas-fired electricity generation should continue to improve.
36

37 **Analysis of Energy Substitutes in the Electricity Generation Sector.** As of 2008,
38 natural gas accounted for 40% of electricity generation and petroleum provided an additional
39 1.8%. Both oil and gas fossil fuel generators have an expected lifespan of about 20 to 25 years.
40 In this time frame, therefore, we can expect a complete turnover of the Nation’s oil and gas
41 generators, as well as new additions necessitated by growth in demand. There is significant
42 potential for substitution away from these fuels over that period, depending upon the availability
43 and suitability of other power sources.
44

45 Biofuels represent the most obvious potential substitute for petroleum and gas in terms
46 of fuel characteristics, although, as noted above, they are more likely to be used in the

1 transportation sector, which represents a much larger source of demand. Even assuming
2 significant scale-up of new biofuel production capabilities, the maximum amount available from
3 domestic sources would likely not be enough to meet current levels of both transportation and
4 electricity fossil fuel demand. We therefore exclude biofuels from further consideration here.
5

6 Wind and solar power are more likely alternatives to oil and gas as electricity sources.¹⁸
7 Due to their status as intermittent resources (i.e., generating electricity on an irregular time frame
8 according to the vagaries of weather), however, there are limits to the maximum amount of near-
9 term penetration that these energy sources will likely achieve in a cost-effective manner. A
10 report from the National Renewable Energy Laboratory (NREL) projected that wind power could
11 achieve 20–30% penetration in the eastern United States by 2024, given sufficient investment in
12 transmission upgrades; in the absence of such investment, this level of wind penetration would
13 require significant curtailment (shutting down) of wind plants, with a high associated cost
14 (EnerNex Corporation 2010). Furthermore, a similar study found that 30% wind penetration is
15 technically feasible in the western United States as well, with some modifications to current
16 practice by grid managers (GE Energy 2010). A substantial portion of the long-term wind
17 potential also identified by NREL, 54 gigawatts, is to come from offshore wind. The U.S. has
18 areas appropriate for offshore wind power development near large coastal urban areas. With
19 growing electricity demand and space constraints on land-based electricity generation and
20 transmission, offshore wind is favorably positioned to play a role in meeting future energy
21 demand, though regulatory and permitting requirements may pose challenges in the near term
22 (NREL 2010). In simple terms of magnitude, therefore, wind could theoretically entirely displace
23 oil and gas for electricity generation. Wind is already reasonably cost-competitive with oil and
24 gas, and will become more so if fuel prices rise and/or if climate policy results in a carbon tax or
25 cap-and-trade mechanism. For wind, therefore, the most important constraint will be the ability
26 of the electric grid to accommodate significant amounts of an intermittent resource as well as
27 constructing sufficient transmission infrastructure. Much of the wind potential evaluated by
28 NREL would come from the Great Plains, and while the report emphasizes the benefits of
29 regional integration and coordination, this geographic dynamic suggests that a portion of the
30 wind power is likely to be replacing coal rather than oil or gas.¹⁹ For the coastal areas of the
31 U.S. which rely more heavily on natural gas (and small amounts of oil) for electricity generation
32 than the Midwest for example, any offshore wind development that does come about would help
33 to further reduce dependence on fossil fuels. In addition, some amount of oil or gas will be
34 needed to balance the intermittency of wind resources. Nonetheless, wind power could
35 potentially replace a major portion of oil- and gas-fired electricity generation.
36

¹⁸ This is true in terms of electricity produced and thus fuel used on an ongoing basis; with regard to capacity, it is a more dubious proposition. Since wind and solar are not firm resources, a certain level of natural gas or oil capacity will generally be required as “backstop” resources to protect against grid problems in times when the supply of these renewables cannot meet the instantaneous demand for electricity.

¹⁹ Although coal is a baseload power source, and thus not directly replaceable by a given wind plant, a widely dispersed network of wind plants could provide sufficiently firm power in the aggregate to eliminate the need for a portion of the region’s coal-fired capacity. The NREL report frames its results in terms of smaller increases in capacity of fossil plants, rather than absolute reductions, but it appears that it forecasts wind to displace a mix of coal and gas plants.

1 Solar power, although not expected to play a significant role in electricity generation over
2 the next few years, could become more important, given the right mix of technological
3 improvements and market or policy influences. A study by the research firm Clean Edge, Inc.,
4 and the non-profit Co-op America found that photovoltaic and concentrated solar power could
5 reach 10% of electricity generation by 2025, although this would require a capital investment of
6 hundreds of billions of dollars. As a resource that is generally available during times of peak
7 demand (i.e., warm-weather periods), widespread use of solar power would imply significant
8 displacement of both oil and gas. Such a scenario is dependent on significant cost decreases in
9 the manufacturing process, to be driven both by the realization of economies of scale and by
10 other technological improvements (Clean Edge, Inc. and Co-op America 2008).

11
12 All in all, given favorable conditions, solar and wind power could be used to replace a
13 significant portion of oil and gas used for electricity generation. The technical constraints posed
14 by their status as intermittent resources mean that these energy sources cannot be used to
15 completely replace fossil fuels, however, even with investments in the transmission grid and/or
16 in battery storage. While it is not the aim of this report to develop a detailed forecast, some
17 simple math can illustrate the potential scope of the substitution. The EIA's 2010 Annual
18 Energy Outlook forecasts electricity generation to grow at 1% annually over the next 25 yr
19 (EIA 2009d). At that rate, total electricity generation would be approximately
20 5,389 billion MW-hr in 2035, up from 4,119 billion MW-hr in 2008. If wind is in fact able to
21 reach 20% penetration, and solar to reach 10%, this would imply a total of about 1,078 and
22 539 billion MW-hr, respectively, produced from these sources. (By way of comparison, wind
23 accounted for 1.34% of all generation in 2008, while solar was virtually zero.) If we assume that
24 half of the growth in these renewables replaces oil and gas, and half coal, then this suggests that
25 they could displace 772 billion MW-hr of oil- and gas-fired electricity annually. This could
26 result in more than 80% of the current total produced from these sources, or roughly two-thirds
27 of what would come from these fossil fuels in 2035 if they were to continue to hold their current
28 proportions of total generation.

29
30 Nuclear power represents another potential substitute for natural gas. After years of no
31 new construction, the Nuclear Regulatory Commission is actively reviewing applications for
32 operating licenses for 22 new nuclear power plants; power companies are considering additional
33 plants as well. However, since natural gas is used primarily as an intermediate or peak power
34 source, whereas nuclear power is a baseload resource, the potential for substitution is limited.
35 Furthermore, the extent to which nuclear power will be able to successfully compete with other
36 baseload resources, such as coal or biomass, will depend on climate policy, the relative ease or
37 difficulty of gaining regulatory approval, and fuel cost and availability.

38
39 Finally, we note that climate change and energy policy could have a significant effect on
40 shaping the electricity sector. There are several means by which the industry could be shifted
41 away from natural gas and oil. These include:

- 42
43 • *USEPA regulation of greenhouse gases as criteria pollutants under the CAA.*
44 In April 2009, the USEPA declared CO₂ and five other greenhouse gases to
45 be endangering public health and welfare, setting the stage for the agency to
46 regulate them under the CAA. Electric utilities would be a likely first target

1 for rules that would most likely either take the form of a cap-and-trade system
2 similar to the SO₂ regime already in place or firm facility-level emissions
3 limits. If put in place, such regulations would most likely have the greatest
4 impact on coal, which is more greenhouse gas intensive, and could actually
5 result in greater use of oil and gas as a result (as well as greater use of
6 renewable power sources). The prospects for such regulation are unclear;
7 Congress is considering legislation to preclude the USEPA from issuing such
8 regulations.

- 9
- 10 • *A Nationwide renewable energy standard.* A renewable energy standard, such
11 as that included in the Waxman-Markey climate bill passed by the House of
12 Representatives, would require electric utilities to meet a minimum amount of
13 electricity demand (e.g., 20%) through renewable sources. In this case,
14 natural gas and oil would likely be impacted more heavily, since they are
15 more expensive than coal and thus are more economically inefficient
16 tradeoffs.
 - 17
 - 18 • *Subsidies for renewable energy production.* Finally, policymakers could
19 continue existing incentives for generation from renewable sources, such as
20 the production tax credit of 2.1 cents per kilowatt-hour for wind or the
21 investment tax credit of 30% of the cost of solar installations. This would
22 have largely the same effect (albeit on a more modest scale) as a renewable
23 energy standard, making renewables more cost-competitive compared to other
24 energy sources. Again, as higher-cost resources, natural gas and oil would
25 likely be impacted more heavily than coal.
- 26

27 These or other policy measures will influence the mix of renewables, oil, gas, and other
28 resources in the electricity sector, but they will be unlikely to change the maximum potential
29 levels of substitution described above. Even over a 25-year time horizon, natural gas is likely to
30 contribute a significant portion of electricity generation in the United States.

31

32

33 **4.5.7.1.3 Oil and Gas Uses and Alternatives – Industrial Sector.**

34

35 **Current Use of Oil and Gas in the Industrial Sector.** The industrial sector used
36 1.68 billion barrels of petroleum in 2008, with primary energy use of 8,586 trillion Btu. It
37 consumed a similar 8,149 trillion Btu in natural gas, slightly more than was used for electricity
38 generation. The industrial sector was therefore the second-largest petroleum-consuming sector
39 of the economy after transportation and the highest gas-consuming sector (EIA 2009e, f).

40

41 Industrial oil use peaked in the United States in 1979 at just less than two billion barrels.
42 More recently, levels of consumption have remained relatively steady from year to year; from
43 1998 to 2007, annual industrial petroleum use held between 1.77 and 1.91 billion barrels, a
44 difference of less than 10%. Oil use was lower in 2008, likely due to the broad economic
45 downturn in that year. What has changed over the past decades is the composition of the sector's
46 petroleum inputs. Liquid petroleum gases, or LPGs, have steadily increased as a proportion of

1 total petroleum, from 5% in 1950 to 24.2% in 1980 to 33.3% in 2008. As LPG use has grown,
2 residual fuel oil has virtually disappeared, dropping from 33.4% of industrial oil in 1950 to just
3 1.7% in 2008 (EIA 2009g). Since LPGs are comparatively cleaner than residual fuel oil, this
4 indicates that the net environmental impact of industrial oil use has moderated over time.
5

6 Natural gas use peaked in 1973 at 10,388 trillion Btu, industrial natural gas consumption
7 fell sharply in the late 1970s and early 1980s, before climbing back during the 1990s. Natural
8 gas use has been falling again in recent years, from 9,933 trillion Btu in 1997 to 8,149 trillion
9 Btu in 2008 (EIA 2009f). This could reflect a response to a long-term trend of rising natural gas
10 prices over that time period.
11

12 Oil and gas are used for three broad purposes within the industrial sector: (1) to generate
13 heat and steam for industrial processes, either in boilers or in direct process heating; (2) for
14 heating and air-conditioning of ambient air; and (3) as nonfuel feedstocks for a variety of
15 products, including solvents, lubricants, plastics, asphalt, and various chemicals. Oil and natural
16 gas are also used by many industrial facilities for cogeneration, which produces electricity as
17 well as usable heat and steam to be consumed either onsite or by neighboring facilities. These
18 end uses are discussed in greater detail below.
19

20 **Process Heating.** Process heating is the practice of heating particular materials used in
21 manufacturing, including metals, plastics, and ceramics. Process heating softens, melts or
22 evaporates materials, and may be used to catalyze chemical reactions. This can be accomplished
23 through a variety of equipment types, including furnaces, ovens, dryers, and specially designed
24 heaters for the process in question. Process heating systems may use fuel directly or may be
25 electricity- or steam-based; we consider only direct fuel-burning equipment here.
26

27 Process heating is the largest industrial fuel use of natural gas. Excluding onsite
28 transportation within industrial facilities, electricity generation, and unspecified uses, process
29 heating accounted for 47% of industrial natural gas use in 2006. In 2002 (the date of EIA's
30 previous Manufacturing Energy Consumption Survey [MECS]), this number stood at 49%.
31 Total gas use for process heating dropped by 9% over that time period.
32

33 Process heating is also a major industrial use of petroleum, if nonfuel applications are
34 excluded. Process heating represented 32% of industrial petroleum fuel use in 2006 (once again
35 excluding transportation, electricity generation, and unspecified uses). Petroleum use for process
36 heating dropped 23% from 2002, at which point it had accounted for 42% of industrial petroleum
37 fuel use. If nonfuel applications are included, however, process heating accounted for less than
38 5% of total petroleum use in both 2002 and 2006 (EIA 2009h, i).
39

40 **Boilers and Cogeneration.** Boilers use a fuel source such as oil or gas to produce steam,
41 which is, in turn, used to heat other materials and/or the ambient environment or to drive
42 turbines. Conventional boilers accounted for 28% of industrial petroleum use for fuel in 2006,
43 with cogeneration responsible for another 20%, a total of 48%. The numbers were somewhat
44 lower for natural gas, at 24% and 16%, respectively, for a total of 40%. Again, these figures
45 exclude onsite transportation, non-cogeneration electricity production, nonfuel applications, and
46 unspecified uses. There was relatively little change in these proportions from 2002. Including

1 nonfuel use has only a modest impact on natural gas, but drops the proportion of petroleum use
2 for boilers and cogeneration dramatically, to 4% for boilers and 3% for cogeneration. Both
3 natural gas and petroleum use for boilers and cogeneration were virtually unchanged in absolute
4 terms from 2002 to 2006 (EIA 2009j, k).

5
6 ***Heating, Ventilation, and Air Conditioning (HVAC).*** After process heating and boilers
7 and cogeneration, HVAC is the only significant industrial end use of petroleum and natural gas
8 except use as chemical feedstocks. HVAC accounted for 4% of petroleum and 7% of natural gas
9 fuel use in both 2002 and 2006. The proportion of petroleum use drops to less than 1% when
10 nonfuel applications are factored in. Natural gas use for HVAC saw a modest decline in absolute
11 terms from 2002, matching the overall pattern in industrial gas use, while petroleum remained
12 constant (EIA 2009j, k).

13
14 ***Non-energy Uses.*** While nonfuel applications make up a relatively small proportion of
15 industrial gas use — just 7% in 2006, down from 11% in 2002 — they account for nearly 90% of
16 petroleum consumption. Thus, the use of petroleum products as chemical feedstocks deserves
17 particular attention.

18
19 Over half of the nonfuel consumption of petroleum takes place at petroleum refineries.
20 In addition to various forms of petroleum fuels, refineries also produce a range of
21 petrochemicals, including lubricating oils, paraffin wax, and asphalt and tar; however, the
22 information available is not sufficiently detailed to indicate petroleum use for each of these
23 products (EIA 2009k).²⁰

24
25 The next most significant source of demand is plastics materials and resins, which
26 accounts for nearly 20% of nonfuel petroleum consumption (EIA 2009k). Plastics come in a
27 wide variety of forms and are used for an equally wide variety of applications, but almost all
28 plastics are composed of chains of carbon and hydrogen (sometimes with other elements
29 included). This structure makes petroleum an ideal feedstock for plastics. Most plastic
30 manufacturing processes have very little material waste and incorporate virtually all of the
31 petroleum input into the final product (Graedel and Howard-Grenville 2005).

32
33 The other major consuming sectors of nonfuel petroleum are classified as
34 “petrochemicals” and “other basic organic chemicals.” Again, the information available does not
35 provide any further detail. “Other basic organic chemicals” is also a major nonfuel user of
36 natural gas. However, the most significant nonfuel consumer of natural gas is nitrogenous
37 fertilizers, which are widely used throughout the agricultural sector (EIA 2009k).

38
39 Notably, nonfuel use of both petroleum and natural gas was significantly lower in 2006
40 than in 2002. The most significant decline for each came in chemicals. Detailed information
41 was not available for petroleum. For natural gas, the decline was especially significant in

²⁰ The input source for this sector is classified as “other” in the MECS table regardless of the actual material type (petroleum, natural gas, coal). However, given the function of oil refineries, this energy is almost certainly taken from petroleum products. This discrepancy accounts for much of the “other” nonfuel consumption in the table above.

1 nitrogenous fertilizers (which fell by 40%), basic organic chemicals (which dropped by 54%),
2 and plastics (83%). Although there is less detail, data from earlier years suggests this may be a
3 sustained decrease rather than an isolated phenomenon. There was relatively little change in
4 nonfuel consumption of petroleum at petroleum refineries or for plastics, the only major
5 categories for which data are available for both years (EIA 2009k).
6

7 **Analysis of Energy Substitutes in the Industrial Sector.** Industrial equipment is
8 typically long-lived. The Chartered Institute of Building Services Engineers (CIBSE) lists the
9 “indicative life expectancy” for boilers at 15–25 yr, and gas- or oil-fired furnaces at 15 yr
10 (CIBSE undated). In addition, such equipment often represents a significant expenditure. As a
11 result, turnover rates are relatively low. Only in extreme circumstances would a change in fuel
12 prices prompt a facility manager to replace petroleum- or gas-fired equipment significantly in
13 advance of its planned retirement date. For that reason, we consider any form of fuel switching
14 that would require replacing major equipment for industrial facilities as a long-term possibility.
15

16 The potential for biofuel production has already been discussed in the transportation
17 section and is not repeated in detail here. Biofuels could displace a significant portion of
18 petroleum use over the next 25 yr, perhaps up to 30% of total nationwide consumption, but most
19 petroleum substitution will take place in the transportation sector. Most likely there is
20 comparatively little room for expanded biofuel use in the industrial realm. Furthermore, due to
21 the limits on potential biofuel supply (based on available land to dedicate to growing fuel crops),
22 if overall biofuel use does approach the upper boundary of 30%, any substitution of biofuels for
23 petroleum that did happen in the industrial sector would come at the expense of similar
24 substitution elsewhere. This would be true for bio-based inputs for plastics manufacturing as
25 well as for fuel use.
26

27 Industrial facilities could also use equipment powered by electricity instead of oil- and
28 gas-fired equipment. Given that most industrial oil- and gas-using equipment is used simply to
29 provide heat (e.g., for process heating or in boilers), such a move would generally be
30 thermodynamically inefficient; while electricity generation and consumption produce
31 considerable energy losses, combustion for heat is far more efficient at using embodied energy
32 from a fuel source. Even so, electricity is a viable option, and if generated from renewable
33 sources, it may result in lower environmental impacts.
34

35 For non-fuel uses such as plastics, there may be greater potential for substitution away
36 from petroleum. The manufacture of bio-based plastics, mostly produced from starch, sugar, and
37 cellulose, increased by 600% between 2000 and 2008, although they still represent a small
38 proportion of total plastics (Ceresana Research 2009). Globally, demand for bio-plastics is
39 forecast to grow at approximately 25% annually from 2010 to 2015 (Pira International 2010).
40 This suggests the potential for bio-based plastics to replace a portion of conventional plastics.
41

42 Plastics manufacturing accounted for the equivalent of 1,198 trillion Btu of petroleum
43 consumption in 2006. While it is not clear what proportion of total plastic produced in the
44 United States currently derives from non-petroleum sources, 5–10% appears to be reasonable,
45 based on global estimates (U.K. National Nonfood Crop Centre 2010; Nova Institute 2009).
46 From this base, the projected growth rates in bio-plastic manufacture just reported would suggest

1 that an additional 130–260 trillion Btu of petroleum for plastics manufacturing could be replaced
2 by biological feedstocks over the next 5 years. This amounts to approximately 1.5–3% of total
3 industrial petroleum use (EIA 2009g).

4
5 Increased plastic recycling would be a form of substitution away from industrial
6 petroleum use. A recent report on the European plastics industry notes that Germany recycled
7 the highest proportion of its post-consumer plastic waste of any European country, at 33.9%; an
8 additional 60% of Germany's plastic waste was sent to waste-to-energy plants (PlasticsEurope,
9 EuPC, EuPR, and EPRO 2010). Compared to the United States' current 7.1% recycling rate, this
10 would constitute an ambitious goal. We therefore use it as an upper boundary on the potential
11 for long-term recycling in the United States.

12
13 Thirty million tons of plastic waste was generated in the United States in 2009; this figure
14 has held relatively constant in recent years (USEPA 2010b). If this level of waste production
15 continues into the future, 33.9% recycling would represent an increase of 26.8% above current
16 levels, or an additional 8 million tons of plastic. This level of recycling would save 192 trillion
17 Btu of petroleum, or about 2.2% of total industrial petroleum use (EIA 2009g).

18 19 20 **4.5.7.1.4 Residential and Commercial Sector.**

21
22 **Uses of Oil and Gas in the Residential and Commercial Sector.** Oil and gas use in
23 residences and commercial establishments is dominated by only a few particular end uses. There
24 has been a long-term shift away from oil use and toward electricity in these applications, while
25 natural gas use has not changed as dramatically. The potential substitutes for commercial and
26 residential use of oil and gas are also similar to those for the commercial sector, consisting
27 mainly of electricity and biogas, although efficiency could also be considered a feasible
28 substitute in certain applications.

29
30 The commercial and residential sectors consume negligible amounts of petroleum
31 compared to the transportation and industrial sectors, but contribute more substantially to
32 gas consumption. Residences used 1,204 trillion Btu of petroleum in 2008; commercial
33 buildings used another 638 trillion Btu, for a total of 1,842 trillion Btu (378 million barrels)
34 (EIA 2009l, m). This amounts to just 5% of nationwide petroleum consumption (EERE 2011a).
35 For natural gas, the residential sector consumed 4,989 trillion Btu in 2008 and the commercial
36 sector consumed 3,211 trillion Btu, for a total of 8,200 trillion Btu (EIA 2009l). Combined,
37 these sectors accounted for 34% of gas consumption, nearly equivalent to industrial levels and
38 more than electricity generation (EERE 2011b).

39
40 Petroleum consumption has been falling steadily in both the residential and commercial
41 sectors since the early 1970s. Residential petroleum consumption reached its highest point in
42 1972, at 2,856 trillion Btu, while commercial use peaked one year later at 1,604 trillion Btu.
43 Overall oil use has fallen by nearly 60% for both sectors since that time (EIA 2009l).

44
45 Most residential petroleum and natural gas use is for space heating and water heating. To
46 a lesser extent, these fuels are also used for appliances such as ranges, ovens, and refrigerators.

1 Similarly, commercial gas and oil use is dominated by space heating and water heating, with
2 additional small amounts for cooking and miscellaneous other applications. Electricity was
3 another major energy source for these applications.
4

5 **Space Heating.** Space heating is the most significant use of petroleum and natural gas in
6 both the residential and commercial sectors. Space heating accounted for three-fourths of all
7 residential oil use and 62% of residential gas use in 2005. Electricity use for space heating was
8 comparatively small. A similar proportion of natural gas use in the commercial sector was for
9 space heating in 2008 (63%), but oil use was minimal and electricity more substantial
10 (EIA 2009n; EERE 2011c).
11

12 The proportion of homes with natural gas as their primary heating fuel has declined only
13 slightly over the past several years. In 1980, 55% of homes used gas for space heating; in 2005
14 the number stood at 52%. The proportion of homes using oil has been cut nearly in half, from
15 20% to 12%. Perhaps surprisingly, given the low total amount of electricity used for residential
16 space heating, 30% of homes used electricity as their primary heating type in 2005, a figure that
17 has climbed steadily since 1980 (EIA 2009p). The apparent mismatch between total
18 consumption and proportional use suggests that electricity is used for heating primarily in areas
19 with mild winters, and thus low heating demand.
20

21 **Water Heating.** After space heating, water heating is the other most significant end use
22 of oil and gas in the residential and commercial sectors, comprising 21% of residential oil use
23 and 29% of residential gas use in 2005. In the commercial sector, water heating used negligible
24 amounts of oil, but accounted for 18% of natural gas use in 2008 (EIA 2009n; EERE 2011c).
25

26 As might be expected, the proportion of homes that use natural gas for water heating is
27 similar to space heating, 53% in 2005. This has remained essentially unchanged since 1980.
28 Just 8% of homes use petroleum for water heating, down from 13%. The remaining 39% of
29 homes relied on electricity for water heating in 2005, a modest increase from 33% in 1980. Less
30 than 1% of homes used other energy sources, such as solar water heating (EIA 2009p).
31

32 **Cooking and Appliances.** Cooking and appliances represent the final major end uses of
33 residential and commercial gas. About 9% of residential and 7% of commercial gas use went
34 toward cooking and appliances; residences also used a small amount of petroleum for these
35 purposes. There is no information readily available on the proportion of homes using oil, gas,
36 and other fuels for these end uses. In absolute terms, however, natural gas for appliance
37 applications grew by about 20% from 1980 to 2005, less than the rate of population growth.
38 Meanwhile, oil use remained essentially unchanged and electricity use increased by 80%
39 (EIA 2009n; EERE 2011c). The rise in total electricity use could be due in part to increased
40 per-capita consumption, but it seems more likely that, matching the trend with space heating and
41 water heating, an increasing proportion of homes are using electricity rather than oil or gas as
42 their primary fuel. It would stand to reason that a home that used gas (or oil) for one major end
43 use would be more likely to use it for others as well.
44

45 **Analysis of Energy Substitutes in the Commercial and Residential Sector.** Furnaces
46 and boilers, water heaters, and cooking appliances — the equipment directly responsible for oil

1 and gas consumption in the commercial and residential sectors – are durable, long-lived goods.
2 Water heaters have an average life span of 13 years, while furnaces, boilers, and range/ovens
3 typically last for 20 years or more (California Energy Commission undated a). Such items also
4 represent significant investments for most buyers. Thus, similar to industrial consumers,
5 residential and commercial consumers would be unlikely to replace their oil- or gas-fired
6 equipment any earlier than necessary except under extreme conditions. For that reason, we
7 consider any fuel-saving strategy that required major new equipment to be a long-term process.
8 Commercial and residential consumers will have an opportunity to shift away from oil- and gas-
9 fired equipment when their space and water heating equipment and appliances reach the end of
10 their useful lifespan. Construction of new building stock and renovations of existing buildings
11 allow further prospects for substitution.

12
13 The easiest mode of substitution would be to replace oil- or gas-fired space and water
14 heating equipment and appliances with electric-powered units, which are readily available and
15 widely used. As noted above, 30% of households used electricity as the primary energy source
16 for space heating in 2005, and 39% used it for water heating. Both of these proportions have
17 been growing over the past several years (EIA 2009p).

18
19 However, in most cases there is no clear advantage for any given residence or
20 commercial building to switch to electricity, which is thermodynamically inefficient at delivering
21 heat. The Federal Energy Management Program (FEMP) estimates the annual energy cost of a
22 typical gas water heater as at approximately half the cost of an electric unit (EERE 2010), while
23 the California Energy Commission reports that electricity usually costs three times as much as
24 gas (California Energy Commission undated b). While gas water heaters are generally more
25 expensive up front, the difference in fuel costs outweighs this initial price premium. Similarly,
26 higher operating costs mean that electric furnaces and electric oven/ranges are generally
27 uneconomical compared to gas or oil units (EERE 2011d; California Energy Commission
28 undated c). Nonetheless, electricity remains a viable, if unlikely, substitute for these end uses.
29 The associated environmental impacts would depend on the fuel mix used to produce the
30 electricity. These issues have been discussed previously, and we do not repeat them here.

31
32 A second substitute comes in the form of renewable energy, and specifically, solar water
33 heaters. Solar water heaters use collectors to gather solar energy, which is then used to heat
34 water in a storage tank. Active solar water heaters contain a circulating pump, while passive
35 systems do not. Although solar water heaters are most effective in warm, sunny areas such as
36 Florida or California, they can be used in colder locations as well; Germany, for example, has
37 more than 9,800 MW(t) of solar thermal capacity installed, while Austria has more than
38 3,200 MW(t); most, but not all, of this is for water heating (Eurobserv'er 2011). In the
39 United States, all 50 States have some form of incentive for solar water heating systems, while
40 the Federal Government provides a tax credit covering 30% of the installed cost of such systems
41 (N.C. Solar Center and Interstate Renewable Energy Council, undated).

42
43 Solar water heaters usually have a gas or electric backup, to provide supplemental heating
44 on cloudy days, in cold seasons, or in high-demand hours. As a result, they do not eliminate gas
45 use entirely; the Solar Rating & Certification Corporation and the Energy Star program both
46 estimate that typical solar water heaters cut gas consumption in half (Solar Rating and

1 Certification Corporation undated; USDOE and USEPA undated a). If applied nationwide, this
2 would imply residential gas savings of 700 trillion Btu and an additional oil savings of
3 150 trillion Btu. Solar water heating in the commercial sector could contribute modest further
4 savings. For example, a 10% adoption, with savings of 70 trillion and 15 trillion Btu, would
5 represent an enormous increase over current levels (less than 1% of U.S. homes used solar water
6 heaters in 2005) (EIA 2009p). However, this would require massive policy support; without
7 generous tax credits or other incentives, the higher upfront cost of a solar water heating system
8 would make it uneconomical for most consumers to purchase them, especially in less favorable
9 climates, therefore, wide-spread adoption of the use of solar water heating is at present unlikely.

10
11 The other options for long-term substitution involve improvements to the building stock
12 itself. Improved building envelope efficiency has already been discussed as a short-term option.
13 We estimated above that if 200,000 homes per year are renovated, the resulting savings could
14 reach 8.5 trillion Btu annually after 5 yr. Simply extending this trend to a 25-yr period would
15 indicate that renovations to 5 million homes could save 42.5 trillion Btu in oil, gas, or electricity
16 used for space heating. Of course, a more aggressive approach covering more homes would see
17 proportionally greater impacts.

18
19 Over the long run, the building stock will also go through a more fundamental
20 transformation, as new buildings are built to replace aging ones and to accommodate population
21 growth. One well-regarded analysis estimates that 89 million new or replaced homes and
22 190 billion ft² of nonresidential building will be constructed by 2050, and that two-thirds of
23 buildings that will exist at that time did not exist in 2007 (Ewing et al. 2008). For context, in
24 2005 there were an estimated 111 million households nationwide (EIA 2009p).

25
26 Given the massive scale of building expected, more efficient construction could produce
27 substantial savings in oil and gas use for space heating (as well as electricity, for both heating
28 and cooling). This could take the form of a greater number of high-efficiency buildings, such as
29 those constructed to the Energy Star or Leadership in Energy and Environmental Design
30 (LEED), managed by the EPA and the Department of Energy (USDOE and USEPA undated b),
31 and the U.S. Green Building Council's LEED family of standards (U.S. Green Building
32 Council 2011a). Further, improvements to building codes that raise minimum performance
33 requirements for all buildings would contribute to substantial savings in oil and gas use for space
34 heating.

35
36 Specifically, the Energy Star program reports that 14,475 commercial buildings are
37 currently Energy Star-certified, which means they must be more efficient than 75% of
38 comparable buildings nationwide. This is roughly equivalent to 25% less energy use. As of
39 March 2011, there were just over 30,000 registered commercial LEED building projects. A
40 2008 study found that, while there was considerable variation between projects, the average
41 LEED-certified commercial building had energy use 25% below that of conventional buildings
42 (Turner and Frankel 2008). Overall then, we can assume that new commercial buildings meeting
43 either the LEED or the Energy Star standard will result in at least a 25% reduction in energy use
44 below current levels.

1 Both Energy Star and LEED also have programs addressing homes. Energy Star homes
2 must be at least 15% more efficient than the 2004 International Residential Code, but with the
3 additional energy-saving features included, they are, again, typically 25–30% more efficient than
4 standard homes. There are currently more than 1 million Energy Star homes in the United States
5 (USDOE and USEPA undated c). The LEED for Homes program has not been as popular, with
6 just under 50,000 registered homes as of March 2011. As with commercial buildings, LEED
7 measures energy gains versus standard new buildings. It estimates an average of 30% energy
8 savings for LEED-certified homes (U.S. Green Building Council 2011b).

9
10 We can safely assume that most if not all new residential and commercial buildings will
11 meet the stricter minimum standards envisioned by the latest IECC and ASHRAE energy codes.
12 Meanwhile, the overall impact of LEED, Energy Star, and other voluntary green building
13 standards will depend on market penetration. While not attempting a definitive analysis, we can
14 make some rough, order-of-magnitude approximations to demonstrate the scale of potential
15 savings. If, over the next 25 years, half of all currently existing residences and commercial
16 buildings are replaced, through new construction or retrofits, with buildings that are 25% more
17 efficient in space heating (a conservative estimate, since space heating will likely account for a
18 disproportionate level of total energy savings), this would translate into an aggregate 12.5%
19 reduction in space heating energy demand, or about 564 trillion Btu of natural gas and
20 164 trillion Btu of oil. If 10% of these buildings met Energy Star and/or LEED standards and
21 realized a further 25% improvement from the new baseline, they would save an additional
22 42 trillion Btu of natural gas and 12 trillion Btu of oil from space heating. In total, then, under
23 these assumptions, more efficient new buildings could save approximately 782 trillion Btu of oil
24 and natural gas per year within 25 years.

25 26 27 **4.5.7.2 Analysis of the Environmental Effects of the No Action Alternative**

28
29 The selection of the No Action Alternative would eliminate all oil and gas activities that
30 were projected to occur under the Program. OCS-related activities could still occur, however, in
31 these areas as a result of leasing activity during previous and future programs. At the same time,
32 the No Action Alternative would require energy substitutes to replace the oil and gas production
33 that would not occur as a result of the Program. The energy substitutions would be associated
34 with their own potential environmental impacts that could occur within or outside program areas
35 that were considered in the proposed action.

36
37
38 **4.5.7.2.1 Energy Substitutions for OCS Oil and Gas.** With less oil and gas available
39 from the OCS under the No Action Alternative, consumers could obtain oil and gas from other
40 sources, substitute to other types of energy, or consume less energy overall. Similarly, energy
41 production may shift from OCS oil and gas to onshore oil and gas, overseas oil and gas
42 production, or domestic production of oil and gas alternatives (e.g., coal). Each of these shifts in
43 consumption and production relative to the proposed action yield environmental impacts that this
44 section evaluates.

1 The process for calculating these impacts begins with the application of MarketSim, a
2 multi-market equilibrium model that simulates the energy supply, demand, and price effects of
3 OCS oil and gas production compared with baseline projections from the EIA’s Annual Energy
4 Outlook. In addition to simulating oil and natural gas markets, MarketSim includes separate
5 modules for coal and electricity, enabling the model to capture the broad effects of the No Action
6 Alternative across individual segments of the energy market. Modeling each of these sectors,
7 MarketSim produces an estimate of the energy market’s response to the absence of production
8 that would occur as a result of the No Action Alternative.
9

10 Table 4.5.7-1 presents the changes in energy markets projected by MarketSim for the
11 No Action Alternative. The table presents the quantities of the energy sources that would be
12 used to replace the lost production of OCS hydrocarbons under the NAA. The quantities of
13 domestic onshore production of both oil and natural gas is projected to increase but will make up
14 for only a fraction of foregone OCS production. To ensure that demands for oil and gas are met,
15 MarketSim projects a sharp increase in oil and gas imports under the No Action Alternative, via
16 both tanker and pipeline. The model also projects that the reduction in OCS oil and gas
17 production under the No Action Alternative will be replaced by an increase in domestic coal and
18 electricity production and by energy conservation.
19
20

21 **TABLE 4.5.7-1 Cumulative Energy Substitutions**
22 **for Oil and Gas Under the No Action Alternative**

Energy Sector	Quantity ^a	Replacement Percent (%)
Domestic Onshore Oil	53–402	1–3
Domestic Onshore Gas	759–2,326	13–17
Oil Imports	3,540–7,870	56–62
Gas Imports	458–1,224	8–9
Other	108–274	2
Coal	335–925	6–7
Electricity ^b	146–388	3
Reduced Demand ^c	330–814	6

^a Quantities expressed as energy equivalents of a million bbl (Mbbbl) of oil. Values derived from MarketSim output rounded to the nearest Mbbbl. Range of values based on price assumptions of \$60 and \$160/bbl for oil and \$4.27 and \$11.39 per million cubic feet of gas. Quantities were calculated for a 40 year time period, which is slightly different than the 40-50 year assumed life of the program.

^b Electricity generated from sources other than oil, gas or coal such as nuclear, hydro, solar and wind.

^c Demand reductions resulting from energy conservation.

1 MarketSim projects that natural gas consumption will decline, while domestic
2 consumption of oil, coal, and electricity will increase. Given that domestic oil production
3 declines under the No Action Alternative, the increase in oil consumption may be somewhat
4 unexpected. This increase in consumption reflects the fact that oil and gas are substitutes within
5 the industrial sector and, to a lesser extent, the residential and commercial sectors. Therefore, as
6 natural gas prices increase under the No Action Alternative, consumption of substitutes,
7 including oil, increases. The increase in oil prices under the No Action Alternative may cause
8 substitution in the opposite direction (i.e., from gas to oil), but the impact of increased gas prices
9 is the more dominant of the two effects.

10 11 12 **4.5.7.2.2 Impact Analysis.** 13

14 **Oil Spills.** Table 4.5.7-2 shows the amount of oil projected to be developed in the
15 planning areas considered in the Program and the amount of additional oil imported into
16 planning areas that would be at risk from tanker spills because of their location relative to ports
17 and terminals that would receive oil imports under the No Action Alternative. The table presents
18 volumes of oil as a single quantity, rather than as a range of values, to simplify the comparison of
19 quantities. The number of oil spills greater than 1,000 bbl that could result from import tanker
20 accidents under the No Action Alternative and from accidents at OCS facilities and pipelines
21 under the Proposed Action are presented. The number of spills was calculated by applying oil
22 spill rates to the volume of OCS production and to the volume of import tankering projected
23 under the two alternatives. Notably, the GOM is projected to experience four fewer large spills
24 under the No Action Alternative. Part of this reduction is explained by the fact that the volume
25 of oil imports under the No Action Alternative is smaller than the precluded volume of OCS oil
26 that would have been produced under the No Action Alternative. Another factor is that tankering
27 has a lower spill risk than OCS production in part because OCS production includes the risk of
28 spills during both the production and the transportation phases, while tankering involves only
29 risk during transportation. The production risk associated with oil import substitutes would
30 occur in oil-exporting nations. It is interesting to note that while the Central GOM Planning
31 Area accounts for most of the OCS oil production, and therefore would experience the greatest
32 amount of reduction in oil spill risk under the No Action Alternative, the Western GOM
33 Planning Area would experience the greatest amount of risk from the increased import tankering
34 that is projected to occur.
35

36 Cook Inlet is projected to produce a small amount of oil under the proposed action and to
37 import a small amount of oil as an energy substitute under the No Action Alternative. As a
38 result, there would be no appreciable difference in oil spill risk between the two alternatives.
39 Since there are no oil import ports or terminals in the Alaskan Arctic program area, the No
40 Action Alternative would eliminate the risk from OCS sources without introducing any risk from
41 oil tankers. It is important to keep in mind, however, that a reduction in the risk of oil spills from
42 OCS production redistributes, rather than totally eliminates, the spill risk. As Table 4.5.7-2
43 shows, the Atlantic and Pacific coasts could each be exposed to an additional import tanker spill
44 occurrence along these coasts under the No Action Alternative, whereas these areas would have
45 no exposure to oil spill risk from OCS activities under the proposed action.
46

1
2

TABLE 4.5.7-2 Projected Large Spill Occurrences under the No Action Alternative

Planning Area	Volume of Oil at Risk for Spill ^a (Bbbl)		Change in Spill Occurrence under the No Action Alternative ^a
	Proposed Action	Oil Imports	
Atlantic Coast	0	1.3	
North Atlantic	0	0.6	+1
Mid-Atlantic	0	0.5	
South Atlantic	0	0.1	
Straits of Florida	0	0.1	
Total Atlantic Coast	0	1.3	+1
Gulf of Mexico	4.1	2.7	
Central GOM	3.2	0.7	-2
Western GOM	0.8	1.9	1
Eastern GOM	<0.1	<0.1	0
Total GOM	4.1	2.7	-1
Pacific/South Alaska Coasts	0	1.6	
Southern California	0	0.4	+1
Central California	0	0.5	
Washington/Oregon	0	0.4	
Gulf of Alaska	0	0.2	
Shumagin	0	0.1	
Total Pacific/South Alaska Coasts	0	1.6	+1
Alaska Program Areas			
Cook Inlet	0.2	0.1	0
Arctic	1.6	0	-2
Alaska Program Area	1.8	0.01	-2

^a OCS spill rate calculated as platform spill rate (0.25 spills/Bbbl) plus the pipeline spill rate (0.88 spills/Bbbl) since spills could occur at the platform or during transport. The tanker spill rate was calculated as 0.34 spills/Bbbl in lower 48 and 0.46 spills/Bbbl in Alaska.

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Routine Operations. Routine OCS operations, such as installing offshore facilities and pipelines, transporting materials and personnel from the coast to offshore, and conducting seismic surveys, are associated with impact factors that could have potential environmental effects. The effects of noise, collisions with service vessels, air emissions, drilling and production discharges, and other impact factors associated with OCS activities were analyzed in Section 4.4 of this draft PEIS. With no new OCS activity occurring under the No Action Alternative, the potential for impacts from these factors would be eliminated within the program areas considered in the proposed action. The elimination of potential impacts in these program

1 areas could redistribute a range of other environmental impacts that would result from the
2 development and transportation of energy substitutions. These impacts could occur on or near
3 the OCS, or elsewhere. While insufficient data are available for quantification of these
4 substituted impacts, some issues of particular environmental concern from energy substitutions
5 are listed below.
6

7 ***Acid Mine Drainage from Coal Mining.*** Runoff from coal mining sites may increase the
8 acidity of surface waters near and downstream from coal mining sites, adversely affecting habitat
9 for aquatic organisms and limiting human recreational uses.
10

11 ***Contamination of Groundwater from Oil and Gas Extraction.*** The extraction of oil and
12 gas from onshore sources can, in some cases, lead to the contamination of local groundwater
13 supplies. For example, focusing on shale gas extracted from wells in Pennsylvania and New
14 York, Osborn et al. (2011) found that average methane concentrations in drinking water wells
15 increased with proximity to the nearest gas well and were 17 times greater than wells not located
16 near extraction sites (Osborn et al. 2011). In addition, oil and gas wells may lead to groundwater
17 contamination from accidental spills, losses of well control, and/or pipeline leaks.
18

19 ***Water Discharges from Oil and Gas Operations.***²¹ To facilitate resource extraction
20 from subsurface formations, oil and gas producers use water to develop pressure, causing oil and
21 gas to rise to the surface (e.g., enhanced oil recovery and hydraulic fracturing). Producers must
22 manage these waters as well as waters extracted from geologic formations during oil/gas
23 extraction. The environmental impacts associated with this “produced water” vary based on the
24 geologic characteristics of the reservoir that produced the water and the separation and treatment
25 technologies employed by producers.
26

27 ***Coal Combustion Impacts.*** Coal consumed in place of gas under the No Action
28 Alternative will result in environmental costs associated with diminished air quality and the
29 disposal of coal combustion residuals. The combustion of coal in power plants or industrial
30 boilers produces higher emissions of NO_x, SO_x, and PM than the combustion of natural gas and
31 results in greater CO₂ emissions.²² In addition, coal combustion residuals generated by power
32 plants or coal-fired industrial boilers may pose a risk to local groundwater supplies when
33 disposed in surface impoundments or landfills when such units are not properly maintained.
34

35 ***Socioeconomic and Sociocultural Effects.*** Sections 4.4.9.1 and 4.4.13.1 describe the
36 effects of the proposed action on socioeconomic and sociocultural conditions, respectively, in the
37 GOM. OCS oil- and gas-related activities have been an important source of employment and
38 income in GOM coastal areas. According to Henry et al. (2002), the nature of blue-collar jobs in
39 the oil and gas industry has been instrumental in the formation and persistence of Cajun culture
40 in South Louisiana. The No Action Alternative would result in reduced employment and income
41 opportunities and potentially could affect the stability and cohesion of communities and cultures.
42 The No Action Alternative could also be interpreted as a boom-bust event. The infrastructure

²¹ This discussion is based on USEPA (2008).

²² For detailed emissions data for power plants, see USEPA (2010d).

1 and population of affected areas in the GOM have developed over decades in association with a
2 regular occurrence of lease sales and resulting OCS activities. The No Action Alternative could
3 result in situations in which local infrastructure and populations could not be maintained,
4 resulting in out-migration and a reduction in public services. Furthermore, the No Action
5 Alternative's disruption of a continuous process of activity in the GOM could affect future
6 investments which would compound the social, economic, and cultural effects associated with
7 the No Action Alternative.
8

9 **Conclusion.** No potential impacts from routine operations or from accidental discharges
10 described in Section 4.4 would occur under the No Action Alternative. Most of the oil that was
11 projected to be developed in the Arctic under the Proposed Action would be replaced by tanker
12 imports that would offload at U.S. ports, none of which are located within the arctic area. Under
13 the NAA, arctic program areas would therefore not receive any impacts from the Program or
14 from energy substitutions such as tankering. The spill risk associated with replacing the lost
15 OCS Arctic oil production would be transferred to other Planning Areas along the Atlantic,
16 GOM, and Pacific coasts where increases in oil imports and associated risks of tanker spills
17 would occur. The Pacific and Atlantic coasts would each be exposed to the risk of one additional
18 tanker spill under the NAA. About two-thirds of the lost OCS production in the GOM would be
19 replaced by tanker imports into GOM terminals. The spill risk from tankering would be greater
20 in the Western GOM Planning Area than in the Central GOM based on the location of terminals.
21 There would be effects of the NAA on socioeconomic conditions in the GOM and potential
22 effects on community cohesion and levels of public services available there. The potential risk
23 from impacts associated with routine OCS operations and activities removed under the NAA
24 would be transferred to other areas within and beyond the OCS where energy substitutes such as
25 imported and onshore oil and gas, and coal would be developed and transported.
26
27

28 **4.6 ENVIRONMENTAL IMPACTS OF THE CUMULATIVE CASE**

29
30

31 **4.6.1 Cumulative Case Scenario**

32

33 Cumulative effects are the impacts on the environment that result from the incremental
34 impact of the proposed action when added to other past, present, and reasonably foreseeable
35 future actions regardless of what agency, industry, or person undertakes the other actions. The
36 cumulative analyses presented in this chapter evaluate OCS activities associated with the
37 Program (the proposed action), as well as activities resulting from other past and future 5-yr OCS
38 programs that could occur over the next 40 to 50 yr. It is reasonable to analyze cumulative
39 impacts in the context of the proposed action (Alternative 1) because of all the action
40 alternatives, it proposes the most geographically extensive lease sale scenario under the Program
41 (and presumably, the most extensive potential impacts). The cumulative analyses also evaluate
42 impacts from activities and processes that are not related to OCS development. These activities
43 and processes will be identified in the following analyses where they apply. There are some
44 activities and processes, however, that are pandemic actions (oil and gas programs in State
45 waters and imported oil), emerging trends affecting multiple-use issues on the OCS (alternate
46 energy), or phenomena that could affect the regional geophysical environment (climate change).

1 Because these activities have widespread importance as potential cumulative impacting factors,
2 we describe them in this section to provide a framework for their inclusion in the appropriate
3 cumulative analyses.

6 **4.6.1.1 OCS Program Oil and Gas Activities**

7
8 Tables 4.6.1-1 and 4.6.1-2 show the numeric estimates for all OCS program activities for
9 the GOM and Alaska, respectively, that could occur on the OCS over the next 40 to 50 yr. These
10 estimates include activities that will be part of the Program, as well as those from previous and
11 future 5-yr programs. It should be noted that the cumulative scenario for the arctic planning
12 areas reflects inherent uncertainty about the future of OCS oil and gas activities. To date, there
13 have been no activities on the arctic OCS due largely to operational issues related to the extreme
14 environmental conditions as well as legal issues associated with approving activities in the
15 region. Table 4.6.1-2 presents the exploration and development scenarios for the cumulative
16 case and the proposed action for Alaska; the values for the cumulative case reflect a small
17 increase in activity in Alaska as a result of future leasing beyond the Program. These values are
18 for analytical purposes only and are not intended as forecasts of future activity. At this time,
19 future activity is unpredictable and could span a considerable range. Transportation and other
20 scenario assumptions that were used in the proposed action explanation and development
21 scenario and impact analyses (Section 4.4.1) also apply to the cumulative analyses.

22
23 Estimates of the assumed numbers of large and small oil spills that could result from all
24 OCS oil and gas activities are presented in Table 4.6.1-3. The source and number of assumed
25 OCS spills were based on the volume of anticipated oil production in each region, the assumed
26 mode of transportation (pipeline and/or tanker), and the spill rates for large spills. Assumptions
27 regarding the number of large oil spills from import tankers were based on the estimated level of
28 crude oil imports and worldwide tanker spill rates. We assume that these spills would occur with
29 uniform frequency over the life of the proposed action.

30
31 There are currently a total of 29,097 lease blocks in the GOM OCS Planning Areas; of
32 these, 7,800 are active (Section 4.4.1.1). Shallow-water oil production in the GOM OCS has
33 been in decline since 1997, and is expected to be offset by deepwater production over the life of
34 the proposed action. Over the next 5 yr, BOEM projects that GOM OCS oil production will
35 exceed 1.7 Mbbl/day (620 Mbbl annually). Gas production is expected to increase, then level off
36 to about 8 Bcf/day (2,920 Bcf annually) (Karl et al. 2007).

37
38 The Cook Inlet Planning Area has had oil and gas operations in State waters since the late
39 1950s and currently has a well-established oil and gas infrastructure. The most recent sale in
40 which leases were purchased occurred in 1997 (when two leases were purchased). A lease sale
41 was held in 2004, but no leases were purchased (Section 4.4.1.2). There are currently no existing
42 OCS activities in Cook Inlet.

43
44 There has been no oil and gas development activity in the arctic Program areas. Since
45 1979, 10 lease sales have been held in the Beaufort Sea Planning Area and three in the Chukchi
46 Sea Planning Area, but no activity has resulted to date (Section 4.4.1.3).

1
2

TABLE 4.6.1-1 Offshore Exploration and Development Scenario for the OCS Program GOM Cumulative Case and Proposed Action^a

Scenario Elements	Cumulative Case	Proposed Action
Years of activity	40–50	40–50
Oil (Bbbl) ^b	18–26	2.7–5.4
Gas (Tcf) ^c	76–112	12–24
Platforms	1,400–2,000	200–450
FPSOs ^d	1–6	0–2
No. of exploration and delineation wells	6,900–9,800	1,000–2,100
No. of development and production wells	8,500–12,000	1,300–2,600
Miles of pipeline	19,000–43,000	2,400–7,500
Service vessel trips/week	1,400–1,900	300–600
Helicopter trips/week	12,000–24,000	2,000–5,500
New pipeline landfalls	0–40	0–12
New natural gas processing facilities	0–14	0–12
Platforms removed with explosives	870–1,200	150–275
<i>Drill Muds/Well (tons)</i>		
Exploration and delineation wells	1,000	1,000
Development and production wells	1,000	1,000
<i>Drill Cuttings/Well (tons)</i>		
Exploration and delineation wells	1,200	1,200
Development and production wells	1,200	1,200
<i>Produced Water/yr (Mbbbl)^e</i>		
Oil well	19,000–27,000	73–140
Natural gas well	161–247	26–52
<i>Bottom Area Disturbed (ha)^f</i>		
Platforms	960–12,000	150–2,500
Pipeline	9,500–69,000	2,000–11,500

^a Values for the cumulative case represent the proposed action (under the 2012 to 2017 OCS program) and actions associated with ongoing and future OCS program oil and gas activities.

^b Bbbl = billion barrels.

^c Tcf = trillion cubic feet.

^d FPSOs = floating, production, storage, and offloading systems.

^e Based on 1.04 bbl produced water/bbl of oil, and 86 bbl produced water/1 Mcf gas (Clark and Veil 2009); Mbbbl = million barrels. Calculations based on the total volume of oil or gas produced; actual discharges at a well are highly variable depending on geologic formation and age of well.

^f Assumes 0.7–6 ha (1 ac) per platform and 0.5–1.6 ha (1.2–2.5 ac) per mile of pipeline.

TABLE 4.6.1-2 Offshore Exploration and Development Scenario for the OCS Program Alaska Cumulative Case and Proposed Action^a

Scenario Elements	Arctic Region				South Central Alaska Region	
	Beaufort Sea		Chukchi Sea		Cook Inlet	
	Cumulative Case	Proposed Action	Cumulative Case	Proposed Action	Cumulative Case	Proposed Action
Years of activity	40–0	40–50	40–50	40–50	40–50	40–50
Oil (Mbbbl) ^b	500–1,350	200–400	1,500–7,700	500–2,200	100–200	100–200
Gas (Tcf) ^c	0–7.0	0–2.2	0–31	0–8.0	0–0.68	0–0.68
Platforms	2–12	1–4	3–20	1–5	1–3	1–3
No. of exploration and delineation wells	12–48	6–16	12–66	6–20	6–12	6–12
No. of platform production wells	90–375	40–120	180–1,100	60–280	42–110	42–110
No. of subsea production wells	20–30	10	54–290	18–82	0	0
Miles of new offshore pipelines	50–520	30–155	150–1,300	25–250	25–150	25–150
Miles of new onshore pipelines	40–375	10–80	250–750	0	50–105	50–105
Service vessel trips/week ^d	1–18	1–12	1–23	1–15	1–3	1–3
Helicopter trips/week	1–18	1–12	1–23	1–15	1–3	1–3
New pipeline landfalls	0	0	0	0	0–1	0–1
New shore bases	0	0	0	0	0	0
New waste facilities	2–4	0	2–4	0	0	0
New natural gas processing facilities	2–4	0	2–4	0	0	0
Docks/causeways	2–4	0	2–4	0	0	0
Exploration well muds, cuttings, produced water	425 tons dry mud with 80% recycled; 525 tons dry rock cuttings, totaling 610 tons discharged at each well site.		425 tons dry mud with 80% recycled; 525 tons dry rock cuttings, totaling 610 tons discharged at each well site.		360 tons dry mud, with 80% recycled; 450 tons dry rock cuttings; totaling 522 tons per site.	
Development wells muds, cuttings, produced water	All muds, cuttings, and produced water treated and disposed of in wells.		All muds, cuttings, and produced water treated and disposed of in wells.		All muds, cuttings, and produced water discharged down hole.	
<i>Bottom Area Disturbed (ha)^e</i>						
Platforms	1–72	1–24	2–180	1–30	1–18	1–18
Pipelines ^f	25–830	15–250	75–2,100	13–400	13–240	13–240

TABLE 4.6.1-2 (Cont.)

Scenario Elements	Arctic Region				South Central Alaska Region	
	Beaufort Sea		Chukchi Sea ^a		Cook Inlet	
	Cumulative Case	Proposed Action	Cumulative Case	Proposed Action	Cumulative Case	Proposed Action
<i>Surface Soil Disturbed (ha)</i>						
Pipeline	20–600	5–130	130–1,200	0	25–170	25–170

- ^a Values for the cumulative case represent the proposed action (under the 2012 to 2017 OCS program) and actions associated with ongoing and future OCS program oil and gas activities. Because no OCS program oil and gas activities other than those associated with the 5-yr 2012–2017 OCS program are anticipated in the Cook Inlet Planning Area, the cumulative case scenario for the Cook Inlet Planning Area is the same as for the proposed action.
- ^b Mbbl = million barrels.
- ^c Tcf = trillion cubic feet.
- ^d In the Arctic region, service vessel trips will only occur during open-water and broken-ice conditions (typically during August and September).
- ^e Assumes 0.7–6 ha (1.7–15 ac) per platform and 0.5–1.6 ha (1.2–4.0 ac) per mile of pipeline.
- ^f Value represents bottom area disturbance from offshore pipeline construction only.

1 **TABLE 4.6.1-3 Large and Small Oil Spill Assumptions for the Cumulative Case**

Scenario Elements	Assumed Spill Volume	Number of Spill Events ^a		
		Gulf of Mexico Region	Arctic Region	South Alaska Region
			Beaufort and Chukchi Seas	Cook Inlet
<i>Oil Production (Bbbl)^b</i>		18–26	2–6	0.1–0.2
Large (bbl)	≥1,000			
Pipeline	1,700 ^c	16–23	1–6	1 spill from either
Platform	5,000 ^d	4–7	1–2	
Tanker	3,100–5,800 ^e	5–10		
Small (bbl) ^f	≥50 to <1,000	230–330	25–80	1–3
	≥1 bbl to <50	1,350–1,950	150–450	7–15

^a The assumed number of spills are estimated using the 1996–2010 spill rates in Anderson (in preparation). For the Alaska OCS region, the 1996–2010 spill rates were compared to fault-tree rates in Bercha Group, Inc. (2008a, b, 2006). The greater number of spills from Anderson (in preparation) is represented in Table 4.4.2-1. The values provided for the Arctic region are the combined totals for the Beaufort and Chukchi Seas.

^b Bbbl = billion barrels.

^c During the last 15 years (1996–2010), 7 oil spills ≥1,000 bbl occurred from U.S. OCS pipelines. The median spill size was 1,720 bbl. The maximum spill size between 1996 and 2010 from U.S. OCS pipelines was 8,212 bbl.

^d During the last 15 years (1996–2010), 2 oil spills ≥1,000 bbl occurred from U.S. OCS platforms. During Hurricane Rita, one platform and two jack-up rigs were destroyed, and a combined total of 5,066 bbl were spilled. The median spill size, when not accounting for a decreasing trend in the rate of platform spills over 1964–2010, is 7,000 bbl. The low-probability very large spill occurrence, such as the DWH event, is represented as a catastrophic spill event.

^e 3,100 bbl for tankers in the GOM; 5,800 bbl for TAPS tankers transporting Alaska OCS oil.

^f The number of spills <1,000 bbl is estimated using a spill rate for both pipeline and platform spills.

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4.6.1.2 Non-OCS Program Oil and Gas Activities

4.6.1.2.1 Offshore and Coastal Oil and Gas.

Gulf of Mexico. All the GOM States except Florida²³ have active oil and natural gas programs in both offshore State waters and on coastal lands. In 2009, oil and natural gas produced in GOM State waters totaled 503 million barrels (Mbbbl) and 114 Bcf, respectively

²³ A drilling moratorium in Florida State waters has been in effect since July 1990 and there has been no leasing of tracts since the early 1980s (Lloyd et al. 1991).

1 (EIA 2010a, b). Offshore State oil and gas activity levels are highest in Texas and Louisiana, a
2 long-established trend that will likely continue through the life of the Program.
3

4 Crude oil production in Texas has a long history, but has declined over the past decade
5 (from approximately 449 Mbbbl in 1999 to 404 Mbbbl in 2009). During the same period, its
6 offshore production increased from 475,000 to 897,000 bbl (EIA 2000, 2010a). From 2005 to
7 2009, the State's offshore gas withdrawals (from gas and oil wells) totaled 38 Bcf (EIA 2010b).
8 Louisiana's offshore program produced 5.5 Mbbbl of crude oil in 2009; from 2005 to 2009, its
9 offshore gas withdrawals totaled 76 Bcf (EIA 2010a, b).
10

11 Although Mississippi ranked eleventh in the nation in both crude oil and natural gas
12 production in 2009 (EIA 2010a, b), the State does not currently have an offshore program.
13 Alabama did not produce crude oil from offshore waters in 2009; however, from 2005 to 2009 its
14 offshore gas withdrawals totaled 109 Bcf (EIA 2010b).
15

16 **Alaska.** The Beaufort Sea and Cook Inlet are the only areas in Alaska with producing
17 offshore leases. About 92% of Alaska's oil production takes place on the North Slope, and as of
18 2009 about 16,200 Mbbbl of oil²⁴ have been produced from North Slope oil fields. Oil produced
19 from the North Slope (including Beaufort Sea) is transported down the TAPS pipeline to
20 Valdez, Alaska, where it is loaded onto tankers and exported. Significant volumes of natural gas
21 (a net²⁵ of about 6.5 Tcf) have been produced along with oil recovery in North Slope fields;
22 much of this gas has been reinjected into reservoirs (ADNR 2009c).
23

24 We assume that the North Slope fields will continue to account for most of Alaska's
25 production during the life of the proposed action, although projections from the State of Alaska
26 anticipate a 60% production decline by 2021 (ADNR 2000). Remaining North Slope oil reserves
27 through 2050 are estimated by the State of Alaska to be about 5,200 Mbbbl (ADNR 2009c). Over
28 this period, almost half of the oil produced is expected to come from the Prudhoe Bay oil field
29 (2,450 Mbbbl) (ADNR 2009c). Natural gas reserves of 35 Tcf have been discovered within
30 existing North Slope oil fields, with 93% located in four fields: Prudhoe Bay (23 Tcf), Point
31 Thomson (8 Tcf), Lisburne (1 Tcf), and Kuparuk (1 Tcf) (EIA 2009q). About 3.7 Tcf of natural
32 gas from these reserves has been produced. This gas has been used as a fuel for facilities or has
33 been reinjected into the hydrocarbon reservoir to enhance oil recovery.
34

35 There are also some leases in the Cook Inlet Planning Area. As of 2009, about
36 1,300 Mbbbl of oil and 7,800 Bcf of natural gas (net) have been produced from reserves in Cook
37 Inlet. Remaining reserves (including oil and natural gas liquids) through 2034 are estimated to
38 be about 34 Mbbbl, with annual production declining from 3.4 Mbbbl in 2010 to about 0.52 Mbbbl
39 in 2034 (ADNR 2009c).
40
41

²⁴ Historic figures include both oil and natural gas liquids produced at Prudhoe Bay and surrounding fields.

²⁵ Net gas production is the difference between total gas injected (to enhance oil recovery) and total gas recovered.

1 **4.6.1.2.2 Other Federal and Canadian Arctic Activities.** The National Petroleum
2 Reserve in Alaska (NPR-A) is a 9.3-million-ha [23-million-ac] site on the North Slope of Alaska
3 that is managed by the BLM. The USGS has estimated that there is between 1.3 and 5.6 Bbbl
4 and 39.1 and 83.2 Tcf of natural gas on Federal lands within the NPR-A. Integrated activity
5 plans have been developed by BLM (2004, 2006a) that identify the lands within the NPR-A
6 available for leasing, as well as those restricted from leasing, and identify stipulations and
7 restrictions on surface activities in the lease areas of the NPR-A. To date, there have been four
8 lease sales in the NPR-A (in 1999, 2002, 2004, and 2006), and as a result of these sales, the BLM
9 currently administers 381 Federal oil and gas leases on the NPR-A. To date, no production wells
10 have been established in the NPR-A, although 23 exploration wells have been drilled within the
11 reserve since 2000, and as many as an additional 11 exploration wells may be established by
12 2011 (BLM 2006b). It is uncertain at this time whether or not production facilities will be
13 established within the NPR-A during the life of the Program.
14

15 Northern Canada contains about a quarter of Canada's remaining discovered resources of
16 conventional petroleum and a third to a half of the country's estimated potential (Northern Oil
17 and Gas Directorate 2007). This resource is distributed throughout northern Canada as follows:
18

- 19 • *Mackenzie Valley and onshore Yukon.* Twenty-six significant discoveries and
20 three producing fields: the Norman Wells oil field produces oil at rates of
21 30,000 bbl per day (6.294 bbl = 1 m³) with initial recoverable reserves of
22 235 Mbbl; the Kotaneelee and Pointed Mountain fields close to the British
23 Columbia-Alberta border had produced 417 billion ft³ (35.3 ft³ = 1 m³) of gas
24 by the end of 1997.
25
- 26 • *Arctic Islands.* Nineteen significant discoveries after fewer than
27 200 exploration wells; the Bent Horn field in the Arctic Islands, which
28 produced high-quality light oil for many years on a seasonal basis, has only
29 recently been abandoned.
30
- 31 • *Mackenzie Delta/Beaufort Sea.* Discovered resources of in excess of 1 Bbbl
32 of oil and 9 Tcf of gas in 53 significant discoveries. Four Tcf of marketable
33 gas have been discovered in three onshore discoveries, and offshore
34 discoveries include over 200 Mbbl in the Amauligak field. On the Mackenzie
35 Delta, the Ikhil gas discovery is being developed to supply natural gas to the
36 town of Inuvik, where it will replace imported diesel oil for power generation
37 and domestic use.
38

39 **4.6.1.2.3 Imported Oil.** U.S. imports of crude oil and petroleum products grew steadily
40 every year from 1981, when the annual total was 2.2 Bbbl, to a peak in 2005, when the annual
41 total was 5.0 Bbbl. Since 2005, imports have been in decline, dropping to an annual total of
42 4.3 Bbbl in 2009 (its lowest point since 2000). The Gulf Coast district was the largest importer
43 of crude oil, with a total of 1.9 Bbbl in 2009 (EIA 2010, 2011a). The USDOE estimates that
44 crude oil imports will continue to decline from 2009 to 2035 as the growth in demand is met by
45 domestic production (EIA 2011b). Canadian oil imports, representing about 21% of the total in
46

1 2009, are delivered by pipeline (EIA 2010a). The remaining oil arrives in the United States on
2 tankers.

3 4 5 **4.6.1.3 Mining Activity** 6

7 Because mining is such a large component of the Alaskan economy (McDowell Group,
8 Inc. 2006) and activity could occur in the future in areas potentially affected by OCS oil and gas
9 activity, we have included a description of other mining activities. Alaska's mining industry
10 includes exploration, mine development, and mineral production, and produces zinc, lead, gold,
11 silver, and coal, as well as construction minerals such as sand, gravel, and rock (Research
12 Development Council 2007). Approximately 73 open-pit, underground, mechanical placer, and
13 suction dredge mines were in production in Alaska in 2005. In addition, there are at least
14 37 rock quarries and 71 active sand and gravel operations in the State (Research Development
15 Council 2007). Two large mines, the Kensington Gold Project and the Pogo Gold Project, are
16 expected to begin operation in 2007. The three largest mines in Alaska are the Red Dog,
17 Ft. Knox, and Greens Creek mines. The Red Dog Mine, located in the Northwest Arctic
18 Borough, is the world's largest zinc producer.

19
20 Among the large active mines currently operating in the State, only the Red Dog Mine is
21 located adjacent to any of the Alaska OCS planning areas addressed in this PEIS. This mine,
22 located in the DeLong Mountains approximately 88.5 km (55 mi) east of the Chukchi Sea,
23 discharges treated water into Red Dog Creek, whose waters eventually feed into the Wulik River
24 and drain into the Chukchi Sea.

25
26 In addition to the active and planned mine sites in the State, there are numerous
27 exploration projects for gold, copper, nickel, silver, lead, zinc, and coal. In July 2006, BHP
28 Billiton Energy Coal entered into an exploration agreement with the Arctic Slope Regional
29 Corporation (ASRC) to conduct a 5-yr exploration program on corporation lands in the
30 Northwest Arctic. Coal deposits in the Northwest Arctic run from the Colville River north to the
31 Arctic Ocean. The coal reserves in the area are thought to be the largest coal resource in the
32 United States and one of the largest worldwide, with estimated reserves of 5 billion tons of coal
33 underlying 77,700 km² (30,000 mi²). In early 2009, BHP Billiton suspended all exploration
34 activities, and in the summer of 2009, the company terminated its agreement with ASRC. The
35 company indicated that the decision was based on the current economic situation.

36 37 38 **4.6.1.4 Alternate Energy** 39

40 The Energy Policy Act of 2005 amended Section 8 of the Outer Continental Shelf Lands
41 Act (OCSLA) (43 USC 1337) to give the Secretary of the Interior authority to issue a lease,
42 easement, or ROW on the OCS²⁶ for activities that are not otherwise authorized by the OCSLA
43 or other applicable law, if those activities:

²⁶ This excludes areas on the OCS within the exterior boundaries of any unit of the National Park System, National Wildlife Refuge System, National Marine Sanctuary System, or any National Monument.

- 1 • Produce or support production, transportation, or transmission of energy from
2 sources other than oil and gas; or
3
- 4 • Use, for energy-related purposes or other authorized marine-related purposes,
5 facilities currently or previously used for activities authorized under the
6 OCSLA, except that any oil and gas energy-related uses shall not be
7 authorized in areas in which oil and gas preleasing, leasing, and related
8 activities are prohibited by a moratorium.
9

10 In response to this new authority, the BOEM of the USDOJ, formerly the Minerals
11 Management Service (MMS), established an Alternative Energy and Alternate Use Program
12 on the OCS (now referred to as its Renewable Energy Program) to approve and manage these
13 potential activities. The BOEM completed its PEIS to evaluate the potential environmental
14 impacts of implementing the program and established initial policies and best management
15 practices to mitigate these impacts in October 2007 (MMS 2007d). Each project developed
16 under this new program will be subject to environmental reviews under the National NEPA, and
17 each project may have additional project-specific mitigation measures. On April 22, 2009, the
18 BOEM published its final regulations to establish an environmentally responsible Renewable
19 Energy Program on the OCS. Documents and information related to the program can be found at
20 <http://www.boemre.gov/offshore/RenewableEnergy/index.htm>.
21

22 While it is too early to predict the number and types of alternate uses and renewable
23 energy projects that could be developed during the life of the Program, several OCS renewable
24 energy projects have been proposed at the current time. Most of these are wind energy projects.
25 The first commercial wind lease (Cape Wind off the coast of Massachusetts) was signed by the
26 Secretary of the Interior in 2010 and its construction is expected to begin by the end of 2011
27 (BOEMRE 2011g). Noncompetitive leases for 14 lease areas off the coasts of New Jersey (6),
28 Delaware (1), Georgia (3), and southeast Florida (4) have also been approved. These leases are
29 for data collection and technology testing activities related to the development of wind and
30 ocean current resources (BOEMRE 2011h). None of these leases are within the subject regions
31 for this PEIS.
32
33

34 **4.6.1.5 Climate Change** 35

36 Because a growing body of evidence shows that climate change is occurring
37 (Section 3.3), we have included it as an impacting factor in the cumulative analysis of some
38 resources. The resources that include climate change as a cumulative impact factor meet one or
39 both of the following two criteria:
40

- 41 • The resource is already experiencing impacts from climate change, so the
42 effects are observable and not speculative. In Alaska, for example, the effects
43 of climate change in recent decades have resulted in decreased extent and
44 thickness of sea ice and other changes that could affect biological resources
45 and subsistence.
46

- The resource will be directly affected by warming temperatures. An example of direct impacts of warming is increased melting of continental ice that leads to accelerated sea-level rise and inundation of coastal wetlands and beaches in the GOM.

We have not analyzed impacts from climatic and hydrologic changes that are the indirect result of temperature change because these indirect impacts are too uncertain to predict. For example, it is reasonable to expect changes in precipitation regimes as a result of climate change. Furthermore, it is also likely that precipitation changes would, in turn, affect the coastal salinity balance between freshwater flow and tidal influence in some areas, and that these changes would affect fisheries and fish populations in some way. Both the magnitude and direction of each factor in this sequence of occurrences, however, are uncertain. While we acknowledge that continuing climate change could result in changing regional ecological and socioeconomic patterns and distributions, at this stage of our understanding of underlying processes, the rates and directions of many of these changes are too speculative to include in the cumulative analyses that follow. A more in-depth discussion of climate change is provided in Section 3.3.

4.6.2 Marine and Coastal Physical Resources

4.6.2.1 Gulf of Mexico Region

4.6.2.1.1 Water Quality. Section 4.4.3 discusses water quality impacts in coastal, continental shelf, and deepwater environments in the GOM resulting from the proposed action (OCS program activities from 2012 to 2017). Cumulative impacts on water quality result from the incremental impacts of the proposed action (described in Section 4.4.3) when added to impacts from existing and reasonably foreseeable future OCS program activities (that are not part of the proposed action) and other non-OCS program activities. Table 4.6.1-1 presents the exploration and development scenario for the GOM cumulative case (encompassing the proposed action and other OCS program activities). Non-OCS program activities contributing to adverse cumulative impacts on water quality in the GOM are summarized in Table 4.6.2-1.

Ongoing and future routine OCS program activities, including those of the proposed action, involve vessel traffic, well drilling, pipelines (trenching, landfalls, and construction), chemical releases (drilling, operation discharges, and sanitary wastes), platforms (anchoring, mooring, and removal, except in deep waters), and onshore construction (coastal waters only). All of these have the potential to adversely affect water quality in the GOM. Accidental oil spills are also counted among OCS program-related activities; assumptions for oil spills under the cumulative case scenario are provided in Table 4.6.1-3.

OCS program-related marine vessel traffic in the GOM could be as high as 1,900 trips per week over the next 40 to 50 yr; vessel traffic associated with the proposed action (600 trips per week) represents about 30% of this traffic. Extensive non-OCS program marine traffic also

1

TABLE 4.6.2-1 Ongoing and Reasonably Foreseeable Future Non-OCS Activities Contributing to Cumulative Impacts on Water Quality

Type of Action	Associated Activities and Facilities (Impacting Factors)	Description
Marine vessel traffic	Discharges of bilge water and waste Accidental oil spills	Marine traffic includes crude oil and LNG tankers, commercial container vessels, military and USCG vessels, cruise ships, commercial fishing, and small watercraft. In 2009, a total 18,956 vessel calls were made in GOM ports, comprising about 34% of all U.S. vessel calls; U.S. vessel calls overall have been in decline in recent years (down 7% in 2009 from 5 yr earlier) (USDOT 2011b). It is estimated that about 60% of all crude oil imports into the United States are delivered by tanker ships entering through the GOM (VesselTrax 2007). See Section 4.6.1.2.2 on imported oil.
Wastewater discharge to coastal and marine waters	Permitted discharge points Pollutant releases via surface runoff (non-point discharges)	<p>The major point sources of pollution include discharges (by discrete conveyances such as pipes or man-made ditches) from sewage treatment plants, industrial facilities, and power generating plants. Discharges are regulated through the NPDES permit program. Section 403 of the Clean Water Act (CWA) established the Ocean Discharge Criteria, which provide additional requirements for these types of discharges (USEPA 2011g).</p> <p>Non-point sources of pollution include rainfall, snowmelt, or irrigation water that runs over land or through the ground, entraining pollutants and depositing them into rivers, lakes, and coastal waters (including wetlands and estuaries). Pollutants such as fertilizers, herbicides, and insecticides; oil, grease, and toxic chemicals; sediment; and bacteria and nutrients can make their way to coastal waters and have harmful effects on drinking water supplies, recreation, fisheries, and wildlife. Non-point source management programs under Section 319 of the CWA regulate these pollutant sources. The USEPA and NOAA also co-administer State Coastal Non-Point Pollution Control Programs under Section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990 (USEPA 2011g).</p>

2

TABLE 4.6.2-1 (Cont.)

Type of Action	Associated Activities and Facilities (Impacting Factors)	Description
Dredging and marine disposal	Excavation of subaqueous sediments Transport of sediments (by dredger or pipeline) Relocation and disposal of sediments	<p>Excess nutrients (particularly nitrogen and phosphorus) released to the GOM have created an oxygen-depleted zone (the hypoxic zone) at the bottom of the continental shelf off Louisiana and Texas that is harmful to aerobic organisms. The USEPA predicts that the hypoxic zone will cover an average area of 24,400 km² (9,420 mi²) in the summer of 2011, the largest area recorded since systematic mapping of the zone began. The hypoxic zone is attributed to the discharge of excess nutrients (from agricultural runoff) carried to the GOM from the Mississippi River and stratification (due to salinity and temperature differences across the water column) that prevents mixing of water (USEPA 2011f).</p> <p>The USEPA is responsible for designating and managing Ocean Dredged Material Disposal Sites as authorized by the Marine Protection, Research and Sanctuaries Act. Permits for ocean dumping of dredged materials are granted by the USACE, subject to USEPA review and concurrence, as authorized by Section 404 of the CWA (USEPA 2011c).</p> <p>There are currently 27 designated ocean dredged material disposal sites in the GOM, including 21 off the coast of Texas and Louisiana and in the Mississippi River GOM outlet (USEPA Region 6) and six off the coasts of Mississippi, Alabama, and Florida (USEPA Region 4) (USEPA 2011d, e). The largest quantities of disposed materials come from dredging of the Mississippi River bar channel (USACE 2011).</p>

TABLE 4.6.2-1 (Cont.)

Type of Action	Associated Activities and Facilities (Impacting Factors)	Description
Liquefied natural gas (LNG) terminals	Construction and operation of new LNG facilities on the OCS Increased risk of explosions and fires Increased LNG tanker traffic Cooled water releases	The United States is an importer and exporter of natural gas (EIA 2010b). The USDOE projects a significant increase in overall natural gas consumption between 2009 and 2035; estimates of LNG imports over this period are variable, ranging from 140 to 2,140 Bcf by 2035 (EIA 2011b). The United States currently operates five LNG import terminals, only one of which is located offshore (Gulf Gateway Deepwater Port off the coast of Louisiana). It is reasonably foreseeable that additional LNG terminals will be constructed in the GOM to offload LNG from tankers into the existing offshore natural gas pipeline system. Currently in the GOM, there are 16 applications for licenses to import LNG (seven licenses have been issued) (USDOT 2011a). See Section 4.3.1.1.2.
Oil and gas production in State-owned marine waters	Exploratory drilling and seismic testing Drilling of production wells Operation of infrastructure (pipelines and platforms) Transportation (by pipeline or tanker) Onshore refineries Hazardous spills/releases (e.g., loss of well control events) Decommissioning (plugging production wells and removing infrastructure)	Most of the historical production of oil and natural gas in State-owned marine waters in the GOM has occurred offshore of Texas and Louisiana. See Section 4.6.1.2.1.

TABLE 4.6.2-1 (Cont.)

Type of Action	Associated Activities and Facilities (Impacting Factors)	Description
Hard mineral mining	Vessel traffic Bottom sampling and shallow coring Mining	<p>Hard minerals, such as quartz sand, sulfur, and sand, are currently being extracted for commercial purposes in the northern part of the GOM. Mineral resource deposits within coastal waters include phosphate, oyster shell, limestone, sand and gravel, and magnesium (Continental Shelf Associates 2004d).</p> <p>Mining from the cap rock of coastal and offshore salt domes has been active along the Texas–Louisiana coast since the 1890s (Kyle 2002). Currently, the Main Pass Block 299 mine, operated by Freeport-McMoRan, is leased to mine sulphur and salt in Federal waters of the GOM (lease OCS-G9372). The mine is located about 26 km (16 mi) offshore, east of Plaquemines Parish, Louisiana. It was closed in 2002 and proposed to be used as a disposal facility for exploration and production waste (67 FR 5847).</p>
Oil- and gas-related infrastructure	Ports Oil and gas pipelines Tanker vessels Onshore fuel storage tanks and transfer stations Hazardous spills/releases	<p>The oil and gas industry in the GOM is one of the most developed in the world. There are currently 3,172 active platforms in operation at water depths less than 61 m (200 ft) and 63 active platforms at water depths greater than 61 m (200 ft) (26 of which are in waters greater than 300 m [1,000 ft] deep). An estimated 41,843 km (26,000 mi) of oil and gas pipeline stretches across the seafloor. As of July 2011, there were more than 37,000 approved applications to drill in the GOM (BOEMRE 2011j; NOAA 2011c).</p>
USDOD and U.S. Department of Homeland Security marine operations	Surface vessels Aircraft Aerial operations (e.g., flight training) Submarine operations	<p>Numerous U.S. military bases are located along the GOM coast (see Section 4.3). Several U.S. Navy air stations serve as training bases in jet aviation, sea and air rescue, and coastal mine countermeasures, as well as home ports for various ships and operations. Some support U.S. Army and USCG activities. The USCG (part of the U.S. Department of Homeland Security) conducts routine missions, such as search, rescue, environmental protection, and homeland security on sea vessels and aircraft. The U.S. Air Force conducts training activities over the deepwater region of the GOM.</p>

TABLE 4.6.2-1 (Cont.)

Type of Action	Associated Activities and Facilities (Impacting Factors)	Description
Renewable energy development	Wind, wave, and ocean current technologies Technology testing (bottom sampling, deep-tow sonar surveys, borings) Facility construction and operation Facility decommissioning (removal of facility)	To date, the United States has no offshore renewable energy projects, but the first commercial wind lease (Cape Wind off the coast of Massachusetts) was signed by the Secretary in 2010. See Section 4.3.1.1.3.

1 occurs in the GOM, one of the world's most concentrated shipping areas (USACE 2010). Non-
2 OCS program traffic includes that related to crude oil and natural gas imports, commercial
3 container vessels, military and USCG vessels, cruise ships, commercial fishing, and small
4 watercraft. In 2010, the Port of New Orleans alone handled about 7,500 vessel calls (mainly
5 tanker and dry bulk carrier), about 140 vessel calls per week (USDOT 2011b). Impacts on water
6 quality from marine traffic arise from regular discharges of bilge water and waste, leaching of
7 antifouling paints, and incidental spills (MMS 2001d), although operational discharges and
8 spillage from marine vessels have declined substantially in the past few decades (NRC 2003b).

9
10 The number of production wells and oil platforms constructed over the period of the
11 Program (at most 2,600 and 450, respectively) will be proportional to the amount of oil
12 produced; these numbers represent about 21% of the total number of production wells and
13 platforms (respectively) anticipated to be built in the GOM over the next 45 yr as part of the
14 OCS program. The length of new pipeline (at most 12,070 km [7,500 mi]) added as part of the
15 Program represents about 17% of that anticipated as part of the OCS program.

16
17 The area of disturbed sea bottom from construction of platforms and pipelines over the
18 period of the Program (as much as 14,000 ha [34,600 ac] total) represents about 18% of that
19 associated with the OCS program over the next 40 to 50 yr. Bottom disturbance degrades water
20 quality by increasing water turbidity in the vicinity of the operations and adding contaminants to
21 the water column. It also changes sediment composition as suspended sediments (and
22 contaminants, if present) are entrained in currents and deposited in new locations.

23
24 An inventory conducted by NOAA found that there were about 766 major and
25 8,147 minor land-based point sources of pollution releasing to watersheds and coastal drainage
26 areas of the GOM; these included discharges from industrial facilities (6,909), wastewater
27 treatment plants (1,925), and power plants (79) — most of which were located in the watersheds
28 of the Atchafalaya/Vermilion Bays and Galveston Bays at the time of the inventory
29 (NOAA 1995). The kinds of contaminants released range from nitrogen (from organic
30 chemicals, petroleum refining, industrial plants, and pesticide sources), phosphorus, metals (zinc,
31 arsenic, cadmium, lead, and mercury), and oil and grease, to elevated suspended solids
32 (turbidity) and biocides and heat (from power plant cooling water discharges). Nonpoint sources
33 release pollutants to the GOM via rivers and on-land drainages and are primarily from urban and
34 agricultural runoff (containing animal waste and residual fertilizer, in particular nitrogen and
35 phosphorous compounds), but also originate from seepage from landfills and industrial facilities
36 and various kinds of on-land spills. These sources (together with similar sources from Mexico)
37 combine to degrade water quality in the GOM, especially in coastal waters. Coastal water
38 quality is also adversely affected by the loss of wetlands (Section 3.7.1).

39
40 Activities taking place within GOM waters also contribute to the degradation of water
41 quality in the GOM. These include sediment dredging and disposal (suspended sediments and
42 contaminants), LNG terminal operations (biocide-laden, cooled water), and activities related to
43 the oil and gas industry, which operates hundreds of platforms in State and Federal waters and
44 discharges large volumes of drilling wastes, produced water, and other industrial waste streams
45 into GOM waters. Hydrocarbon releases through natural oil seeps along the continental slope
46 and accidental oil spills are additional sources of water and sediment contamination.

1 There are 27 designated ocean dredged material disposal sites in the GOM, including
2 21 off the coast of Texas and Louisiana and in the Mississippi River GOM outlet. Dredging
3 operations are routinely conducted for channel construction and maintenance, pipeline
4 emplacement, access to support facilities, creation of harbor and docking areas, and siting for
5 onshore facilities. Offshore disposal, authorized under Title I of the Marine Protection, Research
6 and Sanctuaries Act of 1972, as amended (33 USC 1401), and the Federal Water Pollution
7 Control Act, as amended (33 USC 1251), consists primarily of dredged sediments but may also
8 include fish wastes and vessels. The site management and monitoring plans for many of these
9 sites are available on the USEPA's website (<http://www.epa.gov>). The USACE maintains an
10 online database that tracks the projects (including quantities of materials, dredging and transport
11 methods, and dumping frequency, size, and location) that dispose of materials at designated
12 offshore disposal sites (<http://el.erd.usace.army.mil/odd>). The direct impacts of dredging on
13 water quality (increased turbidity and decreased dissolved oxygen at the dredge site) are fairly
14 short lived; however, the long-term landscape-scale changes can have significant adverse
15 impacts on aquatic organisms and their habitats (Nightingale and Simenstad 2001)
16 (Sections 4.6.3 and 4.6.4).

17
18 Currently, there is only one offshore LNG terminal in the GOM (Gulf Gateway
19 Deepwater Port off the coast of Louisiana). However, natural gas demand growth in the
20 United States has accelerated since the 1980s, and LNG imports are expected to increase
21 significantly to meet this demand. As a result, 25 LNG terminal proposals have been approved
22 to serve the U.S. market (Parfomak and Vann 2009). At least seven new licenses have been
23 issued for additional facilities in the GOM, and it is anticipated that more LNG facilities will be
24 built over the coming decades (USDOT 2011c) (Section 4.6.1.5). The impacts of LNG transport
25 and LNG receiving terminals are associated with explosions and fires and with the cryogenic and
26 cooling effects of either an accidental release of LNG or the release of cooled water during the
27 vaporization process.

28
29 The majority of oil released to the GOM comes from chronic releases, mainly from
30 naturally occurring seeps and runoff from land-based sources (NRC 2003b). Oil seeps are
31 estimated to contribute up to 62% of the oil input in U.S. marine waters overall; runoff from
32 land-based sources, about 21% (NRC 2003b). As many as 350 crude oil and tar seeps have been
33 identified in the GOM. Seepage rates for the northern part of the GOM (along the continental
34 slope) have been estimated at about 73,000 tons (526,000 bbl) per year,²⁷ about twice that
35 estimated for spills from the OCS program (based on a worst-case scenario of about 230,000 bbl
36 per year, excluding catastrophic events; Table 4.6.2-3). Spills associated with the proposed
37 action (based on a worst-case scenario of about 44,300 bbl per year, excluding catastrophic
38 events (Table 4.4.2-1) represent a small fraction, about 6%, of the combined annual oil inputs
39 from oil seeps and oil spills (from pipelines, platforms, and tankers/barges and incidental spills)
40 from the OCS program over the next 40 yr. Natural gas seeps are also common, but little is
41 known about their seepage rates (Kvenvolden and Cooper 2003).

42

²⁷ Total estimates for the GOM, taking into account oil seeping from the Campeche Basin offshore of Mexico in
the southern part of the Gulf, run as high as 140,000 tons (1 Mbbbl) per year (Kvenvolden and Cooper 2003).

1 The second largest contribution to oil releases in U.S. marine waters overall is related to
2 oil consumption (about 32%): land-based runoff and river discharge (21%), recreational marine
3 and non-tank vessels (2.6%), tank vessel operational discharges (<1%), atmospheric deposition
4 (8.1%), and jettisoned aircraft fuel (<1%). Other important sources of oil releases include those
5 associated with non-OCS program oil extraction/transportation activities (about 4.7% in total):
6 platforms, produced water, atmospheric deposition, pipeline and tank vessel spills, operational
7 discharges (cargo washings), and coastal facility spills (NRC 2003b).

8
9 Another issue of importance to the water quality in the GOM concerns the hypoxic zone
10 in the GOM coast shelf waters (offshore of Louisiana and Texas to the west of the Mississippi
11 Delta). The hypoxic zone is an area near the sea bottom that contains less than 2 ppm of
12 dissolved oxygen, causing a condition of hypoxia that is inhospitable to fish and causes stress or
13 death to benthic organisms (USGS 2011c). It is the second largest area of oxygen-depleted
14 waters in the world, with an area of about 22,015 km² (98,500 mi²) (in 2002). The hypoxic zone
15 is attributed to water column stratification (driven by weather and river flow) and the
16 decomposition of organic matter in bottom waters, as well as organic matter and nutrients (that
17 fuel phytoplankton growth) carried by the Mississippi River. The USEPA predicts that the
18 hypoxic zone will cover an average area of 24,400 km² (9,420 mi²) in the summer of 2011, the
19 largest area recorded since systematic mapping of the zone began (USEPA 2011f). The
20 proposed action is not expected to have a large effect on the hypoxic zone, because inflows of
21 contaminants causing hypoxia are mainly from Mississippi River waters discharging to the
22 GOM.

23
24 Catastrophic oil spills are rare events, but their releases have a high potential to degrade
25 water quality in both coastal and deep waters. The 2010 DWH event released an estimated
26 4.9 Mbbl. In response to the spill, 7,000 m³ (1.84 million gal) of chemical dispersants were also
27 released (Section 3.4.1.3). The short- and long-term impacts of the spill on water quality in the
28 GOM are still being assessed, but as of January 2011, oiling was still present on many shorelines
29 and on barrier islands. Although traces of oil and dispersant were found in the offshore and
30 deepwater zones, water quality benchmarks (for oil- and dispersant-related chemicals) were not
31 exceeded in samples collected. In its August 2010 assessment, the National Incident Command
32 (NIC) estimated that half of the oil was removed from the water column either by direct
33 recovery, by burning or skimming, or by evaporation and dissolution. Another 24% was
34 dispersed. About 26% of the oil (an estimated 1.3 Mbbl) remained on or near the water surface,
35 or was deposited onshore, or buried in sand and sediments. The Georgia Sea Grant Oil Spill
36 Update, published on August 17, 2010, estimated that between 70 and 79% (2.9 and 3.2 Mbbl) of
37 the oil spilled during the 2010 DWH event remains at or below the water surface. It
38 recommended further assessment of dispersed and dissolved forms of oil to determine its
39 potential threat to the ecosystem because such forms of oil remain highly toxic
40 (Hopkinson 2010).

41
42 Climate change predictions are based on models that simulate all relevant physical
43 processes under a variety of projected greenhouse gas emission scenarios (Section 3.3). Because
44 the complexity of modeling global and regional climate systems is so great, uncertainty in
45 climate projections can never be eliminated. The Intergovernmental Panel on Climate Change

1 (IPCC) projections relating generally to water and water quality over the next two decades
2 include:

- 3
- 4 • Sea level will rise by 0.18 to 0.59 m (0.6 to 2 ft) by the end of the twenty-first
5 century;
- 6
- 7 • Sea ice, glaciers, and ice sheets in polar regions will continue melting;
- 8
- 9 • Ocean pH will decrease by 0.14 to 0.35 over the twenty-first century;
- 10
- 11 • Tropical cyclones will become more intense (>66% likely);
- 12
- 13 • Precipitation will increase at high latitudes (>90% likely); and
- 14
- 15 • Annual river discharges (runoff) will increase by 10 to 40% at high latitudes
16 and decrease by 10 to 30% in the dry regions at mid-latitudes.
- 17

18 The GOM region has already experienced increasing atmospheric temperatures since the
19 1960s. From 1900 to 1991, sea surface temperatures increased in coastal areas and decreased in
20 offshore areas. Sea level rise along the northern coast is as high as 0.01 m/yr (0.03 ft/yr) and has
21 contributed to the loss of coastal wetland and mangroves and increased the rates of shoreline
22 erosion. Future sea level rise is expected to cause saltwater intrusion into coastal aquifers,
23 potentially making some unsuitable as potable water supplies (Section 3.3.1).

24

25 Significant changes (increases or decreases) in precipitation and river discharges to the
26 GOM would affect salinity and water circulation — which in turn affects water quality. Water
27 quality impacts associated with increased river discharges result from increases in nutrients
28 (nitrogen and phosphorous) and contaminants to estuaries, increases in harmful algal blooms,
29 and an increase in stratification. Such changes could also affect dissolved oxygen content and
30 the extent of the GOM hypoxic zone. Decreased discharge would diminish the flushing of
31 estuaries and increase concentrations of pathogens.

32

33 **Conclusion.** Water quality in coastal and marine waters would be impacted by the
34 following activities associated with the proposed action: vessel traffic, well drilling, pipelines
35 (trenching, landfalls, and construction), chemical releases (drilling, operation discharges, and
36 sanitary wastes), platforms (anchoring, mooring, and removal, except in deep waters),
37 construction of shore-based infrastructure (coastal waters only), and accidental oil spills. Coastal
38 water in the GOM is also affected by numerous other factors, including river inflows,
39 urbanization, agricultural practices, municipal waste discharges, and coastal industry. Non-OCS
40 program activities likely to contribute to cumulative impacts include marine vessel traffic,
41 wastewater discharge to coastal and marine waters, dredging and marine disposal, oil and gas
42 production in State-owned marine waters, hard mineral mining, oil- and gas-related
43 infrastructure, military operations, and renewable energy development. Natural seepage of oil
44 along the continental slope is also significant. The cumulative impacts on GOM water quality
45 from all OCS and non-OCS activities in the GOM over the next 40 to 50 yr are expected to be

1 moderate, and the incremental contribution of the routine Program activities to water quality
2 impacts would be small (see Section 4.4.3.1).

3
4 The USEPA, in collaboration with other Federal and coastal State agencies, has assessed
5 the coastal conditions of each region of the United States, including the GOM coast, by
6 evaluating five indicators of condition, one of which was water quality, based on such
7 parameters as dissolved oxygen, chlorophyll *a*, nitrogen, phosphorus, and water clarity.²⁸ The
8 most recent assessment found the overall condition of the coastal waters of the GOM coast
9 region to be fair to poor, with an overall condition rating score of 2.2 (on a 5.0-point scale) and
10 an individual indicator score of 3.0 for water quality. Parameters such as dissolved oxygen and
11 water clarity vary in relation to climatic factors (e.g., annual rainfall) (USEPA 2008b).²⁹ In
12 addition, the hypoxic zone is predicted to cover a larger area of the GOM shelf than in any other
13 year since it has been measured.

14
15 The number of accidental spills in GOM waters for most activities associated with the
16 proposed action would represent only a small increase over the number of expected spills from
17 ongoing OCS and non-OCS program activities, and a very small increase relative to releases
18 from naturally occurring oil seeps (except for catastrophic spills). The incremental increase in
19 adverse water quality impacts from these spills would depend on the weather and sea conditions
20 at the spill location, the type of waves and tidal energy at the spill locations, the type of oil
21 spilled (very light to very heavy), the depth of the spill event (deep water, shallow water, or
22 surface water), and the volume and rate of spillage. Spill response and cleanup activities
23 (e.g., *in situ* burning and use of chemical dispersants) could contribute to these impacts. A more
24 detailed discussion of the effects of oil spills on water quality in the GOM is presented in
25 Section 4.4.3.1.2.

26
27
28 **4.6.2.1.2 Air Quality.** Section 4.4.4 discusses air quality impacts on onshore and
29 offshore areas of the GOM resulting from the proposed action (OCS program activities from
30 2012 to 2017). Cumulative impacts on air quality result from the incremental impacts of the
31 proposed action (described in Section 4.4.4) when added to impacts from existing and reasonably
32 foreseeable future OCS program activities (that are not part of the proposed action) and other
33 non-OCS program activities. Table 4.6.1-1 presents the exploration and development scenario
34 for the GOM cumulative case (encompassing the proposed action and other OCS program
35 activities). Non-OCS program activities also contribute to adverse cumulative impacts on air
36 quality in the GOM; they are discussed below.

37
38 Ongoing and future routine OCS program activities, including those of the proposed
39 action, involve production platforms, exploration wells, platform construction and removal,

²⁸ Other indicators used to assess coast conditions include sediment quality (toxicity, contaminants, and total organic carbon), benthic community condition, coastal habitat loss, and fish tissue contaminants. The assessment found sediment quality in the Gulf coast region also to be poor (with sediments containing pesticides, metals, PCBs, and PAHs) (USEPA 2008b).

²⁹ The water quality score does not include the impact of the hypoxic zone in offshore Gulf coast waters or the recent DWH oil spill (USEPA 2008b).

1 marine vessels (pipelaying, support, and survey), helicopters, and tanker and barge transport. All
2 these activities have the potential to adversely affect air quality in the GOM. Accidental oil
3 spills are also counted among OCS program-related activities; assumptions for oil spills under
4 the cumulative case scenario are provided in Table 4.6.1-3. Other emission sources on the OCS
5 that are not associated with oil and gas development activities include commercial marine
6 vessels, commercial and recreational fishing, tanker lightering, military vessels, and natural
7 sources such as oil or gas seeps. Onshore emission sources include power generation, industrial
8 processing, manufacturing, refineries, commercial and home heating, on-road vehicles, and non-
9 road engines (e.g., aircraft, locomotives, and construction equipment).

10
11 **Criteria Pollutants.** Over the past 20 yr, the USEPA has promulgated a series of
12 measures to reduce regional and nationwide emissions from fuel combustion sources (e.g., diesel
13 marine engines), and the beneficial effects of these measures are evident in the data collected in
14 2006 (the most recent year for which data are reported). NO_x emissions, mainly from
15 transportation and fuel combustion sources, decreased nationwide by about 29% between 1990
16 and 2006. Most of the reductions in NO_x emissions occurred between 1998 and 2006 and are
17 attributed to implementation of the Acid Rain Program and the NO_x State Implementation Plan
18 (SIP) Call. SO₂ emissions, mainly from fuel combustion, industrial processes, and transportation
19 sources, also decreased nationwide by about 38% between 1990 and 2006. During this same
20 period, emissions from PM_{2.5}, PM₁₀, and CO decreased by 14, 30, and 38%, respectively
21 (USEPA 2008c). At the State level, data collected between 1990 and 2002 indicate overall
22 emissions have also declined in the five GOM coast States (Alabama, Florida, Louisiana,
23 Mississippi, and Texas) in total: NO_x, down by 31%; SO₂, down by 15%; PM₁₀, down by 34%;
24 and VOCs, down by 8%. Increases were observed only in Florida (NO_x up by 15% and VOCs
25 up by 20%) and Alabama (VOCs up by 2%) during this period (USEPA 2011h).

26
27 Table 4.6.2-2 lists the estimated annual emissions associated with all ongoing and future
28 OCS oil and gas activities in the GOM over the next 40 to 50 yr. These emissions were
29 estimated by BOEM using emission factors from the *2008 Gulfwide Emission Inventory Study*
30 (Wilson et al. 2010). In terms of absolute amounts, the largest emissions would be NO_x,
31 followed by CO, with lesser amounts of VOC, SO_x, PM₁₀, and PM_{2.5}, in order of decreasing
32 emissions. Under both the high and low scenarios, support vessels would be the largest source of
33 NO_x, SO_x, and PM; production platforms would be the largest source of VOC and CO.
34 Emissions from the Program (proposed action) generally represent about 27% of the cumulative
35 case emissions.

36
37 Table 4.6.2-2 also presents the emissions calculated from an inventory of all non-OCS
38 activities collected by Wilson et al. (2010) in calendar year 2008. The non-OCS program
39 emissions estimates are based on the same source categories as for the OCS oil and gas program,
40 but also include biogenic/geogenic sources; commercial fishing, marine, and military vessels; the
41 Louisiana offshore oil port; and vessel lightering. The estimated OCS program annual emissions
42 for the cumulative case are greater than those measured for non-OCS program activities in
43 calendar year 2008 for all pollutants except SO_x. Many OCS and non-OCS program activities
44 (e.g., support, commercial, and military marine vessel trips) are expected to increase in the
45 future; however, emissions related to these activities are expected to be reduced by meeting
46 USEPA standards.

1 **TABLE 4.6.2-2 Estimated Total Air Emissions for OCS and Non-OCS Program Activities for the**
2 **Gulf of Mexico Cumulative Case**

Activity	Pollutant (tons/yr) ^a					
	NO _x	SO _x	PM ₁₀	PM _{2.5}	CO	VOC
Well drilling (E&D)	34,865–44,826	4,437–5,705	615–791	606–779	8,385–10,780	830–1,067
Well drilling (D&P)	33,924–48,418	4,318–6,162	599–854	590–841	8,158–11,644	807–1,152
Platform installation/removal	1,257–1,842	176–258	29–42	29–42	159–234	29–42
Pipeline installation	10,925–23,762	1,855–4,035	412–897	412–897	2,268–4,932	412–897
Production platforms	71,080–104,176	1,738–2,547	661–969	656–961	79,611–116,680	45,404–66,545
Support vessels	127,954–187,532	17,242–25,270	2,216–3,248	2,216–3,248	12,188–17,863	2,216–3,248
Helicopters	1,054–1,545	260–381	205–301	205–301	12,903–18,911	2,548–3,735
Tankers loading	0–536	0–261	0–58	0–58	0–318	0–10,935
Tankers in transit	0–33,114	0–4,014	0–502	0–502	0–2,759	0–10,184
Tankers unloading	0–1,534	0–261	0–58	0–58	0–318	5,497
Total (Cumulative OCS)	281,059–448,283	30,026–44,619	4,738–7,720	4,714–7,687	123,672–181,361	52,247–87,621
Total (Proposed Action) ^b	60,019–125,167	6,765–14,440	1,058–2,268	1,051–2,268	8,907–22,692	23,510–45,853
Year 2008 non-OCS emissions ^c	100,880	52,022	7,004	6,481	8,432	22,442

^a The range of values reflects the low and high end of the exploration and development scenarios for the cumulative scenario.

^b Values from Table 4.4.4-1.

^c Emissions are from inventory collected in calendar year 2008 and reported in Wilson et al. (2010).

3
4
5 The USEPA's Acid Rain Program (established under Title IV of the 1990 CAA
6 amendments) sets a permanent cap on the total amount of SO₂ that can be released from the
7 electric power sector, with the final 2010 cap set at 8.95 million tons (about half of the emissions
8 from the electric power industry in 1980). NO_x emissions from coal-fired boilers were also
9 limited under the program (to about 8.1 million tons). Between 1980 and 2008, SO₂ emissions
10 were reduced by about 52% compared to 1990 levels. In 2008, SO₂ emissions had already fallen
11 below the emissions cap set for 2010 and monitoring data indicated the national composite
12 average of SO₂ mean ambient concentrations declined by 71% between 1980 and 2008. NO_x
13 emissions from the electric power sector in 2008 were also greatly reduced (by as much as 63%
14 relative to projected levels in 2000 without the program). The USEPA also reports significant
15 improvements in acid deposition indicators (wet sulfate and nitrogen deposition)
16 (USEPA 2011i).
17

1 The Cross-State Air Pollution Rule was finalized in 2011 (replacing the USEPA's 2005
2 Clean Air Interstate Rule) and will take effect in 2012. The rule requires 27 States in the eastern
3 half of the United States (including all of the GOM coast States) to reduce power plant emissions
4 contributing to ozone and/or fine particulate pollution in other States by mandating significant
5 reductions in SO₂ and NO_x emissions from power plants. The USEPA estimates that these
6 actions will reduce SO₂ and NO_x emissions by 73% and 54%, respectively, from 2005 levels
7 (USEPA 2011j).

8
9 The MMS (currently BOEM) performed a cumulative air quality modeling analysis of
10 platform emissions in a portion of the GOM in 1992 (MMS 1997b). The modeling incorporated
11 a 40% increase in emissions above the 1992 levels to account for growth in oil and gas
12 development. Predicted concentrations were well within the NAAQS and the Prevention of
13 Significant Deterioration (PSD) Class II maximum allowable increases. An inventory study in
14 the Breton National Wilderness Area (BNWA), a Class I area under the USEPA's PSD
15 regulations, was conducted by the MMS to estimate the contribution of OCS and non-OCS
16 program emissions to concentrations of NO_x and SO₂ in the BNWA³⁰ (Billings and
17 Wilson 2004). A recent modeling-based cumulative increment analysis for SO₂ and NO₂,
18 conducted by MMS, considered the cumulative effect of all onshore and offshore emission
19 sources in the area with respect to the baseline year (Wheeler et al. 2008). The model results are
20 summarized as follows:

- 21
22 • The increase in the 3-hr SO₂ concentration within the BNWA since 1977 (the
23 baseline year) ranges from 0.42 to 1.70 µg/m³; the maximum increment of
24 25.0 µg/m³ has not been exceeded within the BNWA but a small portion of
25 the increment may have been consumed. The largest change within a 50-km
26 (31-mi) radius of the BNWA is 2.6 µg/m³ and occurs to the south and east of
27 Breton Island.
- 28
29 • The increase in the 24-hr SO₂ concentration within the BNWA since 1977
30 ranges from 0.11 to 1.18 µg/m³; the maximum increment of 5.0 µg/m³ has not
31 been exceeded within the BNWA but a portion of the increment may have
32 been consumed. The maximum 24-hr average SO₂ has increased over most of
33 the GOM since 1977; it has increased or decreased over land, depending on
34 location. For example, it has decreased as much as 7.7 µg/m³ near Mobile,
35 Alabama. In areas east of the Chandeleur Islands and southeast of the Breton
36 Islands, it has increased between 1.0 and 1.64 µg/m³.
- 37
38 • The annual SO₂ concentration within the BNWA has decreased by 1.07 to
39 1.89 µg/m³ since 1977. The decrease in annual SO₂ is less than 0.5 µg/m³
40 over much of the GOM and is greatest (more than 1.5 µg/m³) near the GOM
41 coast and inland over south Mississippi, Alabama, and eastern Louisiana.

³⁰ Under the CAA, water quality degradation is limited in Class I areas by establishing stringent "increment" limits for NO_x and SO₂. These increments are the maximum increases in ambient pollutant concentrations allowed over baseline concentrations (Billings and Wilson 2004).

1 Isolated increases at grid points in Louisiana and the GOM are likely due to
2 local additions of SO₂ point sources since 1977.

- 3
- 4 • The maximum increase in annual NO₂ concentration within the BNWA since
5 1988 (the baseline year) is 0.10 µg/m³, well below the maximum allowable
6 increment of 2.5 µg/m³. Only a very small portion of the increment has been
7 consumed. Since 1988, annual NO₂ concentrations have decreased over land
8 where controls have been implemented, but have increased over the GOM due
9 to the addition of offshore NO_x emission sources. The boundary between
10 decreased onshore concentrations and increased offshore concentrations
11 follows the southern Louisiana coastline then turns northeastward away from
12 the Louisiana coast and over the GOM where it crosses the BNWA and runs
13 through the northern part of the Chandeleur Island chain. Part of the BNWA
14 has experienced an increase in NO₂ concentrations since 1988. Larger
15 increases are observed in areas within 75 km (47 mi) of the BNWA
16 boundaries.

17

18 The BOEM continues to consult with the USFWS, which manages the BNWA, on any
19 plans within 100 km (62 mi) of the BNWA.

20

21 **Ozone Formation.** In the Nation's ozone (O₃) nonattainment areas, emissions of NO_x
22 and VOCs are being reduced through the SIP process in order for those areas to achieve
23 compliance with the national O₃ standard. Prior to the revocation of the 1-hr O₃ standard in
24 2004, the Houston-Galveston-Brazoria (Texas) and Baton Rouge (Louisiana) areas were
25 classified as severe nonattainment; the Beaumont-Port Arthur (Texas) nonattainment
26 classification was serious. While the 1-hr O₃ standard no longer applies, the same emission
27 controls will remain in effect while each State develops its plan to reach compliance with the
28 new 8-hr standard. In October 2008, the USEPA reclassified the Houston-Galveston-Brazoria
29 O₃ nonattainment area from a moderate 8-hr O₃ attainment area to a severe 8-hr O₃
30 nonattainment area and required the State to submit a revised SIP addressing the severe O₃
31 requirements of the CAA (73 FR 56983). In September 2010, the USEPA published a notice
32 that the Baton Rouge moderate 8-hr O₃ attainment area had attained the 1997 8-hr O₃ NAAQS
33 (75 FR 54778); the Beaumont-Port Arthur area was also designated an attainment area for the
34 1997 8-hr O₃ NAAQS in 2010 (75 FR 64675). There are no O₃ nonattainment areas in
35 Alabama, Florida, or Mississippi.

36

37 Ozone levels in the southeast Texas have been in a steady downward trend since 1995.
38 The maximum observed fourth highest 8-hr O₃ concentration in the Houston-Galveston area
39 decreased from about 0.140 parts per million (ppm) in 1995 to around 0.100 ppm in 2005.
40 Ozone levels in the Baton Rouge area remained steady over the same period, but the number of
41 exceedances of the O₃ standard decreased. This data indicates that emission-reduction measures
42 have been effective in reducing O₃ levels.

43

44 Modeling studies were performed using the preliminary emissions inventory prepared by
45 Wilson et al. (2004) to examine the O₃ impacts with respect to the 8-hr O₃ standard of 80 parts
46 per billion (ppb). One modeling study focused on the coastal areas of Louisiana extending

1 eastward to Florida (Haney et al. 2004). This study showed that the impacts of OCS emissions
2 on onshore O₃ levels were very small, with the maximum contribution at locations where the
3 standard of 1 ppb or less was exceeded. Another study, conducted by Yarwood et al. (2004),
4 evaluated O₃ levels in southeast Texas. The results of this study indicated a maximum
5 contribution to areas exceeding the standard of 0.2 ppb or less. The projected emissions for the
6 cumulative case would be about the same as the emissions used in these modeling studies. The
7 contributions to O₃ levels would therefore be similar. As emissions within the nonattainment
8 areas are expected to decrease further in the future, the cumulative impacts from the OCS oil and
9 gas program on O₃ levels would likely be reduced.

10
11 **Visibility Impairment.** Gaseous and fine particulate matter in the atmosphere can
12 potentially degrade atmospheric visibility. Existing visibility in the eastern United States,
13 including the GOM coast States, is impaired due to fine particulate matter containing primarily
14 sulfates and carbonaceous material. High humidity is an important factor in visibility
15 impairment in the GOM coastal areas. The absorption of water by the particulate matter makes
16 them grow to a size that enhances their ability to scatter light and reduce visibility. The
17 estimated natural mean visibility in the eastern United States is 97 to 129 km (60 to 80 mi)
18 (Malm 1999).

19
20 Based on data presented by Malm (2000), the observed mean visual range in coastal
21 Louisiana, Mississippi, and Alabama is about 38 to 48 km (24 to 30 mi). In the Texas coastal
22 areas, the average visibility is about 48 to 64 km (30 to 40 mi). In the GOM coast States, about
23 60 to 70% of the human-induced visibility degradation (impairment) is attributed to sulfate
24 particles, while about 20% is from organic or elemental carbon particles. About 8% of the
25 visibility degradation is attributed to nitrate particles (Malm 2000; USEPA 2001).

26
27 Visibility degradation in large urban areas, such as Houston, can be especially
28 pronounced during air pollution episodes. In some severe cases, it may hinder navigation by
29 boats and aircraft. Degraded visibility also adds to the perception by the observer of bad air
30 quality even when monitors do not record unhealthful pollutant levels.

31
32 A study of visibility from platforms off Louisiana revealed that significant reductions in
33 Louisiana coastal and offshore visibility are almost entirely due to transient occurrences of fog
34 (Hsu and Blanchard 2005). Episodes of haze are short-lived and affect visibility much less.
35 Offshore haze often appears to result from plume drift generated from coastal sources. The
36 application of visibility screening models to individual OCS facilities has shown that the
37 emissions from a single facility are not large enough to significantly impair visibility. It is not
38 known to what extent aggregate OCS sources contribute to visibility reductions; however, the
39 effects from OCS sources are likely to be very minor because offshore emissions are
40 substantially smaller than the onshore emissions.

41
42 In July 1999, the USEPA published its Regional Haze Regulations Final Rule to address
43 visibility impairment in the Nation's National Parks and Wilderness Areas (64 FR 35714).
44 These regulations established goals for improving visibility in Class I areas through long-term
45 strategies for reducing emissions of air pollutants that cause visibility impairment. The rule
46 requires States to establish goals for each affected Class I area to improve visibility on the

1 haziest days and to ensure no degradation occurs on the clearest days. Since visibility
2 impairment involves considerable cross-boundary transport of air pollutants, States are
3 encouraged to coordinate their efforts through regional planning organizations. Texas and
4 Louisiana are part of the Central States Regional Air Planning Association. Mississippi,
5 Alabama, and Florida are members of the Visibility Improvement State and Tribal Association of
6 the Southeast. The USEPA provides funding to the regional planning organizations to address
7 regional haze by developing regional strategies to reduce emissions of particulate matter and
8 other pollutants that lead to haze (USEPA 2011k).

9
10 The Regional Haze Regulations along with the rules on ozone and acid rain should result
11 in a lowering of regional emissions and improvement in visibility. Projected emissions from all
12 cumulative OCS program activities are not expected to be substantially different from year 2000
13 emissions. The contribution of OCS program-related emissions to visibility impairment is
14 expected to be very minor.

15
16 **Conclusion.** The effects of various USEPA regulations and standards are expected to
17 result in a steady, downward trend in future air emissions. This trend should be realized in spite
18 of continued industrial and population growth along the GOM coast. Previous O₃ nonattainment
19 areas in the GOM coast region (Beaumont-Port Arthur, Texas, and Baton Rouge, Louisiana)
20 were reclassified as attainment areas in 2010. States such as Texas are required to implement
21 SIPs to reduce emissions in their O₃ nonattainment areas. The overall cumulative impacts on air
22 quality in the GOM over the next 40 to 50 yr are expected to be minor to moderate, and the
23 incremental contribution of the routine Program activities to air quality impacts would be small
24 (see Section 4.4.4.1).

25
26 The OCS program contributes slightly to onshore levels of NO₂, SO₂, and PM₁₀, but
27 concentrations are well within the national standards and PSD increments. The effects from
28 future OCS program activities are expected to remain about the same as in previous years.
29 Portions of the GOM coast region have O₃ levels that exceed the Federal standard, but the
30 contribution from all OCS program activities to ozone levels is very small (about 1%; see
31 Section 4.4.4.1.1). Ozone levels are on a declining trend due to air pollution control measures
32 that have been implemented by the States. This trend is expected to continue as a result of local
33 as well as nationwide control efforts. The contribution of the Program to onshore O₃ would
34 therefore remain very small. The GOM coast region has significant visibility impairment from
35 anthropogenic emission sources. However, visibility is expected to improve somewhat as a
36 result of regional and national programs to reduce emissions. The contribution from OCS
37 program activities to visibility impairment, therefore, is expected to remain small.

38
39 Impacts from the evaporation of accidental oil spills for the cumulative case would be
40 similar to those for the Program (see Section 4.4.4.1.2). Since impacts from individual spills
41 would be localized and temporary (due to the spreading of oil and action by winds, waves, and
42 currents that disperse volatile compounds to extremely low levels over a relatively larger area),
43 the magnitude of their impacts would be no different from those associated with the proposed
44 action. However, as many as 330 small (greater than 50 bbl and less than 1,000 bbl) and 40 large
45 oil spills (greater than 1,000 bbl; with the largest spills from tanker vessels) are projected to
46 occur over the 40 to 50 yr. Impacts from fires would also be localized and short in duration.

1 A more detailed discussion of the effects of oil spills on air quality in the GOM is presented in
2 Section 4.4.4.1.2.

3
4
5 **4.6.2.1.3 Acoustic Environment.** Section 4.4.5.1 discusses impacts on the acoustic
6 environment in the GOM resulting from the proposed action (OCS program activities from 2012
7 to 2017). Section 4.4.7 evaluates the direct and indirect impacts of noise on marine fauna
8 (mammals, birds, and fish), and Section 4.6.4 addresses the cumulative impacts of noise on
9 marine fauna. Cumulative impacts on the acoustic environment result from the incremental
10 impacts of the proposed action when added to impacts from existing and reasonably foreseeable
11 future OCS program activities (that are not part of the proposed action) and other non-OCS
12 program activities. Table 4.6.1-1 presents the exploration and development scenario for the
13 GOM cumulative case (encompassing the proposed action and other OCS program activities).
14 Ongoing and reasonably foreseeable non-OCS program activities contributing to adverse
15 cumulative impacts on the acoustic environment in the GOM include marine subsurface and
16 surface vessel traffic, aircraft traffic (helicopters and fixed-wing aircraft), dredging, construction
17 of onshore and offshore facilities (e.g., production platforms and drilling rigs in State waters),
18 LNG facility operations, renewable energy projects (foreseeable), marine geophysical (seismic)
19 surveys, active sonars, underwater explosions, ocean science studies, and mining operations.
20 This section addresses the quality of the acoustic environment only; the cumulative impacts of
21 noise on GOM marine fauna are discussed in Section 4.6.4.1.

22
23 Ambient (background) noise has numerous natural and man-made sources that vary with
24 respect to season, location, depth of occurrence, time of day, and noise characteristics
25 (e.g., frequency and duration).³¹ Natural sources of ambient noise include wind and waves, surfs
26 (produced by waves breaking onshore), precipitation (rain and hail), lightning, volcanic and
27 tectonic noise, and biological noise (from fishes, shrimp, and marine mammals). Vessels are the
28 greatest man-made contributors to overall marine noise in the GOM. Underwater explosions in
29 open water are the strongest point sources of man-made sound. Baseline acoustic conditions in
30 the GOM are discussed in more detail in Section 3.6.1.

31
32 Ongoing and future routine OCS program activities, including those of the proposed
33 action, that generate noise include operating air gun arrays (during marine seismic surveys),
34 drilling, pipeline trenching, and onshore and offshore construction and decommissioning of
35 platforms and drilling rigs. Vessel and aircraft traffic (including those associated with
36 emergency-response and cleanup activities in the event of a spill), accidental releases (e.g., loss
37 of well control events), and vessel collisions also contribute to noise. A preliminary study of the
38 noise impacts of OCS-related geophysical surveys found that marine seismic surveys have the
39 greatest impact on marine mammals, sea turtles, fish, and commercial and recreational fisheries
40 (MMS 2004a). Noise generated from OCS and non-OCS program activities would be
41 transmitted through both air and water, and may be transient or more extended (occurring over
42 the long term).

³¹ Higher frequencies are attenuated with distance from the source more rapidly than lower frequencies. Traffic noise generated in deep water contributes to background noise levels at greater distances than traffic noise generated in shallow water.

1 **Conclusion.** The quality of the acoustic environment in the GOM would continue to be
2 adversely affected by ongoing and future OCS program and non-OCS program activities.
3 Activities under the proposed action would contribute to adverse cumulative impacts on the
4 quality of the acoustic environment in the GOM. The magnitude of cumulative impacts in the
5 GOM is time- and location-specific and could range from minor to major, depending on the
6 ambient acoustic conditions and the nature and combination of all OCS and non-OCS program
7 activities in the GOM over the next 40 to 50 yr, and the incremental contributions due to noise
8 generated by routine Program activities (minor impacts) would also vary with time and location
9 and would depend on the characteristics of noise sources present (e.g., their frequency and
10 duration). The cumulative impacts of noise on marine fauna are discussed in Section 4.6.4.
11
12

13 **4.6.2.2 Alaska Region – Cook Inlet**

14
15
16 **4.6.2.2.1 Water Quality.** Section 4.4.3.2 discusses water quality impacts in coastal and
17 marine waters in the Cook Inlet resulting from the proposed action (OCS program activities from
18 2012 to 2017). Cumulative impacts on water quality result from the incremental impacts of the
19 proposed action when added to impacts from reasonably foreseeable future non-OCS program
20 activities. Table 4.6.1-2 presents the exploration and development scenario for the Cook Inlet
21 cumulative case. Non-OCS program activities contributing to adverse cumulative impacts on
22 water quality in Cook Inlet are summarized in Table 4.6.2-3.
23

24 OCS program activities (i.e., those of the proposed action; there are no existing OCS
25 program activities) involve vessel traffic, chemical releases (permitted discharges), and
26 disturbance of bottom sediments. Accidental oil spills are also counted among OCS program-
27 related activities; assumptions for oil spills under the cumulative case scenario are provided in
28 Table 4.6.1-3. All these activities have the potential to adversely affect water quality in Cook
29 Inlet.
30

31 OCS program-related marine vessel traffic in Cook Inlet could be as high as one to
32 three trips per week over the next 40 yr, all of which are associated with the proposed action.
33 Extensive non-OCS program marine traffic also occurs in Cook Inlet. Non-OCS program traffic
34 includes that related to crude oil and finished product transport, LNG and ammonia carriers (at
35 the Nikiski industrial complex), commercial fishing boats, and cruise ships. Fuel barge traffic is
36 minimal since much of the refined oil for regional consumption is transported to Anchorage by a
37 pipeline from the Tesoro refinery in Nikiski. An estimated 704 large vessels (other than fuel
38 barges on domestic trade) called at Cook Inlet ports between January 1, 2005, and July 15, 2006.
39 About 65% of these were made by container vessels, roll-on/roll-off cargo ships, or ferries; 29%
40 were gas or liquid tank ships calling at Nikiski. The remaining traffic consisted of bulk carriers,
41 general cargo ships, tugs, and fishing and passenger vessels. Impacts on water quality from
42 vessel traffic in Cook Inlet result mainly from oil and gasoline spills when vessels run aground,
43 collide, catch fire, or sink (Eley 2006).
44

45 The number of production wells and oil platforms constructed over the period of the
46 Program (at most, 114 and 3, respectively) will be proportional to the amount of oil produced

TABLE 4.6.2-3 Ongoing and Reasonably Foreseeable Future Non-OCS Activities Contributing to Cumulative Impacts on Water Quality – Cook Inlet

Type of Action	Associated Activities and Facilities (Impacting Factors)	Description
Marine vessel traffic	Accidental oil spills	Large vessel calls at marine facilities and terminals totaled 704 between January 1, 2005, and July 15, 2006. Most of these calls (65%) were container vessels, roll-on/roll-off cargo ships, or ferries; 29% were gas or liquid tankships. Another 6% were bulk carriers and general cargo; another 2% were tugs and fishing and passenger vessels. Facilities in Cook Inlet include the Nikiski industrial complex terminals (between Homer and Anchorage), the Port of Anchorage docks, and the Drift River terminal (37 km [23 mi] west-southwest of Nikiski) (Eley 2006).
Nikiski industrial complex	Permitted discharge points Pollutant releases via surface runoff (non-point discharges) Accidental oil or chemical spills Increased risk of explosions and fires Cooled water and biocide releases (LNG plant) Increased vehicle and marine traffic	The LNG plant on the East Foreland peninsula of Cook Inlet (at Nikiski) is currently the only LNG export operation in the United States; it exported about 30 Bcf of gas in 2010. The USDOE has extended the plant’s export license to 2013; however, in February 2011, ConocoPhillips announced it would close the plant, citing concerns over the gas supply and the deteriorated LNG market in Asia (Bradner 2011). See entry under “Oil- and gas-related activities and infrastructure” (this table).
Wastewater discharge to Cook Inlet	Permitted discharge points Pollutant releases via surface runoff (non-point discharges)	The major point sources of pollution in Cook Inlet include discharges (by discrete conveyances such as pipes or man-made ditches) from municipal wastewater treatment plants (e.g., Anchorage), seafood processors, and the petroleum industry (MMS 1995a). 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. Discharges are regulated through the USEPA NPDES permit program. Section 403 of the CWA established the Ocean Discharge Criteria, which provide additional requirements for these types of discharges. The Alaska Department of Environmental Quality issues all NPDES permits in Alaska except for those related to oil and gas, munitions, cooling water, pesticides, and offshore seafood processors, and

TABLE 4.6.2-3 (Cont.)

Type of Action	Associated Activities and Facilities (Impacting Factors)	Description
		those on tribal lands. Current NPDES permits in Alaska are available on the USEPA website at http://yosemite.epa.gov/r10/water.nsf/NPDES+Permits/CurrentAK822 .
		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 environment also introduces oil, grease, antifreeze, chemicals, trash, animal wastes, salt, and sediments (sand, gravel, suspended and dissolved solids) (ADEC 2007b). Non-point source management programs under Section 319 of the CWA regulate these pollutant sources. The USEPA and NOAA also co-administer State Coastal Non-Point Pollution Control Programs under Section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990 (USEPA 2011).
Dredging and marine disposal	Excavation of subaqueous sediments Transport of sediments (by dredger or pipeline) Relocation and disposal of sediments	The USACE currently has dredging projects in Anchorage Harbor, Homer Small Boat Harbor, and Ninilchik Harbor (Anderson 2010).

TABLE 4.6.2-3 (Cont.)

Type of Action	Associated Activities and Facilities (Impacting Factors)	Description
Oil- and gas-related activities and infrastructure	Port of Anchorage Nikiski industrial complex Exploration wells Oil and gas pipelines Tanker vessels Onshore fuel storage tanks and transfer stations Hazardous spills/releases	<p>Except for the Beaver Creek Unit, all other oil-producing fields in Cook Inlet are in State waters (MMS 2003a). There are 15 active offshore production platforms in the inlet. Crude oil production is handled through the Trading Bay facility and the Tesoro refinery in Nikiski; natural gas is consumed locally and processed through several plants in Nikiski. There is also a LNG plant (Phillips Marathon) at Nikiski (slated to close in 2011). Most of Cook Inlet’s oil reserves have been produced; oil production in the region, therefore, has been in decline since 1970.</p> <p>The Port of Anchorage stages all of the refined petroleum products from Fairbanks and facilitates petroleum deliveries from refiners on the Kenai Peninsula and in Valdez (it does not receive foreign crude oil imports). The port is currently undergoing expansion that would likely begin in 2013 (Municipality of Anchorage 2011).</p>

1 and reflects the total number of production wells and platforms anticipated to be built in Cook
2 Inlet over the next 40 to 50 yr as part of the OCS program. The length of new pipeline (at most
3 241 km [150 mi] offshore and 169 km [105 mi] onshore) added as part of the Program represents
4 all of that anticipated over the next 40 yr as part of the OCS program.
5

6 The area of sea bottom disturbed from construction of platforms and pipelines over the
7 period of the Program (as much as 260 ha [640 ac] total) also represents that associated with the
8 OCS program over the next 40 to 50 yr. Bottom disturbance degrades water quality by
9 increasing water turbidity (i.e., suspended sediment concentration) in the vicinity of the
10 operations and adding contaminants to the water column. It also changes sediment composition
11 as suspended sediments (and contaminants, if present) are entrained in currents and deposited in
12 new locations.
13

14 As summarized in Section 3.4.2, the principal point sources of pollution in Cook Inlet
15 include municipal discharges, as well as discharges from seafood processors and the petroleum
16 industry. Point-source pollution is rapidly diluted by the energetic tidal currents in Cook Inlet,
17 and the USEPA *National Coastal Condition Report III* has rated the coastal waters of south
18 central Alaska, including Cook Inlet, as good (although water clarity in upper Cook Inlet was
19 rated poor because of very high loadings of glacial river sediments) (USEPA 2008b). Non-point
20 sources release a range of contaminants via rivers and on-land drainages and are primarily from
21 urban runoff (related to land development); forest practices (e.g., timber harvest operations);
22 harbors and marinas; roads, highways, and bridges; hydromodification (related to dams, channel
23 modification, and stream bank erosion); mining; and agriculture (ADEC 2007). Point-source
24 discharges are anticipated to remain at present levels for the foreseeable future; non-point-source
25 discharges should improve as a result of Alaska's water pollution control strategy (as outlined in
26 ADEC 2007). Low concentrations of hydrocarbons are found throughout the waters of Cook
27 Inlet and are attributed to natural sources — natural oil seeps, river discharges carrying carbon
28 compounds of biogenic origin, and the deposition of fuel and natural organic matter (e.g., from
29 fires) (MMS 2003a).
30

31 Activities taking place within Cook Inlet waters also contribute to the degradation of
32 water quality. These include oil spills associated with vessel traffic, sediment dredging and
33 disposal in local harbors (suspended sediments and contaminants), and activities related to the oil
34 and gas industry, which operates platforms in State waters and discharges drilling wastes,
35 produced water, and other industrial waste streams into Cook Inlet waters (MMS 2003a).
36

37 Most of the oil released to Cook Inlet is from commercial and recreational vessels
38 (MMS 2003a). Small spills (less than 1,000 bbl) from commercial and recreational vessels or
39 from OCS program activities (e.g., accidental releases) are not expected to affect the overall
40 quality of Cook Inlet water (because they would be localized and short in duration); however,
41 large spills (greater than 1,000 bbl) could temporarily degrade the overall quality of its water
42 (MMS 2003a). Oil spills in ice-covered waters during winter months are generally contained
43 within a much smaller area (compared with spills in open waters) because oil weathering
44 (i.e., spreading, evaporation, and migration) is much slower and some oil may solidify. While
45 such factors have proven to be favorable for most response strategies, the presence of ice can
46 also complicate response efforts. Spills on ice are fairly easy to detect and map, unless there is

1 fresh snowfall at the time of the spill; however, oil spilled within and under the ice can be hidden
2 from view. Broken ice also makes spilled oil difficult to detect and map, and it can reduce the
3 effectiveness of conventional recovery systems (MMS 2009b; DF Dickens Associates,
4 Ltd. 2004).

5
6 Climate change predictions are based on models that simulate all relevant physical
7 processes under a variety of projected greenhouse gas emission scenarios (Section 3.3). Because
8 the complexity of modeling global and region climate systems is so great, uncertainty in climate
9 projections can never be eliminated. The IPCC projections relating generally to water and water
10 quality over the next two decades include:

- 11
- 12 • Sea level will rise by 0.18 to 0.59 m (0.6 to 2 ft) by the end of the twenty-first
13 century;
- 14
- 15 • Sea ice, glaciers, and ice sheets in polar regions will continue melting;
- 16
- 17 • Ocean pH will decrease by 0.14 to 0.35 over the twenty-first century;
- 18
- 19 • Precipitation will increase at high latitudes (>90% likely); and
- 20
- 21 • Annual river discharges (runoff) will increase by 10 to 40% at high latitudes
22 and decrease by 10 to 30% in the dry regions at mid-latitudes.
- 23

24 Alaska has experienced extensive regional warming since the 1960s, with a rise in annual
25 temperature of about 3°C (5°F) since the 1960s. The general effects of warming include the
26 extensive melting of glaciers, thawing of permafrost, and increased precipitation (Section 3.3).
27 Modeling studies of warming in Cook Inlet project very large warming trends, ranging from 4°C
28 to 10°C (7°F to 18°F) by the year 2100; precipitation is projected to increase by 20 to 25% (Kyle
29 and Brabets 2001).

30
31 **Conclusion.** Water quality in Cook Inlet would be impacted by the following activities
32 associated with the proposed action: vessel traffic, chemical releases (sanitary wastes),
33 disturbance of bottom sediments, and accidental oil spills (from vessels and the oil and gas
34 industry). Water quality is also affected by many other factors, including river inflows,
35 urbanization, forest practices, mining, and agriculture. Non-OCS program activities likely to
36 contribute to cumulative impacts include marine vessel traffic, wastewater discharge to the inlet,
37 dredging and marine disposal, and oil and gas related activities, as well as infrastructure in State-
38 owned marine waters. Natural seepage of oil along the west part of the inlet may also
39 significant. The cumulative impacts on Cook Inlet water quality from all OCS and non-OCS
40 activities in Cook Inlet over the next 40 to 50 yr are expected to be minor to moderate, and the
41 incremental contribution of the routine Program activities to water quality impacts would be
42 minor. These impacts may lessen with time since oil and gas production in the Cook Inlet is
43 currently on the decline (see Section 4.4.3.2).

44
45 The USEPA, in collaboration with other Federal and coastal State agencies, has assessed
46 the coastal conditions of each region of the United States, including Cook Inlet, by evaluating

1 five indicators of condition, one of which was water quality, based on such parameters as
2 dissolved oxygen, chlorophyll *a*, nitrogen, phosphorus, and water clarity. The most recent
3 assessment found the overall condition of the coastal waters of south-central Alaska, including
4 Cook Inlet, good (although water clarity in upper Cook Inlet was rated poor). Point source
5 discharges are anticipated to remain at present levels for the foreseeable future; non-point source
6 discharges should improve as a result of Alaska's water pollution control strategy. Low
7 concentrations of hydrocarbons are found throughout the waters of Cook Inlet and are attributed
8 to natural sources.
9

10 The number of accidental spills in Cook Inlet waters for most activities associated with
11 the proposed action would represent only a small increase over the number of expected spills
12 from ongoing non-OCS program activities. The incremental increase in adverse water quality
13 impacts from these spills would depend on the weather and sea conditions at the spill location
14 (e.g., whether ice is present), the type of waves and tidal energy at the spill locations, the type of
15 oil spilled (very light to very heavy), the depth of the spill event (deep water, shallow water, or
16 surface water), and the volume and rate of spillage. A more detailed discussion of the effects of
17 oil spills on water quality in Cook Inlet is presented in Section 4.4.3.2.2.
18
19

20 **4.6.2.2.2 Air Quality.** Section 4.4.4.2 discusses air quality impacts in onshore and
21 offshore areas of Cook Inlet resulting from the proposed action (OCS program activities from
22 2012 to 2017). Cumulative impacts on air quality result from the incremental impacts of the
23 proposed action when added to impacts from other reasonably foreseeable future OCS program
24 activities.³² Table 4.6.1-2 presents the exploration and development scenario for the Cook Inlet
25 cumulative case. Non-OCS program activities may also contribute to adverse cumulative
26 impacts on air quality in the Cook Inlet region; they are discussed below.
27

28 OCS program activities, i.e., those of the proposed action (there are no existing OCS
29 program activities), involve production platforms, exploration wells, platform construction and
30 removal, marine vessels (pipelaying, support, and survey), helicopters, and tanker and barge
31 transport. All these activities have the potential to adversely affect air quality in the Cook Inlet
32 region via direct emissions or other releases to air (e.g., volatile components of fuel). Accidental
33 oil spills are also counted among OCS program-related activities; assumptions for oil spills under
34 the cumulative case scenario are provided in Table 4.6.1-3. Existing emission sources in the
35 Cook Inlet Planning Area include oil production activities in State waters, onshore petroleum
36 processing and refining, onshore oil and gas production, marine terminals, and commercial
37 shipping.
38

39 Except for a few population centers such as Anchorage, Fairbanks, and Juneau, the
40 existing air quality in Alaska is relatively pristine, with pollutant concentrations well within
41 ambient standards (Section 3.5.2.2). The primary industrial emissions in the Cook Inlet region
42 are associated with oil and gas production, power generation, small refineries, paper mills, and
43 mining. Other sources include vessel traffic in Cook Inlet and emissions from on-land motor

³² Currently, there are no existing OCS activities in Cook Inlet and no future activities other than those planned for the 2012-2017 OCS program.

1 vehicles and refuse burning (MMS 2003a). While some growth of these activities is likely to
2 take place in the future, overall emissions are expected to remain low. More stringent emission
3 standards on motor vehicles and new USEPA standards on non-road engines and marine vessels
4 would result in a downward trend in emissions.

5
6 Modeling studies of proposed OCS production facilities in the Cook Inlet show that
7 concentrations of NO₂, SO₂, and PM₁₀ are within the PSD Class II and Class I maximum
8 allowable increments and the NAAQS. Pollutant concentrations within the Tuxedni NWA, the
9 only Class I area adjacent to the Cook Inlet Planning Area, exceed the Class I significance levels.
10 As a consequence, any proposed facilities that would exceed the Class I significance levels,
11 would need a comprehensive PSD increment consumption analysis done before permitting
12 (MMS 2003a).

13
14 The baseline conditions and impacts from OCS activities on ozone and visibility are
15 discussed in Sections 3.5.2.2 and 4.4.4.2, respectively. Because conditions in Alaska are seldom
16 favorable for significant O₃ formation, the contribution of leasing activity associated with the
17 Program to O₃ levels in the Cook Inlet region is expected to be small. OCS emission sources
18 affecting visibility are also small; however, preliminary visibility screening for the Tuxedni
19 NWA suggests sources within about 50 km (30 mi) may result in a plume visible from the site
20 (MMS 2003a).

21
22 Accidental oil spills are sources of gaseous emissions. No more than one large spill
23 (greater than 1,000 bbl) and 15 small spills (less than 50 bbl) are projected for the Cook Inlet
24 Planning Area cumulative case as a result of the OCS program. Most accidental spills in the
25 Cook Inlet region are of non-crude products caused by onshore train derailments, pipeline
26 failures, and leaks (crude oil comprises about 4% of all product spills) (ADEC 2007). Since
27 1976, there have been nine major crude oil spills in the inlet, ranging in volume from 10,000 to
28 396,000 gal (with the largest of these coming from construction barges, offshore platforms, and
29 jet fuel releases); the last major oil spill occurred in 1997 as a result of a loss of well control
30 incident at the Steelhead Platform (State of Alaska 2011). Oil spills cause localized increases in
31 VOC concentrations (proportional to the size of the spill) due to evaporation. Most of these
32 emissions would be expected to occur within a few hours of the spill and decrease (by
33 dispersion) drastically after that period (MMS 2003a). However, oil spills in ice-covered waters
34 during winter months would be contained within a much smaller area (compared with spills in
35 open waters) because oil weathering (i.e., spreading, evaporation, and migration) is much slower
36 and some oil may solidify (MMS 2009b). A more detailed discussion of the effects of oil spills
37 on air quality in Cook Inlet is presented in Section 4.4.4.2.

38
39 Catastrophic events at well locations may result in fires; *in situ* burning is also a preferred
40 technique for cleanup and disposal of oil spills (documented in soil spill contingency plans).
41 Smoke generated from such fires would be expected to reach shore quickly (within a day), but
42 would be limited in geographic extent (MMS 2003a). A discussion of the effects of fires on air
43 quality in the Arctic region is presented in Section 4.4.4.2.

44
45 **Conclusion.** OCS program activities in combination with other oil and gas exploration,
46 development, and production activities in the Cook Inlet Planning Area could affect air quality in

1 the region over the next 40 to 50 yr. Air pollutant concentrations associated with offshore and
2 onshore emission sources are expected to remain well within applicable State and Federal
3 standards over the life of the Program. Therefore, the overall cumulative impacts on air quality
4 in Cook Inlet from all OCS and non-OCS activities in the GOM over the next 40 to 50 yr are
5 expected to be minor to moderate, and the incremental contribution of the routine Program
6 activities to air quality impacts would be small (see Section 4.4.4.2).

7
8 Impacts from the evaporation of accidental oil spills for the cumulative case would be
9 similar to those for the Program (see Section 4.4.4.2.2). Since impacts from individual spills
10 would be localized and temporary (due to the spreading of oil and action by winds, waves, and
11 currents that disperse volatile compounds to extremely low levels over a relatively larger area or
12 solidification of oil during winter months), the magnitude of their impacts would be no different
13 from those associated with the proposed action. However, as many as three small (greater than
14 50 bbl and less than 1,000 bbl) and one large oil spills are projected to occur over the next 40 to
15 50 yr. Impacts from fires would also be localized and short in duration. A more detailed
16 discussion of the effects of oil spills on air quality in Cook Inlet is presented in Section 4.4.4.2.2.

17
18
19 **4.6.2.2.3 Acoustic Environment.** Section 4.4.5.2 discusses impacts on the acoustic
20 environment in Cook Inlet resulting from the proposed action (OCS program activities from
21 2012 to 2017). Section 4.4.7 evaluates the direct and indirect impacts of noise on marine fauna
22 (mammals, birds, and fish), and Section 4.6.4 addresses the cumulative impacts of noise on
23 marine fauna. Cumulative impacts on the acoustic environment result from the incremental
24 impacts of the proposed action when added to impacts from reasonably foreseeable future OCS
25 program activities (that are not part of the proposed action) and other non-OCS program
26 activities.³³ Table 4.6.1-1 presents the exploration and development scenario for the Cook Inlet
27 cumulative case (encompassing the proposed action and other OCS program activities).
28 Ongoing and reasonably foreseeable non-OCS program activities contributing to adverse
29 cumulative impacts on the acoustic environment in the Cook Inlet include aircraft overflights,
30 vessel activities and traffic, construction and decommissioning of onshore and offshore facilities
31 (e.g., related to ongoing oil and gas exploration and development in State waters), and other
32 activities (e.g., seismic surveys) conducted as part of the existing oil and gas industry in the inlet.
33 This section addresses the quality of the acoustic environment only; the cumulative impacts of
34 noise on Cook Inlet marine fauna are discussed in Section 4.6.4.2.

35
36 Ambient (background) noise has numerous natural and man-made sources that vary with
37 respect to season, location, depth of occurrence, time of day, and noise characteristics
38 (e.g., frequency and duration).³⁴ Natural sources of ambient noise include wind and wave
39 action, strong tidal fluctuations, currents, ice, precipitation (rain and hail), lightening, volcanic
40 and tectonic noise, and biological noise (from marine mammals and coastal birds). Vessels
41 (e.g., tankers, supply ships, tugboats, barges, and fishing boats) are the greatest man-made

³³ Currently, there are no existing OCS program activities in Cook Inlet.

³⁴ Higher frequencies are attenuated with distance from the source more rapidly than lower frequencies. Traffic noise generated in deep water contributes to background noise levels at greater distances than traffic noise generated in shallow water.

1 contributors to overall marine noise in Cook Inlet. Baseline acoustic conditions in Cook Inlet are
2 discussed in more detail in Section 3.6.2.

3
4 Ongoing and future routine OCS program activities, including those of the proposed
5 action, that generate noise include operating air gun arrays (during marine seismic surveys),
6 drilling, pipeline trenching, and onshore and offshore construction of platforms and drilling rigs.
7 Vessel and aircraft traffic (including that associated with emergency response and cleanup
8 activities in the event of a spill), accidental releases (e.g., loss of well control events), and vessel
9 collisions also contribute to noise. A preliminary study of the noise impacts of OCS-related
10 geophysical surveys found that marine seismic surveys have the greatest impact on marine
11 mammals, sea turtles, fish, and commercial and recreational fisheries (MMS 2004a). Noise
12 generated from OCS and non-OCS program activities would be transmitted through both air and
13 water, and may be transient or more extended (occurring over the long term).

14
15 **Conclusion.** The quality of the acoustic environment in Cook Inlet would continue to be
16 adversely affected by ongoing and future non-OCS program activities and by future OCS
17 program activities (currently there are no existing OCS activities). Activities under the proposed
18 action would contribute to adverse cumulative impacts on the quality of the acoustic
19 environment in the inlet. The magnitude of cumulative impacts due to noise in Cook Inlet from
20 all OCS and non-OCS activities in Cook Inlet over the next 40 to 50 yr is time- and location-
21 specific and could range from minor to major, depending on the ambient acoustic conditions and
22 the nature of activities taking place. The incremental contribution of the routine Program
23 activities (minor impacts) would also vary with time and location and would depend on the
24 characteristics of noise sources present (e.g., their frequency and duration). The cumulative
25 impacts of noise on marine fauna are discussed in Section 4.6.4.

26 27 28 **4.6.2.3 Alaska Region – Arctic**

29
30
31 **4.6.2.3.1 Water Quality.** Section 4.4.3.3 discusses water quality impacts in coastal and
32 marine waters in the Beaufort and Chukchi Seas resulting from the proposed action (OCS
33 program activities from 2012 to 2017). Cumulative impacts on water quality result from the
34 incremental impacts of the proposed action when added to impacts from existing and reasonably
35 foreseeable future OCS program activities (that are not part of the proposed action) and other
36 non-OCS program activities.³⁵ Table 4.6.1-2 presents the exploration and development scenario
37 for the Arctic region cumulative case. Non-OCS program activities contributing to adverse
38 cumulative impacts on water quality in Beaufort and Chukchi Seas are summarized in
39 Table 4.6.2-4.

40

³⁵ Currently, there are no existing OCS program activities in the Beaufort Sea and Chukchi Sea Planning Areas, but it is assumed that exploration and development activities as a result of Sale 193 (Chukchi Sea) will have occurred before commencement of the exploration and development activities associated with the proposed action (Section 4.4.1.3).

TABLE 4.6.2-4 Ongoing and Reasonably Foreseeable Future Non-OCS Activities Contributing to Cumulative Impacts on Water Quality – Arctic Region

Type of Action	Associated Activities and Facilities (Impacting Factors)	Description
Marine vessel traffic	Discharges of bilge water and waste Accidental oil spills	<p>Current level of vessel traffic is low, consisting mainly of vessels supporting the oil and gas industry (e.g., cargo vessels, tugs/barges, service vessels, spill-response vessels, and hovercraft). Other vessels include those used by the military, arctic researchers (icebreakers), and by local communities for hunting and between-village transportation during the open water period. As open water season begins earlier and ends later, vessel traffic is likely to increase for shipping, research, and cruise-ship tourism (MMS 2008b).</p> <p>There is substantial international vessel traffic in the Bering Strait (the narrow international strait that connects the north Pacific Ocean to the Arctic Ocean) and Chukchi Sea; activity in this region increased from 245 marine vessel transits in 2008 (in the Bering Strait) to 325 transits in 2010. This trend is expected to continue with ongoing exploration and drilling activities on the U.S. and possibly the Russian portion of the Chukchi shelf (USCG 2011).</p>
Wastewater discharges	Permitted discharge points Pollutant releases via surface runoff (non-point discharges)	<p>Point-source discharges to the Beaufort and Chukchi Seas include those from facilities related to the oil and gas industry, hard-rock and placer mining, military operations, and seawater treatment (ADEC 2010; USEPA 2010c). Most of these activities would remain at present levels for the foreseeable future and are not expected to affect the overall water quality in these regions. Discharges are regulated through the USEPA NPDES permit program. Section 403 of the CWA established the Ocean Discharge Criteria, which provide additional requirements for these types of discharges. The Alaska Department of Environmental Quality issues all NPDES permits in Alaska except for those related to oil and gas, munitions, cooling water, pesticides, and offshore seafood processors, and those on tribal lands. Current NPDES permits in Alaska are available on the USEPA Web site at http://yosemite.epa.gov/r10/water.nsf/NPDES+Permits/CurrentAK822.</p>

TABLE 4.6.2-4 (Cont.)

Type of Action	Associated Activities and Facilities (Impacting Factors)	Description
Dredging and marine disposal	Excavation of subaqueous sediments Transport of sediments (by dredger or pipeline) Relocation and disposal of sediments	<p>Non-point sources of pollution include stormwater and snowmelt that run over land or through the ground, entraining pollutants and depositing them into Arctic waters. The most common forms of pollution in Alaska’s urban runoff include fecal coliform, sedimentation, and petroleum. Snow disposal into the marine environment also introduces oil, grease, antifreeze, chemicals, trash, animal wastes, salt, and sediments (sand, gravel, suspended and dissolved solids) (ADEC 2007b). Non-point source management programs under Section 319 of the CWA regulate these pollutant sources. The USEPA and NOAA also co-administer State Coastal Non-Point Pollution Control Programs under Section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990.</p> <p>Mechanical and hydraulic dredges have been used to excavate materials to construct artificial islands (drilling platforms), helipads, and coastal harbors/shipping corridors in the Beaufort Sea. All past dredging activities have been conducted to support the oil and gas industry — in the 1950s and 1960s, it was for shipping and transportation; in the 1970s and 1980s, it was mainly for the construction of islands (30 islands were built during this time). Most dredging occurred during the open water season in water depths less than 50 m (150 ft). Harbors, channels, and mooring basins were dredged in MacKinley Bay, Tuft Point, and Tuktoyaktuk. Several regulations govern the dredging operations in arctic waters (IMG Golder Corp. 2004). The likelihood of future dredging projects is not known but is considered to be low.</p>

TABLE 4.6.2-4 (Cont.)

Type of Action	Associated Activities and Facilities (Impacting Factors)	Description
Oil- and gas-related activities and infrastructure	Ports and terminals Exploration wells Oil and gas pipelines Tanker vessels Onshore fuel storage tanks and transfer stations Hazardous spills/releases	<p>Thirty-five oil-producing fields and satellites have been developed on the North Slope and nearshore areas of the Beaufort Sea. Industrial development centers on Prudhoe Bay; infrastructure includes roadways, pipelines, production and processing facilities, gravel mines, and docks. After 30 yr of leasing in the Alaska OCS, there are no commercial oil or gas facilities located on Federal OCS lands. Most projects are located offshore in the State waters of the Beaufort Sea (MMS 2008b).</p> <p>Two large diesel fuel spills have occurred in the Beaufort Sea — one of 2,440 bbl from a diesel tank on an eroded gravel island in the Canadian Beaufort Sea (September 1985) and one of 1,600 bbl from a punctured barge delivering fuel to Kaktovik (August 1988) (MMS 2008b).</p> <p>There were 4,481 spills of seawater, produced water, crude oil, diesel, and drilling muds on the Alaska North Slope subarea between 1995 and 2005 (totaling 45,000 bbl); 98% of the volume released resulted from spills greater than 99 gal. Oil exploration and production facilities were responsible for more than 90% of the spills and about 90% of the volume. Over the past 20 yr, most large spills were of diesel fuel and occurred in local villages (ADEC 2007a; MMS 2008b).</p>

TABLE 4.6.2-4 (Cont.)

Type of Action	Associated Activities and Facilities (Impacting Factors)	Description
Red Dog Mine	Transport by barge	<p>The Red Dog Mine, operated by Teck Cominco Alaska, is one of the largest lead and zinc mines in the world and the only base-metal lode mine currently in production in northwest Alaska. The open-pit mine (with processing mill, tailings impoundment, and support facilities) is located in the DeLong Mountains about 130 km (82 mi) north of Kotzebue and 74 km (46 mi) inland from the Chukchi seacoast; it has produced more than a million tons of zinc and lead concentrates annually but is estimated to be mined out by 2012. Teck Cominco Alaska is proposing to mine an adjacent deposit (Aqqaluk Deposit) and continue its operations until 2031 (ADNR 2011; USEPA 2009).</p>
		<p>Processed ore (concentrate) is transported from the Red Dog Mine by an 84-km (52-mi) road to the DeLong Mountain Terminal, a port facility located on the Chukchi Sea. The terminal consists of a housing unit, six diesel storage tanks, two concentrate storage buildings, a laydown area, and a concentrate conveyor/ship loading system. Although concentrate is shipped from the mine to the terminal year-round, shipping of concentrate by barge (to deep sea cargo ships) occurs only during months when the waters are ice-free (generally from July through October). The port site also includes a small domestic wastewater treatment system that discharges to the Chukchi Sea under a NPDES permit (USEPA 2009).</p>
		<p>The Red Dog Mine may be a source of trace metals in the Chukchi Sea (Section 3.4.3).</p>
Gold (placer mining) on Seward Peninsula (Chukchi Sea)	Use of mercury for amalgamation	<p>Mining of placer gold in beach deposits and bench gravels continued through 1900 and could present a risk of contamination to nearby water and sediments.</p>

1 Ongoing and future routine OCS program activities (i.e., those of the proposed action and
2 existing OCS program activities) involve vessel traffic, waste disposal, chemical releases
3 (permitted discharges), and disturbance of bottom sediments. All these activities have the
4 potential to adversely affect water quality in the Beaufort and Chukchi Seas. Accidental oil
5 spills are also counted among OCS program-related activities; assumptions for oil spills under
6 the cumulative case scenario are provided in Table 4.6.1-3.

7
8 OCS program-related marine vessel traffic in the Beaufort and Chukchi Seas could be as
9 high as 41 trips per week (up to 18 in the Beaufort Sea and 23 in the Chukchi Sea) over the next
10 40 to 50 yr; vessel traffic associated with the proposed action represents about 66% of this traffic
11 but would occur only during open-water and broken ice conditions (typically during August and
12 September). Non-OCS program traffic in the Beaufort and Chukchi Seas is relatively low and
13 includes that related to the oil and gas industry (e.g., cargo vessels, spill response vessels, and
14 hovercraft), military operations, and arctic research. Small vessels are used by local
15 communities for hunting and between-village transportation during the open water period
16 (MMS 2008b). Impacts on water quality from marine traffic arise from regular discharges of
17 bilge water and waste, leaching of anti-fouling paints, and incidental spills (MMS 2001).

18
19 In the Beaufort Sea Planning Area, the number of production wells and oil platforms
20 constructed over the period of the Program (at most 120 and 4, respectively) will be proportional
21 to the amount of oil produced; these numbers represent about 32 and 33% (respectively) of the
22 total number of production wells and platforms anticipated to be built in the planning area over
23 the next 40 to 50 yr as part of the Program. The lengths of new onshore and offshore pipeline (at
24 most 129 km [80 mi] and 250 km [155 mi], respectively) added as part of the Program represent
25 about 21 and 30%, respectively, of that anticipated as part of the OCS program.

26
27 In the Chukchi Sea Planning Area, the number of production wells and oil platforms
28 constructed over the period of the Program (at most 280 and 5, respectively) will be proportional
29 to the amount of oil produced; these numbers represent about 25% (for each) of the total number
30 of production wells and platforms anticipated to be built in the planning area over the next 40 yr
31 as part of the OCS program. The lengths of new onshore and offshore pipeline (at most 0 km
32 [0 mi] and 402 km [250 mi], respectively) added as part of the Program represent about 0 and
33 19%, respectively, of that anticipated as part of the OCS program.

34
35 The area of sea bottom disturbed from construction of platforms and pipelines over the
36 period of the Program (as much as 430 ha [1,100 ac] in the planning areas combined) represents
37 about 19% of that associated with the OCS program over the next 40 yr. Bottom disturbance
38 degrades water quality by increasing water turbidity in the vicinity of the operations and adding
39 contaminants to the water column. It also changes sediment composition as suspended
40 sediments (and contaminants, if present) are entrained in currents and deposited in new locations.

41
42 As summarized in Section 3.4.3, the water quality in the Beaufort and Chukchi Seas is
43 relatively uncontaminated by anthropogenic pollutants (compared to other regions that typically
44 receive pollutants from industrial, agricultural, and municipal discharges and related runoff).
45 The principal point sources of pollution are facilities related to the oil and gas industry, hard-rock
46 and placer mining, military operations, and seawater treatment. Non-point sources release a

1 range of contaminants via rivers and onland drainages that could include contaminated runoff
2 related to mining operations (e.g., gold mining on the Seward Peninsula). Most of these
3 activities would remain at present levels for the foreseeable future and are not expected to affect
4 the overall water quality in these regions.

5
6 Activities taking place within arctic waters also contribute to the degradation of water
7 quality. These include oil spills associated with vessel traffic, sediment dredging and disposal in
8 local harbors (suspended sediments and contaminants), and activities related to the oil and gas
9 industry, which operates platforms in State waters and discharges drilling wastes, produced
10 water, and other industrial waste streams into the Beaufort Sea (MMS 2008b; ADEC 2007a).

11
12 Most of the oil released to arctic waters is from leaks related to the oil industry
13 (ADEC 2007a). Small spills (less than 1,000 bbl) from commercial and recreational vessels or
14 from OCS program activities (e.g., accidental releases) are not expected to affect the overall
15 quality of the Beaufort or Chukchi Seas because they are localized and short in duration;
16 however, large spills (greater than 1,000 bbl) could temporarily degrade the overall quality of
17 their water (MMS 2003a). Oil spills in ice-covered waters are generally contained within a much
18 smaller area (compared with open-water spills) because in the cold arctic environment, oil
19 weathering (i.e., spreading, evaporation, and migration) is much slower and some oil may
20 solidify. While such factors have proven to be favorable for most response strategies, the
21 presence of ice can also complicate the response strategy. Spills on ice are fairly easy to detect
22 and map, unless there is fresh snowfall at the time of the spill; however, oil spilled within and
23 under the ice can be hidden from view. Broken ice also makes spilled oil difficult to detect and
24 map, and it can reduce the effectiveness of conventional recovery systems (MMS 2009b;
25 DF Dickens Associates, Ltd. 2004).

26
27 Climate change predictions are based on models that simulate all relevant physical
28 processes under a variety of projected greenhouse gas emission scenarios (Section 3.3). Because
29 the complexity of modeling global and region climate systems is so great, uncertainty in climate
30 projections can never be eliminated. Changes to the arctic climate include:

- 31
32
- 33 • Atmospheric temperature increases of 1 to 2°C (2–4°F) since the 1960s and
34 continuing increases at a rate 1°C (2°F) per decade in winter and spring;
 - 35 • Precipitation increases at a rate of about 1% per decade;
 - 36
 - 37 • Decreases in sea ice extent at a rate of about 3% per decade (since the 1970s);
 - 38
 - 39 • Multi-year ice decreases at a rate of about 9% per decade (since the 1980s);
 - 40
 - 41 • Temperatures increases at the top of the permafrost layer by up to 3°C (5°F)
42 since the 1980s; and
 - 43
 - 44 • Thawing of the permafrost base at a rate of up to 0.04 m/yr (0.13 ft/yr).
 - 45

1 The retreat of sea ice is increasing impacts on coastal areas from storms. In areas where
2 permafrost has thawed, coastlines are more vulnerable to erosion from wave action.
3

4 **Conclusion.** Water quality in the Beaufort and Chukchi Seas would be affected by the
5 following activities associated with the proposed action: vessel traffic, waste disposal, chemical
6 releases (permitted discharges), disturbance of bottom sediments, and accidental oil spills (from
7 vessels and the oil and gas industry). Non-OCS program activities likely to contribute to
8 cumulative impacts include marine vessel traffic, wastewater discharge, dredging and marine
9 disposal, oil-related, and gas-related activities and infrastructure in State-owned marine waters,
10 and activities related to the Red Dog Mine. The cumulative impacts on arctic water from all
11 OCS and non-OCS activities in the Arctic over the next 40 to 50 yr are expected to be moderate
12 and the incremental contribution of the routine Program activities (such as non-OCS program oil
13 and gas activities to water quality impacts would be minor to moderate (see Section 4.4.3.3).
14 The number of large spills in arctic waters for most activities associated with the proposed action
15 would represent only a small increase over the number of expected spills from ongoing OCS and
16 non-OCS program activities. The incremental increase in adverse water quality impacts from
17 these spills would depend on the weather and sea conditions at the spill location (e.g., whether
18 ice is present), the type of waves and tidal energy at the spill locations, the type of oil spilled
19 (very light to very heavy), the depth of the spill event (deep water, shallow water, or surface
20 water), and the volume and rate of spillage. A more detailed discussion of the effects of oil spills
21 on water quality in arctic waters is presented in Section 4.4.3.3.2.
22
23

24 **4.6.2.3.2 Air Quality.** Section 4.4.4.1 discusses air quality impacts on onshore and
25 offshore areas of the Arctic region resulting from the proposed action (OCS program activities
26 from 2012 to 2017). Cumulative impacts on air quality result from the incremental impacts of
27 the proposed action when added to impacts from existing and reasonably foreseeable future OCS
28 program activities (that are not part of the proposed action) and other non-OCS program
29 activities.³⁶ Table 4.6.1-2 presents the exploration and development scenario for the Arctic
30 region cumulative case (encompassing the proposed action and future OCS program activities).
31 Non-OCS program activities also contribute to adverse cumulative impacts on air quality in the
32 region; they are discussed below.
33

34 Ongoing and future routine OCS program activities, including those of the proposed
35 action, involve production platforms, exploration wells, platform construction and removal,
36 marine vessels (pipelaying, support, and survey), helicopters, and tanker and barge transport. All
37 these activities have the potential to adversely affect air quality in the Beaufort and Chukchi
38 Seas. Accidental oil spills are also counted among OCS program-related activities; assumptions
39 for oil spills under the cumulative case scenario are provided in Table 4.6.1-3. Existing emission
40 sources in the Beaufort and Chukchi Sea Planning Areas include oil and gas exploration,
41 development, and production activities in State waters (Beaufort Sea only); onshore petroleum

³⁶ Currently, there are no existing OCS program activities in the Beaufort and Chukchi Sea Planning Areas, but it is assumed that exploration and development activities as a result of Sale 193 (Chukchi Sea) will have occurred before commencement of the exploration and development activities associated with the proposed action (Section 4.4.1.3).

1 processing and refining; marine terminals (e.g., DeLong Mountain Terminal on the Chukchi
2 Sea); aircraft traffic; and vessel traffic.

3
4 Except for a few population centers such as Anchorage, Fairbanks, and Juneau, the
5 existing air quality in Alaska is relatively pristine with pollutant concentrations well within
6 ambient standards (Section 3.5.2.3). This is also the case in the Chukchi and Beaufort Seas and
7 the North Slope area, with the exception of “arctic haze,” which is attributed to combustion
8 sources in Russia (MMS 2010). The primary industrial emissions in the Beaufort and Chukchi
9 Sea Planning Areas are associated with onshore oil development and production, offshore oil
10 development and production (in State waters), power generation, mining (Red Dog Mine), and
11 marine transportation. While some growth of these activities is likely to take place in the future,
12 overall emissions are expected to remain low. More stringent emission standards on motor
13 vehicles and new USEPA standards on non-road engines and marine vessels would result in a
14 downward trend in emissions.

15
16 On the Alaska North Slope, the main sources of air emissions are associated with onshore
17 oil production from the Prudhoe Bay, Kuparuk River, Colville River, Oooguruk, Milne Point,
18 and Badami fields and oil production in State waters (Northstar and Duck Island fields). As of
19 2009, about 16.2 Bbbl³⁷ of oil have been produced from North Slope reservoirs, including the
20 Beaufort Sea (ADNR 2009). Production from the region peaked at about 730 Mbbl in 1988 and
21 has been in decline since then (EIA 2011c). The USDOE projects that the annual production of
22 oil will continue to decline, from about 234 Mbbl in 2010 to 37 Mbbl in 2050 (EIA 2009q).
23 There are a number of planned and potential future oil development projects, both onshore and in
24 State and Federal waters in the Beaufort Sea Planning Area. There are very few other emission
25 sources in the Chukchi Sea Planning Area.

26
27 Air monitoring at a number of sites in the Kuparuk and Prudhoe Bay fields has shown
28 that concentrations of NO₂, SO₂, and PM₁₀ are well within the NAAQS. Modeling studies for
29 the Liberty project indicate that emissions from these areas have little effect on ambient
30 concentrations in other locations (with maximum concentrations occurring within 100 to 200 m
31 [330 to 660 ft] from the facility boundary and considerably lower concentrations at a distance of
32 1 km [0.62 mi]) (MMS 2010). For this reason, it is anticipated that emissions from new facilities
33 would be small and localized with little interaction between facilities.

34
35 The baseline conditions and impacts from OCS activities on ozone and visibility are
36 discussed in Sections 3.5.2.3 and 4.4.4.3, respectively. Because conditions in Alaska are seldom
37 favorable for significant O₃ formation, the contribution of leasing activity associated with the
38 Program to O₃ levels in the Beaufort and Chukchi Sea Planning Areas is expected to be small.
39 OCS emission sources affecting visibility are also small.

40
41 Accidental oil spills are a source of gaseous emissions. No more than six large spills
42 (of volume greater than 1,000 bbl) and 450 small spills (of volume less than 50 bbl) are projected
43 for the Beaufort and Chukchi Sea Planning Areas cumulative case as a result of the OCS
44 program (Table 4.6.1-3). Most of the accidental spills in the North Slope region are of non-crude

³⁷ Historic figures include both oil and natural gas liquids produced at Prudhoe Bay and surrounding fields.

1 products during fuel transfer operations at remote villages (ADEC 2007a). While there is no
2 discernable trend in the annual number of spills or total volume released, there is a seasonal
3 pattern to spill events, with increases occurring during winter months (likely coinciding with
4 increased exploration activities). Since 1976, there have been no major crude oil spills in arctic
5 waters (State of Alaska 2011). Oil spills cause localized increases in VOC concentrations
6 (proportional to the size of the spill) due to evaporation. Most of these emissions would be
7 expected to occur within a few hours of the spill and decrease (by dissipation) drastically after
8 that period (MMS 2010). However, oil spills in ice-covered waters during winter months would
9 be contained within a much smaller area (compared with spills in open waters) because oil
10 weathering (i.e., spreading, evaporation, and migration) is much slower and some oil may
11 solidify (MMS 2009b). A more detailed discussion of the effects of oil spills on air quality in the
12 Arctic region is presented in Section 4.4.4.3.

13
14 Catastrophic events at well locations may result in fires; *in situ* burning is also a preferred
15 technique for cleanup and disposal of oil spills (documented in oil spill contingency plans).
16 Smoke generated from such fires would be expected to reach shore quickly (within a day), but
17 would be limited in geographic extent (MMS 2003a). A discussion of the effects of fires on air
18 quality in the Arctic region is presented in Section 4.4.4.3.

19
20 **Conclusion.** OCS program activities in combination with other oil and gas exploration,
21 development, and production activities in the Beaufort and Chukchi Sea Planning Areas could
22 affect air quality in the region. Air pollutant concentrations associated with offshore and onshore
23 emission sources are expected to remain well within applicable State and Federal standards over
24 the life of the Program. Therefore, the overall cumulative impacts on air quality in the Beaufort
25 and Chukchi Sea Planning Areas are expected to be minor to moderate, and the incremental
26 contribution of routine Program activities to air quality impacts would be small (see
27 Section 4.4.4.3).

28
29 Impacts from the evaporation of accidental oil spills for the cumulative case would be
30 similar to those for the Program (see Section 4.4.4.3.2). Since impacts from individual spills
31 would be localized and temporary (because in the cold arctic environment oil weathering is
32 slower and some oil may solidify), the magnitude of their impacts would be no different from
33 those associated with the proposed action. However, as many as 80 small (greater than 50 bbl
34 and less than 1,000 bbl) and eight large oil spills are projected to occur over the next 40 to 50 yr.
35 Impacts from fires would also be localized and short in duration. A more detailed discussion of
36 the effects of oil spills on air quality in the Arctic region is presented in Section 4.4.4.3.2.

37
38
39 **4.6.2.3.3 Acoustic Environment.** Section 4.4.5.3 discusses impacts on the acoustic
40 environment in the Arctic region resulting from the proposed action (OCS program activities
41 from 2012 to 2017). Section 4.4.7 evaluates the direct and indirect impacts of noise on marine
42 fauna (mammals, birds, and fish), and Section 4.6.4 addresses the cumulative impacts of noise on
43 marine fauna. Cumulative impacts on the acoustic environment result from the incremental
44 impacts of the proposed action when added to impacts from reasonably foreseeable future OCS
45 program activities (that are not part of the proposed action) and other non-OCS program

1 activities.³⁸ Table 4.6.1-1 presents the exploration and development scenario for the Beaufort
2 Sea and Chukchi Sea Planning Areas cumulative case (encompassing the proposed action and
3 other OCS program activities). Ongoing and reasonably foreseeable non-OCS program activities
4 contributing to adverse cumulative impacts on the acoustic environment in the Arctic region
5 include aircraft overflights, vessel activities and traffic, construction of onshore and offshore
6 facilities (e.g., related to ongoing oil and gas exploration and development in State waters), and
7 other activities (e.g., seismic surveys) conducted as part of the existing oil and gas industry in the
8 Beaufort and Chukchi Seas. This section addresses the quality of the acoustic environment only;
9 the cumulative impacts of noise on marine fauna in the Beaufort and Chukchi Seas are discussed
10 in Section 4.6.4.3.

11
12 Ambient (background) noise has numerous natural and manmade sources that vary with
13 respect to season, location, depth of occurrence, time of day, and noise characteristics
14 (e.g., frequency and duration).³⁹ Natural sources of ambient noise include wind and wave
15 action, currents, ice, precipitation (rain and hail), lightning, and biological noise (from marine
16 mammals and coastal birds). Vessels (e.g., tankers, supply ships, tugboats, barges, and fishing
17 boats) are the greatest man-made contributors to overall marine noise in the Arctic region.
18 Baseline acoustic conditions in the region are discussed in more detail in Section 3.6.3.

19
20 Ongoing and future routine OCS program activities, including those of the proposed
21 action, that generate noise include operating air gun arrays (during marine seismic surveys),
22 drilling, pipeline trenching, and onshore and offshore construction and decommissioning of
23 platforms (including artificial islands and causeways), and drilling rigs. Vessel and aircraft
24 traffic (including that associated with emergency response and cleanup activities in the event of a
25 spill), accidental releases (e.g., loss of well control events), and vessel collisions also contribute
26 to noise. A preliminary study of the noise impacts of OCS related geophysical surveys found
27 that marine seismic surveys have the greatest impact on marine mammals, sea turtles, fish, and
28 commercial and recreational fisheries (MMS 2004a). Noise generated from OCS and non-OCS
29 program activities would be transmitted through both air and water, and may be transient or more
30 extended (occurring over the long term).

31
32 **Conclusion.** The quality of the acoustic environment in the Beaufort and Chukchi Seas
33 would continue to be adversely affected by ongoing and future non-OCS program activities and
34 by future OCS program activities (currently there are no existing OCS activities). Activities
35 under the proposed action would contribute to adverse cumulative impacts on the quality of the
36 acoustic environment in the Arctic region. The magnitude of cumulative impacts due to noise in
37 the Beaufort and Chukchi Seas from all OCS and non-OCS activities in the Arctic over the next
38 40 to 50 yr is time- and location-specific and could range from minor to major, depending on the
39 ambient acoustic conditions and the nature of activities taking place. The incremental

³⁸ Currently, there are no existing OCS program activities in the Beaufort Sea and Chukchi Sea Planning Areas, but it is assumed that exploration and development activities as a result of Sale 193 (Chukchi Sea) will have occurred before the proposed action (Section 4.4.1.3).

³⁹ Higher frequencies are attenuated with distance from the source more rapidly than lower frequencies. Traffic noise generated in deep water contributes to background noise levels at greater distances than traffic noise generated in shallow water.

1 contribution due to noise generated by the routine Program activities (minor impacts) would vary
2 with time and location and would depend on the characteristics of noise sources present
3 (e.g., their frequency and duration). The cumulative impacts of noise on marine fauna are
4 discussed in Section 4.6.4.

7 **4.6.3 Marine and Coastal Habitats**

10 **4.6.3.1 Gulf of Mexico Region**

13 **4.6.3.1.1 Coastal and Estuarine Habitats.** A number of activities associated with the
14 proposed action could result in impacts on coastal and estuarine habitats (Section 4.4.6.1). These
15 activities include construction of pipelines and shoreline facilities, maintenance dredging of
16 inlets and channels, and vessel traffic. Impacts associated with these activities could include
17 (1) losses of beach and dune habitat and indirect effects that contribute to reductions in beach
18 habitat in areas of ongoing shoreline degradation; and (2) elimination of wetland habitat and
19 indirect effects that contribute to reductions in wetland habitat. Similar activities will be
20 occurring from previous and future sales during the life of the Program (see Table 4.6.1-1).
21 Excluding the estimated number of offshore pipelines installed, which is not relevant to this
22 analysis, the activities associated with the proposed action will be about 15–30% of the total
23 amount of OCS program activity that will occur during the life of the Program.

25 **Barrier Beaches and Dunes.** Impacts on barrier beaches and dunes primarily result
26 from factors that reduce sediment input to downdrift areas or that directly contribute to increased
27 erosion of beaches and dunes. Construction projects may reduce the sediment contribution to the
28 GOM barrier landforms from inflowing rivers, or they may restrict the movement of sediments
29 to downdrift areas and natural replenishment of barrier beaches. Other activities may disturb
30 barrier dune vegetation, thereby promoting dune erosion, or directly disturb beach and dune
31 substrates, resulting in increased erosion of beaches and dunes. Increases in wave action can
32 also contribute to beach erosion.

34 Ongoing non-OCS activities that could affect barrier beaches and dunes include those
35 related to State oil development, commercial shipping, coastal development, and recreation.
36 These activities can be reasonably expected to continue into the future. A number of activities
37 reduce the sediment supply to barrier beaches and dunes. Past activities that have contributed to
38 sediment deprivation and submergence of coastal lands have contributed to erosion and land
39 losses, particularly along the Louisiana coast, and are expected to continue into the foreseeable
40 future. Channelization and diversion of Mississippi River flows, as well as the construction of
41 Mississippi River dams and reservoirs, and subsequent reductions in sediment supply to deltaic
42 areas to the west have resulted in the continued extensive erosion of coastal habitats. Past
43 construction of dams on other rivers discharging to the western GOM has also resulted in a
44 reduction in sediments delivered to the coast, which, along with natural causes of sediment
45 supply reductions, have resulted in ongoing land loss along the Texas coast. The emplacement
46 of groins, jetties, and seawalls for beach stabilization in much of the GOM contributes to the

1 reduction of sediment inputs and the acceleration of coastal erosion in downdrift areas.
2 Maintenance dredging of barrier inlets and bar channels, in combination with channel jetties, has
3 resulted in impacts on adjacent barrier beaches down-current due to sediment deprivation,
4 especially on the sediment-starved coastal areas of Louisiana. Maintenance dredging is an
5 ongoing practice and is expected to continue to be an impacting factor into the future; this
6 includes, for example, efforts to accommodate larger cargo vessels. The past construction of
7 canals for pipelines and navigation has resulted in losses of coastal barrier habitat. Although
8 new navigation canals from the GOM to inland areas are unlikely to be needed and current
9 pipeline construction methods result in little, if any, impacts on barrier landforms, existing
10 pipeline canals are expected to continue to be sediment sinks and to promote the reduction of
11 adjacent barrier island dunes and beaches. However, the replenishment of barrier beaches with
12 sand obtained from OCS sources and the beneficial use of dredged material are expected to
13 continue to aid in the restoration of barrier islands. The impacts on barrier beaches and dunes
14 from sediment removal activities associated with maintenance dredging under the proposed
15 action would represent a very small contribution to the past, ongoing, and expected future
16 degradation of barrier beaches and dunes from non-OCS activities.

17
18 Although coastal barrier islands in most of the Central GOM Planning Area generally
19 receive minimal recreational use, most barrier beaches in Texas, Alabama, and Florida are
20 accessible and extensively used for recreation. Pedestrian and vehicular traffic on beaches and
21 dunes can destabilize substrates, either by reducing vegetation density—and thus increasing
22 erosion by wind, waves, and traffic—or by directly disturbing or displacing substrates. In
23 addition, considerable private and commercial development has occurred on many barrier islands
24 in the GOM, resulting in losses of beach and dune habitat. The impacts on barrier beaches and
25 dunes from substrate-disturbance activities associated with pipeline construction under the
26 proposed action are expected to be greatly minimized by non-intrusive construction techniques
27 and would not be expected to appreciably add to the cumulative effects of other substrate-
28 disturbing activities.

29
30 Activities that increase wave action along barrier beaches and dunes can contribute to
31 their erosion. The construction of seawalls, groins, and jetties in Texas and Louisiana has
32 contributed to coastal erosion in part by increasing or redirecting the erosional energy of waves.
33 Vessel traffic related to shipping and transportation can result in wake erosion of channels
34 between barrier islands. A large number of vessels use the navigation channels near the GOM
35 coast. A portion of the impacts related to vessel traffic would be associated with the proposed
36 action; however, activities conducted under the proposed action would contribute a relatively
37 small number of vessel trips to the total.

38
39 Barrier beaches and dunes could be impacted by accidental spills of oil or petroleum
40 products resulting from cumulative OCS activities (Section 4.6.1.1). Although the majority of
41 these spills would be small (less than 50 bbl), catastrophic releases can impact extensive areas of
42 shoreline. Oil released into coastal waters as a result of the DWH event, April–July 2010,
43 affected more than 1,046 km (650 mi) of the GOM coastal habitat, from the Mississippi River
44 delta to the Florida panhandle, with the Louisiana, Mississippi, Alabama, and Florida coasts all
45 affected (OSAT-2 2011; National Commission 2011). The greatest impacts were in Louisiana.
46 More than 209 km (130 mi) of coastal habitat were moderately to heavily oiled, with only 32 km

1 (20 mi) occurring outside of Louisiana (National Commission 2011). Little or no oil affected
2 Texas coastal habitats. Heavy to moderate oiling occurred along a substantial number of
3 Louisiana beaches, with the heaviest oiling on the Mississippi Delta, in Barataria Bay, and on the
4 Chandeleur Islands (OSAT-2 2011). The majority of Mississippi barrier islands had light oiling
5 to trace oil, although heavy to moderate oiling occurred in some areas. Some heavy to moderate
6 oiling also occurred on beaches in Alabama and Florida, with the heaviest stretch of oiling
7 extending from Dauphin Island, Alabama, to near Gulf Breeze, Florida (OSAT-2 2011). Light to
8 trace oiling occurred from Gulf Breeze to Panama City, Florida. Deposition of oil occurred in
9 the supratidal zone (above the high tide mark), deposited and buried during storm events;
10 intertidal zone; and subtidal zone, there remaining as submerged oil mats (OSAT-2 2011). On
11 Grand Isle, Louisiana, and Bon Secour, Alabama, oil was found up to 105 cm (41 in.) below the
12 surface (OSAT-2 2011). Although much of the oil remaining after cleanup is highly weathered,
13 several constituents have the potential to cause toxicological effects (OSAT-2 2011). Non-OCS
14 activities, such as the domestic transportation of oil, foreign crude oil imports, and State oil
15 development may also result in accidental spills that could potentially impact coastal barrier
16 beaches and dunes. The amount of oil contacting barrier islands from a spill would depend on a
17 number of factors such as the location and size of the spill, waves and water currents, and
18 containment actions. Naturally occurring seeps may also be a source of crude oil introduced into
19 GOM waters (NRC 2003b; Kvenvolden and Cooper 2003). The magnitude of resulting impacts
20 and the persistence of oil would depend on factors such as the amount of oil deposited,
21 remediation efforts, substrate grain size, and localized erosion and deposition patterns. In areas
22 of barrier beach erosion, such as Louisiana, remediation would likely include the minimization
23 of sand removal or replacement of removed sand. The impacts of potential oil spills associated
24 with the proposed action would be expected to add a small contribution to the impacts of other
25 sources of oil.

26
27 Indirect effects on coastal barrier beaches and dunes could result from global climate
28 change. Factors associated with global climate change include changes in temperature and
29 rainfall, alteration in stream flow and river discharge, sea level rise, changes in hurricane
30 frequency and strength, sediment yield, mass movement frequencies and coastal erosion, and
31 subsidence (Yanez-Arancibia and Day 2004). Potential thermal expansion of ocean water and
32 melting of glaciers and ice caps could result in a global rise in mean sea level (Section 4.6.1.6).
33 Recent rates of sea level rise have been approximately 3 mm/yr (0.12 in./yr), but this rate may
34 increase to 4 mm/yr (0.16 in./yr) by 2100 (Blum and Roberts 2009). Sea-level rise could result
35 in increased inundation of barrier beaches and increases in losses of beach habitat. Effects of sea
36 level rise include damage from inundation, floods and storms; and erosion (Nicholls et al. 2007).
37 Effects of increased storm intensity include increases in extreme water levels and wave heights;
38 increases in episodic erosion, storm damage, risk of flooding, and defence failure
39 (Nicholls et al. 2007). Patterns of erosion and accretion can also be altered along coastlines
40 (Nicholls et al. 2007). The small tidal range of the GOM coast increases the vulnerability of
41 coastal habitats to the effects of climate change.

42
43 Hurricanes and other severe storm events can affect coastal barrier beaches and dunes.
44 Increased wave action and intensity on barrier habitats may result in increased erosion and
45 changes in beach and dune topography or losses of habitat. Hurricanes and tropical storms are
46 inherent components of the GOM ecosystem that have long influenced coastal habitats and are

1 expected to continue to be sources of impacts. Anthropogenic impacts on barrier beaches and
2 dunes may be greatly exacerbated by severe storm events such as hurricanes. In 2005,
3 Hurricanes Katrina and Rita caused extensive erosion of barrier landforms in the central and
4 western GOM. Extreme storms such as these can result in relatively permanent change to these
5 habitats, particularly in areas that are already experiencing erosion and retreat as a result of
6 sediment deprivation, sea level rise, and coastal development.

7
8 **Wetlands.** Factors that affect coastal wetlands include the direct elimination of wetland
9 habitat by excavation or filling, the reduction of sediment inputs, the erosion of wetland
10 substrates, and the degradation of wetland communities by reduced water quality or hydrologic
11 changes. Construction projects may fill wetlands for facility siting or excavate wetlands for the
12 construction of canals or pipelines. Other projects may reduce the sediment delivered to coastal
13 wetlands from inflowing rivers. A number of activities may degrade wetlands or promote
14 wetland losses indirectly by causing changes to wetland hydrology or introducing contaminants.
15 Routine OCS operations could have direct impacts on wetlands as a result of direct losses of
16 habitat from construction activities, pipeline landfalls and channel dredging, and indirect impacts
17 as a result of altered hydrology caused by channel dredging.

18
19 Ongoing non-OCS activities that could affect coastal wetlands include those related to
20 State oil and gas development, commercial shipping, coastal development, dredging operations,
21 discharge of municipal wastes and other effluents, domestic transportation of oil and gas, and
22 foreign crude oil imports. These activities can be reasonably expected to continue into the
23 future. A number of these activities result in the localized destruction of wetlands. The
24 construction of pipelines and navigation channels would result in direct losses of wetlands that
25 are crossed, due to excavation. In addition, the creation of spoil banks along canals would bury
26 wetland habitat. Large areas of coastal wetlands are also lost by drainage and filling, due to
27 urban development and agricultural use (Gosselink et al. 1979; Bahr and Wascom 1984).
28 Although activities that impact wetlands are regulated by State and Federal agencies,
29 construction of industrial facilities, commercial sites, and residential developments would be
30 expected to result in continued wetland losses. Pipeline installation and vessel traffic outside of
31 established traffic routes could have short-term impacts on seagrass communities, which are
32 primarily located in the eastern GOM. The direct impacts on coastal wetlands from pipeline,
33 navigation canal, or facility construction under the proposed action would represent a small
34 contribution to the past, ongoing, and expected future losses of wetlands from non-OCS
35 activities.

36
37 Indirect impacts on wetlands from non-OCS activities are expected to continue to
38 contribute to wetland degradation and conversion of wetlands to open water. A major factor that
39 has contributed to the ongoing loss of coastal wetlands, particularly in the Mississippi River
40 Delta region of Louisiana, is the reduction in sediments provided to coastal marshes. Reductions
41 in sediment supply, in combination with natural subsidence, have contributed significantly to the
42 conversion of coastal marsh to open water. The construction of dams and levees and
43 channelization along the Mississippi River restrict the sediment supply and overbank flow of
44 floodwaters, limiting the release of sediments and fresh water to coastal marshes
45 (LCWCRTF 1998, 2003; USACE 2004).

1 Coastal wetlands are also lost due to the effects of large storm events, and the continuing
2 erosion of barrier islands reduces their capacity to act as buffers for coastal wetlands
3 (LCWCRTF 2001). Construction of canals for pipelines and navigation would result in future
4 continuing progressive losses from canal widening and failure of mitigation structures, which
5 would contribute to the conversion of wetlands to open water. Canal construction and
6 maintenance dredging of navigation canals result in hydrologic changes, primarily high levels of
7 tidal and storm flushing and draining potential of interior wetland areas. Such alterations of
8 water movement can result in erosion of marsh substrates and increase inundation levels, and can
9 result in substantial impacts on the hydrologic basin. Construction and maintenance of canals
10 through coastal wetlands can increase the impacts of coastal storms, such as hurricanes, in the
11 conversion of wetlands to open water. Saltwater intrusion results from canal construction and
12 reduced freshwater inputs due to river channelization, and causes considerable deterioration of
13 coastal wetlands. Wetland losses due to subsidence have also been attributed to extraction of oil
14 in some portions of the Mississippi River Delta, or the withdrawal of groundwater along the
15 Texas coast. Changes in wetland hydrology, as well as increases in turbidity and sedimentation,
16 as a result of construction projects, can affect wetlands.

17
18 Degradation of wetlands can result from water quality impacts due to stormwater
19 discharges and discharges of waste water from vessels, municipal treatment plants, and industrial
20 facilities. Water quality may also be impacted by waste storage and disposal sites. The direct
21 and indirect impacts on coastal wetlands under the proposed action would represent a small
22 contribution to the past, ongoing, and expected future impacts on wetlands from non-OCS
23 activities.

24
25 Accidental spills of oil or petroleum products from OCS activities (Section 4.4.6.1) could
26 impact coastal wetlands. The majority of these spills would be small (less than 50 bbl). Should
27 spills occur in shallow water from vessel accidents and pipelines, they could contact and affect
28 coastal wetlands. Most spills that occur in deep water would be unlikely to contact and impact
29 wetlands. Catastrophic releases in deep water, however, can impact extensive areas of shoreline.
30 Oil released into coastal waters as a result of the DWH event, April–July 2010, affected more
31 than 1,046 km (650 mi) of the GOM coastal habitat, from the Mississippi River delta to the
32 Florida panhandle, with the Louisiana, Mississippi, Alabama, and Florida coasts all affected
33 (OSAT-2 2011; National Commission 2011). Non-OCS activities, such as State oil
34 development, the domestic transportation of oil, and foreign crude oil imports, may also result in
35 accidental spills that could potentially impact coastal wetlands. Naturally occurring seeps may
36 also be a source of crude oil that could potentially affect coastal wetlands. The amount of oil
37 contacting wetlands, the magnitude of resulting impacts, and the length of time for recovery
38 would depend on a number of factors such as the location and size of the spill, containment
39 actions, waves and water currents, type of oil, types of remediation efforts, amount of oil
40 deposition, duration of exposure, season, substrate type, and extent of oil penetration. Impacts
41 from oil spills would be expected to range from short-term effects on vegetation growth to
42 permanent loss of wetlands and conversion to open water. The impacts of potential oil spills
43 associated with the proposed action would be expected to constitute a small addition to the
44 impacts of all other sources of oil in the GOM.

1 Global climate change could result in indirect effects on coastal wetlands. Factors
2 associated with global climate change include changes in temperature and rainfall, alteration in
3 stream flow and river discharge, wetland loss, salinity, sea level rise, changes in hurricane
4 frequency and strength, sediment yield, mass movement frequencies and coastal erosion, and
5 subsidence (Yanez-Arancibia and Day 2004). Effects of sea level rise include damage from
6 inundation, floods and storms; erosion; saltwater intrusion; rising water tables/impeded drainage;
7 and wetland loss and change (Nicholls et al. 2007). Effects of increased storm intensity include
8 increases in extreme water levels and wave heights; increases in episodic erosion, storm damage,
9 risk of flooding, and defence failure (Nicholls et al. 2007). Patterns of erosion and accretion can
10 also be altered along coastlines (Nicholls et al. 2007). The small tidal range of the GOM coast
11 increases the vulnerability of coastal habitats to the effects of climate change. A study of coastal
12 vulnerability along the entire U.S. GOM coast found that 42% of the shoreline mapped was
13 classified as being at very high risk of coastal change due to factors associated with future sea
14 level rise (Thieler and Hammar-Klose 2000). A revised coastal vulnerability index study of the
15 coast from Galveston, Texas, to Panama City, Florida, indicated that 61% of that mapped
16 coastline was classified as being at very high vulnerability, with coastal Louisiana being the most
17 vulnerable area of this coastline (Pendleton et al. 2010). Potential thermal expansion of ocean
18 water and melting of glaciers and ice caps could result in a global rise in mean sea level
19 (Section 4.6.1.6). Sea level rise would result in greater inundation of coastal wetlands and likely
20 result in an acceleration of coastal wetland losses, particularly in Louisiana, as wetlands are
21 converted to open water. In addition, large changes in river flows into the GOM could affect
22 salinity and water circulation in estuaries, which, in turn, could impact estuarine wetland
23 communities.
24

25 Hurricanes and other severe storm events impact coastal wetlands through increased
26 wave action and intensity, resulting in increased erosion of wetland substrates and conversion of
27 coastal wetlands to open water. Hurricanes and tropical storms are inherent components of the
28 GOM ecosystem that have long influenced coastal habitats and are expected to be continuing
29 sources of impacts. However, impacts on wetlands as a result of human activities, such as those
30 that create marsh openings that enhance tidal and storm-driven water movements, may be
31 amplified by severe storm events such as hurricanes. In 2005, Hurricanes Katrina and Rita
32 caused extensive impacts on wetlands in the Central and Western GOM. For example, up to
33 259 km² (100 mi²) of coastal wetlands in Louisiana may have been converted to open water as a
34 result of the storms, and up to 60,700 ha (150,000 ac) of coastal wetlands and bottomland forests
35 were damaged in national wildlife refuges along the GOM coast (FWS 2006). It is possible that
36 extreme storms such as these could result in relatively permanent change to these habitats,
37 particularly in areas that are already experiencing erosion and conversion of wetlands to open
38 water as a result of sediment deprivation, sea-level rise, channelization, and coastal development.
39

40 **Seagrass Beds.** As identified in Section 4.4.6.1, the principal OCS activities under the
41 proposed action that could potentially affect seagrass beds include placement of structures
42 (e.g., pipelines) and vessel traffic within the vicinity of the beds. In addition, coastal
43 development associated with OCS oil and gas activities could contribute to cumulative impacts
44 on submerged seagrass beds. Most of the seagrass beds in the GOM are in the Eastern GOM
45 Planning Area, where no OCS activities are proposed during the Program.
46

1 Non-OCS activities that may contribute to cumulative effects on seagrass habitats include
2 anchoring, fishing/trawling, offshore shipping, diving, and continued onshore development. The
3 extensive seagrass beds located in the eastern GOM may be susceptible to impacts from non-
4 OCS activities such as dredging and onshore development that contribute to increased
5 sedimentation, turbidity, nutrient input, and various types of point and non-point source
6 contamination.

7
8 As noted in Section 4.4.6.1, oil spills reaching coastal areas could affect submerged
9 seagrass beds. The majority of these spills would be small (less than 50 bbl). Should spills
10 occur in shallow water from vessel accidents and pipelines, they could contact and affect
11 seagrass beds. Most spills that occur in deep water would be very unlikely to contact and impact
12 seagrasses; however, catastrophic releases can impact extensive areas of shoreline. As identified
13 in Table 4.6.1-3, it is assumed that up to 40 large oil spills (>1,000 bbl), up to 330 small-sized
14 spills 50 to 999 bbl, and up to 1,950 small oil spills of less than 50 bbl could occur as a result of
15 ongoing and currently planned OCS activities. A catastrophic spill event would have an
16 assumed spill size of 4,000,000 bbl. As discussed previously, non-OCS activities and oil seeps
17 could also contribute substantially to releases of oil in the GOM. Oil spills in shallow water in
18 the GOM from OCS and non-OCS activities could have significant effects on submerged
19 seagrass beds. The magnitude and severity of potential effects on seagrass beds from oil spills
20 would be a function of the location, timing, duration, and size of the spill; the proximity of the
21 spill to seagrass beds; and the timing and nature of spill containment and cleanup activities.
22 Releases that occur in the shallow portions of the eastern GOM have the potential to be of
23 greatest significance, due to the more extensive growth of seagrasses along that coastline. It is
24 unlikely that OCS spills would contact the extensive seagrass areas offshore Florida and along its
25 coast because of the great distance between these resources and locations in the Central and
26 Western GOM Planning Areas where leasing will occur.

27
28 **Conclusion.** Ongoing OCS and non-OCS program activities in combination with
29 naturally occurring events have resulted in considerable losses of coastal and estuarine habitats
30 in the GOM; cumulative impacts on these resources, therefore, are considered to be moderate to
31 major. Operations under the proposed action would result in small localized impacts, primarily
32 due to facility construction, pipeline landfalls, channel dredging, and vessel traffic; however, the
33 incremental contribution of routine Program activities to cumulative impacts would be small
34 (see Section 4.4.6.1.1).

35
36 The cumulative impacts of past, present, and future oil spills and natural seeps on
37 submerged seagrass beds would be moderate to major. The incremental impacts of accidental oil
38 spills associated with the proposed action on seagrass beds would be small to large, depending
39 on the location, timing, duration, and size of the spill; the proximity of the spill to seagrass beds;
40 and the timing and nature of spill containment and cleanup activities (see Section 4.4.6.1.1). The
41 majority of these spills would be small (less than 50 bbl). Large oil releases that occur in or
42 reach shallower nearshore areas have the greatest potential to affect coastal and estuarine
43 habitats. Most spills would be unlikely to contact and affect coastal and estuarine habitats.
44 Large oil spills and catastrophic discharge events, however, can affect extensive areas of
45 shoreline.

1 **4.6.3.1.2 Marine Benthic and Pelagic Habitats.** Cumulative impacts could result from
2 the combination of the proposed action and past, present, and reasonably foreseeable future OCS
3 and non-OCS activities. Impacts on marine benthic and pelagic habitat resulting from ongoing
4 and future routine OCS program activities, including those of the proposed action, could result
5 from noise (vessel, seismic surveys, and construction), well drilling, pipeline placement
6 (trenching, landfalls, and construction), platform placement (anchoring, mooring, and removal,
7 except in deep waters) and routine discharges (drilling, production, platform, and vessel).
8 Accidental oil spills are also counted among OCS program-related activities.

9
10 Up to 12,000 development and production wells and 2,000 oil platforms are anticipated
11 to be built in the GOM under the cumulative scenario (Table 4.6.1-1). In addition, up to
12 69,200 km (43,000 mi) of offshore pipeline could be added. The construction of platforms and
13 pipelines would disturb as much as 81,000 ha (200,200 ac) in total over the next 40 to 50 yr
14 (Table 4.6.1-1). Bottom disturbance resulting from the proposed action may degrade water
15 quality by increasing water turbidity in the vicinity of the operations and adding contaminants to
16 the water column. It also changes sediment composition as suspended sediments (and
17 contaminants, if present) are entrained in currents and deposited in new locations. The increased
18 amount of drilling anticipated under the proposed action will result in OCS discharges of drill
19 muds, cuttings, and produced waters. Impacts of OCS routine operations (exploration,
20 production and decommissioning activities) on marine benthic and pelagic habitat are discussed
21 in detail in Sections 4.4.6.2.1 and 4.4.6.3.1. Overall, routine operations represent a negligible to
22 moderate long-term disturbance, with the severity of the impacts generally decreasing
23 dramatically with distance from the well site.

24
25 Non-OCS activities with a potential to impact marine benthic and pelagic habitats in the
26 GOM include sediment dredging and disposal, sand mining, anchoring, fishing/trawling, and
27 tankering of imported oil. Anchoring by non-OCS vessels could cause significant chronic
28 disturbance the benthic habitat and biota and temporarily reduce water quality by generating
29 turbidity in the water column. Anchoring could involve boats used for recreational and
30 commercial fishing or scuba diving, and commercial ship traffic. The amount of damage that
31 could result from anchoring activity would depend upon vessel size, the size of the anchor and
32 chain, sea conditions at the time of anchoring, and the location or position of the anchor on the
33 feature. Areas damaged by anchors may take more than 10 years to recover, depending upon the
34 severity of the damage. Due to a lack of regulation of non-OCS activities on these features, there
35 is a likelihood of damages increasing due to heavier usage of the resources in the future. Sand
36 mining and dredging operations in conjunction with ship channel maintenance and construction,
37 pipeline placement and burial, and support facility access occur throughout the GOM as part of
38 non-OCS activities. Sediments dredged and sidecast or transported to approved dredged material
39 disposal sites would alter bottom habitat and communities and remove, injure, or kill local biotic
40 communities in addition to generating turbidity over the length of the water column. Similarly,
41 bottom trawling degrades benthic habitats and temporarily increases the turbidity of the water
42 (Jones 1992).

43
44 Other non-OCS activities with a potential to impact marine benthic and pelagic habitats
45 include offshore marine transportation, and pollutant inputs from point and non-point sources.
46 Vessel traffic is a source of chronic noise that could temporarily and episodically reduce local

1 habitat quality by disturbing pelagic and shallow water benthic organisms. Multiple contaminant
2 sources exist from nearshore point sources and contaminants can also be delivered to the
3 continental shelf during storms and high river discharge. A primary example is the cultural
4 eutrophication of the GOM, which has resulted in a large seasonal hypoxic zone off the coasts of
5 Louisiana and Texas and restricts the use of benthic and bottom water habitat by marine biota
6 over a wide area. In addition to non-point source pollution, LNG terminal operations (biocide-
7 laden, cooled water), and activities related to the oil and gas industry, which operates hundreds
8 of platforms in State and Federal waters, discharges large volumes of drilling wastes, produced
9 water, and other industrial waste streams to GOM waters. Pollutant inputs into the GOM and
10 their impact on water quality are discussed in Section 4.6.2.1. The impacts of these activities on
11 marine pelagic habitat can be temporary or long term and could result in reduced habitat quality
12 for marine biota.

13
14 In the benthic and pelagic habitats of the GOM, climate change may cause the temporal
15 variability of key chemical and physical parameters — particularly hydrology, dissolved oxygen,
16 salinity, and temperature — to change or increase, which could significantly alter the existing
17 structure of the benthic and phytoplankton communities (Rabalais et al. 2010). For example,
18 freshwater discharge into the GOM has been increasing and is expected to continue to increase
19 as a result of the increased rainfall in the Mississippi River Basin (Dai et al. 2009). Such
20 changes could result in severe long-term or short-term fluctuations in temperature and salinity
21 that could reduce or eliminate sensitive species. Such changes are most likely to occur in the
22 Mississippi Estuarine Ecoregion, where freshwater inputs are highest. In addition, greater
23 rainfall may increase inputs of nutrients into the GOM, potentially resulting in more intense
24 phytoplankton blooms that could promote benthic hypoxia (Rabalais et al. 2010). Hypoxic or
25 anoxic conditions can reduce or eliminate the suitability of benthic habitat for marine organisms.

26
27 Marine benthic and pelagic habitat and biota could be affected by oil spills from both
28 OCS program activities and non-OCS activities such as the domestic transportation of oil, the
29 import of foreign crude oil, and State development of oil. Storms, operator error, and
30 mechanical failures may result in accidental oil releases from a variety of non-OCS related
31 activities. Assumptions for oil spills under the cumulative case scenario are provided in
32 Table 4.6.2-3, and for catastrophic spills, in Table 4.4.2-2. Large and potentially catastrophic
33 spills could result from pipeline ruptures, tanker spills associated with an FPSO system, or loss
34 of well control. In addition, crude oil enters the environment of the GOM from naturally
35 occurring seeps. At least 63 seeps have been identified in the GOM (mostly off the coast of
36 Louisiana) (MacDonald et al. 1996), and more than 350 naturally occurring and constant oil
37 seeps that produce perennial slicks of oil at consistent locations may be present in the GOM
38 (MacDonald and Leifer 2002, as cited in Kvenvolden and Cooper 2003). Seeps in the northern
39 GOM have been estimated to discharge more than 28,000 bbl of crude oil annually to overlying
40 GOM waters (MacDonald 1998b).

41
42 For both OCS and non-OCS oil spills, it is assumed that the magnitude and severity of
43 the potential effects on benthic and pelagic habitat would be a function of the location, timing,
44 duration, and size of the spill and the timing and nature of spill containment and cleanup
45 activities. Detailed discussion of the impacts of OCS accidental hydrocarbon releases on marine
46 benthic and pelagic habitat can be found in Sections 4.4.6.2.1 and 4.4.6.3.1.

1 **Coral Reefs and Hard-Bottom Habitat.** Sensitive coral reef and hard-bottom benthic
2 habitats in the GOM may be more susceptible to OCS impacts and take longer to recover if
3 impacts were to occur. Consequently, these habitats receive special protection. Four coral reef
4 and hard-bottom habitats are designated for the various protections: (1) banks offshore of Texas
5 and Louisiana (including the FGBNMS), (2) the Pinnacle Trend off the Louisiana-Alabama
6 coast, (3) seagrass and low-relief live-bottom areas primarily located in the Central and Eastern
7 Planning Areas, and (4) potentially sensitive biological features of moderate to high relief that
8 are not protected by (1) and (2). As identified in Section 4.4.6.2.1, NTL No. 2009-G39 has
9 several protections in place to minimize and mitigate the adverse effects of oil and gas
10 exploration and development on coral reefs and hard-bottom habitat.

11
12 Cumulative impact factors for coral reef and hard-bottom habitat include both OCS and
13 non-OCS cumulative activities. Impacts of OCS exploration, production and decommissioning
14 activities on coral reefs and hard-bottom habitat could result from noise, well drilling, pipeline
15 placement (trenching, landfalls, and construction), chemical releases (drilling discharges,
16 operation discharges, and sanitary wastes), and platforms placement (anchoring, mooring, and
17 removal, except in deepwaters). Impacts of OCS exploration, production and decommissioning
18 activities on marine benthic and pelagic habitat are discussed in detail in Section 4.4.6.2.1.
19 Overall, impacts on coral reef and live-bottom habitat from routine activities should be
20 minimized by the protection stipulated by NTL 2009-G39. However, low-relief or small,
21 isolated, unmapped live-bottom could be affected by direct mechanical damage and turbidity and
22 sedimentation.

23
24 Non-OCS activities with a potential to impact these habitats include anchoring by non-
25 OCS activity vessels, fishing/trawling, discharges by non-OCS offshore marine transportation,
26 and tankering of imported oil. Anchoring could involve boats used for recreational and
27 commercial fishing or scuba diving, and commercial ship traffic. The amount of damage that
28 could result from anchoring activity would depend upon vessel size, the size of the anchor and
29 chain, sea conditions at the time of anchoring, and the location or position of the anchor on the
30 feature. Recovery of areas damaged by anchors may be long term, depending upon the severity
31 of the damage. Due to a lack of regulation of non-OCS activities on these features, there is a
32 likelihood of damages increasing due to heavier usage of the resources in the future.

33
34 Trawling activities are another source of damage to coral and hardbottom habitat.
35 Because anchoring and collection activities by scuba divers on the living reef areas of the Flower
36 Garden Banks are prohibited, biota associated with the Flower Garden Banks are unlikely to be
37 significantly affected by these activities. Similarly, use of spiny lobster and stone crab traps may
38 also damage bottom substrate such as seagrasses and corals. Strings of traps deployed without
39 buoys are sometimes retrieved by dragging 18-kg (40-lb) grapnels and chains across the bottom
40 until the trap string is hooked, potentially damaging bottom habitats in the process.

41
42 Impacts could also occur due to discharges from other non-OCS activities, including
43 tankers or other marine traffic passing in the vicinity of coral reef and hard-bottom habitat.
44 Because water depths are typically greater than 20 m (66 ft) at the tops of most of the banks,
45 dilution of discharges would greatly reduce concentrations of potentially toxic components

1 before they could come in contact with these features; consequently, it is assumed that
2 discharges from such activities would not be concentrated enough to reduce habitat quality.

3
4 Climate change has the potential to profoundly affect coral communities on coral and
5 hard-bottom features in several ways including (Section 3.7.1.1.4):

- 6
7 • Increased frequency of bleaching as a stress response to warming water
8 temperatures (Hoegh-Guldberg et al. 2007);
- 9
10 • Excessive algal growth on reefs and an increase in bacterial, fungal, and viral
11 agents (Boesch et al. 2000; Twilley et al. 2001);
- 12
13 • Greater frequency of mechanical damage to corals from greater severity of
14 tropical storms and hurricanes (Janetos et al. 2008);
- 15
16 • Decreases in the oceanic pH and carbonate concentration are expected to
17 reduce the reef formation rate, weaken the existing reef structure, and alter the
18 composition of coral communities (Janetos et al. 2008); and
- 19

20 In addition, climate change may allow the range expansion of non-native species. Many
21 of the decommissioned platforms will be converted into artificial reefs. By acting as stepping
22 stones across the GOM, oil platforms have been implicated in the introduction of a non-native
23 coral species (*Tubastraea coccinea*) and fishes such as sergeant majors (*Abudefduf saxatilis*) and
24 yellowtail snapper (*Ocyurus chrysurus*) into the FGB (Hickerson et al. 2008).

25
26 Oil spills from both OCS and non-OCS activities could affect coral reef and hard-bottom
27 habitat and biota. Detailed discussion of the impacts of OCS accidental hydrocarbon releases on
28 hard-bottom and coral reef habitat can be found in Section 4.4.6.2.1. It is assumed that
29 accidental oil releases from most non-OCS activities would be at the surface or located
30 sufficiently far from coral reef and hard-bottom habitat and biota that they would be unlikely to
31 greatly affect these habitats. The magnitude and severity of potential effects on coral reef and
32 hard-bottom habitat and biota from such exposure would be a function of the location, timing,
33 duration, and size of the spill; the proximity of the spill to the features; and the timing and nature
34 of spill containment and cleanup activities. Depending upon location, spills from non-OCS
35 sources and releases from natural seeps could contribute to the overall exposure of communities
36 associated with topographic features in the GOM OCS planning areas to oil, with corresponding
37 lethal or sublethal effects.

38
39 **High Density Deepwater Communities (HDDC).** High density deepwater communities
40 (HDDCs) include coldwater corals and chemosynthetic communities. Cumulative impact factors
41 for HDDCs include both OCS and non-OCS cumulative activities. Potential impacts on HDDCs
42 resulting from ongoing and future routine OCS program activities, including those of the
43 proposed action, could result from noise, well drilling, pipeline placement (trenching, landfalls,
44 and construction), chemical releases (drilling discharges, operation discharges, and sanitary
45 wastes), and platform placement (anchoring, mooring, and removal, except in deep waters).
46 Mitigation measures instituted to protect these HDDCs include Notice to Lessee (NTL) 2009-

1 G40, which requires the avoidance of HDDCs or areas that have a high potential for supporting
2 these community types, as interpreted from geophysical records. Impacts of OCS exploration,
3 production, and decommissioning activities on HDDCs are discussed in detail in
4 Section 4.4.6.2.1. Overall, impacts on HDDCs from exploration and site development activities
5 are expected to be minimal because of the provisions in NTL 2009-G40 that protect HDDCs
6 from oil and gas development activities. However, small and unmapped HDDCs may be
7 completely or partially destroyed by bottom-disturbing activities. In such cases, recovery would
8 likely be long term, although permanent loss of the affected feature is also possible.
9

10 Non-OCS activities that have the potential to adversely affect HDDCs include
11 fishing/trawling, anchoring, and offshore marine transportation. Due to the water depths of these
12 areas and the widely scattered nature of these habitats, such activities are unlikely to greatly
13 affect HDDCs in the GOM. However, deepwater trawling could destroy HDDCs and recover
14 could be long term or may not occur at all. Generally, commercially important deepwater fish
15 species use *Lophelia* reefs as juveniles (SAFMC 1998).
16

17 As climate change has the potential to affect warm water corals, it could affect coldwater
18 *Lophelia* reefs (Section 3.7.2.1.7). The saturation depth of aragonite (the primary carbonate
19 formed used by hard corals) appears to be a primary determinant of deepwater coral distribution,
20 with reefs forming in areas of high aragonite solubility (Orr et al. 2005). The depth at which the
21 water is saturated with aragonite is projected to become shallower over the coming century, and
22 most coldwater corals may be in undersaturated waters by 2100 (Orr et al. 2005). Consequently,
23 the spatial extent, density, and growth of deepwater corals may decrease, diminishing their
24 associated ecosystem functions (Orr et al. 2005). There is evidence that oil and gas extraction
25 reduces the natural release of hydrocarbons that support deep-sea chemosynthetic communities
26 (Quigley et al. 1999). Unlike chemosynthetic communities, *Lophelia* corals do not depend on
27 hydrocarbon seepage to meet their metabolic requirements (Becker et al. 2009) and presumably
28 would not be affected.
29

30 Oil spills from both OCS and non-OCS activities could affect HDDCs. Detailed
31 discussion of the impacts of OCS accidental hydrocarbon releases can be found in
32 Section 4.4.6.2.1. The magnitude and severity of potential effects on biota associated with
33 topographic features from such exposure would be a function of the location, timing, duration,
34 and size of the spill, the proximity of the spill to the features, and the timing and nature of spill
35 containment and cleanup activities. It is assumed that most accidental oil releases would be at
36 the surface or located sufficiently far from HDDCs that they would be unlikely to greatly affect
37 communities associated with the topographic features.
38

39 **Conclusion.** Impacting factors for marine benthic and pelagic habitats include both OCS
40 and non-OCS activities. For OCS activities, planning and permitting procedures and stipulations
41 that promote identification and avoidance of sensitive habitats should minimize the potential for
42 direct impacts on sensitive seafloor areas during routine OCS activities. In the GOM,
43 stipulations that are currently in place restrict OCS activities in the immediate vicinity of seafloor
44 areas containing important topographic features, live bottom habitat, and HDDC, and there is
45 relatively little likelihood that cumulative OCS activities will affect overall viability of
46 ecological resources in such areas. Non-OCS activities with a potential to impact marine benthic

1 and pelagic habitats in the GOM include oil and gas production in State waters, sediment
2 dredging and disposal, sand mining, anchoring, fishing/trawling, and tankering of imported oil.
3 Disturbances from these activities such as noise, vessel discharges, and bottom disturbance
4 would occur in addition to similar impacts from OCS Program activities. Cumulative impacts to
5 major topographic features, live bottom habitats and HDDC as a result of OCS and non OCS
6 Program activities would be minor, either because impacts would occur to relatively small
7 proportions of the available habitats or because there are various restrictions in place to limit the
8 potential for impacts. The incremental contribution of routine Program activities to these
9 impacts would be small (see Section 4.4.6.2.1).

10
11 Oil spills could result from both OCS and non-OCS activities. The cumulative impacts
12 of past, present, and future oil spills on seafloor habitats would be minor to major. The
13 incremental impacts of accidental oil spills associated with the proposed action on these
14 resources would be small to large, depending on the location, timing, duration, and size of spills;
15 the proximity of spills to particular habitats; and the timing and nature of spill containment and
16 cleanup activities (see Section 4.4.6.2.1). Spills in deeper water, whether from OCS or non-OCS
17 sources, are unlikely to have overall community-level effects on seafloor habitats because of the
18 relatively small proportion of seafloor area that would come in contact with released oil at
19 concentrations great enough to elicit toxic effects. Catastrophic oil spills that affect shallow and
20 intertidal habitats have the potential to be of greatest significance. Although pelagic habitat is
21 likely to recover quickly following an oil spill, the recovery time for intertidal and shallow
22 subtidal benthic habitat directly impacted by oil spills could be long term.

23
24
25 **4.6.3.1.3 Essential Fish Habitat.** This section identifies activities that could affect fish
26 resources in the GOM, including non-OCS activities and current and planned OCS activities that
27 would occur during the life of the Program, and the potential incremental effects of
28 implementing the proposed action. Cumulative effects on EFH could occur from a variety of
29 OCS and non-OCS activities that have a potential to directly kill managed fish species, disturb
30 ocean bottom habitats, increase sediment suspension, degrade water quality, or affect the food
31 supply for fishery resources.

32
33 Cumulative impacting factors for EFH include both OCS and non-OCS activities.
34 Impacts on marine benthic and pelagic habitat resulting from ongoing and future routine OCS
35 program activities, including those of the proposed action, could result from noise, well drilling,
36 pipeline placement (trenching, landfalls, and construction), platform placement (anchoring,
37 mooring, and removal, except in deep waters) and routine discharges (drilling, production,
38 platform, and vessel). Accidental oil spills are also counted among OCS program-related
39 activities.

40
41 Routine OCS activities could disturb bottom areas due to the installation of platforms and
42 pipelines and the anchoring of vessels and structures. Up to 12,000 production wells and
43 2,000 oil platforms are anticipated to be built in the GOM under the cumulative scenario
44 (Table 4.6.1-1). In addition, up to 69,200 km (43,000 mi) of offshore pipeline could be
45 constructed. The construction of platforms and pipelines over the period of the Program would
46 disturb as much as 81,000 ha (200,200 ac) in total (Table 4.6.1-1). Under the cumulative

1 scenario, it is anticipated that less than 40 new pipeline landfalls could occur in the GOM
2 (Table 4.6.1-1) with up to 12 of these resulting from the proposed action. As discussed in
3 Section 4.4.6.4, deposition of drilling muds and cuttings could potentially affect EFH by altering
4 grain-size distributions and chemical characteristics of sediments such that benthic prey of some
5 managed fish species would be affected in the immediate area surrounding drill sites. Produced
6 water will also be released into the GOM during the production phase.

7
8 Platform removals using explosives will likely kill some fish, including managed species
9 for which EFH has been established, and would remove platform-associated fouling
10 communities that serve as prey for managed species. Up to 280 platforms may be removed
11 under the proposed action compared with up to 1,200 platforms removed using explosives as a
12 result of cumulative OCS activities during the life of the Program. If large numbers of fish are
13 killed as the result of removal of platforms using explosives, there could be effects on managed
14 species and their prey in the immediate vicinity of the removed platforms. Once a platform is
15 removed, the fouling community that serves as a food source for some managed and prey fish
16 species in the vicinity would no longer be available, and the associated fishes would be forced to
17 relocate to other foraging areas. However, given the relatively small area that would be affected
18 by such removals, Gulfwide effects on managed species are not anticipated.

19
20 See Section 4.4.6.4.1 for a detailed discussion of the impacts of routine operations on
21 EFH and managed species in the GOM. Overall, it is expected that the cumulative impacts of
22 exploration and site development activities on marine EFH would be moderate, and impacts are
23 not expected to permanently reduce the EFH available to managed species or result in
24 population-level impacts to managed species. The most sensitive benthic habitats, such as those
25 associated with hard bottoms and topographic features, should not be affected by routine
26 operations, and effects would be minimized or eliminated by existing lease stipulations.

27
28 There are also State oil and gas activities that can affect EFH. Louisiana and Texas have
29 experienced substantial oil and gas development within their coastal areas including exploratory
30 drilling, production platform installation, and pipeline installation. Factors that could affect EFH
31 from these activities would be similar to those described above for OCS activities. However, the
32 effects from non-OCS oil and gas activities could possibly be more severe than the effects from
33 routine OCS activities because the activities are closer to shore and in shallower environments.
34 As a consequence, more benthic EFH may be damaged, and resulting changes in sedimentation
35 and turbidity could affect a greater proportion of the water column.

36
37 Other non-OCS activities that influence EFH may include commercial fishing,
38 commercial shipping (tanker transportation), land development, water quality degradation,
39 dredge and fill and dredge disposal operation, and construction of channel stabilization structures
40 such as jetties could affect EFH (GMFMC 1998). As discussed below, these non-OCS activities
41 when combined with OCS activities could result in cumulative impacts on EFH over time,
42 especially if these impacts occur frequently or are of sufficient magnitude that habitat recovery
43 times are prolonged.

44
45 Barges carrying cargo arrive and depart through ports and travel through the GOM
46 Intracoastal Water Way, which serves as a major route for needed goods and supplies.

1 Discharges of treated wastes or hazardous chemicals could negatively affect water quality
2 (Section 4.6.2.1.1), a component of EFH, as well as aquatic vegetation. Pollutants generated
3 from boat maintenance activities on land and water could also negatively impact water quality.
4 Oil and grease are commonly found in bilge water, especially in vessels with inboard engines,
5 and these products may be discharged during vessel pump out (USEPA 1993).
6

7 Sand mining and routine dredging operations for channel construction and maintenance,
8 pipeline emplacement, and creation of harbor and docking areas can affect EFH in the GOM by
9 suspending sediments and affecting water quality. As suspended sediments settle to the bottom,
10 the benthic prey of some managed fish species could be smothered. In most cases, benthic
11 organisms would recolonize such areas unless maintenance dredging operations are repeated
12 frequently. Dumping sites for dredge spoils in the GOM, most of which are located within State
13 waters, could also alter water quality and affect benthic organisms that serve as prey for some
14 managed fish species.
15

16 See individual sections on water quality, coastal habitats, and marine and pelagic habitats
17 for a discussion of the effects of climate change on EFH in the GOM. One primary impact
18 expected to result from climate change is the loss of wetland habitat, which is an important EFH
19 for many larval and juvenile stages of managed species. Wetland loss could be caused by
20 several factors including erosion, sea level rise, discharging nutrient-laden waters to the
21 environment, reduced sediment load of the Mississippi River, and human-induced subsidence
22 from groundwater withdrawals, among others. Cumulative effects on wetlands are discussed in
23 Section 4.6.3.1.1.
24

25 Commercial and recreational fisheries in the GOM also impact EFH. For example, most
26 of the wild shrimp caught are harvested using bottom trawls. The nets are held open with bottom
27 sled devices made from wood or steel. In addition to capturing and killing some nontarget fish
28 and invertebrate species, the sleds, or “doors,” drag along the bottom, potentially digging up
29 sediments and hard substrate. Such activities could disrupt the benthic community and increase
30 the turbidity of the water (Jones 1992). Similarly, use of spiny lobster and stone crab traps may
31 also damage bottom substrate such as seagrasses and corals.
32

33 Other events, including hurricanes, turbidity plumes, and hypoxia, could also affect
34 various managed fish or their habitat, although the GOM fish community as a whole should be
35 adapted to such events. For example, a hurricane or a series of hurricanes could temporarily
36 degrade the quality of large areas of wetlands that serve as nursery and feeding areas for a
37 variety of managed fish and invertebrate species.
38

39 Oil spills from OCS and non-OCS activities may cumulatively affect several resources
40 that contribute to EFH, including sediments, water quality, fish resources, coastal habitats, and
41 seafloor habitats and benthic communities (see Sections 4.6.2 and 4.6.3). Large, potentially
42 catastrophic spills could result from pipeline ruptures, tanker spills associated with an FPSO
43 system, or loss of well control. Other potential sources of oil spills that could affect EFH include
44 non-OCS oil development activities and non-OCS tankering activities. Spills from import
45 tankers could occur offshore in shipping lanes or in coastal waters as tankers prepare to make
46 landfall.

1 Oil from shallow-water spills could impact life stages of managed fish species that use
2 surface waters as part of their lifecycle, especially those that release pelagic eggs and have
3 pelagic larvae. Unlike adult fish that can move away from oiled waters, pelagic eggs and larvae
4 are largely transported by wind and water currents. Those that come into contact with surface oil
5 could be injured or killed through smothering or an accumulation of oil on the gills. Thus, oiled
6 surface waters would temporarily reduce the amount of EFH available for these life stages.
7 Detailed discussion of the impacts of oil spills on fish can be found in Section 4.4.7.3.1.
8

9 In marine waters, several individual reefs and banks located offshore of the Louisiana-
10 Texas border have been designated HAPCs by the GMFMC (NMFS 2010a). As identified in
11 Section 4.4.6.2.1, NTL No. 2009-G39 has several protections in place to minimize and mitigate
12 the adverse effects of oil and gas exploration and development on these banks. However, large
13 or catastrophic spills could adversely affect hard-bottom HAPC by causing lethal or sublethal
14 impacts to corals (Section 4.4.6.2.1). The HAPC for bluefin tuna extends from the 100 m
15 (328 ft) isobath seaward to the EEZ. The HAPC could also be affected by oil spills, and
16 population-level impacts to bluefin tuna could result from catastrophic spills. Habitat areas of
17 particular concern in nearshore areas include intertidal and estuarine habitats with emergent and
18 submerged vegetation, sand and mud flats, and shell and oyster reefs that may provide food and
19 rearing for managed juvenile fish and shellfish. Shallow-water spills may reach these coastal
20 EFH areas and have negative impacts. Shallow-water wave action could increase entrainment of
21 oil and tar balls in the water column. This could temporarily diminish the quality and quantity of
22 benthic EFH. Settled tar balls may be ingested by bottom-feeding fishes and may harm or prove
23 fatal to them. During a spill, aquatic vegetation, which provides habitat for juveniles and for
24 prey of some managed species, could become coated with oil. In such cases, organisms that are
25 sessile or that have limited ability to avoid spills could be killed. These areas represent
26 important nursery areas for fishes and invertebrates that contribute to estuarine, coastal, and shelf
27 food webs. Loss of such habitat by oil spills would be compounded by the existing high natural
28 loss of wetlands.
29

30 The actual locations of the spills will determine the degree to which EFH would be
31 affected. The HAPC in the Eastern Planning Area that could be affected by oil spills from the
32 Central or Western Planning Areas include the Florida Middle Grounds, the Madison-Swanson
33 Marine Reserve. Pulley Ridge, and Tortugas North and South Ecological Reserve are also
34 located in the southern tip of Florida, and are unlikely to be contacted by oil. Spills have the
35 greatest potential to harm EFH resources if they occur in shallow waters, where benthic habitats
36 or wetlands can be affected, or if they occur when large numbers of pelagic eggs and larvae of
37 managed species are present. If the location of a spill coincided with the location of eggs and
38 larvae, large numbers of these organisms would be injured or killed. Oil reaching the surface
39 from deepwater pipeline spills and deepwater tanker spills could affect EFH for the eggs and
40 larvae of federally managed pelagic fish species, neuston prey species, and *Sargassum* and its
41 associated fauna. Pelagic eggs and larvae contacting the spilled oil would be smothered, and
42 *Sargassum* within affected areas would be fouled and potentially killed.
43

44 **Conclusion.** Impacting factors for EFH include both OCS and non-OCS activities. Non-
45 OCS activities with a potential to impact EFH in the GOM include oil and gas production in
46 State waters, sediment dredging and disposal, and vessel traffic. Impacts from OCS activities

1 would be limited by specific lease stipulations. Cumulative impacts to EFH as a result of OCS
2 and non-OCS program activities would be minor, due to the small proportion of EFH area that
3 would likely be affected. The incremental contribution of routine Program activities to these
4 impacts would be small (see Section 4.4.6.3.1).

5
6 Accidental releases of oil and gas from OCS and non-OCS facilities could also have
7 effects on EFH. The cumulative impacts of past, present, and future oil spills on EFH would be
8 minor to moderate. The incremental impacts of accidental spills associated with the proposed
9 action on EFH would be small to large, depending on the location, timing, duration, and size of
10 spills; the proximity of spills to particular fish habitats; and the timing and nature of spill
11 containment and cleanup activities (see Section 4.4.6.3.1). While most accidents related to OCS
12 activities assumed under the cumulative spill scenario would be small and would have relatively
13 small incremental impacts on EFH, spills that reach coastal wetlands could have more persistent
14 impacts and could require remediation. Spills in deeper water, whether from OCS or non-OCS
15 sources, are unlikely to have overall population-level effects on fish resources because of the
16 relatively small proportion of similar available fish habitats that would come in contact with
17 released oil at concentrations great enough to elicit toxic effects. Oil spills that have the greatest
18 potential to impact EFH and managed species are those that occur in shallower subtidal and
19 intertidal areas and spills that reach areas at the same time where substantial numbers of eggs or
20 larvae of managed species are present.

21 22 23 **4.6.3.2 Alaska – Cook Inlet**

24
25
26 **4.6.3.2.1 Coastal and Estuarine Habitats.** A number of activities associated with the
27 proposed action could result in impacts on coastal and estuarine habitats in the Cook Inlet
28 Planning Area (Section 4.4.6.1.2). These activities include construction of pipelines and pipeline
29 landfalls and operation of service vessels and existing facilities. Impacts could include losses of
30 beach and wetland habitat and indirect effects that contribute to reductions in these habitats or
31 impacts on biota. There are no past or ongoing OCS activities in the Cook Inlet Planning Area.

32
33 Pipeline landfalls could directly disturb tidal marshes, beaches, rocky shores, or other
34 coastal habitats, depending on the location of the landfalls. Sedimentation from physical
35 disturbance of substrates may affect biota in intertidal or shallow subtidal habitats. In addition,
36 accidental spills may impact shoreline habitat.

37
38 Ongoing non-OCS activities that could affect coastal and estuarine habitats include those
39 related to State oil and gas development, commercial shipping and other marine vessels, coastal
40 development, discharge of municipal wastes and other effluents, domestic transportation of oil
41 and gas, and logging. These activities can be reasonably expected to continue into the future.

42
43 Factors that impact coastal wetlands include the direct elimination of wetland habitat by
44 excavation or filling and the degradation of wetland communities by reduced water quality or
45 hydrologic changes. The construction of pipelines, docks, or shorebases associated with State oil
46 and gas exploration and development could result in direct losses of habitat. Habitats and

1 associated biota within the Cook Inlet Planning Area could also be impacted by routine
2 discharges from marine vessels, discharges of municipal and industrial wastewater, or
3 sedimentation from upland areas, including erosion from logging operations within the Cook
4 Inlet watershed. Activities that increase wave action along beaches could contribute to their
5 erosion. Barge and service vessel traffic supporting State oil and gas development may result in
6 wake erosion. The direct and indirect impacts on wetlands from pipeline construction, service
7 vessel operation, and operation of existing facilities under the proposed action would represent a
8 very small contribution to the past, ongoing, and expected future impacts on coastal and
9 estuarine habitats from non-OCS activities.

10
11 Accidental spills of oil or other liquid hydrocarbons, resulting from activities conducted
12 under the proposed action, could impact shoreline habitats. As under the proposed action, the
13 majority of these spills would be small (less than 50 bbl). Spills from onshore pipelines and
14 facilities could impact freshwater wetlands, or tidal wetlands if carried to coastal habitats by
15 streams. Non-OCS activities, such as State oil and gas development, domestic transportation of
16 oil or refined petroleum products, including LNG from Cook Inlet and the Alaska Peninsula, the
17 production and storage of petroleum products and LNG, and commercial shipping, may also
18 result in accidental spills that could potentially impact shoreline habitats. Oil spills have resulted
19 in past impacts on beaches and other intertidal habitats, as in the case of the *Exxon Valdez* oil
20 spill. Spills can result in short- or long-term effects on vegetation growth and changes in the
21 composition of intertidal or shallow subtidal communities, or extensive mortality of biota
22 associated with shoreline habitats, and may persist in substrates for decades. The amount of oil
23 contacting shoreline habitats from a spill depends on a number of factors such as the location and
24 size of the spill, waves and water currents, and containment actions. Naturally occurring seeps
25 may also be a source of crude oil introduced into nearshore waters (Kvenvolden and
26 Cooper 2003). The magnitude of resulting impacts and the persistence of oil would depend on
27 factors such as the amount of oil deposited, remediation efforts, substrate grain size, and
28 localized erosion and deposition patterns. Recovery of affected wetlands could require several
29 decades. The impacts of potential spills associated with the proposed action would be expected
30 to add a small contribution to the impacts of other sources of oil in the planning area.

31
32 Indirect effects on coastal and estuarine habitats could result from global climate change.
33 Potential thermal expansion of ocean water and melting of glaciers and ice caps could result in a
34 global rise in mean sea level (Section 4.6.1.6). Sea-level rise could result in increased inundation
35 of shorelines and erosion of beach habitat and conversion of wetlands to open water. In addition,
36 large changes in river flows into nearshore marine waters could affect salinity and water
37 circulation in estuaries, which, in turn, could impact estuarine wetland communities.

38
39 **Conclusion.** Future OCS program and ongoing and future non-OCS program activities
40 in combination with naturally occurring events have resulted in losses of coastal habitats in Cook
41 Inlet; cumulative impacts on these resources, therefore, are considered to be moderate to major.
42 Operations under the proposed action would result in small localized impacts, primarily due to
43 facility construction, pipeline landfalls, channel dredging, and vessel traffic; however, the
44 incremental contribution of routine Program activities to cumulative impacts would be small
45 (see Section 4.4.6.2.2).

1 The cumulative impacts of past, present, and future oil spills on coastal and estuarine
2 habitats would be moderate. The incremental impacts of accidental oil spills associated with the
3 proposed action on these resources would be small to large, depending on the location, timing,
4 duration, and size of the spill; the proximity of the spill to particular habitats; and the timing and
5 nature of spill containment and cleanup activities (see Section 4.4.6.2.2). The majority of these
6 spills would be small (less than 50 bbl). Large oil releases that occur in or reach shallower
7 nearshore areas have the greatest potential to affect coastal and estuarine habitats. Most spills
8 would be unlikely to contact and affect coastal and estuarine habitats. Large oil spills and
9 catastrophic discharge events, however, can affect extensive areas of shoreline.

10
11
12 **4.6.3.2.2 Marine Benthic and Pelagic Habitats.** Cumulative impacting factors for
13 marine benthic and pelagic habitats in Cook Inlet Planning Area include both OCS and non-OCS
14 activities. Potential impacts on marine benthic and pelagic habitat resulting from ongoing and
15 future routine OCS program activities, including those of the proposed action, could result from
16 noise (vessel, seismic surveys, construction, operations), well drilling, pipeline placement
17 (trenching, landfalls, and construction), platform placement (anchoring, mooring, and removal),
18 and discharges (drilling, vessel and platform). All these activities have the potential to adversely
19 affect marine benthic habitats in the Cook Inlet Planning Area. Accidental oil spills are also
20 counted among OCS program-related activities; assumptions for oil spills under the cumulative
21 case scenario are provided in Table 4.6.2-3, and catastrophic spill assumptions are provided in
22 Table 4.4.2-2.

23
24 Because there is no OCS activity in Cook Inlet Planning Area, the new OCS activities
25 under the proposed action represent a 100% increase in all associated OCS activities in Cook
26 Inlet. Over the life of the Program, up to 114 production wells and up to three oil platforms are
27 anticipated. In addition, up to 241 km (150 mi) of new offshore pipeline is anticipated. Bottom
28 disturbance resulting from OCS program activities degrades water quality by increasing water
29 turbidity in the vicinity of the operations and adding contaminants to the water column. It also
30 changes sediment composition as suspended sediments (and contaminants, if present) are
31 entrained in currents and deposited in new locations. Construction of platforms in areas
32 previously lacking hard substrate could have localized effects on the biodiversity and distribution
33 of benthic communities by favoring organisms that prefer a hard substrate. Impacts of OCS
34 routine operations (exploration, production and decommissioning activities) on marine benthic
35 and pelagic habitat in the Cook Inlet Planning Area are discussed in detail in Sections 4.4.6.2.2
36 and 4.4.6.3.2. Overall, routine operations represent a negligible to moderate long-term
37 disturbance, with the severity of the impacts generally decreasing dramatically with distance
38 from the well site.

39
40 The increased amount of drilling in Cook Inlet anticipated under the proposed action will
41 result in OCS discharges of drill muds and cuttings from exploration and delineation wells.
42 Drilling muds and cuttings from production wells as well as all produced waters will be disposed
43 of in the well rather than discharged into Cook Inlet. The OCS discharges of drill muds,
44 cuttings, and produced waters could potentially affect benthic and pelagic habitat by increasing
45 turbidity and altering grain size distributions and chemical characteristics of sediments. The

1 impacts of drilling discharges on benthic and pelagic habitats are discussed in detail in
2 Sections 4.4.6.2.3 and 4.4.6.3.3.

3
4 Various non-OCS activities in Cook Inlet, including State oil and gas programs, dredging
5 and disposal of dredging spoils in OCS waters, anchoring, and commercial or sportfishing
6 activities, and commercial shipping (including imported oil) could contribute to cumulative
7 effects on pelagic and seafloor habitats. Drilling of wells in State waters could also require
8 construction of platforms and pipelines in waters of Alaska. Effects on seafloor and pelagic
9 habitat and biota would be similar to those described above for OCS oil and gas programs
10 (Sections 4.4.6.2.2 and 4.4.6.3.2). Dredging operations in conjunction with ship channel
11 maintenance and construction, pipeline placement and burial, and support facility access occur
12 throughout the Cook Inlet Planning Area as part of non-OCS activities. Non-OCS dredging and
13 marine disposal activities would involve excavation of nearshore sediments and subsequent
14 disposal in offshore or nearshore areas, thereby disturbing seafloor habitats and generating
15 temporary turbidity in the water column. Sediments dredged and sidecast or transported to
16 approved dredged material disposal sites could cause smothering and some mortality of sessile
17 animals in the vicinity of the activity. Anchoring of non-OCS activity vessels on these features
18 could cause significant chronic disturbance to benthic and bottom water habitat and biota.
19 Anchoring could involve boats used for recreational and commercial fishing and commercial
20 ship traffic. The amount of damage that could result from anchoring activity would depend upon
21 vessel size, the size of the anchor and chain, sea conditions at the time of anchoring, and the
22 location or position of the anchor on the feature. Similarly, some fishing methods, such as
23 trawling and shellfish dredging, could damage seafloor habitats and increase the turbidity of the
24 water column (Jones 1992). The effects of dredging, anchoring, and trawling activities on
25 marine benthic and pelagic habitats are expected to be similar to those described for OCS bottom
26 disturbing activities (Sections 4.4.6.2.2 and 4.4.6.3.2). Impacts on pelagic habitat would be
27 localized and temporary, while benthic habitat damaged by anchors may take more than 10 years
28 to recover, depending upon the nature of the habitat and severity of the damage.

29
30 As a heavily river influenced system, climate change may cause the temporal variability
31 of key chemical and physical parameters the Cook Inlet Planning Area — particularly hydrology,
32 dissolved oxygen, salinity, and temperature. These changes could significantly alter the existing
33 benthic and pelagic habitat and biota. A predicted increase in river discharge could change the
34 salinity, temperature, and turbidity regimes in nearshore areas and alter the composition of
35 existing phytoplankton and benthic communities. Other changes could result from:

- 36
37
- 38 • Ocean acidification from increasing CO₂ inputs into the ocean that may
39 reduce the availability of calcite and aragonite to calcifying marine organisms.
 - 40 • The expected reduction in landfast ice extent and duration resulting from
41 rising temperatures may reduce the scouring of intertidal and shallow subtidal
42 habitats on the western side of Cook Inlet.
 - 43
44 • Warmer temperatures may also increase phytoplankton productivity,
45 potentially resulting in greater food inputs to benthic habitats and subsequent
46 increases in the productivity of benthic biota.

1 Oil spills from both OCS and non-OCS activities could affect benthic and pelagic habitat
2 in Cook Inlet. The total number of oil spills and the extent of affected seafloor habitat would
3 likely increase under the cumulative scenario, in conjunction with increased levels of petroleum
4 exploration and production. Accidental hydrocarbon releases can occur at the surface from
5 tankers or platforms or at the seafloor from the wellhead or pipelines. Non-OCS activities, such
6 as oil and gas development in State waters, domestic transportation of oil or refined petroleum
7 products, and commercial shipping, may also result in accidental spills that could affect benthic
8 and pelagic habitats within the Cook Inlet Planning Area.
9

10 For both OCS and non-OCS oil spills, it is assumed the magnitude and severity of
11 potential impacts on benthic and pelagic habitat would be a function of the location (including
12 habitats affected), timing, duration, and size of the spill and containment and cleanup activities.
13 It is anticipated that most small to medium spills would have limited effects because of the
14 relatively small areas likely to be exposed to high concentrations of hydrocarbons and the short
15 period of time during which potentially toxic concentrations would be present. Oil spills would
16 likely have the greatest impacts on benthic habitat and communities in shallow subtidal waters
17 and in intertidal areas. Although pelagic habitat is likely to recover quickly following an oil
18 spill, the recovery time for intertidal and shallow subtidal benthic habitat directly impacted by oil
19 spills could be long term (Section 4.4.6.2.2). Multiple spills would further contribute to
20 cumulative effects. Detailed discussion of the impacts of OCS accidental hydrocarbon releases
21 on marine benthic and pelagic habitat can be found in Sections 4.4.6.2.2 and 4.4.6.3.2.
22

23 **Conclusion.** Impacting factors for marine benthic and pelagic habitats include both OCS
24 and non-OCS activities. Non-OCS activities in Alaskan waters, including oil and gas
25 development in State waters, commercial fishing and sportfishing, sediment dredging and
26 disposal, anchoring, and tankering of imported oil, could also contribute to cumulative effects on
27 seafloor habitats. Disturbances from these activities including noise, vessel discharges, and
28 bottom disturbance would occur in addition to similar impacts from OCS activities. Cumulative
29 impacts to marine benthic and pelagic habitats, as a result of OCS and non-OCS program
30 activities, would be minor, either because of the limited time frame over which most individual
31 activities would occur or the small proportion of available habitats that would be affected during
32 a given period. The incremental contribution of routine Program activities to these impacts
33 would be small (see Section 4.4.6.2.2).
34

35 Oil spills could result from both OCS and non-OCS activities. The cumulative impacts
36 of past, present, and future oil spills on seafloor habitats would be moderate. The incremental
37 impacts of accidental oil spills associated with the proposed action on these resources would be
38 small to large, depending on the location, timing, duration, and size of spills; the proximity of
39 spills to particular seafloor habitats; and the timing and nature of spill containment and cleanup
40 activities (see Section 4.4.6.2.2). Oil from catastrophic spills that reach shallow and intertidal
41 habitats have the potential to be of greatest significance. Although pelagic habitat is likely to
42 recover quickly following an oil spill, the recovery time for intertidal and shallow subtidal
43 benthic habitat directly impacted by oil spills could be long-term.
44
45

1 **4.6.3.2.3 Essential Fish Habitat.** This section identifies activities that could affect fish
2 resources in Cook Inlet, including non-OCS activities and current and planned OCS activities
3 that would occur during the life of the Program, and the potential incremental effects of
4 implementing the proposed action. Cumulative effects on EFH could occur from a variety of
5 OCS and non-OCS activities that have a potential to directly kill managed fish species, disturb
6 ocean bottom habitats, increase sediment suspension, degrade water quality, or affect the food
7 supply for fishery resources.

8
9 Cumulative impacting factors for EFH include both OCS and non-OCS activities.
10 Impacts on marine benthic and pelagic habitat from ongoing and future routine OCS program
11 activities, including those of the proposed action, could result from noise, well drilling, pipeline
12 placement (trenching, landfalls, and construction), platform placement (anchoring, mooring, and
13 removal), and routine discharges (drilling, platform, and vessel). Accidental oil spills are also
14 counted among OCS program-related activities.

15
16 Because there is no OCS activity in Cook Inlet Planning Area, the new OCS activities
17 under the proposed action represent a 100% increase in all associated OCS activities in Cook
18 Inlet. Over the next Program life, up to 114 production wells and up to three oil platforms are
19 anticipated. In addition, up to 241 km (150 mi) of new offshore pipeline are anticipated.
20 Implementation of the proposed action would also result in seismic survey activity and the
21 release of drilling muds and cuttings to offshore areas (Table 4.6.2-2).

22
23 Although there are is no oil and gas development in OCS waters, oil and gas operations
24 have existed in State waters of Cook Inlet for decades. Impacting factors from OCS and non-
25 OCS oil and gas activities would be similar. Overall, it is expected that the cumulative impacts
26 of exploration and site development activities on marine EFH would be moderate, and impacts
27 are not expected to permanently reduce the EFH available to managed species or result in
28 population-level impacts on managed species. The most sensitive benthic habitats, such as those
29 associated with hard-bottoms and kelp communities, should not be affected by routine
30 operations, and effects would be minimized or eliminated by existing protections. The
31 construction of all platforms and pipelines would disturb bottom habitats to some degree.
32 Deposition of drilling fluids and cuttings could potentially affect EFH by altering grain size
33 distributions and chemical characteristics of sediments such that benthic prey of some managed
34 fish species or water quality in offshore areas would be affected in the immediate area
35 surrounding drill sites. Although muds and cuttings from exploration and delineation wells
36 could be discharged to surrounding waters, it is assumed that muds, cuttings, and produced
37 waters from production wells would be discharged into wells and not released to open waters.
38 See Section 4.4.6.4.2 for a detailed discussion of the impacts of routine operations on EFH and
39 managed species in Cook Inlet Planning Area.

40
41 Freshwater areas used by salmon and other anadromous fish are considered to be EFH
42 and could be affected by nearshore OCS and non-OCS oil and gas activity such as pipeline
43 dredging or by onshore pipelines that cross bodies of water, especially streams. The primary
44 effects of pipeline crossings would be increasing turbidity and sedimentation of the benthic
45 environment during construction and blocking migration of anadromous fish following
46 construction. As a consequence, crossings of anadromous fish streams would be minimized and

1 consolidated with other utility and road crossings of such streams. In addition, onshore pipelines
2 would be designed, constructed, and maintained to reduce risks to fish habitats from a spill,
3 pipeline break, or construction activities. Other non-OCS activities, such as logging, road
4 construction, and development in general could also contribute to water quality degradation and
5 blockage of fish passage in anadromous fish streams.
6

7 Other non-OCS activities that could impact fish communities include land use practices,
8 point and non-point source pollution, logging, dredging/ and disposal of dredging spoils in OCS
9 waters, anchoring, and commercial or sportfishing activities, and commercial shipping (including
10 imported oil). Many of these activities would result in bottom disturbance that would affect
11 bottom dwelling fishes as well as their food sources in a manner similar to those described for
12 OCS activities (Section 4.4.7.3.2). These non-OCS activities when combined with OCS
13 activities could over time result in cumulative impacts on EFH and managed species especially if
14 these impacts occur frequently or are of sufficient magnitude that habitat recovery times are
15 prolonged. See Section 4.6.3.2.1 and Section 4.6.3.2.2 for a discussion of impacts of these non-
16 OCS activities on benthic and pelagic EFH.
17

18 Logging could also degrade riverine habitats that are important reproductive and juvenile
19 habitat for managed migratory fish species. Erosion from areas undergoing commercial logging
20 could increase the silt load in streams and rivers, which could reduce levels of invertebrate prey
21 species and adversely affect spawning success and egg survival. The introduction of fine
22 sediments into spawning gravels may render these habitats unsuitable for salmon spawning.
23 Logging could also remove riparian canopies along some streams, which could increase solar
24 heating of freshwater habitats. Downed timber could physically block salmon migrations.
25 Because of past damage inflicted by commercial logging, improved forestry practices have been
26 initiated, and timber harvests have been curtailed. Continued implementation of effective forest
27 management techniques should help mitigate the adverse effects of logging in the future.
28 Cumulative impacts on migratory species could also occur as a result of activities that obstruct
29 fish movement in marine environments during migration periods.
30

31 Commercial fishing practices that are indiscriminate, such as trawling and pots, are
32 responsible for significant amounts of bycatch that can injure or kill juveniles of many fish
33 species. These types of fishing practices could damage future year classes, reduce available prey
34 species, and damage benthic habitat for many Cook Inlet fish resources. A wide variety of
35 methods are used to target numerous species of fishes and shellfishes, including longlines,
36 seines, setnets, trawls, and traps. Some fisheries target particular fish species returning to their
37 natal stream or river, while other fisheries take place in pelagic waters and target mixed stocks of
38 fishes or shellfishes.
39

40 As a consequence of the pressure commercial fishing places on fishery resources,
41 appropriate management is required to reduce the potential for depletion of stocks due to
42 overharvesting. Fisheries in Alaskan waters and in adjacent offshore areas are managed by the
43 Alaska Department of Fish and Game and the North Pacific Fishery Management Council of the
44 National Marine Fisheries Service through implementation of fishing regulations such as fishing
45 seasons and harvest limits and through hatchery production of some fishery resources (primarily
46 salmon). Even with management, the possibility of overfishing still exists. Occasionally

1 fisheries are closed when stocks are considered insufficient to support harvesting, and will
2 sometimes remain closed for multiple seasons before stocks are deemed sufficient. While
3 occasional or sustained declines in fishery stocks may not be fully attributable to commercial
4 fishing, it appears that commercial fishing is an important factor in the abundance, or lack
5 thereof, of fishery resources.
6

7 Although the magnitude of harvests is considerably smaller than for commercial fisheries
8 (Fall et al. 2009), sportfishing also contributes to cumulative effects on the abundance of some
9 fishery resources. Recreational fisheries are managed to prevent overharvesting, but recreational
10 harvests can be a substantial portion of fisheries landings. Consequently, recreational fishing
11 activities have a potential to result in overharvest of managed species over the life of the
12 Program. However, recreational fishing methods are less destructive of EFH compared to
13 commercial fisheries.
14

15 Subsistence fishing may also contribute to the cumulative effects on the abundance of
16 some fishery resources. Alaska State law defines subsistence as the “noncommercial customary
17 and traditional uses” of fish and wildlife. The Alaska Department of Fish and Game defines
18 subsistence fishing to include “the taking of, fishing for, or possession of fish, shellfish, or other
19 fisheries resources by a resident of the State for subsistence uses with gill net, seine, fish wheel,
20 long line, or other means defined by the Board of Fisheries.” These fishing methods have more
21 limited impacts on EFH compared to commercial fishing methods. Subsistence fishing is subject
22 to harvest limits that reduce the potential for overfishing and much of Cook Inlet is defined as a
23 nonsubsistence area, and subsistence fishing is therefore not authorized. Consequently,
24 subsistence fishing makes a relatively minor contribution to the reduction in fish stocks
25 compared to commercial fishing (Fall et al. 2009).
26

27 Another source of cumulative impacts to fishery resources are personal use fisheries
28 which are a legally defined as “the taking, fishing for, or possession of finfish, shellfish, or other
29 fishery resources, by Alaska residents for personal use and not for sale or barter, with gill or dip
30 net, seine, fish wheel, long line, or other means defined by the Board of Fisheries.” In the Cook
31 Inlet Planning Area, there are areas designated for personal use fisheries for salmon, tanner crab,
32 herring, and eulachon, all of which are managed species. All personal use fisheries are subject to
33 harvest limits that reduce the potential for overfishing. Personal use fishing makes a relatively
34 minor contribution to the reduction in fish stocks compared to commercial fishing.
35

36 See individual sections on water quality, coastal habitats, and marine and pelagic habitats
37 for a discussion of the effects of climate change on EFH in the Cook Inlet Planning Area. As a
38 heavily river-influenced system, climate change may cause the temporal variability of key
39 chemical and physical parameters, which could significantly alter the existing benthic and
40 pelagic habitat and biota. A predicted increase in river discharge could change the salinity,
41 temperature, and turbidity regimes in nearshore areas and alter the composition of existing
42 phytoplankton and benthic communities. Other changes could result from ocean acidification,
43 reduction in landfast ice extent and duration, and increase phytoplankton productivity.
44

45 The total number of oil spills and the extent of affected EFH areas would likely increase
46 under the proposed action in conjunction with increased levels of petroleum exploration and

1 production. The proposed action would contribute 100% of the OCS spills in the Cook Inlet
2 Planning Areas. See Table 4.6.2-3 for oil spill assumptions for Alaska. Catastrophic spills
3 assumptions are provided in Table 4.4.2-2. Non-OCS activities, such as oil and gas development
4 in State waters, domestic transportation of oil or refined petroleum products, and commercial
5 shipping, may also result in accidental spills that could potentially impact fish resources within
6 the Cook Inlet Planning Area. While effects on EFH resources would depend on the timing,
7 location, and magnitude of specific oil spills, it is anticipated that most small to medium spills
8 that occur in OCS waters would have limited effects on EFH, due to the relatively small areas
9 likely to be exposed to high concentrations of hydrocarbons and the short period of time during
10 which potentially toxic concentrations would be present. See Section 4.4.6.4 for a detailed
11 discussion of the impact of oil spills on EFH.

12
13 Because of the high concentrations of individuals likely to be present, EFH for
14 anadromous salmon are at higher risk from an OCS oil spill in the Cook Inlet Planning Areas.
15 The greatest potential for damage to salmon stocks would be if a spill were to occur along
16 migration routes. However, because of the limited area affected by even large oil spills relative
17 to the wide pelagic distribution and migratory patterns of salmonids, it is anticipated that most
18 impacts would be limited to small fractions of exposed salmon populations. Oil spills occurring
19 at constrictions in migration routes would have an increased potential for adversely affecting
20 salmon. Adverse effects of oil spills on EFH for groundfishes of southern Alaska would also be
21 a function of spill magnitude, location, and timing. Adult groundfishes are primarily demersal
22 and would generally be subjected only to the insoluble oil and water-soluble fractions of oil that
23 reach deeper strata. Insoluble oil fractions would sink to the bottom and be distributed diffusely
24 as tar balls over a wide area, and would be unlikely to produce a reduction in the population of
25 adult fishes. Egg and larval stages would be at greater risk of exposure to oil spills because
26 spawning aggregations of many groundfish species (e.g., walleye pollock) produce pelagic eggs
27 that could come into contact with surface oil slicks. Herring are also potentially susceptible to
28 oil spills because they spawn in nearshore waters for protracted periods of time.

29
30 Managed shellfish stocks (such as tanner, snow, and red king crab) are unlikely to be
31 exposed to surface oil. However, oil reaching shallow subtidal and intertidal shellfish or crab
32 habitat could measurably reduce crab populations. Pelagic crab larvae could also be affected if a
33 large surface oil spill occurred during the spring spawning season. However, because the area
34 affected by most spills would be expected to be small relative to overall distributions of crab
35 larvae, overall population levels are unlikely to be noticeably affected.

36
37 **Conclusion.** Impacting factors for EFH include both OCS and non-OCS activities.
38 Non-OCS activities with a potential to impact EFH in the Cook Inlet Planning Area include oil
39 and gas production in State waters, coastline development, commercial and recreational fishing,
40 sediment dredging and disposal, and vessel traffic. Impacts from OCS activities would be
41 limited by specific lease stipulations. Cumulative impacts to EFH as a result of OCS and
42 non-OCS program activities would be minor to moderate, proportional to the EFH area affected.
43 The incremental contribution of routine Program activities to these impacts would be small
44 (see Section 4.4.6.3.2).

45

1 Accidental releases of oil and gas from OCS and non-OCS facilities could also have
2 effects on EFH. The cumulative impacts of past, present, and future oil spills on EFH would be
3 minor to moderate. The incremental impacts of accidental spills associated with the proposed
4 action on EFH would be small to large, depending on the location, timing, duration, and size of
5 spills; the proximity of spills to particular fish habitats; and the timing and nature of spill
6 containment and cleanup activities (see Section 4.4.6.3.2). While most accidents related to OCS
7 activities assumed under the cumulative spill scenario would be small and would have relatively
8 small incremental impacts on EFH, oil that reaches coastal wetlands could have more persistent
9 impacts and could require remediation. Spills in deeper water, whether from OCS or non-OCS
10 sources, are unlikely to have overall population-level effects on fish resources because of the
11 relatively small proportion of similar available fish habitats that would come in contact with
12 released oil at concentrations great enough to elicit toxic effects. Oil spills that have the greatest
13 potential to impact EFH and managed species are those that occur in shallower subtidal and
14 intertidal areas and spills that reach areas at the same time substantial numbers of eggs or larvae
15 of managed species are present.

16 17 18 **4.6.3.3 Alaska Region – Arctic**

19 20 21 **4.6.3.3.1 Coastal and Estuarine Habitats.**

22
23 **Coastal Barrier Beach and Dunes.** Vessel traffic associated with the proposed action
24 could result in indirect impacts on coastal barrier beaches and dunes in the Arctic region
25 (Section 4.4.6.1.3). Onshore pipeline construction may impact sand beaches and dunes on the
26 margins of lakes and rivers on the Arctic Coastal Plain (ACP). Similar activities are associated
27 with current and planned OCS sales in the Alaska region and would occur during the life of the
28 Program (see Table 4.6.1-2). In the Beaufort and Chukchi Sea Planning Areas, vessel traffic
29 associated with the proposed action would represent approximately 25–35% of such OCS
30 activities, and onshore pipelines associated with the proposed action would represent
31 approximately 30% for the Beaufort Sea Planning Area.

32
33 Impacts on barrier beaches and dunes primarily result from factors that contribute to
34 increased erosion of beaches and dunes. Activities may disturb dune vegetation, thereby
35 promoting dune erosion, or directly disturb beach and dune substrates, resulting in increased
36 erosion of beaches and dunes. Increases in wave action could also contribute to the erosion of
37 beaches. Sedimentation from physical disturbance of substrates or erosion may affect biota in
38 intertidal or shallow subtidal habitats. In addition, accidental spills may impact beach or dune
39 habitat.

40
41 Ongoing non-OCS activities that could affect barrier beaches and dunes include those
42 related to State oil and gas development, commercial shipping and other marine vessels, and
43 coastal development. These activities can be reasonably expected to continue into the future.

44
45 The construction of pipelines, docks, causeways, or shorebases associated with State oil
46 and gas exploration and development could result in direct losses of beach or dune habitat.

1 Construction of facilities on barrier islands could impact beach, dune, or tundra habitat. Erosion
2 of beach or dune substrates adjacent to these constructions may result in additional habitat losses.
3 Intertidal and shallow subtidal organisms in nearby areas may be buried by excavated materials
4 or indirectly impacted by turbidity and sedimentation. Sand beaches and dunes along lagoon
5 shorelines and on the margins of lakes and rivers on the ACP may also be impacted by pipeline
6 construction. The impacts on barrier beaches and dunes from substrate-disturbance activities
7 associated with construction under the proposed action would represent a small contribution to
8 the past, ongoing, and expected future impacts on barrier beaches and dunes from non-OCS
9 activities. Vegetated dunes in the Arctic region may be impacted by vehicles associated with
10 seismic activities (ADNR 2009). Beaches and associated biota within the Beaufort and Chukchi
11 Sea Planning Areas could also be impacted by routine discharges from marine vessels,
12 discharges of municipal and industrial wastewater, or sedimentation from upland areas.
13

14 Activities that increase wave action along barrier beaches and dunes could contribute to
15 their erosion. Barge and service vessel traffic supporting State oil and gas development may
16 result in wake erosion along barrier islands in the Beaufort and Chukchi Sea Planning Areas. A
17 portion of the impacts related to vessel traffic would be associated with the proposed action;
18 however, activities conducted under the proposed action would contribute a relatively small
19 number of vessel trips to the total.
20

21 Accidental spills of oil or other liquid hydrocarbons, resulting from activities conducted
22 under the proposed action, could impact beaches and dunes. Such spills would represent
23 approximately 20–40% of the spills resulting from ongoing OCS activities and planned future
24 sales in the Beaufort and Chukchi Sea Planning Areas (Table 4.6.1-3). As under the proposed
25 action, the majority of these spills would be small (less than 50 bbl). Non-OCS activities, such
26 as State oil and gas development, domestic transportation of oil or refined petroleum products,
27 and commercial shipping, may also result in accidental spills that could potentially impact
28 coastal barrier beaches and dunes. Spills can result in short- or long-term changes in the
29 composition of intertidal or shallow subtidal communities, or extensive mortality of biota
30 associated with coastal habitats, and may persist in substrates for decades. The amount of oil
31 contacting beaches from a spill depends on a number of factors such as the location and size of
32 the spill, waves and water currents, and containment actions. Naturally occurring seeps may also
33 be a source of crude oil introduced into nearshore waters (Kvenvolden and Cooper 2003). The
34 magnitude of resulting impacts and the persistence of oil would depend on factors such as the
35 amount of oil deposited, remediation efforts, substrate grain size, and localized erosion and
36 deposition patterns. The impacts of potential spills associated with the proposed action would be
37 expected to add a small contribution to the impacts of other sources of beach degradation in the
38 Arctic region.
39

40 Indirect effects on coastal barrier beaches and dunes could result from global climate
41 change. Potential thermal expansion of ocean water and melting of glaciers and ice caps could
42 result in a global rise in mean sea level (Section 4.6.1.6). Sea-level rise could result in increased
43 inundation of barrier landforms and erosion of beach habitat. In the Arctic, greater wave activity
44 during storms due to decreases in sea-ice cover, as well as changes in permafrost due to
45 temperature increases, could result in increased coastal erosion.
46

1 **Wetlands.** A number of activities associated with the proposed action could result in
2 impacts on coastal wetlands in the Alaska region (Section 4.4.6.1.3). These activities include
3 construction of pipelines, road construction, and facility maintenance, and activities that result in
4 poorer water and air quality and altered hydrology. Impacts associated with these activities
5 could include elimination of wetland habitat and indirect effects that contribute to reductions in
6 wetland habitat. Similar activities are associated with current and planned OCS lease sales in the
7 Beaufort and Chukchi Sea Planning Areas, and would occur during the life of the Program (see
8 Table 4.6.1-2). In the Beaufort Sea Planning Area, the activities associated with the proposed
9 action would represent approximately 30% of such OCS activities; the proposed action does not
10 include new onshore pipelines in the Chukchi Sea Planning Area.

11
12 Factors that impact coastal wetlands include the direct elimination of wetland habitat by
13 excavation or filling and the degradation of wetland communities by reduced water or air quality
14 or hydrologic changes. Construction projects may fill wetlands for facility siting or excavate
15 wetlands for the construction of pipelines, causeways, or shore bases or for gravel mining. A
16 number of activities may degrade wetlands or promote wetland losses indirectly by causing
17 changes to wetland hydrology or introducing contaminants.

18
19 Ongoing non-OCS activities that could affect coastal wetlands include those related to
20 State oil and gas development, commercial shipping and other marine transportation, coastal
21 development, discharge of municipal wastes and other effluents, and domestic transportation of
22 oil and gas. These activities can reasonably be expected to continue into the future.

23
24 A number of these activities result in the localized destruction of wetlands. The
25 construction of pipeline landfalls, docks, or shorebases associated with State oil and gas
26 exploration and development could result in direct losses of tidal wetlands. The construction of
27 onshore facilities to support State oil and gas development and the exploration of oil reserves on
28 the National Petroleum Reserve-Alaska on the ACP have impacted freshwater wetlands, and
29 future impacts associated with oil and gas development are expected to continue. The
30 construction of buried pipelines results in direct impacts on wetlands due to excavation, and the
31 construction of gravel pads and gravel roads eliminates wetland habitat by filling. Current
32 technology allows for smaller and fewer drilling pads, and some new developments in the Arctic
33 region would not include interconnecting roads. On the ACP, gravel has been used in support of
34 oil development to construct pads for camps, drilling sites, operations and maintenance facilities,
35 airports, and roads for facility access as well as the Dalton Highway/haul road, offshore islands,
36 and causeways (MMS 2003a). Gravel mining operations often result in the excavation of
37 wetland habitat in and near rivers and other water bodies. Over 730 ha (1,800 ac) of tundra have
38 been removed by gravel mining on the ACP (MMS 2003a). The construction of vertical support
39 members for elevated pipelines also contributes to small localized wetland losses. Although
40 activities that impact wetlands are regulated by State and Federal agencies, construction of
41 industrial facilities, commercial sites, and residential developments would be expected to result
42 in continued wetland losses. On the ACP, over 3,900 ha (9,600 ac) of tundra habitat, most of
43 which is wetland, have been impacted by oil development activities (MMS 2002b, 2003a). The
44 direct impacts on coastal wetlands from pipeline construction under the proposed action would
45 represent a very small contribution to the past, ongoing, and expected future losses of wetlands
46 from non-OCS activities.

1 Indirect impacts of many activities have also resulted in wetland losses. The construction
2 of gravel roads and pads has resulted in altered hydrology in some areas, by blocking natural
3 drainage patterns, converting vegetated wetlands to open water, or drying wetlands by restricting
4 water inflow. Snow accumulations adjacent to pads and roads can result in vegetation changes
5 and thermokarst. Windblown dust near gravel pads and roads causes changes in plant
6 communities, reduction of vegetation, and thermokarst, leading to wetland losses. Sedimentation
7 from gravel pads, roads, gravel mining operations, and vehicular impacts on streambanks
8 adversely affect wetlands and may result in losses of vegetation or other associated biota. Ice
9 roads in the Arctic could result in compression of vegetation, microtopography, and tundra soils,
10 altering wetland communities. Vehicles used for seismic surveys could compress
11 microtopography and cause changes in the vegetation community. Organisms in wetland areas
12 near construction activities may be buried by excavated materials or indirectly impacted by
13 turbidity and sedimentation. Degradation of wetlands could result from water quality impacts
14 due to discharges of waste water from vessels, municipal treatment plants, and industrial
15 facilities, and stormwater discharges. Water quality may also be impacted by waste storage and
16 disposal sites. Spills of produced water could kill vegetation and other biota in freshwater
17 wetlands. Impacts on air quality near construction sites or industrial facilities could result in
18 local effects on wetland vegetation, and may include sources such as fugitive dust, off-gassing
19 from processing facilities, or exhaust emissions. Indirect impacts on wetlands from non-OCS
20 activities are expected to continue to contribute to wetland degradation and losses in the Arctic
21 region. The indirect impacts on wetlands from pipeline construction under the proposed action
22 would represent a very small contribution to the past, ongoing, and expected future impacts on
23 wetlands from non-OCS activities.

24
25 Accidental spills of oil or petroleum products as a result of activities conducted under the
26 proposed action could impact tidal or freshwater wetlands (see Section 4.4.6.1.3). Such spills
27 would represent approximately 20–40% of the spills resulting from ongoing OCS activities and
28 planned future sales in the Beaufort and Chukchi Sea Planning Areas (Table 4.6.1-3). Most of
29 these spills (1,350–1,950) would be small (less than 50 bbl), as under the proposed action. Spills
30 in shallow water, primarily those from vessel accidents and pipelines, would be most likely to
31 affect coastal wetlands, whereas deepwater spills, such as those from platforms, would be less
32 likely to impact wetlands. Spills from onshore pipelines and facilities could impact freshwater
33 wetlands or tidal wetlands if carried to coastal habitats by streams. Non-OCS activities such as
34 State oil and gas development, the domestic transportation of oil or refined petroleum products,
35 the production and storage of petroleum products, and commercial shipping may also result in
36 accidental spills that could potentially impact wetlands. Naturally occurring seeps may also be a
37 source of crude oil that could potentially affect coastal wetlands. The amount of oil contacting
38 wetlands, the magnitude of resulting impacts, and the length of time for recovery would depend
39 on a number of factors such as the location and size of the spill, containment actions, waves and
40 water currents, type of oil, types of remediation efforts, amount of oil deposition, duration of
41 exposure, season, substrate type, and extent of substrate penetration. Impacts from oil spills
42 would be expected to range from short-term effects on vegetation growth to extensive mortality.
43 Recovery of affected wetlands could require several decades. The impacts of potential oil spills
44 associated with the proposed action would be expected to constitute a small addition to the
45 impacts of all other sources of oil in the Arctic region.

1 Global climate change could result in indirect effects on coastal wetlands. Potential
2 thermal expansion of ocean water and melting of glaciers could result in a global rise in mean
3 sea level (Section 4.6.1.6). Sea-level rise would result in greater inundation of coastal wetlands,
4 and likely result in conversion of wetlands to open water. In addition, large changes in river
5 flows into nearshore marine waters could affect salinity and water circulation in estuaries, which,
6 in turn, could impact estuarine wetland communities.

7
8 **Conclusion.** Future OCS program and ongoing and future non-OCS program activities
9 in combination with naturally occurring events have resulted in losses of coastal habitats in the
10 Arctic region; cumulative impacts on these resources, therefore, are considered to be moderate to
11 major. Operations under the proposed action would result in small localized impacts, primarily
12 due to facility construction, pipeline landfalls, channel dredging, and vessel traffic; however, the
13 incremental contribution of routine Program activities to cumulative impacts would be small
14 (see Section 4.4.6.1.3).

15
16 The cumulative impacts of past, present, and future oil spills on coastal and estuarine
17 habitats would be moderate. The incremental impacts of accidental oil spills associated with the
18 proposed action on these resources would be small to large, depending on the location, timing,
19 duration, and size of the spill; the proximity of the spill to particular habitats; and the timing and
20 nature of spill containment and cleanup activities (see Section 4.4.6.1.3). The majority of these
21 spills would be small (less than 50 bbl). Large oil releases that occur in or reach shallower
22 nearshore areas have the greatest potential to affect coastal and estuarine habitats. Most spills
23 would be unlikely to contact and affect coastal and estuarine habitats. Large oil spills and
24 catastrophic discharge events, however, can affect extensive areas of shoreline.

25
26
27 **4.6.3.3.2 Marine Benthic and Pelagic Habitats.** Cumulative impacting factors for
28 marine benthic and pelagic habitats in Beaufort and Chukchi Sea Planning Areas include both
29 OCS and non-OCS activities. Potential impacts on marine benthic and pelagic habitat resulting
30 from ongoing and future routine OCS program activities, including those of the proposed action,
31 could result from noise (vessel, seismic surveys, construction, operations), well drilling, pipeline
32 placement (trenching, landfalls, and construction), discharges (drilling, vessel and platform), and
33 platform placement (anchoring, mooring, and removal). All these activities have the potential to
34 adversely affect marine benthic and pelagic habitats in the Beaufort and Chukchi Sea Planning
35 Areas. Accidental oil spills are also counted among OCS program-related activities;
36 assumptions for oil spills under the cumulative case scenario are provided in Table 4.6.2-3, and
37 catastrophic spill assumptions are provided in Table 4.4.2-2.

38
39 Potential environmental impacts associated with the building and operation of OCS
40 facilities such as platforms, subsea wells, artificial islands, and pipelines would increase in
41 conjunction with the increased number of wells (approximately 9 ha [22 ac] for artificial islands
42 versus less than 1.5 ha [3.7 ac] for platforms) and complete burial of existing substrates during
43 construction. Under the cumulative scenario, it is anticipated that up to 1,795 production wells,
44 up to 32 oil platforms, and up to 2,900 km (1,820 mi) of new offshore pipeline would be
45 constructed in the Beaufort and Chukchi Sea Planning Areas. Bottom substrates would be
46 significantly altered by the construction of artificial islands. Marine benthic and pelagic habitats

1 would be affected by bottom disturbance, by temporary increases in turbidity, and by deposition
2 of disturbed sediment. Construction of artificial islands would result in a more complete loss of
3 benthic habitat, due to larger footprints. Bottom disturbance degrades water quality by
4 increasing water turbidity in the vicinity of the operations and adding contaminants to the water
5 column. It also changes sediment composition as suspended sediments (and contaminants, if
6 present) are entrained in currents and deposited in new locations. Construction of platforms and
7 artificial islands in areas previously lacking hard substrate could have localized effects on the
8 biodiversity and distribution of benthic communities by favoring organisms that prefer a hard
9 substrate. Impacts of OCS routine operations (exploration, production and decommissioning
10 activities) on marine benthic and pelagic habitat in the Beaufort and Chukchi Sea Planning Areas
11 are discussed in detail in Sections 4.4.6.2.3 and 4.4.6.3.3. Regulations and mitigating measures
12 should preclude construction of platforms or artificial islands and placements of pipelines or
13 wells in environmentally sensitive areas, such as the Stefansson Sound Boulder Patch in the
14 Beaufort Sea (Section 4.4.6.2.3). Overall, routine operations represent a negligible to moderate
15 long-term disturbance, with the severity of the impacts generally decreasing dramatically with
16 distance from the well site.

17
18 The increased amount of drilling anticipated under the proposed action will result in OCS
19 discharges of drill muds and cuttings from exploration and delineation wells. Deposition of
20 drilling fluids and cuttings could potentially affect benthic and pelagic habitat by increasing
21 turbidity and altering grain size distributions and chemical characteristics of sediments. The
22 impacts of drilling discharges on benthic and pelagic habitats are discussed in detail in
23 Sections 4.4.6.2.3 and 4.4.6.3.3.

24
25 Various non-OCS activities, including oil and gas activities in State waters, commercial
26 shipping (including tanker vessels), dredging and disposal of dredging spoils in OCS waters, and
27 anchoring could contribute to cumulative effects on pelagic and seafloor habitats in the Beaufort
28 and Chukchi Sea Planning Areas. Drilling of wells and oil and gas activities in State waters
29 could also require construction of artificial islands, platforms, and pipelines in waters of Alaska.
30 Effects on seafloor and pelagic habitat and biota would be similar to those described above for
31 OCS oil and gas programs (Sections 4.4.6.2.3 and 4.4.6.3.3). Dredging operations in conjunction
32 with ship channel maintenance and construction, pipeline placement and burial, and support
33 facility access occur throughout the Beaufort and Chukchi Sea Planning Areas as part of non-
34 OCS activities. Dredging and marine disposal activities would involve excavation of nearshore
35 sediments and subsequent disposal in offshore or nearshore areas and could cause temporary
36 turbidity in the water column and smothering of sessile animals in the vicinity of the activity.
37 Anchoring of non-OCS activity vessels on these features could cause significant chronic
38 disturbance to benthic and bottom water habitat and biota. The amount of damage that could
39 result from anchoring activity would depend upon vessel size, the size of the anchor and chain,
40 sea conditions at the time of anchoring, and the location or position of the anchor on the feature.
41 The effects of dredging, anchoring, and trawling activities on marine benthic and pelagic habitats
42 are expected to be similar to those described for the installation of pipelines (Sections 4.4.6.2.2
43 and 4.4.6.3.2). Impacts on pelagic habitat would be localized and temporary, with recovery time
44 depending upon the nature of the habitat and severity of the damage.

45

1 Climate change is expected to have multiple effects on the Beaufort and Chukchi Sea
2 Planning Areas that could impact benthic and pelagic habitat. Increased river discharge could
3 alter the salinity, temperature, and turbidity regimes in nearshore areas (Hopcroft et al. 2008).
4 Several rivers flow into the Beaufort shelf, and this region may be more heavily affected than the
5 western Chukchi shelf. The increase in total suspended solids due to coastal erosion and the
6 greater riverine sediment loading could increase turbidity in the water column and consequently
7 decrease the penetration of photosynthetically active radiation available for kelp production
8 (Hopcroft et al. 2008).

9
10 Climate change is expected to decrease the spatial extent and temporal duration of sea ice
11 and make the ice thinner. Several possible consequences could result, including:

- 12
13 • Reduction in the spatial and temporal extent of subtidal and intertidal benthic
14 scouring, but an increase in wave generated subtidal and intertidal
15 disturbance;
- 16
17 • An increase in the sloughing of sediments from shoreline during storms,
18 adding to the sediment loads and changing water chemistry in nearshore areas;
- 19
20 • An overall increase in biological productivity in the open water with
21 increasing temperature and ice retreat and a shift to a pelagic-based rather than
22 a benthic-based food web (Hopcroft et al. 2008); and
- 23
24 • Reduction in the amount and seasonal availability of sea ice algae.

25
26 In addition, ocean acidification from increasing CO₂ inputs into the ocean is also
27 predicted to continue in arctic waters, which may reduce the availability of calcite and aragonite
28 to calcifying marine organisms in the sediment and water column.

29
30 Oil spills from both OCS and non-OCS activities could affect benthic and pelagic habitat
31 in the Beaufort and Chukchi Sea Planning Areas. The total number of oil spills and the extent of
32 affected seafloor habitat would likely increase under the cumulative scenario, in conjunction
33 with increased levels of petroleum exploration and production. Accidental hydrocarbon releases
34 can occur at the surface from tankers or platforms or at the seafloor from the wellhead or
35 pipelines. The total number of oil spills and the extent of affected seafloor habitat would likely
36 increase under the cumulative scenario, in conjunction with increased levels of petroleum
37 exploration and production. Non-OCS activities, such as oil and gas development in State waters
38 and domestic transportation of oil, may also result in accidental spills that could affect benthic
39 and pelagic habitats within the Beaufort and Chukchi Sea Planning Areas.

40
41 For both OCS and non-OCS oil spills, it is assumed the magnitude and severity of
42 potential impacts on benthic and pelagic habitat would be a function of the location (including
43 habitats affected), timing, duration, and size of the spill and containment and cleanup activities.
44 It is anticipated that most small to medium spills would have limited effects because of the
45 relatively small areas likely to be exposed to high concentrations of hydrocarbons and the short
46 period of time during which potentially toxic concentrations would be present. Oil spills would

1 likely have the greatest impacts on benthic habitat and communities in shallow subtidal waters
2 and in intertidal areas. Although pelagic habitat is likely to recover quickly following an oil
3 spill, the recovery time for intertidal and shallow subtidal benthic habitat directly impacted by oil
4 spills could be long term. If a large amount of oil from a spill were to sink and inundate
5 sensitive boulder communities, the recovery of sensitive species could be long term
6 (Section 4.4.6.2.3). Detailed discussion of the impacts of accidental hydrocarbon releases on
7 marine benthic and pelagic habitat potentially resulting from the Program in the Beaufort and
8 Chukchi Sea Planning Areas can be found in Sections 4.4.6.2.3 and 4.4.6.3.3.
9

10 **Conclusion.** Impacting factors for marine benthic and pelagic habitats include both OCS
11 and non-OCS activities. Non-OCS activities with a potential to impact marine benthic and
12 pelagic habitats in the Beaufort and Chukchi Sea Planning Areas include oil and gas production
13 in State waters, sediment dredging and disposal, and vessel traffic. Disturbances from these
14 activities including noise, vessel discharges, and bottom disturbance would occur in addition to
15 similar impacts from OCS activities. For OCS activities, planning and permitting procedures
16 should minimize the potential for direct impacts on sensitive boulder habitats during routine
17 OCS activities. Cumulative impacts to marine benthic and pelagic habitats as a result of OCS
18 and non-OCS program activities would be minor, either because of the limited time frame over
19 which most individual activities would occur or the small proportion of available habitats that
20 would be affected during a given period. The incremental contribution of routine Program
21 activities to these impacts would be small (see Section 4.4.6.2.3).
22

23 Oil spills could result from both OCS and non-OCS activities. The cumulative impacts
24 of past, present, and future oil spills on seafloor habitats would be moderate. The incremental
25 impacts of accidental oil spills associated with the proposed action on these resources would be
26 small to large, depending on the location, timing, duration, and size of spills; the proximity of
27 spills to particular seafloor habitats; and the timing and nature of spill containment and cleanup
28 activities (see Section 4.4.6.2.3). Spills in deeper water, whether from OCS or non-OCS sources,
29 are unlikely to have overall community-level effects on seafloor habitats because of the
30 relatively small proportion of seafloor area that would come in contact with released oil at
31 concentrations great enough to elicit toxic effects. Catastrophic oil releases that affect shallow
32 and intertidal habitats have the potential to be of greatest significance. Although pelagic habitat
33 is likely to recover quickly following an oil spill, the recovery time for intertidal and shallow
34 subtidal benthic habitat directly impacted by oil spills could be long-term.
35
36

37 **4.6.3.3.3 Essential Fish Habitat.** This section identifies activities that could affect EFH
38 resources in the Beaufort and Chukchi Sea Planning Areas, including non-OCS activities and
39 current and planned OCS activities that would occur during the life of the Program, and the
40 potential incremental effects of implementing the proposed action. Cumulative effects on EFH
41 could occur from a variety of OCS and non-OCS activities that have a potential to directly kill
42 managed fish species, disturb ocean bottom habitats, increase sediment suspension, degrade
43 water quality, or affect the food supply for fishery resources.
44

45 Cumulative impacting factors for EFH include both OCS and non-OCS activities.
46 Impacts on marine benthic and pelagic habitat resulting from ongoing and future routine OCS

1 program activities, including those of the proposed action, could result from noise, well drilling,
2 pipeline placement (trenching, landfalls, and construction), subsea production well and platform
3 placement (anchoring, mooring, and removal), and routine discharges (drilling, platform, and
4 vessel). Accidental oil spills are also counted among OCS program-related activities.

5
6 Under the cumulative scenario it is anticipated that up to 1,795 production wells, up to
7 32 oil platforms, and up to 2,900 km (1,820 mi) of new offshore pipeline would be constructed in
8 the Beaufort and Chukchi Sea Planning Areas over the period of the Program. Drilling muds and
9 cuttings from exploration wells would also be released in to OCS waters.

10
11 Overall, it is expected that the impacts of exploration and site development activities on
12 marine EFH would be moderate, and impacts are not expected to permanently reduce the EFH
13 available to managed species or result in population-level impacts on managed species. The
14 most sensitive benthic habitats, such as those associated with hard-bottoms and kelp
15 communities, should not be affected by routine operations since impacts would be minimized or
16 eliminated by existing protections. Although construction of platforms, artificial islands, and
17 pipelines would all disturb bottom habitats to some degree, artificial islands (Beaufort and
18 Chukchi Seas only) would result in a more complete loss of benthic habitat due to larger
19 footprints (approximately 9 ha [22 ac] for artificial islands versus less than 1.5 ha [3.7 ac] for
20 platforms) and complete burial of existing substrate. Deposition of drilling muds and cuttings
21 could potentially affect EFH by altering sediment characteristics such that benthic prey of some
22 managed fish species, certain stages of the managed species themselves, or water quality in
23 offshore areas would be affected in the immediate area surrounding drill sites. See
24 Section 4.4.6.4.3 for a detailed discussion of the impacts of routine operations on EFH and
25 managed species in the Arctic.

26
27 Various non-OCS activities, such as subsistence fishing, commercial shipping (including
28 tankers), coastal modifications, hardrock mining, dredging and disposal of dredging spoils in
29 OCS waters, and anchoring could contribute to cumulative effects on pelagic and seafloor EFH
30 in the Beaufort and Chukchi Sea Planning Areas. Commercial fishing does not occur in the
31 Beaufort and Chukchi Sea Planning Areas and sportfishing is minor in the Arctic but could
32 increase if regulations change and if warming temperatures allow an increase in vessel traffic.
33 Impacts from these non-OCS activities including noise, vessel discharges, and bottom
34 disturbance would occur in addition to similar impacts from OCS activities. Many of these
35 activities would result in bottom disturbance that would affect bottom dwelling fishes as well as
36 their food sources in a manner similar to those described for OCS activities (MMS 2008;
37 ADEC 2007a; Section 4.4.7.3.3).

38
39 EFH and managed species in the Beaufort and Chukchi Sea fall in the Kotzebue Sound
40 and Northern Subsistence fishing areas ([http://www.adfg.alaska.gov/index.cfm?adfg=](http://www.adfg.alaska.gov/index.cfm?adfg=subsistence.main)
41 [subsistence.main](http://www.adfg.alaska.gov/index.cfm?adfg=subsistence.main)). Subsistence fishing may contribute to the cumulative effects on the
42 abundance of some fishery resources. Alaska State law defines subsistence as the
43 “noncommercial customary and traditional uses” of fish and wildlife. The Alaska Department of
44 Fish and Game defines subsistence fishing to include “the taking of, fishing for, or possession of
45 fish, shellfish, or other fisheries resources by a resident of the State for subsistence uses with gill
46 net, seine, fish wheel, long line, or other means defined by the Board of Fisheries.” These

1 fishing methods have more limited impacts on EFH compared to commercial fishing methods.
2 In addition, subsistence fishing is subject to harvest limits that reduce the potential for
3 overfishing. Consequently, subsistence fishing makes a relatively minor contribution to the
4 reduction in fish stocks.

5
6 Cumulative impacts on anadromous or diadromous managed species could also occur as
7 a result of activities that obstruct fish movement in marine environments during migration
8 periods. For example, some structures along the Beaufort Sea mainland (e.g., the West Dock)
9 have been shown to block the movements of diadromous fishes, particularly juveniles, under
10 certain meteorological conditions (Fechhelm 1999; Fechem et al. 1999). Causeways such as the
11 40 m (131 ft) wide and 60 m (197 ft) long structure associated with the Red Dog Mine may
12 impede coastal movement either by directly blocking fish or by modifying nearshore water
13 conditions to the point where they might become too cold and saline for some species
14 (Fechhelm et al. 1999). Although the presence of causeways has been an issue associated with
15 oil development activities in the Beaufort Sea, the small size of the Red Dog causeway would
16 likely have little effect on the coastal movements and distributions of Chukchi Sea fishes and
17 shellfishes. However, it is anticipated that proper placement and design considerations for future
18 causeway construction along the North Slope would alleviate the potential for such effects on
19 fish movement.

20
21 There are several contaminant sources in the Beaufort and Chukchi Sea Planning Areas.
22 The Red Dog Mine in Alaska is the largest lead and zinc mine in the world, and is presently the
23 only base-metal lode mine operating in northwest Alaska. A study for the National Park Service
24 (Hasselbach et al. 2004) showed extensive airborne transport of cadmium and lead from Red
25 Dog Mine; although the study was focused only on the limits of the Cape Krusenstern National
26 Monument, these contaminants are probably carried out into the Chukchi Sea. There are also
27 natural sources of metals and hydrocarbons. Sediments, peats, and soils from the Sagavanirktok,
28 Kuparuk, and Colville Rivers are the largest source of dissolved and particulate metals and
29 saturated and polycyclic aromatic hydrocarbons in the development area. However, background
30 concentrations in fish sampled in the Arctic Planning Areas are typically at background levels
31 (Neff & Associates 2010).

32
33 There are also State oil and gas activities that can affect EFH in the Beaufort and Chukchi
34 Seas. Factors that could affect EFH from these activities would be similar to those described
35 above for OCS activities including underwater noise, habitat loss and disturbance, seismic survey
36 and exploratory drilling, as well as other ancillary activities. However, the effects from non-
37 OCS oil and gas activities could possibly be more severe than the effects from routine OCS
38 activities because the activities are closer to shore and in shallower environments. As a
39 consequence, more benthic EFH may be damaged, and resulting changes in sedimentation and
40 turbidity could affect a greater proportion of the water column.

41
42 Freshwater areas used by salmon and other anadromous fish are considered to be EFH
43 and could be affected by nearshore OCS and non-OCS oil and gas activities such as pipeline
44 dredging or by onshore pipelines that cross bodies of water, especially streams. The primary
45 effects of pipeline crossings would be increasing turbidity and sedimentation of the benthic
46 environment during construction and blocking migration of anadromous fish following

1 construction. Any pipeline route would be required to comply with various Alaska Coastal
2 Management Program policies. As a consequence, crossings of anadromous fish streams would
3 be minimized and consolidated with other utility and road crossings of such streams. In addition,
4 onshore pipelines would be designed, constructed, and maintained to reduce risks to fish habitats
5 from a spill, pipeline break, or construction activities.
6

7 See individual sections on water quality, coastal habitats, and marine and pelagic habitats
8 for a discussion of the effects of climate change on EFH in the Beaufort and Chukchi Sea
9 Planning Areas. As a heavily river-influenced system, increased river discharge could alter the
10 salinity, temperature, and turbidity regimes in nearshore areas (Hopcroft et al. 2008). Climate
11 change is also expected to decrease the spatial extent and temporal duration of sea ice as well as
12 make the ice thinner, an overall increase in biological productivity in the open water, and a shift
13 to a pelagic-based rather than a benthic-based food web (Hopcroft et al. 2008). In addition,
14 ocean acidification may reduce the availability of calcite and aragonite to marine organisms.
15

16 The total number of oil spills and the extent of affected EFH areas would likely increase
17 under the proposed action in conjunction with increased levels of petroleum exploration and
18 production. See Table 4.6.2-3 for oil spill assumptions for Alaska. Non-OCS activities, such as
19 oil and gas development in State waters, domestic transportation of oil, and commercial
20 shipping, may also result in accidental spills that could potentially impact fish resources within
21 the Arctic. While effects on EFH resources would depend on the timing, location, and
22 magnitude of specific oil spills, it is anticipated that most small to medium spills that occur in
23 OCS waters would have limited effects on EFH, due to the relatively small areas likely to be
24 exposed to high concentrations of hydrocarbons and the short period of time during which
25 potentially toxic concentrations would be present. Large or catastrophic spills could result in
26 long-term impacts to EFH habitat quality and managed species populations. See Section 4.4.6.4
27 for a detailed discussion of the impact of oil spills on EFH.
28

29 Arctic fishes could also be susceptible to adverse effects of oil spills (see
30 Section 4.4.6.4.2). Most offshore spills would be small and likely have little effect on overall
31 populations, since the areas with significant hydrocarbon concentrations would be localized
32 relative to the broad distributions of most marine and anadromous fishes of the Beaufort and
33 Chukchi Seas. However, population level effect could occur if large amounts of oil from a
34 catastrophic spill were to reach shallow subtidal and intertidal sediments. Some anadromous
35 species of the Alaskan North Slope could be at greater risk because of their unique life-history
36 cycles. Juveniles of some species of whitefish (including broad whitefish, humpback whitefish,
37 and least cisco) are intolerant of highly saline marine conditions. During their summer feeding
38 dispersals in the Beaufort Sea, these species tend to remain within a narrow band of warm, low-
39 salinity water along the coast. Offshore barrier islands offer additional protection by helping to
40 maintain low-salinity corridors. Thus, unlike most subarctic fishes, whitefish along the North
41 Slope have a reduced capacity to bypass localized disruptions to their migration corridor by
42 moving offshore and around the impasse. An oil spill, even one of limited area, could block the
43 narrow nearshore corridor and prevent fishes from either dispersing along the coast to feed or
44 returning to their overwintering grounds in rivers of the North Slope. If a spill were localized in
45 the sensitive nearshore zone, its location would also make it more amenable to cleanup by

1 environmental response teams. There is no tanker traffic on the North Slope, which eliminates
2 the possibility of a collision spill in that area.

3
4 Oil from spills occurring under the ice in the Beaufort and Chukchi Seas could remain
5 trapped there throughout the winter unless removed, which, while difficult, could be done.
6 Water quality would be negatively impacted, and overwintering eggs, larvae, and invertebrate
7 prey would likely be killed in affected areas. Surface spills occurring in the summer months
8 would temporarily reduce EFH for surface-dwelling eggs, larvae, and pelagic prey species. Oil
9 reaching nearshore areas could travel short distances upriver in anadromous fish streams as a
10 result of tidal water movements, and some oil could become trapped in the interstitial spaces of
11 the sediments. In such cases, EFH for salmon eggs and larvae could be affected. See
12 Section 4.4.3.3 for a detailed discussion of accidental oil spills in ice and ice-free conditions.

13
14 **Conclusion.** Impacting factors for EFH include both OCS and non-OCS activities. Non-
15 OCS activities with a potential to impact EFH in the Beaufort and Chukchi Sea Planning Areas
16 include oil and gas production in State waters, sediment dredging and disposal, and vessel traffic.
17 Impacts from OCS activities would be limited by specific lease stipulations. Cumulative impacts
18 to EFH as a result of OCS and non-OCS program activities would be minor to moderate,
19 proportional to the EFH area affected. The incremental contribution of routine Program
20 activities to these impacts would be small (see Section 4.4.6.3.3).

21
22 Accidental releases of oil and gas from OCS and non-OCS facilities could also have
23 effects on EFH. The cumulative impacts of past, present, and future oil spills on EFH would be
24 minor to moderate. The incremental impacts of accidental spills associated with the proposed
25 action on EFH would be small to large, depending on the location, timing, duration, and size of
26 spills; the proximity of spills to particular fish habitats; and the timing and nature of spill
27 containment and cleanup activities (see Section 4.4.6.3.3). While most accidents related to OCS
28 activities assumed under the cumulative spill scenario would be small and would have relatively
29 small incremental impacts on EFH, oil that reaches coastal wetlands could have more persistent
30 impacts and could require remediation. Spills in deeper water, whether from OCS or non-OCS
31 sources, are unlikely to have overall population-level effects on fish resources because of the
32 relatively small proportion of similar available fish habitats that would come in contact with
33 released oil at concentrations great enough to elicit toxic effects. Oil spills that have the greatest
34 potential to impact EFH and managed species are those that occur in shallower subtidal and
35 intertidal areas and spills that reach areas at the same time substantial numbers of eggs or larvae
36 of managed species are present.

37 38 39 **4.6.4 Marine and Coastal Fauna**

40
41 Previous BOEM/MMS NEPA documents for OCS lease sales have addressed cumulative
42 impacts on marine and coastal fauna. Unless referenced otherwise, the following cumulative
43 impacts discussion includes information provided in those NEPA documents prepared for the
44 GOM (see <http://www.gomr.boemre.gov/homepg/regulate/environ/nepa/nepaprocess.html>) and
45 for Alaska (see http://alaska.boemre.gov/ref/eis_ea.htm).

1 **4.6.4.1 Gulf of Mexico Region**
2
3

4 **4.6.4.1.1 Mammals.**
5

6 **Marine Mammals.** The cumulative analysis considers past, ongoing, and foreseeable
7 future human and natural activities that may occur and adversely affect marine mammals in the
8 same general area. These activities include effects of the OCS Program (proposed action and
9 prior and future OCS sales), oil and gas activities in State waters, commercial shipping,
10 commercial fishing, recreational fishing and boating activities, military operations, scientific
11 research, and natural phenomena. Specific types of impact-producing factors considered include
12 noise from numerous sources, pollution, ingestion and entanglement in marine debris, vessel
13 strikes, habitat degradation, military activities, industrial development, community development,
14 climate change, and natural catastrophes. Section 4.4.7.1.1 provides the major impact-producing
15 factors related for the proposed action.
16

17 ***Routine Activities.***
18

19 OCS Activities. Marine mammals and their habitats in the GOM could be affected by a
20 variety of exploration, development, and production activities as a result of the proposed and
21 future OCS leasing actions (see Section 4.4.7.1.1). These activities include seismic exploration,
22 offshore and onshore infrastructure construction, discharge of operational wastes, vessel and
23 aircraft traffic, and explosive removal of platforms. Impacts on marine mammals from these
24 activities may include physical injury or death; behavioral disturbances; lethal or sublethal toxic
25 effects; and loss of reproductive, nursery, feeding, and resting habitats.
26

27 Potential impacts (primarily behavioral disturbance) on marine mammals from OCS-
28 related seismic activity would be short term and temporary, and not expected to result in
29 population level impacts for any affected species with implementation of appropriate mitigation
30 measures.
31

32 Impacts from OCS construction and operation activities could include the temporary
33 disturbance and displacement of individuals or groups by construction equipment and long-term
34 disturbance of some individuals from operational noise. No long-term, population-level effects
35 are expected because individuals most affected by these impacts would be those in the immediate
36 vicinity of the construction site or operational platform and disturbance of individuals during
37 construction would be largely temporary.
38

39 Operational and waste discharges (e.g., produced water, drilling muds, and drill cuttings)
40 would be disposed of through downhole injection into NPDES-permitted disposal wells, and
41 would not be expected to result in any incremental impacts on marine mammals. Liquid wastes
42 (such as bilge water) may also be generated by OCS support vessels and on production
43 platforms. While these wastes may be discharged (if permitted) into surface waters, they would
44 be rapidly diluted and dispersed, and are expected to result in minor incremental impacts on
45 marine mammals. Drilling and production wastes may contain materials such as metals and
46 hydrocarbons, which can bioaccumulate through the food chain into the tissues of marine

1 mammals. Although the bioaccumulation of anthropogenic chemicals has been reported for a
2 variety of marine mammals, adverse impacts or population-level effects resulting from such
3 bioaccumulation have not been demonstrated (Norstrom and Muir 1994; Muir et al. 1999).
4

5 Marine mammals could be temporarily disturbed by OCS vessel traffic (all species) or
6 incur injury or death from collisions with support vessels (primarily larger, slower moving
7 cetaceans). The addition of up to 600 OCS vessel trips per week under the proposed actions
8 could result in minor to moderate incremental impacts to marine mammals, be largely short term,
9 and not result in population-level effects. Noise from helicopter overflights would be transient.
10 Impacts on marine mammals would be behavioral in nature, primarily resulting in short-term
11 disturbance in normal activities, and would not be expected to result in population-level effects.
12 Appropriate mitigation measures could lessen the potential for incremental impacts from vessel
13 and helicopter traffic.
14

15 There have been no documented losses of marine mammals resulting from explosive
16 removals of offshore oil and gas structures, but there are sporadic incidents reported of marine
17 mammals being killed by underwater detonations (Continental Shelf Associates 2004;
18 MMS 2007, 2008). Harassment of marine mammals as a result of a non-injurious physiological
19 response to the explosion-generated shock wave as well as to the acoustic signature of the
20 detonation is also possible. However, explosive platform removals would comply with BOEM
21 guidelines and would not be expected to adversely affect marine mammals in the GOM.
22

23 All of the marine mammals in the GOM are potentially exposed to OCS-industrial
24 activities (particularly noise) due to the rapid advance into the GOM deep oceanic waters by the
25 oil and gas industry in recent years; whereas, over two decades ago, the confinement of industry
26 to shallower coastal and continental shelf waters generally only exposed the bottlenose dolphin,
27 Atlantic spotted dolphin, and West Indian manatee to industry activities and their related sounds.
28 Industry noise sources include seismic operations, fixed platforms and drilling rigs, drilling
29 ships, helicopters, vessel traffic, and explosive operations (particularly for structure removal).
30

31 Non-OCS Activities. A number of non-OCS activities such as State oil and gas
32 exploration and development, commercial and recreational fishing, vessel traffic, industrial and
33 municipal discharges, climate change, and invasive species could also affect marine mammals in
34 the GOM.
35

36 *Oil and Gas Exploration and Development in State Waters.* Exploration, construction,
37 and operation activities associated with State leases would occur in nearshore and coastal areas,
38 while OCS platforms and pipelines would be located away from coastal areas (with the exception
39 of relatively few pipeline landfalls and onshore bases and processing facilities). Thus, State oil
40 and gas leasing activities may be expected to have a greater potential for affecting marine
41 mammals in coastal habitats than would the proposed OCS actions. The marine mammal species
42 most likely affected by State leases are the bottlenose dolphin, Atlantic spotted dolphin, and the
43 West Indian manatee.
44

45 *Commercial Fisheries.* Commercial fisheries are an impacting factor for marine
46 mammals in the GOM. These fisheries employ a variety of methods, such as longlines, seines,

1 trawls, and traps, which can result in the entanglement, injury, and death of mammal mammals.
2 For more than a decade, few human-induced mortalities or serious injuries of marine mammals
3 due to commercial fishery interactions have occurred in the GOM. The following interactions
4 with commercial fisheries were reported by Waring et al. (2010):

- 5
- 6 • In 2008, one mortality and two serious injuries of Risso's dolphins in the
7 GOM related to entanglement interactions with the pelagic longline fishery.
- 8
- 9 • In 2008, there was one killer whale released alive after an entanglement
10 incident with the pelagic longline fishery.
- 11
- 12 • In 1999, there was one reported stranding of a false killer whale that was
13 likely caused by fishery interactions or other human-related causes evidenced
14 by its fins and flukes having been amputated.
- 15
- 16 • From 1998 through 2007, there were no reported fishing-related mortalities of
17 short-finned pilot whales in the GOM. However, one animal was released
18 alive after an entanglement interaction with the pelagic longline fishery.
- 19
- 20 • From 1998 through 2007, there were no reported fishing-related mortalities of
21 beaked whales in the GOM. However, during 2007, one unidentified beaked
22 whale was released alive after an entanglement interaction with the pelagic
23 longline fishery.
- 24
- 25 • From 1998 through 2008, there were no reported fishing-related mortalities of
26 sperm whales in the GOM. However, one animal was released alive with no
27 serious injuries after an entanglement interaction with the pelagic longline
28 fishery.
- 29
- 30 • Some bottlenose dolphins have suffered mortalities associated with the shark
31 bottom longline fishery, pelagic longline fishery, shrimp trawl fishery, blue
32 and stone crab trap/pot fisheries, menhaden purse seine fishery, and gillnet
33 fishery. Strandings of bottlenose dolphins have also occurred throughout the
34 northern GOM from both human-caused and natural events. Human-caused
35 strandings result from gear entanglement, mutilation, gunshot wounds, vessel
36 strikes, contaminants, and ingestion of foreign objects.
- 37
- 38 • Fishery interactions likely caused the stranding of two Atlantic spotted
39 dolphins in 2004.
- 40
- 41 • A stranded spinner dolphin had monofilament line around its tail and
42 abrasions around its flukes as though it had been towed. It also had possible
43 propeller marks.
- 44

45 *Vessel Traffic.* There are a number of non-OCS activities that are occurring in the GOM
46 that could result in collisions between marine mammals and ships. These activities include

1 dredging and marine disposal, the domestic transportation of oil and gas, State oil and gas
2 development, foreign crude oil imports, commercial shipping and recreational boating,
3 commercial fisheries, and military training and testing activities. Vessel traffic associated with
4 these activities may also disturb normal behaviors with unknown long-term consequences. With
5 all of these activities, the GOM is one of the world's most concentrated shipping areas
6 (USACE 2003a, b). The GOM also supports an extensive commercial fishery, as well as
7 recreational boating. Because of the very large number of vessels typically present in the GOM,
8 the potential for vessel-marine mammal collisions is high, and may be expected to increase for
9 the foreseeable future. The amount of OCS-related vessel traffic anticipated as a result of the
10 Program is provided in Table 4.4.1-1.

11
12 *Contaminants.* There are a number of non-OCS facilities or activities that discharge
13 wastes to GOM waters, and thus may expose marine mammals to potentially toxic materials or
14 solid debris that could become entangled or ingested. These facilities or activities include
15 sewage treatment plants, industrial manufacturing or processing facilities, electric generating
16 plants, cargo and tanker shipping, cruise ships, commercial fishing, and recreational pleasure
17 craft. In addition, the Mississippi River (and to a lesser extent, other rivers and streams that
18 discharge to the northern GOM) discharges waters containing suspended sediments, fertilizers,
19 herbicides, and urban runoff (Rabalais et al. 2001, 2002). While marine mammals are exposed
20 to a variety of contaminants from these discharges, little is known about the levels of
21 contaminants at which lethal or sublethal effects may be incurred. These discharges may also
22 affect habitat quality in the vicinity of the discharges.

23
24 The role of exposure to toxins to marine mammal mortality is unknown. Elevated levels
25 of chemicals such as polychlorinated biphenyls (PCBs) and pesticides have been measured in
26 individuals sampled from waters that receive municipal, industrial, and agricultural inputs and
27 have high concentrations of contaminants (such as in the immediate vicinity of Tampa Bay)
28 (NOAA 2004b). There is little information, however, regarding the level at which tissue
29 concentrations of contaminants may result in lethal or sublethal effects.

30
31 *Climate Change.* Marine mammal populations throughout the GOM may be adversely
32 affected by climate change and, to a lesser extent, by hurricane events. There is growing
33 evidence that climate change is occurring, and potential effects in the GOM may include a
34 change (i.e., rise) in sea level or a change in water temperatures. Such changes could affect the
35 distribution, availability, and quality of feeding habitats and the abundance of food resources. It
36 is not possible at this time to identify the likelihood, direction, or magnitude of any changes in
37 the environment of the GOM due to changes in the climate, so it is too speculative to further
38 discuss climate change impacts on marine mammals.

39
40 *Natural Catastrophes.* Severe storm events such as hurricanes may result in direct or
41 indirect mortality of manatees and have the potential to impact their nearshore habitats
42 (Langtimm and Beck 2003). Heightened wave action and intensity could alter nearshore
43 channels affecting the abundance and distribution of shallow-water habitats such as lagoons and
44 bays, while sediments deposited into foraging habitats by storm waves may alter the thermal
45 environment and affect aquatic vegetation in feeding habitats. Because hurricanes are annual
46 events that are an inherent component of the overall GOM ecosystem, it may be assumed that

1 marine mammals of the GOM have experienced hurricane impacts in the past and may be
2 expected to continue to experience future hurricane events.

3
4 *Other Impacting Factors.* Marine mammals may also be impacted by other factors such
5 as unusual mortality events (UMEs) and invasive species. A UME is an unexpected stranding
6 that involves a significant die-off of any marine mammal population, and demands immediate
7 response (NMFS 2011b). Since establishment of the UM program in 1991, there have been 53
8 formally recognized UMEs in the U.S., with 33% of them occurring in the GOM (NMFS 2011b).
9 Species in the GOM most commonly involved in UMEs are bottlenose dolphins and manatees.
10 Causes of UMEs have been determined for 25 of the UMEs, and include infections, biotoxins
11 (particularly domoic acid and brevetoxin), human interactions, and malnutrition. Red tides in the
12 GOM, caused by annual blooms of the dinoflagellate *Karenia brevis*, are the source of UMEs
13 caused by biotoxins in the GOM (NMFS 2011b). Invasive species could affect some marine
14 mammals by disrupting local ecosystems and fisheries of the GOM. As examples, the Australian
15 jellyfish (*Phylloriza punctata*) introduced to the northern GOM may feed heavily on juvenile fish
16 and fish eggs (Ray 2005), while exotic shrimp viruses may affect shrimp and other crustaceans
17 such as copepods and crabs (Batelle 2001). These could affect the prey base for some marine
18 mammals.

19
20 *Accidents.* Marine mammals could be exposed to oil accidentally released from
21 platforms, pipelines, and vessels (Table 4.4.2-1). Potential non-OCS sources of oil spills in the
22 planning area include the domestic transportation of oil, State oil and gas development, and
23 natural sources such as oil seeps. Accidental oil releases from OCS activities and other sources
24 could expose marine mammals to oil by direct contact or through the inhalation or ingestion of
25 oil or tar deposits. The magnitude and duration of exposure will be a function of the location,
26 timing, duration, and size of the spill; the proximity of the spill to feeding and other important
27 habitats; the timing and nature of spill containment; and the status of the affected animals.
28 Depending on their location, as well as the location of non-OCS oil sources, accidental spills
29 associated with the proposed action could contribute to the overall exposure of marine mammals
30 in the northern GOM. Most of the small to medium spills would have limited effects on marine
31 mammals due to the relatively small areas likely to incur high concentrations of hydrocarbons
32 and the short period of time during which potentially toxic concentrations would be present. The
33 magnitude of impact would be expected to increase should a spill occur in habitats important to
34 marine mammals or affect a number of individuals from a population listed under the ESA.
35 However, some spills from OCS activity may locally represent the principal source of oil
36 exposure for some species, especially for spills contacting important coastal and island habitats.

37
38 *Conclusion.* Cumulative impacts on marine mammals in the GOM as a result of ongoing
39 and future OCS and non-OCS activities and natural phenomena could be minor to moderate over
40 the next 40 to 50 yr. Non-OCS activities or phenomena include climate change, natural
41 catastrophes, contaminant releases, vessel traffic, commercial fishing, and invasive species. The
42 incremental contribution of routine Program activities to these impacts would be small
43 (see Section 4.4.7.1.1).

44
45 Marine mammals may also be adversely affected by exposure to oil that is accidentally
46 released from OCS and non-OCS activities as well as naturally occurring seeps. The cumulative

1 impacts of past, present, and future oil spills on marine mammals would be minor to moderate.
2 The incremental impacts of accidental spills associated with the proposed action on marine
3 mammals would be small to large, depending on the location, timing, duration, and size of the
4 spill; the proximity of the spill to feeding and other important habitats; the timing and nature of
5 spill containment; and the status of the affected animals (see Section 4.4.7.1.1).
6

7 **Terrestrial Mammals.** Under the proposed action, terrestrial mammals in the GOM are
8 not expected to be affected by normal OCS-related activities (Section 4.4.7.1.1). The terrestrial
9 mammals considered in the impact analysis for the proposed action are four federally endangered
10 GOM coast beach mouse subspecies and the federally endangered Florida salt marsh vole.
11 Because of the listing of these species under the ESA, as well as their occurrence in protected
12 areas, the siting and construction of any onshore facilities associated with the proposed action
13 would be required to take into account these species and their habitats, and construction activities
14 would not be allowed in the habitats of these species.
15

16 Present beach mice habitat is no longer of optimal quality because of historical beach
17 erosion, construction, and tropical storm damage. Dredge-and-fill activities occur throughout the
18 nearshore areas of the U.S. and disrupt beach and transport, which could affect coastal systems
19 of dunes where beach mice live. Coastal construction and traffic can be expected to threaten
20 beach mice populations on a continual basis. Natural catastrophes including storms, floods,
21 droughts, and hurricanes can substantially reduce or eliminate beach mice. Storms can wash
22 large amounts of debris into dune and marsh habitats. Trash and debris may be mistakenly
23 consumed by beach mice or may entangle them. Cleanup efforts to remove debris could result in
24 adverse habitat impacts. Other activities that threaten beach mice and the Florida salt marsh vole
25 include predation and competition, artificial lighting, and coastal spills. Predation from feral and
26 free-ranging cats and dogs, feral hogs, coyotes, and red foxes, and competition with common
27 house mice could reduce beach mice and Florida salt marsh vole populations. Isolation of small
28 populations of beach mice due to habitat fragmentation can preclude gene flow between
29 populations and cause a loss of genetic diversity. Separation of frontal dune habitat from scrub
30 habitat by a highway can make a beach mouse especially vulnerable to hurricane impacts.
31 Global climate change and sea level rise could also impact the species (Bird et al. 2009;
32 Hatley 2003; USFWS 2007, 2008, 2009, 2010; Wooten 2008).
33

34 Activities in the GOM that could result in the accidental release of oil and may affect
35 terrestrial mammals and their habitats include oil production from prior, proposed, and future
36 OCS sales; domestic transportation of oil; State oil development; foreign crude oil imports; and
37 military training activities involving open-water ship refueling. If spills from these activities
38 occur in the vicinity of, or are transported by GOM currents to, the habitats of the beach mice or
39 the Florida salt marsh vole, potential impacts would be similar in nature to those identified for
40 the proposed action. Impacts associated with an oil spill may include loss of thermoregulatory
41 ability from oiling of fur, lethal and sublethal toxic effects from inhalation or ingestion of oil or
42 oil-contaminated foods, a decrease in food supply due to oiled vegetation, a decrease in habitat
43 quantity and quality due to oiling of beach sands, and the fouling of burrows and nests. In
44 addition, spill response activities could further impact habitats due to beach cleanup activities
45 and vehicle and pedestrian traffic.
46

1 Given the relatively small number of spills that are expected under the proposed action
2 and during the life of the Program (Table 4.4.2-1), the requirement under the Oil Pollution Act of
3 1990 to prevent contact of protected or sensitive habitats (such as the habitats of the beach mice
4 and the salt marsh vole) with spilled oil, and the need of a spill to be associated with
5 environmental conditions (such as a storm surge sufficient to transport the spilled oil over
6 foredunes) that could favor exposure of the species and their habitats, relatively few cumulative
7 impacts may be expected from accidental oil spills from all potential sources, and the
8 contribution of spills associated with the proposed action is expected to be limited.
9

10 **Conclusion.** Cumulative impacts on terrestrial mammals in the GOM as a result of
11 ongoing and future OCS and non-OCS program activities could be minor to moderate over the
12 next 40 to 50 yr. Non-OCS activities or phenomena that may affect populations of terrestrial
13 mammals include climate change, natural catastrophes, contaminant releases, vehicle traffic, and
14 invasive and feral species. The incremental contribution of routine Program activities to these
15 impacts would be small (see Section 4.4.7.1).
16

17 Terrestrial mammals may also be adversely affected by exposure to oil that is
18 accidentally released from OCS and non-OCS operations. The cumulative impacts of past,
19 present, and future oil spills on terrestrial mammals would be minor to moderate. The
20 incremental impacts of accidental spills associated with the proposed action on terrestrial
21 mammals would be small to large, depending on the location, timing, duration, and size of the
22 spill; the proximity of the spill to feeding and other important habitats; the timing and nature of
23 spill containment; and the status of the affected animals (see Section 4.4.7.1).
24
25

26 **4.6.4.1.2 Marine and Coastal Birds.** Section 4.4.7.2.1 discusses impacts on marine and
27 coastal birds in the GOM resulting from the proposed action (OCS program activities from 2012
28 to 2017). Cumulative impacts on marine and coastal birds result from the incremental impacts of
29 the proposed action when added to impacts from existing and reasonably foreseeable future OCS
30 program activities (that are not part of the proposed action) and other non-OCS program
31 activities. Table 4.6.1-1 presents the exploration and development scenario for the GOM
32 cumulative case (encompassing the proposed action and other OCS program activities) over the
33 next 40 to 50 yr. A number of OCS program activities could affect GOM marine or terrestrial
34 birds or their habitats; these include offshore structure placement and pipeline trenching,
35 offshore structure removal, operational discharges and wastes, service vessel and aircraft traffic,
36 construction and operation of onshore infrastructure (including new pipeline landfalls), and
37 noise. Potential impacts on marine and coastal birds from service program activities include
38 injury or mortality of birds from collisions with platforms, vessels, and aircraft; exposure to
39 operational discharges and ingestion of trash or debris; loss or degradation of habitat due to
40 construction activities; and behavioral disturbance due to the presence of, and noise generated
41 by, equipment and human activity.
42

43 Non-OCS program activities affecting marine and coastal birds include dredging and
44 marine disposal; coastal and community development; onshore and offshore construction and
45 operations of facilities associated with State oil and gas development and with the extraction of
46 nonenergy minerals; commercial and recreational boating; and small aircraft traffic. Potential

1 impacts on marine and coastal birds from these activities are similar to those under the OCS
2 program and include injury or mortality of birds from collisions with platforms associated with
3 State oil and gas development and other onshore and offshore structures (e.g., radio, television,
4 cell phone towers or wind towers); non-energy mineral mines (e.g., sand and gravel and other
5 hard minerals mined in the northern part of the GOM; onshore industrial, commercial, and
6 residential development; exposure to discharges from permitted point sources such as sewage
7 treatment discharges and nonpoint sources such as irrigation runoff, or accidental releases
8 (e.g., oil spills), as described in Section 4.6.2.1.1 and Table 4.6.2-1; exposure to emissions from
9 various onshore and offshore sources (e.g., power generating stations, refineries, and marine
10 vessels), as described in Section 4.6.2.1.2; ingestion of trash or debris; loss or degradation of
11 habitat due to construction and operations activities; and behavioral disturbance due to the
12 presence of noise generated by equipment and human activity. Other trends such as sea level
13 rise and increasing seawater temperature brought on by global climate change, as well as
14 extreme wind conditions from storm events, are also expected to adversely affect marine and
15 coastal birds over the next 40 to 50 yr.

16
17 **Injury or Mortality from Collisions.** Annual bird collision mortalities under the
18 proposed action (estimated at about 10,000 to 22,500) represent less than 0.01% of the hundreds
19 of millions of birds that annually migrate across the GOM (Russell 2005). Under the cumulative
20 scenario, annual collision mortality (estimated at 200,000 birds under current OCS activities in
21 the GOM) could increase by about 8%. During the life of the proposed action from 2012 to
22 2017, older platforms would be decommissioned and removed as new platforms are installed, so
23 it is likely that the estimated 200,000 collision-related deaths per year would persist throughout
24 the life of the program. The proposed action would likely result in a small incremental increase
25 of the total annual bird collision mortality in the GOM that occurs from collisions with other
26 OCS and non-OCS structures (Klem 1990; Kerlinger 2000).

27
28 **Exposure to Wastewater Discharges and Air Emissions.** The discharge of operational
29 wastes and air emissions from current OCS- and non-OCS-related vessel traffic and platform
30 operations is strongly regulated and would continue to be regulated over the next 40 to 50 yr.
31 However, such wastes and emissions would still expose marine and coastal birds to potentially
32 toxic materials or to solid debris that could be ingested or result in entanglement. In addition, the
33 Mississippi River, and, to a lesser extent, other rivers and streams annually discharge waters
34 containing suspended sediments, agricultural fertilizers and herbicides, and urban runoff to the
35 northern GOM (Rabalais et al. 2001, 2002). Birds and their habitats in the vicinity of these
36 discharges may be exposed to lethal and sublethal levels of contaminants. Operational
37 wastewater discharges and air emissions associated with the proposed action would contribute to
38 the overall cumulative risk of toxic exposure and debris ingestion or entanglement of existing
39 OCS and non-OCS wastewater discharges and air emissions in the GOM, but the incremental
40 increase in impact is expected to be small relative to these other activities.

41
42 Under the proposed action, marine and coastal birds could be exposed to oil accidentally
43 released from platforms, pipelines, and marine vessels, and would be most susceptible to adverse
44 impacts from spills occurring in coastal areas and affecting feeding and nesting areas.
45 Accidental oil releases occur in the GOM from a variety of non-OCS related activities, such as
46 the domestic transportation of oil, import of foreign crude oil, and State development of oil.

1 Crude oil may also enter the environment of the northern GOM from naturally occurring seeps
2 (MacDonald et al. 1996; MacDonald 1998b; Mitchell et al. 1999; NRC 2003). Oil releases from
3 all sources may expose marine and coastal birds via direct contact or through the inhalation or
4 ingestion of oil or tar deposits (see Section 4.4.7.2.1).

5
6 The spills that could occur in the cumulative scenario are shown in Table 4.6.1-3. Spills
7 from non-OCS sources could occur from import tankers, State oil and gas operations, and coastal
8 transportation of crude and refined petroleum products. Releases from natural seeps in the
9 northern part of the GOM have been estimated at about 73,000 tons (526,000 bbl) per year
10 (Kvenvolden and Cooper 2003). Most spills associated with the proposed action would be
11 relatively small (less than 50 bbl) (Table 4.4.2-1). Depending on their location, accidental spills
12 associated with the proposed action could represent a major component of the overall exposure
13 of marine and coastal birds in the GOM OCS Planning Areas.

14
15 The magnitude and duration of exposure, and any subsequent adverse effects, would be a
16 function of the location, timing, duration, and size of the spill; the proximity of the spill to
17 feeding habitats; and the timing and nature of spill containment. Spills in nearshore coastal areas
18 have the greatest potential for impacting high concentrations of bird populations. Most activities
19 associated with the Program would take place in deep or ultradeep waters. Some seabirds spend
20 a significant amount of time offshore and could be exposed to accidental oil spills that occur in
21 these deep waters, but even marine birds that remain in coastal waters could be exposed to
22 accidental oil spills if they were to occur closer to shore.

23
24 **Loss and Degradation of Habitat.** Marine and coastal birds could be affected by
25 platform construction and removal activities, and pipeline trenching, which could disrupt
26 behaviors of nearby birds. Platforms constructed under the proposed action would increase the
27 number of offshore platforms present in open-water areas of the northern GOM; and these
28 structures may be used by birds to rest or avoid bad weather conditions during spring and fall
29 migrations across the GOM (see Section 4.4.7.2). The proposed action would increase the
30 number of platforms to be removed by only 9% of current OCS numbers, and up to 75% of the
31 construction of new platforms would occur in deep water (i.e., 300 m [1,000 ft] or greater), well
32 away from coastal areas. Under the proposed action, there would also be construction associated
33 with no more than 12 new pipeline landfalls and offshore pipeline placement (Table 4.4.1-1).
34 These platform and pipeline construction activities could add to the overall disturbance level of
35 birds and their habitats from all construction sources in the GOM.

36
37 Platform construction and removal under the proposed action would be localized
38 (primarily in deep water areas) and short in duration, and would result in only a small increase in
39 the overall level of disturbance incurred by birds and their habitats from all construction
40 activities in the GOM OCS Planning Areas. Pipeline trenching and landfall construction that
41 would occur under the proposed action would similarly be of short duration and limited in extent
42 (associated with no more than 12 new landfalls), and would be expected to contribute little to
43 overall levels of bird disturbance that occur in coastal areas of the GOM on a much more regular
44 basis from existing OCS and non-OCS construction activities, such as channel construction and
45 maintenance, creation of harbor and docking areas and facilities, State oil and gas development

1 (including platform construction and removal), non-energy minerals extraction, and pipeline
2 emplacement.

3
4 Vessel traffic potentially disturbs, feeding and nesting birds with unknown long-term
5 consequences. The GOM is one of the world's most concentrated commercial shipping areas
6 (COE 2003a,b), and it supports extensive commercial fishing and recreational boating. As a
7 result, OCS and non-OCS program-related vessel traffic disturbs birds on a daily basis. This
8 trend is expected to increase as marine traffic in the GOM increases over the next 40 to 50 yr
9 (see Table 4.6.2-1). OCS program-related marine vessel traffic in the GOM could be as high as
10 1,900 trips per week over the next 40 to 50 yr; vessel traffic associated with the proposed action
11 represents about 27% of this traffic (Section 4.6.2.1). Non-OCS program traffic includes that
12 related to crude oil and natural gas imports, commercial container vessels, military and USCG
13 vessels, cruise ships, commercial fishing, and small watercraft. In 2010, the Port of New Orleans
14 alone handled about 7,500 vessel calls (mainly tanker and dry bulk carrier), about 140 vessel
15 calls per week (USDOT 2011b). Impacts on water quality from marine traffic arise from regular
16 discharges of bilge water and waste, leaching of antifouling paints, and incidental spills
17 (MMS 2001d), although operational discharges and spillage from marine vessels have declined
18 substantially in the past few decades (NRC 2003b). Vessel traffic associated with the proposed
19 action would result in a small increase in the overall disturbance of birds in the GOM region.
20

21 **Disturbance Due to Noise.** Noise generated during construction activities and normal
22 operations (e.g., helicopter overflights) may disturb marine and coastal birds, causing a short-
23 term change in normal behavior and potentially disrupting feeding and nesting activities.
24 Non-OCS activities that currently generate noise in the GOM include construction and/or
25 operation of offshore structures for State oil and gas development; offshore LNG facilities and
26 tankers; hard mineral extraction; dredging and marine disposal; commercial and recreational
27 vessel traffic; small aircraft flight; and military training and testing activities. These activities
28 are expected to continue or increase in the foreseeable future. Although noise generated as a
29 result of the proposed action would likely add only a small increment to the overall (cumulative)
30 noise levels in the GOM, locally it could represent the dominant noise in the environment,
31 resulting in more moderate impacts on marine and coastal birds.
32

33 **Climate Change and Storm Events.** Populations of marine and coastal birds
34 throughout the GOM may be adversely affected by climate change and, to a lesser extent, by
35 storm events (including hurricanes). As discussed in Section 3.3, there is growing evidence that
36 climate change is occurring, and potential effects in the GOM may include sea level rise and
37 increases in water temperatures in the GOM. Over time these changes will result in a loss of
38 wetlands in the GOM, important water bird habitat. Climate change could also affect the
39 distribution, availability, and quality of feeding habitats and the abundance of food resources. It
40 is not possible at this time to identify the likelihood, direction, or magnitude of any changes in
41 the environment of the GOM due to changes in climate, so it is too speculative to identify the
42 extent of effects on GOM populations of marine and coastal birds. It should be noted that such
43 information is not essential to a reasoned choice among OCS program alternatives, even in a
44 cumulative analysis, because the information missing here is missing across the board for all
45 action alternatives.
46

1 Severe storm events such as hurricanes may result in direct or indirect mortality of
2 marine and coastal birds and may impact important coastal habitats. Heightened wave action
3 and intensity could alter nearshore channels, affecting the abundance and distribution of shallow-
4 water habitats such as lagoons and bays, while sediments deposited into foraging habitats by
5 storm waves may alter the thermal environment and affect aquatic vegetation in feeding habitats.
6 Extreme wind conditions could damage or destroy historic rookery sites or disrupt nesting birds.
7 Because storms (including hurricanes) are annual events that are an inherent component of the
8 overall GOM ecosystem, it could be assumed that marine and coastal birds have experienced and
9 largely tolerated extreme weather conditions in the past and may be expected to continue to do so
10 in the foreseeable future. The occurrences and aftermaths of Hurricanes Katrina and Rita in
11 2004, however, have impacted avian habitats on a large scale throughout the GOM. Large areas
12 of coastal wetlands have been converted to open-water habitat, potentially affecting avian
13 species that utilized the wetlands for foraging, nesting, and as stopover points during migration
14 (Congressional Research Service 2005). Impacts on these habitats have the potential to result in
15 population-level impacts affecting both abundance and distribution of some species. For
16 example, the coastal habitats that were significantly impacted in southeastern Louisiana and the
17 Galveston Bay area of Texas support nesting by up to 15% of the world's brown pelicans and
18 30% of the world's sandwich terns (FWS 2006). Impacts on these habitats could reduce future
19 nesting success and affect overall population levels of these species.
20

21 Hurricane impacts on bottomland forest habitat along the Louisiana and Mississippi
22 coasts represent further loss of avian habitat affecting many different species; up to 70% of the
23 cavity trees used by the endangered red-cockaded woodpecker at Big Branch Marsh National
24 Wildlife Refuge were destroyed by Hurricane Katrina (FWS 2006). The long-term effects of
25 avian habitat loss due to these hurricanes is not known, and agencies such as the USFWS and
26 USGS are implementing numerous studies and monitoring programs to determine the extent and
27 magnitude of impacts on affected avian populations. The occurrence of similar magnitude
28 storms during the life of the 5-year OCS program could result in population-level impacts on
29 some bird species.
30

31 **Conclusion.** Marine and coastal birds in the GOM could be adversely affected by
32 activities associated with the proposed action as well as those associated with other OCS
33 program and non-OCS program activities. Potential impacts include injury or mortality of birds
34 from collisions with platforms associated with OCS and State oil and gas development and other
35 onshore and offshore structures (e.g., radio, television, cell phone, or wind towers), non-energy
36 mineral mines; onshore industrial, commercial, and residential development; exposure to
37 discharges from permitted point sources or accidental releases; exposure to emissions from
38 various onshore and offshore sources; ingestion of trash or debris; loss or degradation of habitat
39 due to construction and operations activities; and behavioral disturbance due to the presence of,
40 and noise generated by, equipment and human activity. Other trends such as sea level rise and
41 increasing seawater temperature brought on by global climate change, as well as extreme wind
42 conditions from storm events, are also expected to adversely affect marine and coastal birds over
43 the next 40 to 50 yr. While the cumulative impact of all OCS and non-OCS activities in the
44 GOM is expected to be moderate, the incremental impact due to the proposed action would be
45 small (see Section 4.4.7.2.1).
46

1 Marine and coastal birds may also be adversely affected by exposure to oil (via direct
2 contact or through the inhalation or ingestion of oil or tar deposits) that is accidentally released
3 from OCS and non-OCS activities, especially near coastal areas and affecting feeding and
4 nesting areas. The incremental impacts of accidental spills associated with the proposed action
5 on marine and coastal birds would be small to large, depending on the location, timing, duration,
6 and size of the spill; the proximity of the spill to feeding and nesting areas; the timing and nature
7 of spill containment; and the status of the affected birds (see Section 4.4.7.2.1).
8
9

10 **4.6.4.1.3 Fish.** There are numerous fish species that inhabit different niches throughout
11 the surface waters, water column, and benthic environments of the GOM. Routine activities will
12 cumulatively have varied effects on these fish populations depending on their habitat and life
13 history. Impacts on fish resulting from ongoing and future routine OCS program activities,
14 including those of the proposed action, could result primarily from noise (vessel, seismic
15 surveys, and construction), well drilling, pipeline placement (trenching, landfalls, and
16 construction), platform placement (anchoring, mooring, and removal, except in deep waters) and
17 routine discharges (drilling, production, platform, and vessel). Accidental oil spills are also
18 counted among OCS program-related activities. Cumulative impacts could result from the
19 combination of the proposed action and past present and reasonably foreseeable future OCS and
20 non-OCS activities.
21

22 Routine OCS activities that temporarily disturb sediments and increase turbidity include
23 installation of new pipelines and platforms and discharges of drill cuttings and associated fluids.
24 This could cause soft-bottom fish such as Atlantic croaker, sand sea trout, Atlantic bumper, sea
25 robins, and sand perch to temporarily move from or be attracted to the disturbed area. Fish
26 species that are normally associated with reefs, such as snappers, groupers, grunts, and
27 squirrelfishes, may also move from areas of increased turbidity. Sedimentation could smother
28 eggs, larvae, and juvenile fishes as well as the benthic prey of some of these fish species. See
29 Table 4.6.2-1 for a quantification of bottom disturbance and drilling and operational discharges
30 expected during the life of the Program. The impacts of routine activities (exploration and site
31 development, production and decommissioning) on fish communities are discussed in detail in
32 Section 4.4.7.3.1. Overall, routine activities represent up to a minor disturbance, primarily
33 affecting demersal fishes, with the severity of the impacts generally decreasing dramatically with
34 distance from bottom-disturbing activities.
35

36 Up to 2,100 additional platforms would be constructed under ongoing and future OCS
37 activities, including up to 450 from the proposed action. The addition of new platforms may act
38 as fish attracting devices (FADs). Many reef species, as well as highly migratory species, use
39 platforms as habitat. There has been some speculation that an increase in FADs could impact the
40 migration patterns of highly migratory species. While many platforms may be allowed to remain
41 as artificial reefs, removal of platforms will reduce available substrate and structures for these
42 fish and some of their prey species. Some fish will be killed in the process of these platform
43 removals, especially when explosives are used to accomplish the removals. A total of up to
44 1,250 platforms would be subject to explosive removal over the life of the Program, including up
45 to 275 platforms under the proposed action. A detailed discussion of oil platforms as FADs can
46 be found in Section 4.4.7.3.1.

1 Non-OCS actions may also negatively influence fish resources in various life stages and
2 habitats. Non-OCS oil and gas exploration and production activities in GOM State waters occur
3 primarily off Louisiana and Texas, and off Alabama in the vicinity of Mobile Bay. The States of
4 Florida and Mississippi have had limited activities in State waters, with a moratorium on drilling
5 activity now in effect in Florida waters. The increasing presence of offshore LNG facilities
6 could lead to impacts associated with entrainment and impingement of eggs, larvae, and juvenile
7 lifestages and discharges of water used in the vaporization process. In addition to the thermal
8 discharge, biocides are also discharged from the facilities. Other non-OCS activities that could
9 impact fish communities include non-OCS activities with a potential to impact marine benthic
10 and pelagic habitats, such as sand mining, sediment dredging and disposal, anchoring, offshore
11 marine transportation, and pollutant inputs from point and non-point sources. Many of these
12 activities would affect bottom-dwelling fishes at various life stages as well as their food sources
13 in a manner similar to OCS bottom-disturbing activities (Section 4.4.7.3.1).
14

15 Commercial fishing practices that are indiscriminate, such as some types of trawling and
16 pots, are responsible for significant amounts of bycatch that can injure or kill juveniles of many
17 fish species. These types of fishing practices could damage future year classes, reduce available
18 prey species, and damage benthic habitat for many GOM fish resources. Sportfishing may also
19 contribute significantly to cumulative effects on some fishery resources. As a consequence of
20 the pressure fishing places on fishery resources, appropriate management is required to reduce
21 the potential for depletion of stocks due to overharvesting. Even with management, the
22 possibility of overfishing still exists.
23

24 The eutrophication that has contributed to the hypoxic zone in the GOM will continue to
25 act as a source of lethal and sublethal stress to fish communities. In addition, natural events,
26 including hurricanes and turbidity plumes, could also cause localized damage to important
27 habitat areas and could affect individuals or populations. However, the GOM fish community as
28 a whole should be adapted to such natural events.
29

30 Climate change could affect fish communities through direct physiological action, habitat
31 loss, and by altering large-scale oceanographic and ecosystem processes (Section 3.8.4.1). At
32 the level of individual behavior and physiology, increasing water temperature could increase the
33 spread and virulence of new and existing pathogens, and alter reproductive rates by speeding
34 growth and altering the timing of migrations (including reproductive movements). Fish in river-
35 influenced systems such as the GOM would be particularly susceptible to changes in salinity,
36 turbidity, and temperature linked to changes in the hydrology of the Mississippi River and
37 Atchafalaya River. At larger scales, climate change could promote the range expansion of new
38 species into the GOM, reduce or eliminate critical fish habitats including estuarine waters and
39 coral reef due to sea level rise, and increase the size of the GOM “dead zone,” reducing the
40 amount of benthic habitat available to demersal fishes (Rabalais et al. 2010).
41

42 Oil spills resulting from both OCS and non-OCS activities could impact fish communities
43 in the GOM. See Table 4.6.1-3 for anticipated oil spills over the life of the Program.
44 Catastrophic spill assumptions are provided in Table 4.4.2-2. Crude oil may also enter the
45 environment from naturally occurring seeps. Large spills may also occur from tankers carrying
46 imported oil in the GOM. The potential effects of spills from non-OCS activities would be

1 similar to those described for OCS activities (Section 4.4.7.3.1). Most adult fish in marine
2 environments are highly mobile and are capable of avoiding high concentrations of
3 hydrocarbons, although they may be subject to sublethal exposures. However, eggs and larvae
4 do not have the ability to avoid spills and may therefore suffer lethal or sublethal effects. Any
5 oil spills reaching shallow seagrass, estuarine, or coastal marine habitats could affect fish species
6 that use the affected areas as spawning or juvenile nursery habitat. Coastal pelagic fish and
7 highly migratory species throughout the GOM could come into contact with surface oil, but
8 would most likely move away from affected areas. Because of the wide dispersal of early life
9 history stages of fishes in the GOM surface waters, it is anticipated that only a relatively small
10 proportion of early life stages present at a given time would be impacted by a particular oil spill,
11 which would limit the potential for population-level effects. However, the impact magnitude
12 would also depend on the temporal and spatial scope of the oil spill. Since some species of fish
13 spawn in a limited geographic area(s) during a small temporal window, a spill could have
14 population-level impacts if the spill coincided in time and space with spawning activity. In
15 addition, fish species such as tuna, swordfish, and billfish that currently have depressed
16 populations and important spawning grounds in the GOM could experience population-level
17 impacts if high numbers of early life stages were killed by a spill. The potential impacts of oil
18 spills on fish communities are discussed in detail in Section 4.4.7.3.1.

19
20 **Threatened or Endangered Species.** Routine activities such as placement and removal
21 of structures, discharges of operational wastes, and accidental spills of oil have the potential to
22 physically harm or disturb individual Gulf sturgeon, smalltooth sawfish, or their respective
23 habitats; cause sedimentation of areas that provide food; or elicit lethal or sublethal toxic effects.
24 As described in Section 3.8.4.1.4, most routine activities would not take place in shallow
25 nearshore habitat preferred by Gulf sturgeon. Gulf sturgeon are also not likely to be directly
26 affected by routine operations that impact estuarine areas because the more vulnerable egg and
27 larval stages are not present in estuarine areas and juveniles and adults will be able to avoid most
28 disturbances. Consequently, it is anticipated that effects on Gulf sturgeon from routine OCS
29 activities would be limited. Smalltooth sawfish are primarily found in peninsular Florida away
30 from the Central and Western Planning Areas. Vulnerable early life stages of smalltooth sawfish
31 exist only in shallow estuarine areas far removed from most routine OCS activities. Adults and
32 larger juveniles do occupy coastal waters where OCS activities would occur. However, it is
33 expected that, given their size, they will be able to avoid direct impacts from routine operations,
34 although their habitat would be disturbed.

35
36 In addition to potential effects from OCS oil and gas activities identified above, Gulf
37 sturgeon and smalltooth sawfish could be affected by non-OCS activities such as commercial
38 fishing, water quality degradation, coastal and upland development, dredge and fill activities, and
39 damming of major spawning rivers (Section 3.8.4.1.4). Even though it is illegal to fish for Gulf
40 sturgeon or smalltooth sawfish, some individuals, particularly smalltooth sawfish, may be
41 harmed or killed when captured as bycatch during trawling activities. Dredging and fill activities
42 in estuaries may disturb smalltooth sawfish and Gulf sturgeon habitat. Increased barriers
43 (e.g., locks or dams) to major spawning sites may result in Gulf sturgeon reproducing in less
44 desirable locations. The eggs and fry of Gulf sturgeon are also susceptible to other fish and
45 invertebrate predators as well as anthropogenic effects, such as artificially increased water

1 temperatures due to the release of cooling water from power plants and exposure to pesticides
2 and heavy metals.

3
4 Other events, including hurricanes, turbidity plumes, and hypoxia, could also affect Gulf
5 sturgeon, smalltooth sawfish, or their habitat. Regardless, a severe event could cause localized
6 damage to important habitat areas and could result in the introduction of contaminants via
7 surfacewater runoff. Therefore, such events could affect individual Gulf sturgeon or population
8 levels for some period of time.

9
10 Oil is released in GOM waters by accidental oil spills (OCS and non-OCS) and natural
11 seepage, primarily in deep water. Non-OCS oil and gas exploration and production activities in
12 GOM State waters occur primarily off Louisiana and Texas, and off Alabama in the vicinity of
13 Mobile Bay. The States of Florida and Mississippi have had limited activities in State waters,
14 with a moratorium on drilling activity now in effect in Florida waters. Non-OCS spills in the
15 GOM could have impacts similar to those for OCS spills. Smalltooth sawfish are primarily
16 found in peninsular Florida and are uncommon in most of the Central and Western GOM
17 Planning Areas. Therefore, oil spills in the GOM have the greatest potential to impact Gulf
18 sturgeon populations. Most spills would be minor and are unlikely to reach estuarine and shelf
19 habitat of adult sturgeon. Spills in shallow areas have the greatest potential to affect Gulf
20 sturgeon. As identified in Section 3.8.4.1, eggs and larvae of Gulf sturgeon are typically located
21 in freshwater areas, and oil from OCS-related spills are unlikely to come into contact with these
22 life stages. Because adult sturgeons are benthic feeders, they are relatively unlikely to come into
23 contact with surface oil in deeper waters.

24
25 **Conclusion.** Cumulative impacts on fish communities in the GOM Planning Areas could
26 result from OCS and non-OCS activities. Overall, routine activities represent up to a minor
27 disturbance, primarily affecting demersal fishes, with the severity of the impacts generally
28 decreasing dramatically with distance from bottom-disturbing activities. In addition to routine
29 OCS activities, non-OCS actions including oil and gas development in State waters, sand mining,
30 sediment dredging and disposal, LGN facilities, hypoxia, anchoring, fishing/trawling,
31 commercial shipping, and pollutant inputs from point and non-point sources could also adversely
32 affect invertebrate populations. Many of these activities would affect bottom-dwelling fish at
33 various life stages as well as their food sources in a manner similar to OCS bottom-disturbing
34 activities. Fish could also be affected by the environmental changes predicted to result from
35 climate change. The proposed action is expected to contribute only a small increment (impacts
36 ranging from negligible to minor) to the potential for overall cumulative effects on fish resources
37 because of existing regulations, the limited time frame over which most individual activities
38 would occur, and the small proportion of available habitats that would be affected during a given
39 period (see Section 4.4.7.3.1). Therefore, it is anticipated that the cumulative effects of OCS and
40 non-OCS activities on fish species in the GOM Planning Areas would be similar to the effects of
41 non-OCS activities alone.

42
43 The magnitude and severity of potential effects to fish resources from oil spills would be
44 a function of the location, timing, duration, and size of spills; the proximity of spills to particular
45 fish habitats; and the timing and nature of spill containment and cleanup activities. Small spills,
46 whether from OCS or non-OCS sources, are unlikely to have overall population-level effects on

1 fish resources. However, oil from catastrophic spills that contacted shallow nearshore areas of
2 these planning areas has the potential to be of greatest significance to fish communities. Such
3 spills could result in long-term, population-level impacts on fish communities.
4

5 Although Gulf sturgeon may be affected by a variety of OCS and non-OCS activities,
6 most OCS activities occur in deeper areas that are outside of the normal habitat areas used by
7 Gulf sturgeon. Similarly, smalltooth sawfish are primarily found in peninsular Florida away
8 from the Central and Western Planning Areas. Consequently, it is anticipated that the
9 cumulative effects of OCS and non-OCS activities on Gulf sturgeon and smalltooth sawfish
10 would be similar to the effects of non-OCS activities alone, and the proposed action is expected
11 to contribute little to any overall incremental impacts on these species.
12
13

14 **4.6.4.1.4 Reptiles.** Section 4.4.7.4 discusses impacts on reptiles in the GOM coastal
15 environment resulting from the proposed action. Cumulative impacts result from the incremental
16 impacts of the proposed action when added to impacts from existing and reasonably foreseeable
17 future OCS program activities (that are not part of the proposed action) and other non-OCS
18 program activities. Table 4.6.1-1 presents the exploration and development scenario for the
19 GOM cumulative case (encompassing the proposed action and other OCS program activities).
20 Non-OCS program activities contributing to adverse cumulative impacts on reptiles include
21 activities associated with offshore construction (e.g., seismic surveys, dredging and marine
22 disposal, extraction of nonenergy minerals, State oil and gas development, domestic
23 transportation of oil and gas, and foreign crude oil imports), onshore construction (e.g., coastal
24 and community development), the discharge of municipal and other waste effluents, and vessel
25 traffic (e.g., commercial shipping, recreational boating, and military training and testing
26 activities).
27

28 Ongoing and future routine OCS program activities include seismic surveys, onshore and
29 offshore construction (including pipeline trenching and removal of offshore structures), the
30 discharge of operational wastes (such as produced water and ship wastes), and vessel traffic. All
31 these activities have the potential to adversely affect reptiles in the GOM via physical injury or
32 death, lethal or sublethal toxic effects, or loss of reproductive, nursery, and feeding habitats
33 (Section 4.4.7.4). Accidental oil spills are also counted among OCS program-related activities;
34 assumptions for oil spills under the cumulative case scenario are provided in Table 4.6.1-3.
35

36 Anthropogenic mortality in sea turtles has been attributed to a number of sources
37 (NRC 1990; NOAA 2003). Human activities responsible for mortality of sea turtle eggs and
38 hatchlings include (in descending order of relative importance) beach development, beach
39 lighting, beach use, entanglement in trash and debris, and beach replenishment. Each of these
40 activities is associated, either exclusively or to a large degree, with coastal development. In
41 addition, the contributions of exposure of eggs and hatchlings to toxins and of the ingestion of
42 plastics and debris by hatchlings are unknown (NRC 1990; NOAA 2003). Human activities
43 responsible for mortality of juvenile and adult turtles include shrimp trawling and other fisheries,
44 beach lighting, beach use, vessel collisions, dredging, entanglement, power plant entrainment,
45 and oil platform removal (NRC 1999; NOAA 2003). The role of exposure to toxins in overall

1 sea turtle mortality is unknown. However, this information is not necessary to make a reasoned
2 choice among the alternatives.
3

4 Non-OCS offshore (deepwater and nearshore) construction activities in the GOM that
5 could affect sea turtles include channel construction and maintenance activities (e.g., dredging)
6 conducted by Federal, State, and local governments and the public; the offshore extraction of
7 nonenergy minerals; State oil and gas development; and the transport of domestic and foreign oil
8 and gas (requiring loading and offloading facilities). Potential impacts on sea turtles from these
9 activities may include physical injury or death of individuals present in the immediate
10 construction area. In addition, construction or removal of offshore OCS facilities may result in a
11 relatively small incremental increase in the potential for adverse impacts on sea turtles within the
12 GOM planning areas. However, the mitigation measures established by BOEMRE for
13 construction and platform removal activities may be expected to reduce the contribution of these
14 proposed activities to cumulative impacts to sea turtles from all offshore construction activities
15 throughout the GOM planning areas (MMS 2003, 2004, 2005).
16

17 Onshore construction in coastal areas can impact sea turtle nesting habitat. Coastal
18 development is an ongoing activity throughout the GOM and may be expected to continue or
19 increase for the foreseeable future. Residential (i.e., housing developments) and commercial
20 (i.e., casinos) development near nesting beaches may disrupt nesting adults and disorient
21 emerging hatchlings, while increasing the potential for recreational human activities on nesting
22 beaches. Compliance with regulatory requirements and the implementation of appropriate
23 mitigation measures may be expected to reduce the potential for the siting, construction, and
24 operation of onshore facilities.
25

26 There are a number of types of facilities or activities that discharge wastes to GOM
27 waters and thus expose sea turtles to potentially toxic materials or solid debris that could
28 entangle or be ingested by sea turtles. These facilities or activities include sewage treatment
29 plants, industrial manufacturing or processing facilities, electric generating plants, cargo and
30 tanker shipping, cruise ships, commercial fishing, pleasure craft, and vessel traffic associated
31 with the Program. In addition, the Mississippi River (and to a lesser extent other rivers and
32 streams that discharge to the northern GOM) annually discharges waters containing suspended
33 sediments, agricultural fertilizers and herbicides, and urban runoff (Rabalais et al. 2001, 2002).
34 The exposure of sea turtles to these discharges may result in physical injury or death, or a variety
35 of lethal or sublethal toxic effects on adults, juveniles, and hatchlings. These discharges may
36 also affect habitat quality in the vicinity of the discharges.
37

38 Operational discharges and wastes associated with OCS activities could adversely affect
39 sea turtles, especially those in the immediate vicinity of discharging platforms and vessels
40 (Section 4.4.7.4). However, discharges from OCS program-related vessels and platforms would
41 be strongly regulated under the proposed action (as they are for current OCS program-related
42 discharges). Thus, the potential for sea turtles to be exposed to discharges under the proposed
43 action may be expected to be much less than the potential of exposure to many of the nonpoint
44 and non-OCS related discharge sources. Similarly, because of existing USCG and USEPA
45 regulations, the nature of the OCS discharges that could occur are expected to be less toxic or
46 less likely to cause entanglement than discharges from non-OCS program sources.

1
2 The GOM is one of the world’s most concentrated shipping areas, with extensive
3 commercial traffic transporting a variety of materials ranging from agricultural products to
4 domestic and foreign oil (USACE 2003a). For example, in 2003, the Port of New Orleans
5 handled over 255,000 domestic and foreign container vessels, while the port at Gulfport,
6 Mississippi, handled more than 161,000 foreign container vessels (USACE 2003b). The GOM
7 also supports extensive commercial fisheries as well as recreational boating. For example, there
8 were 2 million recreational watercraft between 4 and 20 m (12 and 64 ft) in length registered in
9 the GOM States, many of which are used in GOM waters (USCG undated). The GOM also
10 supports training by U.S. Navy vessels as well as routine USCG activities. Because of the very
11 large number of vessels typically present in the GOM, the potential for sea turtles colliding with
12 watercraft is high, and may be expected to continue and increase into the foreseeable future. In
13 comparison with the overall level of vessel traffic in the GOM, the additional numbers of vessel
14 trips that would occur to support OCS program activities is expected to result in a minor
15 incremental increase to the overall potential for sea turtle–vessel collisions in the GOM planning
16 areas.

17
18 The information on the extent to which sea turtles may be affected by noise is very
19 limited (Section 4.4.7.4). However, this information is not necessary to make a reasoned choice
20 among the alternatives Current noise generating activities in the GOM unrelated to OCS
21 activities or the proposed action include the construction of offshore structures (such as those
22 supporting State oil and gas development or nonenergy minerals extraction), dredging,
23 commercial and recreational vessel traffic, and military training and testing activities. These
24 may be expected to continue or increase in the foreseeable future.

25
26 Sea turtles could be exposed to OCS oil spills that could occur from platform, pipeline,
27 and/or vessel accidents (see Section 4.4.7.4). Most spills associated with the proposed action
28 would be relatively small (less than 50 bbl), and most would be expected to occur in water
29 depths of 300 m (984 ft) or more (BOEMRE 2011).

30
31 Storms, operator error, and mechanical failures may result in accidental oil releases from
32 a variety of non-OCS related activities, such as the domestic transportation of oil, the import of
33 foreign crude oil, and State development of oil. Crude oil may also enter the environment of the
34 northern GOM from naturally occurring seeps. At least 63 seeps have been identified in the
35 northern GOM (mostly off the coast of Louisiana) (MacDonald et al. 1996), and more than
36 350 naturally occurring and constant oil seeps that produce perennial slicks of oil at consistent
37 locations may be present in the GOM (MacDonald and Leifer [2002], as cited in Kvenvolden and
38 Cooper [2003]). Seeps in the northern GOM have been estimated to discharge more than
39 1.2 million gal of crude oil annually to overlying GOM waters (MacDonald 1998). Using
40 remotely sensed satellite data, Mitchell et al. (1999) identified approximately 1,000 km²
41 (390 mi²) of floating oil in the northern GOM, presumably from natural seeps.

42
43 Accidental oil releases from these activities and from naturally occurring seeps could
44 impact reptiles by oiling (fouling) nesting beaches and nest sites and hatchlings, and through the
45 inhalation or ingestion of oil or tar deposits. The magnitude and severity of potential effects on
46 reptiles from such exposure will be a function of the location, timing, duration, and size of the

1 spill; the proximity of the spill to nesting beaches and feeding habitats; and the timing and nature
2 of spill containment and cleanup activities. Depending on their location, as well as the location
3 of spills from other sources and releases from natural seeps, accidental spills associated with the
4 proposed action could contribute to the overall exposure of nest beaches, eggs, and hatchlings to
5 oil, and subsequent lethal and sublethal effects, in the GOM planning areas. For example,
6 American crocodiles in southern Florida might only be affected by natural seepage and
7 accidental releases of oil in the Eastern Planning Area or from catastrophic spills in the Central
8 and Western Planning Areas.

9
10 Reptile populations throughout the GOM may be adversely affected by climate change or
11 hurricane events. As previously discussed (Section 4.4.7.4), there is growing evidence that
12 climate change is occurring, and potential effects in the GOM may include a change (i.e., rise) in
13 sea level or a change in water temperatures. Climate change could affect the availability or
14 quality of nesting beaches, the location and duration of current convergence areas utilized by
15 hatchlings in the open waters of the GOM, and the distribution, availability, and quality of
16 feeding habitats. For reptiles that rely on temperature to determine the gender of offspring in
17 incubating eggs (referred to as temperature-dependent sex determination), including sea turtles
18 and crocodylians, subtle increases in atmospheric temperatures could skew sex ratios of
19 hatchlings, which could have future population implications (Walther et al. 2002).

20
21 Severe storm events such as hurricanes have the potential to impact nesting beaches if
22 they result in a change in beach topography or in the composition of beach materials.
23 Heightened wave action and intensity could erode nesting beach sites, storm surges could flood
24 beaches and drown eggs and hatchlings, and sediments deposited onto beach surfaces by storm
25 waves may alter the thermal and structural environment of nest sites, potentially decreasing the
26 availability and/or quality of the nesting areas (Milton et al. 1994; Hays et al. 2001; Holloman
27 and Godfrey 2005). Hurricanes Katrina and Rita adversely affected sea turtle habitats in 2005.
28 Approximately 50 Kemp's ridley sea turtle nesting sites were destroyed along the Alabama coast
29 (Congressional Research Service 2005; FWS 2006). The loss of beaches through the affected
30 coastal areas has probably affected other existing nests and nesting habitats of this species, as
31 well as the loggerhead turtle. Similarly, impacts on seagrass beds may affect the local
32 distribution and abundance of species that use these habitats, such as the green sea turtle and
33 Kemp's ridley sea turtle. Although hurricanes are annual events that are an inherent component
34 of the overall GOM ecosystem, including sea turtle nesting beaches, if hurricanes similar in
35 magnitude to Katrina and Rita occur during the life of the Program, population-level impacts on
36 reptiles could occur, particularly since the availability of nesting habitat (e.g. beaches) has
37 become limited because of coastal residential and commercial development.

38
39 **Conclusion.** Impacts on reptiles may occur in the future as a result of normal activities
40 related to the proposed action, as a result of activities related to ongoing and expected OCS
41 leasing, and as a result of non-OCS program activities. The potential impacts associated with
42 normal OCS operations represent a relatively small incremental increase in the impacts incurred
43 by reptiles from non-OCS program activities in the GOM (see Section 4.4.7.4). Accidental oil
44 spills under the proposed action would result in a comparatively small incremental increase in
45 the overall impact of exposure to oil from other anthropogenic activities (such as spills from

1 foreign tankers). Additional impacts on reptiles may occur as a result of habitat loss or alteration
2 due to climate change and hurricanes, and from exposure to oil from naturally occurring seeps.
3
4

5 **4.6.4.1.5 Invertebrates and Lower Trophic Levels.** Cumulative impacts could result
6 from the combination of the proposed action and past present and reasonably foreseeable future
7 OCS and non-OCS activities. Routine activities will cumulatively have varied effects on
8 invertebrate populations in the sediment and water column depending on their habitat and life
9 history. Impacts resulting from ongoing and future routine OCS program activities, including
10 those of the proposed action, could result primarily from noise (vessel, seismic surveys, and
11 construction), well drilling, pipeline placement (trenching, landfalls, and construction), platform
12 placement (anchoring, mooring, and removal, except in deep waters) and routine discharges
13 (drilling, production, platform, and vessel). Accidental oil spills are also counted among OCS
14 program-related activities.
15

16 Routine activities that temporarily disturb sediments and increase turbidity include
17 installation of new pipelines and platforms and discharges of drill cuttings and associated fluids.
18 Under the cumulative scenario, as much as 55,450 ha (137,020 ac) of sea bottom would be
19 disturbed by construction of platforms and pipelines over the period of the Program
20 (Table 4.6.1-1). Bottom-disturbing impacts would most directly affect benthic and near bottom
21 invertebrates. The impacts of routine activities (exploration and site development, production
22 and decommissioning) on invertebrate communities are discussed in detail in Section 4.4.7.5.1.
23 Overall, routine activities represent up to a moderate disturbance, with the severity of the impacts
24 generally decreasing dramatically with distance from bottom-disturbing activities.
25

26 The addition of up to 2,100 new platforms over the life of the Program (up to 450 new
27 platforms under the proposed action) would allow the colonization of invertebrates requiring
28 hard substrate. While many platforms may be allowed to remain as artificial reefs, removal of
29 platforms will reduce available substrate and structures for invertebrates and injure or kill them
30 during removal.
31

32 Non-OCS actions may negatively influence invertebrate resources in various life stages
33 and habitats. Non-OCS oil and gas exploration and production activities in GOM State waters
34 occur primarily off Louisiana and Texas, and off Alabama in the vicinity of Mobile Bay. The
35 States of Florida and Mississippi have had limited activities in State waters, with a moratorium
36 on drilling activity now in effect in Florida waters. The increasing presence of offshore LNG
37 facilities could lead to impacts associated with discharges of water used in the vaporization
38 process. In addition to the thermal discharge, biocides are also discharged from the facilities.
39 Other non-OCS activities that could impact invertebrate communities include non-OCS activities
40 with a potential to impact marine benthic and pelagic habitats, such as sand mining, sediment
41 dredging and disposal, anchoring, fishing/trawling, offshore marine transportation, and pollutant
42 inputs from point and non-point sources. Many of these activities would affect bottom-dwelling
43 invertebrates at various life stages as well as their food sources in a manner similar to OCS
44 bottom-disturbing activities (Section 4.4.7.5.1).
45

1 The eutrophication that has contributed to the hypoxic zone in the GOM will continue to
2 act as a source of lethal and sublethal stress to invertebrate communities. Natural events,
3 including hurricanes and turbidity plumes, could also cause localized damage to important
4 habitat areas and could affect individuals or populations, although the invertebrate community as
5 a whole should be adapted to such natural events.
6

7 Commercial fishing practices that are indiscriminate, such as some types of trawling and
8 pots, are responsible for significant amounts of bycatch that can injure or kill large numbers of
9 invertebrates. Bottom trawling also degrades benthic habitats and temporarily increases the
10 turbidity of the water, both of which represent chronic disturbances to invertebrates. Bottom
11 trawling is particularly common in the GOM because of the importance of the shrimp fishery.
12

13 Several major classes of invertebrates could be affected by the environmental changes
14 predicted to result from climate change. Climate change could affect invertebrate communities
15 through direct physiological action, habitat loss, and by altering large-scale oceanographic and
16 ecosystem processes (Section 3.8.5.1). A significant loss of habitat-forming invertebrates like
17 corals could result from increased water temperature and ocean acidification. The impacts of
18 climate change on habitat-forming invertebrates are discussed in detail in Section 3.7.2.1.
19 Potential impacts on benthic and water column invertebrates resulting from climate change
20 include:
21

- 22 • An increase in the range and temporal variability of a water column's oxygen,
23 salinity, and temperature, which could significantly alter the existing
24 invertebrate community structure, particularly in nearshore areas;
25
- 26 • A reduction in important estuarine habitats from sea level rise;
27
- 28 • A range expansion of new invertebrate species into the GOM;
29
- 30 • An increase in the extent and duration of the GOM hypoxic zone that could
31 kill or displace existing invertebrate communities and reduce the amount of
32 suitable habitat available; and
33
- 34 • Reduced oceanic pH, which could reduce the fitness of calcifying marine
35 organisms like corals, echinoderms, foraminiferans, and mollusks.
36

37 Oil spills resulting from both OCS and non-OCS activities could impact invertebrate
38 communities in the GOM. See Table 4.6.1-3 for anticipated oil spills over the life of the
39 Program. Crude oil also enters the environment from naturally occurring seeps. Spills could
40 occur from tankers carrying imported oil in the GOM. The potential effects of spills from non-
41 OCS activities would be similar to those described for OCS activities (Section 4.4.7.5.1). In
42 general, larger benthic and water column invertebrates that come into contact with oil would
43 most likely move away from affected areas, while zooplankton and sessile or small infauna
44 would not be able to avoid spills. Oil contacting invertebrates could have lethal or sublethal
45 impacts. Any oil spills reaching shallow seagrass, estuarine, or coastal marine habitats could
46 affect commercially important species such as shrimp, oysters, and blue crab that use these areas

1 as spawning or juvenile nursery habitat. If they were to occur, deepwater surface spills could
2 also affect invertebrate eggs and larvae, neuston communities such as jellyfish species, and
3 *Sargassum*, together with any associated vertebrate and its invertebrate organisms. Because of
4 the wide dispersal of invertebrates in the GOM surface waters, it is anticipated that only a
5 relatively small proportion of early life stages present at a given time would be impacted by a
6 particular oil spill event, which would limit the potential for population-level effects. The
7 potential impacts of oil spills on invertebrate communities are discussed in Section 4.4.7.5.1.
8

9 **Conclusion.** Cumulative impacts on invertebrate communities in the GOM Planning
10 Areas could result from OCS and non-OCS activities. Overall, routine activities represent up to
11 a moderate disturbance, with the severity of the impacts generally decreasing dramatically with
12 distance from bottom-disturbing activities. In addition to routine OCS activities, non-OCS
13 actions including offshore LNG facilities, sand mining, sediment dredging and disposal, hypoxia,
14 anchoring, fishing/trawling, offshore marine transportation, and pollutant inputs from point and
15 non-point sources could also adversely affect invertebrate populations. Many of these activities
16 would affect bottom-dwelling invertebrates at various life stages as well as their food sources in
17 a manner similar to OCS bottom-disturbing activities. Several major classes of invertebrates
18 could also be affected by the environmental changes predicted to result from climate change. It
19 is anticipated that the cumulative effects of OCS and non-OCS activities on invertebrates would
20 be similar to the effects of non-OCS activities alone, and routine Program activities, with impacts
21 ranging from negligible to minor, are expected to contribute only a small increment to the
22 potential for overall cumulative effects on invertebrate resources.
23

24 The magnitude and severity of potential effects to invertebrate resources from oil spills
25 would be a function of the location, timing, duration, and size of spills; the proximity of spills to
26 particular habitats; and the timing and nature of spill containment and cleanup activities. Spills
27 in deeper water, whether from OCS or non-OCS sources, are unlikely to have overall population-
28 level effects on invertebrate resources because of the relatively small proportion of similar
29 available habitats that would come in contact with released oil at concentrations great enough to
30 elicit toxic effects. Oil from catastrophic spills that reaches shallower, nearshore areas of these
31 planning areas has the potential to be of greatest significance to invertebrate communities.
32 Impacts from such spills could result in long-term, population level impacts on invertebrate
33 communities.
34
35

36 **4.6.4.1.6 Areas of Special Concern.** Section 4.4.8.1 identified potential effects of the
37 proposed action on areas of special concern in the GOM. This section identifies activities that
38 could affect such areas in the GOM, including non-OCS activities and current and planned OCS
39 activities that would occur during the life of the Program, and the potential incremental effects of
40 implementing the proposed action.
41

42 **National Marine Sanctuaries.** The FGBNMS is the only National Marine Sanctuary
43 located in the Western and Central GOM Planning Areas. The Flower Gardens Bank sanctuary
44 is protected from direct mechanical damage due to oil and gas exploration and development by
45 an MMS Topographic Features Stipulation, which includes a No Activity Zone (Section 4.4.6.2).
46 Additional OCS activities that could affect the marine sanctuaries include discharges of drilling

1 cuttings, drilling muds, and produced waters. However, as identified in Section 4.4.6.2, the
2 Topographic Features Stipulation does not allow discharges from OCS activities to be released
3 within the vicinity of the FGBNMS. Consequently, it is anticipated that the sanctuary would not
4 be affected by discharges from OCS activities.

5
6 Non-OCS activities that could affect the marine sanctuaries include fishing, diving,
7 offshore marine transportation, and tankering. Natural events such as hurricanes could also
8 impact the sanctuaries. Fishing and diving impacts are controlled by sanctuary guidelines
9 regulating these activities. The distance of the Flower Garden Banks from shore (over 160 km
10 [99 mi]) serves to reduce the number of visitors to the sanctuary, further reducing the potential
11 for impacts from fishing and diving activities. Sanctuary regulations also prohibit collecting
12 activities and ban anchoring within the sanctuary in order to minimize structural damage to the
13 reef system from commercial and recreational vessels.

14
15 Climate change has the potential to profoundly affect coral communities on topographic
16 features in several ways, including:

- 17
18 • Increased frequency of bleaching as a stress response to warming water
19 temperatures (Hoegh-Guldberg et al. 2007);
- 20
21 • Excessive algal growth on reefs and an increase in bacterial, fungal, and viral
22 agents (Boesch et al. 2000; Twilley et al. 2001);
- 23
24 • Greater frequency of mechanical damage to corals from greater severity of
25 tropical storms and hurricanes (Janetos et al. 2008);
- 26
27 • Decreases in the oceanic pH and carbonate concentration are expected to
28 reduce the reef formation rate, weaken the existing reef structure, and alter the
29 composition of coral communities (Janetos et al. 2008); and
- 30
31 • Invasive species may expand their range into the GOM due to climate change.

32
33 Impacts on the marine sanctuaries could occur due to surface hydrocarbon discharges
34 from platform spills, OCS and non-OCS tankers, or other marine traffic passing in the vicinity of
35 the sanctuary. Discharges in the vicinity of the FGBNMS should be greatly diluted before they
36 could reach reef features because water depths within the sanctuary are greater than 20 m (66 ft).
37 Consequently, it is anticipated that concentrations of contaminants within such discharges would
38 be diluted to levels unlikely to have toxic effects on reef organisms. Oil spills could also impact
39 the Flower Garden Banks communities. The No Activity Zone mandated in the Topographic
40 Features Stipulation and adopted as a regulation for the Flower Garden Banks precludes
41 placement of platforms or pipelines immediately adjacent to the marine sanctuary and reduces
42 the likelihood that oil from a pipeline leak would reach bank communities. If oil from a series of
43 subsurface spills were to reach one of these banks, sensitive biota could be affected. Potential
44 impacts have been discussed in Section 4.4.6.2. It is anticipated that impacts of a large oil spill
45 reaching coral reef or hard-bottom habitat may be long term.

1 **National Parks, Reserves, and Refuges.** As identified in Section 4.4.8.1, routine OCS
2 activities potentially affecting parks, reserves, and refuges include placement of structures,
3 pipeline landfalls, operational discharges and wastes, and vessel and aircraft traffic. It is
4 assumed that pipeline landfalls, shore bases, and waste facilities would not be located in national
5 parks, NWRs, or national estuarine research reserves because of the special status and
6 protections afforded these areas. Consequently, there would be no direct impacts from these
7 activities on any GOM national parks, reserves, or refuges.
8

9 It is possible that future pipeline landfalls, shore bases, and waste facilities could be
10 located in one or more estuaries in the Western or Central GOM Planning Areas that are included
11 in the National Estuary Program. This includes Corpus Christi Bay (Coastal Bend Bays and
12 Estuaries), Galveston Bay, Barataria-Terrebonne Estuarine Complex, and Mobile Bay. Under
13 the cumulative scenario, it is anticipated that less than 40 new pipeline landfalls could occur in
14 the GOM, with less than 12 of these resulting from the proposed action (Table 4.4.1-1). In
15 addition, gas-processing facilities could be built in the GOM area under the cumulative scenario.
16 It is assumed that new onshore facilities and structures would be subject to additional evaluations
17 under the NEPA and that they would be sited to avoid national parks, reserves, and refuges and
18 to limit impacts on estuarine and coastal habitats.
19

20 Trash and debris are a recognized problem affecting enjoyment and maintenance of
21 recreational beaches along the GOM coast. From extensive aerial surveys conducted by NMFS
22 over large areas of the GOM, floating offshore trash and debris was characterized by Lecke-
23 Mitchell and Mullin (1997) as a ubiquitous, Gulfwide problem. Not surprisingly, such trash and
24 debris frequently washes up on beaches, including those associated with areas of special concern
25 such as the Padre Island National Seashore. Trash and debris can detract from the aesthetic
26 quality of beaches, can be hazardous to beach users and wildlife, and can increase the cost of
27 maintenance programs.
28

29 Trash and debris in the GOM originates from various sources, including OCS operations,
30 offshore and onshore oil and gas operations in State waters, naval operations; merchant vessels,
31 commercial and recreational fishing activities, and onshore residences and businesses (Miller and
32 Echols 1996). The discharge or disposal of solid debris from OCS structures and vessels is
33 prohibited by the MMS (30 CFR 250.40) and by the USCG (MARPOL, Annex V, Public
34 Law 100-220 [101 Statute 1458]). Assuming that operators of OCS facilities comply with
35 regulations, most potential impacts would be avoided, although some accidental loss of materials
36 is inevitable. Natural phenomena (such as storms, hurricanes, and river outflows) contribute to
37 movement of trash and debris onto the beaches in the GOM.
38

39 Vessel wakes from a large number of vessel trips can, over time, erode shorelines along
40 inlets, channels, and harbors. The GOM is one of the world's most concentrated shipping areas,
41 and the Port of New Orleans supports extensive commercial shipping traffic. The GOM also
42 supports extensive commercial fisheries as well as recreational boating. The GOM also supports
43 training by U.S. Navy vessels as well as routine USCG activities (Section 4.3). The additional
44 vessel activity that would occur under the proposed action will result in an increase in the overall
45 potential for wakes to affect sensitive shorelines in the GOM OCS Planning Areas.
46

1 Overall, it is assumed that there could be 1,400–1,900 OCS-related vessel trips per week
2 in the GOM under the cumulative scenario; 300 to 600 of these would occur as a result of OCS
3 activities attributable to the proposed action (Table 4.4.1.1-1). The majority of such vessel trips
4 would occur in offshore waters, thereby precluding effects on shorelines associated with national
5 parks, reserves, and refuges. Existing regulations typically limit vessel speeds in the sensitive
6 inland waterways of areas of special concern. With these measures in place, most impacts due to
7 vessel traffic in such areas would be avoided.

8
9 Under the proposed action, national parks, NWRs, national estuarine research reserves, or
10 national estuary program sites could be exposed to oil accidentally released from platforms,
11 pipelines, and vessels (see Section 4.4.8.1). In addition to the potential for spills from OCS
12 sources, storms, operator error, and mechanical failures could also result in accidental oil
13 releases from a variety of non-OCS-related activities including domestic transportation of oil,
14 importing foreign crude oil, and development of oil production under State programs. The
15 potential exists for impacts to National Parks, Reserves, and Refuges that could result from both
16 oiling of the shoreline and mechanical damage during the cleanup process. Most spills
17 associated with the proposed action would be relatively small (less than 50 bbl), and most would
18 be expected to occur in waters depths of 200 m (656 ft) or more (Table 4.4.2-1) where they are
19 not likely to affect coastal areas. Because of the expected distribution of leasing activities, it is
20 assumed that such spills would occur in either the Western or Central GOM Planning Areas.

21
22 Based on the expected distribution of activities and facilities associated with current or
23 proposed activities under OCS leasing programs, it is assumed that any accidental oil spills from
24 OCS-activities would occur in either the Western or Central GOM Planning Area. In contrast,
25 non-OCS spills could occur anywhere in the GOM. Thus, while it is considered likely that only
26 national seashores, NWRs, national estuarine research reserves, and National Estuary Program
27 sites in the Western or Central GOM are at risk from spills due to ongoing or proposed OCS
28 activities, any of these types of properties located along the GOM coast has a potential to be
29 affected by non-OCS accidental spills. Regardless of the source, oil from a large or catastrophic
30 spill that reached the shoreline of any of these sites could have adverse effects on resources or
31 resource values.

32
33 Hurricanes and tropical storms occur regularly in the GOM area. The natural
34 environments that parks and refuges preserve and maintain have developed in a setting of regular
35 occurrences of severe storms. In 2004 and 2005, however, Hurricanes Katrina, Rita, and Ivan
36 severely impacted numerous national parks, NWRs, and national estuaries. In 2004, Hurricane
37 Ivan damaged 10 NWRs between the Florida panhandle and Louisiana. In 2005, Hurricane
38 Katrina affected 16 refuges in the same area, temporarily closing all of them. Impacts included
39 damage to beaches, dunes, vegetation and infrastructure. Breton NWR in Louisiana was reduced
40 to about one-half its pre-Katrina size. Many impacted refuges remain impacted by huge
41 quantities of debris and hazardous gases and liquids spread over large areas of wetlands within
42 the sanctuaries. Should storms of similar strength and size occur during the life of the Program,
43 long-term impacts on areas of special concern in the GOM could occur.

44
45 **Conclusion.** In addition to OCS activities, non-OCS activities that could affect National
46 Sanctuaries, Parks, Reserves and Refuges include fishing, diving trash and debris, vessel wakes,

1 vessel traffic, tinkering, and oil and gas activities in State waters. Hurricanes and tropical storms
2 also occur regularly in the GOM area potentially causing damage. Due to existing protections, it
3 is anticipated that the FGBNMS would not be affected by OCS activities. Development of OCS
4 onshore facilities within National Park lands is considered unlikely, making impacts from
5 cumulative routine OCS operations unlikely in these areas. Offshore construction of pipelines
6 and platforms could contribute to cumulative effects on wildlife and on scenic values for park
7 visitors. Impacts could also include increases to the amount of trash or debris that currently
8 washes up on shorelines, and increases in shoreline erosion due to increased vessel traffic in
9 inshore waters. Overall, routine Program activities could result in minor incremental increases in
10 effects on areas of special concern compared to existing non-OCS activities within the Gulf of
11 Mexico (see Section 4.4.8.1).

12
13 The proposed action would be expected to result in a small incremental increase in the
14 risk of impacts from oil spills to areas of special concern. The cumulative level of impacts from
15 spills would depend on spill frequency, location, and size; the type of product spilled; weather
16 conditions; effectiveness of cleanup operations; and other environmental conditions at the time
17 of the spill. Large and catastrophic oil spills in areas adjacent to the National Parks, NWRs, or
18 National Forests, whether from OCS or non-OCS sources, could negatively impact the FGBNMS
19 and coastal habitats and fauna and could also affect subsistence uses, commercial or recreational
20 fisheries, and tourism.

21 22 23 **4.6.4.2 Alaska Region – Cook Inlet**

24 25 26 **4.6.4.2.1 Marine Mammals.**

27
28 **Marine Mammals.** The cumulative analysis considers past, ongoing, and foreseeable
29 future human and natural activities that may occur and adversely affect marine mammals in the
30 same general area. These activities include effects of the OCS Program (proposed action and
31 prior and future OCS sales), oil and gas activities in State waters, commercial and subsistence
32 shipping, commercial fishing, recreational fishing and boating activities, military operations,
33 scientific research, and natural phenomena. Specific types of impact-producing factors
34 considered include noise from numerous sources, pollution, ingestion and entanglement in
35 marine debris, vessel strikes, habitat degradation, subsistence harvests, military activities,
36 industrial development, community development, climate change, and natural catastrophes.
37 Section 4.4.7.1.2 provides the major impact-producing factors for the proposed action in Cook
38 Inlet.

39 40 ***Routine Activities.***

41
42 **OCS Activities.** Marine mammals and their habitats in the Cook Inlet Planning Area
43 could be affected by a variety of exploration, development, and production activities as a result
44 of the proposed and future OCS leasing actions (see Section 4.4.7.1.2). These activities include
45 seismic exploration, offshore and onshore infrastructure construction, the discharge of
46 operational wastes, and vessel and aircraft traffic. Impacts on marine mammals from these

1 activities may include physical injury or death; behavioral disturbances; lethal or sublethal toxic
2 effects; and loss of reproductive, nursery, feeding, and resting habitats. The degree of impact at
3 the population level depends greatly on the status of the population (reflected in its listing under
4 the ESA) and the degree of disturbance or harm from OCS-related activities in areas important to
5 species survival (i.e., feeding, breeding, molting, rookery, or haulout areas).
6

7 Potential impacts (primarily behavioral disturbance) on marine mammals from OCS-
8 related seismic activity would be short term and temporary, and not expected to result in minor
9 impacts on any affected species.
10

11 Impacts from OCS construction and operation activities could include the temporary
12 disturbance and displacement of individuals or groups by construction equipment and long-term
13 disturbance of some individuals from operational noise. No long-term, population-level effects
14 would be expected because individuals most affected by these impacts would be those in the
15 immediate vicinity of the construction site or operational platform and disturbance of individuals
16 during construction would be largely temporary. In addition, appropriate mitigation measures
17 could lessen the potential for impacts.
18

19 Operational and waste discharges (e.g., produced water, drilling muds, and drill cuttings)
20 would be disposed of through downhole injection into NPDES-permitted disposal wells, and thus
21 would not be expected to result in any incremental impacts on marine mammals. Liquid wastes
22 (such as bilge water) may also be generated by OCS support vessels and on production
23 platforms. While these wastes may be discharged (if permitted) into surface waters, they would
24 be rapidly diluted and dispersed and would result in minor incremental impacts on marine
25 mammals. Drilling and production wastes may contain materials such as metals and
26 hydrocarbons, which can bioaccumulate through the food chain into the tissues of marine
27 mammals. Although the bioaccumulation of anthropogenic chemicals has been reported for a
28 variety of marine mammals, adverse impacts or population-level effects resulting from such
29 bioaccumulation have not been demonstrated (Norstrom and Muir 1994; Muir et al. 1999).
30

31 Marine mammals could be temporarily disturbed by OCS vessel traffic (all species) or
32 incur injury or death from collisions with support vessels (primarily larger, slower moving
33 cetaceans). The low level of expected OCS vessel trips in the Cook Inlet Planning Area under
34 the proposed action (one to three trips per week) would be a minor contribution to all vessel
35 traffic occurring in the Cook Inlet. Noise from the one to three helicopter overflights expected
36 each week would be transient in nature and be a minor component of all aircraft flights that
37 occur within Cook Inlet. Overflights disturbing active rookery sites could result in decreased
38 pup survival and in population-level impacts on some species, although overflight restrictions
39 and flightline selection to avoid rookeries would greatly limit the potential for adversely
40 affecting animals at these locations.
41

42 No platforms would be removed under the proposed action for the Cook Inlet Planning
43 Area. It is possible that platforms would be removed from future lease sales or from platforms
44 associated with oil and gas activities in State waters. There have been no documented losses of
45 marine mammals resulting from explosive removals of offshore oil and gas structures, but there
46 are sporadic incidents reported of marine mammals being killed by underwater detonations

1 (Continental Shelf Associates 2004; MMS 2007, 2008). Harassment of marine mammals as a
2 result of a non-injurious physiological response to the explosion-generated shock wave, as well
3 as to the acoustic signature of the detonation, is also possible. However, explosive platform
4 removals would comply with appropriate BOEM or State guidelines and would not be expected
5 to adversely affect marine mammals in Cook Inlet.
6

7 Non-OCS Activities. A number of non-OCS activities such as oil and gas exploration
8 and development in State waters: commercial, subsistence, and recreational fishing; vessel
9 traffic; and climate change could also affect marine mammals in the Cook Inlet Planning Area
10 (or portions of the Gulf of Alaska that could be affected by activities in Cook Inlet). Many of the
11 effects of these activities on marine mammals would be similar in nature to those resulting from
12 OCS-related activities, namely, behavioral disturbance, habitat disturbance, injury or mortality,
13 and exposure to toxic substances. Marine mammals may also be adversely affected by climate
14 change.
15

16 *Oil and Gas Exploration and Development in State Waters.* The State of Alaska has
17 made nearshore State lands available for leasing along the northern portion of Cook Inlet (above
18 Homer). Exploration, construction, and operation activities associated with State leases would
19 occur in nearshore and coastal areas, while OCS platforms and pipelines would be located away
20 from coastal areas. Thus, State oil and gas leasing activities may be expected to have a greater
21 potential for affecting marine mammals in coastal habitats than would the proposed OCS actions.
22

23 *Commercial and Subsistence Fishing and Harvesting.* Commercial and subsistence
24 fishing has been identified as impacting many of the marine mammals in Alaskan waters (Allen
25 and Angliss 2011). These fisheries employ a variety of methods, such as longlines, seines,
26 trawls, and traps, and can result in the entanglement, injury, and death of individuals of marine
27 mammal species. Fisheries also remove a portion of the prey base for some marine mammals.
28 Subsistence harvest has targeted and continues to target some marine mammal species,
29 especially some of the whale species.
30

31 The following are minimum reported estimated annual mortality rates incidental to
32 commercial fisheries and subsistence harvests for marine mammals that occur in Cook Inlet
33 and/or in the Gulf of Alaska that could be affected by the proposed action in Cook Inlet (Allen
34 and Angliss 2011):
35

- 36 • The estimated minimum mortality rate for Western U.S. Stock of the Steller
37 sea lion incidental to Alaska commercial fisheries is 26.2 animals per year.
38 The best estimate of annual subsistence harvest of the Steller sea lion is
39 197 animals.
- 40 • The estimated minimum mortality rate for Eastern Pacific Stock of the
41 northern fur sea lion incidental to Alaska commercial fisheries is 1.9 animals
42 per year. The best estimate of annual subsistence harvest of the northern fur
43 seal is 562 animals.
44
45

- 1 • The estimated minimum mortality rate for Gulf of Alaska Stock of the harbor
2 seal incidental to Alaska commercial fisheries is 24 animals per year. The
3 best estimate of annual subsistence harvest of the harbor seal is 807 animals.
4
- 5 • There are no reports of mortality incidental to commercial fisheries for the
6 Cook Inlet Stock of the beluga whale. Annual subsistence harvest of Cook
7 Inlet beluga whales ranged from 30 to over 100 between 1993 and 1999.
8 Since 2000, subsistence harvests totaled only 11 whales, with no subsistence
9 harvests allowed between 2008 and 2012 (Allen and Angliss 2011;
10 NMFS 2008b).
11
- 12 • The estimated minimum mortality rate for the Alaska Resident Stock of the
13 killer whale incidental to Alaska commercial fisheries is 1.2 animals per year.
14 There are no reports of subsistence harvests of killer whales in Alaska.
15
- 16 • The estimated minimum mortality rate for the Gulf of Alaska, Aleutian
17 Islands, and Bering Sea Transient Stock of the killer whale incidental to
18 Alaska commercial fisheries is 0.4 animal per year. There are no reports of
19 subsistence harvests of killer whales in Alaska.
20
- 21 • There are no reports of mortality incidental to commercial fisheries or
22 subsistence harvest for the ATI Transient Stock of the killer whale.
23
- 24 • There were no serious injuries or mortalities observed or reported incidental to
25 commercial fisheries between 2002 and 2006 for the North Pacific Stock of
26 the Pacific white-sided dolphin. However, between 1978 and 1991, thousands
27 of individuals died annually incidental to high seas fisheries (these fisheries
28 have not operated in the central North Pacific since 1991). There are no
29 reports of subsistence harvests of Pacific white-sided dolphins.
30
- 31 • The estimated minimum mortality rate for the Gulf of Alaska Stock of the
32 harbor porpoise incidental to commercial fisheries is 71.4 animals per year.
33 There are no reports of subsistence harvests of the harbor porpoise. Two
34 harbor porpoises were taken incidentally in subsistence gillnets in 1995.
35
- 36 • The estimated minimum mortality rate for the Alaska Stock of the Dall's
37 porpoise incidental to commercial fisheries is 29.6 animals per year. There
38 are no reports of subsistence harvests of the Dall's porpoise.
39
- 40 • The estimated minimum mortality rate for the North Pacific Stock of the
41 sperm whale incidental to commercial fisheries in the Gulf of Alaska is
42 2.01 animals per year. There are no reports of subsistence harvests of the
43 sperm whale. The sperm whale was the dominant species killed by the
44 commercial whaling industry in the North Pacific in the years following the
45 Second World War.
46

- 1 • The estimated annual mortality rate for the Alaska Stock of Cuvier’s beaked
2 whale incidental to commercial fisheries is zero. There are no reports of
3 subsistence harvests of the Cuvier’s beaked whale.
4
- 5 • Serious injuries to or mortalities of Eastern North Pacific Stock of the gray
6 whale occur throughout their range incidental to commercial fisheries and
7 from strandings due to various causes. The annual mortality rate incidental to
8 U.S. commercial fisheries is 3.3 whales. Annual subsistence take averaged
9 121 whales between 2003 to 2007. Russian Chukotka people take most of the
10 gray whales. The U.S. Makah Indian Tribe has a yearly average quota of only
11 4 whales. In 2005, an unlawful subsistence hunt and kill of a gray whale
12 occurred in Alaska.
13
- 14 • The Western North Pacific Stock of the humpback whale’s feeding area
15 includes the Gulf of Alaska. The estimated annual mortality incidental to
16 U.S. commercial fisheries is 0.2 humpback whales per year based on one
17 mortality observed in the Bering Sea sablefish pot fishery from 2002 through
18 2006. Bycatch in Japan and Korea average 1.1 to 2.4 humpback whales per
19 year. The annual mortality rate for subsistence takes for the 2003 to 2007
20 period was 0.2 whales. The species received full protection in 1965; however,
21 the Union of Soviet Socialist Republics (USSR) continued illegal catches until
22 1972. From 1961 through 1971, 6,793 humpback whales were illegally killed.
23 Many of these were taken from the Gulf of Alaska and the Bering Sea.
24
- 25 • The Central North Pacific Stock of the humpback whale feeding area includes
26 the Gulf of Alaska area that encompasses Cook Inlet. Based on observations
27 from 2003 through 2007, the estimated annual mortality in Alaska is
28 3.4 animals per year from commercial fishery, 0.2 animals per year from
29 recreational fishery, and 1.6 animals per year from vessel collisions.
30 Subsistence harvesting is not allowed for humpback whales from the Central
31 North Pacific Stock.
32
- 33 • There was one observed incidental mortality of a fin whale from the Northeast
34 Pacific Stock in the Bering Sea/Aleutian Island pollock trawl fishery. No
35 current or historical subsistence takes of this stock are reported from Alaska or
36 Russia. Between 1925 and 1975, commercial whaling throughout the North
37 Pacific killed 47,645 fin whales.
38
- 39 • For the Alaska Stock of the minke whale, the total estimated mortality and
40 serious injury incidental to U.S. commercial fisheries for 2002 through 2006
41 was zero. Prior to that time, whale mortalities were very rare. Subsistence
42 take by Alaska Natives is rare (e.g., only nine between 1930 and 1995).
43
- 44 • There are no records of North Pacific right whale mortalities incidental to
45 U.S. commercial fisheries. There are no reported subsistence takes of the
46 species in Alaska or Russia. Up to 37,000 North Pacific right whales were

1 killed by whaling from 1839 to 1909; while 742 were killed by whaling from
2 1900 to 1999, in addition to 372 killed illegally, taken by the U.S.S.R., from
3 1963 through 1967, primarily in the Gulf of Alaska and Bering Sea, that left
4 the population at an estimated 50 individuals (Allen and Angiss 2011;
5 Encyclopedia of Life 2011).
6

- 7 • Based on commercial fisheries observer program results, fishing mortality and
8 serious injury for the south central Alaska Stock of the northern sea otter is
9 insignificant (i.e., approaches zero mortalities and serious injuries). The mean
10 annual report of subsistence take for the stock from 2002 through 2006 was
11 346 animals.
12
- 13 • The total fishery mortality and serious injury rate for the Southwest Alaska
14 stock of the northern sea otter is less than 10 animals per year. The mean
15 annual report of subsistence take for the stock from 2002 through 2006 was
16 91 animals.
17

18 In addition to the above, no serious injuries or mortalities due to fisheries or subsistence have
19 been reported for blue whales in Alaska (Carretta et al. 2011).
20

21 *Climate Change.* A concern regarding marine mammals in polar regions is the potential
22 for climate change and associated changes in the extent of sea ice in some arctic and subarctic
23 waters. It is not possible at this time to identify the likelihood, direction, or magnitude of any
24 changes in the environment of Cook Inlet waters due to changes in the climate, or how climate
25 change could impact marine mammals in these waters. The current state of climate change and
26 its impacts on marine mammals would also be further considered in any subsequent
27 environmental reviews for lease sales or other OCS-related activities; therefore, this information
28 is not essential to a reasoned choice among the alternatives presented in this PEIS.
29

30 *Other Impacting Factors.* Marine mammals in the Cook Inlet area may also be impacted
31 by other factors such as UMEs and invasive species. A UME is an unexpected stranding that
32 involves a significant die-off of any marine mammal population, and demands immediate
33 response (NMFS 2011b). Since establishment of the UM program in 1991, there have been
34 53 formally recognized UMEs in the U.S.; only one UME occurred in Alaska and involved sea
35 otters (NMFS 2011b). Causes have been determined for 25 of the UMEs, and include infections,
36 biotoxins (particularly domoic acid and brevetoxin), human interactions, and malnutrition. The
37 cause of the UME in Alaska is undetermined (NMFS 2011b). Invasive species could affect some
38 marine mammals by disrupting local ecosystems and fisheries of the area of Cook Inlet. For
39 example, introduced northern pike (*Esox lucius*) consume salmon, trout, and whitefish, affecting
40 total populations of these prey species where pike become established. The potential
41 introductions of other invasive species of concern, such as the Chinese mitten crab (*Eriocheir*
42 *sinensis*), which could eat and/or out compete native invertebrate species, could adversely affect
43 natural communities (McClory and Gotthardt 2008). These and other invasive species could
44 affect the prey base for some marine mammals. As climate change continues to warm Alaskan
45 waters, Alaska may become more susceptible to invasive species (McClory and Gotthardt 2008).
46

1 **Accidents.** Marine mammals could be exposed to oil accidentally released from
2 platforms, pipelines, and vessels in each of the areas offshore Alaska included in the proposed
3 Program (Table 4.4.2-1). Non-OCS sources of oil in Cook Inlet may include the domestic
4 transportation of oil, State oil and gas development, and natural sources such as seeps.
5 Accidental oil releases from OCS activities and other sources could expose marine mammals to
6 oil by body contact or through the inhalation or ingestion of oil or tar deposits. Indirect effects
7 may occur as a result of loss or displacement of prey resources or habitat loss resulting from oil.
8 The magnitude and duration of exposure will be a function of the location, timing, duration, and
9 size of the spill; the proximity of the spill to feeding and other important habitats; the timing and
10 nature of spill containment; and the status of the affected animals.

11
12 It is anticipated that most of the small to medium spills would have limited effects on
13 marine mammals due to the relatively small areas likely to incur high concentrations of
14 hydrocarbons and the short period of time during which potentially toxic concentrations would
15 be present. The magnitude of impact would be expected to increase should a spill occur in
16 habitats important to marine mammals or affect a number of individuals from a population listed
17 under the ESA, and, as such, a significant spill would have a high probability of producing
18 significant, population-level cumulative impacts on Cook Inlet beluga whales.

19
20 **Conclusion.** Cumulative impacts on marine mammals in the Cook Inlet Planning Area as
21 a result of future OCS program and ongoing and future non-OCS program activities could be
22 minor to moderate over the next 40 to 50 yr. Non-OCS program activities or phenomena include
23 climate change, natural catastrophes, contaminant releases, vessel traffic, commercial fishing,
24 subsistence harvests, and invasive species. The incremental contribution of routine Program
25 activities to these impacts would be small (see Section 4.4.7.1.2).

26
27 Marine mammals may also be adversely affected by exposure to oil that is accidentally
28 released from OCS and non-OCS activities as well as naturally occurring seeps. The cumulative
29 impacts of past, present, and future oil spills on marine mammals would be minor to moderate.
30 The incremental impacts of accidental spills associated with the proposed action on marine
31 mammals would be small to large, depending on the location, timing, duration, and size of the
32 spill; the proximity of the spill to feeding and other important habitats; the timing and nature of
33 spill containment; and the status of the affected animals (see Section 4.4.7.1.2).

34
35 **Terrestrial Mammals.** Terrestrial mammals and their habitats could be affected by a
36 variety of activities associated with the proposed OCS actions (Section 4.4.7.1.2). These
37 activities include the construction and operation of onshore pipelines and aircraft traffic. Impacts
38 on terrestrial mammals may include physical injury or death; behavioral disturbances; lethal or
39 sublethal toxic effects; and loss of reproductive, nursery, feeding, and resting habitats. There are
40 currently no ongoing OCS activities in the Cook Inlet; thus all OCS development and any
41 associated impacts on terrestrial wildlife in the Cook Inlet Planning Area would result from the
42 proposed action and future actions.

43
44 Impacts from OCS pipeline construction and operation could include the injury or death
45 of smaller mammals (such as mice and voles) and the disturbance and displacement of
46 individuals or groups of larger species (such as deer and bear). Individuals most affected by

1 these impacts would be those in the immediate vicinity of the pipeline. Because of the limited
2 areal extent of new facilities under the proposed action, disturbance (primarily behavioral in
3 nature) of most of these species during construction would be largely temporary, and no long-
4 term population-level effects would be expected. However, careful siting of pipelines to avoid
5 important habitats could minimize the potential impacts.
6

7 Under the proposed action, vehicle traffic associated with normal construction, operation,
8 and maintenance of the onshore pipelines could disturb wildlife. Vehicle traffic could disturb
9 wildlife foraging along pipelines or access roads, causing affected wildlife to temporarily stop
10 normal activities (e.g., foraging, resting) or leave the area, while collision with vehicles could
11 injure or kill some individuals. Because vehicle traffic would be infrequent, vehicle-related
12 impacts associated with the proposed action would be minimal. In the Cook Inlet, vehicle traffic
13 along any new access roads would be very light and infrequent and, thus, not expected to affect
14 more than a few individuals or result in population-level impacts on wildlife.
15

16 In the Cook Inlet area, terrestrial mammals are mostly habituated to aircraft due to year-
17 round military and civilian aircraft operations. Only up to three weekly helicopter trips are
18 projected in the Cook Inlet Planning Area under the proposed action. Impacts on terrestrial
19 mammals from helicopter overflights would be behavioral in nature, primarily resulting in short-
20 term disturbance in normal activities, and would not result in population-level effects.
21

22 Terrestrial mammals could also be affected by a number of non-OCS activities, including
23 oil and gas exploration and development in State waters, and coastal and community
24 development. Many of the effects of these activities on terrestrial mammals would be similar in
25 nature to those resulting from OCS-related activities, namely behavioral disturbance, habitat
26 disturbance, and injury or mortality. The State of Alaska has made leases of State waters
27 available along the northern portion of Cook Inlet (above Homer) since the 1950s. Impacts on
28 terrestrial mammals that could result with oil and gas lease sales in State waters may exceed
29 potential impacts that could occur under the OCS proposed action because of the greater extent
30 of offshore and onshore development. In addition, much of the infrastructure is over 40 yr old,
31 and many of the pipes are aging and corroded (NMFS 2008c). Terrestrial mammals may be
32 affected as a result of coastal and community development. Such development may result in the
33 loss of habitat and the permanent displacement of some species from the developing areas.
34 Implementation of the proposed action could increase coastal and community development,
35 indirectly adding to impacts on terrestrial mammals and their habitats.
36

37 Terrestrial wildlife could be adversely affected by the accidental release of oil from an
38 onshore pipeline, or by offshore spills contacting beaches and shorelines utilized by terrestrial
39 mammals (such as Sitka black-tailed deer or brown bear). Impacts on terrestrial mammals from
40 an oil spill would depend on such factors as the time of year, volume of the spill, type and extent
41 of habitat affected, food resources used by the species, and home range or density of the wildlife
42 species. Spills contacting high-use areas could locally affect a relatively large number of
43 animals. It is anticipated that most of the spills would have limited effects on terrestrial
44 mammals, due to the relatively small, mostly offshore, areas likely to be directly exposed to the
45 spills and due to the small number and size of spills projected for the proposed action and for any
46 future OCS oil and gas developments.

1 State oil and gas development poses a major potential for accidental oil releases in the
2 Cook Inlet Planning Area. Because of the much greater level of oil and gas development in State
3 waters and the aging infrastructure associated with many of these developments, accidental spills
4 associated with the proposed OCS action could contribute relatively little to the overall potential
5 exposure of terrestrial mammals to accidental oil releases in Cook Inlet.
6

7 **Conclusion.** Cumulative impacts on terrestrial mammals in the Cook Inlet Planning Area
8 as a result of future OCS program and ongoing and future non-OCS activities could be minor to
9 moderate over the next 40 to 50 yr. Non-OCS activities or phenomena that may affect
10 populations of terrestrial mammals include climate change, natural catastrophes, contaminant
11 releases, and vehicle traffic. The incremental contribution of routine Program activities to these
12 impacts would be small (see Section 4.4.7.1.2).
13

14 Terrestrial mammals may also be adversely affected by exposure to oil that is
15 accidentally released from OCS and non-OCS operations. The cumulative impacts of past,
16 present, and future oil spills on terrestrial mammals would be minor to moderate. The
17 incremental impacts of accidental spills associated with the proposed action on terrestrial
18 mammals would be small to large, depending on the location, timing, duration, and size of the
19 spill; the proximity of the spill to feeding and other important habitats; the timing and nature of
20 spill containment; and the status of the affected animals (see Section 4.4.7.1.2).
21
22

23 **4.6.4.2.2 Marine and Coastal Birds.** Section 4.4.7.2.2 discusses impacts on marine and
24 coastal birds in Cook Inlet resulting from the proposed action (OCS program activities from
25 2012 to 2017). Cumulative impacts on marine and coastal birds result from the incremental
26 impacts of the proposed action when added to impacts from existing and reasonably foreseeable
27 future OCS program activities (that are not part of the proposed action) and other non-OCS
28 program activities. Table 4.6.1-2 presents the exploration and development scenario for the
29 Cook Inlet cumulative case (encompassing the proposed action and other OCS program
30 activities) over the next 40 yr. A number of OCS program activities could affect Cook Inlet
31 marine or terrestrial birds or their habitats; these include offshore exploration, construction of
32 offshore platforms and pipelines, construction of onshore pipeline landfalls and pipelines,
33 operations of offshore and onshore facilities, and OCS-related marine vessel and aircraft traffic.
34 Potential impacts on marine and coastal birds from OCS program activities include injury or
35 mortality from collisions with platforms, vessels, and aircraft; lethal and sublethal exposure to
36 operational discharges; injury or mortality from the ingestion of trash or debris from OCS vessels
37 and platforms; loss or degradation of habitat due to construction; and behavioral disturbance due
38 to the presence of, and noise generated by, equipment and human activity.
39

40 Non-OCS program activities affecting marine and coastal birds in Cook Inlet (both inside
41 and outside of the Planning Area proper) include dredging and marine disposal; coastal and
42 community development; onshore and offshore construction and operations of facilities
43 associated with State oil and gas development and other industrial complexes (e.g., at Nikiski);
44 commercial and recreational boating; and small aircraft traffic. Potential impacts on marine and
45 coastal birds from these activities are similar to those under the OCS program and include injury
46 or mortality of birds from collisions with platforms associated with State oil and gas

1 development and other onshore and offshore structures (e.g., radio, television, or cell phone
2 towers), onshore industrial, commercial, and residential development; exposure to discharges
3 from permitted point sources such as sewage treatment discharges and nonpoint sources such as
4 urban runoff, or accidental releases (e.g., oil spills), as described in Section 4.6.2.1.2 and
5 Table 4.6.2-3; exposure to emissions from various onshore and offshore sources (e.g., power
6 generating stations, refineries, and marine vessels), as described in Section 4.6.2.1.2; ingestion of
7 trash or debris; loss or degradation of habitat due to construction and operations activities; and
8 behavioral disturbance due to the presence of, and noise generated by, equipment and human
9 activity. Other trends such as extensive melting of glaciers (and increasing river discharges) and
10 increased precipitation brought on by global climate change are also expected to adversely affect
11 marine and coastal birds over the next 40 yr.

12

13 **Injury or Mortality from Collisions.** Under the cumulative scenario, annual collision
14 injury or mortality in Cook Inlet could increase in the near term as platforms are built under the
15 proposed action. Such impacts would be minor relative to those that currently involve non-OCS
16 structures. Over time, the injury or mortality impacts from collisions could decrease as oil and
17 gas production in the inlet declines.

18

19 **Exposure to Wastewater Discharges and Air Emissions.** The discharge of operational
20 wastes and air emissions from current non-OCS related vessel traffic and platform operations in
21 Cook Inlet is strongly regulated and would continue to be so regulated over the next 40 yr.
22 However, such wastes and emissions would still expose marine and coastal birds to potentially
23 toxic materials or to solid debris that could be ingested or result in entanglement. These facilities
24 and activities include sewage treatment plants, industrial manufacturing or processing facilities,
25 electric generating plants, dredging and marine disposal, and vessel traffic (e.g., cargo and tanker
26 ships, cruise ships, commercial fishing vessels, and recreational vessels). Operational
27 wastewater discharges and air emissions associated with the proposed action would contribute to
28 the overall cumulative risk of toxic exposure and debris ingestion or entanglement of existing
29 non-OCS wastewater discharges and air emissions in the inlet, but the incremental increase in
30 impact is expected to be small relative to these other activities.

31

32 Under the proposed action, marine and coastal birds could be exposed to oil accidentally
33 released from platforms, pipelines, and vessels, and would be most susceptible to adverse
34 impacts from spills occurring in coastal areas and affecting feeding and nesting areas. Most of
35 the oil released to Cook Inlet is from commercial and recreational vessels (Section 4.6.2.2.1).
36 Oil releases from all sources may expose marine and coastal birds via direct contact or through
37 the inhalation or ingestion of oil or tar deposits (see Section 4.4.7.2.1).

38

39 Marine and coastal birds may become entangled in, or ingest, floating, submerged, and
40 beached debris (Heneman and the Center for Environmental Education 1988; Ryan 1987, 1990).
41 Entanglement may result in strangulation, injury or loss of limbs, entrapment, or the prevention
42 or hindrance of the ability to fly or swim; all of these effects may be considered lethal. Ingestion
43 of debris may irritate, block, or perforate the digestive tract, suppress appetite, impair digestion
44 of food, reduce growth, or release toxic chemicals (Fry et al. 1985; Dickerman and Goelet 1987;
45 Ryan 1988; Derraik 2002). Because the discharge or disposal of solid debris into offshore waters
46 from OCS structures and vessels is prohibited by BOEM (30 CFR 250.40) and the USCG

1 (MARPOL, Annex V, Public Law 100 220 [101 Statute 1458]), entanglement in or ingestion of
2 OCS-related trash and debris by marine and coastal birds would not be expected under normal
3 operations.

4
5 **Oil Spills and Cleanup Activities.** Oil spills under the cumulative scenario are shown in
6 Table 4.6.1-3. No more than one large spill (between 1,000 and 5,300 bbl from either a platform
7 or a pipeline) and 18 small spills (less than 1,000 bbl) would be expected as a result of the Cook
8 Inlet Planning Area OCS program over the next 40 yr. Previous modeling of similar-sized oil
9 spills in Cook Inlet indicates that land segments with the highest chance of contact with an
10 offshore platform or pipeline spill are generally along the western shore of lower Cook Inlet in
11 Kamishak Bay and Shelikof Strait (MMS 2002b). A large number of seabird colonies occur in
12 these areas (USGS undated) and could be affected by oil spills reaching these areas.

13
14 Nesting and brood-rearing seabirds, waterfowl, and a few shorebirds, as well as the many
15 species of waterfowl/loons, seabirds, and shorebirds that molt, stage, migrate through, or
16 overwinter in large numbers in south central Alaska would be vulnerable to the potential
17 disturbance resulting from elevated vessel and aircraft activity associated with cleanup of an oil
18 spill. For all species, the degree of impact depends heavily on the location of the spill and
19 cleanup response and its timing with critical natural behaviors (e.g., breeding, molting, feeding).
20 Survival and fitness of individuals may be affected, but this infrequent disturbance is not
21 expected to result in significant population losses.

22
23 As a result of response to the *EVOS* of 1989, and subsequent study of its effect on
24 regional bird populations, there exists an extensive literature concerning the effects of a large oil
25 spill in the South Alaska region (e.g., Agler and Kendall 1997; Boersma et al. 1995;
26 Day et al. 1997a,b; *EVOS* Trustee Council 2004; Irons et al. 2000; Klowsiewski and Laing 1994;
27 Lanctot et al. 1999; Murphy et al. 1997; Piatt and Ford 1996; Piatt et al. 1990; Rosenberg and
28 Petrula 1998; van Vliet and McAllister 1994; Wiens et al. 2001). An estimated 100,000 to
29 300,000 marine birds died as a result of this spill (Piatt and Ford 1996), which occurred in
30 March, when substantial numbers of overwintering birds were present in Prince William Sound
31 and downstream to the west, and large numbers of seabirds were aggregating near colonies from
32 Prince William Sound to the western Gulf of Alaska, prior to the breeding season. Although
33 surveys and other studies carried out every year since the spill occurred indicate that populations
34 of some marine bird species have recovered from their initial losses (e.g., common murre, black
35 oystercatcher [*EVOS* Trustee Council 2004]), or are recovering (e.g., marbled murrelet), several
36 species have shown little or no recovery (e.g., common loon, three cormorant species, harlequin
37 duck, pigeon guillemot) or the recovery status is unknown (Kittlitz's murrelet). Although the
38 effect on a bird population that is observed immediately following a spill to have suffered a large
39 mortality is quite obvious, without frequent monitoring of each species following a spill it
40 usually is difficult to be certain whether changes in measured population parameters are the
41 result of lingering spill effects or natural variations that generally occur in all populations over
42 time (Wiens and Parker 1995; Wiens 1996; Wiens et al. 2001). For example, forage fish
43 populations utilized by many marine bird species may have experienced lingering spill effects of
44 severe mortality or interruption of the annual cycle, in turn affecting food availability following
45 the spill and thus influencing the effect of the spill on these bird populations or their recovery
46 from it.

1 In addition to the birds occupying the open water of bays and inlets, shorebirds
2 numbering in the tens to hundreds of thousands are at risk of oiling where they occupy various
3 shore habitats during their spring passage to northern breeding areas (Gill and Tibbitts 1999).
4 Particularly large numbers would be at risk on the southern Redoubt Bay, Fox River Delta,
5 northern Montague Island, Kachemak Bay, and Copper River Delta, but substantial numbers
6 may be at risk along most shorelines of the region during this season (Gill et al. 1994; Gill and
7 Senner 1996; Gill and Tibbitts 1999; Alaska Shorebird Working Group 2000). Based on the
8 experience of the *Exxon Valdez* oil spill, where studies extending 15 yr after the event continue
9 to find oil or effects on organisms from exposure to oil, it is highly probable that not all oil
10 spilled would be removed from the environment. Because substantial numbers of birds are
11 present year round in the marine environment of south central Alaska, major effects are expected
12 to result from a spill at any time of year.

13
14 **Loss or Degradation of Habitat.** Marine and coastal birds could be affected by
15 platform construction and removal activities, and pipeline trenching, which could disrupt
16 behaviors of nearby birds. Platforms constructed under the proposed action would increase the
17 number of offshore platforms present in the inlet by three, and up to 241 km (150 mi) of new
18 offshore pipeline could be constructed. Platform emplacement could disturb birds temporarily;
19 pipeline trenching may also affect birds in nearshore coastal habitats if it occurs in or near
20 foraging, overwintering, or staging areas, or near seabird colonies. About 169 km (105 mi) of
21 new pipeline and one pipeline landfall may be constructed under the proposed action. The
22 pipelines would likely result in the short- and/or long-term disturbance of a small amount of
23 habitat along the pipeline routes.

24
25 While habitat impacts from the construction and operations of onshore facilities could be
26 long term in nature, the areas disturbed would be largely limited to the immediate vicinity of the
27 pipelines and represent a very small portion of habitat available in the Cook Inlet Planning Area.
28 Siting new pipelines and facilities away from coastal areas would reduce the amount of marine
29 or coastal bird habitat that could be affected. Potential habitat impacts could be further reduced
30 by locating the new pipelines within existing utility or transportation rights-of-way, and by
31 locating the new pipeline landfalls away from active colony sites or coastal staging areas of
32 migratory birds. Because there are relatively few nesting colonies in Cook Inlet of Anchor Point
33 (USGS undated), only a few seabird colonies could be affected by onshore construction activities
34 in this area. The disturbance of birds in these colonies could be reduced or avoided by siting
35 new pipelines and facilities away from colony sites, and by scheduling construction activities to
36 avoid nesting periods. Overall, onshore construction activities are expected to affect only a
37 relatively small number of birds and not result in population-level effects.

38
39 Only small numbers of nesting birds are likely to be displaced away from the vicinity of
40 onshore pipeline corridors (a few hundred meters) by construction activity and support vessel
41 traffic in the Cook Inlet Planning Area. Onshore habitat alteration is likely to be relatively minor
42 in most of the development support centers. Offshore, disturbance of bottom habitats by
43 platform placement may disrupt small areas of potential diving duck and seabird foraging
44 habitat, but these small removals would be inconsequential.

1 Construction of landfalls, onshore pads, and roads is not expected to affect the relatively
2 low numbers of loons, waterfowl, and shorebirds nesting in south central Alaska adjacent to
3 likely oil development areas, particularly because construction may take place mainly during the
4 winter season. Like loons and waterfowl that do not migrate out of State, seabirds disperse into
5 nearshore or offshore waters in winter, away from likely development activity.
6

7 **Disturbance Due to Noise.** Noise and human activities (such as normal maintenance)
8 could disturb birds arriving in the area during spring migration and later in the year during
9 nesting, fall molting, and staging periods, causing them to avoid the area and nearby habitats.
10 Because of the small number of new platforms (no more than three), the disturbance of birds in
11 offshore waters by operational noise and human activity would likely be limited to the
12 individuals that might be present around a platform. Potential impacts on colonies could be
13 avoided or mitigated by siting platforms and onshore facilities away from colony sites. Noise
14 from air guns and disturbance from survey vessel traffic could displace foraging seabirds in
15 offshore waters, especially if exploration occurs in high seabird density areas such as the open
16 waters adjacent to the Stevenson and Kennedy Entrances to Cook Inlet and off of the
17 northwestern coast of Kodiak Island (MMS 2003b).
18

19 Nesting, staging, migrant, or overwintering loons, waterfowl, and seabirds occurring in
20 areas closer to primary Cook Inlet support facilities on the Kenai Peninsula and vicinity, for
21 example, are more likely to be overflown by aircraft than those in more distant lease areas. This
22 is due to the convergence of routes from offshore sites to the support area, and is expected to be
23 the case in the Gulf of Alaska, Kodiak Island, and Alaska Peninsula areas, where there are few
24 communities capable of adequate support activity. Effects from noise disturbance would be
25 greater in areas where higher concentrations of birds occurred and less where birds were more
26 dispersed and in fewer numbers. The degree of effect is also dependent on whether birds are
27 engaged in critical aspects of their seasonal activity, as well as the intensity and type of
28 disturbance (aircraft overflights, seismic surveys, vessel traffic). In addition, several open-water
29 areas in the vicinity of Kachemak and Kamishak Bays represent important wintering areas
30 (December–April) for the threatened Steller eider (USFWS unpublished data), and disturbance
31 during the winter in these areas has a greater potential to affect this listed species.
32

33 **Effects on ESA-Listed Species in South Central Alaska.** The cumulative effects of
34 OCS and non-OCS program activities on the endangered short-tailed albatross, threatened
35 Steller's eider, formerly threatened Aleutian Canada goose, and proposed Kittlitz's murrelet are
36 expected to be similar to those noted for nonlisted species over the next 40 yr. Continued
37 compliance with ESA regulations and coordination with the USFWS would ensure that lease-
38 specific OCS operations would be conducted in a manner likely to avoid or greatly minimize the
39 potential for affecting these species.
40

41 Short-tailed albatrosses occur in waters of south central Alaska, and particularly in
42 continental shelf waters, which places them at considerable oil-spill risk. Although their small
43 population is spread throughout the North Pacific Ocean and few would be expected to be
44 present during any given oil-spill event, the species has a high oil vulnerability index (King and
45 Sanger 1979), and the loss of a few individuals could be detrimental to their small population
46 size (MM 2003b). Because Aleutian Canada geese are not known to occupy marine waters

1 during migration to any great extent, their risk of oil-spill contact in that habitat is considered
2 low. It is unlikely that infrastructure development would occur near the two nesting areas, thus
3 avoiding disturbance and onshore spills that could contact the species.
4

5 Factors such as disturbance due to increased boat traffic related to wildlife cruises and
6 offshore oil and gas development, impacts related to oil spills, and a high oil vulnerability index
7 (King and Sanger 1979) make the Kittlitz's murrelet particularly vulnerable to population
8 declines. Although impacts of oil spills have been documented (van Vliet and McAllister 1994;
9 Carter and Kuletz 1995), little is known about potential impacts of disturbance on courtship
10 behavior, foraging ecology and feeding, or energetics (Day et al. 1999). The relatively small
11 population size, limited distribution, apparent periodic breeding failures and low reproductive
12 potential (Beissinger 1995), in conjunction with the above factors, has led to Kittlitz's status as a
13 candidate species (priority 5; 50 CFR 17) under the ESA.
14

15 Steller's eiders occupying nearshore areas of the eastern Aleutian Islands to Cook Inlet
16 from late fall to early spring could be exposed to the disturbance of air and vessel traffic, seismic
17 surveys, oil-spill cleanup, and pipeline construction. Such activities would be scattered in
18 occurrence, as are the flocks of eiders, or confined to specific corridors in the case of aircraft and
19 vessels, which the flocks are likely to avoid. In general, interactions are expected to result in
20 short-term and localized displacement. Pipeline construction is expected to result in the loss of a
21 small amount of eider nearshore bottom-feeding habitat. Steller's eiders could be killed or
22 injured as a result of collisions with platforms. This is most likely during migration; when visual
23 conditions are reduced, such as in foggy weather; and during movement among habitats on
24 wintering grounds. Because they typically are present throughout the winter, they are at risk of
25 oil-spill contact, particularly in the northern portion of the region including Cook Inlet, where
26 development may first occur, and potentially in the Kodiak Archipelago. However, mortality
27 from a spill is difficult to estimate because of the substantial variation in between-year, seasonal,
28 or even weekly presence and distribution of eiders and uncertainties of where an oil spill might
29 occur. Based on USFWS assumptions, there is greater potential for the majority of individuals
30 affected by factors discussed above to be from the Russian breeding population rather than the
31 ESA-listed Alaska breeding population.
32

33 Kittlitz's murrelets typically show a very patchy distribution and are generally found in
34 the vicinity of glaciated fjords of Cook Inlet, Prince William Sound, and southeast Alaska
35 (Kendall and Agler 1998; Dat et al. 1999; Kuletz et al. 2003a). Exploration and development
36 activities are expected to be separated in time, so exposure to disturbing factors such as aircraft
37 and vessel traffic, seismic surveys, and pipeline construction could be infrequent and localized in
38 areas where this species concentrates. There is a greater potential for effects if disturbance
39 occurs in areas where murrelets concentrate and displacement becomes a possibility. In addition,
40 the potential impacts from oil spills vary depending on the timing and location of the spill. For
41 example, oil spills in College or Harrison Fjords during peak breeding or post-breeding would
42 have larger impacts and could cause population-level effects, especially if birds come in contact
43 with spilled oil or larger numbers of breeding age females are impacted. A large spill is likely to
44 spread over a sufficiently large area to contact one or more bays where they may be concentrated
45 during the summer breeding season, or offshore areas where they may be wintering in the Gulf
46 of Alaska. For example, the *EVOS* spill resulted in the loss of an estimated 500 to

1 1,000 individuals, probably a substantial proportion of the world population, and certainly a
2 major effect on this species.

3
4 **Conclusion.** Marine and coastal birds in Cook Inlet, including those that are ESA-listed,
5 could be adversely affected by activities associated with the proposed action, as well as those
6 associated with future OCS and non-OCS program activities. Potential impacts include injury or
7 mortality of birds from collisions with platforms associated with OCS and State oil and gas
8 development and other onshore and offshore structures (e.g., radio, television, or cell phone
9 towers), onshore industrial, commercial, and residential development; exposure to discharges
10 from permitted point sources such as sewage treatment discharges and nonpoint sources such as
11 urban runoff, or accidental releases (e.g., oil spills); exposure to emissions from various onshore
12 and offshore sources; ingestion of trash or debris; loss or degradation of habitat due to
13 construction and operations activities; and behavioral disturbance due to the presence of, and
14 noise generated by, equipment and human activity. Other trends such as extensive melting of
15 glaciers (and increasing river discharges) and increased precipitation brought on by global
16 climate change are also expected to adversely affect marine and coastal birds over the next 40 to
17 50 yr. While the cumulative impact of all OCS and non-OCS activities in Cook Inlet could be
18 minor to moderate, the incremental impact due to routine Program activities would be small
19 (see Section 4.4.7.2.2). Compliance with ESA regulations and coordination with the USFWS
20 would ensure that lease-specific OCS operations would be conducted in a manner that is likely to
21 avoid or to greatly minimize the potential for affecting these species.

22
23 Marine and coastal birds may also be adversely affected by exposure to oil (via direct
24 contact or through the inhalation or ingestion of oil or tar deposits) that is accidentally released
25 from OCS and non-OCS activities, especially near coastal areas and affecting feeding and
26 nesting areas. The incremental impacts of accidental spills associated with the proposed action
27 on marine and coastal birds would be small to large, depending on the location, timing, duration,
28 and size of the spill; the proximity of the spill to feeding and nesting areas; the timing and nature
29 of spill containment; and the status of the affected birds (see Section 4.4.7.2.2).

30
31 Whether net cumulative impacts are minor or moderate depends on the nature and
32 duration of activities that reduce bird survival and productivity. Losses would be limited in areas
33 occupied by scattered flocks during relatively brief staging and migration periods or scattered
34 nest sites during the brief nesting season; however, in cases for which exposure to localized
35 disturbance is greater, impacts have the potential to rise to the population level.

36
37
38 **4.6.4.2.3 Fish.** This section evaluates the cumulative effects of the proposed action,
39 future OCS activities, and non-OCS activities on populations of fishes in Cook Inlet that could
40 occur during the life of the Program. The primary routine OCS activities in the Cook Inlet
41 Planning Area that could result in impacts on fish include seismic surveys, drilling, platform and
42 pipeline placement; releases of permitted discharges from wells; and removal of existing
43 structures. Potential environmental impacts associated with the building and operation of OCS
44 facilities such as platforms and pipelines would increase in conjunction with the increased
45 number of wells. The impacts of routine activities (exploration and site development,
46 production, and decommissioning) on fish communities are discussed in detail in

1 Section 4.4.7.3.2. Overall, routine activities represent up to a minor disturbance, primarily
2 affecting demersal fishes, with the severity of the impacts generally decreasing dramatically with
3 distance from bottom-disturbing activities.
4

5 In the Cook Inlet Planning Area, up to three platforms would be constructed, all of which
6 would result from the proposed action. The addition of new platforms may act as FADs that
7 would attract rockfish and cod-like fishes in Cook Inlet. While some platforms may be allowed
8 to remain as artificial reefs, removal of platforms would reduce available substrate and structures
9 for these fish and some of their prey species. Some fish would be killed in the process of these
10 platform removals although the chance of mortality would be greatly reduced by the fact that
11 explosives would not be used in removal.
12

13 Oil and gas exploration and development in State waters could also contribute to
14 cumulative effects on fishery resources in the Cook Inlet. Drilling of wells in State waters could
15 also require construction of platforms and pipelines in waters of Alaska. The effects on fish
16 would be similar to those described above for OCS oil and gas programs (Section 4.4.7.3.2).
17 Other non-OCS activities that could impact fish communities include land use practices, point
18 and non-point source pollution, logging, dredging and disposal of dredging spoils in OCS waters,
19 anchoring, and commercial or sportfishing activities, and commercial shipping (including
20 imported oil). Many of these activities would result in bottom disturbance that would affect
21 bottom-dwelling fishes as well as their food sources in a manner similar to those described for
22 OCS activities (Section 4.4.7.3.2).
23

24 Logging could also degrade riverine habitats that are important reproductive and juvenile
25 habitat for migratory fish species. Erosion from areas undergoing commercial logging could
26 increase the silt load in streams and rivers, which could reduce levels of invertebrate prey species
27 and adversely affect spawning success and egg survival. The introduction of fine sediments into
28 spawning gravels may render these habitats unsuitable for salmon spawning. Logging could also
29 remove riparian canopies along some streams, which could increase solar heating of freshwater
30 habitats. Downed timber could physically block salmon migrations. Because of past damage
31 inflicted by commercial logging, improved forestry practices have been initiated, and timber
32 harvests have been curtailed. Continued implementation of effective forest management
33 techniques should help mitigate the adverse effects of logging in the future. Cumulative impacts
34 on migratory species could also occur as a result of activities that obstruct fish movement in
35 marine environments during migration periods.
36

37 Commercial fishing practices that are indiscriminate, such as trawling and pots, are
38 responsible for significant amounts of bycatch that can injure or kill juveniles of many fish
39 species (Cooke and Cowx 2006). These types of fishing practices could damage future year
40 classes, reduce available prey species, and damage benthic habitat for many Cook Inlet fish
41 resources. A wide variety of methods are used to target numerous species of fishes and
42 shellfishes, including longlines, seines, setnets, trawls, and traps. Some fisheries target particular
43 fish species returning to their natal stream or river, while other fisheries take place in pelagic
44 waters and target mixed stocks of fishes or shellfishes.
45

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5 methods are used to target numerous species of fishes and shellfishes, including long lines,
6 seines, setnets, trawls, and traps. Some fisheries target particular fish species returning to their
7 natal stream or river, while other fisheries take place in pelagic waters and target mixed stocks of
8 fishes or shellfishes.

9
10 As a consequence of the pressure commercial fishing places on fishery resources,
11 appropriate management is required to reduce the potential for depletion of stocks due to
12 overharvesting. Fisheries in the Cook Inlet Planning Area are managed by State (Alaska
13 Department of Fish and Game) and Federal (North Pacific Fishery Management Council of the
14 National Marine Fisheries Service) agencies. Even with management, the possibility of
15 overfishing still exists. Occasionally fisheries are closed when stocks are considered insufficient
16 to support harvesting, and will sometimes remain closed for multiple seasons before stocks are
17 deemed sufficient.

18
19 Although the magnitude of harvests is considerably smaller than for commercial fisheries
20 (Fall et al. 2009), sportfishing also contributes to cumulative effects on the abundance of some
21 fishery resources. Recreational fisheries have a potential to result in overharvest of managed
22 species over the life of the Program. Recreational fishing is subject to harvest limits that reduce
23 the potential for overfishing and recreational fishing methods are less destructive of EFH
24 compared to commercial fisheries.

25
26 Subsistence fishing may also contribute to the cumulative effects on the abundance of
27 some fishery resources. Alaska State law defines subsistence as the “noncommercial customary
28 and traditional uses” of fish and wildlife. Subsistence fishing is subject to harvest limits that
29 reduce the potential for overfishing. Also, much of Cook Inlet is defined as a nonsubsistence
30 area and subsistence fishing is therefore not authorized. Consequently, subsistence fishing
31 makes a relatively minor contribution to the reduction in fish stocks compared to commercial
32 fishing (Fall et al. 2009).

33
34 Another source of cumulative impacts to fishery resources is the “personal use” fishery
35 which is a legally defined as “the taking, fishing for, or possession of finfish, shellfish, or other
36 fishery resources, by Alaska residents for personal use and not for sale or barter, with gill or dip
37 net, seine, fish wheel, long line, or other means defined by the Board of Fisheries.” In the Cook
38 Inlet Planning Area, there are personal use fisheries for salmon, herring, and eulachon. Personal
39 use fisheries are subject to harvest limits that reduce the potential for overfishing. Like
40 subsistence fishing, the personal use fishery is a relatively minor contributor to the reduction in
41 fish stocks compared to commercial fishing.

42
43 Climate change may affect fish communities in the Cook Inlet Planning Area. Climate
44 would only be one of several factors that regulate fish abundance and distribution. Many fish
45 populations are already subject to stresses, and global climate change may aggravate the impacts
46 of ongoing and future commercial fishing and human use of the coastal zone. Fish respond

1 directly to climate fluctuations, as well as to changes in their biological environment including
2 predators, prey, species interactions, disease, and fishing pressure. Projected changes in
3 hydrology and water temperatures, salinity, and currents could affect the growth, survival,
4 reproduction, and spatial distribution of marine fish species and of the prey, competitors, and
5 predators that influence the dynamics of these species (Watson et al. 1998). Changes in primary
6 production levels in the ocean because of climate change may affect fish stock productivity.
7

8 Climate change could potentially affect large-scale ecological processes. Important
9 coastal habitats could be reduced or eliminated by rising sea levels and increased storm damage.
10 For species spawning in low-lying areas or the intertidal zone, or species using coastal estuaries
11 as nursery grounds, rising sea levels could eliminate spawning or juvenile habitat. Anadromous
12 fish and species using nearshore marshes are likely to be most affected. In addition, the current
13 trend of steadily increasing sea surface temperature may favor higher trophic-level fish by
14 increasing their local productivity or by promoting the expansion of large temperate predators
15 into Alaskan waters (Litzow 2006). The establishment of temperate species and non-native fish
16 introduced by human activities could come at the expense of native species, particularly forage
17 fish like herring and capelin. However, given the complexity and compensatory mechanisms of
18 the ecosystem, predictions about the indirect effects of climate change on specific fish species
19 are subject to great uncertainty.
20

21 Oil spills could result from OCS and non-OCS activities. The total number of oil spills
22 and the extent of affected areas would likely increase under the proposed action in conjunction
23 with increased levels of petroleum exploration and production (Table 4.6.2-3). Non-OCS
24 activities, such as oil and gas development in State waters, domestic transportation of oil or
25 refined petroleum products, and commercial shipping, may also result in accidental spills that
26 could potentially impact fish resources within the Cook Inlet Planning Area. While effects on
27 fishery resources would depend on the timing, location, and magnitude of specific oil spills, it is
28 anticipated that most small to medium spills that occur in OCS waters would have limited effects
29 on fishery resources due to the relatively small areas likely to be exposed to high concentrations
30 of hydrocarbons and the short period of time during which potentially toxic concentrations
31 would be present. Most adult fish in marine environments are highly mobile and may avoid high
32 concentrations of hydrocarbons, although they may be subject to sublethal exposures. However,
33 eggs and larvae as well as small obligate benthic species do not have the ability to avoid spills
34 and may therefore suffer lethal or sublethal effects. Oil from a catastrophic spill that reaches
35 shallower, nearshore areas of these planning areas has the potential to be of greatest significance
36 to fish communities. Impacts from such spills could result in long-term, population level impacts
37 on fish communities. The potential impacts of OCS oil spills on fish communities in Cook Inlet
38 are discussed in detail in Section 4.4.7.3.2.
39

40 Oil reaching salmon spawning areas, nursery areas, or migration routes has the greatest
41 potential to reduce salmon stocks. However, because of the limited area affected by oil spills
42 relative to the wide pelagic distribution and highly mobile migratory patterns of salmonids, it is
43 anticipated that most impacts would be limited to small fractions of exposed salmon populations.
44 Oil spills occurring at constrictions in migration routes would have an increased potential for
45 adversely affecting salmon. However, the weathering and dispersal of the spilled oil would limit
46 the length of time that an area would be affected. Pacific salmon are also able to detect and

1 avoid oil spills in marine waters (Weber et al. 1981), which would help to reduce the potential
2 for contact. Aggregations of salmon in marine waters typically consist of mixed stocks, so even
3 in the unlikely event of contact with an oil spill, it is anticipated that only a small fraction of any
4 unique spawning population would be adversely affected.

5
6 Adverse effects of oil spills on groundfishes of southern Alaska would also be a function
7 of spill magnitude, location, and timing. Adult groundfishes are primarily demersal and would
8 generally be subjected only to the insoluble oil and water-soluble fractions of oil that reach
9 deeper strata. Insoluble oil fractions would sink to the bottom and be distributed diffusely as tar
10 balls over a wide area, and would be unlikely to produce noticeable reductions in the overall
11 numbers of adult fishes. Egg and larval stages would be at a greater risk of exposure to oil spills
12 because spawning aggregations of many groundfish species (e.g., walleye pollock) produce
13 pelagic eggs that could come into contact with surface oil slicks. Herring are also potentially
14 susceptible to oil spills because they spawn in nearshore waters for protracted periods of time.

15
16 **Conclusion.** Cumulative impacts on fish communities in the Cook Inlet Planning Area
17 could result from OCS and non-OCS activities. Overall, routine OCS activities represent up to a
18 minor disturbance, with the severity of the impacts generally decreasing dramatically with
19 distance from bottom-disturbing activities. In addition to routine OCS activities, non-OCS
20 actions including oil and gas development in State waters, sediment dredging and disposal,
21 logging, anchoring, fishing/trawling, commercial shipping, and pollutant inputs from point and
22 non-point sources could also adversely affect fish populations. Many of these activities would
23 affect fish at various life stages as well as their food sources in a manner similar to OCS
24 activities. Fish could also be affected by the environmental changes predicted to result from
25 climate change. The proposed action is expected to contribute only a small increment to the
26 potential for overall cumulative effects on fish resources because of existing regulations, the
27 limited timeframe over which most individual activities would occur, and the small proportion of
28 available habitats that would be affected during a given period (see Section 4.4.7.3.2).
29 Therefore, it is anticipated that the cumulative effects of OCS and non-OCS activities on fish
30 species in the Cook Inlet Planning Areas would be similar to the effects of non-OCS activities
31 alone.

32
33 The magnitude and severity of potential effects to fish resources from oil spills would be
34 a function of the location, timing, duration, and size of spills; the proximity of spills to particular
35 fish habitats; and the timing and nature of spill containment and cleanup activities. Small spills,
36 whether from OCS or non-OCS sources, are unlikely to have overall population-level effects on
37 fish resources. However, oil from catastrophic spills that contacted shallow nearshore areas of
38 these planning areas has the potential to be of greatest significance to fish communities. Such
39 spills could result in long-term, population-level impacts on fish communities (see
40 Section 4.4.7.3.2).

41
42
43 **4.6.4.2.4 Invertebrates and Lower Trophic Levels.** This section evaluates the
44 cumulative effects of the proposed action, and any past, present, and reasonably foreseeable
45 future actions from OCS activities, and non-OCS activities on invertebrates in the Cook Inlet
46 Planning Area that could occur during the life of the Program. The primary routine OCS

1 activities that could result in impacts on invertebrates include seismic surveys, drilling, platform
2 and pipeline placement; releases of permitted discharges from wells; and removal of existing
3 structures. Potential environmental impacts associated with the building and operation of OCS
4 facilities such as platforms and pipelines would increase in conjunction with the increased
5 number of wells. The impacts of routine activities (exploration and site development, production
6 and decommissioning) on invertebrate communities are discussed in detail in Section 4.4.7.5.2.
7 Overall, routine activities represent up to a moderate disturbance, primarily affecting benthic
8 infaunal invertebrates, with the severity of the impacts generally decreasing dramatically with
9 distance from bottom-disturbing activities.

10
11 Up to three platforms could be constructed over the life of the Program, all of which
12 would result from the proposed action, would allow the colonization of invertebrates requiring
13 hard substrate. While some platforms may be allowed to remain as artificial reefs, removal of
14 platforms will reduce available substrate and structures for invertebrates and injure or kill them
15 during removal.

16
17 Oil and gas exploration and development in State waters could also contribute to
18 cumulative effects on invertebrates in the Cook Inlet Planning Area. Drilling of wells in State
19 waters could also require construction of platforms and pipelines in waters of Alaska. The
20 effects on invertebrates would be similar to those described above for OCS oil and gas programs
21 (Section 4.4.7.5.2). Other non-OCS activities that could impact invertebrate communities
22 include land use practices, point and non-point source pollution, logging, dredging and disposal
23 of dredging spoils in OCS waters, anchoring, commercial or sportfishing activities, and
24 commercial shipping (including shipping of imported oil). Many of these activities would affect
25 bottom-dwelling invertebrates at various life stages as well as their food sources in a manner
26 similar to OCS bottom-disturbing activities (Section 4.4.7.5.2). Other non-OCS activities
27 generating pollution and noise may contribute to general habitat degradation (Section 4.6.3.2.2).

28
29 Commercial fishing practices that are indiscriminate, such as trawling and pots, are
30 responsible for significant amounts of bycatch that can injure or kill juveniles of many
31 invertebrate species. These types of fishing practices could also damage benthic habitat for
32 many Cook Inlet invertebrate resources.

33
34 Physical and chemical changes to invertebrate habitat resulting from climate change
35 could alter the existing distribution, composition, and abundance of invertebrates in Cook Inlet,
36 since physical and chemical parameters are the primary influence on invertebrate communities.
37 For example, the increase in seawater temperature may facilitate a northward expansion of
38 subarctic and temperate invertebrate species. Rising seawater temperatures are also expected to
39 decrease winter ice extent and duration. Currently, ice formation primarily occurs on the western
40 side of Cook Inlet, and changes in benthic invertebrate community structure could result from
41 the reduction in ice scour. In addition, in heavily river influenced systems like Cook Inlet, the
42 predicted hydrologic alterations associated with climate change can rapidly alter existing
43 invertebrate communities in the water column and benthos if the new chemical conditions are not
44 within the physiological tolerance of the existing communities. Another significant source of
45 physiological stress is the expected increase in ocean acidification. Crustaceans, echinoderms,

1 foraminiferans, and mollusks could have greater difficulty in forming shells, which could result
2 in a reduction in their fitness, abundance, and distribution (Fabry et al. 2008).

3
4 Oil spills could result from OCS and non-OCS activities. The total number of oil spills
5 and the extent of affected areas would likely increase under the proposed action in conjunction
6 with increased levels of petroleum exploration and production (Table 4.6.1-3). Non-OCS
7 activities, such as oil and gas development in State waters, domestic transportation of oil or
8 refined petroleum products, and commercial shipping, may also result in accidental spills that
9 could potentially impact invertebrate resources within the Cook Inlet Planning Area. While
10 effects on invertebrate resources would depend on the timing, location, and magnitude of
11 specific oil spills, it is anticipated that most small to medium spills that occur in OCS waters
12 would have limited effects due to the relatively small areas likely to be exposed to high
13 concentrations of hydrocarbons and the short period of time during which potentially toxic
14 concentrations would be present. Large water column and benthic invertebrates are mobile and
15 therefore have the potential to avoid high concentrations of hydrocarbons although they may be
16 subject to sublethal exposures. However, zooplankton and infauna do not typically have the
17 ability to avoid spills and may therefore suffer lethal or sublethal effects. Oil from catastrophic
18 spills that reaches shallower, nearshore areas of the Cook Inlet Planning Area has the potential to
19 be of greatest significance to invertebrate communities. Impacts from such spills could result in
20 long-term, population-level impacts on intertidal invertebrate communities. The potential
21 impacts of OCS oil spills on invertebrate communities in Cook Inlet are discussed in detail in
22 Section 4.4.7.5.2.

23
24 Commercial shellfish stocks (such as tanner, snow, and red king crab) are unlikely to be
25 exposed to surface oil. Although soluble and insoluble hydrocarbon fractions could reach deeper
26 strata, these fractions would be distributed diffusely over wide areas and would likely not
27 constitute a threat to shellfish stocks. Pelagic crab larvae could be affected if a large surface oil
28 spill occurred during the spring spawning season. However, because the area affected by most
29 spills would be expected to be small relative to overall distributions of crab larvae, overall
30 population levels are unlikely to be noticeably affected.

31
32 **Conclusion.** Cumulative impacts on invertebrate communities in the Cook Inlet
33 Planning Area could result from OCS and non-OCS activities. Overall, routine activities
34 represent up to a moderate disturbance, primarily to benthic and near bottom invertebrates, with
35 the severity of the impacts generally decreasing dramatically with distance from bottom-
36 disturbing activities. Non-OCS actions including oil and gas development in State waters,
37 sediment dredging and disposal, logging, anchoring, fishing/trawling, commercial shipping, and
38 pollutant inputs from point and non-point sources could also adversely affect invertebrate
39 populations. Several major classes of invertebrates could also be affected by the environmental
40 changes predicted to result from climate change. The proposed action is expected to contribute
41 only a small increment to the potential for overall cumulative effects on invertebrate resources
42 because of existing regulations, the limited timeframe over which most individual activities
43 would occur, and the small proportion of available habitats that would be affected during a given
44 period (see Section 4.4.7.5.2). Therefore, it is anticipated that the cumulative effects of OCS and
45 non-OCS activities on invertebrates in the Cook Inlet Planning Areas would be similar to the
46 effects of non-OCS activities alone.

1 **4.6.4.2.5 Areas of Special Concern.** Section 4.4.8.2 identifies potential impacts that
2 could result from routine activities or accidents related to the proposed leasing program on areas
3 of special concern adjacent to and in the Cook Inlet Planning Area. In considering the potential
4 cumulative effects of OCS activities on these areas, the level of routine activities and the
5 potential for accidental spills under the proposed action must be considered with other past,
6 present, and reasonably foreseeable future actions that would occur during the 40-yr life of the
7 proposed program. Overall cumulative impacts on these areas of special concern in Cook Inlet
8 consider impacts from both OCS and non-OCS activities.
9

10 **National Park Service Lands.** As identified in Section 4.4.8.2, NPS lands are
11 potentially susceptible to cumulative impacts from activities related to OCS oil and gas
12 development as a consequence of the proposed 5-yr leasing program in Cook Inlet. The
13 potentially affected lands include the Lake Clark National Park and Preserve and the Katmai
14 National Park and Preserve and Aniakchak National Monument. Kenai Fjords National Park is
15 east of Cook Inlet on the GOA, but it could be affected by an oil spill associated with OCS
16 activities in Cook Inlet.
17

18 Impacts from routine OCS operations could come from facilities developed to support oil
19 drilling and production, and could include effects from pipeline landfalls, dredging, air pollution,
20 and the construction of roads and new facilities. Onshore oil facilities are permissible only on
21 private acreage within each national park. All of these national parks, monuments, and preserves
22 contain privately held acreage, and development of onshore oil support facilities is possible in
23 these areas. Because of the more confined nature of Cook Inlet, OCS construction of facilities
24 within the Cook Inlet Planning Area could have some negative effects on scenic values for some
25 users if the facilities were visible from shore or air during flightseeing. It is assumed that
26 pipeline landfalls, shore bases, and waste facilities would not be located in national parks,
27 because of the special status and protections afforded these areas.
28

29 Increased traffic (i.e., land, sea, and air) and development within the vicinity of NPS
30 lands could also contribute to cumulative impacts on these areas. Because the amount of traffic
31 is restricted and activities within the parks regulated, traffic would likely create a minor addition
32 to cumulative impacts on the NPS lands. It is anticipated that noise generated by OCS offshore
33 construction activities would be at low levels and intermittent, and would not persist for more
34 than a few months at any one time. It is considered unlikely that these additional activities
35 would noticeably affect wildlife or park user values compared to current (non-OCS) activities
36 within the considered planning areas. Increased traffic may also affect air quality
37 (see Section 4.4.4.2 and Section 4.6.2.1.2). Air quality in Alaska is expected to remain good,
38 with pollutant concentrations associated with offshore and onshore emission sources well within
39 applicable State and Federal standards. The contribution of OCS program activities to
40 cumulative air quality impacts would be small. Air quality impacts from oil spills and fires
41 would be localized and short in duration.
42

43 Impacts on these areas could occur due to accidental releases of oil spilled from onshore
44 facilities and offshore drilling rigs (Table 4.6.1-3). Non-OCS activities, such as oil and gas
45 development in State waters, the domestic transportation of oil or refined petroleum products
46 including LNG from Cook Inlet and the Alaska Peninsula, the production and storage of

1 petroleum products and LNG, and commercial shipping, could also result in accidental spills that
2 could affect park lands. In addition to affecting the National Parks mentioned above, oil spills
3 from tankering to and from Valdez could also affect Kenai Fjords NP and Wrangell St Elias
4 NPP. Naturally occurring seeps may also be a source of crude oil introduced into nearshore
5 waters (Kvenvolden and Cooper 2003). An oil spill would have the greatest effect if it came into
6 contact with shoreline habitats. Impacts would depend primarily on the spill location, size, and
7 time of year. In general, directly affected coastal fauna could include invertebrates; marine
8 mammals; fishes that reproduce in, inhabit, or migrate through coastal areas; terrestrial mammals
9 that feed on these fishes; and marsh birds and seabirds. Spilled oil could also affect subsistence
10 harvests in those parks in which subsistence hunting and fishing are allowed (see Section 4.6.5.2)
11 and could affect the number of park visitors.

12
13 **National Wildlife Refuges.** NWRs in the vicinity of Cook Inlet are identified in
14 Section 3.9.2.2. NWRs potentially affected by OCS activities in the Cook Inlet Planning Areas
15 include the Alaska Peninsula NWR, Becharof NWR, Kodiak NWR, Kenai NWR, and Izembek
16 NWR. These refuges could be contaminated by oil spilled from offshore projects or could be
17 subject to negative effects from routine operations associated with the development of onshore
18 oil and gas support facilities. They could also be affected by non-OCS activities within or
19 adjacent to refuges, including oil and gas development in State waters, the domestic
20 transportation of oil or refined petroleum products including LNG from Cook Inlet and the
21 Alaska Peninsula, the production and storage of petroleum products and LNG, and commercial
22 shipping. Numerous refuge lands have been conveyed to private owners and Native
23 corporations. Section 22(g) of ANCSA requires that new development on these lands must be in
24 accordance with the purpose for which the refuge was formed. Thus, while development of
25 onshore oil and gas support facilities is technically possible, such development would be subject
26 to intensive review (as would any other development).

27
28 The potential cumulative effects of routine operations and accidental events on these
29 NWRs are essentially the same as those discussed above for the NPS lands. In addition,
30 subsistence hunting and fishing are permitted on all refuges in Alaska and could, therefore, be
31 affected by accidents and routine operations in the immediate vicinity of refuge properties.

32
33 **National Forests.** The only national forest within the vicinity of the Cook Inlet Planning
34 Area is the Chugach National Forest, which is located mainly on the eastern side of the Kenai
35 Peninsula (Figure 3.9.2-1). Because there would be no OCS-related development, such as
36 pipelines or other onshore facilities, within the Chugach National Forest, it would not be affected
37 by routine OCS activities associated with lease sales in the Cook Inlet Planning Area. Because
38 of the forest location, oil spills from OCS platforms or pipelines within the Cook Inlet Planning
39 Area would not be expected to affect shoreline areas or other resources within Chugach National
40 Forest.

41
42 The Chugach National Forest is adjacent to the Gulf of Alaska. It also borders Prince
43 William Sound and is close to Valdez. The Chugach National Forest is, therefore, potentially
44 susceptible to cumulative effects of routine oil-related operations from transport and tanker
45 loading of oil produced (OCS and non-OCS) in other regions (e.g., the Beaufort Sea Planning

1 Area) and transported by pipeline to the Port of Valdez. Potential effects include increased noise
2 and air pollution from tanker traffic.
3

4 Additional, non-OCS-related cumulative impacts in the national forest could result from
5 mining operations (e.g., for gold or gravel/stone), hunting, flightseeing, ski resorts, trains, and
6 tourism. However, the impacts of these activities are regulated through a permitting process
7 following an approved resource use plan.
8

9 The Chugach National Forest would be potentially susceptible to oil (mostly non-OCS)
10 spilled from tankers that utilize the loading facilities at the Port of Valdez. Oil spills that reached
11 the coastline could affect coastal fauna; subsistence, recreational, and commercial fishing; and
12 tourism. Impacts would depend on the size and timing of a spill and would be expected to be
13 minor to moderate.
14

15 **Other Areas of Special Concern.** There are multiple State parks and State recreation
16 areas near the Cook Inlet Planning Area, many of which border Cook Inlet or are located in areas
17 that could be contacted by accidental oil spills. Such areas include Captain Cook State
18 Recreation Area, Clam Gulch State Recreation Area, Chugach State Park, Kachemak Bay State
19 Park and State Wilderness Park, and Ninilchik State Recreation Area. In addition, the Kachemak
20 Bay National Estuarine Research Reserve is located in Cook Inlet on the southern end of the
21 Kenai Peninsula. Cumulative impacts from offshore activities would be similar to those
22 described above for National Parks and Refuges. Existing protections and restrictions on uses
23 should limit the direct terrestrial cumulative impacts from OCS and non OCS activities on these
24 areas. There is existing oil and gas infrastructure in State waters of Cook Inlet and the addition
25 of OCS infrastructure and activities could have negative effects on scenic values for some users
26 if the facilities were visible from shore or the air during flightseeing. It is assumed that pipeline
27 landfalls, shore bases, and waste facilities would not be located in the State parks and recreation
28 areas. Increased traffic (i.e., land, sea, and air) and development within the vicinity of State
29 parks lands could also contribute to cumulative impacts on these areas. It is anticipated that
30 noise generated by OCS offshore construction activities would be at low levels, intermittent, and
31 would not persist for more than a few months at any one time. It is considered unlikely that
32 these additional activities would noticeably affect wildlife or park user values compared to
33 current (non-OCS) activities within the considered planning areas.
34

35 As described above, impacts on State parks and recreational areas could occur due to
36 accidental releases of oil spilled from onshore facilities and offshore drilling rigs. An oil spill
37 contacting shoreline habitats could affect subsistence harvests in those parks in which recreation
38 and subsistence hunting and fishing are allowed and could affect the number of park visitors.
39 Impacts would depend primarily on the spill location, size, and time of year.
40

41 **Conclusion.** Overall, routine OCS operations could result in minor incremental increases
42 in effects on national sanctuaries, parks, refuges, and estuarine research reserves compared to
43 existing non-OCS activities (see Section 4.4.8.2). Development of onshore facilities within
44 national park lands in the vicinity of the areas included in the Program is considered unlikely,
45 thereby making impacts from cumulative routine OCS operations unlikely in these areas.
46 Offshore construction of pipelines and platforms could contribute to cumulative effects on

1 wildlife and on scenic values for park visitors due to noise and activity levels, particularly in the
2 vicinity of Cook Inlet. However, such effects would be localized, intermittent, and temporary.
3

4 Compared to the existing potential for oil spills to affect such areas, the activities under
5 the proposed action would be expected to result in a small incremental increase in the risk of
6 impacts from oil spills to areas of special concern. The cumulative level of impacts from spills
7 would depend on spill frequency, location, and size; the type of product spilled; weather
8 conditions; effectiveness of cleanup operations; and other environmental conditions at the time
9 of the spill. Large and catastrophic oil spills in areas adjacent to the national parks, NWRs, or
10 national forests, whether from OCS or non-OCS sources, could negatively impact coastal
11 habitats and fauna and could also affect subsistence uses, commercial or recreational fisheries,
12 and tourism.
13

14 **4.6.4.3 Alaska Region – Arctic**

15 **4.6.4.3.1 Marine Mammals.**

16
17
18 **Marine Mammals.** The cumulative analysis considers past, ongoing, and foreseeable
19 future human and natural activities that may occur and adversely affect marine mammals in the
20 Arctic Planning Areas. These activities include effects of the OCS Program (proposed actions
21 and prior and future OCS sales), oil and gas activities in State waters, vessels, subsistence
22 harvests, recreational fishing and boating activities, military operations, scientific research, and
23 natural phenomena. Specific types of impact-producing factors considered include noise from
24 numerous sources, pollution, ingestion and entanglement in marine debris, vessel strikes, habitat
25 degradation, subsistence harvests, military activities, industrial development, community
26 development, climate change, and natural catastrophes. Section 4.4.7.1.3 provides the major
27 impact-producing factors related to the proposed action in Cook Inlet.
28
29
30

31 ***Routine Activities.***

32
33 **OCS Activities.** Marine mammals and their habitats in the Arctic Planning Areas could
34 be affected by a variety of exploration, development and production activities as a result of the
35 proposed and future OCS leasing actions (see Section 4.4.7.1.3). These activities include seismic
36 exploration, offshore and onshore infrastructure construction, the discharge of operational
37 wastes, and vessel and aircraft traffic. Impacts to marine mammals from these activities may
38 include physical injury or death; behavioral disturbances; lethal or sublethal toxic effects; and
39 loss of reproductive, nursery, feeding, and resting habitats. The degree of impact at the
40 population level depends greatly on the status of the population (reflected in its listing under the
41 ESA) and the degree of disturbance or harm from OCS-related activities in areas important to
42 species survival (i.e., feeding, breeding, molting, rookery or haulout areas).
43

44 Potential impacts (primarily behavioral disturbance) to marine mammals from OCS-
45 related seismic activity would be short-term and temporary, and not expected to result in

1 population level impacts for any affected species if appropriate mitigation measures are
2 implemented.

3
4 Impacts from OCS construction and operation activities could include the temporary
5 disturbance and displacement of individuals or groups by construction equipment and long-term
6 disturbance of some individuals from operational noise. No long-term, population-level effects
7 would be expected because individuals most affected by these impacts would be only those in
8 the immediate vicinity of the construction site or operational platform and disturbance of
9 individuals during construction would be largely temporary. In addition, appropriate mitigation
10 measures could lessen the potential for impacts.

11
12 Operational and waste discharges (e.g., produced water, drilling muds, and drill cuttings)
13 would be disposed of through downhole injection into NPDES-permitted disposal wells, and thus
14 would not be expected to result in any incremental impacts to marine mammals. Liquid wastes
15 (such as bilge water) may also be generated by OCS support vessels and on production
16 platforms. While these wastes may be discharged (if permitted) into surface waters, they would
17 be rapidly diluted and dispersed, and would not be expected to result in any incremental impacts
18 to marine mammals from exposure to these wastes. Drilling and production wastes may contain
19 materials such as metals and hydrocarbons, which can bioaccumulate through the food chain into
20 the tissues of marine mammals. Although the bioaccumulation of anthropogenic chemicals has
21 been reported for a variety of marine mammals, adverse impacts or population-level effects
22 resulting from such bioaccumulation have not been demonstrated (Norstrom and Muir 1994;
23 Muir et al. 1999).

24
25 Marine mammals could be temporarily disturbed by OCS vessel traffic (all species) or
26 incur injury or death from collisions with support vessels (primarily larger, slower moving
27 cetaceans). The low level of OCS vessel trips in the Arctic Planning Areas under the proposed
28 actions would likely limit potential cumulative impacts to a few individuals, be largely short-
29 term in nature, and not result in population-level effects. Noise from helicopter overflights
30 would be transient in nature. Impacts to marine mammals would be behavioral in nature,
31 primarily resulting in short-term disturbance in normal activities, and would not be expected to
32 result in population-level effects. Overflights and vessels could disturb pinnipeds on rookeries
33 and haul-outs. In particular, disturbance of walrus can cause stampedes, where younger
34 animals and calves can be killed, possibly causing population-level impacts to some species.
35 Appropriate mitigation measures such as overflight restrictions and flightline selection to avoid
36 rookeries and haul-outs would limit the potential for adversely affecting animals at these
37 locations.

38
39 No platforms would be removed under the proposed action for the Arctic Planning Areas.

40
41 Non-OCS Activities. A number of non-OCS activities such as oil and gas exploration
42 and development in State waters, subsistence harvests, vessel traffic, and climate change could
43 also affect marine mammals in the Arctic Planning Areas. Many of the effects of these activities
44 on marine mammals would be similar in nature to those resulting from OCS-related activities,
45 namely, behavioral disturbance, habitat disturbance, injury, or mortality, and exposure to toxic
46 substances. Marine mammals may also be adversely affected by climate change.

1 *Oil and Gas Exploration and Development in State Waters.* The State of Alaska has
2 made nearshore State lands available for leasing along the Beaufort Sea coast. The exploration
3 activities (and associated impacts to marine mammals) that could result with State oil and gas
4 lease sales may greatly outnumber exploration activities (and potential impacts to marine
5 mammals) that could occur under the OCS proposed action.
6

7 Exploration, construction, and operation activities associated with State leases would
8 occur in nearshore and coastal areas, while OCS platforms and pipelines would be located away
9 from coastal areas (with the exception of relatively few pipeline landfalls and onshore bases and
10 processing facilities). Thus, State oil and gas leasing activities may be expected to have a greater
11 potential for affecting marine mammals in coastal habitats than would the proposed OCS actions.
12

13 *Subsistence Harvesting.* Subsistence harvesting has been identified as impacting marine
14 mammals in Alaskan waters (Allen and Angliss 2011). However, annual mortality from
15 subsistence harvests is considered to have little adverse effect on most marine mammal
16 populations or stocks. The following are the reported estimated annual Alaska-wide subsistence
17 harvests for marine mammals that occur in the Beaufort and/or Chukchi Seas (Allen and
18 Angliss 2011):
19

- 20 • The best estimate of annual subsistence harvest of spotted seals is
21 5,265 animals.
- 22
- 23 • The best estimate of annual subsistence harvest of bearded seals is
24 6,788 animals.
- 25
- 26 • The best estimate of annual subsistence harvest of ringed seals is
27 9,567 animals.
- 28
- 29 • The best estimate of annual subsistence harvest of ribbon seals is 193 animals.
30
- 31 • The best estimate of annual subsistence harvest for the Beaufort Sea whale
32 stock is 139 animals, which includes 25 individuals in Alaska and
33 114 individuals in Canada.
- 34
- 35 • The best estimate of annual subsistence harvest for the Eastern Chukchi Sea
36 beluga whale stock is 59 animals.
- 37
- 38 • There are known subsistence harvests of narwhals by Alaska Natives.
- 39
- 40 • There are no known subsistence harvests of the Bering Sea stock of harbor
41 porpoises by Alaska Natives. However, Suydam and George (1992) noted
42 that individuals from this stock have been entangled in subsistence nets.
- 43
- 44 • Annual subsistence take of grey whales averaged 121 individuals between
45 2003 to 2007. Russian Chukotka people take most of the gray whales. The

1 U.S. Makah Indian Tribe has a yearly average quota of 4 whales. In 2005, an
2 unlawful subsistence hunt and kill of a gray whale occurred in Alaska.

- 3
- 4 • No subsistence takes of the Northeast Pacific stock of fin whales are reported
5 from Alaska or Russia.
- 6
- 7 • Subsistence take of minke whales by Alaska Natives is rare (e.g., only nine
8 between 1930 and 1995).
- 9
- 10 • Alaska Native subsistence hunters take 14 to 72 bowhead whales per year (0.1
11 to 0.5% of the population). Russian and Canadian subsistence hunters also
12 take a few bowhead whales. The annual subsistence take from 2004 to 2008
13 for Alaska, Russian, and Canadian Natives averaged 41.2 bowhead whales.
14 Several cases of fishing rope or net entanglement have been reported from
15 whales taken in subsistence hunts.
- 16
- 17 • The 1925 to 1953 estimated annual Alaska harvests of polar bears for
18 subsistence, handicrafts, and recreation was 120 animals. Recreational
19 harvests by non-Native sports hunters using aircraft averaged 150 annually
20 from 1951 to 1960 and 260 annually from 1960 to 1972. A prohibition on
21 non-Native hunting became effective in 1973. The annual subsistence
22 harvests for the Chukchi/Bering Seas stock was 92/year in the 1980s, 49/year
23 in the 1990s, and 43/year in the 2000s.
- 24
- 25 • The annual harvests for the Southern Beaufort Sea polar bear stock was
26 39/year in the 1980s, 33/year in the 1990s, and 32/year in the 2000s.
- 27
- 28 • The estimated annual subsistence harvests for the Pacific walrus from 2003 to
29 2007 were at 4,960 to 5,457 animals/year and included those harvested in the
30 U.S. and Russia.
- 31

32 *Climate Change.* A concern regarding marine mammals in polar regions is the potential
33 for climate change and associated loss in the extent of sea ice in some Arctic and subarctic
34 waters. Some species, such as the bearded seal and polar bear, are dependent on sea ice for at
35 least part of their life history, and may be more sensitive to changes in arctic weather, sea-surface
36 temperatures, or extent of ice cover (Allen and Angliss 2011). Ice edges are biologically
37 productive systems where ice algae form the base of the food chain. The ice algae are crucial to
38 arctic cod, which is a pivotal species in the arctic food web. As ice melts, there is concern that
39 there will be loss of prey species of marine mammals, such as arctic cod and amphipods, that are
40 associated with ice edges (MMS 2004a). Changes in the extent, concentration, and thickness of
41 the sea ice in the Arctic may alter the distribution, geographic ranges, migration patterns,
42 nutritional status, reproductive success, and, ultimately, the abundance of ringed seals and other
43 ice-dependent pinnipeds that rely on the ice platform for pupping, resting, and molting
44 (MMS 2004a). Reductions in sea ice coverage would adversely affect the availability of
45 pinnipeds as prey for polar bears. More polar bears may stay onshore during the summer
46 (MMS 2004a). If the arctic climate continues to warm and early spring rains become more

1 widespread, ringed seal lairs might collapse prematurely, exposing ringed seal pups to increased
2 predation by polar bears and Arctic foxes, negatively impacting the ringed seal population and,
3 therefore, eventually the polar bear population (MMS 2004a).
4

5 The loss of sea ice could have several potential effects on bowhead whales. These would
6 include increased noise and disturbance related to increased shipping, increased interactions with
7 commercial fisheries, including noise and disturbance, incidental intake, and gear entanglement;
8 changes in prey species concentrations and distribution; changes in subsistence-hunting
9 practices; increased predation from expanding killer whale range; and competition from
10 expanding fin, humpback, and other baleen whale ranges. Bowhead whale seasonal distribution
11 may change with changes in seasonal ice distribution as well.
12

13 *Other Impacting Factors.* Marine mammals may also be impacted by other factors such
14 as UMEs and invasive species. A UME is an unexpected stranding that involves a significant
15 die-off of any marine mammal population, and demands immediate response (NMFS 2011b).
16 Causes of UMEs include infections, biotoxins, human interactions, and malnutrition
17 (NMFS 2011b). Since establishment of the UM program in 1991, there have been 53 formally
18 recognized UMEs in the U.S., none of which occurred Arctic Planning Areas (NMFS 2011b).
19 Invasive species could affect some marine mammals by disrupting local species and ecosystems,
20 affecting the prey base for some marine mammals. Currently, invasive species are not a major
21 factor in the Arctic Planning Areas. However, as climate change continues to warm Alaskan
22 waters, the Arctic Planning Areas may become more susceptible to invasive species (e.g., from
23 ballast discharges associated with increased vessel traffic).
24

25 *Accidents.* Marine mammals could be exposed to oil accidentally released from
26 platforms, pipelines, and vessels from the Program (Table 4.4.2-1). Potential non-OCS sources
27 of oil spills include the domestic transportation of oil, oil and gas development in State waters,
28 and natural sources such as seeps. Accidental oil releases could expose marine mammals to oil
29 by direct contact or through the inhalation or ingestion of oil or tar deposits. The magnitude and
30 duration of exposure will be a function of the location, timing, duration, and size of the spill; the
31 proximity of the spill to feeding and other important habitats; the timing and nature of spill
32 containment; and the status of the affected animals. It is anticipated that most of the small to
33 medium spills would have limited effects on marine mammals due to the relatively small areas
34 likely to incur high concentrations of hydrocarbons and the short period of time during which
35 potentially toxic concentrations would be present. The magnitude of impact would be expected
36 to increase should a spill occur in habitats important to marine mammals or affect a number of
37 individuals from a population listed under the ESA. Some spills from OCS activity may locally
38 represent the principal source of oil exposure for some species, especially for spills contacting
39 important coastal and island habitats or collecting along ice leads.
40

41 *Conclusion.* Cumulative impacts on marine mammals in the Beaufort and Chukchi Sea
42 Planning Areas as a result of future OCS program and ongoing and future non-OCS program
43 activities could be minor to moderate over the next 40 to 50 yr. Non-OCS program activities or
44 phenomena that may affect populations of marine mammals include climate change, contaminant
45 releases, vessel traffic, subsistence harvests, and invasive species. The incremental contribution
46 of routine Program activities to these impacts would be small (see Section 4.4.7.1.3).

1 Marine mammals may also be adversely affected by exposure to oil that is accidentally
2 released from OCS and non-OCS activities. The cumulative impacts of past, present, and future
3 oil spills on marine mammals would be minor to moderate. The incremental impacts of
4 accidental spills associated with the proposed action on marine mammals would be small to
5 large, depending on the location, timing, duration, and size of the spill; the proximity of the spill
6 to feeding and other important habitats; the timing and nature of spill containment; and the status
7 of the affected animals (see Section 4.4.7.1.3).

8
9 **Terrestrial Mammals.** Terrestrial mammals and their habitats could be affected by a
10 variety of activities associated with the proposed OCS actions (Section 4.4.7.1.3). These
11 activities include construction and operation of onshore pipelines and vehicle and aircraft traffic.
12 Impacts to terrestrial mammals from these activities may include physical injury or death;
13 behavioral disturbances; lethal or sublethal toxic effects; and loss of reproductive, nursery,
14 feeding, and resting habitats. In the Arctic Planning Areas, these impacts would be in addition
15 to similar (in nature) impacts resulting from ongoing and planned OCS lease sales under the
16 Program.

17
18 Impacts from OCS construction and operation activities could include the injury or death
19 of smaller mammals (such as mice and voles) and the disturbance and displacement of
20 individuals or groups of larger species (such as caribou, muskoxen, and brown bear). Because of
21 the limited areal extent of new pipeline under the proposed action, disturbance (primarily
22 behavioral in nature) of most of these species during construction would be largely temporary,
23 and no long-term population level effects would be expected. However, construction activities
24 in the Arctic could disturb caribou in calving, foraging, or insect avoidance habitats, which could
25 affect adult and calf survival. However, the potential for such impacts could be minimized by
26 careful siting of new pipelines to avoid important habitats.

27
28 Species such as the Arctic fox that habituate to human activity and facilities could
29 experience local increases in density, while bears may experience increases in mortality
30 associated with defense of life and property killings. In the Arctic, pipelines and roads
31 associated with the proposed action have the potential to incrementally affect local and seasonal
32 movements of caribou.

33
34 Under the proposed action, vehicle traffic associated with normal operations and
35 maintenance of onshore pipelines could disturb wildlife. Vehicle traffic could disturb wildlife
36 foraging along pipelines or access roads, causing affected wildlife to temporarily stop normal
37 activities (e.g., foraging, resting) or leave the area, while collision with vehicles could injure or
38 kill some individuals. Because vehicle traffic would be infrequent, vehicle-related impacts
39 associated with the proposed action would result in little incremental increase in vehicle-related
40 impacts from current or ongoing OCS activities in the Arctic.

41
42 Up to 27 weekly helicopter trips would occur to platforms in the Arctic Planning Areas.
43 Impacts to terrestrial mammals from helicopter overflights would be behavioral in nature,
44 primarily resulting in short-term disturbance in normal activities, and would not be expected to
45 result in population-level effects. Overflights disturbing active calving and overwintering sites
46 could result in decreased survival of young or adults, and potentially result in population level

1 impacts to some species. Selection of flight lines to avoid overflights of important habitats
2 would greatly limit the potential for adversely affecting calving or overwintering animals.
3

4 Terrestrial mammals in the Arctic Planning Area could also be affected by a number of
5 non-OCS activities, including oil and gas exploration and development in State waters, and
6 coastal and community development, and climate change. Many of the effects of these activities
7 on terrestrial mammals would be similar in nature to those resulting from OCS-related activities,
8 namely behavioral disturbance, habitat disturbance, and injury or mortality. The State of Alaska
9 has made leases of State waters available along much of the Beaufort Sea coast. Because these
10 leases are closer to shore than those for the proposed action, impacts on terrestrial mammals may
11 exceed the potential impacts that could occur under the OCS proposed action. Implementation
12 of the proposed action could increase coastal and community development, indirectly adding to
13 impacts to terrestrial mammals and their habitats. Terrestrial mammals could be adversely
14 affected by the accidental release of oil from an onshore pipeline, or by offshore spills contacting
15 beaches and shorelines utilized by terrestrial mammals (such as caribou or brown bears).
16 Impacts to terrestrial mammals from an oil spill would depend on such factors as the time of year
17 and volume of the spill, type and extent of habitat affected, and home range or density of the
18 species. Spills contacting high-use areas (such as caribou calving areas) could locally affect a
19 relatively large number of animals. It is anticipated that most of the spills would have limited
20 effects on terrestrial mammals, due to the relatively small areas likely to be directly exposed to
21 the spills, and the small number and size of spills projected for the proposed action and for
22 current and planned OCS oil and gas developments. However, some spills may locally represent
23 the principal source of oil exposure for some species, especially for spills contacting important
24 calving or overwintering habitats.
25

26 **Conclusion.** Cumulative impacts on terrestrial mammals in the Beaufort and Chukchi
27 Sea Planning Areas as a result of future OCS program and ongoing and future non-OCS
28 activities could be minor to moderate over the next 40 to 50 yr. Non-OCS activities or
29 phenomena that may affect populations of terrestrial mammals include climate change, natural
30 catastrophes, contaminant releases, and vehicle traffic. The incremental contribution of routine
31 Program activities to these impacts would be small (see Section 4.4.7.1.3).
32

33 Terrestrial mammals may also be adversely affected by exposure to oil that is
34 accidentally released from onshore (e.g., Prudhoe Bay) and State offshore oil and gas activities.
35 The cumulative impacts of past, present, and future oil spills on terrestrial mammals would be
36 minor to moderate. The incremental impacts of accidental spills associated with the proposed
37 action on terrestrial mammals would be small to large, depending on the location, timing,
38 duration, and size of the spill; the proximity of the spill to feeding and other important habitats;
39 the timing and nature of spill containment; and the status of the affected animals (see
40 Section 4.4.7.1.3).
41
42

43 **4.6.4.3.2 Marine and Coastal Birds.** Section 4.4.7.2.3 discusses impacts to marine and
44 coastal birds in the Arctic region resulting from the proposed action (OCS program activities
45 from 2012 to 2017). Cumulative impacts on marine and coastal birds result from the incremental
46 impacts of the proposed action when added to impacts from existing and reasonably foreseeable

1 future OCS program activities (that are not part of the proposed action) and other non-OCS
2 program activities. Table 4.6.1-2 presents the exploration and development scenario for the
3 Beaufort and Chukchi Seas cumulative cases (encompassing the proposed action and other OCS
4 program activities) over the next 50 yr. A number of OCS program activities could affect Arctic
5 marine or terrestrial birds or their habitats; these include offshore exploration, construction of
6 offshore platforms and pipelines, construction of onshore pipelines, operations of offshore
7 platforms, operational discharges and wastes, and OCS-related marine vessel and aircraft traffic.
8 Potential impacts on marine and coastal birds from OCS program activities include injury or
9 mortality of birds from collisions with platforms, vessels, and aircraft; exposure to operational
10 discharges; ingestion of trash or debris; loss or degradation of habitat due to construction; and
11 behavioral disturbance due to the presence of, and noise generated by, equipment and human
12 activity.

13
14 Non-OCS program activities affecting marine and coastal birds in the Beaufort Sea and
15 Chukchi Sea Planning Areas include dredging and marine disposal; coastal and community
16 development; onshore and offshore construction and operations of facilities associated with State
17 oil and gas development (mainly Prudhoe Bay); commercial and recreational boating; and small
18 aircraft traffic. Potential impacts on marine and coastal birds from these activities are similar to
19 those under the OCS program and include injury or mortality of birds from collisions with
20 platforms associated with State oil and gas development and other onshore and offshore
21 structures (e.g., radio, television, or cell phone towers); onshore industrial, commercial, and
22 residential development; exposure to discharges from permitted point sources such as sewage
23 treatment discharges and nonpoint sources such as snowmelt and stormwater runoff; or
24 accidental releases (e.g., oil spills), as described in Section 4.6.2.1.3 and Table 4.6.2-4; exposure
25 to emissions from various onshore and offshore sources (e.g., power generating stations and
26 marine vessels), as described in Section 4.6.2.1.3; ingestion of trash or debris; loss or
27 degradation of habitat due to construction and operations activities; and behavioral disturbance
28 due to the presence of, and noise generated by, equipment and human activity. Other trends such
29 as extensive melting of glaciers (and increasing river discharges), thawing of permafrost, and
30 increased precipitation brought on by global climate change are also expected to adversely affect
31 marine and coastal birds over the next 50 yr.

32
33 **Injury or Mortality from Collisions.** Under the cumulative scenario, annual collision
34 injury or mortality in the Beaufort and Chukchi Sea Planning Areas could increase in the near
35 term as platforms are built under the proposed action. Such impacts would be minor relative to
36 those that currently involve non-OCS structures. Over time, the injury or mortality impacts from
37 collisions could decrease as oil and gas production in the inlet declines.

38
39 **Exposure to Wastewater Discharges and Air Emissions.** The discharge of operational
40 wastes and air emissions from current non-OCS related vessel traffic and platform operations in
41 the Beaufort and Chukchi Seas is strongly regulated and would continue to be so regulated over
42 the next 50 yr. Many wastes (such as produced water, drilling muds, and drill cuttings) would be
43 disposed of through onsite injection into NPDES-permitted disposal wells. However, such
44 wastes and emissions would still expose marine and coastal birds to potentially toxic materials or
45 to solid debris that could be ingested or result in entanglement. These facilities and activities
46 include sewage treatment plants, industrial manufacturing or processing facilities, electric

1 generating plants, dredging and marine disposal, and vessel traffic (e.g., cargo and tanker ships
2 and military and research vessels). Operational wastewater discharges and air emissions
3 associated with the proposed action would contribute to the overall cumulative risk of toxic
4 exposure and debris ingestion or entanglement of existing non-OCS wastewater discharges and
5 air emissions in the inlet, but the incremental increase in impact is expected to be small relative
6 to these other activities.

7
8 Under the proposed action, marine and coastal birds could be exposed to oil accidentally
9 released from platforms, pipelines, and vessels, and would be most susceptible to adverse
10 impacts from spills occurring in coastal areas and affecting feeding and nesting areas. Most of
11 the oil released to arctic waters is from leaks related to the oil industry (Section 4.6.2.3.1). Oil
12 releases from all sources may expose marine and coastal birds via direct contact or through the
13 inhalation or ingestion of oil or tar deposits (see Section 4.4.7.3.1).

14
15 Marine and coastal birds may become entangled in, or ingest, floating, submerged, and
16 beached debris (Heneman and the Center for Environmental Education 1988; Ryan 1987, 1990).
17 Entanglement may result in strangulation, injury or loss of limbs, entrapment, or the prevention
18 or hindrance of the ability to fly or swim; all of these effects may be considered lethal. Ingestion
19 of debris may irritate, block, or perforate the digestive tract, suppress appetite, impair digestion
20 of food, reduce growth, or release toxic chemicals (Fry et al. 1985; Dickerman and Goelet 1987;
21 Ryan 1988; Derraik 2002). Because the discharge or disposal of solid debris into offshore waters
22 from OCS structures and vessels is prohibited by BOEM (30 CFR 250.40) and the USCG
23 (MARPOL, Annex V, Public Law 100 220 [101 Statute 1458]), entanglement in or ingestion of
24 OCS-related trash and debris by marine and coastal birds would not be expected under normal
25 operations.

26
27 **Oil Spills and Cleanup Activities.** Oil spills under the cumulative scenario are shown in
28 Table 4.6.1-3. No more than six large spills (between 1,000 and 5,300 bbl from either a platform
29 or a pipeline) and 530 small spills (less than 1,000 bbl) would be expected as a result of the
30 Beaufort Sea and Chukchi Sea Planning Areas OCS program over the next 50 yr.

31
32 Loons, waterfowl, and shorebirds in onshore habitats are generally at low risk of
33 contacting a spill while nesting, but risk of exposure increases as they leave the mainland nesting
34 areas and concentrate in coastal or marine habitats for brood rearing, molting, or staging prior to
35 southward migration. In addition, some species (e.g., red-throated loons) forage almost
36 exclusively offshore and bring food back to their nestlings or young, so impacts of oil spills may
37 be greater on these species (Eberl and Picman 1993). Likewise, species nesting on barrier
38 islands, such as common eider, gulls, and terns, are at risk when post-nesting individuals join
39 other species in lagoons and other nearshore habitats. Substantial numbers occupy Simpson and
40 other Beaufort Sea lagoons, Harrison and Smith Bays, Kasegaluk Lagoon, and Peard and
41 Ledyard Bays in the Chukchi Sea at this time. For example, tens of thousands of long-tailed
42 ducks molting in Beaufort Sea lagoons, far outnumbering other species, are at risk in July and
43 August, and in late August and early September, a large proportion of the Pacific flyway brant
44 population could be exposed to a spill that enters Kasegaluk Lagoon. Substantial numbers of
45 non-breeding, foraging, or staging birds that occupy offshore areas in both the Beaufort and
46 Chukchi Seas, when open water beyond the barrier islands is available, could be exposed to an

1 oil spill. Most brood rearing of loons, swans, and geese occurs on large lakes or coastal
2 saltmarsh. Risk of oil spill contact is much greater for those using the latter habitat. The most
3 important molting area for brant and several other species of geese (and to a lesser extent ducks)
4 is the Teshekpuk Lake Special Area (Derksen et al. 1979, 1982). Beached oil along these
5 coastlines could expose hundreds to low thousands or possibly greater numbers of shorebirds
6 that pause along the coast during migration (Connors et al. 1979; Smith and Connors 1993;
7 Andres 1994). In the southeastern Chukchi Sea, large numbers of murre and kittiwakes nesting
8 in seabird colonies at Capes Lisburne and Thompson, together with nonbreeding individuals,
9 form foraging flocks containing tens to hundreds of individuals that also could be exposed to an
10 oil spill. Major effects on bird populations during the open water season are expected to follow a
11 spill. A spill occurring in winter, when birds are virtually absent, still may have serious impacts
12 if substantial quantities of oil are entrained in the ice and then released during the following
13 breeding season.

14
15 Large flocks of long-tailed ducks molting in Beaufort Sea lagoons and common eiders
16 occupying barrier islands or lagoons are particularly susceptible to oil spill impacts if they are
17 nesting, brood rearing, or flightless. Likewise, brant staging in Kasegaluk Lagoon in the
18 Chukchi Sea would be particularly vulnerable. For all species, the degree of impact depends
19 heavily on the location of the spill and its timing with respect to critical natural behaviors
20 (e.g., breeding, molting, feeding). Survival and fitness of individuals may be affected, but in
21 many cases, this infrequent disturbance is not expected to result in significant population losses.
22 However, effects may be greater if a spill and cleanup were to occur in the spring when large
23 numbers of king and common eiders, long-tailed ducks, and other waterfowl, seabirds, and
24 shorebirds are present following spring ice-lead systems. In addition, it is unlikely that all
25 spilled oil would be removed from the environment, especially in winter; thus the remaining
26 accumulations could move under the ice and into leads.

27
28 In addition to the potential impacts from spilled oil, the oil spill cleanup process may also
29 affect marine and coastal birds in the Arctic region. The presence of large numbers of workers,
30 boats, and additional aircraft during the breeding season following a spill is expected to displace
31 waterfowl or other seabirds occupying affected offshore or nearshore waters, and shorebirds in
32 coastal habitats for one to several seasons. Cleanup in coastal areas late in the breeding season
33 may disturb brood-rearing, juvenile, or staging birds. Cleanup and the presence of oil can
34 dramatically influence avian species composition and distribution (Piatt et al. 1990). It is
35 extremely difficult to separate the effects of oiling and disturbance from cleanup activities, but
36 either separately or together they have the potential to influence habitat use by birds (Wiens
37 1996). Survival and fitness of individuals may be affected to some extent, but this infrequent
38 disturbance is not expected to result in significant population losses.

39
40 **Loss or Degradation of Habitat.** Marine and coastal birds could be affected by
41 platform construction and removal activities, and pipeline trenching, which could disrupt
42 behaviors of nearby birds. The proposed action would include the placement of up to
43 36 exploration and development wells and 9 offshore platforms; up to 652 km (405 mi) of new
44 offshore pipeline and 129 km (80 mi) (0 in the Chukchi Sea) of onshore pipeline could be
45 constructed (Table 4.4.1.1-4). Platform emplacement could disturb birds temporarily; pipeline
46 trenching may also affect birds in nearshore coastal habitats if it occurs in or near foraging,

1 overwintering, or staging areas, or near seabird colonies. No pipeline landfalls would be
2 constructed under the proposed action. Depending on where they are sited, the pipelines would
3 likely result in the permanent elimination of a small amount of habitat along pipeline routes.
4

5 Any construction activities that take place in summer (one season) (e.g., platform
6 installation for field development) could displace birds from within about 1 km (0.62 mi) of the
7 construction site. However, localized burial of potential prey and destruction of a few square
8 kilometers of foraging habitat as a result of pipeline trenching or island construction are not
9 expected to cause a significant decline in prey availability. It is likely that much construction,
10 particularly of gravel islands, roads, pads, and pipelines, would take place during winter when
11 most birds are absent. Several studies speculate that increased predator populations sustained by
12 scavenging opportunities around human habitation may indirectly contribute to long-term
13 declines of common eiders and long-tailed duck populations currently in evidence (Day 1998;
14 S.R. Johnson 2000; Troy 2000). The effect of any habitat loss on the species' productivity
15 would likely be localized to these areas but may persist over the life of any offshore field and
16 beyond. The potential exists for long-term adverse effects to occur (e.g., fecundity reduced after
17 location to suboptimal habitat due to disturbance).
18

19 Gravel placement (for artificial islands) results in nesting and foraging habitat loss for
20 most shorebirds (Troy 2000). On the North Slope, gravel is generally extracted from the
21 floodplains of large rivers (Pamplin 1979; BLM 2002). The effects of gravel
22 extraction/placement would be reduced if areas where particular species seasonally concentrate
23 are avoided.
24

25 Winter construction would also utilize ice roads to build and access gravel island
26 construction sites. Ice roads may be constructed over both tundra habitats and frozen ocean
27 habitats. Ice roads constructed in tundra habitats may delay ice-off and snow melt
28 (NRC, 2003b), potentially reducing the availability of such areas for early nesting species. Ice
29 roads could also flatten underlying vegetation, which may discourage use of the area by tundra-
30 nesting birds (Walker et al., 1987a, b). Water removal from lakes and ponds for ice road
31 construction may reduce the quality or quantity of aquatic habitats important for breeding and
32 postmolting for some species. In each of these cases, the impacts to potential nesting habitat
33 would be temporary and localized, and birds would likely respond by selecting other areas for
34 nesting or postmolting.
35

36 Construction camps to support onshore construction activities would temporarily remove
37 some areas from potential use by birds, and this loss may be short- or long-term depending on
38 the nature and effectiveness of camp abandonment following completion of construction
39 activities. Regardless of the duration of the effect, the amount of habitat that would be disturbed
40 would be relatively small and not be expected to affect more than a few birds.
41

42 The construction and operation of up to 320 km (200 mi) of new overland pipelines
43 would be expected to affect bird populations in a manner similar to that identified for the
44 construction and operation of new onshore processing facilities and associated infrastructure
45 (especially access roads). Potential nesting or post-molting habitat would be permanently lost
46 within the footprint of the new pipelines, causing birds to select habitats in other locations.

1 Although pipeline trenching would also be carried out in winter when most seabird and
2 waterfowl species are not present, seafloor trenching could locally disrupt benthic invertebrate
3 communities that may serve as food sources for waterfowl during other seasons. The extent to
4 which benthic food sources could be affected and the subsequent impact to waterfowl will
5 depend on the type and amount of benthic habitat that would be permanently disturbed by
6 trenching, the importance of the specific habitats in providing food resources to waterfowl, and
7 the number of waterfowl that could be affected. Because no more than three new pipelines could
8 be built under the proposed action within the entire Arctic region, relatively little benthic habitat
9 could be disturbed (no more than 120 ha [297 ac] within the entire region). In addition, portions
10 of the new pipelines would be in water depths down to 60 m (200 ft) and potentially unavailable
11 for many marine birds and waterfowl. Thus, any impacts to food sources from pipeline
12 trenching would be very localized and short-term, and not expected to result in population-level
13 impacts to local waterfowl populations.

14
15 The construction of new facilities and pipelines would permanently eliminate potential
16 bird habitat at the construction sites. While this habitat loss would be long-term, the areas
17 disturbed would represent a small portion of the habitat present in the Arctic region. Careful
18 siting of any new facilities to avoid important nesting or post-molting habitat would further
19 reduce the magnitude of any potential effects on local bird populations.

20
21 Helicopter or fixed-wing aircraft overflights are generally conducted at low altitudes and
22 could disturb birds in onshore and offshore locations (Ward and Stein 1989; Ward et al. 1994;
23 Miller 1994; Miller et al. 1994). Helicopter and aircraft overflights during spring breakup of
24 pack ice may disturb marine species feeding in open waters and waterfowl in coastal waters,
25 causing birds to leave the area. Similarly, overflights in summer could displace waterfowl and
26 seabirds from preferred foraging areas and waterfowl from coastal nesting or brood-rearing areas
27 such as the lagoon systems of the Beaufort and Chukchi Seas. Molting and staging waterfowl
28 may temporarily leave an area experiencing helicopter overflights (Derksen et al. 1992), while
29 geese have been reported to exhibit alert behavior and flight in response to helicopter overflights
30 (Ward and Stein 1989; Ward et al. 1994). The type of response elicited by the birds and the
31 potential effect on the birds will depend in large part on the time of year for the overflights and
32 the species disturbed. Birds experiencing frequent overflights may permanently relocate to less
33 favorable habitats (MMS 2002b). In addition, the temporary absence of adult birds may increase
34 the potential for predation of unguarded nests and young (NRC 2003b).

35
36 Marine vessel trips could disturb seabirds and waterfowl in preferred foraging, molting,
37 and staging areas, causing them to leave the area and move to potentially less favorable habitats.
38 Vessel traffic that displaces nesting seabirds or waterfowl may result in an increased predation
39 rate on eggs and young, especially in areas near gull colonies (Day 1998; S.R. Johnson 2000;
40 Noel et al. 2005). However, the amount of vessel and aircraft traffic that could occur under the
41 proposed action would be relatively limited. Which birds could be affected, the nature of their
42 response, and the potential consequences of the disturbance will be a function of a variety of
43 factors, including the specific routes, the number of trips per day, the seasonal habitats along the
44 routes, the species using the habitats and the level of their use, and the sensitivity of the birds to
45 vessel traffic. Traffic over heavily used feeding or nesting habitats of sensitive species could

1 result in population-level effects, while impacts from traffic over other areas with less sensitive
2 species would largely be limited to a few individuals and not result in population-level effects.
3

4 Marine and coastal birds could be affected by accidental oil spills from offshore
5 platforms and pipelines, as well as from onshore processing facilities and pipelines. In general,
6 loons, waterfowl, seabirds, and shorebirds are not expected to survive moderate to heavy oil
7 contact. Oiled feathers lose their insulative and water repellent characteristics, and birds die of
8 hypothermia (Albers and Gay 1982). Swallowed oil is toxic and causes impaired physiological
9 function and production of fewer young. Oiled eggs have significantly reduced hatching success
10 (Albers 1980). Vulnerability of bird populations to an oil spill is highly variable because of their
11 seasonally patchy distribution in areas where the probability of spill contact also is variable and
12 depends on location, oceanography, weather patterns, and habitats typically occupied by and
13 habits of, the particular species. Because they are unable to fly, molting birds probably are the
14 most vulnerable. For all species, the degree of impact depends heavily on the location of the
15 spill and its timing with respect to critical natural behaviors (e.g., breeding, molting, feeding).
16

17 If losses are substantial in a species with a low reproductive rate, including most marine
18 species, recovery may take many years, or populations may not recover to their prespill size.
19 Rate of recovery from oil spill mortality depends both on the numbers lost from a particular
20 species population and its prevailing population trend, which in turn are determined by
21 reproductive rate and survival rate. Oil contamination of food resources may influence recovery
22 of a local population by affecting reproductive success and survival, with the degree of impact
23 largely dependent on the patterns of prey distribution. Species dependent on widely dispersed
24 prey would have more limited effects. However, seabirds, in particular, are attracted to patchy
25 prey sources found on oceanic fronts (Piatt and Springer 2003) and would experience greater
26 effects from prey reduction. In addition, nonbreeding individuals and those that have completed
27 annual parental activities are better able to search for prey in uncontaminated areas. However,
28 those individuals actively feeding young and dependent upon nearby food resources would be
29 unable to seek uncontaminated prey elsewhere. If a leak in an onshore pipeline were to occur on
30 a pad, the extent of the spill likely would be restricted by containment berms. If the spill
31 occurred along the off-pad portion of the pipeline, the area covered may include several acres; if
32 the spill were to enter streams or lakes, a larger area could be affected as the oil spreads over a
33 water surface or is carried down a watercourse. From mid- to late summer, such an occurrence
34 could contact broodrearing females and their young, as well as potentially large flocks of
35 nonbreeding and postbreeding individuals undergoing wing molt.
36

37 Most bird species are absent from the Arctic region from late October to at least early
38 April. During spring migration, substantial numbers of migrants moving north along the spring
39 lead system in the Chukchi Sea are at risk if oil enters this habitat, since there are few
40 alternatives until open water off river deltas is available as the ice breaks up in late spring. The
41 most numerous species include king eider, common eider, long-tailed duck, brant, and murre.
42 Likewise, a similar rather restricted open water situation exists in both the Beaufort and Chukchi
43 Seas for migrants that pause awaiting further melting to the north or east, and for birds
44 occupying delta waters and nearshore areas that have melted prior to general ice breakup and
45 awaiting the availability of onshore habitats.
46

1 **Disturbance Due to Noise.** Noise and human activities (such as normal maintenance)
2 could disturb birds. Operational facilities may provide additional nesting and feeding
3 opportunities for some species. Unexpected noise can startle birds and potentially affect feeding,
4 resting, or nesting behavior, and often causes flocks of birds to abandon the immediate area.
5 Some species may react by avoiding nearby habitats, while other species may show little
6 response or become habituated. Because of the small number of new onshore facilities (no more
7 than four in the entire Arctic region), the disturbance of birds by operational noise and activity
8 would likely be limited to relatively few individuals and would not be expected to result in
9 population-level effects. Prolonged or repeated periods of maintenance activities could have a
10 greater impact on nesting birds by increasing cooling periods of eggs, and on brood-rearing birds
11 by increasing the time that young and adult birds are separated.

12
13 **Effects on ESA-Listed Species in the Arctic Region.** The cumulative effects of OCS
14 and non-OCS program activities on ESA-listed species in the Arctic region, including the
15 spectacled eiders and Steller's eider, are expected to be similar to those noted for nonlisted
16 species over the next 50 yr. Continued compliance with ESA regulations and coordination with
17 the USFWS would ensure that lease-specific OCS operations would be conducted in a manner
18 likely to avoid or greatly minimize the potential for impacting these species.

19
20 The risk of oil contact to spectacled eiders using the spring lead system to move north
21 into the Chukchi Sea during spring migration could be high if a spill entered the area of the
22 leads. Since most spectacled eiders probably use overland routes from the Chukchi to complete
23 their spring migration to nesting areas on the ACP, they are not likely to be contacted by an oil
24 spill during migration. During the broodrearing period, when the young are led to watercourses
25 and ultimately to nearshore marine environments for further development, staging, and fall
26 migration, the risk of oil contact is much greater. Males could be exposed to an oil spill in any of
27 the several bays and lagoons occupied for molting and staging in both the Beaufort and Chukchi
28 Seas (Petersen et al. 1999). The period of highest exposure risk for a given individual migrating
29 across the Beaufort is about 3–5 days. Females and young are at risk of contact primarily when
30 they occupy Smith Bay in the Beaufort (Troy 2003) and Ledyard and Peard Bay (Laing and
31 Platte 1994) in the Chukchi (this area is used by nonbreeding, failed breeding, and successful
32 breeders, as well as both sexes) for the molt prior to fall migration (Petersen et al. 1999).
33 Ledyard Bay has been defined as critical habitat for spectacled eiders. Since most, if not all, of
34 the successfully breeding females (and their young) from the ACP could be concentrated in
35 Ledyard Bay critical habitat area during the molt period, a spill affecting this group in this
36 location could have a long-term population-level effect.

37
38 The small ACP population of Steller's eider is not likely to be exposed to an oil spill
39 during nesting or postnesting periods, since most presumably move to the Russian side of the
40 Chukchi prior to migrating south to molting areas. However, there is some evidence to suggest
41 use of Peard Bay by postbreeding Steller's eiders (Martin unpubl. data; Dau and Larned 2004,
42 2005).

43
44 **Climate Change.** Climate change could have dramatic impacts on the Beaufort Sea and
45 Chukchi Sea Planning Areas. The expected changes in air temperature would have the most
46 immediate effect on the distribution and biology of arctic seabirds and the seabird species most

1 dependent on the presence of ice and snow would be expected to be among the first affected. If
2 temperature increases in the Arctic region are as high as predicted, the Beaufort Sea pack ice
3 could retreat more than 100 km (62 mi) from mainland Alaska (Meehan et al. 1998). This sea
4 ice retreat could have major adverse effects on seabirds that rely on prey associated with ice
5 edges.
6

7 **Conclusion.** Marine and coastal birds in the Beaufort and Chukchi Sea Planning Areas,
8 including those that are ESA-listed, could be adversely affected by activities associated with the
9 proposed action as well as those associated with future OCS and non-OCS program activities.
10 Potential impacts include injury or mortality of birds from collisions with platforms associated
11 with OCS and State oil and gas development and other onshore and offshore structures
12 (e.g., radio, television, or cell phone towers), onshore industrial, commercial, and residential
13 development; exposure to discharges from permitted point sources such as sewage treatment
14 discharges and nonpoint sources such as urban runoff, or accidental releases (e.g., oil spills);
15 exposure to emissions from various onshore and offshore sources; ingestion of trash or debris;
16 loss or degradation of habitat due to construction and operations activities; and behavioral
17 disturbance due to the presence of, and noise generated by, equipment and human activity. Other
18 trends such as extensive melting of glaciers (and increasing river discharges) and increased
19 precipitation brought on by global climate change are also expected to adversely affect marine
20 and coastal birds over the next 40 to 50 yr. While the cumulative impact of all OCS and non-
21 OCS activities in the Beaufort and Chukchi Seas could be minor to moderate, the incremental
22 impact due to the proposed action would be small (see Section 4.4.7.2.3). Compliance with ESA
23 regulations and coordination with the USFWS would ensure that lease-specific OCS operations
24 would be conducted in a manner that is likely to avoid or to greatly minimize the potential for
25 impacting these species.
26

27 Marine and coastal birds may also be adversely affected by exposure to oil (via direct
28 contact or through the inhalation or ingestion of oil or tar deposits) that is accidentally released
29 from OCS and non-OCS activities, especially near coastal areas and affecting feeding and
30 nesting areas. The incremental impacts of accidental spills associated with the proposed action
31 on marine and coastal birds would be small to large, depending on the location, timing, duration,
32 and size of the spill; the proximity of the spill to feeding and nesting areas; the timing and nature
33 of spill containment; and the status of the affected birds (see Section 4.4.7.2.3).
34

35 Whether net cumulative impacts are minor or moderate depends on the nature and
36 duration of activities that reduce bird survival and productivity. Losses would be limited in areas
37 occupied by scattered flocks during relatively brief staging and migration periods or scattered
38 nest sites during the brief nesting season; however, in cases where exposure to localized
39 disturbance is greater, impacts have the potential to rise to the population level. Population-level
40 effects could be incurred due to the tendency for large numbers of individuals of some bird
41 species to concentrate in certain coastal arctic locations.
42
43

44 **4.6.4.3.3 Fish.** This section evaluates the cumulative effects of the proposed action,
45 ongoing or planned OCS activities that would occur during the life of the Program, and non-OCS
46 activities on populations of fishes in the Beaufort and Chukchi Sea Planning Areas. The primary

1 routine OCS activities that could result in impacts on fish include seismic surveys; construction
2 of artificial islands, ice roads, drilling, platforms and pipeline placement; releases of permitted
3 discharges from wells; and removal of existing structures. Potential environmental impacts
4 associated with the building and operation of OCS facilities such as subsea production wells,
5 platforms, artificial islands, and pipelines would increase in conjunction with the increased
6 number of wells. Although all of these activities would disturb bottom habitats to some degree,
7 artificial islands result in a more complete loss of benthic habitat due to larger footprints
8 (approximately 9 ha for artificial islands versus less than 1.5 ha for platforms) and due to
9 complete burial of existing substrate during construction. The impacts of routine activities
10 (exploration and site development, production and decommissioning) on fish communities are
11 discussed in detail in Section 4.4.7.3.3. Overall, routine activities represent up to a minor
12 disturbance, primarily affecting demersal fishes, with the severity of the impacts generally
13 decreasing with distance from bottom-disturbing activities.
14

15 Oil and gas exploration and development in State waters could also contribute to
16 cumulative effects on fishery resources in the Beaufort and Chukchi Planning Areas. Drilling of
17 wells in State waters could also require construction of platforms and pipelines in waters of
18 Alaska. The effects on fish would be similar to those described above for OCS oil and gas
19 programs (Section 4.4.7.3.2). Other non-OCS activities that could impact fish communities
20 include subsistence fishing, hardrock mining, sediment dredging and disposal of dredging spoils
21 in OCS waters, and commercial shipping (tanker vessels) and anchoring. Many of these
22 activities would result in bottom disturbance that would affect bottom dwelling fishes as well as
23 their food sources in a manner similar to those described for OCS activities (MMS 2008;
24 ADEC 2007a; Section 4.4.7.3.3). Commercial fishing does not occur in the Beaufort and
25 Chukchi Sea Planning Areas, and sportfishing is minor in the Arctic but could increase if
26 regulations change and if warming temperatures allow an increase in vessel traffic. Effects on
27 fish resources from non-OCS dredging and marine disposal activities are expected to be similar
28 to those described for OCS bottom disturbing activities (Section 4.4.7.3.3). Due to the small
29 number and limited use of disposal sites in the vicinity of the Beaufort and Chukchi Sea Planning
30 Areas, these activities are not expected to noticeably alter fish populations.
31

32 Beaufort and Chukchi Seas fall in the Kotzebue Sound and Northern Subsistence fishing
33 areas. Subsistence fishing may contribute to the cumulative effects on the abundance of some
34 fishery resources. Alaska State law defines subsistence as the “noncommercial customary and
35 traditional uses” of fish and wildlife. The Alaska Department of Fish and Game defines
36 subsistence fishing to include “the taking of, fishing for, or possession of fish, shellfish, or other
37 fisheries resources by a resident of the state for subsistence uses with gill net, seine, fish wheel,
38 long line, or other means defined by the Board of Fisheries.” These fishing methods have more
39 limited impacts on fish and fish habitat compared to commercial fishing methods. In addition,
40 subsistence fishing is subject to harvest limits that reduce the potential for overfishing.
41 Consequently, subsistence fishing makes a relatively minor contribution to the reduction in fish
42 stocks.
43

44 Cumulative impacts on diadromous species could also occur as a result of activities that
45 obstruct fish movement in marine environments during migration periods. For example, some
46 structures along the Beaufort Sea mainland (e.g., the West Dock) have been shown to block the

1 movements of diadromous fishes, particularly juveniles, under certain meteorological conditions
2 (Fechhelm 1999; Fechem et al. 1999). Causeways such as the 40 m wide and 60 m long
3 structure associated with the Red Dog Mine may impede coastal movement either by directly
4 blocking fish or by modifying nearshore water conditions to the point where they might become
5 too cold and saline for some species (Fechhelm et al. 1999). Although the presence of
6 causeways has been an issue associated with oil development activities in the Beaufort Sea, the
7 small size of the Red Dog causeway would likely have little effect on the coastal movements and
8 distributions of Chukchi Sea fishes and shellfishes. However, it is anticipated that proper
9 placement and design considerations for future causeway construction along the North Slope
10 would alleviate the potential for such effects on fish movement.

11
12 There are several contaminant sources in the Beaufort and Chukchi Sea Planning Areas.
13 The Red Dog Mine in Alaska is the largest lead and zinc mine in the world, and is presently the
14 only base-metal lode mine operating in northwest Alaska. A study for the National Park Service
15 (Hasselbach et al. 2004) showed extensive airborne transport of cadmium and lead from Red
16 Dog Mine; although the study was focused only on the limits of the Cape Krusenstern National
17 Monument, these contaminants are probably carried out into the Chukchi Sea. There are also
18 natural sources of metals and hydrocarbons. Sediments, peats, and soils from the Sagavanirktok,
19 Kuparuk and Colville Rivers are the largest source of dissolved and particulate metals and
20 saturated and polycyclic aromatic hydrocarbons in the development area. However,
21 concentrations of metals and organics in fish sampled in the Arctic Planning Areas are typically
22 at background levels (Neff & Associates 2010).

23
24 Climate change may affect fish communities in the Beaufort and Chukchi Sea Planning
25 Areas. Climate would only be one of several factors that regulate fish abundance and
26 distribution. Many fish populations are already subject to stresses, and global climate change
27 may aggravate the impacts of ongoing and future human use of the coastal zone. Fish respond
28 directly to climate fluctuations, as well as to changes in their biological environment including
29 predators, prey, species interactions, and disease. Projected changes in hydrology and water
30 temperatures, salinity, and currents can affect the growth, survival, reproduction, and spatial
31 distribution of marine fish species and of the prey, competitors, and predators that influence the
32 dynamics of these species (Watson et al. 1998). Changes in primary production levels in the
33 ocean because of climate change may affect fish stock productivity. Climate change may have a
34 number of effects on fish communities, including:

- 35
36
- Changes in the timing of seasonal fish migrations;
 - 37
 - 38 • Increased storm damage to nearshore areas as the amount of open water
 - 39 increases and their reduction or elimination by rising sea levels;
 - 40
 - 41 • Reduction in habitat for sea ice dependent species; and
 - 42
 - 43 • Replacement of true Arctic species such as Arctic cod and capelin by the
 - 44 range expansions of subarctic species.
 - 45

1 Large-scale changes in oceanographic and ecosystem processes resulting from climate
2 change could indirectly affect fish populations in the Arctic in several ways. For example, under
3 the existing temperature regime, the Chukchi Sea has a food web dominated by benthic
4 consumers and cryopelagic (sea ice-associated) fishes. The loss of sea ice and the increased
5 surface water temperature may promote a shift to a pelagic-based food web with high
6 phytoplankton and zooplankton productivity and greater numbers of predatory fish (Loeng 2005;
7 Hopcraft et al. 2008). Ultimately, however, predictions about the indirect and cascading
8 ecological impacts of climate change on specific species are subject to great uncertainty, given
9 the complexity of the ecosystem.

10
11 Oil spills could result from OCS and non-OCS activities. The total number of oil spills
12 and the extent of affected areas would likely increase under the proposed action in conjunction
13 with increased levels of petroleum exploration and production. The potential impacts of OCS oil
14 spills on fish communities in the Beaufort and Chukchi Sea are discussed in detail in
15 Section 4.4.7.3.3. Non-OCS activities, such as oil and gas development in State waters,
16 domestic transportation of oil or refined petroleum products, and commercial shipping (including
17 tinkering), may also result in accidental spills that could potentially impact fish resources within
18 the Beaufort and Chukchi Sea Planning Areas. While effects to fishery resources would depend
19 on the timing, location, and magnitude of specific oil spills, it is anticipated that most small to
20 medium spills that occur in OCS waters would have limited effects on fishery resources due to
21 the relatively small areas likely to be exposed to high concentrations of hydrocarbons and the
22 short period of time during which potentially toxic concentrations would be present. In general,
23 adult fish in marine environments are highly mobile and capable of avoiding high concentrations
24 of hydrocarbons although they may be subject to sublethal exposures. However, fish eggs and
25 larvae as well as small benthic obligate fish species do not typically have the ability to avoid
26 spills and may therefore suffer lethal or sublethal effects. Oil from large and catastrophic spills
27 that reaches shallower, nearshore areas of these planning areas has the potential to be of greatest
28 significance to fish communities. The potential impacts of OCS oil spills on fish communities in
29 the Beaufort and Chukchi Sea Planning Areas are discussed in detail in Section 4.4.7.3.3.

30
31 Some diadromous species of the Beaufort and Chukchi Sea Planning Areas could be at
32 greater risk from oil spills because of their unique life-history cycles. Oil spills occurring at
33 constrictions in migration routes, nursery areas, and spawning areas would have an increased
34 potential for adversely affecting diadromous fishes, and catastrophic spills could result in long-
35 term, population-level impacts on diadromous fish communities. Pacific salmon are also able to
36 detect and avoid oil spills in marine waters (see Section 4.4.7.3.2), which would help to reduce
37 the potential for contact. Aggregations of salmon in marine waters typically consist of mixed
38 stocks, so even in the unlikely event of contact with an oil spill, it is anticipated that only a small
39 fraction of any unique spawning population would be adversely affected. Juveniles of some
40 species of whitefish (including broad whitefish, humpback whitefish, and least cisco) are
41 intolerant of highly saline marine conditions. During their summer feeding dispersals in the
42 Beaufort Sea, these species tend to remain within a narrow band of warm, low-salinity water
43 along the coast. Thus, unlike most subarctic fishes, North Slope whitefish have a reduced
44 capacity to bypass localized disruptions to their migration corridor by moving offshore and
45 around the impasses. An oil spill, even one of limited area, could block the narrow nearshore

1 corridor and prevent fishes from either dispersing along the coast to feed or returning to their
2 overwintering grounds in North Slope rivers.

3
4 **Conclusion.** Cumulative impacts on fish communities in the Beaufort and Chukchi Sea
5 Planning Areas could result from OCS and non-OCS activities. It is anticipated that the
6 cumulative effects of OCS and non-OCS activities on fish species in the Beaufort and Chukchi
7 Sea Planning Areas would be similar to the effects of non-OCS activities alone, and the proposed
8 action is expected to contribute only a small increment to the potential for overall cumulative
9 effects on fish resources (see Section 4.4.7.3.3). because of existing regulations, the limited
10 timeframe over which most individual activities would occur and the small proportion of
11 available habitats that would be affected during a given period.

12
13 The magnitude and severity of potential effects to fish resources from oil spills would be
14 small to large, depending on the location, timing, duration, and size of spills; the proximity of
15 spills to particular fish habitats; and the timing and nature of spill containment and cleanup
16 activities. Small spills, whether from OCS or non-OCS sources, are unlikely to have overall
17 population-level effects on fish resources. However, oil from catastrophic spills that contacted
18 shallow nearshore areas of these planning areas has the potential to be of greatest significance to
19 fish communities. Such spills could result in long-term, population-level impacts on fish
20 communities.

21
22
23 **4.6.4.3.4 Invertebrates and Lower Trophic Levels.** This section evaluates the
24 cumulative effects of the proposed action, ongoing or planned OCS activities that would occur
25 during the life of the Program, and non-OCS activities on invertebrates in the Beaufort and
26 Chukchi Sea Planning Areas. The primary routine OCS activities that could result in impacts on
27 invertebrates include seismic surveys, drilling, the placement of subsea wells, platforms, and
28 pipelines; releases of permitted discharges from wells; and removal of existing structures.
29 Potential environmental impacts associated with the building and operation of OCS facilities
30 such as platforms, and pipelines would increase in conjunction with the increased number of
31 wells. The impacts of routine activities (exploration and site development, production and
32 decommissioning) on invertebrate communities are discussed in detail in Section 4.4.7.5.3.
33 Overall, routine activities represent up to a moderate disturbance, primarily affecting benthic
34 infaunal invertebrates, with the severity of the impacts generally decreasing dramatically with
35 distance from bottom-disturbing activities.

36
37 The placement of new platforms over the life of the Program would allow the
38 colonization of invertebrates requiring hard substrate. While some platforms may be allowed to
39 remain as artificial reefs, removal of platforms will reduce available substrate and structures for
40 invertebrates and injure or kill them during removal.

41
42 Oil and gas exploration and development in State waters could also contribute to
43 cumulative effects on invertebrates in the Beaufort and Chukchi Sea Planning Areas. Drilling of
44 wells in State waters could also require construction of platforms and pipelines in waters of
45 Alaska. The effects on invertebrates would be similar to those described above for OCS oil and
46 gas programs (Section 4.4.7.5.3). Other non-OCS activities that could impact invertebrate

1 communities include land use practices, point and non-point source pollution, logging, dredging/
2 and disposal of dredging spoils in OCS waters, and anchoring. Commercial fishing does not
3 occur in the Arctic and therefore is not expected to add to cumulative impacts on invertebrate
4 communities. However, this could change if regulations change and if warming temperatures
5 allow an increase in vessel traffic. Effects on invertebrates from non-OCS dredging and marine
6 disposal activities are expected to be similar to those described for OCS bottom disturbing
7 activities (Section 4.4.7.5.3). Recovery of benthic invertebrates at the dredge and disposal sites
8 to their pre-disturbance composition would likely take multiple years. Many of these activities
9 would affect bottom dwelling invertebrates at various life stages as well as their food sources in a
10 manner similar to OCS bottom disturbing activities (Section 4.4.7.5.1). Other non-OCS
11 activities generating pollution and noise may contribute to general habitat degradation
12 (Section 4.6.3.2.2).
13

14 There are several contaminant sources in the Beaufort and Chukchi Sea Planning Areas.
15 The Red Dog Mine in Alaska is the largest lead and zinc mine in the world, and is presently the
16 only base-metal lode mine operating in northwest Alaska. A study for the National Park Service
17 (Hasselbach et al. 2004) showed extensive airborne transport of cadmium and lead from Red
18 Dog Mine; although the study was focused only on the limits of the Cape Krusenstern National
19 Monument, these contaminants are probably carried out into the Chukchi Sea. There are also
20 natural sources of contaminants. Sediments, peats, and soils from the Sagavanirktok, Kuparuk
21 and Colville Rivers are the largest sources of dissolved and particulate metals and saturated and
22 polycyclic aromatic hydrocarbons in the development area. However, contaminant
23 concentrations in the benthic invertebrates collected in the Beaufort and Chukchi Sea Planning
24 Areas are typically at background levels (Neff & Associates 2010).
25

26 It is predicted that physical and chemical changes to arctic and subarctic invertebrate
27 habitat could result from climate change (Section 3.3). These changes could alter the existing
28 distribution, composition, and abundance of invertebrates, since physical and chemical
29 parameters are the primary influence on invertebrate communities. In general, the increase in
30 seawater temperature will facilitate a northward expansion of subarctic invertebrate species from
31 the Bering Sea. Weslawski et al. (2011) identified the Bering Strait as a major corridor through
32 which new invertebrate species will expand their range northward. Such expansion will likely
33 increase overall invertebrate species diversity in the Arctic, but the new species may displace
34 existing species or alter existing inter-specific species interactions. The change in species
35 composition may be greatest in the eastern Beaufort Sea where arctic species currently
36 predominate. It is predicted that a decrease in sea ice habitat would result from increasing water
37 temperature. This may have several impacts on invertebrate communities in the Arctic
38 including:
39

- 40 • Loss of habitat for invertebrates specialized to inhabit sea ice;
- 41
- 42 • An increase in the productivity of water column invertebrates with increasing
43 temperature and open water;
- 44
- 45 • An increase in the abundance of benthic invertebrates in nearshore areas with
46 the reduction in ice scour extent and duration (Weslawski et al. 2011); and

- An increase in benthic disturbance from severe weather as the amount of open water increases.

Changes in the magnitude, frequency, and timing of river discharge into the Beaufort/Chukchi Shelf Ecoregion are expected to result from climate change (Arctic Council 2005). Invertebrates in marine ecoregions with strong riverine inputs — like the Beaufort Neritic Ecoregion — would likely be affected by alterations in the salinity, temperature, and sediment delivery regime. Hydrologic change can rapidly alter existing invertebrate communities in the water column and benthos, if the new chemical conditions are not within the physiological tolerance of the existing communities. The greater variability in hydrologic conditions could favor tolerant and opportunistic species, thereby homogenizing invertebrate species composition and decreasing overall species diversity in the Beaufort and Chukchi Seas (Weslawski et al. 20011).

The expected increase in ocean acidification is considered to be another significant source of physiological stress. Crustaceans, echinoderms, foraminiferans, and mollusks could have greater difficulty in forming shells, which could reduce their fitness, abundance, and distribution (Fabry et al. 2008).

Oil spills could result from OCS and non-OCS activities. The total number of oil spills and the extent of affected areas would likely increase under the proposed action in conjunction with increased levels of petroleum exploration and production (Table 4.6.1-3). The potential impacts of OCS oil spills on invertebrate communities in the Beaufort and Chukchi Sea are discussed in detail in Section 4.4.7.5.3. Non-OCS activities, such as oil and gas development in State waters, domestic transportation of oil or refined petroleum products, and commercial shipping, may also result in accidental spills that could potentially impact invertebrate resources within the Beaufort and Chukchi Sea Planning Areas. While effects to invertebrates would depend on the timing, location, and magnitude of specific oil spills, it is anticipated that most small to medium spills that occur in OCS waters would have limited effects due to the relatively small areas likely to be exposed to high concentrations of hydrocarbons. Oil from catastrophic spills that reach shallower, nearshore areas of these planning areas has the potential to be of greatest significance to invertebrate communities. Large, mobile epifaunal invertebrates are capable of avoiding high concentrations of hydrocarbons although they may be subject to sublethal exposures. However, infauna and invertebrate eggs and larvae do not typically have the ability to avoid spills and may therefore suffer lethal or sublethal effects. Catastrophic spills could result in long-term alterations in the abundance of intertidal and shallow subtidal invertebrate communities. The potential impacts of OCS oil spills on invertebrate communities in the Arctic planning areas are discussed in detail in Section 4.4.7.5.3.

Conclusion. Cumulative impacts on invertebrate communities in the Beaufort and Chukchi Sea Planning Areas could result from OCS and non-OCS activities. Multiple non-OCS activities could impact invertebrate populations. It is anticipated that the cumulative effects of OCS and non-OCS activities on invertebrates would be similar to the effects of non-OCS activities alone, and the proposed action is expected to contribute only a small increment to the potential for overall cumulative effects on invertebrate resources (see Section 4.4.7.5.3).

1 The magnitude and severity of potential effects to invertebrate resources from oil spills
2 would be a function of the location, timing, duration, and size of spills; the proximity of spills to
3 particular habitats; and the timing and nature of spill containment and cleanup activities. Spills
4 in deeper water, whether from OCS or non-OCS sources, are unlikely to have overall population-
5 level effects on invertebrate resources because of the relatively small proportion of similar
6 available habitats that would come in contact with released oil at concentrations great enough to
7 elicit toxic effects. Oil from catastrophic spills that reaches shallower, nearshore areas of these
8 planning areas has the potential to be of greatest significance to invertebrate communities.
9 Impacts from such spills could result in long-term, population level impacts on invertebrate
10 communities.

11
12
13 **4.6.4.3.5 Areas of Special Concern.** Cumulative impacts to these areas of special
14 concern include impacts from both OCS and non-OCS activities. Section 4.4.8.3 identifies
15 potential impacts that could result from routine activities or accidents related to the proposed
16 leasing program on areas of special concern adjacent to and in the Beaufort Sea and Chukchi Sea
17 Planning Areas.

18
19 **National Park Service Lands.** In the Arctic, activities associated with the Red Dog
20 Mine and its port facility south of Kivalina on the Chukchi Sea would contribute to cumulative
21 impacts on the Cape Krusenstern National Monument. The road from the mine (located just
22 outside the monument) to the port crosses the northern boundary of the monument. Impacts
23 from this facility, such as habitat loss or disturbance, are expected to be minor due to the limited
24 activity associated with the mine.

25
26 There is minor land and air traffic in the Arctic and most visitors would arrive by sea.
27 Because the amount of traffic is restricted and activities within the parks regulated, traffic would
28 likely create a minor addition to cumulative impacts on the NPS lands. It is anticipated that
29 noise generated by OCS offshore construction activities would be at low levels, intermittent, and
30 would not persist for more than a few months at any one time. It is considered unlikely that
31 these additional activities would noticeably affect wildlife or park user values compared to
32 current (non-OCS) activities within the Beaufort and Chukchi Sea Planning Areas.

33
34 Impacts on these areas could occur due to accidental releases of oil spilled from onshore
35 facilities and offshore drilling rigs. Non-OCS activities, such as oil and gas development in State
36 waters, the domestic transportation of oil or refined petroleum products, the production and
37 storage of petroleum products, and commercial shipping (tanker traffic) could also result in
38 accidental spills that could affect park lands. Naturally occurring seeps may also be a source of
39 crude oil introduced into nearshore waters (Kvenvolden and Cooper 2003). Noatak National
40 Preserve, Kobuk River National Preserve, Cape Krusenstern National Monument, and Bering
41 Land Bridge National preserve all have coastlines on or near the Chukchi Sea and could
42 potentially be affected by spills from tanker traffic. Although not an NPS land, the National
43 Petroleum Reserve is managed by BLM and has a large shoreline component that borders the
44 Chukchi Sea. An oil spill would have the greatest effect if it came into contact with shoreline
45 habitats. Impacts would depend primarily on the spill location, size, and time of year. In
46 general, directly affected coastal fauna could include marine mammals; fishes that reproduce in,

1 inhabit, or migrate through coastal areas; terrestrial mammals that feed on these fishes; and
2 marsh birds and seabirds. Spilled oil could also affect subsistence harvests in those parks in
3 which subsistence hunting and fishing are allowed and could affect the number of park visitors.
4

5 **National Wildlife Refuges.** NWRs in the vicinity of the Beaufort and Chukchi Sea
6 Planning Areas are identified in 3.9.3.2 for the Beaufort and Chukchi Seas. NWRs (including
7 three units of the Alaska Maritime NWR) potentially affected by OCS activities include the
8 Arctic National Wildlife Refuge (ANWR) and the Alaska Maritime NWR (Chukchi Sea Unit,
9 Gulf of Alaska Unit, Alaska Peninsula Unit).
10

11 Oil drilling and facility development are prohibited in the ANWR and are discretionary
12 on all other refuges; however, refuges could potentially be affected by OCS oil and gas
13 development from adjacent regions under the cumulative case scenario. These refuges could be
14 contaminated by oil spilled from offshore projects, or could be subject to negative effects from
15 routine operations associated with the development of onshore oil and gas support facilities.
16 They could also be affected by non-OCS activities within or adjacent to refuges including State
17 oil and gas development, the domestic transportation of oil or refined petroleum products, the
18 production and storage of petroleum products and LNG, and commercial shipping. Numerous
19 refuge lands have been conveyed to private owners and Native corporations. Section 22(g) of
20 the Arctic Native Claims Settlement Act (1971) requires that new development on these lands
21 must be in accordance with the purpose for which the refuge was formed. Thus, while
22 development of onshore oil and gas support facilities is technically possible, such development
23 would be subject to intensive review (as would any other development).
24

25 The potential cumulative effects of routine operations and accidental events on these
26 NWR's are essentially the same as those discussed above for the NPS lands. In addition,
27 subsistence hunting and fishing are permitted on all refuges in Alaska and could, therefore, be
28 affected by accidents and routine operations in the immediate vicinity of refuge properties.
29

30 **National Forests.** There are no national forests in the Beaufort and Chukchi Sea
31 Planning Areas.
32

33 **Conclusion.** Overall, routine OCS operations could result in small incremental increases
34 in effects on national parks and wildlife refuges compared to existing non-OCS activities.
35 Development of onshore facilities within national park lands in the vicinity of the areas included
36 in the Program is considered unlikely, thereby making impacts from cumulative routine OCS
37 operations unlikely in these areas. Offshore construction of pipelines and platforms could
38 contribute to cumulative effects on wildlife and on scenic values for park visitors due to noise
39 and activity levels. However, such effects would be localized, intermittent, and temporary. It is
40 anticipated that lease stipulations applied at the lease sale stage could minimize the potential for
41 cumulative impacts from routine operations on these areas.
42

43 Compared to the existing potential for oil spills to affect such areas, the activities under
44 the proposed action would be expected to result in a small incremental increase in the risk of
45 impacts from oil spills to areas of special concern. The cumulative level of impacts from spills
46 would depend on spill frequency, location, and size; the type of product spilled; weather

1 conditions; effectiveness of cleanup operations; and other environmental conditions at the time
2 of the spill. Large and catastrophic oil spills in areas adjacent to the national parks or refuges,
3 whether from OCS or non-OCS sources, could negatively impact coastal habitats and fauna and
4 could also affect subsistence uses.

7 **4.6.5 Social, Cultural, and Economic Resources**

10 **4.6.5.1 Gulf of Mexico Region**

13 **4.6.5.1.1 Population, Employment, and Income.** Section 4.4.9.1 discusses the
14 potential impacts from the proposed action (OCS program activities from 2012 to 2017) on
15 population, employment, and income in the GOM coast region. Cumulative impacts on these
16 resources result from the incremental impacts of the proposed action when added to impacts
17 from existing and reasonably foreseeable future OCS program activities (that are not part of the
18 proposed action) and other non-OCS program activities. Specific types of impact-producing
19 factors related to OCS program activities considered in this analysis include total employment
20 and regional income for counties in the 23 LMAs in the five States in the GOM coast region
21 (described in Section 3.10). Non-OCS program activities affecting the region include
22 employment and earnings related to various other industrial sectors (e.g., construction,
23 manufacturing, services, and State and local government) and the high unemployment rates in
24 the five GOM coast States.

26 The population in the GOM coast counties increased at an average annual rate of 1.6%
27 between 1980 and 1990, 1.2% between 1990 and 2000, and 1.5% between 2000 and 2009.
28 During each of these periods, the greatest increases consistently occurred in Texas (with an
29 average annual increase of 2.1% between 2000 and 2009) and Florida (with an average annual
30 increase of 1.6% between 2000 and 2009). The components of population increase include the
31 natural increase due to births and net positive domestic and international migration; these trends
32 will likely continue in the GOM coast region over the next 40 to 50 yr.

34 Although the proposed action would add an average of 9,084 to 14,839 jobs annually
35 between 2012 and 2017, this increase is considered minor (though positive) since it would
36 amount to less than 1% of total GOM coast regional employment. The largest increases would
37 occur in Louisiana and Texas. Likewise, income produced in the region would range from
38 \$648.6 million to \$1,066.2 million, with the greatest impacts occurring in Louisiana and Texas.

40 Population increases of 7,455 to 16,497 would be expected in Louisiana on average in
41 each year of the proposed action, with increases of 6,260 to 14,131 occurring in Texas. Smaller
42 population increases of 1,065 to 2,311 per new job would occur in Florida, with increases of
43 342 to 750 in Alabama and 283 to 620 in Mississippi. These increases also represent small
44 changes (about 1% in the region overall), assuming a 1.5% average annual increase in population
45 between 2009 and 2017.

1 Employment impacts of oil spills reaching landfall can vary considerably depending upon
2 the total volume of oil reaching land, land area affected, and sensitivity of local environmental
3 conditions to oil impacts. The primary impacts of oil spills would most likely fall on such
4 activities as beach recreation, diving, commercial fishing, recreational fishing, and sightseeing.
5 Oil spills reaching land can have both short- and long-term effects on these recreational coastal
6 activities. Past studies (Sorenson 1990) have shown that there could be a one-time seasonal
7 decline in tourist visits of 5 to 15% associated with a major oil spill. Since tourist movement to
8 other coastal areas in the region often offsets a reduction in the number of visits to one area, the
9 associated loss of business tends to be localized. As discussed in Section 4.4.9, the employment
10 and regional income impact from an oil spill related to the proposed action would likely be
11 greatest in Texas and Florida and this would likely continue over the next 40 to 50 yr. Oil spills
12 will generate only temporary employment (and population) increases during cleanup operations,
13 because such operations are expected to be of short duration.

14
15 Hurricanes are recurring events in the GOM area to which the demographic and
16 economic patterns have adjusted. In 2005, however, Hurricanes Katrina and Rita resulted in
17 major socioeconomic changes throughout the GOM region, affecting population, employment,
18 and regional income. Katrina-related flooding affected 49 counties in Alabama, Louisiana, and
19 Mississippi, resulting in estimated damage of more than \$155 billion (Burton and Hicks 2005).
20 Damage or loss of hundreds of thousands of homes has resulted in the out-migration of hundreds
21 of thousands of individuals from the region, with varying levels of long-term population
22 displacement. Estimated declines in employment due to hurricane damage and population
23 displacement have ranged from 150,000 to 500,000 jobs, although employment is expected to
24 increase as reconstruction of impacted areas proceeds (Congressional Budget Office 2005).
25 Estimated declines in the 2005 total annual personal income in the GOM range from \$10 million
26 in Texas to more than \$18 million in Louisiana (Bureau of Economic Analysis 2006).

27
28 **Conclusion.** The cumulative impacts of ongoing and future OCS program and non-OCS
29 program activities would be considered beneficial because these activities would increase
30 employment and earnings in the region over the next 40 to 50 yr. The proposed action would
31 add to these beneficial impacts, especially in Texas and Louisiana. The incremental impact of
32 the proposed action is expected to be small, however, because the added employment demands
33 are less than 1% of the total GOM coast regional employment (see Section 4.4.9.1).

34
35 In areas with a large proportion of impact-sensitive industry (such as tourism), the
36 cumulative impacts of accidental oils spills could be moderate to major, depending on the total
37 volume of oil reaching land, the land area affected, and the sensitivity of local environmental
38 conditions to oil impacts. The incremental impacts of oil spills associated with the proposed
39 action would be small to medium relative to those associated with ongoing and future OCS
40 program and non-OCS program activities.

41
42
43 **4.6.5.1.2 Land Use and Infrastructure.** Localized site-dependent impacts to land use
44 and existing infrastructure are anticipated as a result of the construction of new OCS program oil
45 and gas facilities in the GOM over the next 40 to 50 yr. Depending on the location selected,
46 onshore development may necessitate minimal changes of existing or potential future uses, as

1 well as minor increases in demands on roads, utilities, and public services (MMS 2007c). Land
2 use generally would evolve over time, with a majority of change to occur from general, regional
3 economic, and demographic growth rather than from activities associated with the existing OCS
4 program and/or State offshore petroleum production or future planned OCS or State lease sales
5 (BOEMRE 2011a).
6

7 Recently, deepwater gas production has increased while gas production along the coast
8 has substantially decreased. These trends have combined to lower the need for new gas
9 processing facilities along the GOM coast. As a result, BOEM has concluded that “spare
10 capacity at existing facilities should be sufficient to satisfy new gas production for many years,
11 although there remains a slim chance that a new gas processing facility may be needed”
12 (BOEMRE 2011a). With some modifications, current facilities and land use classifications
13 would be expected to support oil and gas production associated with new leases. Likewise,
14 service-based infrastructure would be able to support offshore petroleum-related activities in
15 both the OCS and State waters (BOEMRE 2011a).
16

17 Ongoing non-OCS program activities that could affect land use and onshore
18 infrastructure are expected to continue into the foreseeable future. These include offshore and
19 onshore construction, the discharge of municipal and other waste effluents, and vessel traffic
20 (MMS 2007c).
21

22 Activities within the GOM may be affected by post-DWH event conditions. A
23 significant amount of information has been generated regarding the consequences of the oil spill
24 and subsequent drilling moratorium. As the post-DWH event situation is dynamic, BOEM has
25 been conducting ongoing monitoring of post-DWH event impacts on land use and coastal
26 infrastructure. BOEM plans to continue to conduct targeted and peer-reviewed research, as long
27 as the monitoring identifies long-term impacts of concern (BOEMRE 2011a).
28

29 Accidental oil releases may occur as a result of both OCS and non-OCS activities. Oil is
30 also released from naturally occurring seeps. The extent of the impacts would depend on the
31 location and size of the releases, but could include stresses of spill response on the community
32 infrastructure, increased traffic to respond to cleanup, and restricted access to particular lands
33 while cleanup is conducted. In general, these releases would be expected to have a temporary
34 impact on land use and infrastructure (MMS 2007c).
35

36 **Conclusion.** Localized site-dependent impacts to land use and existing infrastructure are
37 anticipated as a result of ongoing and future OCS program and non-OCS program activities in
38 the GOM. These impacts could range from minor to major depending on the nature (extent and
39 duration) of the land use change. Minimal changes of existing or potential future uses, as well as
40 minor increases in demands on roads, utilities, and public services would be expected at
41 locations of OCS program development. Ongoing non-OCS program activities (e.g., offshore
42 and onshore construction and municipal discharges) that could affect land use and onshore
43 infrastructure are expected to continue into the foreseeable future (see Section 4.4.10.1).
44 Activities within the GOM also may be affected by the post-DWH event conditions; BOEM
45 continues to monitor the region to identify long-term impacts of concern.
46

1 The extent of land use-related impacts resulting from accidental oil spills and naturally
2 occurring seeps could be minor to major, depending on the location and size of the releases.
3

4 5 **4.6.5.1.3 Commercial and Recreational Fisheries.** 6

7 **Commercial Fisheries.** Routine OCS activities over the next 40 to 50 yr could harm or
8 kill individual fishes, resulting in temporary movements of fishes away from areas where
9 activities were being conducted. Impacts would vary depending on the nature of a particular
10 structure, the phase of operation, the fishing method or gear, and the target species group.
11 Impacts would be higher for drifting gear such as purse nets, bottom longlines, and pelagic
12 longlines than for trawls and handlines (MMS 2005). Nevertheless, areas in which commercial
13 fishing would be affected are small relative to the entire fishing area available to surface
14 longliners or purse seiners. Although long-term effects on populations of most fishes in the
15 GOM as a whole are not anticipated, populations of rare fishes or those that have highly limited
16 distributions within the GOM could be more substantially affected if activities occurred in areas
17 with high concentrations of individuals.
18

19 Offshore oil and gas structures placed within the depth range 0 to 60 m (0 to 200 ft)
20 would increase annual commercial fishing costs by between \$1,993 and \$3,819 in the Western
21 Planning Area, while reducing costs by between \$2,507 and \$11,243 in the Central Planning
22 Area. Currently, there are no data available on the placement of offshore platforms in the
23 Eastern Planning Area; consequently, we can draw no conclusions regarding their impact on
24 commercial fishing costs.
25

26 Depending upon the location, magnitude, and timing of accidental oil spills from OCS
27 platforms or pipelines, lethal or sublethal toxic effects could occur, especially for species that
28 have pelagic eggs and larvae. If spills occurred in areas with high concentrations of eggs or
29 larvae of a particular species, the abundance of a particular year-class could be affected. The
30 effects of spilled oil on commercial fisheries include fishing ground area closures, contaminated
31 fish, fouled fishing gear and associated equipment, and degradation of fishing grounds.
32 Accidental oil releases from non-OCS activities are possible anywhere on the OCS or in State
33 waters (i.e., from vessel collisions or transfer/lightering operations); crude oil also enters the
34 environment from naturally occurring seeps. Although such releases typically occur in deeper
35 water, the released oil should rise to the surface relatively quickly, and although it is anticipated
36 that most adult fish would be able to avoid the resulting plumes of oil, larvae or eggs of some
37 fish species could be affected and commercial fishing gear could become fouled with oil. In
38 many cases, commercial fisheries would be able to return to the area after slicks have been
39 cleaned up or dispersed. However, shallow coastal spills could contaminate tissues of target
40 organisms (e.g., oyster beds and shallow benthic fishes), and affected commercial fisheries could
41 be closed for one or more seasons.
42

43 Non-OCS program activities and factors that could affect fish populations in the GOM
44 include State oil and gas activities, commercial shipping, land development, dredging and
45 dredge-disposal operations, marine mineral extraction, and water quality degradation from both
46 point and nonpoint pollution sources. In particular, space-use conflicts resulting from

1 exploration and delineation activities and establishment of development and production
2 platforms could affect commercial fisheries, with some areas precluded from commercial
3 fisheries. There are temporary exclusions from fishing in areas during exploration and
4 delineation activities. Underwater OCS structures such as pipelines could also cause space- and
5 gear-related conflicts, and increased vessel traffic to and from the rigs and platforms will also
6 increase the amount of marine traffic and possible conflicts with commercial fishers. The
7 potential for spatial preclusion also exists in both nearshore and offshore waters with increased
8 levels of seismic survey activity.

9
10 **Recreational Fisheries.** While space-use conflicts with recreational fisheries caused by
11 routine OCS operations would be minimal, there is recreational shrimp trawling for wild shrimp,
12 and trawls could become entangled with OCS structures in the water. Deepwater recreational
13 rod-and-reel anglers typically target oil and gas platforms because these structures usually attract
14 target species. Noise from rig and platform installation and from seismic surveys during
15 exploration and delineation activities could scatter target species away from some recreational
16 fishing areas while activities are occurring and potentially for some period afterward.
17 Temporary reductions in hook-and-line captures have been reported in some areas following
18 seismic surveys. This may result in decreased recreational catch. Platform removal using
19 explosives may also impact recreational fisheries. The noise would drive some fish away, some
20 fish would be killed, and a structure that may be targeted as a fishing location by recreational
21 anglers could be eliminated.

22
23 Oil spills from OCS or non-OCS sources could affect recreational fisheries by fouling
24 gear with oil, tainting the catch, and degrading water quality and fishing grounds. Accidental oil
25 releases from non-OCS activities are possible anywhere on the OCS or in State waters, and crude
26 oil also enters the environment from naturally occurring seeps. The OCS oil spills most likely to
27 affect recreational anglers would be shallow water spills, since recreational anglers are less likely
28 to venture far offshore. Non-OCS oil and gas activities likely pose a greater risk in terms of
29 potential oil spills that could affect recreational fisheries, because such activities are located
30 closer to shore. Closure of some areas to fishing, perhaps for multiple seasons, could occur as a
31 result of oil spills. In addition, public perception of the effects of a spill on marine life and its
32 extent could result in a loss of revenue for the fishing-related recreation industry. Party and
33 charter boat recreational fisheries often have losses of income because of reduced interest in
34 fishing when a spill has occurred. Local hotels, restaurants, bait-and-tackle shops, and boat
35 rental companies associated with recreational fisheries may experience reduced sales because of
36 public perception related to an oil spill.

37
38 **Conclusion.** The proposed action would represent a small increment to the potential for
39 overall cumulative effects on fisheries in the GOM. Routine OCS program activities would be
40 unlikely to have cumulative population- or community-level effects on fishery resources because
41 of the limited timeframe over which most individual activities would occur, because a small
42 proportion of habitat, relative to similar available habitat, could be affected during a given period
43 and because existing stipulations are in place to avoid impacts on sensitive habitats such as hard-
44 bottom areas and topographic features. Non-OCS program activities, including State oil and gas
45 development, commercial fishing, and sportfishing, could also contribute to cumulative effects
46 on fisheries. Depending on specific conditions during a large spill, there could be substantial

1 economic losses for commercial fisheries as a consequence of reduced catch, loss of gear, or loss
2 of fishing opportunities during cleanup and recovery periods. Non-OCS program sources of
3 spills, including State oil and gas production, have a potential to cause similar effects. The
4 occurrence of a very large spill, such as could occur from a tanker accident, could have
5 substantially greater effects on fisheries.
6

7 It is anticipated that the proposed action would represent a small increment to the overall
8 cumulative effects on recreational fisheries in the GOM. Routine OCS activities from the
9 proposed action, as well as from ongoing and planned OCS activities would be unlikely to have
10 cumulative population- or community-level effects on fishery resources because of the limited
11 timeframe over which most individual activities would occur, because only a small proportion of
12 habitat, relative to similar available habitat, could be affected during a given period, and because
13 of existing stipulations that are in place to avoid impacts to sensitive habitats such as hard bottom
14 areas and topographic features. Construction of new platforms could represent a small increase
15 in the availability of desirable recreational fishing locations for recreational anglers.
16
17

18 **4.6.5.1.4 Tourism and Recreation.** Noise from platform installation and platform
19 removal can affect recreational fishing by temporarily disturbing fish and by possible fish kills if
20 explosives are used to remove platforms. Platforms installed within 16 km (10 mi) of coastal
21 recreation areas, such as beaches, parks, and wilderness areas, can affect recreational experiences
22 by affecting ocean views. Transportation of oil and gas, combined with other commercial,
23 industrial, and recreational transportation activities that continue to occur within the GOM, can
24 impact recreational experiences through increased noise, boat wake disturbances, visual
25 intrusions, and increased trash and debris washing ashore. In addition to transportation and oil
26 and gas, other activities contribute to the trash and debris found on the beaches including (but not
27 limited to) beach visitors, commercial and recreational fishing, merchant shipping, naval
28 operations, and cruise lines.
29

30 Non-OCS activities that might impact recreation and tourism include offshore
31 construction (e.g., dredging and marine disposal, extraction of non-energy minerals, State oil and
32 gas development, domestic transportation of oil and gas, and foreign crude oil imports), onshore
33 construction (e.g., coastal and community development), the discharge of municipal and other
34 waste effluents, and vessel traffic (e.g., commercial shipping, recreational boating, and military
35 training and testing).
36

37 Accidental oil releases may occur as a result of both OCS and non-OCS activities, and oil
38 is also released from naturally occurring seeps. The magnitude of the impacts would depend on
39 the location and size of the releases, as well as their timing with respect to peak tourism seasons.
40 These releases are expected to have a temporary impact on recreation and tourism in the GOM
41 region. Closures of recreational areas for up to 6 weeks could occur to accommodate cleanup
42 operations. Releases identified under the proposed action are anticipated to be small, for the
43 most part, and to occur in waters greater than 200 m (660 ft) in depth. These releases would be a
44 small addition to releases associated with other OCS and non-OCS activities.
45

1 Severe storm events such as hurricanes have the potential to impact the recreation and
2 tourism economy if they result in severe beach damage and/or destruction of existing public
3 infrastructure. While hurricanes are regularly occurring events in the GOM, Hurricanes Katrina
4 and Rita in 2005 caused unusually large amounts of damage to the tourism and recreation
5 infrastructure in the area. These storms destroyed recreational beaches, public piers, hotels,
6 casinos, marinas, recreational pleasure craft and charter boats, and numerous other recreational
7 infrastructure. Almost 70% of the recreational fishing assets in Mississippi alone were damaged
8 by Katrina (Posadas 2005). Of the 13 casino-barge structures present along the Mississippi coast
9 prior to Katrina, most suffered severe external damage, seven broke completely free of their
10 moorings, two partially broke free and damaged adjoining structures, one sank, and one was
11 deposited inland by the storm surge (National Institute of Standards and Technology, draft). The
12 full extent of impacts to tourism and recreation by the hurricanes has yet to be fully quantified,
13 but it will likely take years for tourism and recreation to return to pre-hurricane levels.

14
15 **Conclusion.** Cumulative impacts on recreation and tourism from OCS and non-OCS
16 program activities in the GOM would be limited for most routine activities, with the exception of
17 impacts associated with large oil spills during the peak tourist season, which could be moderate
18 (but short-term). The incremental contribution of routine Program activities to cumulative
19 impacts would be minor, resulting from small incremental increases in construction and
20 transportation noise and related visual intrusions, potential increases in trash and debris related to
21 these activities, and the potential for a relatively small number of accidental releases
22 (see Section 4.4.12.1).

23
24
25 **4.6.5.1.5 Sociocultural Systems.** The GOM coastal commuting zone is ethnically and
26 culturally diverse and includes a well-established oil and gas industry focused mainly in
27 Louisiana and Texas (Section 3.14.1.1). For the most part, oil and gas development on the OCS
28 will make use of existing pipelines and onshore infrastructure. Increases in activities associated
29 with OCS program development are anticipated to be incremental and qualitatively similar to
30 current patterns. However, as deepwater drilling expands, jobs that require longer, unbroken
31 periods of offshore work will increasingly attract a more international workforce promoting
32 sociocultural heterogeneity in coastal support communities, particularly in Texas and Louisiana.

33
34 Non-OCS program activities and processes affecting sociocultural systems are expected
35 to continue. These include oil and gas development in State waters, coastal habitat changes,
36 coastal land loss, regional economic changes, and recovery from storms and major oil spills.
37 These activities and processes can lead to major impacts related to population change, job
38 creation and loss, and changes in social institutions including family, government, politics, and
39 education.

40
41 Accidental oil and other spills could result from both OCS and non-OCS activities. The
42 magnitude of spill impacts depends on their size, location, and timing. With the exception of
43 major spills (such as occurred with the DWH event), they are expected to have only temporary
44 physical and economic effects and therefore should not significantly alter sociocultural systems.

1 The wetlands that supply subsistence resources are susceptible to oil spills. The
2 Louisiana parishes of St. Mary, Terrebonne, and Lafourche, are home to populations engaged in
3 renewable resource harvesting, are also areas of heavy to moderate concentrations of oil and gas
4 industry facilities. As discussed in Section 3.7, the wetlands in coastal Louisiana are rapidly
5 diminishing because of engineering projects to control the Mississippi River, natural subsidence,
6 the development of the oil and gas industry, and climate change (Field et al. 2007). Because of
7 the construction of flood-control structures, the Mississippi River no longer floods Louisiana's
8 wetlands; these floods previously deposited new silt to offset coastal erosion. Extraction of oil
9 and gas from coastal areas may have resulted in some subsidence of bayou lands. In many areas,
10 Louisiana's coastal wetlands have been cut by a network of canals constructed to lay pipes
11 bringing oil and gas to onshore refining facilities (Field et al. 2007). Cut in straight lines from
12 the shore, these canals exacerbate the erosive force of tides and storm surges. Climate change
13 has resulted in slowly increasing sea levels and an increased intensity of coastal storms and
14 hurricanes. The end result has been an overall decrease in Louisiana's wetlands and a reduction
15 in fresh and brackish wetlands and the subsistence species they support, along with an increase in
16 salt marshes. Cumulatively, these changes constitute major impacts on a way of life that was
17 once common along the GOM coast.

18
19 It is anticipated that global climate change will result in increased temperatures and rising
20 relative sea levels along the GOM coast and these changes will be accompanied by an increase in
21 severe storms in the coming decades. Rising relative sea levels and increased erosion have been
22 observed all along the coast (Field et al. 2007). Those who rely at least in part on harvesting
23 renewable resources from the sea, either as subsistence or commercial fishers and shrimpers, are
24 predicted to be most vulnerable to adverse effects resulting from these changes
25 (Nicholls et al. 2007).

26
27 **Conclusion.** Absent a major oil spill, the greatest contribution to cumulative impacts
28 from the proposed action is expected to come from the expansion of deepwater activities, which
29 would create jobs that require longer, unbroken periods of work offshore, specialized skills, and
30 in-migration of part of the workforce. These are already trends in the OCS oil and gas industry.
31 Since these and other potential sociocultural effects are expected to be minimal additions to
32 existing trends, the incremental impact on sociocultural systems during the life of the Program
33 would not result in significant changes to these systems and would, therefore, be small
34 (see Section 4.4.13.1).

35
36 In terms of subsistence and renewable resource harvesting, non-OCS activities such as
37 flood control along the Mississippi River and natural trends such as global climate change have
38 produced major adverse impacts on the GOM coast region. Ongoing and future OCS and non-
39 OCS program activities would add to these impacts. The relative contribution of the proposed
40 action to cumulative impacts on subsistence harvesting is expected to be small to medium.

41
42
43 **4.6.5.1.6 Environmental Justice.** Over the next 40 to 50 yr, air emissions from OCS
44 and non-OCS onshore facilities and helicopter and vessel traffic traversing coastal areas would
45 be highest in the States such as Texas and Louisiana that contain the greatest amounts of
46 infrastructure. Lesser amounts of infrastructure would occur in Mississippi and Alabama. No

1 onshore infrastructure supporting OCS operations currently exists in Florida, and none will be
2 built as a result of the proposed action. It is assumed that 75% of the activity from the Program
3 will occur in deep and ultra-deep waters, with offshore air emissions greatest in the coastal areas
4 of Texas and Louisiana, the areas with the greatest amounts of oil and gas activity, with lesser
5 amounts in occurring in Mississippi and Alabama. The coastal areas of Florida are located so far
6 from OCS activities that no environmental justice issues from offshore air emissions are
7 expected to impact the coastal parts of the State. The effects of the OCS program on air quality
8 have been analyzed in Section 4.4.4. This analysis concluded that routine operations associated
9 with the proposed 5-yr program would result in NO₂, SO₂, PM₁₀, and CO levels that are well
10 within the NAAQS. Disproportionate impacts on low-income or minority populations would be
11 minor, because the coastal effects from offshore activities are expected to be small, based on the
12 established and increasing trend toward movement of oil and gas activities into deeper waters of
13 the GOM.

14
15 The proposed action would result in levels of infrastructure use and construction similar
16 to those which have already occurred in the GOM coast region during previous programs. These
17 activities are not expected to expose residents to notably higher risks than currently occur. While
18 the distribution of offshore-related activities and infrastructure indicates that some places and
19 populations in the GOM region would continue to be of environmental justice concern, the
20 incremental contribution of the Program is not expected to affect those places and populations.

21
22 Non-OCS activities and processes that are ongoing, expected to continue into the
23 foreseeable future, and that have the potential for creating environmental justice impacts include
24 non-OCS oil and gas development, coastal habitat changes, coastal land loss, economic
25 development, regional economic changes, and recovery from storms. These activities and
26 processes could disproportionately impact low-income and minority populations.

27
28 In addition to oil and chemical spills that could occur with the proposed action, oil
29 releases and spills could also occur from other non-OCS sources such as natural oil seeps, State
30 oil and gas activity, and petrochemical refining and processing. While the timing and location of
31 these spills cannot be determined and some low-income and minority populations are resident in
32 some areas of the GOM coast, in general the coasts are home to more affluent groups. Low-
33 income and minority groups are not more likely to bear more negative impacts than are other
34 groups.

35
36 **Conclusion.** In the GOM, ongoing and future OCS and non-OCS program activities in
37 combination with the effects of storm and hurricane damage and regional economic issues would
38 result in disproportionate moderate to major adverse cumulative impacts on low-income and
39 minority populations. The incremental contribution of routine Program activities to these
40 impacts would be small (see Section 4.4.14.1).

41
42 The incremental impacts of accidental oil spills associated with the proposed action
43 would be small to large, depending on the size, location, and timing of the spill (see
44 Section 4.4.14.1).

45
46

1 **4.6.5.1.7 Archeological and Historic Resources.** Section 4.4.1.5 discusses the potential
2 impacts from the proposed action (OCS program activities from 2012 to 2017) on onshore and
3 offshore environments in the GOM. Cumulative impacts on archeological and historic resources
4 result from the incremental impacts of the proposed action when added to impacts from existing
5 and reasonably foreseeable future OCS program activities (that are not part of the proposed
6 action) and other non-OCS program activities. Table 4.6.1-1 presents the exploration and
7 development scenario for the GOM cumulative case (encompassing the proposed action and
8 other OCS program activities). Specific types of impact-producing factors related to OCS
9 program activities considered in this analysis include drilling rig and platform emplacement,
10 pipeline emplacement, anchoring, new onshore facilities, ferromagnetic debris associated with
11 OCS activities, and oil spills. Non-OCS program activities include trawling, sport diving,
12 commercial treasure hunting, and channel dredging. Natural phenomena such as waves,
13 currents, and tropical storms are also considered.
14

15 **Prehistoric Resources.** Offshore development could result in an interaction between a
16 drilling rig, platform, pipeline, or anchors and an inundated prehistoric site. This direct physical
17 contact with a site could destroy artifacts or site features and could disturb the stratigraphic
18 context of the site. The result would be the loss of archaeological data on prehistoric migrations,
19 settlement patterns, subsistence strategies, and archaeological contacts for the Americas and the
20 Caribbean.
21

22 Since 1973, BOEM (formerly the MMS) has required that an archaeological survey be
23 conducted prior to development of mineral leases determined to have potential for cultural
24 resources including prehistoric archaeological sites. High-probability areas for the occurrence of
25 prehistoric sites in the GOM include the region of the OCS shoreward of the 45-m (50-ft)
26 isobath. Although an archaeological survey would identify most of the cultural resources in the
27 APE for the project and routine operations related to OCS program activities would avoid all
28 known cultural resources, it is likely that impacts to prehistoric resources may have already
29 occurred as a result of OCS program and non-program activities that took place before
30 implementation of the 1973 archaeological survey requirement.
31

32 Onshore development could result in direct physical contact between the construction of
33 new onshore facilities or pipeline trenches and previously unidentified prehistoric sites. This
34 direct physical contact with a prehistoric site could cause physical damage to or complete
35 destruction of information on the prehistory of the region and North America. Federal and State
36 laws and regulations initiated in the 1960s began requiring archaeological surveys prior to
37 permitting any activity that might disturb a significant archaeological site. Therefore, it can be
38 assumed that, since the introduction of the archaeological resource protection laws, most coastal
39 archaeological sites have been located, evaluated, and mitigated prior to construction. However,
40 impacts to coastal prehistoric resources may have already occurred as a result of various onshore
41 construction activities prior to enactment of the archaeological resource protection laws.
42

43 Trawling activity in the GOM affects only the uppermost portion of the sediment column
44 (Garrison et al. 1989). This zone would already have been disturbed by natural factors relating
45 to the destructive effects of marine transgression and continuing effects of wave and current

1 action. Therefore, the effect of future trawling on most prehistoric archaeological sites is
2 expected to be minor.

3
4 Tropical storms and hurricanes are yearly occurrences in the GOM and may be increasing
5 in intensity as a result of global climate change (Section 3.3.1). Past storm events have affected
6 all areas of the GOM, from west Texas to south Florida, and broad areas are affected by each
7 storm (DeWald 1980). Prehistoric sites in shallow waters or coastal beach sites are exposed to
8 the destructive effects of wave action and scouring currents during these events. Under such
9 conditions, it is highly likely that artifacts would be dispersed and the site context disturbed,
10 resulting in the loss of archaeological information. Overall, a significant loss of data from
11 nearshore and coastal prehistoric sites may have occurred, and will continue to occur, from the
12 effects of tropical storms and hurricanes. It is assumed that some of the data lost have been
13 significant and/or unique, resulting in a moderate to major level of impact.

14
15 Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas
16 have a high probability for prehistoric archaeological sites, as they are associated with drowned
17 river valleys, which are known to have a high probability for prehistoric sites. It is assumed that
18 some of the archaeological data that have been lost as a result of dredging have been significant
19 and unique; therefore, the impact to prehistoric archaeological sites as a result of past channel
20 dredging activities has probably been moderate to major. In many areas, the USACE now
21 requires remote-sensing surveys prior to dredging activities to minimize such impacts (Espey,
22 Huston & Associates 1990).

23
24 An accidental oil spill could affect coastal prehistoric archaeological sites, but the direct
25 impact of oil on most sites is uncertain. Protection of such sites during an oil spill event requires
26 specific knowledge of its location, condition, nature, and extent prior to impact; however, the
27 GOM coastline has not been systematically surveyed for archaeological sites. Existing
28 information indicates that, in coastal areas of the GOM, prehistoric sites occur frequently along
29 the barrier islands and mainland coast and along the margins of bays and bayous. Thus, any spill
30 that contacts land would involve potential impacts on prehistoric sites.

31
32 Heavy oiling of a coastal area could conceal intertidal sites that may not be recognized
33 until they are inadvertently damaged during cleanup (Whitney 1994). Crude oil may also
34 contaminate organic material used in ¹⁴C dating, and, although there are methods for cleaning
35 contaminated ¹⁴C samples, greater expense is incurred (Dekin et al. 1993). The major source of
36 potential impacts from oil spills is the harm that could result from unmonitored shoreline cleanup
37 activities. Unauthorized collecting of artifacts by cleanup crew members is also a concern, albeit
38 one that can be mitigated with effective training and supervision. Damage or loss of significant
39 archaeological information could result from the contact between an oil spill and a prehistoric
40 archaeological site; therefore, cumulatively the level of impacts from oil spills (past, present, and
41 future) to prehistoric archaeological sites ranges from moderate to high.

42
43 **Historic Resources.** Direct physical contact between a routine activity and a shipwreck
44 site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and
45 could disturb the site context. The result would be the loss of archaeological data on ship

1 construction, cargo, and the social organization of the vessel's crew, and the concomitant loss of
2 information on maritime culture for the time period from which the ship dates.

3
4 Since 1973, BOEM has required archaeological (historical) surveys be conducted prior to
5 development of mineral leases determined to have potential for historic-period shipwrecks. The
6 high-probability areas for the occurrence of historic-period shipwrecks in the GOM consist of
7 nearshore areas, port vicinities, and ship-specific polygons. Based on experience from the last
8 10 years (as reported by Church and Warren [2008]; Ford et al. [2008]; Atauz et al. [2006]),
9 archaeological surveys are now also being requested for the APE that includes any potential
10 bottom-disturbing activities in deepwater areas that could be affected by a project. Although an
11 archaeological survey would identify most of the cultural resources in the APE for the project
12 and routine operations related to OCS program activities would avoid all known cultural
13 resources, it is likely that impacts on historic-period shipwrecks may have already occurred as a
14 result of OCS program and non-program activities that took place before implementation of the
15 archaeological survey requirement in 1973.

16
17 Onshore development could result in direct physical contact between the construction of
18 new onshore facilities or pipeline trenches and previously unidentified historic sites. Federal and
19 State laws and regulations initiated in the 1960s began requiring archaeological surveys prior to
20 permitting any activity that might disturb a significant archaeological site. Therefore, it can be
21 assumed that, since the introduction of the archaeological resource protection laws, most coastal
22 archaeological sites have been located, evaluated, and mitigated prior to construction. However,
23 impacts to coastal historic sites may have already occurred as a result of various onshore
24 construction activities prior to enactment of the archaeological resource protection laws.

25
26 Trawling activities in the GOM only affect the uppermost portion of the sediment column
27 (Garrison et al. 1989). On many wrecks, this zone would already have been disturbed by natural
28 factors and would contain only artifacts of low specific gravity (e.g., ceramics and glass) which
29 have lost all original contexts. Therefore, the effect of future trawling on most historic
30 shipwreck sites would be minor.

31
32 Sport diving and commercial treasure hunting are significant factors in the loss of historic
33 data from shipwreck sites. While commercial treasure hunters generally affect wrecks having
34 intrinsic monetary value, sport divers may collect souvenirs from all types of shipwrecks. It is
35 assumed that some of the data lost have been significant and/or unique. The known extent of
36 these activities suggests that they have resulted in a major impact to historic-period shipwrecks.

37
38 Tropical storms and hurricanes are yearly occurrences in the GOM and may be increasing
39 as a result of global climate change (Section 3.3.1). Past storms have affected all areas of the
40 GOM, from west Texas to south Florida, and broad areas are affected by each storm
41 (DeWald 1980). Shipwrecks in shallow waters and coastal historic sites are exposed to greatly
42 intensified longshore currents and high-energy waves during tropical storms (Clausen and
43 Arnold 1975). Under such conditions, it is highly likely that artifacts of low specific gravity
44 would be dispersed. Some of the original information contained in the site would be lost in this
45 process, but a significant amount of information may also remain. BOEM-sponsored studies
46 conducted specifically to examine the effect of hurricanes on shipwrecks in the GOM found that

1 storm effects on wrecks varied, with some wrecks being damaged, some unaffected, and others
2 protected because the storm caused sediment to be deposited on the wreck (Gearhart et al. 2011).
3 Overall, a significant loss of data from historic sites has probably occurred, and will continue to
4 occur, from the effects of tropical storms and hurricanes. It is assumed that some of the data lost
5 has been significant and/or unique, resulting in a moderate to major level of impact.
6

7 Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas
8 have a high probability for historic shipwrecks, and the greatest concentrations of historic wrecks
9 are likely to be associated with these features (Garrison et al. 1989). Assuming that some of the
10 data lost have been unique, the impact to historic sites as a result of past channel dredging
11 activities has probably been moderate to major. In many areas, the USACE requires remote-
12 sensing surveys prior to dredging activities, to minimize such impacts (Espey, Huston &
13 Associates 1990).
14

15 Past, present, and future oil and gas exploration and development on the OCS will result
16 in the deposition of tons of ferromagnetic debris on the seafloor. This modern marine debris will
17 tend to mask the magnetic signatures of historic shipwrecks, particularly in areas that were
18 developed prior to requiring archaeological surveys. Such masking of the signatures
19 characteristic of historic shipwrecks increases the potential that significant or unique historic
20 information may be lost. However, BOEM requires avoidance or investigation of any
21 unidentified magnetic anomaly that could be related to a shipwreck site prior to permitting
22 bottom-disturbing activities. The increase in impacts to historic shipwrecks from magnetic
23 masking could range from minor to moderate.
24

25 An accidental oil spill could affect a coastal historic site, but the direct impact of oil on
26 most historic sites is uncertain. The primary source of potential impacts from oil spills is
27 unmonitored shoreline cleanup activities (Bittner 1996; see Section 4.4.15.1.2). Unauthorized
28 collecting of artifacts by cleanup crew members is also a concern, albeit one that can be
29 mitigated with effective training and supervision. Damage or loss of significant historic
30 information could result from oil spill cleanup activities; therefore, the cumulative impact from
31 oil spills (past, present, and future) on historic sites could range from moderate to major.
32

33 **Conclusion.** The cumulative impacts of ongoing and future OCS and non-OCS program
34 activities on prehistoric and historic archaeological sites in the GOM are currently unknown, but
35 could range from minor to moderate, mainly because activities occurring on the OCS prior to
36 BOEM's survey requirement (in effect since 1973) may already have affected significant
37 archaeological sites. Other important impact-producing factors that likely have had, and will
38 continue to have, an impact on both prehistoric and historic archaeological sites are channel
39 dredging, tropical storms, and hurricanes. Commercial treasure hunting and sport diving may
40 also result in a loss of artifacts at historic-period shipwreck sites. The incremental contribution
41 of routine Program activities is expected to be small because required archaeological surveys
42 would identify significant cultural resources to be avoided (see Section 4.4.15.1).
43

44 Cumulative impacts on prehistoric and historic sites due to accidental oil spills would
45 result mainly from cleanup activities (direct impacts to the sites are uncertain) and could range
46 from moderate to major. The incremental impacts of oil spills associated with the proposed

1 action would be small to medium relative to those associated with ongoing and future OCS and
2 non-OCS program activities.

3 4 5 **4.6.5.2 Alaska – Cook Inlet**

6
7
8 **4.6.5.2.1 Population, Employment, and Income.** Section 4.4.9 discusses the potential
9 impacts from the proposed action (OCS program activities from 2012 to 2017) on population,
10 employment, and income in the south-central Alaska region. Cumulative impacts on these
11 resources result from the incremental impacts of the proposed action when added to impacts
12 from reasonably foreseeable future OCS program activities (there are no existing OCS program
13 activities) and other non-OCS program activities. Specific types of impact-producing factors
14 related to OCS program activities considered in this analysis include total employment and
15 regional income for the south Alaska region, which corresponds to the Cook Inlet Planning Area
16 (described in Section 3.10). Non-OCS program activities affecting the region include
17 employment and earnings related to various other industrial sectors (e.g., construction,
18 manufacturing, services, and State and local government).

19
20 The population in the Cook Inlet Planning Area increased at an average annual rate of
21 3.2% between 1980 and 1990, 1.3% between 1990 and 2000, and 1.2% between 2000 and 2009.
22 During each of these periods, the greatest increases consistently occurred on the Kenai Peninsula
23 (with an average annual increase of 1.1% between 2000 and 2009) and in Anchorage (also with
24 an average annual increase of 1.1% between 2000 and 2009). The components of population
25 increase include the natural increase due to births and net positive domestic and international
26 migration; these trends will likely continue in south central Alaska over the next 40 to 50 yr.

27
28 Although the proposed action would add an average of 83 to 113 jobs annually between
29 2012 and 2017, this increase is considered minor (though positive) since it would amount to less
30 than 5% of total Alaska employment (additional jobs created in the rest of Alaska during the
31 same period would range from 1,400 to 1,890). Likewise, income produced in the region would
32 range from \$2.8 million to \$3.8 million annually in south central Alaska, which constitutes about
33 13% of income in Alaska overall.

34
35 Employment impacts of oil spills reaching landfall can vary considerably depending upon
36 the total volume of oil reaching land, the land area affected, and the sensitivity of local
37 environmental conditions to oil impacts. The primary impacts of oil spills would most likely fall
38 on such activities as beach recreation, commercial fishing, recreational fishing, and sightseeing.
39 Oil spills reaching land can have both short- and long-term effects on these recreational coastal
40 activities. Past studies (Sorenson 1990) have shown that there could be a one-time seasonal
41 decline in tourist visits of 5% to 15% associated with a major oil spill. Since tourist movement
42 to other coastal areas in the region often offsets a reduction in the number of visits to one area,
43 the associated loss of business tends to be localized. Although an oil spill could occur anywhere
44 in the lease sale area, cleanup-related employment would likely occur in the area directly
45 affected, generally in locations remote from communities. Oil spills will generate only

1 temporary employment (and population) increases during cleanup operations, because such
2 operations are expected to be of short duration.

3
4 **Conclusion.** The cumulative impacts of future OCS program and ongoing and future
5 non-OCS program activities would be considered beneficial because these activities would
6 increase employment and earnings in the region over the next 40 to 50 yr. The proposed action
7 would add to these beneficial impacts, especially on the Kenai Peninsula and in Anchorage. The
8 incremental impact of the proposed action is expected to be small, however, because the added
9 employment demands are less than 5% of total Alaska employment (see Section 4.4.9.2).

10
11 In areas with a large proportion of impact-sensitive industry (such as commercial and
12 recreational fishing), the cumulative impacts of accidental oils spills could be moderate to major,
13 depending on the total volume of oil reaching land, the land area affected, and the sensitivity of
14 local environmental conditions to oil impacts. The incremental impacts of oil spills associated
15 with the proposed action would be small to medium relative to those associated with future OCS
16 program and ongoing and future non-OCS program activities.

17
18
19 **4.6.5.2.2 Land Use and Infrastructure.** Localized and site-dependent impacts to land
20 use and existing infrastructure are anticipated as a result of the construction of new OCS
21 program oil and gas facilities in Cook Inlet over the next 40 to 50 yr. Impact-producing factors
22 from OCS program activities would include increased vehicular traffic (e.g., helicopter trips);
23 modifications to current land use designations to incorporate new facilities, if they are needed;
24 and some infrastructure expansion. Ongoing non-OCS program activities affecting land use and
25 onshore infrastructure are expected to continue into the foreseeable future. These include
26 offshore construction, onshore construction, and vessel traffic. Where land is largely
27 undeveloped and no established oil and gas infrastructure is present, development could result in
28 land use and infrastructure impacts, such as the conversion of existing land use
29 (e.g., undeveloped, residential, or commercial) to industrial land use to accommodate oil and gas
30 production (MMS 2007e).

31
32 Accidental oil releases may occur as a result of both OCS and non-OCS activities, and oil
33 is also released from naturally occurring seeps. The extent of the impacts would depend on the
34 location and size of the releases, but could include stresses of spill response on the community
35 infrastructure, increased traffic to respond to cleanup, and restricted access to particular lands
36 while cleanup is conducted. In general, these releases would be expected to have a temporary
37 impact on land use and infrastructure (MMS 2007c).

38
39 **Conclusion.** Localized and site-dependent impacts to land use and existing infrastructure
40 are anticipated as a result of future OCS and ongoing and future non-OCS program activities in
41 Cook Inlet. These impacts could range from minor to major depending on the nature (extent and
42 duration) of the land use change. Ongoing non-OCS program activities that could affect land use
43 and onshore infrastructure are expected to continue into the foreseeable future (see
44 Section 4.4.10.2). Potential cumulative impacts to land use and infrastructure resulting from
45 accidental oil spills include stresses of spill response on the community infrastructure, increased
46 traffic to respond to cleanup, and restricted access to particular lands while cleanup is conducted.

1 The extent of land use-related impacts resulting from accidental oil spills and naturally
2 occurring seeps could be minor to major, depending on the location and size of the releases.
3
4

5 **4.6.5.2.3 Commercial Fisheries and Recreational Fisheries.** Some OCS exploration,
6 development, and production activities have a potential to result in space-use conflicts with
7 fishing activities over the next 40 to 50 yr. In some cases, fishing vessels could be excluded
8 from normal fishing grounds for safety reasons during construction periods or after facilities are
9 in place. In other instances, fishery crews or anglers could decide to avoid certain areas to
10 reduce the potential for gear loss. Such conflicts can sometimes be avoided by conducting
11 construction activities or seismic surveys during closed fishing periods or seasons. A potential
12 also exists for loss of gear or loss of access to fishing areas when floating drill rigs used for
13 exploration are being moved and during other vessel operations.
14

15 Offshore construction of platforms or artificial islands could infringe on commercial
16 fishing activities by excluding commercial fishing from adjacent areas due to safety
17 considerations. Drilling discharges associated with exploration activities would likely affect
18 only a small area near drilling platforms or islands, and are not expected to interfere with
19 commercial fishing. During development and production phases, potential effects of such
20 discharges would cease because all muds, cuttings, and produced waters would be discharged
21 into wells instead of being released to open waters. Potential effects of platform construction
22 and operation are expected to be highly localized. Because only a very small area of the
23 individual planning areas would be affected, interference with commercial fisheries is expected
24 to be small.
25

26 The impacts of oil and gas development on commercial fishing costs would vary
27 considerably by placement depth. In the Kodiak area, the largest cost increases would occur
28 with structures located in water between 300 and 1,500 m (984 and 4,921 ft) deep, with an
29 annual increase of \$43 in costs from a single structure; a single structure in each depth range
30 would increase annual costs by \$44. In the Cook Inlet area, the largest increase would come
31 with a single structure placed in water between 150 and 300 m (492 and 984 ft), with an overall
32 increase in costs of \$57 per year. Cost impacts in the Gulf of Alaska area would be the largest, at
33 \$93 per year with a structure in each depth range, the largest cost increases occurring with a
34 structure placed at between 300 to 1,500 m (984 and 4,921 ft). In each of the areas, single
35 structures would have relatively insignificant impacts compared to fishery revenues in each
36 depth range.
37

38 Various non-OCS activities, including State oil and gas programs, dredging and disposal
39 of dredging spoils in OCS waters, logging operations, and commercial or sport fishing activities,
40 could also contribute to cumulative effects on fisheries. Drilling of wells under State oil and gas
41 programs would also require construction of pipelines and artificial islands or platforms in
42 Alaskan waters. Potential effects on fishery resources and on space-use conflicts from State oil
43 and gas activities would be similar to those described above for OCS program oil and gas
44 activities. Dredging and marine disposal activities would involve excavation of nearshore
45 sediments and subsequent disposal in offshore or nearshore areas, thereby disturbing seafloor
46 habitats in some areas and burying benthic organisms that help to support fishery resources.

1 Logging operations have a potential to contribute to cumulative effects on fishery resources by
2 degrading riverine habitats that are important for salmon reproduction and the rearing of
3 juveniles.
4

5 Non-OCS activities, such as State oil and gas development, domestic transportation of oil
6 or refined petroleum products, and commercial shipping, may also result in accidental spills that
7 could affect fisheries within the waters of the south central Alaska region. Fisheries resources
8 could become exposed to oil as a consequence of accidental oil spills, which could cause
9 declines in subpopulations of some species inhabiting the affected planning areas. It is
10 anticipated that there would be no long-term effects on overall fish populations in Alaskan
11 waters as a result of such spills. However, even localized decreases in stocks of fish could have
12 effects on some fisheries by reducing catches or increasing the amount of effort or the distances
13 that must be traveled to obtain adequate catches.
14

15 Even if fish stocks are not reduced as a consequence of a spill, specific fisheries could be
16 closed due to actual or perceived contamination of fish or shellfish. It is anticipated that most
17 small to medium spills would have limited effects on fisheries because of the relatively small
18 areas likely to be exposed to high concentrations of hydrocarbons and the short period of time
19 during which oil slicks would persist. In the event of a large spill, commercial, recreational, or
20 subsistence fisheries for shellfish in nearshore subtidal and intertidal areas that become oiled are
21 likely to be affected. Fisheries for shellfish that occur in deeper waters, where oil concentrations
22 would likely be too low to cause direct effects on biota, are less likely to be affected.
23 Regardless, even shellfish from deeper areas could become commercially unacceptable for
24 market due to actual or perceived contamination and tainting.
25

26 Oil spills that enter nearshore waters could also damage setnet fisheries, as evidenced by
27 the *Exxon Valdez* oil spill of 1989. While only a relatively small volume of weathered oil
28 entered the lower Cook Inlet region as a result of that spill, the commercial salmon fishery was
29 closed to protect both gear and harvest from possible contamination. Within the Cook Inlet
30 Planning Areas, a spill the size of the assumed largest OCS spill could result in temporary
31 closures to commercial and subsistence setnet fishing until cleanup operations or natural
32 processes reduced oil concentrations to levels considered safe.
33

34 Although pelagic fishes would be less likely to be affected than fishes in shallow subtidal
35 or intertidal areas, spilled oil could contaminate gear used for pelagic fishing, such as purse
36 seines and drift nets. A large oil spill before or during the season when such fishing gears are in
37 use could result in closures of some short-period, high-value commercial fisheries in order to
38 protect gear or harvests from potential contamination. Lines from longline fisheries for halibut,
39 Pacific cod, black cod, and other fish species in the Cook Inlet Planning Area could also be
40 affected by oil. Some lines and buoys fouled with small amounts of oil could be unfit for future
41 use. Although it is unlikely that a trawler would be operating in an oiled area, the trawl catches
42 could be contaminated by oil and rendered unfit for consumption and unprofitable if passed
43 through such an area.
44

45 **Conclusion.** The proposed action would represent a small increment to the potential for
46 overall cumulative effects on fisheries in Cook Inlet. Routine OCS program activities would be

1 unlikely to have cumulative population- or community-level effects on fishery resources because
2 of the limited time frame over which most individual activities would occur; because a small
3 proportion of habitat, relative to similar available habitat, could be affected during a given
4 period; and because of existing stipulations that are in place to avoid impacts to sensitive habitats
5 such as hard bottom areas and topographic features. Non-OCS activities, including State oil and
6 gas development, commercial fishing, and sportfishing, could also contribute to cumulative
7 effects on fisheries. Depending on specific conditions during a large spill, there could be
8 substantial economic losses for commercial fisheries as a consequence of reduced catch, loss of
9 gear, or loss of fishing opportunities during cleanup and recovery periods. Non-OCS sources of
10 spills, including State oil and gas production, have a potential to cause similar effects. The
11 occurrence of a very large spill, such as could occur from a tanker accident in southern Alaskan
12 waters, could have substantially greater effects on fisheries.
13
14

15 **4.6.5.2.4 Tourism and Recreation.** Platform, pipeline, causeway, and facility
16 construction and vessel traffic could interfere with water-based recreational activities (fishing,
17 boating, sightseeing, cruise ships) and could result in some disruption to land-based activities
18 (hiking, picnicking, hunting, visiting Native communities, camping, wildlife viewing, and
19 sightseeing), depending on the location of recreational activities relative to proposed
20 development; increases in amounts of trash and debris from OCS activities; and possible
21 competition between workers and tourists for local services, such as air transport, hotel
22 accommodations, and other visitor services. Non-OCS activities that could have an impact on
23 tourism and recreation include offshore construction (e.g., State oil and gas development,
24 domestic transportation of oil and gas), onshore construction (e.g., coastal and community
25 development), and vessel traffic (e.g., commercial shipping, recreational boating, military
26 training and testing).
27

28 Non-OCS activities and proposed and future OCS activities represent a continuation of
29 existing onshore and offshore oil and gas construction trends close to the Cook Inlet Planning
30 Area. Substantial infrastructure for related oil and gas development already exists in this area,
31 including platforms, exploration and production wells, pipelines to transport oil from offshore
32 platforms to common-carrier pipeline systems onshore, and processing facilities. Therefore,
33 there should not be additional visual disruption for the tourists in these areas. Pipeline
34 construction would present a temporary disruption to tourism and recreation due to workers
35 competing with tourists for short-term housing (hotels) and air transport; aesthetic impacts
36 (visual and auditory) associated with construction sites; and possible temporary prevention of
37 access to some recreational or wilderness areas. In addition, the new pipeline in the Arctic
38 region could create road access into previously undeveloped lands used primarily for
39 subsistence, creating a potential conflict between subsistence practices and recreational hunting
40 or other possible tourist activities.
41

42 Oil spills associated with OCS and non-OCS activities, as well as oil from naturally
43 occurring seeps, could also affect recreation and tourism, and could result in both short-term and
44 long-term effects, depending on public perception and reaction. Potential cumulative impacts
45 include direct land impacts (e.g., oil contamination of a national wildlife refuge or recreational

1 port); aesthetic impacts of the spill and associated cleanup; increased traffic to respond to
2 cleanup operations; and restricted access to particular lands while cleanup is being conducted.
3

4 **Conclusion.** Cumulative impacts on recreation and tourism from future OCS program
5 and ongoing and future non-OCS program activities in Cook Inlet would be minor for most
6 routine activities, with the exception of impacts associated with large oil spills during the peak
7 tourist season, which could be moderate to major (but short-term). The incremental contribution
8 of routine Program activities to cumulative impacts would be small, resulting from small
9 incremental increases in construction and transportation noise and related visual intrusions,
10 potential increases in trash and debris related to these activities, and the potential for a relatively
11 small number of accidental releases (see Section 4.4.12.1).
12

13 Oil spills could affect recreation and tourism temporarily in all areas, but would not likely
14 result in long-term effects, depending on public perception and reaction. The magnitude of
15 impacts from an oil spill could range from minor to major, depending on the size, location, and
16 timing of the spill. The greatest impacts would be expected to occur in popular tourist areas
17 during the main tourist season.
18

19
20 **4.6.5.2.5 Sociocultural Systems.** The area surrounding the Cook Inlet Planning Area is
21 demographically diverse and includes relatively remote Native villages that rely on subsistence
22 harvesting, towns that rely on commercial fishing, and ethnically diverse cities
23 (Section 3.14.1.2). Future non-OCS activities include oil and gas development on State
24 submerged lands, changes in commercial fishing patterns and maritime shipping, and limited
25 industrialization.
26

27 The Cook Inlet Planning Area is already the location of offshore oil and gas
28 development. Supporting infrastructure and a trained workforce are already available in relative
29 proximity. As part of this industrial mix, development of the OCS is likely to have minor
30 cumulative impacts relative to development on the Arctic coast. No new shore bases are planned
31 and only one new pipeline is projected under the Program.
32

33 Oil spills can cause damage to resources important to subsistence harvesters, affect fish
34 populations important to commercial fishers, and have sociological impacts in affected
35 communities. Most spills projected to result from exploration and development of the OCS
36 would be a relatively minor component of the existing mix of oil and gas development and
37 commercial shipping. However, as the *Exxon Valdez* event has shown, coastal communities are
38 susceptible to sociocultural disruption as the result of large-scale spills that disrupt commercial
39 fishing and subsistence harvesting.
40

41 OCS program development could temporarily displace fish and sea mammal populations
42 harvested by subsistence hunters and fishers. Helicopter flights associated with development
43 could disturb nesting and roosting sites of birds that are harvested, and temporarily and locally
44 disturb terrestrial game animals.
45

1 **Conclusion.** Cumulative impacts on sociocultural systems as a result of future OCS and
2 ongoing and future non-OCS activities would be minor to moderate. Important impacting factors
3 include the displacement of fish and sea mammal populations and the disturbance of nesting and
4 roosting sites and terrestrial game animals (e.g., by noise). The contribution of the proposed
5 action to cumulative impacts on sociocultural systems in the Cook Inlet Planning Area would be
6 small because no significant changes are anticipated (see Section 4.4.13.2).
7
8

9 **4.6.5.2.6 Environmental Justice.** Although no new pipe yards, pipeline landfalls, or
10 gas processing facilities would be built as a result of the proposed 5-yr OCS program, additional
11 offshore construction could include increased noise and traffic, air and water pollution, impacts
12 to residential property values, and land use changes. Much of the Alaska Native population
13 resides in the coastal areas of Alaska. New offshore infrastructure resulting from this program
14 could be located near areas where subsistence hunting occurs. The OCS program would result in
15 levels of infrastructure use and construction similar to what is occurring in south central Alaska.
16 These activities are not expected to expose residents to notably higher risks than currently occur.
17

18 Any adverse environmental impacts to fish and mammal subsistence resources from
19 installation of infrastructure and routine operations of these facilities could have
20 disproportionately higher health or environmental impacts to Alaska Native populations. OCS
21 activities could potentially disrupt marine mammal harvests (primarily walrus, seals, and beluga
22 whales) by diverting marine migrations or by causing other behavioral changes such as increased
23 wariness.
24

25 Air emissions from onshore facilities and helicopter and vessel traffic traversing coastal
26 areas will be highest in areas containing the greatest amounts of infrastructure. It is assumed that
27 the majority of the activity from the proposed action would occur in deep waters, with offshore
28 air emissions greatest in the coastal areas with the greatest amounts of oil and gas activity, with
29 lesser amounts occurring elsewhere. The effects of the OCS program on air quality have been
30 analyzed in Section 4.4.4.2. This analysis concluded that routine operations associated with the
31 proposed 5-yr program would result in NO₂, SO₂, PM₁₀, and CO levels that are well within the
32 NAAQS. Disproportionate impacts on low-income or minority populations of the inlet would be
33 minor, because coastal effects from offshore activities are expected to be small, based on the
34 established and increasing trend toward movement of oil and gas activities into deeper waters of
35 the inlet.
36

37 Oil spill events in the region and related cleanup activities pose the greatest potential for
38 cumulative effects on low-income and minority population groups. It is reasonable to expect that
39 most of these spills will occur in deepwater areas located away from the coast, based on the
40 established trend for oil and gas activity to move into deep waters located for the most part at a
41 substantial distance from the coast. The magnitude of impacts from such spills cannot be
42 predicted, should they contact the coast, and depends on their location, size, and timing. While
43 the location of possible oil spills cannot be determined and while low-income and minority
44 populations are resident in some areas of the coast, in general, the coasts are home to more
45 affluent groups. Low-income and minority groups are not more likely to bear more negative
46 impacts than are other groups.

1 **Conclusion.** In the Cook Inlet Planning Area, future OCS program and ongoing and
2 future non-OCS program activities in combination with the effects of onshore and offshore
3 construction, increased marine vessel and helicopter traffic, and land use changes would result in
4 disproportional moderate to major adverse cumulative impacts on low-income and minority
5 populations (especially those dependent on subsistence harvesting and fishing). The incremental
6 contribution of routine Program activities to these impacts would be small (see Section 4.4.14.2).
7

8 The incremental impacts of accidental oil spills associated with the proposed action
9 would be small to large, depending on the size, location, and timing of the spill (see
10 Section 4.4.14.2).
11
12

13 **4.6.5.2.7 Archeological and Historic Resources.** Section 4.4.15.2 discusses the
14 potential impacts from the proposed action (OCS program activities from 2012 to 2017) on
15 archeological and historic resources in the Cook Inlet Planning Area. Cumulative impacts on
16 archeological and historic resources result from the incremental impacts of the proposed action
17 when added to impacts from existing and reasonably foreseeable future OCS program activities
18 (that are not part of the proposed action) and other non-OCS program activities. Table 4.6.1-2
19 presents the exploration and development scenario for the Cook Inlet cumulative case
20 (encompassing the proposed action and future OCS program activities). Specific types of
21 impact-producing factors related to OCS program activities considered in this analysis include
22 drilling rig and platform emplacement, pipeline emplacement, new onshore facilities, and oil
23 spills. Non OCS-program activities (e.g., oil and gas industry in State waters) and natural
24 geologic processes such as ice gouging and erosion due to high-energy waves/currents and
25 thermokarst collapse are also considered.
26

27 **Archeological Resources.** Offshore development could result in an interaction between
28 a drilling rig, platform, pipeline, or anchors and an inundated prehistoric site. This direct
29 physical contact with a site could destroy artifacts or site features and could disturb the
30 stratigraphic context of the site. The result would be the loss of archaeological data on
31 prehistoric migrations, settlement patterns, subsistence strategies, and archaeological contacts
32 between northeast Asia and the Americas.
33

34 Since 1973, BOEM has required that an archaeological survey be conducted prior to
35 development of mineral leases determined to have potential for cultural resources, including
36 prehistoric archaeological sites. Relative sea-level data, which are used to define the portion of
37 the continental shelf having potential for prehistoric sites, suggest that the portion of the
38 continental shelf shoreward of about the 60-m (200-ft) isobath would have potential for
39 prehistoric sites. Although an archaeological survey would identify most of the cultural
40 resources in the APE for the project and routine operations related to OCS program activities
41 would avoid all known cultural resources, it is likely that impacts to prehistoric resources may
42 have already occurred as a result of non-OCS program activities prior to the implementation of
43 the 1973 archaeological survey requirement.
44

45 Onshore development could result in direct physical contact between the construction of
46 new onshore facilities or pipeline trenches and previously unidentified prehistoric sites. This

1 direct physical contact with a prehistoric site could cause physical damage to or complete
2 destruction of information on the prehistory of the region and North America. Federal and State
3 laws and regulations initiated in the 1960s began requiring archaeological surveys prior to
4 permitting any activity that might disturb a significant archaeological site. Therefore, it can be
5 assumed that, since the introduction of the archaeological resource protection laws, most coastal
6 archaeological sites have been located, evaluated, avoided, or mitigated prior to construction.
7 However, impacts to coastal prehistoric resources may have already occurred as a result of
8 various onshore construction activities prior to enactment of the archaeological resource
9 protection laws.

10
11 Trawling activity in Cook Inlet only affects the uppermost portion of the sediment
12 column (Krost et al. 1990). This zone would already be disturbed by natural factors relating to
13 the destructive effects wave and current action (Cook Inlet is a high-energy wave environment;
14 see Section 4.2.3.2.2). Therefore, the effect of trawling on most prehistoric archaeological sites
15 would be minor.

16
17 Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas
18 have a high probability for prehistoric archaeological sites, as they are often associated with
19 drowned river valleys, which are known to have a high probability for prehistoric sites. It is
20 assumed that some of the archaeological data that have been lost as a result of dredging have
21 been significant and unique; therefore, the impact to prehistoric archaeological sites as a result of
22 past channel dredging activities has probably been moderate to major. In many areas, the
23 USACE now requires remote-sensing surveys prior to dredging activities to minimize such
24 impacts (Espey, Huston & Associates 1990).

25
26 Natural geologic processes such as ice gouging and thermokarst erosion may affect
27 prehistoric archaeological sites associated with Cook Inlet. No specific studies examining the
28 effects of geological processes on archaeological sites have been conducted in Cook Inlet.
29 However, coastal prehistoric sites are exposed to the erosional effects of high-energy waves and
30 thermokarst erosion. These natural processes could cause artifacts to be dispersed and the site
31 context to be disturbed or even completely destroyed, resulting in the loss of archaeological
32 information. Cook Inlet is a high-energy area affected by strong tidal movements. The seafloor
33 of lower Cook Inlet contains characteristics such as lag gravels, sand ribbons, and sand wave
34 fields (MMS 2003a). These features are formed only in areas of high energy. High-energy
35 water movement may have removed the potential for archaeological resources to be present.
36 Additional research is needed to determine the extent of the disturbance. Studies conducted in
37 the Beaufort Sea indicate that seafloor sediments have been affected by ice gouging and by
38 increased river flows resulting from glaciation (Darigo et al. 2007). It is likely that similar
39 processes have operated in Cook Inlet and that they have affected the integrity of archaeological
40 sites. Overall, some loss of data from submerged and coastal prehistoric sites has probably
41 occurred, and will continue to occur, from the effects of natural geologic processes. It is
42 assumed that some of the data lost have been significant and/or unique, resulting in a major level
43 of impact. Additional studies specifically addressing these topics are required.

44
45 An accidental oil spill could affect coastal prehistoric archaeological sites, but the direct
46 impact of oil on most sites is uncertain. Protection of such sites during an oil spill requires

1 specific knowledge of their location, condition, nature, and extent prior to impact; however, the
2 Cook Inlet coastline has not been systematically surveyed for archaeological sites.

3
4 Heavy oiling of a coastal area could conceal intertidal sites that may not be recognized
5 until they are inadvertently damaged during cleanup (Whitney 1994). Crude oil may also
6 contaminate organic material used in ¹⁴C dating, and although there are methods for cleaning
7 contaminated ¹⁴C samples, greater expense is incurred (Dekin et al. 1993). The major source of
8 potential impact from oil spills is the harm that could result from unmonitored shoreline cleanup
9 activities. Unauthorized collecting of artifacts by cleanup crew members is also a concern, albeit
10 one that can be mitigated with effective training and supervision. Damage or loss of significant
11 archaeological information could result from the contact between an oil spill and a prehistoric
12 archaeological site; therefore, cumulatively the level of impacts from oil spills (past, present, and
13 future) to prehistoric archaeological sites ranges from moderate to high.

14
15 **Historic Resources.** Direct physical contact between a routine activity and a shipwreck
16 site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and
17 could disturb the site context. The result would be the loss of archaeological data on ship
18 construction, cargo, and the social organization of the vessel's crew, and the concomitant loss of
19 information on maritime culture for the time period from which the ship dates.

20
21 Since 1973, BOEM has required archaeological (historical) surveys be conducted prior to
22 development of mineral leases when a historic-period shipwreck is reported to lie within or
23 adjacent to the lease area. Although an archeological survey would identify most of the cultural
24 resources in the APE for the project and routine operations related to OCS activities would avoid
25 all known cultural resources, it is likely that impacts on historic-period shipwrecks may have
26 already occurred as a result of non-OCS program activities that took place before
27 implementation of the 1973 archaeological survey requirement.

28
29 Onshore development could result in direct physical contact between the construction of
30 new onshore facilities or pipeline trenches and previously unidentified historic sites. Federal and
31 State laws and regulations initiated in the 1960s began requiring archaeological surveys prior to
32 permitting any activity that might disturb a significant archaeological site. Therefore, it can be
33 assumed that, since the introduction of the archaeological resource protection laws, most coastal
34 archaeological sites that would have been impacted have been located, evaluated, avoided, or
35 mitigated prior to construction. However, impacts to coastal historic sites may have resulted
36 from onshore construction activities prior to enactment of the archaeological resource protection
37 laws, but the magnitude of this possible impact is impossible to quantify.

38
39 Trawling activity in south central Alaska affects only the uppermost portion of the
40 sediment column (Krost et al. 1990). On many wrecks, this zone would already be disturbed by
41 natural factors and would contain only artifacts of low specific gravity which have lost all
42 original context. Therefore, the effect of trawling on most historic shipwreck sites would be
43 minor.

44
45 Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas
46 have a high probability for historic shipwrecks. Assuming that some of the data lost have been

1 unique, the impact on historic sites as a result of past channel dredging activities has probably
2 been moderate to major. In many areas, the USACE now requires remote-sensing surveys prior
3 to dredging activities to minimize such impacts (Espey, Huston & Associates 1990).

4
5 Natural geologic processes such as ice gouging and erosion due to high-energy
6 waves/currents and thermokarst collapse affect historic sites in Cook Inlet. No specific studies
7 addressing this topic have been undertaken. Coastal historic sites are exposed to the erosional
8 effects of wave energy and thermokarst erosion, which can cause artifacts to be dispersed and the
9 site context to be disturbed or even completely destroyed. Cook Inlet is a high-energy area
10 affected by strong tidal movements. The seafloor of lower Cook Inlet contains seafloor
11 characteristics such as lag gravels, sand ribbons, and sand wave fields (MMS 2003a). These
12 features are only formed in areas of high energy. High-energy water movement may have
13 removed the potential for historic resources to be present. Additional research is needed to
14 determine the extent of the disturbance. Overall, a significant loss of data from submerged and
15 coastal historic sites may have already occurred from the effects of natural geologic processes. It
16 is assumed that some of the data lost have been significant and/or unique, resulting in a major
17 level of impact. Additional studies specifically addressing these topics are required.

18
19 An accidental oil spill could affect a coastal historic site, but the direct impact of oil on
20 most historic sites is uncertain. The primary source of potential impacts from oil spills is
21 unmonitored shoreline cleanup activities (Bittner 1996; see Section 4.4.14.2.2). Unauthorized
22 collecting of artifacts by cleanup crew members is also a concern, albeit one that can be
23 mitigated with effective training and supervision. Damage or loss of significant historic
24 information could result from oil spill cleanup activities; therefore, the cumulative impact of oil
25 spills (past, present, and future) on historic sites could range from moderate to major.

26
27 **Conclusion.** The cumulative impacts of future OCS program and ongoing and future
28 non-OCS program activities on prehistoric and historic archaeological sites in Cook Inlet are
29 currently unknown, but could range from minor to moderate, mainly because activities occurring
30 on the OCS prior to BOEM's survey requirement (in effect since 1973) may already have
31 affected significant archaeological sites. Other important impacting factors that have had, and
32 will continue to have, an impact on both prehistoric and historic archaeological sites are channel
33 dredging and geologic processes, such as ice gouging and erosion due to high-energy
34 waves/currents and thermokarst collapse. Commercial treasure hunting and sport diving may
35 also result in a loss of artifacts at historic-period shipwreck sites. The incremental contribution
36 of routine Program activities is expected to be minor because required archaeological surveys
37 would identify significant cultural resources to be avoided (see Section 4.4.15.2).

38
39 Cumulative impacts on prehistoric and historic sites due to accidental oil spills would
40 result mainly from cleanup activities (direct impacts to the sites are uncertain) and could range
41 from moderate to major. The incremental impacts of oil spills associated with the proposed
42 action would be small to medium relative to those associated with future OCS program and
43 ongoing and future non-OCS program activities.

1 **4.6.5.3 Alaska Region – Arctic**
2
3

4 **4.6.5.3.1 Population, Employment, and Income.** Section 4.4.9 discusses the potential
5 impacts from the proposed action (OCS program activities from 2012 to 2017) on population,
6 employment, and income in the Arctic region. Cumulative impacts on these resources result
7 from the incremental impacts of the proposed action when added to impacts from reasonably
8 foreseeable future OCS program activities (there are no existing OCS program activities) and
9 other non-OCS program activities. Specific types of impact-producing factors related to OCS
10 program activities considered in this analysis include total employment and regional income for
11 the North Slope Borough, which corresponds to the Beaufort Sea and Chukchi Sea Planning
12 Areas (described in Section 3.10). Non-OCS program activities affecting the region include
13 employment and earnings related to various other industrial sectors (e.g., construction,
14 manufacturing, services, and State and local government).
15

16 The population in the Beaufort Sea and Chukchi Sea Planning Areas is concentrated in
17 Barrow. It increased at an average annual rate of 3.6% between 1980 and 1990, and 2.1%
18 between 1990 and 2000; it decreased by 1.0% between 2000 and 2009. The components of
19 population increase include the natural increase due to births and net positive domestic
20 migration; the population trend is uncertain over the next 50 yr and will likely depend on the
21 availability of jobs. Most communities in the borough have a high percentage of American
22 Indian or Alaska Natives.
23

24 Although the proposed action would add an average of 167 to 225 jobs annually between
25 2012 and 2017, this increase is considered minor (though positive) since it would amount to less
26 than 1% of total Alaska employment (additional jobs created in the rest of Alaska during the
27 same period would range from 2,644 to 3,570). Likewise, income produced in the region would
28 range from \$5.6 million to \$7.6 million annually in the Arctic region, which constitutes about
29 50% of income in Alaska overall. Most of the workers directly associated with OCS oil and gas
30 activities would work offshore or onshore in worker enclaves separated from local communities,
31 and most workers will likely commute to work sites from Alaska's larger population centers or
32 from outside the immediate area. While OCS jobs would be available to the local populations in
33 all areas, rural Alaskan employment in the petroleum industry, especially among Alaska Natives,
34 would likely remain relatively low. However, a contingent of Alaska Natives from the Fairbanks
35 area and members of the Doyon Corporation do work in the oil fields of the North Slope, and
36 these jobs are important to them.
37

38 Employment impacts of oil spills reaching landfall can vary considerably depending upon
39 the total volume of oil reaching land, the land area affected, and the sensitivity of local
40 environmental conditions to oil impacts. The primary impacts of oil spills would most likely fall
41 on such activities as beach recreation, commercial fishing, recreational fishing, and sightseeing.
42 Oil spills reaching land can have both short- and long-term effects on these recreational coastal
43 activities. Although an oil spill could occur anywhere in the lease sale area, cleanup-related
44 employment would likely occur in the area directly affected, generally in locations remote from
45 communities. The hiring of cleanup workers would have a regional and State of Alaska
46 emphasis. Oil spills will generate only temporary employment (and population) increases during

1 cleanup operations, because such operations are expected to be of short duration. Employment
2 generated by spills will be a function of the size and frequency of spills.
3

4 **Conclusion.** The cumulative impacts of future OCS program and ongoing and future
5 non-OCS program activities would be considered beneficial because these activities would
6 increase employment and earnings in the region over the next 40 to 50 yr (although rural Alaskan
7 employment in the petroleum industry, especially among Alaska Natives, would likely remain
8 relatively low). The proposed action would add to these beneficial impacts. The incremental
9 impact of the proposed action is expected to be small, however, because the added employment
10 demands are less than 1% of total Alaska employment (see Section 4.4.9.3).
11

12 The cumulative impacts of accidental oil spills could be minor to major, depending on the
13 total volume of oil reaching land, the land area affected, and the sensitivity of local
14 environmental conditions to oil impacts. The incremental impacts of oil spills associated with
15 the proposed action would be small to medium relative to those associated with ongoing and
16 future non-OCS program activities.
17

18
19 **4.6.5.3.2 Land Use and Infrastructure.** Localized and site-dependent impacts to land
20 use and existing infrastructure are anticipated as a result of the construction of new oil and gas
21 facilities in the Beaufort and Chukchi Sea Planning Areas. Impact-producing factors from OCS
22 program activities would include increased vehicular traffic (e.g., helicopter trips); modifications
23 to current land use designations to incorporate new facilities, if they are needed; and some
24 infrastructure expansion.
25

26 Ongoing non-OCS program activities that could affect land use and onshore
27 infrastructure are expected to continue into the foreseeable future. These include offshore
28 construction, onshore construction, and vessel traffic. Where land is largely undeveloped and no
29 established oil and gas infrastructure is present, development could result in land use and
30 infrastructure impacts, such as the conversion of existing land use (e.g., undeveloped, residential,
31 or commercial) to industrial land use to accommodate oil and gas production (MMS 2007e).
32

33 Accidental oil releases may occur as a result of both OCS and non-OCS activities. The
34 extent of impacts would depend on the location and size of the releases, but could include
35 stresses of spill response on the community infrastructure, increased traffic to respond to
36 cleanup, and restricted access to particular lands while cleanup is conducted. In general, these
37 releases would be expected to have a temporary impact on land use and infrastructure
38 (MMS 2007c).
39

40 **Conclusion.** Localized and site-dependent impacts to land use and existing infrastructure
41 are anticipated as a result of future OCS program and ongoing and future non-OCS program
42 activities in the Beaufort and Chukchi Seas. Impacts from Program activities could range from
43 minor to moderate depending on the nature (extent and duration) of the land use change.
44 Ongoing non-OCS program activities that could affect land use and onshore infrastructure are
45 expected to continue into the foreseeable future.
46

1 The extent of land use-related impacts resulting from accidental oil spills could be minor
2 to major, depending on the location and size of the releases.
3
4

5 **4.6.5.3.3 Recreational Fisheries.** Given the importance of this fishing to local villages
6 in the Arctic region, any impacts from the proposed action may directly affect the local economy
7 by causing declines in salmon availability for harvest. Greater declines in the harvest would lead
8 to greater impacts on local communities. However, it is anticipated that impacts from routine
9 OCS operations would be minor as a result of adherence to mitigation measures and compliance
10 with Federal, State, and local requirements.
11

12 The proposed action would represent a small increment to the potential for overall
13 cumulative effects on fishing by local villages in the Arctic region. Routine OCS program
14 activities would be unlikely to have cumulative population- or community-level effects on local
15 fishery resources because of the limited time frame over which most individual activities would
16 occur; because a small proportion of habitat, relative to similar available habitat, could be
17 affected during a given period; and because of existing stipulations that are in place to avoid
18 impacts to sensitive habitats such as hard bottom areas and topographic features. Non-OCS
19 activities, including State oil and gas development, commercial fishing, and sportfishing, could
20 also contribute to cumulative effects on local fisheries.
21

22 Depending on specific conditions during a large oil spill, there could be substantial
23 economic losses for commercial fisheries as a consequence of reduced catch, loss of gear, or loss
24 of fishing opportunities during cleanup and recovery periods. Non-OCS sources of spills,
25 including State oil and gas production, have a potential to cause similar effects. The occurrence
26 of a catastrophic spill, such as could occur from a tanker accident, could have substantially
27 greater effects on fisheries.
28

29 **Conclusion.** The future OCS program in combination with ongoing and future non-OCS
30 program activities could result in moderate to major impacts on recreational fisheries in the
31 Arctic region. The incremental contribution of routine Program activities would be small (see
32 Section 4.4.11.3).
33

34 The incremental impacts of accidental oil spills associated with the proposed action
35 would be small to large, depending on the size, location, and timing of the spill (see
36 Section 4.4.11.3).
37
38

39 **4.6.5.3.4 Tourism and Recreation.** Platform, pipeline, causeway, and facility
40 construction and vessel traffic could interfere with water-based recreational activities (fishing,
41 boating, sightseeing, cruise ships); cause some disruption to land-based activities (hiking,
42 picnicking, hunting, visiting Native communities, camping, wildlife viewing, and sightseeing),
43 depending on the location of recreational activities relative to proposed development; increase
44 amounts of trash and debris from OCS activities; and cause possible competition between
45 workers and tourists for local services, such as air transport, hotel accommodations, and other
46 visitor services. Non-OCS activities that could have an impact on tourism and recreation include

1 offshore construction (e.g., State oil and gas development, domestic transportation of oil and
2 gas), onshore construction (e.g., coastal and community development), and vessel traffic
3 (e.g., commercial shipping, recreational boating, military training and testing).
4

5 Non-OCS activities and proposed and future OCS activities represent a continuation of
6 existing onshore and offshore oil and gas construction trends in the Beaufort Sea and Chukchi
7 Sea Planning Areas. Substantial infrastructure for related oil and gas development already exists
8 in both of these areas, including platforms, exploration and production wells, pipelines to
9 transport oil from offshore platforms to common-carrier pipeline systems onshore, and
10 processing facilities; therefore, there should not be additional visual disruption for the tourists in
11 these areas. Pipeline construction would present a temporary disruption to tourism and
12 recreation due to workers competing with tourists for short-term housing (hotels) and air
13 transport; aesthetic impacts (visual and auditory) associated with construction sites; and possible
14 temporary prevention of access to some recreational or wilderness areas. In addition, the new
15 pipeline in the Arctic region could create road access into previously undeveloped lands used
16 primarily for subsistence, creating a potential conflict between subsistence practices and
17 recreational hunting or other possible tourist activities.
18

19 Oil spills associated with OCS and non-OCS activities, as well as oil releases from
20 naturally occurring seeps, could also affect recreation and tourism, and could result in both short-
21 term and long-term effects, depending on public perception and reaction. Potential cumulative
22 impacts include direct land impacts (e.g., oil contamination of a National Wildlife Refuge);
23 aesthetic impacts of the spill and associated cleanup; increased traffic to respond to cleanup
24 operations; and restricted access to particular lands while cleanup is being conducted.
25

26 **Conclusion.** Infrastructure changes in the Beaufort Sea and Chukchi Sea Planning Areas
27 would result in moderate to major impacts because they would be noticeable to the recreation
28 and tourism community, as no similar infrastructure yet exists in that region, and competition for
29 accommodations and air transport may slow tourism for a time. The incremental contribution of
30 routine Program activities to cumulative impacts would be relatively large, resulting from large
31 incremental increases in construction and transportation noise and related visual intrusions,
32 potential increases in trash and debris related to these activities, and the potential for a relatively
33 large number of accidental releases (see Section 4.4.12.1).
34

35 Oil spills could affect recreation and tourism temporarily in all areas, but would not likely
36 result in long-term effects, depending on public perception and reaction. The magnitude of
37 impacts would depend on the size, location, and timing of the spill. The greatest impacts would
38 be expected to occur in popular tourist areas during the main tourist season (in the summer).
39

40
41 **4.6.5.3.5 Sociocultural Systems.** Small, primarily Alaska Native communities along the
42 Arctic coast are heavily dependent on subsistence harvesting of sea mammals, fish, and
43 terrestrial fauna. Enclaves of workers at Prudhoe Bay and nearby oil fields are employed by the
44 oil and gas industry. They commute from mostly south-central Alaska, Fairbanks, and States
45 outside of Alaska. For the most part, these two communities (Alaska Native communities and
46 worker enclaves) have had little interaction because of the physical distance that separates them.

1 The exception is Nuiqsut. Further development of the oil and gas industry, increases in marine
2 shipping as a result of the diminishing polar ice caps, and the effects of climate change coupled
3 with development of oil and gas resources on the OCS could have cumulative effects on the
4 subsistence harvesting and sociocultural structure of the region.
5

6 A primary concern of Alaska Natives is the health and accessibility of sea mammals
7 including whales, walrus, and seals. Warming climatic conditions have resulted in the early
8 retreat of the polar ice pack. Ice flow haulouts used by seals and walrus are thus farther from
9 shore, increasing the effort required for subsistence hunters to harvest them. More ice-free lanes
10 along the coast have resulted in an increase in shipping in the Beaufort and Chukchi Seas, a
11 pattern that is likely to continue. Increased shipping is likely to disturb bowhead and beluga
12 whale migration patterns, already affected by the noise of seismic survey vessels during oil and
13 gas exploration, and to a lesser extent during drilling and operation of wells. The whale harvest
14 is central to Alaska Native culture, both in terms of the food it provides and its association with
15 Native cultural identity and spirituality. Oil and gas exploration and development combined with
16 increased shipping and the effects of climate change would have an adverse cumulative effect on
17 subsistence harvesting.
18

19 The construction and operation of linear features such as oil and gas pipelines and roads
20 can deflect migration patterns of terrestrial mammals such as caribou that are an important part
21 of the subsistence harvest. As onshore oil and gas development expands from Prudhoe Bay,
22 Native communities such as Nuiqsut feel increasingly cut off from traditional subsistence
23 resource harvesting areas. To the extent that offshore oil development requires onshore support
24 infrastructure, it contributes to a cumulative negative impact on onshore access to subsistence
25 resources. As the distance between Native communities and oil and gas worker enclaves
26 decreases, the interaction between these two groups is likely to increase, raising the potential for
27 cross-cultural conflicts and changes in traditional culture.
28

29 **Conclusion.** Cumulative impacts on sociocultural systems as a result of future OCS and
30 ongoing and future non-OCS activities would be moderate to major. Important impacting factors
31 include early retreat of the polar ice pack (due to warming climate conditions), increased marine
32 shipping (due to more ice-free lanes along the coast), and increased noise (due to seismic surveys
33 and other oil and gas activities) — all of which disturb sea mammals and their migration
34 patterns. Onshore linear features (e.g., pipelines and roads) affect the migration patterns of
35 terrestrial mammals. Because of the high level of dependence on subsistence harvesting, the
36 incremental contribution of the proposed action to cumulative impacts on sociocultural systems
37 in the Beaufort and Chukchi Seas would be medium to large (see Section 4.4.13.3).
38
39

40 **4.6.5.3.6 Environmental Justice.** Additional offshore construction under the proposed
41 action could include increased noise and traffic, air and water pollution, impacts on residential
42 property values, and land use changes. Much of the Alaska Native population resides in the
43 coastal areas of Alaska. New offshore infrastructure resulting from this program could be
44 located near areas where subsistence hunting occurs. The proposed 5-year program will result in
45 levels of infrastructure use and construction similar to what has occurred in the south Alaska

1 region during previous programs. These activities are not expected to expose residents to
2 notably higher risks than currently occur.

3
4 Any adverse environmental impacts on fish and mammal subsistence resources could
5 have disproportionately higher health or environmental impacts on Alaska Native populations.
6 OCS activities could potentially disrupt marine mammal harvests (primarily walrus, seals, and
7 beluga whales) by diverting marine migrations or by causing other behavioral changes, such as
8 increased wariness or having to go further from shore because of the diminishing polar ice cap,
9 and whales migrating further from shore or the synergistic effects of all these factors combined.

10
11 Air emissions from onshore facilities and helicopter and vessel traffic traversing coastal
12 areas will be highest in areas containing the greatest amounts of infrastructure. It is assumed that
13 the majority of the activity from the proposed 5-yr program will occur in waters no more than
14 100 m (30 ft) deep, with the most offshore air emissions occurring in the coastal areas with the
15 greatest amounts of oil and gas activity and with fewer emissions occurring elsewhere. The
16 effects of the OCS program on air quality have been analyzed in Section 4.4.4. This analysis
17 concluded that routine operations associated with the proposed 5-year program would result in
18 NO₂, SO₂, PM₁₀, and CO levels that are well within the NAAQS. Coastal effects from offshore
19 activities are expected to be small, based on the established and increasing trend toward
20 movement of oil and gas activities into deeper waters.

21
22 Oil spill events in the region, and related cleanup activities, pose the greatest potential for
23 impacts on low-income and minority population groups. It is reasonable to expect that most of
24 these spills would occur in deepwater areas located away from the coast, based on the established
25 trend for oil and gas activities to move into deep waters located for the most part at a substantial
26 distance from the coast. The magnitude of impacts from such spills cannot be predicted, should
27 they contact the coast, and depends on their location, size, and timing. However, according to
28 MMS (2002), the probability that an offshore oil spill occurring and impacting coastal
29 populations is low. While the location of possible oil spills cannot be determined, low-income
30 and minority populations are resident in some areas of the coast. Low-income and minority
31 groups could bear more negative impacts than other population groups.

32
33 **Conclusion.** In the Beaufort and Chukchi Sea Planning Areas, OCS and non-OCS
34 program activities in combination with increased marine traffic and climate change could result
35 in major adverse cumulative impacts on human health and the environment, especially if a large
36 oil spill were to occur, because oil spill contamination of subsistence foods is the main concern
37 regarding potential effects on Native health. Impacts on marine and terrestrial ecosystems in the
38 region (described in Section 4.6.4) could affect subsistence resources, traditional culture, and
39 community infrastructure; indigenous communities that are subsistence-based would likely
40 experience disproportionate, highly adverse environmental and health effects. However, the
41 incremental change due to impacts from Program activities is expected to be negligible to minor.

42
43 The incremental impacts of accidental oil spills associated with the proposed action
44 would be small to large, depending on the size, location, and timing of the spill (see
45 Section 4.4.14.3).

1 **4.6.5.3.7 Archeological and Historic Resources.** Section 4.4.15.3 discusses the
2 potential impacts from the proposed action (OCS program activities from 2012 to 2017) on
3 onshore and offshore environments in the Beaufort and Chukchi Sea Planning Areas.
4 Cumulative impacts on archeological and historic resources result from the incremental impacts
5 of the proposed action when added to impacts from existing and reasonably foreseeable future
6 OCS program activities (that are not part of the proposed action) and other non-OCS program
7 activities. Table 4.6.1-2 presents the exploration and development scenario for the Arctic region
8 cumulative case (encompassing the proposed action and future OCS program activities).
9 Specific types of impact-producing factors related to OCS program activities considered in this
10 analysis include drilling rig and platform emplacement, pipeline emplacement, new onshore
11 facilities, and oil spills. Non-OCS program activities (e.g., oil and gas industry in State waters)
12 and natural geologic processes such as ice gouging and thermokarst erosion are also considered
13 (see also Section 4.2.2.2).

14
15 **Archeological Resources.** Offshore development could result in an interaction between
16 a drilling rig, platform, pipeline, or anchors and an inundated prehistoric site. This direct
17 physical contact with a site could destroy artifacts or site features and could disturb the
18 stratigraphic context of the site. The result would be the loss of archaeological data on
19 prehistoric migrations, settlement patterns, subsistence strategies, and archaeological contacts
20 between northeast Asia and the Americas.

21
22 Since 1973, BOEM has required that an archaeological survey be conducted prior to
23 development of mineral leases determined to have potential for cultural resources, including
24 prehistoric archaeological sites. Relative sea-level data, which are used to define the portion of
25 the continental shelf having potential for prehistoric sites, suggest that the portion of the
26 continental shelf shoreward of about the 60-m (200-ft) isobath would have potential for
27 prehistoric sites. Although an archaeological survey would identify all cultural resources in the
28 APE for the project and routine operations related to OCS program activities would avoid all
29 known cultural resources, it is likely that impacts to prehistoric resources may have already
30 occurred as a result of non-OCS program activities prior to the implementation of the
31 archaeological survey requirement.

32
33 Onshore development could result in direct physical contact between the construction of
34 new onshore facilities or pipeline trenches and previously unidentified prehistoric sites. This
35 direct physical contact with a prehistoric site could cause physical damage to or complete
36 destruction of information on the prehistory of the region and North America. Federal and State
37 laws and regulations initiated in the 1960s began requiring archaeological surveys prior to
38 permitting any activity that might disturb a significant archaeological site. Therefore, it can be
39 assumed that, since the introduction of the archaeological resource protection laws, most coastal
40 archaeological sites have been located, evaluated, avoided, or mitigated prior to construction.
41 However, impacts to coastal prehistoric resources may have already occurred as a result of
42 various onshore construction activities prior to enactment of the archaeological resource
43 protection laws.

44
45 Trawling activity in the Arctic region affects only the uppermost portion of the sediment
46 column (Krost et al. 1990). This zone would already be disturbed by natural factors relating to

1 the destructive effects of ice gouging and scouring (see Section 4.2.2). Therefore, the effect of
2 trawling on most prehistoric archaeological sites would be minor.

3
4 Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas
5 have a high probability for prehistoric archaeological sites, as they are often associated with
6 drowned river valleys, which are known to have a high probability for prehistoric sites. It is
7 assumed that some of the archaeological data that have been lost as a result of dredging have
8 been significant and unique; therefore, the impact to prehistoric archaeological sites as a result of
9 past channel dredging activities has probably been moderate to major. In many areas, the
10 USACE now requires remote-sensing surveys prior to dredging activities to minimize such
11 impacts (Espey, Huston & Associates 1990).

12
13 Natural geologic processes such as ice gouging and thermokarst erosion have caused and
14 will continue to cause a significant loss of prehistoric archaeological data in the Alaska region.
15 For example, ice gouges on the Beaufort Sea shelf can create a furrow up to 67 m (220 ft) wide
16 and 4 m (13 ft) deep; however, the average ice gouge is about 8 m (26 ft) wide and 0.5 m (1.6 ft)
17 deep (Barnes 1984). Coastal prehistoric sites are exposed to the destructive effects of
18 thermokarst erosion. These natural processes would cause artifacts to be dispersed and the site
19 context to be disturbed or even completely destroyed, resulting in the loss of archaeological
20 information. Overall, a significant loss of data from submerged and coastal prehistoric sites has
21 probably occurred, and will continue to occur, from the effects of natural geologic processes. It
22 is assumed that some of the data lost have been significant and/or unique, resulting in a major
23 level of impact.

24
25 An accidental oil spill could affect coastal prehistoric archaeological sites, but the direct
26 impact of oil on most sites is uncertain. Protection of such sites during an oil spill requires
27 specific knowledge of their location, condition, nature, and extent prior to impact; however, the
28 Beaufort and Chukchi Sea coastlines have not been systematically surveyed for archaeological
29 sites.

30
31 Heavy oiling of a coastal area could conceal intertidal sites that may not be recognized
32 until they are inadvertently damaged during cleanup (Whitney 1994). Crude oil may also
33 contaminate organic material used in ¹⁴C dating, and, although there are methods for cleaning
34 contaminated ¹⁴C samples, greater expense is incurred (Dekin et al. 1993). The major source of
35 potential impact from oil spills is the harm that could result from unmonitored shoreline cleanup
36 activities. Unauthorized collecting of artifacts by cleanup crew members is also a concern, albeit
37 one that can be mitigated with effective training and supervision. Damage or loss of significant
38 archaeological information could result from the contact between an oil spill and a prehistoric
39 archaeological site; therefore, the cumulative impact from oil spills to prehistoric archaeological
40 sites could range from moderate to major.

41
42 **Historic Resources.** Direct physical contact between a routine activity and a shipwreck
43 site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and
44 could disturb the site context. The result would be the loss of archaeological data on ship
45 construction, cargo, and the social organization of the vessel's crew, and the concomitant loss of
46 information on maritime culture for the time period from which the ship dates.

1 Since 1973, BOEM has required archaeological (historical) surveys be conducted prior to
2 development of mineral leases when a historic-period shipwreck is reported to lie within or
3 adjacent to the lease area. Although an archeological survey would identify all cultural resources
4 in the APE for the project and routine operations related to OCS activities would avoid all known
5 cultural resources, it is likely that impacts to historic-period shipwrecks may have already
6 occurred as a result of non-OCS program activities that took place before implementation of the
7 1973 archaeological survey requirement.
8

9 Onshore development could result in direct physical contact between the construction of
10 new onshore facilities or pipeline trenches and previously unidentified historic sites. Federal and
11 State laws and regulations initiated in the 1960s began requiring archaeological surveys prior to
12 permitting any activity that might disturb a significant archaeological site. Therefore, it can be
13 assumed that, since the introduction of the archaeological resource protection laws, most coastal
14 archaeological sites that would have been impacted have been located, evaluated, avoided, or
15 mitigated prior to construction. However, impacts to coastal historic sites may have resulted
16 from onshore construction activities prior to enactment of the archaeological resource protection
17 laws.
18

19 Trawling activity in the Alaska subregion only affects the uppermost portion of the
20 sediment column (Krost et al. 1990). On many wrecks, this zone would already be disturbed by
21 natural factors and would contain only artifacts of low specific gravity which have lost all
22 original context. Therefore, the effect of trawling on most historic shipwreck sites would be
23 minor.
24

25 Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas
26 have a high probability for historic shipwrecks. Assuming that some of the data lost have been
27 unique, the impact to historic sites as a result of past channel-dredging activities has probably
28 been moderate to major. In many areas, the USACE now requires remote-sensing surveys prior
29 to dredging activities to minimize such impacts (Espey, Huston & Associates 1990).
30

31 Natural geologic processes such as ice gouging and thermokarst erosion may cause a loss
32 of historic data in the Beaufort and Chukchi Seas (see study conducted in the Beaufort Sea by
33 Darigo et al. [2007]). For example, ice gouges on the Beaufort Sea shelf can create furrows up
34 to 67 m (220 ft) wide and 4 m (13 ft) deep; however, the average ice gouge is about 8 m (26 ft)
35 wide and 0.5 m (1.6 ft) deep (Barnes 1984). Darigo et al. (2007) suggest that areas close to
36 islands and the shore may be protected from the effects of ice gouging. Coastal historic sites are
37 exposed to the erosional effects of wave energy and thermokarst erosion, which would cause
38 artifacts to be dispersed and the site context to be disturbed or even completely destroyed. No
39 specific studies have examined the effect of geological processes on site integrity. Overall, a
40 significant loss of data from submerged and coastal historic sites may have already occurred
41 from the effects of natural geologic processes. It is possible that some of the data lost may have
42 been significant and/or unique, resulting in a major level of impact. Additional studies are
43 needed to assess the effect of geological processes on cultural resources.
44

45 An accidental oil spill could affect a coastal historic site, but the direct impact of oil on
46 most historic sites is uncertain. The primary source of potential impact from oil spills is

1 unmonitored shoreline cleanup activities (Bittner 1996; see Section 4.4.15.3.2). Unauthorized
2 collecting of artifacts by cleanup crew members is also a concern, albeit one that can be
3 mitigated with effective training and supervision. Damage or loss of significant historic
4 information could result from oil spill cleanup activities; therefore, the cumulative impact from
5 oil spills (past, present, and future) on historic sites could range from moderate to major.
6

7 **Conclusion.** The cumulative impacts of future OCS program and ongoing and future
8 non-OCS program activities on prehistoric and historic archaeological sites in the Beaufort and
9 Chukchi Seas are currently unknown, but could range from minor to moderate, mainly because
10 activities occurring on the OCS prior to BOEM's survey requirement (in effect since 1973) may
11 already have affected significant archaeological sites. Other important impact-producing factors
12 that likely have had, and will continue to have, an impact on both prehistoric and historic
13 archaeological sites are channel dredging and geologic processes, such as ice gouging and
14 thermokarst erosion. Commercial treasure hunting and sport diving may also result in a loss of
15 artifacts at historic-period shipwreck sites. The incremental contribution of routine Program
16 activities is expected to be small because required archaeological surveys would identify
17 significant cultural resources to be avoided (see Section 4.4.15.3).
18

19 Cumulative impacts on prehistoric and historic sites due to accidental oil spills would
20 result mainly from cleanup activities (direct impacts to the sites are uncertain) and could range
21 from moderate to major. The incremental impacts of oil spills associated with the proposed
22 action would be small to medium relative to those associated with future OCS program and
23 ongoing and future non-OCS program activities.
24
25

26 **4.6.6 Cumulative Impacts Summary Tables**

27

28 The cumulative impacts are incremental contributions of routine Program activities for
29 resources in the GOM, Cook Inlet Planning Area, and Arctic region are summarized in
30 Tables 4.6.6-1, 4.6.6-2, and 4.6.6-3.
31

1 **TABLE 4.6.6-1 Summary of Cumulative Impacts and Incremental Contributions of the Proposed Action, GOM**

Resource	Cumulative Impact				Incremental Contribution			Comments
	Negligible	Minor	Moderate	Major	Small	Medium	Large	
Water Quality			X		X			
Air Quality		X	X		X			
Acoustic Environment		X	X	X	X	X	X	Magnitude of cumulative impacts depends on the ambient acoustic conditions and the nature and combination of OCS and non-OCS program activities taking place.
Coastal and Estuarine Habitat			X	X	X			
Marine Benthic Habitat		X			X			
Essential Fish Habitat		X			X			Magnitude of cumulative impacts depends on size of affected EFH. Impacts from OCS activities would be limited by specific lease stipulations.
Marine Mammals		X	X		X			
Terrestrial Mammals		X	X		X			
Marine and Coastal Birds			X		X			
Fish		X	X		X			
Reptiles		X	X		X			
Invertebrates and Lower Trophic Levels			X		X			

TABLE 4.6.6-1 (Cont.)

Resource	Cumulative Impact				Incremental Contribution			Comments
	Negligible	Minor	Moderate	Major	Small	Medium	Large	
Areas of Special Concern		X			X			
Population, Employment, and Income		X			X			Cumulative impacts would be considered beneficial because past, present, and foreseeable future activities would generally increase employment and earnings in the region over the next 40 to 50 yr. The proposed action would add to these beneficial impacts.
Land Use and Infrastructure		X	X	X	X			The magnitude of cumulative impacts depends on the extent and duration of land use change.
Tourism and Recreation			X	X	X			Cumulative impacts minor for most routine activities except for large oil spills occurring during the peak tourist season (which could result in major impacts).
Commercial and Recreational Fishing		X	X		X			
Sociocultural Systems		X			X			
Environmental Justice		X	X		X			
Archeological and Historic Resources		X	X		X			Incremental contribution from routine Program activities expected to be small because required archaeological surveys would identify significant resources to be avoided.

1

TABLE 4.6.6-2 Summary of Cumulative Impacts and Incremental Contributions of Proposed Action, Cook Inlet Planning Area

Resource	Cumulative Impact				Incremental Contribution			Comments
	Negligible	Minor	Moderate	Major	Small	Medium	Large	
Water Quality		X	X		X			Cumulative impacts may lessen with time since oil and gas production is currently on the decline.
Air Quality		X	X		X			
Acoustic Environment		X	X	X	X	X	X	Magnitude of cumulative impacts depends on the ambient acoustic conditions and the nature and combination of OCS and non-OCS program activities taking place.
Coastal and Estuarine Habitat			X	X	X			
Marine Benthic Habitat		X			X			
Essential Fish Habitat		X	X		X			Magnitude of cumulative impacts depends on size of affected EFH. Impacts from OCS activities would be limited by specific lease stipulations.
Marine Mammals		X	X		X			
Terrestrial Mammals		X	X		X			
Marine and Coastal Birds		X	X		X			Magnitude of cumulative impacts depends on nature and duration of activities that could reduce bird survival and productivity.
Fish		X			X			

TABLE 4.6.6-2 (Cont.)

Resource	Cumulative Impact				Incremental Contribution			Comments
	Negligible	Minor	Moderate	Major	Small	Medium	Large	
Invertebrates and Lower Trophic Levels			X		X			
Areas of Special Concern		X			X			
Population, Employment, and Income		X			X			Cumulative impacts would be considered beneficial because past, present, and foreseeable future activities would generally increase employment and earnings in the region over the next 40 to 50 yr. The proposed action would add to these beneficial impacts.
Land Use and Infrastructure		X	X	X	X			The magnitude of cumulative impacts depends on the extent and duration of land use change.
Tourism and Recreation		X			X			
Commercial and Recreational Fishing		X	X		X			
Sociocultural Systems		X	X		X			
Environmental Justice		X	X		X			
Archeological and Historic Resources		X	X		X			Incremental contribution from routine Program activities expected to be small because required archaeological surveys would identify significant resources to be avoided.

TABLE 4.6.6-3 Summary of Cumulative Impacts and Incremental Contributions of Proposed Action, Arctic Region

Resource	Cumulative Impact				Incremental Contribution			Comments
	Negligible	Minor	Moderate	Major	Small	Medium	Large	
Water Quality			X		X	X		
Air Quality		X	X		X			
Acoustic Environment		X	X	X	X	X	X	Magnitude of cumulative impacts depends on the ambient acoustic conditions and the nature and combination of OCS and non-OCS program activities taking place.
Coastal and Estuarine Habitat			X	X	X			
Marine Benthic Habitat		X			X			
Essential Fish Habitat		X	X		X			Magnitude of cumulative impacts depends on size of affected EFH. Impacts from OCS activities would be limited by specific lease stipulations.
Marine Mammals		X	X		X			
Terrestrial Mammals		X	X		X			
Marine and Coastal Birds		X	X		X			Magnitude of cumulative impacts depends on nature and duration of activities that could reduce bird survival and productivity. Population-level effects could result from the tendency of large numbers of individuals of some bird species to concentrate in certain coastal arctic locations.
Fish		X	X		X			

TABLE 4.6.6-3 (Cont.)

Resource	Cumulative Impact				Incremental Contribution			Comments
	Negligible	Minor	Moderate	Major	Small	Medium	Large	
Invertebrates and Lower Trophic Levels		X	X		X			
Areas of Special Concern		X			X			Lease stipulations applied at the lease sale stage could minimize the potential for cumulative impacts.
Population, Employment, and Income		X			X			Cumulative impacts would be considered beneficial because past, present, and foreseeable future activities would generally increase employment and earnings in the region over the next 40 to 50 yr. The proposed action would add to these beneficial impacts.
Land Use and Infrastructure		X	X	X	X			The magnitude of cumulative impacts depends on the extent and duration of land use change.
Commercial and Recreational Fishing			X	X	X			
Tourism and Recreation		X					X	
Sociocultural Systems		X	X			X	X	
Environmental Justice		X	X			X	X	
Archeological and Historic Resources		X	X		X			Incremental contribution from routine Program activities expected to be small because required archaeological surveys would identify significant resources to be avoided.

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